Table of Contents

October 15, 2008

Dear Governor Crist:

Since you issued Executive Order 07-128 on July 13, 2007, the Governor's Action Team on Energy and Climate Change has worked diligently to develop this comprehensive Energy and Climate Change Action Plan for the State of Florida.

This transmittal is the second and final report of the Governor's Action Team on Energy and Climate Change. The Action Team submitted its Phase 1 report in 2007 containing 35 findings and 30 recommendations. This Phase 2 report details our collective 2008 work and provides 50 separate policy recommendations that will reduce harmful greenhouse gas emissions and provide a framework for climate change adaptation strategies to guide Florida over the coming years and decades. Further, the Phase 2 report provides a separate set of comments toward the current work to develop Florida's cap-and-trade regulatory program, one of the provisions contained in the 2008 Legislature's landmark energy and climate change bill that you signed.

The principal charge provided to the Action Team has been to develop a plan that will fully achieve or surpass the targets for statewide greenhouse gas reductions specified in Executive Order 07-127. If all of the recommendations in this plan were to be implemented, it is estimated that:

- Florida's greenhouse gas emission reductions would *surpass* your Executive Order 07-127 emission reduction targets for 2017 and 2025, by 11 percent and 34 percent, respectively;
- Florida's energy security would increase by reducing our dependence on fossil fuels resulting in a total fuel savings of 53.5 billion gallons of petroleum, 200.2 million short tons of coal, and 6.394 billion cubic feet of natural gas during the period of 2009 through 2025; and,
- Florida's economy would see a net benefit through investments in energy efficiency, low-carbon energy sources, and other greenhouse gas reduction strategies resulting in an estimated total net cost savings of more than $28 billion from 2009 to 2025.

I could not possibly offer enough thanks to the 28 appointed members of the Governor's Action Team on Energy and Climate Change. At their own expense, they participated in this unprecedented effort as a collegial yet dynamic panel, lending their expertise and judicious thought. In the Phase 2 process, we also engaged more than 120 technical experts with resource knowledge in six separate Technical Working Groups. I am truly grateful for their technical wisdom and dedication to serving in these key roles and for ensuring the Action Team had the latest and most complete science and data available. Also, the Center for Climate Strategies was instrumental in developing this report, serving as the independent facilitator, providing technical resources, and helping us ensure a public participation stakeholder process.

This second and final report of the Governor's Action Team on Energy and Climate Change is an exciting marker in Florida's journey on these issues, but it does not mark the end of the work Florida has ahead. It is essential that the recently created Florida Energy and Climate Commission continually track, update, and review these recommendations and analyses as additional data and information become available.

On behalf of the Governor's Action Team on Energy and Climate Change, I want to thank you for the opportunity to serve Florida in this critical and historic endeavor.

Michael W. Sole, Chairman

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Acknowledgments

The work of the Governor's Action Team on Energy and Climate Change was accomplished only through the willingness of many to lend their time and expertise. The Action Team wishes to acknowledge those contributions and to express gratitude to all who have helped this process along.

The Action Team applauds the leadership of Governor Charlie Crist on the issues of energy and global climate change and is grateful to Chris Kise for his contributions at Action Team meetings as the Special Advisor to the Governor on Energy and Climate Change.

The Action Team would like to thank Representative Stan Mayfield, a member of the Action Team, who died on September 30, 2008 after a courageous battle with cancer. Representative Mayfield's leadership on environmental legislation was instrumental in moving Florida forward in addressing climate change. He will be sorely missed.

Commissioner Charles Bronson, Florida Department of Agriculture and Consumer Services, provided valuable information on the measures his agency is undertaking. Alastair Totty, First Secretary, Climate Change, British Embassy, Washington, D.C., for his comments in support of the Action Team's work. In the spirit of the United Kingdom–State of Florida Partnership Agreement, Keith Allan, Her Majesty's Consul General in Miami, has been helpful to the Action Team process.

The Cap-and-Trade Technical Work Group (TWG) would like to thank Jill Duggan, Head of International Emissions Trading for the United Kingdom Department of Environment, Food and Rural Affairs; Warren Bell, Manager of the Climate Change Section, British Columbia Ministry of Water, Lands and Air Protection; Patrick Cunningham, Deputy Director, Arizona Department of Environmental Quality; and Kate Zyla, World Resources Institute, for the presentations and thoughtful insight they provided to the TWG.

The Government Policy TWG would like to thank Nathan Buehler, Marketing & Communications Manager at the Oregon Economic & Community Development Department, for his presentation.

The Adaptation TWG would like to thank Jim Murley and the late Nick Bollman at Florida Atlantic University (FAU) for the intellectual capital provided to the group in developing its final recommendations to the Action Team. The work of the FAU team was supported by the National Commission on Energy Policy who generously offered their findings for use by the Action Team.

State agency personnel were essential to supporting the Action Team. Chairman Sole wishes to express his gratitude to the following: Nancy Blum, Bruce Deterding, Julie Ferris, Jennifer Fitzwater, Carla Gaskin, Kelly Layman, James McNeil, Melanie Meinhardt, Teresa Mussetto, Allena Nelson, Mollie Palmer, and Kathy Shoaf from the Florida Department of Environmental Protection; Tom Ballinger and Mark Futrell from the Florida Public Service Commission; Kathy Neill from the Florida Department of Transportation; and Steve Adams, Brenda Buchan, Kelley Smith, Jeremy Susac, Rob Vickers and Sarah Williams from the Governor's Energy Office.

The Action Team would also like to thank the members of the public who participated in the Action Team and TWG meeting process for their thoughtful comments and contribution.

Special thanks is given to Thomas D. Peterson, Jeff Wennberg and the Center for Climate Strategies and its dedicated team of professionals that contributed time, energy and expertise in providing facilitation services and technical analysis, including Rachel Anderson, Alison Bailie, Donna Boysen, Tiffany Burns, Ken Colburn, Laurie Cullen, Bill Dougherty, Lewison Lem, Steve Roe, Adam Rose, Linda Schade, Joel Smith, Randy Strait, June Taylor, David Von Hipple, Jessica Ward, and Dan Wei.

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Executive Summary

During the past 14 months, the Governor's Action Team on Energy and Climate Change (Action Team) worked diligently to develop the Florida Energy and Climate Change Action Plan (Action Plan). In keeping with the guidance provided in Executive Order 07-128 by Florida Governor Charlie Crist, the Action Team has developed this integrated Action Plan that will, through careful coordination, secure Florida's energy future, reduce greenhouse gas emissions, and heavily support and sustain strategic economic development in the emerging "green tech" sector.

The principal conclusions that have emerged from the Action Team process include:

- Based upon the findings of the 4th Assessment of the Intergovernmental Panel on Climate Change, Florida's resources, communities, and economy are expected to experience significant impacts if the current trajectory of global greenhouse gas emissions is not reversed;
- Early action to address global climate change has significant energy security benefits for Floridians, while positioning the state to become a regional and hemispheric hub of green technology innovation and investment;
- Energy efficiency, demand-side management, and energy conservation present Florida with numerous opportunities to reduce energy costs, increase the buying power of Florida's families, and make the state's business sector more cost-competitive in the global market;
- Investments today in low-carbon energy sources – renewables, nuclear power, and biofuels – will stimulate Florida's economy and redirect current expenditures on imported fossil fuels toward Florida-based energy sources retaining significant flows of money within local economies;
- Market-oriented regulations – many already authorized in Florida law – will efficiently guide a low-carbon economy while protecting energy consumers, maintaining Florida's agricultural competitiveness, and building more sustainable communities.

This Phase 2 report provides 50 separate policy recommendations, plus an additional set of comments toward the current regulatory work to develop Florida's cap-and-trade program to reduce harmful greenhouse gas emissions. These recommendations, if implemented, would result in greenhouse gas emission reductions that would surpass the Governor's 2017 and 2025 emission reduction targets by 11 percent and 34 percent, respectively. Additionally, while some of the recommendations result in an overall societal cost to implement, many were identified to have an overall societal cost-savings. The total net cost savings of all Action Team recommendations combined is more than $28 billion from 2009 to 2025. Additionally, the recommendations would increase Florida's energy security by reducing our dependence on fossil fuels resulting in a total fuel savings of 53.5 billion gallons of petroleum, 200.2 million short tons of coal, and 6.394 billion cubic feet of natural gas during the period of 2009 through 2025.

The Action Team completes its charge during a time of economic uncertainty. While it may be assumed by some readers that the current economic environment would hamper Florida's progress toward a low-carbon economy, the Action Team firmly believes that current economic conditions precisely sharpen the "call to action" first issued by Governor Crist in 2007. Now is the time for strategic investment in Florida's low-carbon energy infrastructure if we are to be successful in diversifying the state's economy, creating new job opportunities, and positioning Florida's "green tech" sector as an economic engine for growth.

The analyses and recommendations provided in the Action Plan are based on current data and projections in the areas of science, demographics, energy consumption, and economics. As Florida moves forward in implementing this Action Plan, it is essential that the Florida Energy and Climate Commission continually update and review these analyses as additional data and information become available.

Background

On July 12 and 13, 2007, Governor Crist hosted "Serve to Preserve: A Florida Summit on Global Climate Change" in Miami. This unprecedented event gathered leaders of business, government, science, and advocacy to examine the unique risks of climate change to Florida and the nation, and to explore the economic development opportunities available through an aggressive response to climate change. At the conclusion of the summit, Governor Crist signed three Executive Orders and two partnership agreements (with Germany and Great Britain) to propel Florida to the forefront of states actively working to address global climate change. One of those orders, Executive Order 07-128 established the Governor's Action Team on Energy and Climate Change and tasked it with creating a comprehensive Florida Energy and Climate Change Action Plan to achieve or surpass the statewide targets for greenhouse gas reduction.

On November 1, 2007, the Action Team issued its Phase 1 report that recommended a range of policies to reduce greenhouse gas emissions and increase Florida's energy security. A number of key issues were referred to Phase 2 for further study and more detailed recommendations.

At the outset of 2008, the State of Florida had a number of energy and climate change initiatives under way. Many of these were in response to the three Executive Orders issued by Governor Crist in 2007. The Legislature passed three bills during the 2008 Regular Session that significantly impacted energy and climate change issues. The most notable is House Bill 7135 (HB 7135), which contains many provisions that are moving Florida aggressively forward in energy security and climate change mitigation. While some of the recently enacted policies and programs are in rulemaking, Florida can point to a significant number of early achievements in state government greenhouse gas emissions reductions, private sector renewable energy projects, utility-based solar energy, energy efficiency, and related research and development.

The Action Team reconvened in February 2008 to begin Phase 2 of Executive Order 07-128 requirements. As identified in the Action Team's Phase 1 report, a facilitated, stakeholder-based, consensus-building process was developed for Phase 2. The Center for Climate Strategies facilitated and provided technical support for this phase of the process. As part of this effort, the Action Team designated six Technical Working Groups to focus on specific issues and sectors of the economy. The six Technical Working Groups were:

- Energy Supply and Demand;
- Transportation and Land Use;
- Agriculture, Forestry, and Waste Management;
- Government Policy and Coordination;
- Cap-and-Trade; and
- Adaptation.

The Action Team and the Technical Working Groups worked diligently in order to meet the October 2008 deadline for completion of this Phase 2 Report. The 28 Action Team members appointed by the Governor gathered a total of eight times in Phase 2 during 2008, representing more than 60 hours of deliberation as a full group. The 122 appointed members of the six Technical Working Groups met more than 71 times on toll-free, public access conference calls, representing more than 155 hours of combined meeting time.

The Action Team's recommendations in this Phase 2 Report build on Florida's accomplishments in 2007 and 2008 and point the way forward for 2009 and beyond.

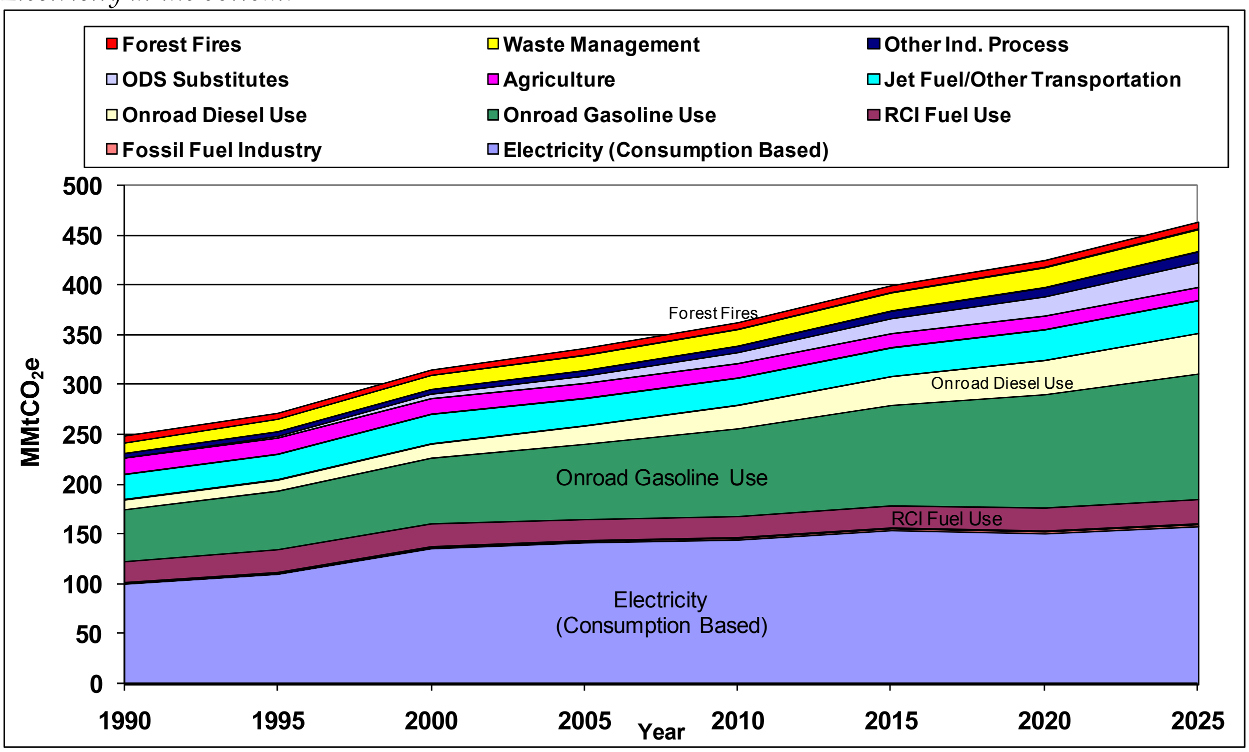
Inventory of Florida's Greenhouse Gas Emissions

In 2005, Florida's gross emissions accounted for approximately 337 million metric tons of carbon dioxide equivalent. Florida's gross emissions of greenhouse gases grew by 35 percent between 1990 and 2005 (roughly twice the national average of 16 percent), driven largely by the growth of population and emissions associated with economic development. The state's emissions on a per capita basis remained relatively flat between 1990 and 2005, as compared to U.S. per capita emissions, which declined slightly (2 percent) during the same period. In the absence of recent developments that Florida has undertaken to control its emissions, gross greenhouse gas emissions are projected to rise steeply to about 463 million metric tons of carbon dioxide equivalent by 2025, or 86 percent more than 1990 levels.

Figure EX-1 depicts the historical and projected gross greenhouse gas emissions by key sectors, during the period from 1990 to 2025. The modeled gross emission levels are predicted using a consumption-based approach and represent the business as usual, or base case scenario. Florida's 16.7 million acres of forests serve to capture and store greenhouse gas emissions (known as "carbon sinks"). On a net emissions basis (including carbon sinks), Florida accounted for approximately 309 million metric tons of carbon dioxide equivalent of emissions in 2005.

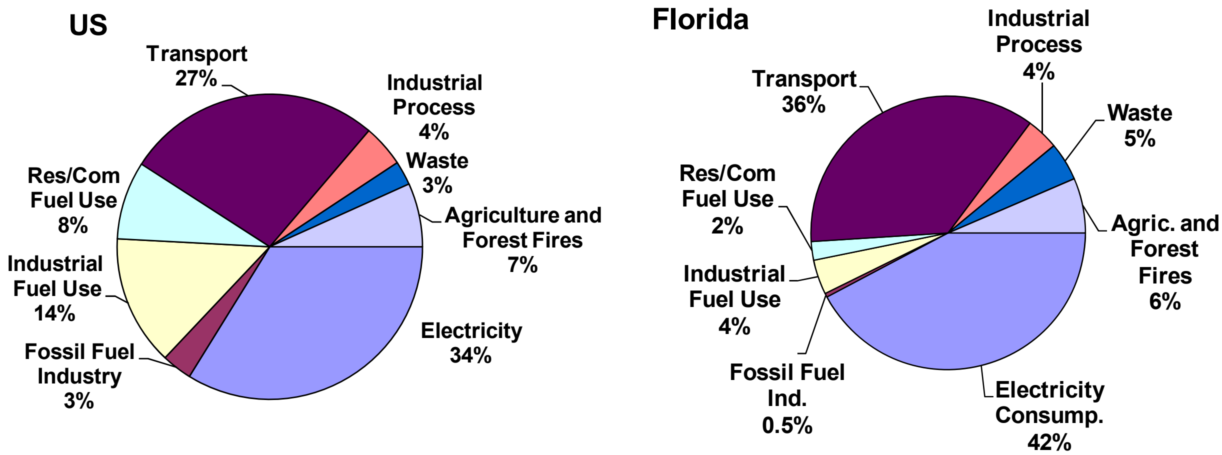
Figure EX-1. Gross greenhouse gas emissions by sector, 1990–2025: historical and projected (consumption-based approach) business as usual/base case

Colors on the graph are displayed left to right, top to bottom in the key, putting Forest Fires at the top and Electricity at the bottom.



RCI = direct fuel use in residential, commercial, and industrial sectors; ODS = ozone depleting substance.

Figure EX-2. Gross greenhouse gas emissions by sector, 2005: Florida and U.S.



The principal sources of Florida's greenhouse gas emissions in 2005 are electricity consumption and transportation, accounting for 42 percent and 36 percent of Florida's gross greenhouse gas emissions, respectively. Other sources of greenhouse gases include emissions from; agriculture and forest fires, waste management, industrial processes, industrial fuel use, residential fuel use, and the fossil fuel industry. Figure EX-2 depicts the 2005 gross greenhouse gas emissions by each of these sectors in Florida and the U.S.

Action Team Recommendations

The Action Team recommends 50 policy actions relating to: energy supply and demand; transportation and land use; agriculture, forestry, and waste management; government policy and coordination; and adaptation strategies associated with climate change. For 28 of these recommendations, the Center for Climate Strategies provided a specific analysis and quantification of the estimated reduction in greenhouse gases associated with each recommendation.

In addition, as part of the cap-and-trade discussion, the Action Team offers a suite of recommendations as guidance to the Florida Department of Environmental Protection as its cap-and-trade rulemaking occurs before submitting its market-based emissions limiting program to the Legislature for consideration and ratification in the 2010 Session (as required by HB 7135).

Table EX-1 shows the levels of emissions for selected years for the reference case, recent actions, target levels and the 28 Action Team recommendations that were quantified.

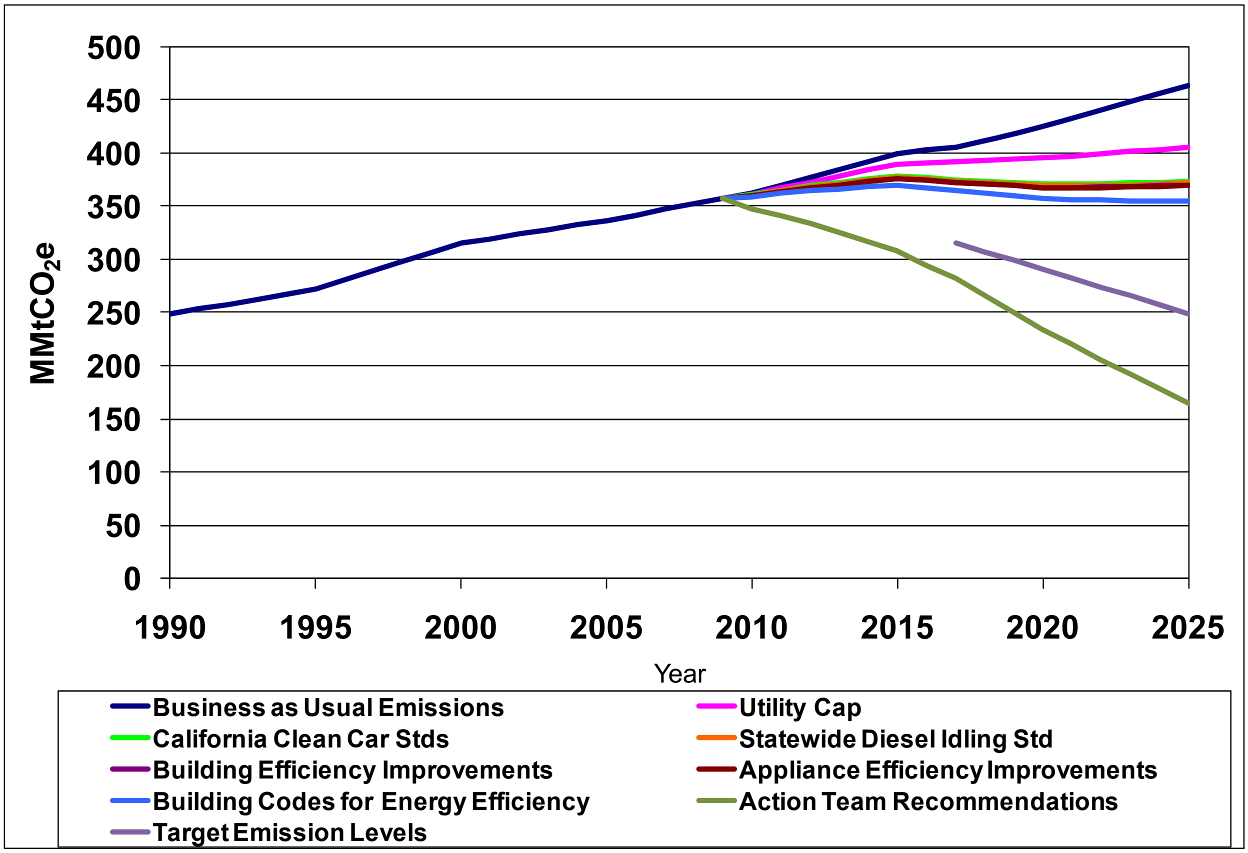
Table EX-1. Annual emissions: reference case projections and impact of Action Team recommendations (consumption-basis, gross emissions)

Annual Emissions ($MMtCO_2e$)	1990	2000	2005	2017	2025
Reference Case Projections	248.8	315.0	336.6	405.0	463.3
Reductions From Recent Actions (Executive Order 07-127)				40.6	108.7
Projected Greenhouse Gas Emissions After Recent Actions				364.4	354.6
Target Emission Levels				315.0	248.8
Total Greenhouse Gas Reductions From Action Team Recommendations				82.6	189.8
Difference Between Action Team Reductions and Target Emission Levels				-33.2	-84.0
Projected Annual Emissions After Quantified Action Team Reductions				281.8	164.8

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

Figure EX-3 shows the total greenhouse gas emissions since 1990 and the reference case projection of emissions from 2005 through 2025 (dark blue line). Below this reference case is a family of lines that represent the contributions of each of the major recent and planned measures resulting from Executive Order 07-127, including improved building codes, utility cap, state clean car standards, and appliance efficiency standards. The impact of these actions is projected to be a 24 percent reduction from the reference case; and would result in a leveling of Florida's greenhouse gas emission growth. The green line represents the cumulative benefits of the Action Team's quantified policy recommendations. Assuming all recommended policies are adopted, in 2017 total emissions would drop to 281.8 million metric tons of carbon dioxide equivalent, or 30 percent below the reference case and 11 percent below the governor's 2017 target. In 2025, assuming all recommended policies are adopted, total emissions would drop to 164.8 million metric tons of carbon dioxide equivalent, more than 64 percent below the reference case and 34 percent below the Governor's 2025 emissions target.

Figure EX-3. Annual greenhouse gas emissions: reference case projections and Action Team recommendations (consumption-basis, gross emissions)



MMtCO2e = million metric tons of carbon dioxide equivalent.

Colors on the graph are displayed left to right, top to bottom in the key, putting Business as Usual Emissions at the top and Action Team Recommendations at the bottom.

Table EX-2 provides a summary by sector of the estimated cumulative impacts of implementing all of the Action Team's recommendations. Note that the cumulative impacts shown in Table EX-2 account for overlaps between policies by eliminating potential double counting of emission reductions and costs or cost savings and have been adjusted for other interactions between the recommended policy actions.

Table EX-2. Summary by sector of estimated impacts of implementing all of the Action Team recommendations (cumulative reductions and costs/savings)

Sector	Greenhouse Gas Reductions ($MMtCO_2e$)			Net Present Value 2009–2025 (Million $)	Cost-Effectiveness ($/tCO_2e$)
	2017	2025	Total 2009–2025		
Energy Supply	44.4	106	841	–$16,143	–$19
Transportation and Land Use	12.7	25.1	214	–$18,400	–$86
Agriculture, Forestry, and Waste Management	25.4	58.2	469	$5,974	$13
Government Policy and Coordination	*Non-quantified, enabling options*				
Adaptation Strategies	*Non-quantified*				
Cap-and-Trade	*Results not included in cross-sector totals*				
TOTAL (includes all adjustments for overlaps and recent actions)	**82.6**	**190**	**1,548**	**-$28,569**	**–$18**

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

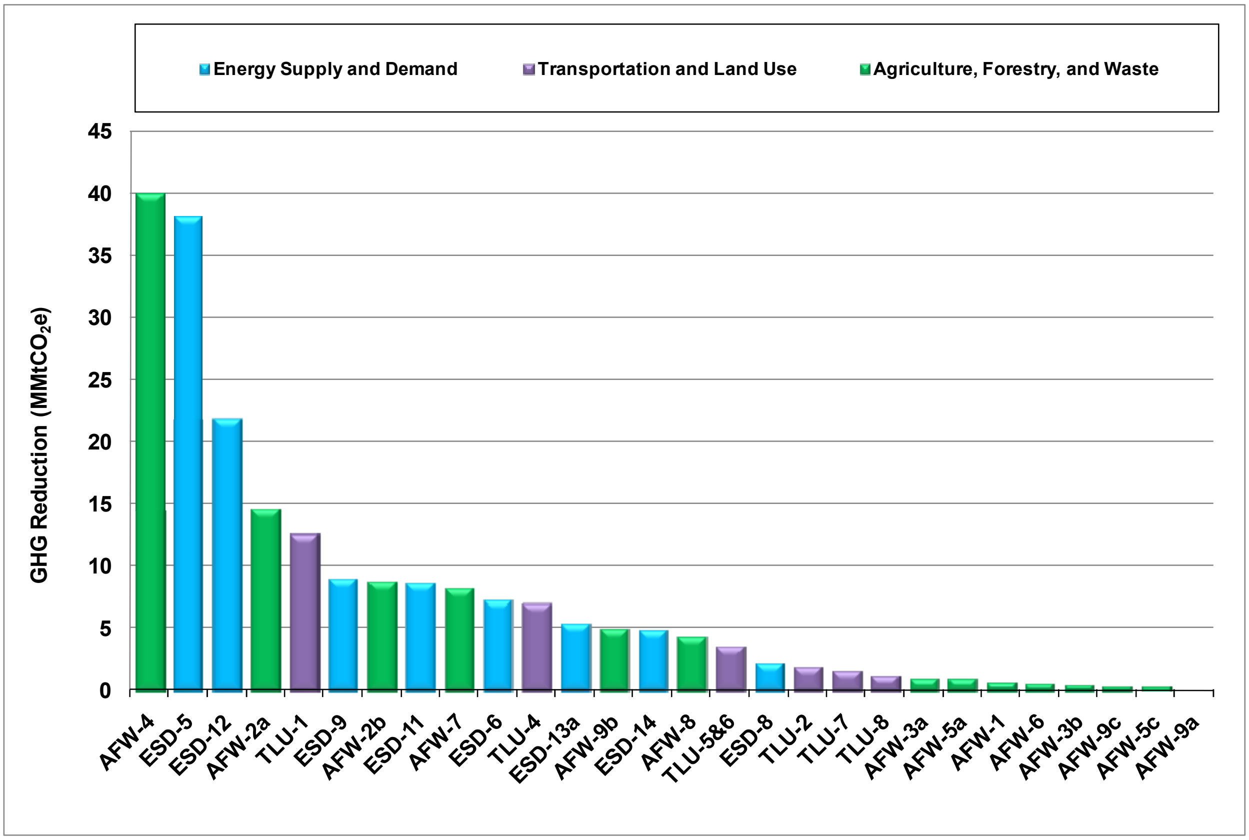
Negative values in the Net Present Value and the Cost-Effectiveness columns represent direct net *cost savings* associated with the options. Within each sector, values have been adjusted to eliminate double counting and other interactions for options or elements of options that overlap.

In order, the sectors with the greatest potential for emissions reductions are:

- energy supply and demand at 56 percent of total reductions and a total net cost savings of $19 per ton;
- agriculture, forestry, and waste management at 27 percent of total reductions and a net cost of $13 per ton; and
- transportation and land use at about 15 percent of total potential emissions reductions and a net cost savings of $86 per ton.

The total net cost savings of all Action Team recommendations combined (after adjustment for overlaps and interactions) is more than $28 billion from 2009 to 2025, at an average net savings of $18 per ton greenhouse gas emissions removed during the same period.

Figure EX-4. Greenhouse gas reductions in 2025 from 28 recommended policies



Key to Figures EX-4 and EX-5	
AFW-1 Forest Restoration	ESD-5a Renewable Portfolio Standards
AFW-2a Afforestation of Forested Landscape	ESD-6 Nuclear Power
AFW-2b Afforestation of Urban Forestry	ESD-8 Combined Heat and Power Systems
AFW-3a Forest Mgt. for Carbon Storage – Pine	ESD-9 Power Plant Efficiency Improvements
AFW-3b Forest Mgt. for Carbon Storage - Public	ESD-11 Landfill Gas-to-Energy
AFW-4 Use of Forestry, Biomass, Feedstocks	ESD-12 Demand-Side Management Programs
AFW-5a Farming Soil Carbon Management	ESD-13a Energy Efficiency in Residential Buildings
AFW-5c Farming Nutrient Management	ESD-14 Improved Building Codes for Efficiency
AFW-6 Reduce Loss of Green Space	TLU-1 Develop and Expand Low-Greenhouse Gas Fuels
AFW-7 Promote In-state Biofuel Production	TLU-2 Low Rolling Resistance Tires
AFW-8 Promote Municipal Solid Waste Tech.	TLU-4 Improve Transportation System Mgt.
AFW-9a Biomass-to-Energy Manure	TLU 5&6 Land Use Planning Processes and Increasing Choices in Modes of Transportation
AFW-9b Biomass-to-Energy Biosolids	TLU 7 Incentive Programs for Increased Vehicle Fleet Efficiency
AFW-9c Biomass-to-Energy Bio-products	TLU 8 Increasing Freight Movement Efficiencies

Quantified recommendations are ranked in Figure EX-4 according to their potential to reduce emissions in 2025. This figure indicates that the greatest reductions are offered by the three policy recommendations known as:

- AFW-4 (Expanded Use of Agriculture, Forestry, and Waste Management, Biomass Feedstocks for Electricity, Heat, and Steam Production);
- ESD-5 (Promoting Renewable Electricity through Renewable Portfolio Standard, Incentives, and Barrier removal); and
- ESD-12 (Demand-Side Management/Energy Efficiency Programs, Funds, or Goals for Electricity).

Figure EX-5 displays the recommendations according to their respective cost-effectiveness, from lowest cost (highest savings) to highest cost. Recommendations with negative numbers represent a total net benefit to Florida's economy after accounting for the costs to implement the recommendation. In most of these cases, a specific investment will be required to initiate the option. Policy recommendations TLU-1 (Develop and Expand Low-Greenhouse Gas Fuels) and TLU-2 (Low Rolling *Resistance Tires and Other Add-On Technologies*) are the policies with the lowest cost-per-ton reduced. Policy recommendation AFW-6 (*Reduce the Rate of Conversion of* Agricultural Land and Open Green Space to Development) has the highest cost per ton.

Figure EX-5. "Opportunity Map" Identifying the Costs and Cost Savings in 2025 from 28 Recommended Policies (Negative Number indicates Cost Savings)

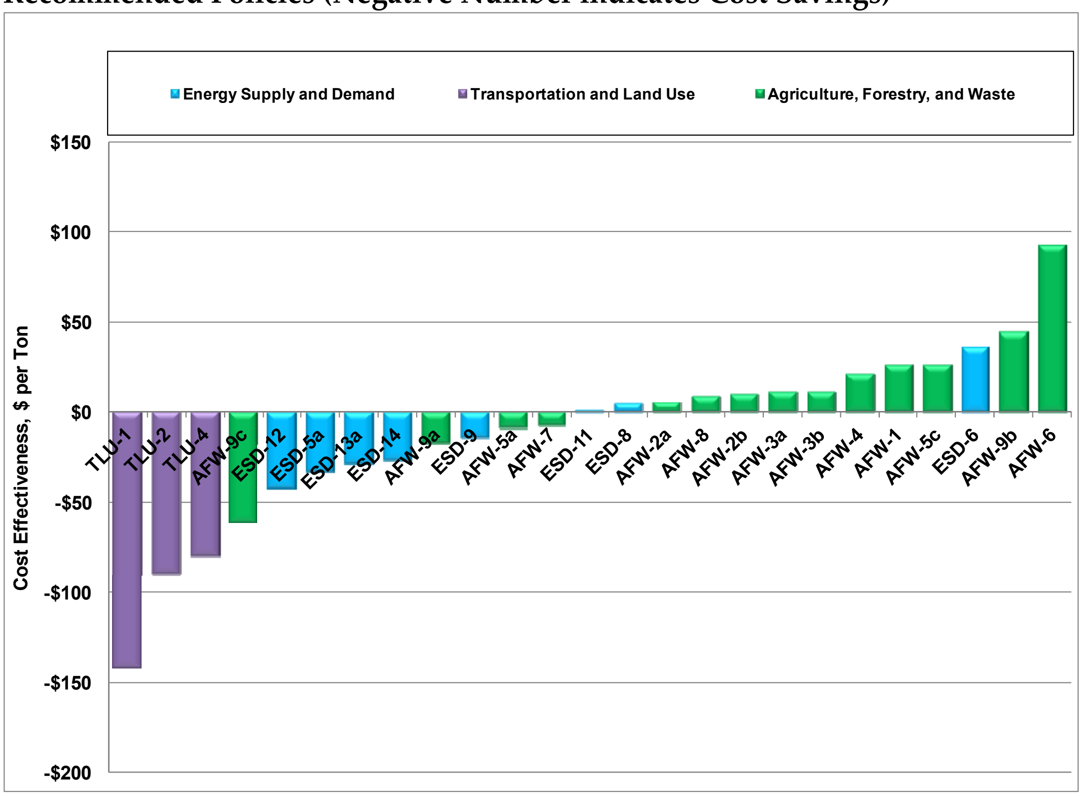
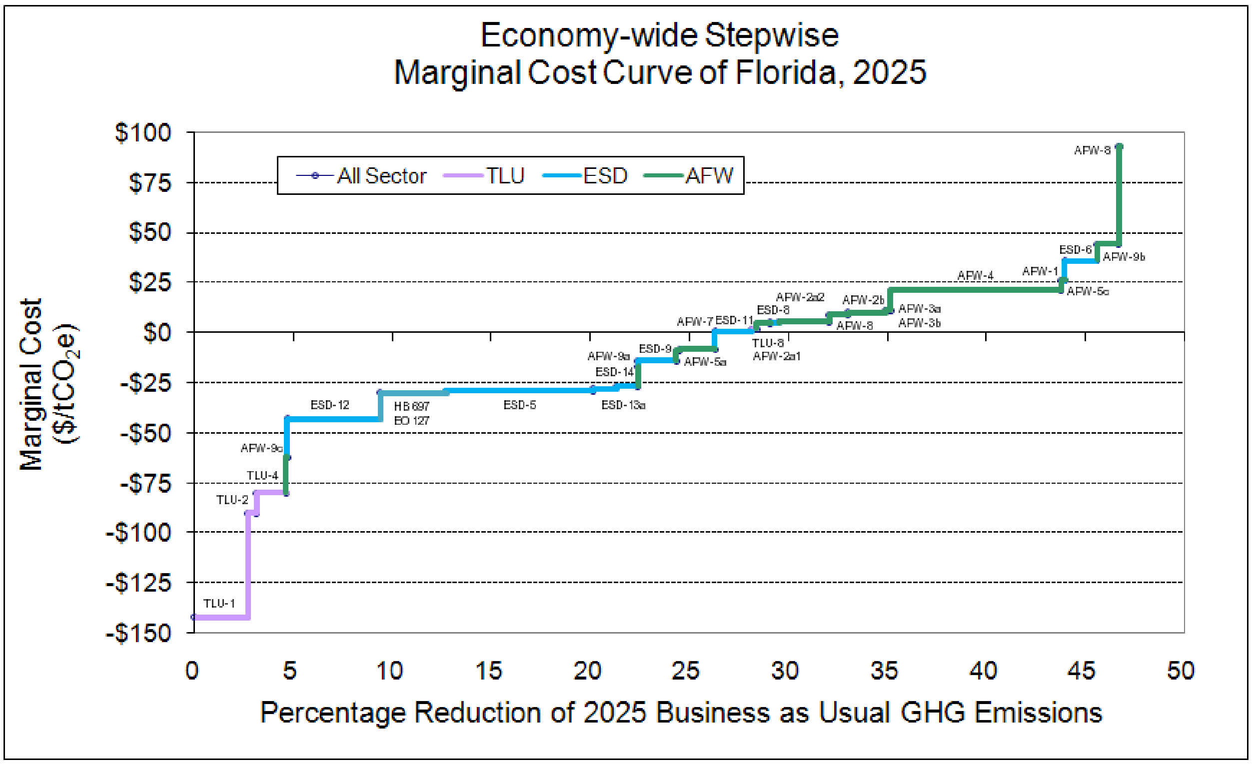


Figure EX-6 displays the quantified policy recommendations in the form of a "cost curve" or step-function showing both policy costs and benefits in 2025. The vertical axis represents the cost or cost savings (negative cost) for each recommendation, which are ranked from lowest cost (highest savings) to highest cost. The horizontal axis represents the amount of greenhouse gas reductions offered by the recommendation, computed as "percent reduction below business-as-usual," with each recommendation's width proportional to its greenhouse gas reduction potential. The wider the recommendation's step, the greater the greenhouse gas mitigation. Each policy moving to the right achieves an increased "percent reduction below Business As Usual," but at an increasing cost.

EX-6. Cost curve for 28 policy recommendations

(Key for Figure EX-6 follows Figure EX-9)



Unquantifiable Recommendations

Some recommendations within this report are not quantified. While many of these unquantifiable policies were estimated by Technical Working Groups and the Action Team to have the likely effect of producing emissions reductions and will involve net costs or cost savings, some of them are foundational—that is, they enable other policies. The lack of quantified results for these recommendations should not be seen as an indication that they are less important or less valuable than the others.

Adaptation

Adaptation represents a unique challenge for Florida. The product of the adaptation investigation is a comprehensive planning framework to guide Florida over the coming years and decades to manage climate impacts that Floridians will likely face regardless of the success of state, national, or international mitigation efforts. The Adaptation recommendations are a comprehensive first look at the issues and opportunities facing Floridians, and contain recommendations for further study and examination as well as measures that can be undertaken immediately to adapt to the many consequences of climate change that may occur in the near future.

Cap-and-Trade

One area of investigation directly assigned to the Phase 2 process from the Phase 1 Report was an examination of cap-and-trade program design. Shortly thereafter, HB 7135 directed the Florida Department of Environmental Protection to initiate rulemaking to create a cap-and-trade program for fossil-fired electric generation plants. The Legislature identified 11 major program design and policy questions to be addressed through rulemaking. The Action Team Chairman (DEP Secretary Michael Sole) suggested that the Action Team provide pre-rulemaking guidance. Therefore, the Action Team asked CCS to perform economic modeling of two policy alternatives, which examined the benefits of Florida joining one of two existing regional climate initiatives. Those results are given in Appendix B. The modeling was not utilized to estimate the cumulative greenhouse gas reductions (or the costs or benefits of the alternatives) in a manner consistent with that used for the other quantified policies. Nor were the emissions reductions and costs of the cap-and-trade options included in the total or summary results. The cap-and-trade program is intended to be implemented concurrently with other recommended policy actions, to guarantee that emissions targets are met within the covered sectors, and, potentially, to generate additional reductions and cost savings.

Government Policy

The Government Policy and Coordination Technical Working Group presented five policies that were ultimately adopted for recommendation by the Action Team. These policies fall into two categories: efforts that enable or enhance the successful implementation of policies recommended for specific sectors, and policies that foster the development and creation of technologies and businesses that mitigate greenhouse gases and promote the creation of jobs and economic growth. Finally, the Government Policy Coordination Technical Working Group examined the multiple planning authorities at all levels of government in Florida, and the Action Team has recommended measures to incorporate greenhouse gas considerations into government planning processes and improve coordination among entities with overlapping jurisdiction.

Energy Security

The Action Team focused considerable time and consideration on the issue of increasing Florida's energy security. Table EX-3 provides a summary total of fuel savings for quantified recommendations by fuel type. Figure EX-7 shows the relative savings of petroleum by policy recommendation. Figure EX-8 shows each recommendation's coal savings by million short tons. Figure EX-9 shows each recommendation's natural gas savings in billions of cubic feet.

Table EX-3. Total fuel savings

Total Fuel Saved 2009-2025 All Recommendations		
Petroleum	53.5	billion gallons
Coal	200.2	million short tons
Natural Gas	6,394.0	billion cubic feet

Figure EX-7. Petroleum savings by recommendation, 2009-2025

(Key for Figure EX-7 follows Figure EX-9)

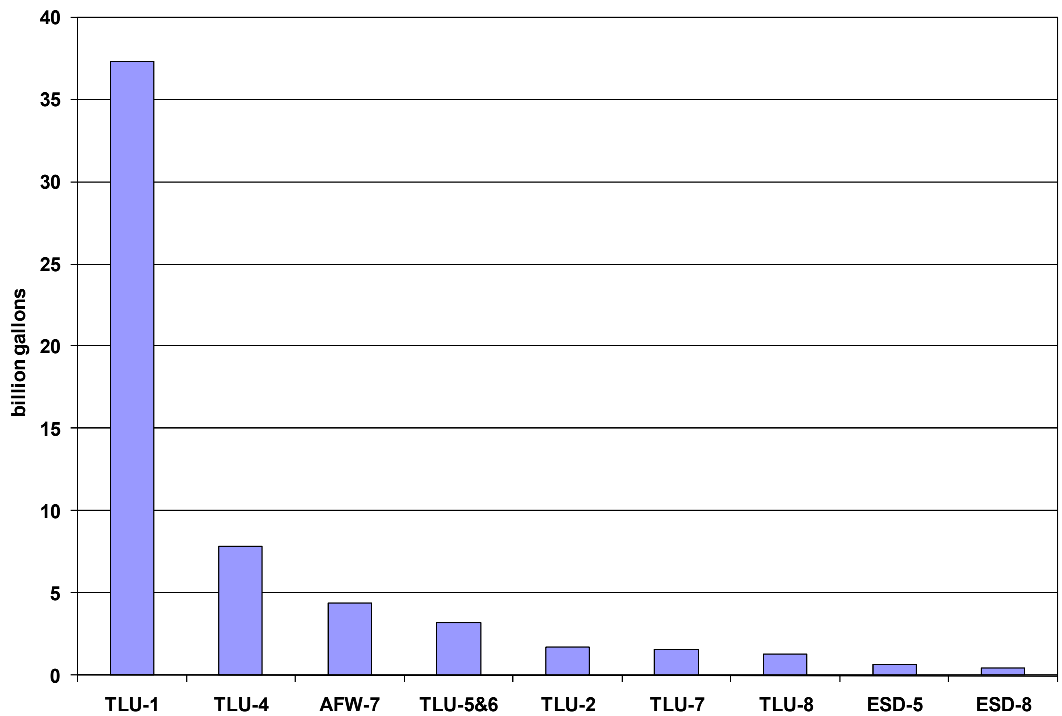


Figure EX-8. Coal savings by recommendation, 2009-2025

(Key for Figure EX-8 follows Figure EX-9)

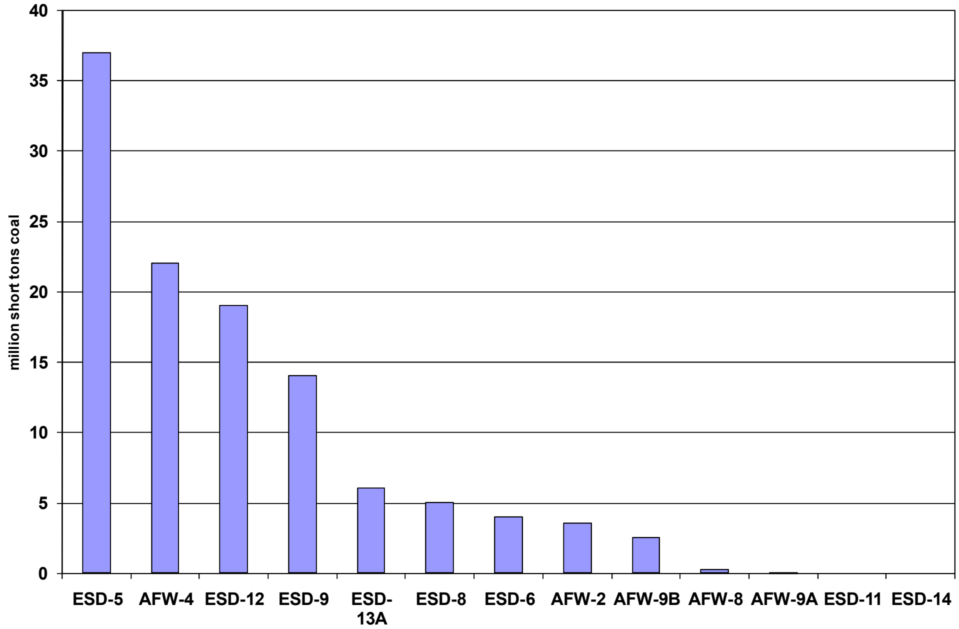
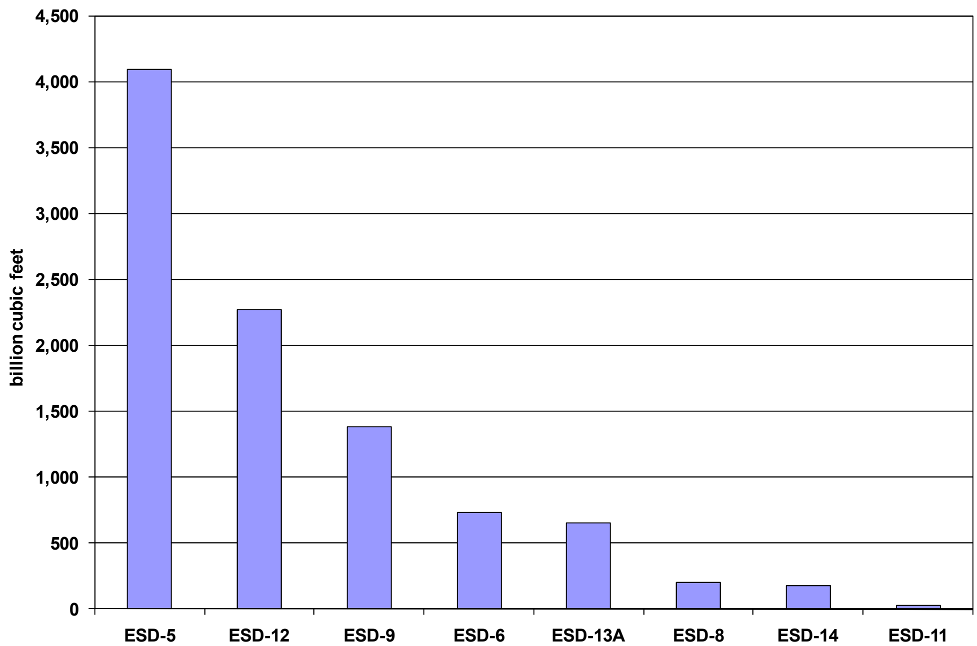


Figure EX-9. Natural gas saved by recommendation, 2009-2025

(Key for Figure EX-9 is on the following page)



Key to Figures EX-7, EX-8, and EX-9	
AFW-1 Forest Restoration	ESD-5a Renewable Portfolio Standards
AFW-2a Afforestation of Forested Landscape	ESD-6 Nuclear Power
AFW-2b Afforestation of Urban Forestry	ESD-8 Combined Heat and Power Systems
AFW-3a Forest Mgt. for Carbon Storage – Pine	ESD-9 Power Plant Efficiency Improvements
AFW-3b Forest Mgt. for Carbon Storage - Public	ESD-11 Landfill Gas-to-Energy
AFW-4 Use of Forestry, Biomass, Feedstocks	ESD-12 Demand-Side Management Programs
AFW-5a Farming Soil Carbon Management	ESD-13a Energy Efficiency in Residential Buildings
AFW-5c Farming Nutrient Management	ESD-14 Improved Building Codes for Efficiency
AFW-6 Reduce Loss of Green Space	TLU-1 Develop and Expand Low-Greenhouse Gas Fuels
AFW-7 Promote In-state Biofuel Production	TLU-2 Low Rolling Resistance Tires
AFW-8 Promote Municipal Solid Waste Tech.	TLU-4 Improve Transportation System Mgt.
AFW-9a Biomass-to-Energy Manure	TLU 5&6 Land Use Planning Processes and Increasing Choices in Modes of Transportation
AFW-9b Biomass-to-Energy Biosolids	TLU 7 Incentive Programs for Increased Vehicle Fleet Efficiency
AFW-9c Biomass-to-Energy Bio-products	TLU 8 Increasing Freight Movement Efficiencies

Action Team Recommendations for Each of the Six TWG Sectors

The following summary tables outline the Action Team's recommendations across each of the six technical working groups. For those recommendations that were quantified during the process, emission reduction potential and cost effectiveness are detailed within each table. Additional detail regarding the policy recommendation is presented in the summary chapters and within the technical appendices of this report.

Table EX-4. Energy Supply and Demand recommendations summary

Policy No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value (See Note 2) 2009–2025 (Million $)	Cost-Effective-ness ($\$/tCO_2e$)	Status of Policy
		2017	2025	Total 2009–2025			
Tier 1							
ESD-5	Promoting Renewable Electricity through Renewable Portfolio Standard (RPS), Incentives and Barrier Removal (20% by 2020)	17	34.5	319	-$9,274	-$29	Approved
ESD-6	Nuclear Power	0.0	7.3	49.4	$1,782	$36	Approved
ESD-7	Integrated Resource Planning (IRP)	Not to be quantified					Approved
ESD-8	Combined Heat and Power (CHP) Systems	1.8	2.2	26.5	$126	$5	Approved
ESD-9	Power Plant Efficiency Improvements	8.4	8.9	111.4	–$1,541	–$14	Approved
ESD-11	Landfill Gas-To-Energy (LFGTE)	3.7	8.7	64.7	$79	$1	Approved
ESD-12	Demand-Side Management (DSM)/Energy Efficiency Programs, Funds, or Goals for Electricity	13.0	21.8	201.4	–$8,566	–$43	Approved
ESD-13a	Energy Efficiency in Existing Residential Buildings	3.4	5.4	50.4	-$1,432	-$28	Approved
ESD-14	Improved Building Codes for Energy Efficiency	0.0	4.9	9.9	-$265	-$27	Approved
ESD-15	Training and Education for Building Operators and Community Association Managers	*Not to be quantified*					Approved
ESD-17	Consumer Education Programs	*Not to be quantified*					Approved
ESD-23	Decoupling	*Not to be quantified*					Approved
Recent Actions							
	Building Codes for Energy Efficiency (HB 697 and Executive Order 127)	8.0	15.4	136.5	-$4,082	-$30	Not applicable
Sector Totals		**47.4**	**93.6**	**832.8**	**-$19,090**	**-$23**	
Sector Totals After Adjusting for Overlaps (see Note 3)		**44.4**	**106.4**	**841.3**	**-$16,143**	**-$19**	
Reductions from Recent Actions		**8.0**	**15.4**	**136.5**	**-$4,082**	**-$30**	
Sector Totals, including recent actions and adjustment for overlaps		**52.4**	**121.8**	**977.8**	**-$20,226**	**-$21**	

Table EX-5. Transportation and Land Use recommendations summary

Policy No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value 2009–2025 (Million $)	Cost-Effective -ness ($/tCO_2e$)	Energy Security Fuel Savings (Gallons Saved 2009–2025) (million gallons)	Level of Support
		2017	2025	Total 2009-2025				
TLU-1	Develop and Expand Low-GHG Fuels	6.20	12.62	106.41	–$15,161	–$142	37,290	Approved
TLU-2	Low Rolling Resistance Tires and Other Add-On Technologies	0.80	1.84	13.99	-$1,259	-$90	1,665	Approved
TLU-3	Smart Growth Planning	Not Quantified Separately; Included in Other Analyses						Approved
TLU-4	Improving Transportation System Management (TSM)	3.94	6.98	63.91	-$5,106	-$80	7,858	Approved
TLU-5&6	Land Use Planning Processes and Increasing Choices in Modes of Transportation	1.77	3.54	28.29	NQ	NQ	3,200	Approved
TLU-7	Incentive Programs for Increased Vehicle Fleet Efficiency	0.84	1.56	13.14	NQ	NQ	1,564	Approved
TLU-8	Increasing Freight Movement Efficiencies	0.59	1.10	11.52	$21	$2	1,302	Approved
	Sector Totals	**14.14**	**27.64**	**237.26**	**-$21,505**	**-$110**	**52,879**	
	Sector Total After Adjusting for Overlaps	**12.73**	**25.14**	**214.35**	**-$18,400**	**-$106**	**48,786**	
	Reductions from Recent Actions	**19.10**	**34.11**	**307.24**				
	Sector Total Plus Recent Actions	**31.83**	**59.25**	**521.59**				

Table EX-6. Agriculture, Forestry and Waste Management recommendations summary

Option No.	Policy Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2009–2025 (Million $)	Cost-Effective-ness ($\$/tCO_2e$)	Energy Security Fuel Savings	Status of Policy
		2017	2025	Total 2009–2025				
AFW-1	Forest Retention—Reduced Conversion of Forested to Non-Forested Land Uses	0.5	0.6	7.2	$186	$26		Approved
AFW-2	Afforestation and Restoration of Non-Forested Lands							
	A. Forested Landscape							Approved
	Afforestation	1.6	3.1	28	$134	$4.9		
	Reforestation	6.1	11.6	104	$555	$5.3		
	B. Urban Forestry	4.6	8.7	78	$759	$10	3.5 million short tons coal, or 76,000 cubic feet natural gas	Approved
AFW-3	Forest Management for Carbon Sequestration							
	A. Pine Plantation Management	0.5	0.9	7.9	$84	$11		Approved
	B. Non-Federal Public Land Management	0.3	0.4	3.9	$41	$11		Approved
AFW-4	Expanded Use of Agriculture, Forestry, and Waste Management (AFW) Biomass Feedstocks for Electricity, Heat, and Steam Production	21	40	361	$7,432	$21	22 million short tons coal **or** 486,000 cubic feet natural gas	Approved
AFW-5	Promotion of Farming Practices That Achieve GHG Benefits							
	A. Soil Carbon Management	0.5	0.9	8.0	–$74	–$9	5 million gallons of diesel fuel	Approved
	B. Land-Use Management That Promotes Permanent Cover	N/Q						Approved
	C. Nutrient Management	0.2	0.3	2.6	$68	$26		Approved
	D. Improved Harvesting Methods to Achieve GHG Benefits	N/Q						Approved
AFW-6	Reduce the Rate of Conversion of Agricultural Land and Open Green Space to Development	0.2	0.5	4.2	$394	$93		Approved

AFW-7	In-State Liquid/Gaseous Biofuels Production	4.0	8.2	68	–$532	–$8	4,075 million gallons gasoline and 271 million gallons diesel	Approved
AFW-8	Promotion of Advanced Municipal Solid Waste (MSW) Management Technologies (Including Bioreactor Technology)	1.9	4.4	34	$294	$9	190,000 short tons coal **or** 4,000 cubic feet NG **and** 109 million gallons diesel	Approved
AFW-9	Improved Commercialization of Biomass-to-Energy Conversion and Bio-Products Technologies							
	A. Manure Digestion/Other Waste Energy Utilization	0.04	0.09	0.8	–$13	–$17	4,500 short tons coal or 100 cubic feet natural gas	Approved
	B. WWTP Biosolids Energy Production & Other Biomass Conversion Technologies	2.4	5.0	42	$1,848	$44	2.5 million short tons coal or 55,000 cubic feet natural gas	Approved
	C. Bio-Products Technologies and Use	0.2	0.3	2.6	–$161	–$62		Approved
AFW-10	Programs to Support Local Farming/Buy Local	N/Q						Approved
	Sector Totals	**44**	**85**	**752**	**$11,014**	$15		
	Sector Total After Adjusting for Overlaps*	**25**	**58**	**469**	**$5,974**	**$13**		
	Reductions From Recent Actions	**—**	**—**	**—**	**—**	**—**		
	Sector Total Plus Recent Actions	***25***	***58***	***469***	***$5,974***	***$13***		

Table EX-7. Government Policy and Coordination recommendations summary

Policy No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$) 2015	2025	Total 2009–2025	Net Present Value 2009–2025 (Million $)	Cost-Effective-ness ($\$/tCO_2e$)	Status of Policy
GP-1	Targets, Reporting, Funding, and Accountability Measures	*Not to be Quantified*					Approved
GP-2	Public Awareness and Education	*Not to be Quantified*					Approved
GP-3	Inter-Governmental Planning Coordination and Assistance	*Not to be Quantified*					Approved
GP-4	"Green" Business Development Policies	*Not to be Quantified*					Approved
GP-5	Introduce Core Competencies Into Professional Licensing Programs	*Not to be Quantified*					Approved

Table EX-8. Adaptation Strategies recommendation summary

Framework Identifier.	Planning Framework Element	Status of Policy
ADP-1	Advancing Science Data and Analysis for Climate Change	Approved
ADP-2	Comprehensive Planning	Approved
ADP-2.1	Local Government Level	Approved
ADP-2.2	Regional Government Level	Approved
ADP-2.3	State Government Level	Approved
ADP-3	Protection of Ecosystems and Biodiversity	Approved
ADP-3.1	Uplands, Freshwater and Marine Systems	Approved
ADP-3.2	Beaches and Beach Management	Approved
ADP-3.3	Species Protection	Approved
ADP-4	Water Resource Management	Approved
ADP-5	Built Environment, Infrastructure and Community Protection	Approved
ADP-5.1	Building Codes and Regulation	Approved
ADP-5.2	Flood Protection	Approved
ADP-5.3	Beaches as Infrastructure	Approved
ADP-5.4	Transportation and Other Infrastructure	Approved
ADP-6	Transportation and Other Infrastructure (moved into ADP-5)	Approved
ADP-7	Economic Development	Approved
ADP-7.1	Tourism	Approved
ADP-7.2	Other Resource-based Industries	Approved
ADP-7.2.1	Agriculture	Approved
ADP-7.2.2	Forests	Approved
ADP-7.2.3	Marine	Approved
ADP-7.2.4	Aquaculture	Approved

Framework Identifier.	Planning Framework Element	Status of Policy
ADP-7.2.5	Mining	Approved
ADP-7.3	Construction	Approved
ADP-8	Insurance (Property and Casualty)	Approved
ADP-9	Emergency Preparedness and Response (Extreme Events)	Approved
ADP-10	Human Health Concerns	Approved
ADP-10.1	Health Care	Approved
ADP-10.2	Air Quality	Approved
ADP-10.3	Wastewater Treatment	Approved
ADP-10.4	Disaster Response	Approved
ADP-10.5	Medical Treatment and Biomedicine Development	Approved
ADP-11	Social Effects	Approved
ADP-11.1	Social Justice Issues	Approved
ADP-11.2	Food and Water Security	Approved
ADP-11.3	Housing	Approved
ADP-11.4	Intersection of Climate Change and Human Behavior	Approved
ADP-12	Organizing State Government for the Long Haul	Approved
ADP-13	State Funding and Financing	Approved
ADP-14	Coordinating with Other Regulatory and Standards Entities	Approved
ADP-14.1	Federal Government	Approved
ADP-14.2	Professional Societies	Approved
ADP-15	Public Education and Outreach	Approved

The Science of Climate Change and Its Importance and Opportunities for Florida

Executive Order 07-128 created the Governor's Action Team on Energy and Climate Change (Action Team) in the summer of 2007. The Action Team was tasked to develop a series of recommendations for addressing climate change in Florida. A brief description of the science of climate change and the potential impacts to Florida is provided here to assist the reader in understanding the nature of these recommendations and the importance of taking action. There are numerous benefits, both environmental and economic, which accrue both to the State of Florida and the private sector due to pursuing energy efficiency and investing in alternative energy technologies.

Natural Warming

The sun's energy drives the Earth's weather and climate and heats its surface. Some of this energy radiates back into space, but some is trapped by naturally occurring greenhouse gases (GHGs) such as carbon dioxide (CO_2), water vapor, and other gases. GHGs are necessary to life as we know it; because they keep the planet's surface warmer than it would be otherwise. However, as the concentrations of these gases continue to increase in the atmosphere, the Earth's temperature is rising above traditional levels. According to the U.S. National Oceanic and Atmospheric Administration and the U.S. National Aeronautics and Space Administration data, the Earth's average surface temperature has increased by about 1.2 to 1.4° Fahrenheit in the past 100 years. The eight warmest years on record (since 1850) have all occurred in the past 10 years (since 1998), with the warmest year being 2005.

Human Activities are Changing the Earth's Climate

In May 2001, the White House asked the National Academy of Sciences (NAS) to assess the current understanding of climate change by answering key questions related to both causes of climate change and projections of future change. The NAS released a report, *Climate Change Science: An Analysis of Some Key Questions (2001)*, and a second report, *Understanding and Responding to Climate Change (2008)*, the latter of which stated, "… [C]limate changes observed over the last several decades are likely mostly due to human activities" and "… additional evidence collected over the past several years has increased confidence in this conclusion."

The accumulation of some GHGs in the atmosphere is a natural part of the Earth's climate system and has been beneficial to our living environment. However, due to the extensive combustion of fossil fuel and land use changes over the past several hundred years, concentrations of GHGs in the Earth's atmosphere now exceed pre-industrial era amounts. Between 1970 and 2004, global emissions increased by 70 percent, with a full 24 percent increase occurring in the 14 years between 1990 and 2004. During that time, GHGs increased from 28.7 to

49 gigatons (GT). Of those, emissions of CO_2 grew by about 80 percent between 1970 and 2004, with the largest increase of 28 percent occurring during the 14 years between 1990 and 2004.[1]

The largest growth in global GHG emissions occurring between 1970 and 2004 came from the energy supply sector, with a 170 percent increase. The next-largest growth in emissions came from the transportation sector with 120 percent, then the industrial sector with 65 percent, and finally land use and forestry with 40 percent. Between 1970 and 1990, direct emissions from agriculture grew by 27 percent. Without specific action, by 2030, global emissions of CO_2 from energy use are projected to grow from 45 percent to 110 percent more than emissions measured in the year 2000.[2]

Fossil fuel consumption in automobiles and electric power plants worldwide results in the emission of approximately 5.5 billion metric tons of CO_2 each year, and deforestation contributes an estimated additional 1.6 billion metric tons annually.[3] GHG increases of methane and nitrous oxide are due primarily to agricultural activities.

If GHGs continue to increase, climate models predict that the average temperature at the Earth's surface could increase from 2.5 to 10.4°F by 2100.[4] Members of the NAS and the scientific members of the Intergovernmental Panel on Climate Change (IPCC) are certain that human activities are changing the composition of the atmosphere, and that increasing the concentration of GHGs will change the planet's climate.[5] At this point in time, scientists do not know with certainty how much it will change, at what rate it will change, or what the exact effects will be.

Florida's Emissions of Greenhouse Gases

Florida's gross GHG emissions increased from 248.8 million metric tons in 1990 to 336.6 million metric tons in 2005 as shown in Figure 1. Florida's GHGs come primarily from fossil fuel combustion attributable to the utility and transportation sectors. The utility sector accounts for 44 percent of GHGs and the transportation sector accounts for 37 percent of GHGs. This means that Florida's GHGs are largely attributed to supplying consumer demand for electricity and transportation. Future GHG growth in Florida is anticipated to come from these same sectors.

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[1] Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report, Working Group III, May 2007, available at: http://news.bbc.co.uk/1/shared/bsp/hi/pdfs/04_05_07_ipcc_report.pdf

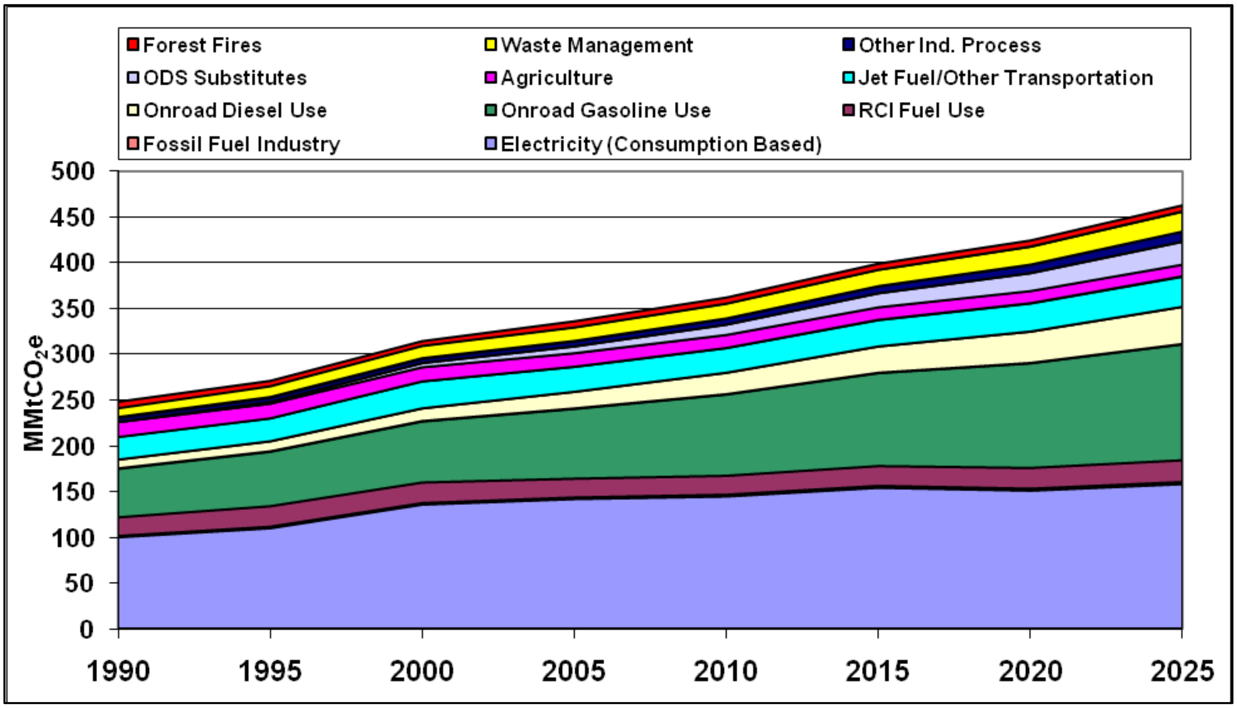
[2] Ibid.

[3] U.S. National Aeronautics and Space Administration. "Earth Observatory: The Carbon Cycle," available at: http://earthobservatory.nasa.gov/Library/Carboncycle/carbon_cycle.html

[4] IPCC. 2007. "Climate Change 2007: the Physical Science Basis," Solomon, S., D. Qin, M. Manning, eds. Contribution of Working Group I to the Fourth Assessment Report of the IPCC, available at: http://news.bbc.co.uk/1/shared/bsp/hi/pdfs/02_02_07_climatereport.pdf

[5] U.S. Environmental Protection Agency. "Climate Change: Basic Information," available at: http://www.epa.gov/climatechange/basicinfo.html

Figure 1. Actual and projected greenhouse gas emissions in Florida by sector, 1990–2025



While climate science is complex and evolving, the scientific community has reached a strong consensus regarding the science of global climate change. The world is undoubtedly warming. This warming is largely the result of emissions of carbon dioxide and other GHGs from human activities, including fossil fuel combustion, industrial processes, and changes in land use, such as deforestation. Although legitimate differences of opinion exist regarding the most effective mix of policies to address this problem, mitigation of GHGs is the essential component.

The Effects of Global Climate Change on Florida

With the release of each new report by the IPCC and the NAS, the consequences of global climate change are becoming better understood. By virtue of Florida's geography, changes in climate and sea level are of particular concern.

The impacts of climate change on Florida will result directly from an increase in air and water temperatures, sea level rise, and a change in precipitation levels.

- **Air Temperature Rise**—The IPCC predicts that the average temperature at the Earth's surface could increase from 2.5 to 10.4°F by 2100.[6]

[6] IPCC. 2007. "Climate Change 2007: the Physical Science Basis," Solomon, S., D. Qin, M. Manning, eds. Contribution of Working Group I to the Fourth Assessment Report of the IPCC, available at: http://news.bbc.co.uk/1/shared/bsp/hi/pdfs/02_02_07_climatereport.pdf.

- **Sea Level Rise—**Higher temperatures are expected to raise sea level by expanding ocean water, melting mountain glaciers and small ice caps, and causing portions of the coastal section of the Greenland and Antarctic ice sheets to melt or "slide" into the ocean. The IPCC estimates that the global average sea level will rise between four and 35 inches, depending on the magnitude of warming.
- **Future Precipitation and Storm Changes—**Tropical storms and hurricanes are likely to become more intense, produce stronger peak winds, and produce increased rainfall over some areas due to warming sea surface temperatures (which can strengthen these storms).[7]

Each of these changes will impact the various sectors of Florida's economy, such as health, agriculture, forestry, water resources, coastal areas, and animal and sea-life species.

- **Health—**Human health can be affected directly and indirectly by climate change in part through extreme periods of heat and cold, storms, and diseases spread by mosquitoes in warm climates.[8] Florida's population of senior citizens, particularly those living alone, would be most adversely affected by heat waves and heat-related illnesses.[9] Further, sea surface warming could increase health threats from marine-borne illnesses, shellfish poisoning, and harmful algal blooms.[10]
- **Agriculture—**Citrus crop yields could decrease with warmer temperatures in the southernmost part of Florida because of the lack of a sufficient dormant period. Changes in cotton and sorghum production are unclear because increasing CO_2 levels and rainfall would likely increase yields. However, the shorter growing season brought on by increasing temperatures could result in plants producing fewer or smaller seeds and fruit.[11] In the short-term, it appears there may be benefits in the agricultural section from global warming; however, the effects in the long-term are unknown.
- **Forestry—**Changes in tree species, geographic extent, and the health and productivity of forests can be expected with a warmer climate. The mixed conifer/hardwood forests found in the northern and Panhandle sections of Florida are likely to retreat northward. These forests eventually would give way to wet tropical forests such as tropical evergreen broadleaf forests and dry tropical savanna. If conditions become drier, the current range of forests could be reduced and replaced by grasslands and pasture.[12]

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[7] Ibid.

[8] U.S. Environmental Protection Agency. "Climate Change: Basic Information," available at: http://www.epa.gov/climatechange/basicinfo.html

[9] U.S. Environmental Protection Agency. "Climate Change and Florida." EPA 230-F-97-008i, September 1997. http://yosemite.epa.gov/OAR/globalwarming.nsf/UniqueKeyLookup/SHSU5BUKSV/$File/fl_impct.pdf

[10] Ibid.

[11] Ibid.

[12] Ibid.

- **Water Resources**—Evaporation is likely to increase with a warmer climate, and that could result in lower river flow and lower lake levels during drier periods. If stream flow and lake levels drop, groundwater could also be reduced. Saltwater intrusion from sea level rise could threaten aquifers used for urban water supplies. These changes could further stress South Florida's water resources. In contrast, more intense rain could increase flooding in some areas.[13]
- **Oceans –** High water temperatures lead to the bleaching of coral, which is the expulsion of the symbiotic algae that corals need for survival, growth, and reproduction. While some corals can recover from bleaching other corals will be eliminated which will reduce local and regional coral diversity. Ocean acidification is another impact of climate change on oceans caused by the increases in atmospheric concentration of CO_2. Higher CO_2 concentration in the air increases the amount of CO_2 dissolved in ocean waters. Increased ocean acidity lowers the concentration of carbonate, which corals and other marine organisms need to build their skeletons.[14]
- **Coastal Areas**—As sea level rises, Florida's wetlands and lowlands along the Gulf and Atlantic coasts could be inundated. Adverse impacts in these areas could include loss of land and structures, loss of wildlife habitat, accelerated coastal erosion, exacerbated flooding and increased vulnerability to storm damage, and increased salinity of rivers, bays, and aquifers, which would threaten supplies of fresh water.[15]
- **Land Plants and Animals**—Scientists are seeing spring events occurring earlier each year. In North America, a northern shift is occurring in plant and animal ranges. Scientists are seeing shifts in ranges and changes in algal, plankton, and fish abundance in Florida associated with rising water temperatures, as well as related changes in salinity, oxygen levels, and circulation.[16]

If Florida and other states and nations act now to reduce GHG emissions, many of these effects can be avoided, minimized, or mitigated. The actions necessary to reduce GHG emissions are available to every household, every community, and every state in the nation. There is a cost associated with some of these actions, but there is also a direct cost for failing to act.

Addressing Climate Change through a Market-Based Solution

There is more than one method for encouraging the reduction in GHGs within the Florida economy. Options range from taxing to mandatory cuts to seeking market-based solutions. The U.S. Environmental Protection Agency had success in the 1980s with reducing acid rain through

[13] Ibid.

[14] The Pew Center on Global Climate Change, Coral Reefs & Global Climate Change, February 2004 http://www.pewclimate.org/docUploads/Coral_Reefs.pdf

[15] U.S. Environmental Protection Agency. "Climate Change and Florida." EPA 230-F-97-008i, September 1997. http://yosemite.epa.gov/OAR/globalwarming.nsf/UniqueKeyLookup/SHSU5BUKSV/$File/fl_impct.pdf

[16] Ibid.

the use of market-based solutions, and many in the world believe the same can be accomplished with GHGs. The market-based solution being pursued by the European Union, as well as the Regional Greenhouse Gas Initiative and the Western Climate Initiative here in the United States, uses a cap-and-trade program to reduce emissions. This initiative is discussed at greater length in Chapter 4. By seeking a market-based solution to Florida's climate change concerns, the resulting economic stimulus will provide multiple benefits to the state. Not only will Florida benefit by slowing climate change through reducing GHGs, but it will stimulate the economy through the creation of new energy technologies, new business opportunities, new green jobs, and a reduction in the state's dependence on foreign sources of fuel, which translates to better energy security.

Market mechanisms are an efficient means to address GHG reductions because these mechanisms use price signals to provide incentives to individuals. To enhance the effectiveness of market mechanisms, consumer outreach programs can educate citizens on the critical role that everyday choices play in reducing GHG. By making conscious choices to conserve energy and to use energy more efficiently, Floridians can make a measurable difference in reducing GHG emissions.

Stimulating Economic Development

In order to address Florida's energy future, the public and the private sector must invest in new fuel sources, new technologies, new infrastructure, and more efficient homes, buildings, appliances, and transportation. These investments also represent real business opportunities in the private sector.

Florida Governor Charlie Crist has pointed out repeatedly that there are many commercial opportunities that can be created by new economic ventures in Florida, specifically that "there is gold in green" for Florida in alternative energy technologies. If Florida is successful in expanding hydrogen, biomass, solar, wind, and ocean energy programs, it will be poised to provide other states and nations with the technologies, expertise, and manufactured parts to take advantage of Florida's renewable energy industry. Entrepreneurs and businesses have the opportunity to invest in new technologies and build an alternative energy market while strengthening Florida's economic future.

Efforts to address energy security and global climate change are creating new markets for products and services that did not exist 20 years ago. One particular sector of Florida's economy that is already seeing new investments is agriculture. In order to reduce national reliance on foreign sources of petroleum, the transportation sector is investing in biofuels. Evidence of the economic opportunities in Florida for alternative fuels is offered by the success of the past three Farm-to-Fuel programs sponsored by the Florida Department of Agriculture and Consumer Services and with the movement of biofuel companies into the state and start-ups created within the state.

Businesses and investors are keenly interested in the new opportunities offered by alternative fuels and emerging technologies. During both of Governor Crist's "Serve to Preserve" Summits on Global Climate Change in 2007 and 2008, attendees heard the experiences of to both emerging and established technology companies capitalizing on the commitment to develop alternative forms of energy. At the state, national, and global levels, venture capitalists are investing in the advanced energy technology sector. In 2006, venture capitalists invested $740 million into biofuel firms, compared with $111 million invested in 2005.[17] The broader advanced energy technology sector attracted $2.9 billion in venture capital in 2006, outpacing even the Fiscal Year 2008 federal appropriations of $2.7 billion.[18]

Achieving Energy Security

Approximately 58 percent of the oil consumed by the United States is imported. Of total imports, 49 percent originates in the Western Hemisphere, 21 percent from Africa, 16 percent from the Persian Gulf, and 14 percent from others sources.[19] Projected trends by the U.S. Department of Energy show dependence on oil imports continuing to increase. In May 2001, the National Energy Policy Development Group concluded that this imbalance, "…if allowed to continue, will inevitably undermine our economy, our standard of living and our national security." Geopolitical challenges are driving the United States to focus on energy security by increasing the domestic production of energy rather than depending on foreign nations.

The pursuit of energy security in the United States has focused on five main objectives:

1. Increase the energy efficiency of transportation, appliances, buildings, power plants, and transmission lines;

2. Modernize energy infrastructure by adding new transmission facilities, retiring old generators that release high emissions, and investing in public transportation;

3. Diversify the fuels used in the electric and transportation sectors;

4. Develop cleaner domestic fuels; and

5. Invest in and encourage alternative and new technologies.

Florida is looking to achieve those same objectives on a state level. Increasing energy efficiency and conservation in our homes, offices, buildings, and industry can have the largest impact on increasing energy security. In addition to every citizen taking personal responsibility to pursue energy efficiency and conservation, the state must upgrade and modernize its energy infrastructure. These upgrades need to come in the form of investments in cleaner electrical generators, new transmission facilities that can accommodate renewable energy sources, and public transportation systems.

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[17] Cleantech Venture Network. "Envy with Green(tech)," TeleSoft Partners. 2007.

[18] Ibid.

[19] United States Energy Information Administration.

The fuel that drives Florida's electric generators comes from out of state and out of the country. For example, coal is delivered to Florida by rail or barge, natural gas is delivered through pipelines, oil is delivered by tanker, and nuclear fuel is delivered by rail and truck. Florida receives 98 percent of its transportation fuel by sea via barge and tanker ship into seven ports. Any one of these transport systems that fuel Florida's electricity and transportation sectors could be, and has been, disrupted by a disaster or severe weather.

In an effort to diversify the state's fuel supply and attempt to keep consumer costs affordable, a number of Florida-based utilities are looking at nuclear facilities for the first time in decades. Because nuclear plants have zero GHGs in the production phase of their plant life cycle, nuclear energy has taken on increased importance in strategies for meeting future energy demand. Two Florida utilities have expressed interest and intent to expand current nuclear capacity or construct new nuclear generating facilities. Through the Energy Policy Act of 2005, the federal government offers tax incentives, loan guarantees, and other subsidies for nuclear power generation. Florida also enacted statutory provisions in 2006 and 2008 to allow for "advanced cost recovery" for nuclear power and its associated transmission system. Ongoing concerns regarding nuclear waste disposal remain a key issue that needs to be addressed.

Florida's utilities are also increasing investments in energy efficiency and in renewable sources of electricity generation. Important changes to Florida law enacted by the 2008 Florida Legislature expanded the range of energy efficiency program coverage and provided added incentives to utilities to achieve additional efficiency gains. Further, investments in renewable sources of energy are increasing in Florida due to increased fossil fuel prices as well as a range of policy actions that have removed market barriers, offset capital costs, and provided guidance for the establishment of a renewable portfolio standard for Florida utilities.

In the transportation sector, national energy security issues focus on U.S. refineries. Currently, domestic oil refineries are running at near-maximum capacity and represent a bottleneck in the oil supply chain. Due to environmental, safety, and aesthetic reasons, adding oil refinery capacity is difficult. Biofuels may help stabilize near-term oil prices by serving as fuel extenders, allowing fuel companies to sell more gallons than their petroleum refineries are capable of producing. Since biofuel plants do not pose as many of the same concerns as oil refineries, they are viewed as a solution to the refinery capacity dilemma. As the demand for transportation fuels increases, Florida's infrastructure for producing, storing, and transporting that fuel or biofuel to market will need to expand, including new storage capacity in some of Florida's ports.

Conclusion

Few single elements have as much economic impact and are as critical to the economic health of the state as energy. Whether it is the electricity to run homes or businesses or the petroleum to power transportation systems, energy is the lifeblood of the economy. Due to its economic importance, one of the primary goals of Florida's energy policy must be to ensure a clean, reliable, fair, and affordable energy supply. This goal is consistent with reducing GHGs because, by encouraging investment in energy efficiency and the use of clean renewable energy sources, Florida will be reducing its demand for imported fuel and securing better sources of energy for the future.

To position the state to take economic advantage of the emerging technology industry, Florida must act now to reduce GHG emissions. Hand-in-hand with pursuing energy efficiency measures that build on the 2008 Legislature's work, Florida should encourage the development of alternative energies to achieve the goals of:

- Mitigating the potential impacts to Florida from climate change;
- Further stimulating economic development in the state associated with the existing and emerging alternative energy industries; and
- Achieving energy security by reducing dependence on foreign fuels.

History and Status of State Actions

In recent years, the State of Florida has undertaken a number of actions to address the issues of energy and climate change. For example, in 2006, the Legislature passed Florida's first comprehensive energy plan, prompted by a series of events, including very active 2004 and 2005 hurricane seasons that heightened concern over energy reliability, energy security, and energy supply. More recently, the growing body of evidence in support of the threat posed by greenhouse gas (GHG) emissions and climate change led Florida Governor Charlie Crist to intensify the state's efforts to address these complex and interrelated challenges. The following provides a brief overview of these and other efforts to date.

2007 Energy and Climate Change Initiatives

On July 12 and 13, 2007, Governor Crist hosted "Serve to Preserve: A Florida Summit on Global Climate Change." The first-ever summit of its kind in Florida brought together leaders of business, government, science, environmental stakeholders, and advocacy groups to examine the risks to Florida and the nation posed by global climate change. At the conclusion of the summit in Miami, Governor Crist signed three Executive Orders and two international partnership agreements that propelled Florida to the forefront of states actively working to address climate change.

Executive Order 07-126 directed state government to "lead by example" by quantifying operational emissions and meeting specific reduction targets by implementing a range of GHG emission reduction efforts that impact state government facilities and vehicle fleets, and by using the purchasing power of state government to promote energy efficiency and reduced emissions.

Executive Order 07-127 established reduction targets for utility sector GHG emissions in Florida. Specifically, the Executive Order established the following emission reduction targets: by 2017, reduce GHG emissions to 2000 levels; by 2025, reduce GHG emissions to 1990 levels; and by 2050, reduce GHG emissions to 80 percent below 1990 levels.

As first steps toward meeting these targets, the Executive Order directed the Florida Department of Environmental Protection (DEP) to set maximum allowable GHG emissions levels for electric utilities, adopt the California motor vehicle emission standards upon the U.S. Environmental Protection Agency's approval of the pending waiver, and adopt a statewide diesel engine-idling reduction standard.

The Executive Order further directed that modifications to the 2007 Florida Energy Code for Building Construction include a 15 percent increase in energy efficiency performance as well as a 15 percent increase in the energy efficiency of certain appliances sold in Florida by 2009. Finally, it requested that the Florida Public Service Commission (PSC) adopt a 20 percent Renewable Portfolio Standard with a strong focus on solar and wind energy, adopt the Institute of Electrical and Electronics Engineers Standard 1547 for Interconnecting Distributed Resources with Electric Power Systems, and require net metering for on-site renewable technologies of up to one megawatt (MW) in capacity.

Executive Order 07-128 established the Governor's Action Team on Energy and Climate Change and tasked it with creating a comprehensive Florida Energy and Climate Change Action Plan to achieve or surpass the statewide targets for GHG reduction specified in Executive Order 07-127. Executive Order 07-128 provided the Action Team with a two-phase process for submitting recommendations. The Action Team was directed to submit its Phase 1 Report to the Governor by November 1, 2007, and its Phase 2 report in October 2008.

The Governor signed partnership agreements with Germany and the United Kingdom focused on climate policies and mutual economic benefits. Pursuant to these agreements, the State of Florida is exchanging delegations with Germany and with the United Kingdom to create a forum for sharing public policy experience and exchanging science and technology, placing a particular emphasis on the sharing of ideas and policies related to energy efficiency and renewable energy sources. The individual partnership agreements also will increase climate-friendly trade.

On August 13, 2007, Governor Crist appointed the first 21 members to the Action Team and appointed DEP Secretary Michael Sole as Chairman and Mayor Rick Baker of the City of St. Petersburg as Vice Chairman. Membership included a diverse cross section of stakeholders, including representatives of business, utilities, academia, and environmental organizations. To meet the first deadline set by Executive Order 07-128, the Action Team conducted more than 36 hours of hearings. The Action Team listened to presentations from international, national, and Florida-based experts, dozens of members of the public, and other interested parties.

Phase 1 Report—Florida's Energy and Climate Change Action Plan: On November 1, 2007, the Governor's Action Team on Energy and Climate Change issued its first report. The report's 35 findings and 30 recommendations addressed the requirements outlined in Executive Order 07-128, and were organized into the following key categories:

1. The power generation sector;
2. The transportation sector;
3. The government sector;
4. Organizing state government for Florida's energy future; and
5. A blueprint for development of actions.

The report recommended policies to:

- increase energy efficiency and conservation;
- examine the potential for capture, sequestration, and storage of carbon;
- expand the production of renewable energy; and
- further examine the role of nuclear energy in Florida.

The Action Team deferred until the Phase 2 Report a recommendation on the precise mechanism for regulating carbon emissions in the state but did recommend pursuing the design of a market-based policy of cap-and-trade for tradable emissions credits; establishing linkages with ongoing emissions trading markets; and reporting emissions to The Climate Registry by the state's electric utilities. The Action Team also recommended that DEP examine and propose additional industry sectors for inclusion in mandatory emissions reporting.

The Action Team acknowledged the importance of transportation in reducing overall GHG emissions. The report contained a series of transportation-related recommendations, including the incorporation of emission reduction strategies into local, state, and regional growth and transportation planning; incentives for reducing vehicle miles traveled; and promotion of efficient public transit systems and low-carbon vehicles. The Action Team also recommended continuing existing incentives for research and development of new fuels, as well as promoting life cycle analyses for fuels in order to comprehend the full impact on the state's resources and environment.

Building on the requirements of Executive Order 07-126, the Action Team identified additional energy and emissions savings opportunities in state government operations and facilities. The Phase 1 Report included recommendations to extend, by statute, the Executive Branch actions contained in the Governor's Executive Order to all other state government operations. The Action Team also recommended removing any barriers to the use of energy performance savings contracts for state government facilities, and providing incentives to assist local governments in achieving green building or similar standards.

The Action Team examined the state's roles in policy, energy regulation, program implementation, and research and market development, and recommended that the state foster greater public-private cooperation with universities and other research centers to develop a low-carbon and alternative energy/technology market in Florida.

Finally, the Action Team recommended the use of a facilitated stakeholder process to in Phase 2 develop the detailed emission reduction strategies that would provide the blueprint for development of actions contained in the final Florida's Energy and Climate Change Action Plan. The Action Team recognized that the stakeholder process must be guided by rigorous analyses of the costs and benefits of various policy options.

2008 Energy and Climate Change Initiatives

At the outset of 2008, the State of Florida had a number of energy- and climate change-related initiatives under way. The Governor's Action Team resumed deliberations and intensified its examination of policy recommendations for its Phase 2 Report. Meantime, the Florida Energy Commission (created by the 2006 Legislature) submitted its final report about this same time, which contained a wide range of recommendations relating to energy affordability, security, efficiency, reliability, and climate change. The Florida Senate and the House of Representatives also embarked on their own respective inquiries into energy and climate change issues, holding committee workshops with experts chosen by the committees.

2008 Energy Legislation—During the 2008 Regular Session, the Legislature enacted several bills that significantly impacted energy and climate change issues. The most notable legislation was House Bill 7135 ("The Energy, Climate Change, and Economic Security Act of 2008"). This comprehensive energy bill codified many of the provisions contained in Governor Crist's 2007 Executive Orders. By drawing on the efforts of the Governor's Action Team on Energy and Climate Change, the Florida Energy Commission, and the extensive deliberations of the Senate and House of Representatives, the bill:

- Created the Florida Energy and Climate Commission within the Executive Office of the Governor to centralize energy and climate change policy development and program implementation;
- Authorized the DEP to develop cap-and-trade regulations for GHG emissions for sources in Florida, subject to legislative ratification in the 2010 Regular Session;
- Expanded key economic development programs to attract specific investments in the renewable energy sector to Florida;
- Adopted a "10 by 10" Renewable Fuel Standard requiring that all gasoline sold for motor vehicles in Florida contain 10 percent ethanol by 2010;
- Required the PSC to develop rules for a renewable portfolio standard subject to legislative ratification in the 2009 Regular Session and provided cost recovery guidance to the PSC for renewable energy projects developed in advance of the final rule;
- Required major emitters to report GHG emissions via The Climate Registry;
- Required the reduction of energy consumption and associated GHG emissions from local and state government operations by requiring that public buildings be constructed to meet recognized green building standards; by considering energy and climate performance in vehicle, commodity, and meeting space procurement; by promoting active energy management among state agencies; and by increasing energy and water efficiencies from government facilities by streamlining existing statutes governing guaranteed performance savings contracts;

- Increased the role of energy efficiency in Florida's energy policy through revisions to the Florida Energy Efficiency and Conservation Act, provided goals for the Florida Building Commission to increase efficiency standards by 10 percent in each triennial review and achieve a 50 percent increase by 2019, and increased efficiency requirements for certain appliances;
- Created the Florida Energy Systems Consortium within the State University System to better coordinate energy-related research in support of Florida's energy and climate change policy objectives; and
- Balanced the need for expanded electric transmission infrastructure within Florida with the need for conservation land protection and informed public participation in the siting process by providing the terms and conditions for use of state lands; clarifying timelines in the transmission line siting process; and increasing public participation through new mail notice requirements and additional hearings for local residents.

On June 25 and 26, 2008, Governor Crist convened the second Annual "Serve to Preserve: A Global Summit on Climate Change." The Governor was joined by members of the Florida Legislature for the signing of House Bill 7135, the landmark 2008 energy legislation. The 2008 summit focused not only on the need to pursue alternative fuels for environmental reasons, but also for the economic benefits brought about by the infusion of green technologies. At the conclusion of the summit, Governor Crist signed a new public-private partnership making Florida among the first states to join the Alliance for Sustainable Air Transportation, which places a premium on energy conservation and air travel safety.

Phase 2 Report—Florida's Energy and Climate Change Action Plan: Pursuant to Executive Order 07-128, the Action Team reconvened in February 2008 to begin Phase 2. Governor Crist expanded the membership of the Action Team from 21 to 27 voting members and retained a 28th ex officio member. Additionally, the Center for Climate Strategies (CCS) was asked to help facilitate and provide technical support. CCS worked with DEP in the development of a stakeholder-based consensus-building process.

As part of this effort, the Action Team designated six Technical Working Groups to focus on specific issues and sectors of the economy and tasked them with responsibility for providing technical analysis and designing policy options for consideration by the full Action Team. The Technical Working Groups consisted of Action Team members (as the minority) as well as other individuals with interest and expertise in issues being addressed (as the majority). The six Technical Working Groups were:

- Energy Supply and Demand;
- Cap-and-trade;
- Transportation and Land Use;
- Agriculture, Forestry, and Waste Management;

- Government Policy and Coordination; and
- Adaptation Strategies.

The Action Team and Technical Working Groups worked diligently to meet the October 2008 deadline for completion of the Phase 2 Report. The 28 Action Team members met a total of eight times, representing more than 60 hours of deliberation. The 122 members of the six Technical Working Groups met 71 times, representing more than 155 hours of combined meeting time. Their respective recommendations are the substance of this report and are discussed at length in subsequent chapters and appendices.

Current Status of Energy and Climate Change Initiatives

While many of the recently enacted policies and programs still might be considered to be in the developmental stage, the State of Florida can point to a significant number of early achievements. Similarly, a number of private sector entities, local governments, community-based organizations, and academic institutions have launched their own energy- and climate change-related initiatives. As a result, Florida is increasingly recognized as a leader in addressing the challenges and opportunities associated with energy and climate change. The following are examples of these accomplishments:

Leading by Example—Through the establishment of the Florida State Greenhouse Gas Reduction Scorecard, the state has generated the first comprehensive assessment of GHG emissions from state government-owned vehicles and facilities**.** The Department of Management Services has implemented Environmentally Preferred Purchasing to assist state entities in the purchase of climate-friendly products. DMS also has established programs to support energy performance contracting in state facilities, and increased fuel efficiency in the state's motor vehicle fleet.

GHG Emission Reductions—The Florida DEP has issued its proposed rule for reducing emissions resulting from long-duration on-road diesel engine idling and is in the process of rule development for adoption of the California motor vehicle emissions standards. The DEP continues the rule development process in support of a cap-and-trade program to reduce GHG emissions from electric utilities.

Renewable Energy—The PSC has adopted new rules to promote the development and interconnection of customer-owned renewable generation and minimize costs for customers attempting to interconnect to their utility service. The rules encourage the development of renewable generation by expanding the size of eligible systems, expanding the type of eligible systems from solely photovoltaic to all renewable technologies, expediting the interconnection of customer-owned renewable generation, and allowing customers to offset consumption through net metering. The PSC is continuing its rule development process in support of the establishment of a statewide Renewable Portfolio Standard.

A number of Florida utilities have taken the initiative to expand renewable energy production. For example, one Florida-based utility has received approval to begin construction of three solar energy centers that will make Florida the second-largest supplier of utility-generated solar power in the nation. Similarly, several utilities are aggressively pursuing additional biomass and co-firing opportunities. A number of Florida's municipal and cooperative utilities have launched their own solar and biomass generation initiatives.

Energy Efficiency—As previously noted, Florida agencies are implementing a wide range of programs designed to increased energy efficiency and reduce carbon emissions within state government operations. The Florida Building Commission is finalizing revisions to the Florida Building Code that will significantly enhance the energy efficiency of new buildings constructed in Florida. Almost 300 hotels and motels around the state have been designated and recognized in the DEP's Florida Green Lodging Program, a public-private partnership that encourages the lodging industry to adopt energy efficient and sustainable practices.

Numerous utilities and local governments have established financial incentives and related programs to encourage the adoption of energy efficiency improvements by consumers. Through a myriad of grant, loan, and rebate programs, these entities are making a variety of energy efficiency measures (increased insulation, solar hot water heating, high-efficiency appliances and HVAC, building envelope improvements, etc.) more affordable to home and building owners.

Energy Policy Governance—Effective July 1, 2008, the Governor's Energy Office was established within the Executive Office of the Governor to centralize and strengthen Florida's energy policy development capabilities. This office staffs and supports the Florida Energy and Climate Commission, the nine-member long-term panel created by HB 7135 and appointed by the Governor (7), Chief Financial Officer (1), and Commissioner of Agriculture and Consumer Services (1).

Investment Policies – In recognition of the emerging risks associated with climate change, Florida became the first state in the nation to institute a process to formally analyze investments for the financial impacts of climate change. This initiative, coordinated through Chief Financial Officer Alex Sink, will assess how public fund managers incorporate climate risk in portfolio holdings as part of prudent investment management. Similarly, Florida has joined with a dozen other states representing more than $1.5 trillion in assets under management to create an action plan to boost fund investments in energy efficiency and clean energy technologies as well as require tougher scrutiny of carbon-intensive investments that may pose long-term financial risks.

Energy-related Research—The recently created Florida Energy Systems Consortium is focusing on a range of projects that have the highest potential of generating near-term impact given the cumulative expertise and infrastructure of all 11 state universities. Areas of focus include, but are not limited to, development of an integrated bioenergy industry; solar thermal power for bulk power and distributed generation; development of Florida's vast ocean energy potential; Florida-based low-cost manufacturing of photovoltaic systems; integration of photovoltaic storage/lighting systems; energy-efficient building technologies and zero-energy homes; and efficient and reliable energy delivery infrastructure.

Conclusion

During the past two years under Governor Crist, Florida has established a solid foundation of policies and programs in response to the increasingly clear dangers associated with climate change. Through the leadership of Governor Crist and the Legislature, the state has acted not only to address the challenges but also to create an atmosphere where Floridians can benefit economically from emerging alternative energy technologies and processes. While the early indications are promising, more work is necessary in the coming years. This report is intended to provide specific strategies that put Florida on the path toward further significant emissions reductions meet the state's overall goals.

Chapter 1
Background and Overview

Action Team and Technical Work Group Deliberations

The Governor's Action Team on Energy and Climate Change (the Action Team) held its first meeting of the Phase 2 process on February 1, 2008, followed by nine months of intensive fact-finding and consensus building. During this period, the Action Team's six Technical Working Groups (TWGs) were instrumental in developing specific findings and recommendations for Action Team consideration. The six TWGs are:

- Energy Supply and Demand;
- Cap-and-Trade;
- Transportation and Land Use;
- Agriculture, Forestry and Waste Management;
- Government Policy Coordination; and
- Adaptation Strategies.

The Action Team's deliberations relied on a facilitated, stepwise consensus-building approach. With oversight by the Florida Department of Environmental Protection (DEP), the process was conducted by the Center for Climate Strategies (CCS), an independent facilitation and technical analysis team. The facilitated process was based on procedures used by CCS in a number of other state-level climate change planning initiatives, but adapted specifically for Florida.

CCS provided facilitation and technical assistance to each of the TWGs and the Action Team. The TWGs consisted of Action Team members as well as individuals with an interest in and expertise regarding the issues being addressed by each TWG. The members of the TWGs were appointed by the Action Team Chairman. The TWGs served as independent advisers to the Action Team and generated initial recommendations on policy recommendations. With the guidance and approval of the Action Team they developed draft proposals on the design characteristics and, where possible, quantified the proposed policy recommendations. When members of a TWG did not fully agree on a recommendation to the Action Team, the summary of their effort was reported to the Action Team for further consideration and action. The Action Team then made all final decisions.

Through this process, the Action Team reached technical consensus on specific mitigation options and findings related to benefits, costs, and feasibility issues associated with the options, followed by the development of consensus on individual policy recommendations. The Action Team sought but did not mandate consensus, and it explicitly documented the level of support for individual recommendations and mitigation options.

The recommendations presented in this report recent extensive evaluation and comment by the Action Team, the TWGs, and through public comment. The TWG recommendations to the Action Team were documented and presented to the Action Team at each Action Team meeting. All meetings were open to the public, were properly noticed, and all materials for and summaries of the Action Team and TWG meetings were posted on the Web site of DEP as well as a special Web site set up by CCS.

Contents of the Report

This report presents the summation of the Governor's Action Team on Energy and Climate Change Phase 2. The report is divided into eight chapters. Chapter 1 provides the reader with an overview of how the report is structured. Chapter 2 discusses the Inventory and Forecast data used and the assumptions behind that data. The next six chapters—Chapters 3 through 8—provide summaries of each TWG's recommendations.

Each TWG chapter summary has a companion Technical Appendix that provides a table listing of all the proposed recommendations considered in each TWG along with the quantification of costs and benefits of each, where possible, and a descriptive definition of each recommendation. The Technical Appendices are provided for those readers who want more detail on each recommendation. Following the Technical Appendices is a listing of Acronyms and Abbreviations used in those documents.

Also, there is an Administrative Appendix that contains Governors Crist's three Executive Orders issued in 2007 and the Governor's Action Team on Energy and Climate Change Phase 1 Report.

Chapter 2
Inventory and Projections of Florida GHG Emissions

Introduction

During Phase 1 of the Action Team process, the Florida Department of Environmental Protection (DEP) prepared a preliminary inventory and reference case projections of emissions. That preliminary inventory and reference case projections was revised, updated, and completed by the Center for Climate Strategies (CCS) in June 2008 to provide the Action Team and its Technical Work Groups (TWGs) an understanding of past, current, and possible future GHG emissions in Florida, and to inform the policy recommendation development process. Since that time, the Action Team and TWGs have reviewed, discussed, and evaluated the draft inventory and methodologies, as well as alternative data and approaches for improving the draft GHG inventory and forecast. Based on that review, the inventory and forecasts have been revised to address the comments provided by the Action Team and the TWGs. The information in this chapter reflects the information presented in the final *Florida Greenhouse Gas Inventory and Reference Case Projections* report (hereafter referred to as the Inventory and Projections report) also provided on the Center for Climate Strategies' Web site at http://www.flclimatechange.us/Inventory_Forecast_Report.cfm.[1]

Historical GHG emissions estimates (1990 through 2005)[2] were developed using a set of generally accepted principles and guidelines for state GHG emissions inventories, relying to the extent possible on Florida-specific data and inputs. The reference case projections (2006-2025) are based on a compilation of various existing projections of electricity generation, fuel use, and other GHG-emitting activities, along with a set of simple, transparent assumptions described in the final Inventory and Projections report.

The Inventory and Projections report covers the six types of gases included in the U.S. GHG inventory: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). Emissions of these GHGs are presented using a common metric, CO_2 equivalence (CO_2e), which indicates the relative contribution of each gas, per unit mass, to global average radiative forcing on a global warming potential-weighted basis.[3]

[1] Center for Climate Strategies, Final Florida Greenhouse Gas Inventory and Reference Case Projections: 1990–2025. Prepared for the Florida Governor's Action Team on Energy and Climate Change, October 2008.

[2] The last year of available historical data for each sector varies between 2000 and 2005.

[3] Changes in the atmospheric concentrations of GHGs can alter the balance of energy transfers between the atmosphere, space, land, and the oceans. A gauge of these changes is called radiative forcing, which is a simple measure of changes in the energy available to the Earth–atmosphere system (IPCC, 2001). Holding everything else constant, increases in GHG concentrations in the atmosphere will produce positive radiative forcing (i.e., a net increase in the absorption of energy by the Earth). See: Boucher, O., et al. "Radiative Forcing of Climate Change."

There are two ways to account for emissions: either through a consumption-based approach or through a production-based method. It is important to note that the emissions estimates used here reflect the GHG emissions associated with the electricity sources used to meet Florida's demands, corresponding to a consumption-based approach to emissions accounting. Another way to look at electricity emissions is to consider the GHG emissions produced by electricity generation facilities in the state—a production-based method. The study covers both methods of accounting for emissions, but for consistency, all total results are reported as consumption-based.

Florida GHG Emissions: Sources and Trends

Table 2-1 provides a summary of GHG emissions estimated for Florida, by sector, for 1990, 2000, 2005, 2010, 2020, and 2025. As shown in this table, Florida is estimated to be a net source of GHG emissions (positive emissions, or gross emissions). Since Florida's forests and forested acreage serve as "carbon sinks" of GHG emissions (removal of CO_2 from the atmosphere, or negative emissions), Florida's net emissions is arrived at by subtracting the equivalent GHG reduction capacity of emission sinks from the gross GHG emissions totals. The following sections discuss GHG emission sources, sinks, trends, projections, and uncertainties.

Historical Emissions

Overview

In 2005, on a gross emissions consumption basis (excluding carbon sinks), Florida accounted for approximately 337 million metric tons (MMt) of CO_2e emissions, an amount equal to 4.7 percent of total U.S. gross GHG emissions. On a net emissions basis (including carbon sinks), Florida accounted for approximately 309 MMtCO_2e of emissions in 2005, an amount equal to 4.9 percent of total U.S. net GHG emissions.[4] Florida's GHG emissions are rising faster than those of the nation as a whole. From 1990 to 2005, Florida's gross GHG emissions increased by 35 percent, while national gross emissions rose by 16 percent.[5]

Table 2-1. Florida historical and reference case GHG emissions, by sector*

(Million Metric Tons CO2e)	1990	2000	2005	2010	2020	2025

Chapter 6 in *Climate Change 2001: The Scientific Basis*. Contribution of Working Group 1 of the Intergovernmental Panel on Climate Change Cambridge University Press. Cambridge, United Kingdom. Available at: http://www.grida.no/climate/ipcc_tar/wg1/212.htm.

[4] The national emissions used for these comparisons are based on 2005 emissions from U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2006*, April 15, 2008, EPA430-R-08-005. Available at: http://www.epa.gov/climatechange/emissions/usinventoryreport.html.

[5] During this period, population grew by 38 percent in Florida and by 19 percent nationally. However, Florida's economy grew at nearly the same rate on a per capita basis as the nation (up 32 percent in Florida compared to 33 percent nationally).

Energy (Consumption Based)	**210.3**	**270.9**	**286.8**	**307.3**	**356.0**	**385.3**
Electricity Use (Consumption)	**100.6**	**136.2**	**142.2**	**145.0**	**151.3**	**158.5**
Electricity Production (in-state)	86.1	124.3	134.1	138.5	151.3	158.5
Coal	*54.1*	*72.3*	*60.4*	*69.2*	*74.4*	*73.5*
Natural Gas	*11.1*	*22.6*	*38.0*	*56.1*	*68.2*	*78.4*
Oil	*20.3*	*28.1*	*32.0*	*9.38*	*5.10*	*3.75*
Biomass (CH_4 and N_2O)	*0.015*	*0.010*	*0.000*	*0.000*	*0.000*	*0.000*
MSW/Landfill Gas	*0.37*	*0.74*	*3.60*	*3.24*	*2.89*	*2.21*
Other	*0.34*	*0.48*	*0.01*	*0.57*	*0.74*	*0.60*
Imported/Exported Electricity	14.5	11.9	8.09	6.57	0.00	0.00
Residential/Commercial/Industrial (RCI) Fuel Use	**21.0**	**23.1**	**21.2**	**21.3**	**23.3**	**24.4**
Coal	*2.84*	*3.02*	*2.58*	*2.81*	*2.83*	*2.91*
Natural Gas	*7.73*	*9.84*	*7.93*	*8.15*	*9.60*	*10.4*
Petroleum	*10.1*	*10.1*	*10.5*	*9.86*	*10.3*	*10.5*
Wood (CH_4 and N_2O)	*0.40*	*0.21*	*0.22*	*0.54*	*0.60*	*0.64*
Transportation	**87.6**	**110.2**	**121.8**	**139.2**	**179.4**	**200.3**
Onroad Gasoline	*52.9*	*66.0*	*76.2*	*88.7*	*114.3*	*126.7*
Onroad Diesel	*9.73*	*14.0*	*18.3*	*23.5*	*34.4*	*40.7*
Marine Vessels	*11.1*	*14.4*	*14.9*	*14.3*	*15.8*	*16.5*
Rail, Natural Gas, LPG, other	*0.70*	*0.69*	*0.96*	*0.99*	*1.04*	*1.07*
Jet Fuel and Aviation Gasoline	*13.2*	*14.5*	*11.5*	*11.7*	*13.9*	*15.3*
Fossil Fuel Industry	**1.02**	**1.36**	**1.55**	**1.70**	**2.00**	**2.09**
Natural Gas Industry	0.95	1.30	1.52	1.67	1.99	2.07
Oil Industry	0.07	0.06	0.04	0.03	0.02	0.01
Industrial Processes	**4.38**	**9.20**	**12.8**	**17.6**	**28.7**	**36.2**
Cement Manufacture (CO_2)	1.20	1.81	2.75	3.63	6.31	8.32
Limestone and Dolomite Use (CO_2)	0.38	0.46	0.49	0.52	0.60	0.64
Soda Ash (CO_2)	0.14	0.15	0.15	0.16	0.16	0.17
Iron & Steel (CO_2)	1.09	1.15	1.03	1.06	1.12	1.15
Ammonia and Urea (CO_2)	0.09	0.06	0.06	0.06	0.06	0.06
ODS Substitutes (HFC, PFC)	0.02	4.64	7.45	11.3	19.7	25.2
Electric Power T&D (SF_6)	1.44	0.87	0.81	0.75	0.69	0.67
Semiconductor Manufacturing (HFC, PFC, and SF_6)	0.02	0.07	0.06	0.06	0.05	0.05
Waste Management	**10.7**	**14.1**	**15.3**	**16.6**	**19.9**	**21.9**
MSW LFGTE	0.39	0.49	0.51	0.53	0.57	0.59
MSW Flared	0.35	0.58	0.68	0.78	1.04	1.21
MSW Uncontrolled	5.86	8.60	9.52	10.5	12.9	14.3
MSW Uncontrolled & closed over 15 year	1.33	0.97	0.79	0.65	0.43	0.36
Industrial Landfills	0.76	1.05	1.14	1.24	1.46	1.59
Waste Combustion	0.23	0.20	0.19	0.17	0.15	0.14
Municipal Wastewater	1.57	2.01	2.23	2.50	3.15	3.54
Industrial Wastewater	0.22	0.22	0.22	0.22	0.22	0.22
Agriculture	**16.3**	**15.5**	**15.0**	**14.4**	**13.6**	**13.1**
Enteric Fermentation	2.51	2.30	2.18	2.05	1.85	1.75

Manure Management	0.76	0.76	0.69	0.63	0.57	0.55
Agricultural Soils	3.36	2.73	2.43	2.03	1.43	1.14
Agricultural Burning	0.01	0.01	0.01	0.01	0.01	0.01
Rice Cultivation	0.06	0.09	0.06	0.06	0.06	0.06
Agricultural Soils (cultivation practices)	9.63	9.63	9.63	9.63	9.63	9.63
Forest Fires (CH_4 and N_2O)	**7.05**	**5.29**	**6.82**	**6.70**	**6.70**	**6.70**
Gross Emissions (Consumption Basis, Excludes Sinks)	**248.8**	**315.0**	**336.6**	**362.6**	**424.9**	**463.3**
Increase relative to 1990		*27%*	*35%*	*46%*	*71%*	*86%*
Emissions Sinks	**-17.8**	**-26.7**	**-27.3**	**-27.2**	**-27.1**	**-27.1**
Forested Landscape	-3.38	-21.1	-21.1	-21.0	-20.9	-20.9
Urban Forestry and Land Use	-14.4	-5.65	-6.23	-6.23	-6.23	-6.23
Net Emissions (Includes Sinks)	**230.9**	**288.3**	**309.4**	**335.3**	**397.8**	**436.2**

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; CH_4 = methane; N_2O = nitrous oxide; MSW = municipal solid waste; LFTGE = landfill gas to energy; LPG = liquefied petroleum gas; ODS = ozone-depleting substance; HFC = hydrofluorocarbon; PFC = perfluorocarbon; SF_6 = sulfur hexafluoride; NG = natural gas; T&D = transmission and distribution;

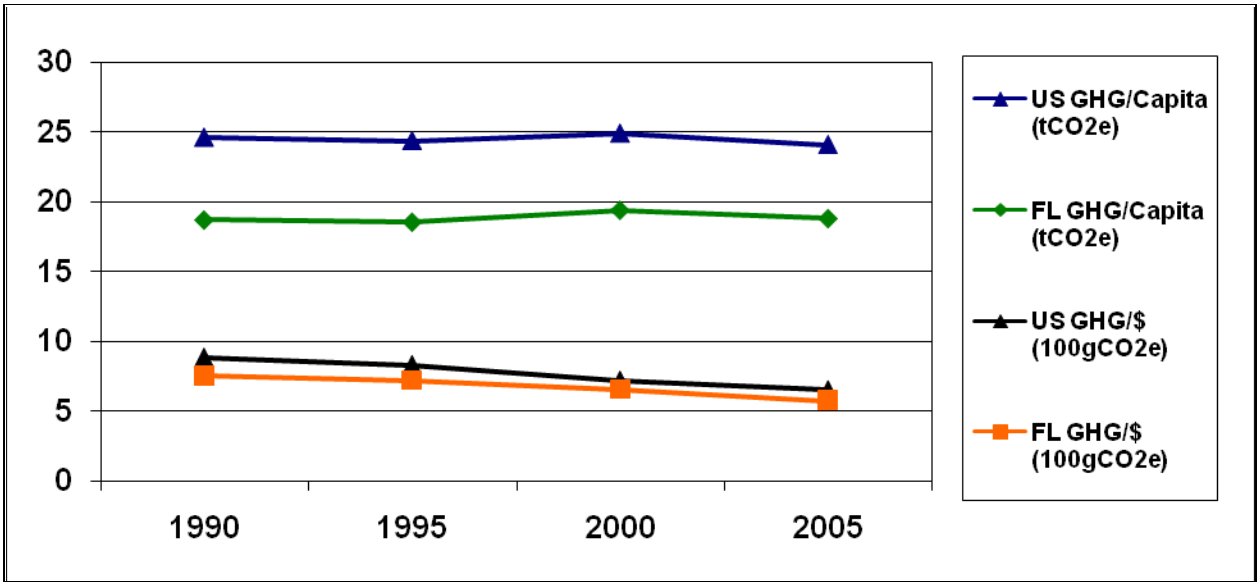
* Totals may not equal exact sum of subtotals shown in this table due to independent rounding.

On a per capita basis, Florida emitted about 19 metric tons (t) of gross CO_2e in 2005, lower than the national average of about 24 tCO_2e. Figure 2-1 illustrates the state's emissions per capita and per unit of economic output. It also shows that Florida per capita emissions have remained relatively flat between 1990 and 2005, similar to the nation as a whole. In both Florida and the nation as a whole, economic growth exceeded emissions growth throughout the 1990-2005 period. From 1990 to 2005, emissions per unit of gross product dropped by 26 percent, both in Florida and nationally.[6]

The principal sources of Florida's GHG emissions in 2005 are electricity consumption and transportation – these account for 42 percent and 36 percent, respectively, of Florida's gross GHG emissions, as shown in Figure 2-2. The direct use of fuels—natural gas, oil products, coal, and wood—in the residential, commercial, and industrial (RCI) sectors accounts for 6 percent of the state's emissions in 2005, significantly lower than the RCI sector contribution for the nation at 22 percent.

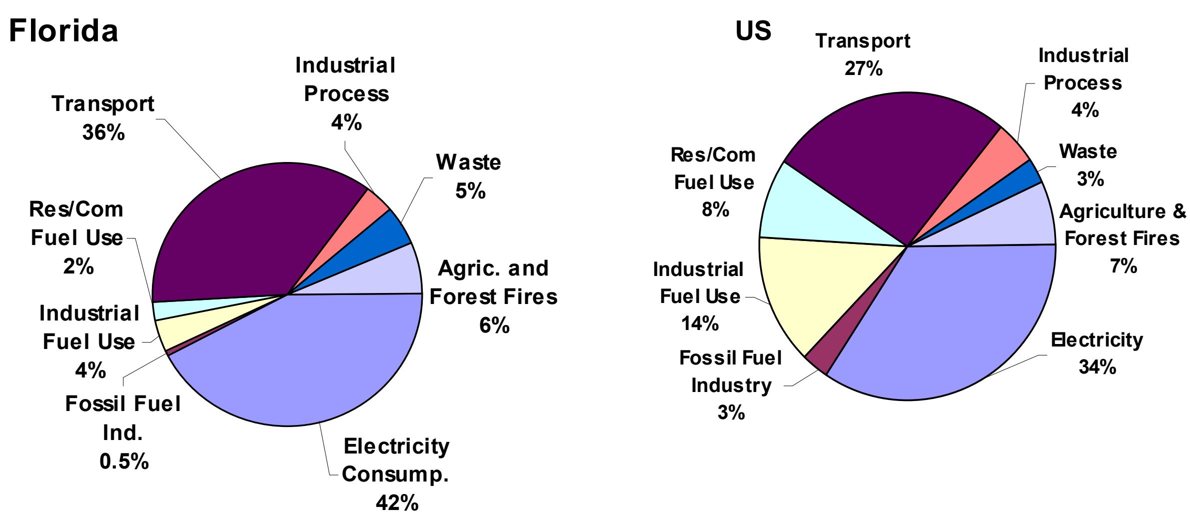
[6] Based on real gross domestic product (millions of chained 2000 dollars), that excludes the effects of inflation, available from the U.S. Department of Commerce, Bureau of Economic Analysis. "Gross Domestic Product by State." Available at: http://www.bea.gov/regional/gsp/.

Figure 2-1. Florida and U.S. gross GHG emissions, per-capita and per-unit gross product



GHG = greenhouse gas; tCO_2e = metric tons of carbon dioxide equivalent; GSP = gross state product; GDP = gross domestic product; g = grams.

Figure 2-2. Gross GHG emissions by sector, 2005: Florida and U.S.



The agricultural and forest wildfire sectors together account for 6 percent of the gross GHG emissions in Florida in 2005. These methane (CH_4) and nitrous oxide (N_2O) emissions primarily come from agricultural soils, rice cultivation, enteric (intestinal) fermentation, and manure management. Landfills and wastewater management facilities produce CH_4 and N_2O emissions that account for 5 percent of total gross GHG emissions in Florida in 2005. These emissions include:

- CH_4 emissions from municipal and industrial solid waste landfills;
- CH_4, CO_2, and N_2O emissions from the combustion of solid waste at open residential sites or in incinerators; and
- CH_4 and N_2O from municipal wastewater and CH_4 from industrial wastewater treatment facilities.

Also, industrial process emissions accounted for another 4 percent of the state's GHG emissions in 2005, and these emissions are rising due to the increasing use of HFCs and PFCs as substitutes for ozone-depleting chlorofluorocarbons.[7] In addition, emissions associated with the production, processing, transmission, and distribution of fossil fuels accounted for 0.5 percent of the gross GHG emissions in 2005.

Forestry emissions refer to the net CO_2 flux[8] from forested lands in Florida, which account for about 47 percent of the state's land area.[9] Florida's forests are estimated to be net sinks of CO_2 emissions in the state, reducing net GHG emissions by 27 $MMtCO_2e$ in 2005.

Reference Case Projections

Relying on a variety of sources for projections, a simple reference case projection of GHG emissions through 2025 was developed. This is illustrated in Figure 2-3 and shown numerically in Table 2-1. Under the reference case projections, Florida's gross GHG emissions would continue to grow steadily, climbing to about 463 $MMtCO_2e$ by 2025, or 86 percent above 1990 levels. This equates to a 1.6 percent annual growth rate from 2005 to 2025. By 2025, transportation emissions would increase to 43 percent while emissions from electricity consumption would decrease to 34 percent. In addition, emissions from industrial processes would increase to 8 percent while emissions from the RCI sector would decrease to 5 percent.

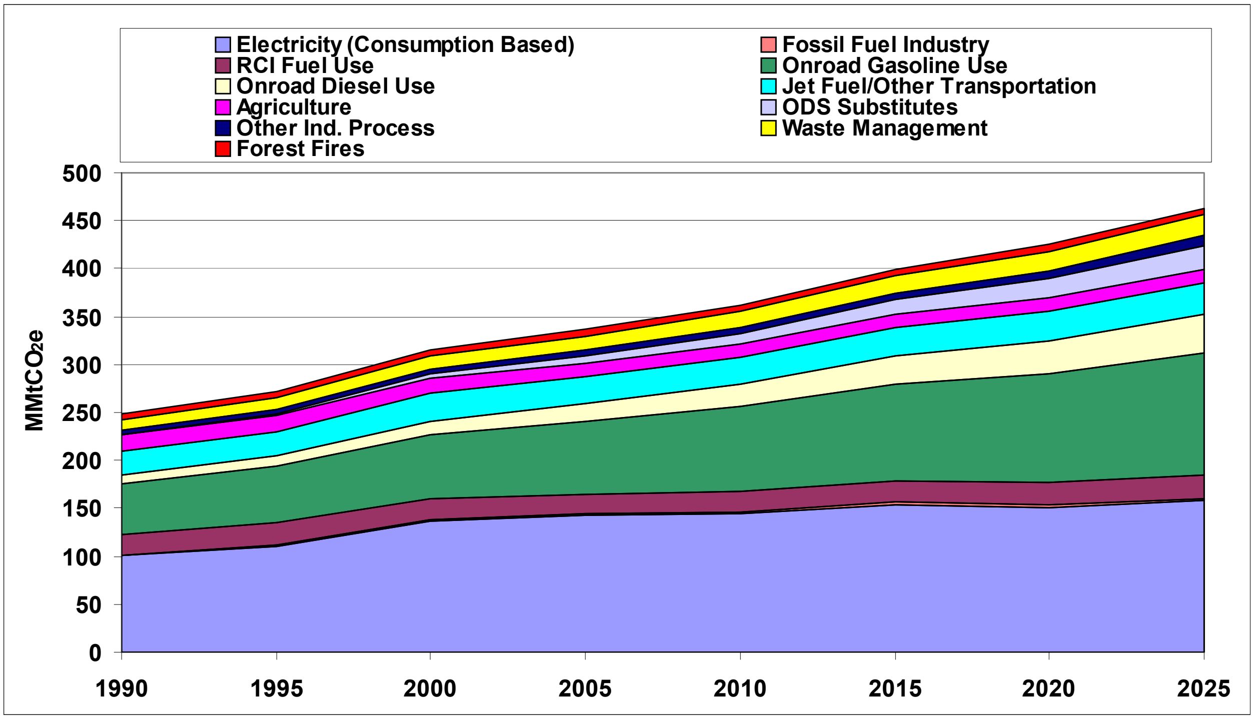
Therefore, emissions associated with the transportation sector are projected to be the largest contributor to future GHG emissions growth in Florida, followed by emissions associated with the increasing use of HFCs and PFCs as substitutes for ozone-depleting substances (ODS) in refrigeration, air conditioning, and other applications. Other sources of emissions growth include electricity consumption, as well as the waste management sector, as shown in Figure 2-4. Table 2-2 summarizes the growth rates in the Florida reference case projections.

[7] Chlorofluorocarbons are also potent GHGs; however, they are not included in GHG estimates because of concerns related to implementation of the Montreal Protocol on Substances That Affect the Ozone Layer. See Appendix I in the Final Inventory and Projections report for Florida (http://www.flclimatechange.us/Inventory_Forecast_Report.cfm).

[8] "Flux" refers to both emissions of CO_2 to the atmosphere and removal (carbon sinks) of CO_2 from the atmosphere.

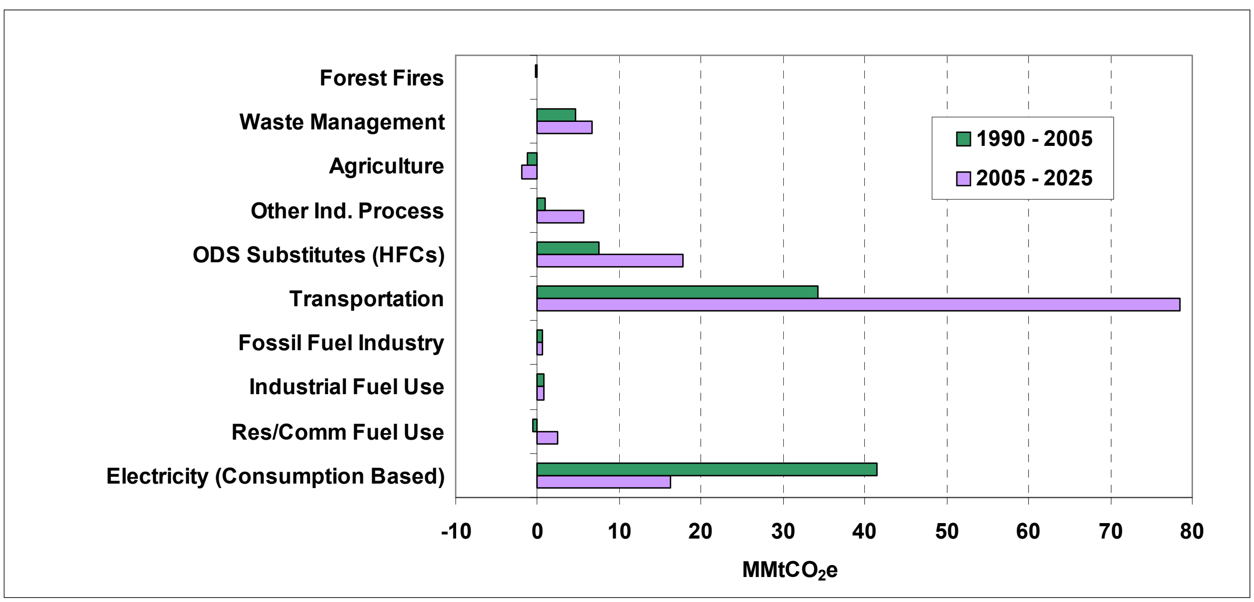
[9] Total forested acreage is 16.3 million acres. For acreage by forest type, see: Richard A. Birdsey and George M. Lewis. "Carbon in United States Forests and Wood Products, 1987–1997: State-by-State Estimates." Florida Estimate for 1987–1997. Available from the U.S. Department of Agriculture, Forest Service, Northern Global Change Research Program, at: http://www.fs.fed.us/ne/global/pubs/books/epa/states/FL.htm. The total land area in Florida is 34.6 million acres (http://www.50states.com/florida.htm).

Figure 2-3. Florida gross GHG emissions by sector, 1990–2025: historical and projected



$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; RCI = direct fuel use in residential, commercial, and industrial sectors; ODS = ozone-depleting substance; Ind. = industrial.

Figure 2-4. Sector contributions to gross emissions growth in Florida, 1990–2025: reference case projections



$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; ODS = ozone-depleting substance; HFCs = hydrofluorocarbons; RCI = direct fuel use in residential, commercial, and industrial sectors.

Table 2-2. Key annual growth rates for Florida, historical and projected

	1990-2005	2005-2025	Sources
Population	2.2%	1.7%	From the Demographic Estimating Conference Database, updated August 2007. http://edr.state.fl.us/population.htm
Electricity Sales Total Sales[a]	3% (1990-1999)	2.2% (2000-2007) 1.7% (2008-2025)	For 1990-1999, annual growth rate in total electricity sales for all sectors combined in Florida calculated from EIA State Electricity Profiles (Table 8) http://www.eia.doe.gov/cneaf/electricity/st_profiles/florida.html For 2000-2007, annual growth rates are based on average growth rates in the SERC/FL and SERC NERC regions in which Florida is located, as reported by the FRCC. For 2008-2025, an annual growth rate of 1.7 percent annually was assumed, based on the recommendation of the Action Team's Energy Supply and Demand TWG, as reviewed and accepted by the Action Team.
Vehicle Miles Traveled	4.1%	2.9%	Based on VMT projections provided by Florida Department of Transportation.

[a] Represents annual growth in total sales of electricity by generators in and outside Florida to RCI sectoral demand within Florida.

A Closer Look at the Two Major Sources: Electricity Consumption and Transportation

As shown in Figure 2-2, electricity use in 2005 accounted for 42 percent of Florida's gross GHG emissions (about 142 $MMtCO_2e$), which is much higher than the national share of emissions from electricity generation (34 percent). On a per capita basis, Florida's GHG emissions from electricity consumption are slightly lower than the national average (in 2005, 7.9 tCO_2e per capita in Florida, versus 8.1 tCO_2e per capita nationally). Electricity generation in Florida comes from a diverse mix of natural gas (38 percent of Florida gross electricity production in 2005), coal (28 percent), petroleum (17 percent), and nuclear (13 percent) fuels. Florida imports 10 percent of its electricity from out of state.

As noted above, these electricity emission estimates reflect the GHG emissions associated with the electricity sources used to meet Florida's demand for electricity, corresponding to a consumption-based approach to emissions accounting. For many years, Florida power plants have produced less electricity than is consumed in the state. In 2005, for example, emissions associated with Florida's electricity consumption (142 $MMtCO_2e$) were about eight $MMtCO_2e$ higher than those associated with electricity production (134 $MMtCO_2e$). The higher level for consumption-based emissions reflects GHG emissions associated with net imports of electricity from coal burning generators in other states to meet Florida's electricity demand.[10] Projections of electricity sales and generation for 2005 through 2025 nominally show Florida's imports of electricity falling to zero by 2017 as current firm import contracts expire[11], though it is

[10] Estimating the emissions associated with electricity use requires an understanding of the electricity sources (both in-state and out-of-state) used by utilities to meet consumer demand. The current estimate reflects some very simple assumptions, as described in Appendix A of the Inventory and Projections report.

[11] Import trends used in the revision of the Action Team forecast of electricity sales, production, and electricity sector emissions were taken from the Florida Reliability Coordinating Council (FRCC) report "2008 Regional Load & Resource Plan", published in July, 2008. As noted above, it is recognized that though imports in the FRCC report

recognized that some of these contracts may be renewed, and that Florida will continue to import electricity for the entire period. The reference case projection assumes that production-based emissions (associated with electricity generated in-state) will increase by about 24 MMtCO_2e between 2005 and 2025, and consumption-based emissions (associated with electricity consumed in-state) will increase by about 16 MMtCO_2e, reflecting the underlying assumption that emissions from electricity imports are decreasing over this time period.

While estimates are provided for emissions from both electricity production and consumption, unless otherwise indicated, the tables, figures, and totals in this report reflect electricity consumption emissions. The consumption-based approach, which is largely unaffected by assumptions regarding power imports, better reflects the emissions (and emission reductions) associated with activities occurring in Florida, particularly with respect to electricity use (and efficiency improvements), and is particularly useful for decision-making. Under this approach, emissions associated with electricity exported to other states would need to be covered in those states' inventories in order to avoid double-counting or exclusions.

Like electricity emissions, GHG emissions from transportation fuel use have risen steadily from 1990 to 2005, at an average annual rate of 2.2 percent. In 2005, gasoline-powered on-road vehicles accounted for about 63 percent of transportation GHG emissions; on-road diesel vehicles for 15 percent; marine vessels for 12 percent; aviation fuels for 9 percent; and rail and other sources (natural gas- and liquefied petroleum gas-fueled vehicles used in transport applications) accounted for the remaining 1 percent. As a result of Florida's population and economic growth and an increase in total vehicle miles traveled (VMT), emissions from on-road gasoline use increased at an annual rate of 2.5 percent from 1990 to 2005. Meanwhile, emissions from on-road diesel use increased by 4.3 percent per year from 1990 to 2005 suggesting an even more rapid growth in freight movement within the state. Emissions from on-road gasoline vehicles in 2025 are projected to increase by 2.6 percent annually from 2005 levels, and emissions from on-road diesel vehicles are projected to increase by 4.1 percent annually from 2005 to 2025, with total transportation emissions expected to reach 200 MMtCO_2e by 2025.

Action Team Revisions

The Action Team made the following revisions to the inventory and reference case projections, which explain the differences between the final Inventory and Projections report and the draft initial assessment completed in June 2008:

- *Electricity Consumption*: The electricity supply forecast was revised based on information from the Florida Reliability Coordinating Council (FRCC) forecasts, as modified based on recommendations from the Energy Supply and Demand TWG. Key revisions are:

trend to zero by the end of the FRCC planning period (2017), imports at some level are, in fact, highly likely to continue past that date.

- Florida Electricity Sales: Using TWG recommendations, sales in 2025 are 8.8 percent lower than the original (AEO2007-based) Action Team forecast, and 13.2 percent lower than the (extrapolated) FRCC forecast.
- Transmission and Distribution (T&D) losses: FRCC estimates T&D losses as a fraction of net generation increase over 2008-2013, and are substantially higher (at about 8 percent of net generation in 2013, remaining stable thereafter) than in the original Action Team forecast (based on U.S. Department of Energy *Annual Energy Outlook* figures).
- Revised estimates of electricity generation by type of generation: There is considerably more nuclear and gas-fired electricity, and considerably less coal- and oil-fired generation, than in the earlier forecast prepared for the Action Team.

- *Agriculture*:
  - A University of Florida report on soil carbon was utilized to update emissions from the cultivation of organic soils. (Original emissions were based on 1997 U.S. Department of Agriculture data.)
- *Waste Management*:
  - DEP provided supplemental landfill facilities information to update the data from the U.S. Environmental Protection Agency's Landfill Methane Outreach Program. Gaps in activity data were augmented with average values and assumptions (described in Appendix G of the Inventory and Forecast report).
  - Solid waste landfills and emissions were separated into five groups: Municipal Solid Waste (MSW) Landfill Gas-to-Energy, MSW Flared, MSW Uncontrolled, MSW Uncontrolled and Closed Over 15 Years, and Industrial Landfills.
  - Historic (2000-2005) growth in emissions from landfills were used as growth rates for projecting 2006-2025 emissions from waste landfilled.
- *Forestry and Land Use*:
  - The Agriculture, Forestry, and Waste Management TWG provided an updated U.S. Forest Service report, *Florida's Forests – 1995*, which was used to revise historic forest carbon flux values for 1987-1995 and 1995-2005.
  - Projections in forest land carbon flux (2005-2025) were originally kept at 2005 levels. The revised projections take into account annual forest area losses based on U.S. Forest Service reports: *Florida's Forests – 1995,* and *Florida's Forests - 2005*.
  - In addition to wildland fire emissions, the Florida Division of Forestry provided activity data for prescribed burning, which increased the overall emissions from forest fires. Also, forest fires emission forecasts were revised to reflect historic

average emissions; this was done due to uncertainty in future forest fire projections and wide annual fluctuations in acres of forest area burned.

Key Uncertainties

Some data gaps exist in this inventory, and particularly in the reference case projections. Key tasks for future refinement of this inventory and forecast include review and revision of key drivers (such as the transportation, electricity demand, and waste management growth rates) that will be major determinants of Florida's future GHG emissions (See Table 2-2 and Figure 2-4). These growth rates are driven by uncertain economic, demographic, and land use trends (including growth patterns and transportation system impacts), all of which deserve closer review and discussion.

Chapter 3
Energy Supply and Demand (ESD)

Overview of Sectoral Greenhouse Gas Emissions

The Energy Supply and Demand (ESD) sector includes all greenhouse gas (GHG) emissions that are associated with energy usage in the residential, commercial, and industrial (RCI) sectors, as well as emissions from the electricity supply sector. These combined sectors are responsible for the majority of Florida's GHG emissions — 53 percent of the total in 2005. The state's future trends in GHG emissions therefore will depend heavily on future activities and climate policies in the ESD arena. ESD emissions can be separated into two categories – emissions that occur as fuels are used on-site at RCI buildings and facilities, and emissions that occur at sites where electricity is produced.

Direct emissions of GHGs from the RCI sectors result principally from the on-site combustion of natural gas, oil, and coal, plus non-energy sources of GHG emissions. Some examples include carbon dioxide (CO_2) generated during cement production; the use of sulfur hexafluoride (SF_6) in the utility industry; the leakage of hydrofluorocarbons (HFCs) from refrigeration and related equipment; and the release of methane (CH_4) and nitrous oxide (N_2O) during oil and gas production and distribution. In Florida, direct emissions from RCI sectors in 2005 account for 11 percent of total GHG emissions – 6 percent from on-site combustion and 5 percent from non-energy sources.

Considering only the direct emissions that occur within buildings and industries, however, ignores the GHG emissions associated with electricity use in these facilities. Virtually all electricity sold in Florida is consumed as the result of activities in the RCI sectors. Emissions associated with producing the electricity consumed in Florida were responsible for about 42 percent of Florida's total GHG emissions in 2005. Since Florida imports almost 10 percent of its electricity from other states, the GHG emissions associated with the imported electricity are included in the accounting of Florida's total emissions.

Figure 3-1 shows GHG emissions from the ESD sectors by fuel type from 2005 through 2025, and illustrates the large fraction of emissions associated with electricity use. As described in Chapter 2, Inventory and Projections, estimates of future GHG emissions are based on projections from the Florida Reliability Coordination Council, the U.S. Energy Information Administration, and other sources. The resulting forecasts indicate that GHG emissions from the ESD sectors will increase by 24 percent from 2005 to 2025, with large increases expected from industrial process activities.

Figure 3-1 Projected ESD GHG emissions by fuel type in Florida, 2005 to 2025

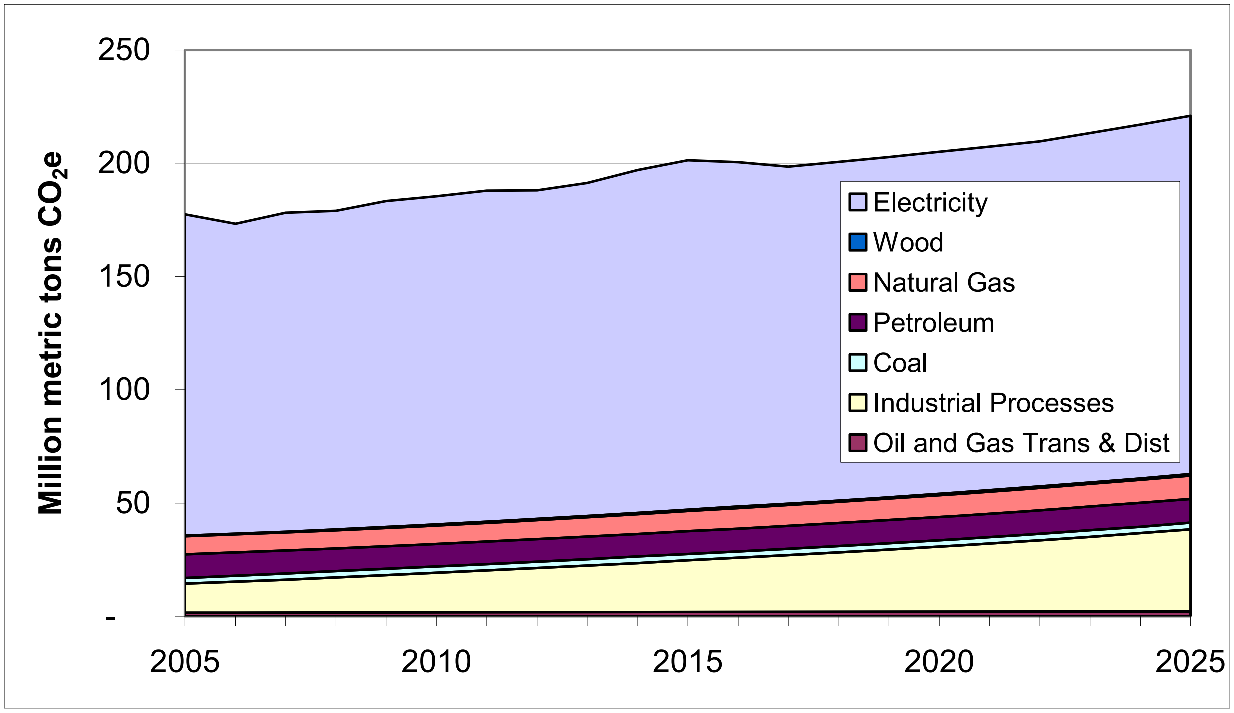
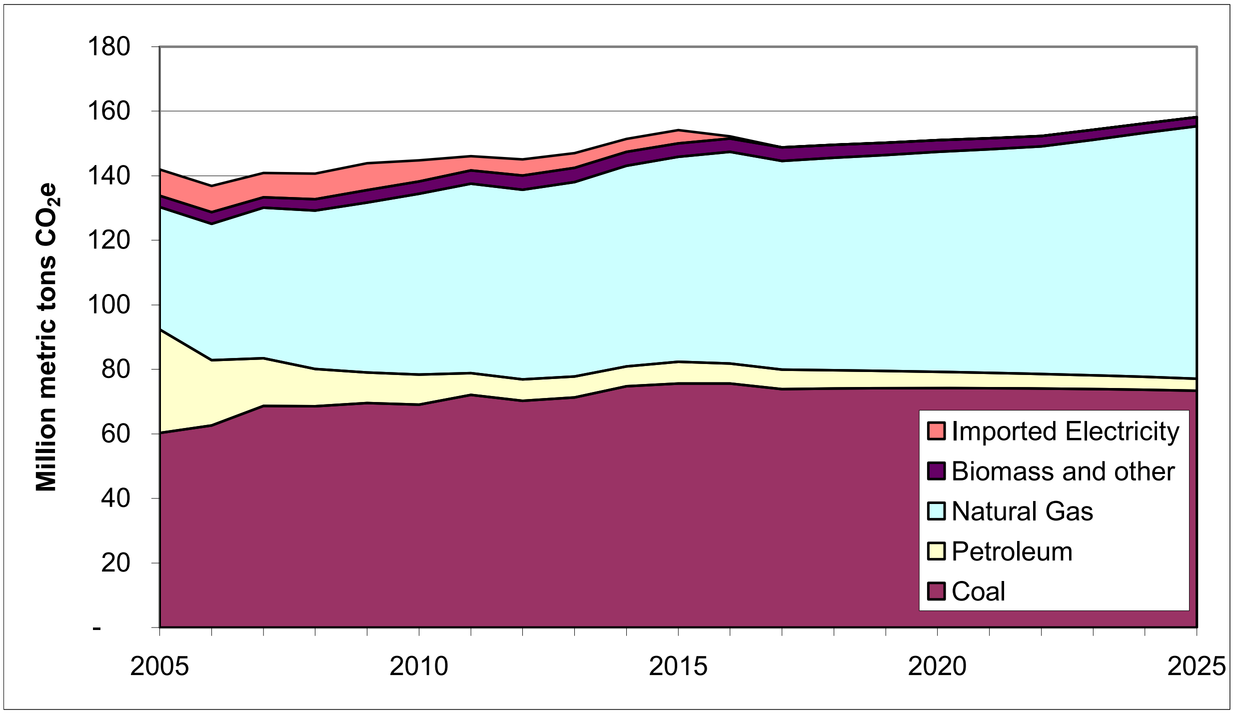


Figure 3-2 shows projected GHG emissions from electricity use in Florida. This information repeats the GHG emissions associated with electricity use in Figure 3-1, but provides additional information on the GHG emissions associated with different fuels used to produce electricity. (Nuclear and renewable power do not appear in Figure 3-2 because consumption of these resources does not directly result in GHG emissions.) As indicated, GHG emissions from electricity use increase by 11 percent from 2005 to 2025, even as electricity sales increase by 39 percent over the same time period. Florida's electricity sector is projected to be less GHG-intensive due to a combination of more nuclear power and more efficient natural gas generation, and less coal and petroleum generation. See Chapter 2 for more information on reference case projections from the electricity sector.

Figure 3-2 Projected Electric Sector GHG emissions by fuel type in Florida, 2005 to 2025



Key Challenges and Opportunities

As shown in the above charts, Florida's GHG emissions from ESD could increase by 24 percent between now and 2025. Florida's increasing population and economic growth, combined with increases in energy consumption per person, are key drivers for this projected increase in emissions. While countering the growth in emissions from the ESD sectors is no small challenge, Florida has a number of opportunities to reduce emissions. The choice and implementation of which climate policies and supporting initiatives will be key to helping citizens and businesses take full advantage of these reduction opportunities.

The opportunities to reduce GHG emissions from ESD in Florida include improving energy efficiency in new and existing buildings and industrial facilities, using renewable resources and other low-GHG energy sources (such as solar water heating, photovoltaics, biomass, and nuclear power) to replace fossil fuels for producing electricity and heat, and increasing distributed (consumer-sited) electricity generation based on combined heat and power.

Recent actions by Governor Crist, the Florida Legislature, and all aspects of state government demonstrate a strong commitment to exploring opportunities that will reduce energy consumption and increase renewable energy supply. In 2008, the Legislature passed new energy efficiency standards in the statewide building codes. The requirements are to be incrementally scaled up to provide a 50 percent improvement in energy efficiency by 2019, relative to the 2007 codes. In addition, Florida's Energy Efficiency and Conservation Act (FEECA) was enacted in 1980, placing an emphasis on reducing the growth rates of weather-sensitive peak demand, reducing and controlling the growth rates of electricity consumption, and reducing the consumption of scarce resources such as petroleum fuels. The Florida Public Service Commission (PSC) adopted rules requiring those electric utilities that are subject to FEECA to implement cost-effective energy efficiency programs and additional incentives for increased efficiency gains, as required by the 2008 legislation signed into law by Governor Crist.

Florida has taken a multifaceted approach to reducing barriers to renewable generation and bringing those technologies to market. For example, the PSC has approved standard offer contracts to reduce regulatory lag and negotiations between qualifying renewable facilities and utilities. In 2008, the PSC approved tariffs to implement one of the nation's most aggressive net-metering laws, intended to promote the development and interconnection of customer-owned renewable generation, such as solar photovoltaic power. The PSC is developing a rule for a Renewable Portfolio Standard (RPS), which could encourage utility-scale renewables. This rule will be presented to the Legislature in 2009.

Overview of Policy Recommendations and Estimated Impacts

The Governor's Action Team on Energy and Climate Change (Action Team) recommends a set of 19 policies for the ESD sector, offering the potential for significant GHG emission reductions. A summary of the ESD recommendations developed is shown in Table 3-1. Policies were grouped into "Tier 1" and "Tier 2" in order to focus the resources for analyzing these opportunities. Criteria for the tiers were based on the following:

- Tier 1 – recommendations which were expected to lead to significant GHG reductions by 2025 and were relatively straightforward to analyze (information readily available, similar policies had been implemented elsewhere).
- Tier 2 – policies that did not meet the criteria for Tier 1.

The Action Team noted the importance of all of the ESD policies, including both Tier 1 and Tier 2, but chose to focus quantitative analysis and subsequent recommendations (as described below) on the Tier 1 recommendations. (More information on Tier 2 options can be found in Appendix A.) Table 3-1 also includes estimated GHG reductions of recent policy actions that have been implemented by Florida. Many of Florida's recent policy actions are included in the reference case forecast. Changes to the building code, however, were quite recent, and since the impacts of those changes are not reflected in the forecast, they have been estimated for the Action Team, with the results of the analysis presented below.

Table 3-1 Summary List of Policy Recommendations

Policy No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value (See Note 2) 2009–2025 (Million $)	Cost-Effective-ness ($\$/tCO_2e$)	Status of Recom-mendation
		2017	2025	Total 2009–2025			
Tier 1							
ESD-5	Promoting Renewable Electricity through Renewable Portfolio Standard (RPS), Incentives and Barrier removal (20% by 2020)	17	34.5	319	-$9,274	-$29	Approved
ESD-6	Nuclear Power	0.0	7.3	49.4	$1,782	$36	Approved
ESD-7	Integrated Resource Planning (IRP)	Not to be quantified					Approved
ESD-8	Combined Heat and Power (CHP) Systems	1.8	2.2	26.5	$126	$5	Approved
ESD-9	Power Plant Efficiency Improvements	8.4	8.9	111.4	–$1,541	–$14	Approved
ESD-11	Landfill Gas-To-Energy (LFGTE)	3.7	8.7	64.7	$79	$1	Approved
ESD-12	Demand-Side Management (DSM)/Energy Efficiency Programs, Funds, or Goals for Electricity	13.0	21.8	201.4	–$8,566	–$43	Approved
ESD-13a	Energy Efficiency in Existing Residential Buildings	3.4	5.4	50.4	-$1,432	-$28	Approved
ESD-14	Improved Building Codes for Energy Efficiency	0.0	4.9	9.9	-$265	-$27	Approved
ESD-15	Training and Education for Building Operators and Community Association Managers	*Not to be quantified*					Approved
ESD-17	Consumer Education Programs	*Not to be quantified*					Approved
ESD-23	Decoupling	*Not to be quantified*					Approved
Recent Actions							
	Building Codes for Energy Efficiency (HB 697 and Executive Order 127)	8.0	15.4	136.5	-$4,082	-$30	Not applicable
Sector Totals		**47.4**	**93.6**	**832.8**	**-$19,090**	**-$23**	
Sector Totals After Adjusting for Overlaps (see Note 3)		**44.4**	**106.4**	**841.3**	**-$16,143**	**-$19**	
Reductions from Recent Actions		**8.0**	**15.4**	**136.5**	**-$4,082**	**-$30**	
Sector Totals, including recent actions and adjustment for overlaps		**52.4**	**121.8**	**977.8**	**-$20,226**	**-$21**	

Policy No.	Policy Recommendation	Energy Security Fuel Savings (Saved 2009 - 2025)		
		Coal (million short tons)	Natural gas (billion cubic feet)	Petroleum (million gallons)
Tier 1				
ESD-5	Promoting Renewable Electricity through Renewable Portfolio Standard (RPS), incentives and barrier removal (20% by 2020)	37	4,092	654
ESD-6	Nuclear Power	4	733	61
ESD-7	Integrated Resource Planning (IRP)	*Not quantified*		
ESD-8	Combined Heat and Power (CHP) Systems	5	198	431
ESD-9	Power Plant Efficiency Improvements	14	1,383	241
ESD-11	Landfill Gas-To-Energy (LFGTE)	0	27	4
ESD-12	Demand-Side Management (DSM)/Energy Efficiency Programs, Funds, or Goals for Electricity	19	2,266	326
ESD-13a	Energy Efficiency in Existing Residential Buildings	6	650	100
ESD-14	Improved Building Codes for Energy Efficiency	0	171	4
ESD-15	Training and Education for Building Operators and Community Association Managers	*Not quantified*		
ESD-17	Consumer Education Programs	*Not quantified*		
ESD-23	Decoupling	*Not quantified*		
Recent Actions				
	Building Codes for Energy Efficiency (HB 697 and Executive Order 127)	16	1,750	279
Sector Totals		**85**	**9,520**	**1,822**
Sector Totals After Adjusting for Overlaps (see Note 3)		**172**	**6,394**	**68**
Reductions from Recent Actions		**16**	**1,750**	**279**
Sector Totals, including recent actions and adjustment for overlaps		**188**	**8,144**	**347**

Policy No.	Policy Option	GHG Reductions ($MMtCO_2e$)			Net Present Value (See Note 2) 2009–2025 (Million $)	Cost-Effective-ness ($\$/tCO_2e$)	Status of Option
		2017	2025	Total 2009–2025			
Tier 2							
ESD-1	Technology Research and Development (R&D) with Commercial Opportunities	**The Action Team noted the importance of all options but the focus for analysis and subsequent recommendations was on Tier 1 policies.**					
ESD-4	Electricity Transmission and Distribution Improvements						
ESD-13b	Incentives for New Residential Buildings and Master Planned Communities Achieving High Energy Performance Standards						
ESD-16	More Stringent Appliance/Equipment Efficiency Standards						
ESD-18	Incentives to Promote Implementation of Customer-Sited Renewable Energy Systems						
ESD-21	Rate Structures and Technologies to Promote Reduced Greenhouse Gas (GHG) Emissions						
ESD-22	Demand-Side Management (DSM)/Energy Efficiency Programs, Funds, or Goals for Natural Gas						

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; HB = House Bill.

Note: The numbering used to denote the above pending priority policies are for reference purposes only; it does not reflect prioritization among these important policies.

Note 2: Negative numbers in the "Net Present Value" column denote recommendations for which the discounted value of the monetary **benefits** of the recommendation are greater than the discounted total **costs** of the policy.

Note 3: The emissions reduction and cost estimates shown for each individual recommendation presume that each policy is implemented alone. Many recommendations interact extensively, as they target the reduction of energy use or emissions from the same sources. Therefore, if multiple recommendations are implemented, the results will not simply be the sum of each individual recommendation result. After individual recommendation assessments were complete, a "combined policies" assessment was conducted to estimate total emission reductions, and to capture the overlaps among policies that are reported here.

These Tier 1 recommendations include efforts to increase the use of renewable and waste-based resources for generating electricity (ESD-5, ESD-11), increase the use of nuclear power (ESD-6), improve the energy and GHG emissions performance of buildings, power plants and other activities (ESD-9, ESD-12, ESD-13a, ESD-14), and increase the penetration of combined heat and power systems (ESD-8). All of these recommendations have been quantitatively analyzed, and the estimates prepared suggest that the recommendations can provide substantial reductions in

GHG emissions. Other Tier 1 recommendations include support for electric power planning requirements (Integrated Resource Planning, ESD-7) that directly considers attributes such as GHG emissions, Training and Education for Building Operators and Community Association Managers (ESD-15), Consumer Education Programs (ESD-17), and a regulatory policy recommendation (Decoupling, ESD-23) designed to reduce disincentives for investor-owned utilities to increase customers' energy efficiency. These recommendations are crucial policies that support the ESD recommendations and have been quantitatively analyzed, but have not been analyzed individually.

The ESD recommendations yield an annual GHG emissions reduction, from reference case projections, of 92 $MMtCO_2e$ in 2025, and cumulative reductions of 708 $MMtCO_2e$ from 2009 through 2025, at a net cost of approximately -$16 billion through the year 2025 on a Net Present Value (NPV) basis. This result accounts for overlaps between recommendations and for the cumulative changes that the electricity savings (through efficiency) and generation, provided by the recommendations, will have on the patterns of electricity demand and supply in Florida. The weighted-average cost of saved carbon for the combination of all ESD recommendations evaluated is -$23/$tCO_2e$ avoided. The negative costs indicate that, over time, the savings from the recommendations (from energy efficiency and/or avoided use of fossil fuels) will exceed the costs of implementation.

The Action Team also analyzed the estimated impact of Florida's recent changes to its building code, as described above, which is expected to result in substantial GHG emission reductions of about 15 $MMtCO_2e$ in 2025, and cumulative reductions of about 136 $MMtCO_2e$ through 2025. The net cost is approximately –$4 billion through the year 2025 on an NPV basis.

Energy Supply and Demand (ESD)
Policy Descriptions for Tier 1 Recommendations

Tier 1 recommendations are described briefly below. More information on each of these recommendations, plus the Tier 2 options, can be found in Appendix A.

ESD-5. Promoting Renewable Electricity Generation through Renewable Portfolio Standard (RPS), Incentives and Barrier Removal

The fundamental policy objectives of encouraging renewable electricity generation are to reduce GHG emissions, provide fuel diversity, provide more energy security, and stimulate Florida's economy. A Renewable Portfolio Standard (RPS) sets the minimum amount of electricity from renewable sources that must be generated and supplied to the electricity grid in a given year.

This minimum requirement is applied to each utility, but provisions are often made for utilities to purchase renewable electricity or credits from other utilities.

Institutional and market barriers to the development of renewable energy include price distortions, failure of the market to value the public benefits of renewables, the social cost of fossil fuel technologies, inadequate information, institutional barriers to grid interconnection, high transaction costs due to small project size, high financing costs because of lender unfamiliarity, and perceived risk. Developing renewable energy incentives and removing market barriers can complement an RPS policy tool.

The PSC is currently engaged in rulemaking for a RPS in Florida. This rule must be presented to the Legislature in its 2009 Session for its consideration and ultimate ratification. The Action Team recommends that the policy require 20 percent of retail electricity sales be met by renewable energy by 2020.

ESD-6. Nuclear Power

Nuclear power has historically presented a low-GHG source of electricity. No new commercial reactor has come on line in the United States since 1996 due to a combination of high capital costs, the absence of an operational system for permanent disposal of nuclear waste, and perceived risks to public safety. The administration of President George W. Bush has been supportive of nuclear expansion, emphasizing its importance in maintaining a diverse energy supply and its reputation for producing electricity with negligible greenhouse gas emissions during operation. Congress also has offered significant financial subsidies for new nuclear plants in an effort to jump-start the industry, including limitations on liability for nuclear accidents.

As of 2006, nuclear power plants provided about 20 percent of electric power nationally and 14 percent of Florida's generation. The goal for this policy is the installation of two additional (relative to the reference case) reactors/units of 1,100 MW each in 2020. The reference case forecast for the electricity sector assumes the installation of the facilities and capacities that are currently planned and permitted in Florida, including a total of four 1,100 MW reactor units at the Turkey Point and Levy sites. The Action Team also recommends vigorous efforts in Florida and across the nation to continue to improve safety standards for nuclear waste material including management, security, transmittal, long-term storage, and reprocessing of spent nuclear material.

ESD-7. Integrated Resource Planning (IRP)

Integrated Resource Planning (IRP), as it relates to electric utilities, is an economic planning process designed to identify the lowest practical cost at which a utility can deliver reliable energy services to its customers. It differs from traditional resource planning (the 10-Year Planning process currently used in Florida), in that it requires the use of analytical tools that assess and compare the costs and benefits of demand and supply-side energy resources. IRP should help to identify and standardize the critical assumptions across each of the varied planning forums that drive utility resource decisions, while building in flexibility to account for future uncertainties. While originally targeted primarily toward cost-minimization, IRP processes increasingly have considered the environmental risks and the potential costs and benefits associated with future GHG regulations.

This recommendation calls on Florida to undertake an integrated resource planning regime that embraces the idea of "least cost-best fit" as its primary criterion. Depending on its design, the IRP regime in Florida could be a means of implementing many of the other ESD recommendations.

ESD-8. Combined Heat and Power (CHP) Systems

Combined heat and power (CHP) is generally considered to refer to the use of a heat engine or a power station to simultaneously generate electricity and useful heat. CHP systems reduce fossil fuel use and GHG emissions through the improved efficiency of the CHP systems, relative to separate heat and power technologies, and by avoiding transmission and distribution losses associated with moving power from central power stations located far away from where the electricity is used. For this policy, CHP is defined broadly to include large-scale projects for heat and waste heat recovery. Also, it is intended to include the potential capture of all sources of byproduct heat generation, including waste heat from exothermic reactions when sulfuric acid is produced (such as is generated in phosphate fertilizer manufacturing).

The Action Team recommends that this policy be implemented by providing financial incentives and addressing the numerous barriers to development of CHP systems, including: inadequate technical information; institutional barriers; high transaction costs due to small project size; lender unfamiliarity and perceived risk; "split incentives" between building owners and tenants; and utility-related policies, such as interconnection requirements, high standby rates, and exit fees.

ESD-9. Power Plant Efficiency Improvements

Efficiency improvements refer to increasing generation efficiency at power stations through incremental improvements at existing plants (for example, more efficient boilers and turbines, improved control systems, or the use of combined cycle technology) and/or repowering. Repowering existing plants refers to switching to lower- or zero-emitting fuels at existing plants or for new capacity additions. This includes use of biomass or natural gas in place of coal or oil, thus reducing emissions rates at existing plants.

The Action Team recommends consideration of a range of policies that would encourage efficiency improvements and repowering of existing plants by including incentives or regulations as described in other recommendations and offering additional financing opportunities for those efficiency improvements.

ESD-11. Landfill Gas-to-Energy

The capture of methane gas from landfills provides an opportunity to reduce direct emissions of methane from landfills and to produce electricity. Added policy benefits of landfill gas power plants include producing base load-like electric generation, and offering the opportunity for combined heat and power to serve nearby thermal loads.

The Action Team recommends consideration of the expansion of landfill gas-to-energy in Florida either through a mandate or an incentive program.

ESD-12. Demand-Side Management (DSM)/Energy Efficiency Programs, Funds, or Goals for Electricity

Demand Side Management (DSM)/energy efficiency programs, and funds or goals for electricity entail actions that influence the quantity and/or patterns of use of energy consumed by end users. For this recommendation, DSM refers to programs implemented by utilities with the objective of reducing electricity consumption. Historically, Florida DSM programs have focused more on peak-power demand savings than on electrical energy savings; thus, this recommendation represents a shift in the objectives, and therefore the application, of DSM by Florida utilities.

This recommendation focuses on increasing investment in electricity efficiency through programs run by utilities or others, energy efficiency funds, and energy efficiency goals. These programs may be designed to work in tandem with other strategies that encourage efficiency gains. The policy design includes two key and linked dimensions: achievable/desirable energy savings and policy/administrative mechanisms to achieve these savings.

The Action Team recommends consideration of a range of policy and administrative mechanisms that might be applied include: regulator-verified savings targets; public benefit charges; portfolio standards; "energy trusts"; IRP as noted above; performance-based incentives; decoupling of rates and revenues; and appropriate rate treatment for efficiency. Potential mechanisms include revisions of existing statutes to enable utility investments in energy efficiency at the levels indicated above, and consideration of eligible programs that are cost-effective, taking into account the valuation of carbon dioxide emissions.

ESD-13a. Energy Efficiency in Existing Residential Buildings

With more than 50 percent of electricity in Florida used in residences, focusing attention on energy efficiency improvements to existing home structures has the potential to provide substantial reductions in electricity usage and associated GHG emissions.

The Action Team recommends consideration of a range of measures, including: incentives that focus on existing residential buildings, including low- or zero-interest energy efficiency loans; rewards for alternative business models aimed at delivering energy efficiency services; usage of energy performance benchmarks for buildings and incentives for exceeding the benchmarks; and health and safety standards that complement energy efficiency features.

ESD-14. Improved Building Codes for Energy Efficiency

Buildings are significant consumers of energy and other resources. Building energy codes can be an effective way to ensure that the most energy-efficient practices are incorporated into new or renovated buildings. This policy sets a goal for reducing building energy consumption to be achieved by increasing standards for the minimum performance of new and substantially renovated commercial and residential buildings through the adoption and enforcement of building codes. Building codes would be made more stringent via incorporation of aspects of advanced or next-generation building designs and construction standards, such as sustainable design and green building standards.

House Bills 697 and 7135 signed into law by Governor Crist in 2008 call for the energy efficiency requirements of the Florida Energy Efficiency Code to be incrementally scaled up to 50 percent higher than the 2007 code by 2019. The Action Team recommends that the scale-up of energy efficiency requirements from House Bill 697 and House Bill 7135 be made to continue beyond 2019.

ESD-15. Training and Education for Building Operators and Community Association Managers

Energy Management Training provides administrative and technical training for energy managers, school officials, building operators, and others responsible for energy-efficient facility operation. The Action Team recommends the following:

- Train commercial building energy managers, for example, by making use of the building operator training and certification program developed in the Pacific Northwest;
- Train industrial energy and facility managers in techniques for improving the efficiency of their steam, process heat, pumping, compressed air, motors, and other systems, perhaps in collaboration with ongoing U.S. Department of Energy programs in this area; and
- Create a credentialing program for certification of "green" energy managers that requires both training and examinations to qualify.

ESD-17. Consumer Education Programs

In many cases, the ultimate effectiveness of emissions reduction activities depends on providing information and education to consumers regarding the energy usage and resulting GHG emissions implications of their choices. Public education and outreach is vital to fostering a broad awareness of climate change issues and effects (including co-benefits, such as clean air and public health) among the state's citizens. Such awareness is necessary to engage citizens in actions to reduce GHG emissions in their personal and professional lives. Public education and outreach efforts should integrate and build on existing outreach efforts involving climate change and related issues in the state. Ultimately, public education and outreach will be the foundation for the long-term success of all of the mitigation actions proposed by the Action Team, as well as those that may evolve in the future from other entities. The Action Team recommends the following measures:

- Institute mandatory labeling programs for time-of-sale energy use for all consumer products, devices, and systems (including all buildings) that can be evaluated by either testing or computer simulation, and educate consumers on the implications of these labels.
- Create a public inquiry "information center" to provide factual answers (vetted by experts in the field) to common energy-efficiency and GHG questions.

- Provide public education materials and energy information that can be used at local levels by minimally trained speakers.
- Create an awards program that recognizes businesses and individuals exhibiting exemplary behavior or performance with respect to local energy and climate public education programs or in local GHG or energy use reduction programs.
- Provide Public Service Announcement (PSA) programs.

ESD-23. Decoupling

Traditional regulatory frameworks tie a utility's recovery of fixed costs of providing service (for example, infrastructure costs) to the quantity of energy sold. As a result, there is a contrary "incentive" for utilities to increase sales in order to boost revenues and minimize investments in energy efficiency (which would lead to lower sales). This recommendation includes the implementation of cost recovery rules that "decouple" the level of utility sales from net revenues earned by investor-owned utilities. Decoupling should be geared exclusively to remove barriers to utility investment in programs to increase customer energy efficiency and reduce customer loads. Decoupling mechanisms should be carefully designed in order to avoid, as much as possible, adverse economic impacts on ratepayers and to ensure that the decoupling mechanism is fair to both consumers and shareholders.

HB 7135 directed the PSC to analyze utility revenue "decoupling" and to provide a report and recommendation to the Governor, President of the Senate, and Speaker of the House of Representatives by 2009. The PSC began its workshops on this topic in August 2008.

Chapter 4
Cap-and-Trade

Overview

A cap-and-trade system works by setting an overall limit on emissions and either selling or distributing, at no cost, emissions "allowances," or permits to emit pollutants, to regulated entities or sources. These regulated entities must periodically surrender enough allowances to match their reported emissions or face a penalty. In a system that freely grants allowances, those sources that are able to reduce their emissions at a lower cost than the allowance price may do so and then sell those unused allowances to any entity that cannot achieve reductions as cost-effectively. In a system where allowances are initially sold, cost-effective emissions reductions reduce the number of allowances that must be purchased. Either way, cap-and-trade creates a financial incentive for emitters to continually seek out new emission-reducing technologies and cut emissions as much as possible. By creating a market for the allowances, regulated entities have the choice of either purchasing allowances or directly reducing emissions; as a result, resources are directed to the most cost-effective emissions reduction investments. To achieve overall emissions reductions over time, programs gradually lower the emissions "cap" by reducing the total number of available allowances.

Perhaps the best known example of cap-and-trade is the U.S. Environmental Protection Agency (EPA) program to cut acid rain-causing sulfur dioxide (SO_2) emissions from power plants. Established under the 1990 Clean Air Act amendments, this program successfully demonstrated the emissions trading concept by achieving dramatic, cost-effective reductions. More recently, the trading approach has been applied to greenhouse gas (GHG) emissions by the European Union (EU)[1] and proposed by several U.S.-based initiatives, including the Northeast Regional Greenhouse Gas Initiative (RGGI),[2] the Western Climate Initiative (WCI),[3] and the Midwestern Regional Greenhouse Gas Reduction Accord.[4]

The Action Team is charged with identifying means by which Florida can fully achieve or surpass the statewide GHG reductions specified in Executive Order 07-127.[5] These recommendations must be guided by an evaluation of the possible consequences to Florida's environment, economy, and society from global climate change. In November 2007, the Action Team issued its Phase 1 Report. The report offered broad policy guidance in key areas for consideration by the Governor and Legislature or further consideration by the Action Team, including a market-based regulatory approach for utility emissions.

[1] http://ec.europa.eu/environment/climat/emission.htm
[2] http://www.rggi.org
[3] http://www.westernclimateinitiative.org
[4] http://www.midwesternaccord.org/
[5] http://www.flclimatechange.us/ewebeditpro/items/O12F15074.pdf

In June 2008, Governor Crist signed House Bill 7135 (HB 7135), a comprehensive energy and climate change package aimed at reducing GHG emissions that included public investment and private-market incentives in alternative and renewable energy technologies. Section 65 of HB 7135 required the Florida Department of Environmental Protection (DEP) to propose rules for the creation of a cap-and-trade regulatory program. This chapter presents the results of the Phase 2 consideration called for in the Phase 1 Report and offers pre-rulemaking guidance to the DEP in response to the requirements of HB 7135.

There is growing expectation that Congress will require a federal cap-and-trade program. By initiating, joining, or developing a state and/or regional cap-and-trade system in the meantime, Florida would be taking an important step toward influencing the outcome of the federal policy debate in the state's favor.

Ultimately the pollution-cutting performance of a cap-and-trade program depends largely on how it is structured. Key design parameters are discussed below.

The cap-and-trade policy is designed and analyzed to work in concert with non-cap-and-trade policies and measures. The integration of other policies reduces compliance costs and eases attainment of both goals and caps. Emissions reductions, costs, and cost-savings from many of these other measures help Florida comply with the cap; and they also serve as a basis for the cap-and-trade modeling. As a result, the expected operation of the cap-and-trade program is integrated with other policies and policy recommendations, and is not presented as a stand-alone program.

Policy Recommendations and Estimated Impacts

Reduction Targets and Time Frames

Table 4-1-1 shows the schedule for GHG emission reductions pursuant to Executive Order 07-127.

Table 4-1-1. Schedule for GHG emission reductions

Year	GHG Reduction Goal
2017	2000 levels
2025	1990 levels
2050	20% of 1990 levels

GHG = greenhouse gas.

Sector Coverage

The regulation of GHG emissions should be economy-wide and should commence as soon as possible; however, a cap-and-trade program may apply only to a limited number of sectors. Sector inclusion in the cap-and-trade program should be guided by cost-effectiveness, administrative efficiency, overall reduction potential, experience by other jurisdictions, and whether alternative policies are preferred. The Florida cap-and-trade program should include the electric sector at the beginning. Rulemaking consideration also should be given to:

(1) industrial stationary source emissions;

(2) residential and commercial fuel use;

(3) transportation fuels; and

(4) energy extraction, processing, and transportation.

These sectors may be better candidates for inclusion in a subsequent phase.

The transportation and residential and commercial fuel use sectors could be considered through rulemaking. They have not been included in cap-and-trade programs to date, although WCI has proposed to include them in its program beginning in 2015. Unlike the electricity, energy extraction, and industrial sectors, these two sectors would most likely have to be regulated upstream of the actual point of emissions. The regulated entity in the transportation and residential and commercial fuel use sectors may need to be the fuel distributor or importer. Transportation and residential and commercial fuel use should be studied further and considered for inclusion in a subsequent phase, or they may be better suited for regulation through non-cap-and-trade market mechanisms. While these and other sectors may not be included in the cap-and-trade program or otherwise regulated at the program start, they should be included or otherwise regulated as soon as possible.

Other sectors may need alternative methods of regulation based on the factors listed above. Land development, forestry, agriculture, and waste management are generally not regulated under a cap-and-trade program due to a lack of historical emissions data, difficulty measuring or verifying current emissions, and other reasons. Emissions reduction projects or programs within these sectors may, however, be well-suited to participate in an "offsets" program as described below.

The Action Team recommends that a *de minimis* exemption below, which sources within the regulated sectors, would be exempt from regulation. The threshold for the exemption could vary by sector.

Regional Programs

First and foremost, a strong national cap-and-trade program is the preferred method for achieving substantial reductions in GHGs, and Florida should advocate for a national program. However, as the federal government deliberates on a national program, Florida should join a regional program to advance its GHG reduction goals. Toward that end, Florida should further examine the economics of joining a regional program, but should not join a regional program where analysis indicates that Florida would be disadvantaged.

Regional Greenhouse Gas Initiative (RGGI) – Initial analysis indicates that Florida would benefit from joining RGGI. RGGI currently comprises 10 northeastern states and will regulate emissions from fossil fuel–powered electric generation units (EGUs) with a nameplate capacity of 25 megawatts (MW) or greater. Two 100 percent auction-based cap-and-trade scenarios for year 2020 are simulated for Florida joining the RGGI program.[6] The two scenarios correspond to hypothetical allowance prices of $7/tCO2e and $1/tCO2e, respectively. Preliminary modeling indicates that Florida sources would represent slightly less than half of the total electric generation emissions from the 11 states (10 current states plus Florida), and, depending on assumptions used, would mitigate between 70 and 76 MMtCO2e in 2020, with the balance of 75 to 80 MMtCO2e accounted for by allowance purchases. Florida's RGGI sources would expect to see a cost-savings of between $1.5 and $2 billion dollars in 2020 by participating. (Note that any additional savings that might be realized from the recycling of the auction revenues by the government are not included.) Complete modeling results and analysis may be found in Appendix B: Cap-and-Trade. The Action Team recommends that Florida seek "observer status" with RGGI as soon as possible to examine the program in greater detail, closely monitor progress, and prepare for membership if it is desired.

Western Climate Initiative (WCI) – Initial analysis indicates that Florida may benefit from joining the cap-and-trade portion of WCI. Further study would be necessary to determine whether participation in the other planned WCI programs (regional low-carbon fuel standard and renewable portfolio standard) would benefit Florida. WCI is currently comprised of seven U.S. states and four Canadian provinces; its proposed cap-and-trade program will cover emissions from multiple sectors representing approximately 90 percent of total regional emissions. The cap-and-trade simulation for Florida joining WCI (based on the WCI proposed program design recommendations released September 23, 2008), covers a much broader range of emission sources than the RGGI simulation (basically all the sectors except the agriculture, forestry, and waste management sectors). The analysis indicates that Florida would be a permit seller in the market. Florida WCI sources would expect to see a cost savings of $191 million in 2020 by participating in the cap-and-trade program as opposed to achieving the same reductions without it. Florida sources would be expected to mitigate 18.46 MMtCO2e *more* than required to meet targets due to the relatively low cost of mitigation and the opportunity to sell

[6] A 100 percent auction is assumed due to limitations in the model resulting from RGGI's low cost mitigation opportunities (see Annex 1 to Appendix B). As a policy matter, the Action Team is neither recommending nor assuming that Florida will use 100-percent auctions as a means of initially distributing allowances.

allowances to other WCI sources. Complete modeling results and analysis are found in Appendix B: Cap-and-Trade. Because WCI is scheduled to begin on January 1, 2012, at the earliest, there is ample opportunity to conduct further economic analysis and possibly observe the early operation of WCI.

The Action Team recommends that Florida seek "observer status" with WCI as soon as possible to examine the program in greater detail, closely monitor progress, and prepare for membership if desired.

These two regional programs may not be mutually exclusive. The Action Team further recommends that Florida explore the economics and potential obstacles, complications, and benefits associated with joining both regional programs.

Other programs – Six Midwestern states and Manitoba are currently engaged in a discussion toward the development of a third regional cap-and-trade program. Recently organized, the group expects to release a draft program design in November 2008, so the Action Team was unable to evaluate whether Florida might benefit. Florida should continue to monitor the progress of this program and investigate the Midwestern program as it develops.

At the same time, Florida should reach out to other Southern states to explore collaborating in one or more ways: (1) jointly influence the development of a national cap-and-trade program; (2) explore the potential for multiple Southern states joining one or more regional programs; (3) help address "leakage" issues (see page 4-9); and (4) explore the creation of a Southern regional climate initiative to reduce GHG emissions, stimulate the development of renewable energy sources, reduce dependence on imported fuels, and stimulate the creation of industries specializing in energy efficiency, renewable energy, and carbon mitigation technologies.

Finally, the Action Team strongly recommends that Florida not pursue a "one state" cap-and-trade program.

Caps and Goals

Florida's GHG reduction cap-and-trade program should be designed to achieve the emission reduction goals set forth in Executive Order 07-127. However, as directed in that Executive Order and the recently enacted HB 7135, Florida should evaluate the conditions under which the state could cost-effectively link its trading system to the systems of other states or regions, such as RGGI or WCI. If Florida joins a regional climate initiative, it should accept the regional goal as long as it is consistent with the state's GHG reduction goals. Current modeling indicates that RGGI should bring Florida's electric sector emissions to the state's goals; however, if it does not, additional policies and measures would be required to reduce GHG emissions to meet the state's goals.

Flexibility and Cost Containment Mechanisms

The mechanisms described below contain a brief description followed by the policy recommendation.

- *Offsets*— Regulated sources can comply with the cap-and-trade program in three ways: reduce emissions directly; acquire and surrender allowances sufficient to cover emissions; or invest in qualifying offset projects and surrender offset credits. Offset projects are voluntary and generate revenue for a project owner through the sale of offset credits, which are equivalent to government-issued allowances. Emission reductions from regulated sources are, therefore, not eligible as offset projects; otherwise these reductions would be double-counted (once for the benefit of the regulated source under the cap, and again for the benefit of the offset purchaser). To ensure the integrity of the emissions cap, offset projects should reduce emissions or sequester carbon from uncapped, out-of-sector projects that are recognized by the program as qualifying for allowance credit. In most cases, any emissions included under any cap-and-trade program's cap cannot be reduced and also qualify as an offset credit under any other cap-and-trade program. Offsets provide an incentive for low-cost investments in uncapped emission reductions as an alternative to higher-cost, in-sector reductions, or allowance purchases.

  Recommendation: The cap-and-trade program should allow offsets without limits; however, the offset program must ensure rigorous quality standards.

- *Safety Valve*—A safety valve is a program feature designed to limit or moderate the cost of allowances for the purpose of ensuring that the program will not have an unacceptable impact on consumer costs. Safety valves can be as direct and simple as an allowance price cap, or as indirect and complex as the RGGI's stepped expansion of offset opportunities triggered by allowance prices[7]. The safety valve can be used in conjunction with other tools to mitigate price volatility (such as banking and borrowing). It should be noted that hitting the safety valve price cap would effectively convert the cap-and-trade program into a carbon tax at that price.

  Recommendation: The cap-and-trade program needs appropriate allowance price containment mechanisms, especially in the early years. Further study is needed before the specific mechanisms can be recommended.

- *Banking*—Banking allows permit holders to withhold unneeded allowances from the market, or from surrender for emissions compliance, without expiration. A banked allowance may be used in any compliance period beyond the issuance period without penalty. Banking is seen as a means of mitigating market volatility by allowing holders to hold allowances (thereby mitigating supply) when prices are low, and to use or sell them (thereby mitigating demand) when prices are high.

[7] The Western Climate Initiative employs banking, offsets and three-year compliance periods to mitigate allowance prices but does not have a "safety valve."

Recommendation: The cap-and-trade program should allow unlimited banking.

- *Borrowing*—Borrowing of allowances permits emitters to release excess tons of GHGs in the current compliance period in return for greater reductions in a future compliance period.

  Recommendation: Borrowing is an important cost containment mechanism and should be allowed, but agreement by the Action Team was not reached on what conditions (e.g., Warner-Lieberman-type limits by emitter, time limits, or interest) should be imposed.

Allowance Distribution

One of the most difficult issues confronting cap-and-trade program designers is how allowances are initially introduced to the market. The two principal methods are free allocation and auction sale. Free allocation is the method used in the EPA SO_2 trading program and was widely used in the first two phases of the EU Emissions Trading Scheme (ETS) program. Meantime, RGGI will auction nearly all of its allowances, and the EU is gradually moving toward greater reliance on auctions.[8] WCI is still deliberating on the issue, although it is likely that a decision on how best to distribute allowances will ultimately rest with participating jurisdictions.

Under a free allocation system, jurisdictions distribute allowances free of charge to regulated entities according to a formula based upon historical emissions, benchmarked emissions (the expected emissions per unit output for a facility with a preferred technological configuration), or on some other basis. Free allocation systems may include equity features such as a "reserve" for new market entrants, to avoid creating a competitive disadvantage. The formula that determines the number of allowances allocated to each source can be challenging to create. Historical emissions are a common approach, but issues such as selecting the time period to use as a basis and various equity adjustments can be difficult to determine. Benchmarking is straightforward in principle but very difficult to achieve in practice.

Under an auction system, allowances are presented to the market by sale at auction. Regulated entities are therefore required to purchase allowances. Revenues are collected by the issuing jurisdiction. Auctioning allowances resolves the "allocation basis" and many equity issues arising from the free allocation method but presents a new set of challenges, including the additional cost imposed on regulated entities and consumers. Emitters in some sectors are able to pass these costs on to their customers, but others are not. The cost passed along to the consumer may be a public policy concern and, in cases where competitive pressure prevents this, the economic impact on the emitter might be a concern. However, these concerns can be addressed by designing the program to be revenue neutral and returning the allowance value from the auction to consumers directly or through programs implemented for their benefit. In addition, there is the question of what the issuing jurisdiction will do with the auction revenues.

[8] On September 25, 2008, RGGI held its first auction, where 100 percent of its allowances were successfully auctioned off at a price of $3.07.

In the free allocation system, there is a concern regarding windfall profits, as happened in some instances in the EU. This can be an issue when the emitter is not price-regulated and can pass along the cost to customers, as can occur with generators in most of the RGGI states. However, in states where generators are price-regulated, such as Florida, through the Public Service Commission rate hearings, the value of the freely allocated allowance can be directed to the benefit of the ratepayer through rate-setting.

Free allocation and auctioning are not mutually exclusive. Programs can distribute some percentage of allowances using one method and then balance with the other. Programs may change the ratio of free allocation to auction distribution over time. Programs also may distribute allowances to different regulated sectors using different methods or a different mix of methods. Programs may even distribute allowances differently among different classes of sources within a sector (whether municipality-owned utilities, cooperative utilities, or investor-owned utilities).

The Action Team was unable to reach a consensus recommendation on the central issue of initial allowance distribution method. By a 13-5 majority, [9] the Action Team recommends that strong consideration be given to auctioning a substantial amount of allowances. The Action Team recognizes that as RGGI and WCI evolve, additional information will become available to DEP and the Legislature to better evaluate the use of auctions at the beginning of the cap-and-trade program and over time.

Those Action Team members who were opposed to this recommendation expressed concern that there has been no Florida-specific analysis of the relative cost to the consumer for allowance distribution by either auction or free-of-charge allocation. Without such information, they argue, any recommendation stating a preference would be premature. Concerns included whether requiring some industries to pay for allowances would put them at a competitive disadvantage. Others were concerned that there was no assurance that revenues from the sale of allowances would be used by the state for related purposes such as those stated below.

Those who supported auctioning pointed out that presentations from representatives of RGGI and the EU ETS had recommended the use of auctioning. Others stated that the revenues generated by the auctions would be needed to finance other key policies and measures proposed by the Action Team. At least one member observed that given the differences among electric utilities in the state, there would be no fair way to allocate allowances among them. The member observed that the formula would likely be the subject of intense lobbying in the Legislature, and, if allowances were distributed on the basis of historical emissions, customers of utilities with historically higher electric rates and cleaner generation would be disadvantaged while those with lower rates and higher emissions would be advantaged. Supporters of the position expressed the belief that auctioning is the most fair distribution method.

[9] The five Action Team members that voted no on this recommendation were: Mayor Rick Baker, Mike Branch, Mark Kaplan, Kathleen Shanahan and Kathy E. Viehe.

By unanimous consent, the Action Team offers the following general recommendations that could guide future policymakers in answering the question of allowance distribution:

Any allowance distribution system needs to be periodically evaluated to determine whether it is working properly and serving the program goals.

- The cap-and-trade program should strive to be revenue-neutral to consumers as much as possible. There are five broad purposes to which allowance value (either the allowances themselves or proceeds from their sale) should be applied. The purposes are not in any priority order:
  - Promote energy efficiency investments,
  - Mitigate impacts on ratepayers and consumers with particular attention to low-income consumers,
  - Accelerate the development and use of emissions mitigation technologies, including renewable or zero-carbon technologies,
  - Mitigate impacts of climate change (for example, fund adaptation strategies), and
  - Protect regulated emitters from competitive disadvantage.

There are a number of other important uses of allowance value which should also be considered, such as stimulating or rewarding investment in carbon emissions abatement technologies, funding program administration, and protecting regulated emitters from economic disadvantage. One member felt strongly that all allowance value should be used to mitigate the program's impact on ratepayers and consumers.

It is the Action Team's strong recommendation that if any revenues are generated from the sale of allowances, they should never be used to supplement General Revenue to the State of Florida.

Reporting

The cap-and-trade reporting system should be consistent with any national requirement. Every effort should be made to ensure that regulated entities are required to complete only one report for both state and national efforts. The reporting system should be as broad as possible; a *de minimis* limit may be needed, given administrative and cost concerns.

Mandatory reporting of GHG emissions is legislatively required at both the state and federal levels. Adoption of reporting rules and collection of emissions data should proceed as quickly as possible in advance of the cap-and-trade program. This is necessary to verify the data from sources and sectors where the historical lack of such requirements injects a significant level of uncertainty into historical emissions estimates and future projections.

Leakage

Leakage occurs when, in response to program incentives, utilities choose to either increase out-of region fossil-based power purchases, or investors choose to construct new generation units in unregulated border jurisdictions. In either case, both the environmental benefits and in-state investment are lost. It is noted that in a national program, leakage is not an issue. Leakage can be addressed through careful design of the point-of-regulation, as in the First Jurisdiction Deliverer (FJD) plan in WCI. FJD requires compliance from any generator within the region, plus any entity that imports fossil-based power from outside the WCI region.[10]

Historically, between 1990 and 2005, electricity imports have contributed between 9 percent and 16 percent of total electricity consumption in Florida. Accordingly, it is critical that the cap-and-trade program baseline include these out-of-state sources and their respective changes over time to accurately define the reduction requirements under the current generation mix.

The Action Team believes leakage is a potentially serious concern. Based on the initial analysis, projected 2020 "business as usual" GHG emissions from imports represent 10 percent of total electricity emissions, or 19.2 million metric tons of carbon dioxide equivalent (MMtCO_2e). This amount is equal to about one-third of the total electric utility sector emissions reductions required by 2020 to meet the Governor's GHG reduction goals. Further, electricity imports and their associated GHG emissions are expected to increase if Florida's electricity generation sector is subject to a carbon cap and if generation in adjacent states was not subject to a similar requirement.

The Action Team recommends that leakage must be addressed by any cap-and-trade program or by Florida through other means if a regional cap-and-trade program does not do so.

Trial Period

The first recommendation in Regional Programs is that there should be a strong federal cap-and-trade program and that Florida should be an advocate for national action. It is recommended that a new national program should incorporate a trial period to facilitate the transition, verify data, and sort out administrative and other details. The trial period should afford greater flexibility to the regulated community than would be otherwise allowed, but it should nonetheless impose enforceable, binding compliance obligations on regulated sources.

The second recommendation under Regional Programs is that Florida should join one or more regional programs. The issue of a trial period in these cases is a matter of regional agreement. Florida should support the trial period requirements of any regional program it might seek to join.

[10] RGGI does not address the issue of leakage within the program design. RGGI recognizes the issue and will monitor inter-regional contracts and purchases to assess whether leakage is occurring. RGGI has indicated that if leakage proves to be a serious issue, action will be taken to address it.

Chapter 5

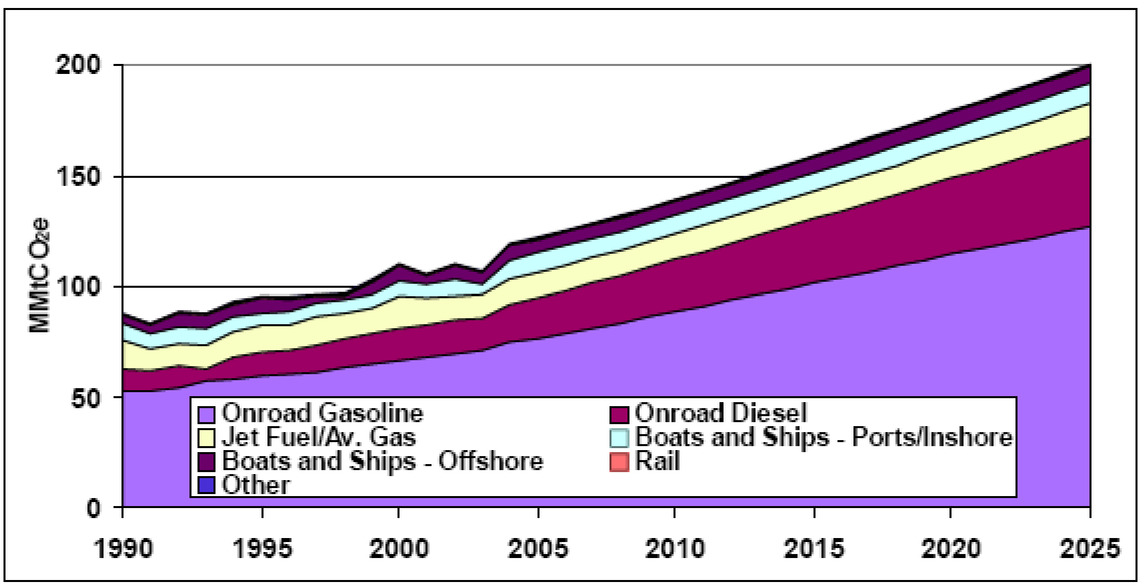
Transportation and Land Use Sectors

Overview of Greenhouse Gas Emissions

The transportation sector is the second-largest contributor to Florida's gross greenhouse gas (GHG) emissions. In 2005, the sector accounted for 36 percent, or about 122 million metric tons of carbon dioxide equivalent ($MMtCO_2e$), of Florida's gross GHG emissions. Emissions from the sector increased by 34 $MMtCO_2e$ between 1990 and 2005. Transportation's share of total GHG emissions has increased slightly over this period, accounting for about 41 percent of the state's net growth in gross GHG emissions.

Figure 5-1 and Table 5-1 show historic and projected transportation GHG emissions by fuel and source. As shown in the figure and table, on-road gasoline vehicles account for the largest share of transportation emissions—about 63 percent in 2005. On-road diesel vehicles account for another 15 percent of emissions, and marine vessels account for roughly 12 percent. Air travel, rail, and other sources produce the remaining emissions.

Figure 5-1. Transportation Gross GHG Emissions by Fuel, 1990–2025



Source: Florida Inventory and Reference Case Projection, October 2008.

Table 5-1. Historic and Projected Gross GHG Emissions from Transportation ($MMtCO_2e$)

Source	1990	1995	2000	2005	2010	2015	2020	2025
Onroad Gasoline	52.89	59.46	66.64	76.22	88.70	101.50	114.30	126.68
Automobiles	*34.14*	*33.88*	*37.03*	*41.24*	*48.59*	*56.05*	*63.38*	*70.36*
Light-Duty Trucks	*17.03*	*23.80*	*27.86*	*33.06*	*38.08*	*43.24*	*48.46*	*53.51*
Heavy-Duty Trucks/Buses	*1.64*	*1.68*	*1.64*	*1.80*	*1.90*	*2.05*	*2.28*	*2.60*
Motorcycles	*0.09*	*0.10*	*0.11*	*0.12*	*0.14*	*0.16*	*0.18*	*0.20*
Onroad Diesel	9.73	11.03	13.99	18.28	23.48	28.84	34.37	40.72
Automobiles	*0.27*	*0.21*	*0.19*	*0.19*	*0.23*	*0.32*	*0.44*	*0.64*
Light-Duty Trucks	*0.44*	*0.62*	*0.84*	*1.00*	*1.33*	*1.81*	*2.50*	*3.60*
Heavy-Duty Trucks/Buses	*9.01*	*10.19*	*12.95*	*17.10*	*21.92*	*26.71*	*31.43*	*36.48*
Jet Fuel/Aviation Gas	13.23	11.60	14.48	11.48	11.70	12.71	13.87	15.26
Boats and Ships - Ports/Inshore	7.19	5.97	6.96	9.01	8.08	8.45	8.83	9.21
Boats and Ships - Offshore	3.88	6.63	7.42	5.89	6.25	6.61	6.97	7.33
Rail	0.31	0.68	0.28	0.58	0.58	0.58	0.58	0.58
Other	0.39	0.37	0.41	0.38	0.41	0.44	0.46	0.49
Total	**87.62**	**95.76**	**110.18**	**121.84**	**139.19**	**159.13**	**179.37**	**200.26**

Source: Florida Inventory and Reference Case Projection, October 2008.

As a result of Florida's population and economic growth and an increase in total vehicle miles traveled (VMT), on-road gasoline consumption grew by 44 percent between 1990 and 2005. Meanwhile, on-road diesel use rose by 88 percent during that period, suggesting an even more rapid growth in freight movement within or across the state boundaries. In the absence of significant increases in vehicle fuel economy, on-road gasoline and diesel emissions are expected to continue to grow at roughly historical rates through 2025. Total transportation emissions are projected to grow by 64 percent, or 78 $MMtC0_2e$, between 2005 and 2025.

The U.S. Energy Independence and Security Act of 2007 contains a provision to increase the corporate average fuel economy (CAFE) of light-duty vehicles (passenger cars and light trucks) to 35 miles per gallon by 2020. The Inventory and Projections report does not include the CAFE or biofuels provisions (or any other provisions) of the Energy Independence and Security Act of 2007. Increases in vehicle fuel economy resulting from this Act will lead to reduced carbon dioxide (CO_2) emissions from on-road vehicles. The effect of the new CAFE standards was accounted for in the estimates of GHG reductions from the various Transportation and Land Use (TLU) sector policy recommendations from the Technical Working Group discussed below.

Key Challenges and Opportunities

Florida has substantial opportunities to reduce GHG emissions from transportation sources. The principal means to reduce GHG emissions in TLU are:

- Improving vehicle fuel efficiency;
- Substituting gasoline and diesel with lower-emission fuels; and
- Reducing total VMT.

In Florida and in the nation as a whole, vehicle fuel efficiency has improved little since the late 1980s, yet many studies have documented the potential for substantial increases in efficiency while maintaining vehicle size and performance. Automobile manufacturers typically oppose dramatic increases in fuel economy. Key points of contention include the cost to manufacturers and the cost to consumers. Even with the adoption of the new federal CAFE requirements, there still may be opportunities for further increases in fuel efficiency while maintaining vehicle size and performance.

The use of fuels with lower per-mile GHG emissions could achieve larger market penetration in Florida. Conventional gasoline- and diesel-fired vehicles can use low-level blends of biofuels. Alternative-technology vehicles can also use higher-level blends, as well as other types of alternative fuels, such as natural gas and hydrogen. The type of fuel used is a crucial determinant of impact on GHG emissions, as some alternative fuels have relatively little GHG benefit. Alternative fuels from biomass, cellulosic residues, and energy crops have been identified by the U.S. Department of Agriculture (USDA) and the U.S. Department of Energy (US DOE) as the best near-term opportunity to reduce oil dependence and GHG emissions.

Key determinants of the possible impact to GHG emissions will be the development and deployment of fuel types. At present, fuel distribution infrastructure is a constraining factor. Existing federal legislation and the 2006 Florida Energy Act provide incentives in the form of corporate income tax credits and sales tax credits for investments in the production, storage, and distribution of biodiesel and ethanol. However, the Florida tax credits "sunset" on June 30, 2010, and are subject to relatively low statewide caps on the amount of credits allowable.

Reducing VMT is crucial to mitigating GHG emissions from the transportation sector. Developing smarter land-use and transportation development patterns that reduce trip length and support transit, ridesharing, biking, and walking can contribute substantially to this goal. A variety of pricing policies and incentive packages can also help to reduce VMT. Developing better planning methods and regulations, and increasing funding of multiple modes of transportation, will be key components in achieving these goals.

Overview of Policy Recommendations and Estimated Impacts

The Florida Governor's Action Team on Energy and Climate Change (Action Team) recommends a set of seven policies for the TLU sector that offer the potential for major economic benefits and emission decreases. Implementing these policy recommendations could lead to emission reductions of:

- 12.73 MMtCO_2e annual reductions in 2025, and
- 57.53 MMtCO_2e cumulative savings from 2009 through 2025.

The weighted-average cost of the recommended policies is -$86/Mt$CO_2$e, for the policies where cost was quantified. This average value includes policies where individual cost-effectiveness ranges from a net savings of about $142/Mt$CO_2$e to a cost of $2/Mt$CO_2$e. The estimated impacts of the individual policies are shown in Table 5-2.

The policies recommended by the Action Team are described briefly here and in more detail in Appendix C of this report. As stated earlier, the recommendations not only could result in significant GHG emission reductions, but offer a host of additional benefits as well. These benefits include reduced local air pollution, more livable/healthier communities, and economic development and job growth from in-state biofuels production. To yield the levels of savings described here, the recommended policies need to be implemented in a timely, aggressive, and thorough manner.

Low-GHG fuels (TLU-1) and improved transportation system management (TLU-4) are important components of the recommended policies. Transportation fuel providers would need to undertake changes in their production and distribution methods in order to achieve the goals set out in TLU-1. There is feasibility issues associated with transporting large volumes of biofuels to and within the state, as well as distributing biofuels to consumers. For example, ethanol has historically not been moved in the pipeline network used to transport gasoline and diesel fuel. The pipeline industry is currently in the process of adapting technology for pipeline distribution of ethanol. To achieve the goals of TLU-1, the challenges of production and distribution of low-GHG fuels will need to be addressed through this and other means.

TLU-4, taken in concert with other aggressive transportation and land use policy actions, could result in significant reductions to VMT on the order of 7-10 percent in urban areas by 2020. Vehicle hours of travel (VHT) can be reduced by amounts that are associated with these VMT reductions. VHT reduction is recognized as a means of reducing driver delay while reducing fuel consumption in congested traffic.

Several other policies would work with TLU-4, and with each other, to further reduce VMT by increasing the viability of multiple modes of travel and providing incentives to use modes other than single-occupant vehicles (SOVs); these are Smart Growth Planning (TLU-3), and Increasing Choices in Modes of Transportation and Factoring GHG Emissions into TLU Planning Processes (TLU-5 & 6). Smart-growth policies are being considered and implemented around the country in a wide range of communities. Because most policies are deregulatory in nature, this significantly lowers political barriers. However, these policies will face several challenges. They require closer coordination between state government, local government, and businesses in many cases. The availability of funding for the provision of additional transit services is uncertain. Also, patterns of development are subject to economic cycles and many private investment decisions. Yet implementation of these policies is essential to make travel by walking, biking, and transit more feasible. Together these policies address the built environment, transportation infrastructure, and the behavior of individuals to reduce per capita VMT.

Table 5-2. Summary of TLU Policy Recommendations

Policy No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value 2009–2025 (Million $)	Cost-Effective -ness ($\$/tCO_2e$)	Energy Security Fuel Savings (Gallons Saved 2009–2025) (million gallons)	Level of Support
		2017	2025	Total 2009-2025				
TLU-1	Develop and Expand Low-GHG Fuels	6.20	12.62	106.41	–$15,161	–$142	37,290	Approved
TLU-2	Low Rolling Resistance Tires and Other Add-On Technologies	0.80	1.84	13.99	-$1,259	-$90	1,665	Approved
TLU-3	Smart Growth Planning	Not Quantified Separately; Included in Other Analyses						Approved
TLU-4	Improving Transportation System Management (TSM)	3.94	6.98	63.91	-$5,106	-$80	7,858	Approved
TLU-5&6	Land Use Planning Processes and Increasing Choices in Modes of Transportation	1.77	3.54	28.29	NQ	NQ	3,200	Approved
TLU-7	Incentive Programs for Increased Vehicle Fleet Efficiency	0.84	1.56	13.14	NQ	NQ	1,564	Approved
TLU-8	Increasing Freight Movement Efficiencies	0.59	1.10	11.52	$21	$2	1,302	Approved
	Sector Totals	**14.14**	**27.64**	**237.26**	**-$21,505**	**-$91**	**52,879**	
	Sector Total After Adjusting for Overlaps	**12.73**	**25.14**	**214.35**	**-$18,400**	**-$86**	**48,786**	
	Reductions from Recent Actions	**17.68**	**32.39**	**284.00**				
	Sector Total Plus Recent Actions	**30.41**	**57.53**	**498.35**				

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Note: The numbering used to denote the above recommended priority policy recommendations is for reference purposes only; it does not reflect prioritization among these important recommended policies.

Florida is currently pursuing adoption of the California Clean Car standards which would increase fuel economy standards beyond those set by the new Federal CAFE standards. Because these standards are a part of the Florida Department of Environmental Protection (DEP) rulemaking process, they are not included as one of the TLU policy recommendations. The Clean Car standards must clear several hurdles before Florida or any other state can adopt them, including U.S. Environmental Protection Agency (EPA) approval of the original California Clean Car standards (that other states can then opt into). If for any reason the Florida Department of Environmental Protection (DEP) is not able to implement the Clean Car standards, other technology-based policy recommendations could play a larger role. For example, Incentive Programs for Increased Vehicle Fleet Efficiency (TLU-7) encourages consumers to buy the most efficient vehicles available on the market. Low Rolling Resistance Tires and Other Add-On Technologies (TLU-2) can improve vehicle fuel economy through vehicle operation and maintenance practices. Other policies, such as Increasing Freight Movement Efficiencies (TLU-8), can promote technological improvements in the heavy-duty vehicle fleet.

Transportation and Land Use Policy Descriptions

The policy recommendations described briefly here could not only result in significant GHG emission reductions and cost savings but also offer a host of additional benefits, such as reduced local air pollution; more livable/healthier communities; and increased transportation choices. Appendix C of this report discusses these policies in more detail.

TLU-1. Develop and Expand Low-GHG Fuels

This recommendation seeks to reduce GHG emissions by decreasing the carbon intensity of vehicle fuels sold in Florida. A low-carbon fuel standard would require all fuel providers in Florida to ensure that the mix of fuel they sell into the Florida market meets, on average, a declining standard for GHG emissions measured in carbon dioxide equivalent (CO_2e) per unit of fuel energy. The state should develop, with industry and stakeholder input, a set of standards for low-carbon fuels, which include biodiesel, cellulosic ethanol, hydrogen, compressed natural gas, liquefied petroleum gas, electricity, and low-carbon ethanol blends such as E10 or E85. The standard would be measured on a life cycle basis in order to include all emissions from fuel production to consumption.

Fuel providers (defined as refiners, importers, and blenders of on-road vehicle fuels) will need to report on an annual basis that the fuel mixtures they provide to the market meet the low-carbon fuel standard. Fuel retailers should be encouraged to provide this information to consumers at the point of sale to the extent information is available.

TLU-2. Low Rolling Resistance Tires and Other Add-On Technologies

The goal of this policy is to improve the fuel economy of the light-duty vehicle (LDV) fleet by reducing the rolling resistance of replacement tires without reducing tire lifetime or otherwise increasing the lifecycle carbon footprint of the tires. There are three avenues by which the rolling resistance of tires may be reduced, and fuel economy improved as a result:

- Consumers could purchase more tires currently available that have lower rolling resistance.

- Tire designs could be modified and new technologies could be introduced to reduce rolling resistance.
- Vehicle operations could be improved, especially through improved maintenance of tire inflation.

Currently, tire manufacturers and retailers are not required to provide information about the fuel efficiency of replacement tires. In addition, there is no current minimum standard for fuel efficiency that all replacement tires must meet. State policy and action can help bridge this gap through a variety of mechanisms. The state could set minimum energy efficiency standards for replacement tires and require that greater information about Low Rolling Resistance replacement tires be made available to consumers at the point of sale. Information also can be provided to consumers about fuel efficiency and cost in relation to the purchase, maintenance, and operation of their vehicles. The state could encourage or provide information about complementary add-on technologies that could facilitate vehicle operation practices which improve fuel efficiency. One example is devices such as the Air Alert Valve Caps, which alert vehicle owners when tire pressure is too low.

TLU-3. Smart-Growth Planning

Smart-growth planning looks at how land use planning, site planning, and urban design at the community level can help achieve carbon and GHG emission reduction goals. The essence and intention of smart growth within the context of climate change is to establish a policy framework, clear guidelines, and measurement parameters for the development of new (and the redevelopment of older) communities that will have a net-zero-carbon effect on the general environment and reduce overall GHG emissions. This can be accomplished through the complex interactions of the three primary elements of community development that have a direct impact on GHG emissions and affect climate change:

- Construction energy and building lifetime energy use as measured by the protocols of Leadership in Energy and Environmental Design (LEED™) Green Building Rating System, Green Globes, or the Florida Green Building Coalition (FGBC);
- Individual VMT generation and other transportation energy use (such as deliveries, maintenance, buses, security, health, fire, and safety) necessary to support human communities; and
- The changing of land uses from carbon-sequestering land uses (such as forests, agriculture, parks, and wetlands) to carbon-releasing land uses (such as building sites and roadways) and development patterns.

This policy aims to bring about reductions in GHG emissions through smart-growth planning. The state could achieve this by providing incentives and promoting redevelopment projects that establish more energy-efficient land use patterns. Any redevelopment project should consider the 10 principles of smart-growth in land use planning[1]. The 10 principles are as follows:

1) Create a range of housing opportunities and choices;
2) Create walkable neighborhoods and communities;
3) Encourage community and stakeholder collaboration and cooperation;
4) Forster distinctive and attractive communities with a strong sense of place;
5) Make development decisions that are predictable, fair, and cost-effective;
6) Mix the land use;
7) Preserve open space, farmland, natural beauty, and critical environment areas;
8) Provide a variety of transportation choices;
9) Strengthen and direct development toward existing communities; and
10) Take advantage of compact building design.

The state also could maximize opportunities to retrofit existing buildings to meet LEED, Green Globes, FGBC, or other approved certification programs that reduce energy consumption and thus reduce GHG emissions.

[1] Smart Growth Online. http//www.smartgrowth.org

TLU-4. Improving Transportation System Management (TSM)

Transportation System Management (TSM) is the concept of pairing transportation demand with transportation supply to help transportation networks serve the demand in an effective and efficient manner. Effective system management may utilize a variety of strategies based on advanced technologies, market-based incentives, regulations, and design standards. Each strategy provides a relatively small benefit to GHG reduction, but when applied in concert, substantial gains can be achieved.

TSM strategies attempt to reduce the number of trips being taken by SOVs, shorten trip lengths, reduce vehicle delay, increase the reliability of the transportation network, and reduce idling and other transportation actions that result in increased GHG emissions. The goal of TSM is to reduce the daily VMT per capita on the transportation network. Effective TSM also will reduce VHT per capita, which measures the amount of traffic congestion delay. Reduction of either VMT or VHT is highly correlated with a reduction in GHG emission.

The state could develop and implement a variety of policies and strategies to reduce GHG emissions through TSM. These policies and strategies could include program funding, financial and development incentives, infrastructure investment, and regulatory requirements to promote transportation system management improvements that result in reduced VMT and/or VHT which, in turn, result in reduced GHG emissions. These actions, taken in concert with other aggressive transportation and land use policy actions, should be designed to reduce urban area VMT by 7-10 percent by 2020 and by 9 - 12 percent by 2050; VHT can be reduced by amounts that are associated with these VMT reductions. VHT reduction is recognized as a means of reducing driver delay while reducing fuel consumption in congested traffic.

TLU-5 &6. Land Use Planning Processes and Increasing Choices in Modes of Transportation

TLU 5 & 6 were combined by the Action Team after it was determined that it was difficult to accurately quantify and compare the cost per ton of CO_2 reductions of transit and rail versus other modes of transportation. The Action Team expressed concern that this quantification might discourage the selection of transit and/or rail as a strategy for the reduction of GHG emissions. The Action Team concluded that transit and rail are important GHG reduction strategies that should be implemented despite high infrastructure costs. This policy seeks to ensure that local and state land use and transportation planning consider the impact of land use and transportation decisions on the reduction of GHG emissions. This policy also aims to double transit ridership; to increase the percentage of people that walk, bicycle, carpool, vanpool, or telecommute; and to develop and implement policies and strategies that include program funding and financial incentives that expand non-automobile infrastructure and provide modal alternatives to SOV travel.

TLU-7. Incentive Programs for Increased Vehicle Fleet Efficiency

Florida can reduce its GHG emissions by improving the fuel economy of the LDV fleet. This recommendation includes several policies and programs to encourage the purchase of low-GHG-emission vehicles through monetary and convenience rewards and incentives throughout the state:

- Tax credits for efficient vehicles.
- Incentive programs for major corporate fleet owners, including rental car and taxi cab companies.
- CO_2-based registration fees and vehicle licensing fees.
- Procurement of efficient fleet vehicles (public, private, or other).
- Study of "feebates."
- Operating incentives for low-GHG vehicles.
- CO_2-based excise taxes.

- CO_2-based product labeling.

TLU-8. Increasing Freight Movement Efficiencies

This policy recommendation aims to reduce the trucking industry's carbon footprint and GHG emissions, while maintaining the current level of service to the state and nation, and encouraging the development and expansion of intermodal and long-distance rail capacity to support both local and transcontinental rail service into and out of Florida. The U.S. Department of Transportation's Federal Highway Administration) lists two major categories of emissions-reducing strategies that Florida can utilize in these goals:

- Technical strategies, which modify a piece of equipment or its fuel to reduce emissions; and
- Operational strategies, which change how a piece of equipment is used, resulting in lower emissions.

Chapter 6
Agriculture, Forestry, and Waste Management

Overview

The Agriculture, Forestry, and Waste Management (AFW) sectors are responsible for moderate amounts of Florida's current greenhouse gas (GHG) emissions. The total AFW contribution to carbon dioxide equivalent (CO_2e) gross emissions in 2005 was 15 million metric tons (MMt), or about 11 percent of the state's total. The AFW contribution to net emissions in 2005 was 3 percent of the state's total, after accounting for the net sequestration of carbon in the forestry sector.

Agricultural emissions include methane (CH_4) and nitrous oxide (N_2O) emissions from enteric (intestinal) fermentation, manure management, agriculture soils, and agriculture residue burning. As shown in Figure 6-1, emissions from soil carbon losses from agricultural soils, livestock soils, manure management, enteric fermentation, and fertilizer application all make significant contributions to the sector totals. Emissions include CO_2 emissions from oxidized soil carbon, application of urea, and application of lime. Sector emissions also include nitrous oxide emissions resulting from activities that increase nitrogen in the soil, including fertilizer (synthetic, organic, and livestock) application and production of nitrogen-fixing crops (legumes), and methane emissions from rice cultivation. There is no significant agricultural burning activity in Florida; therefore, the emissions were estimated to be zero (prescribed burning is covered under the forestry sector).

In keeping with the U.S. Environmental Protection Agency's (US EPA) methods and international reporting conventions, the Inventory and Projections report covers sources of GHGs from human activities. There could be some natural sources of GHGs that are not represented in the inventory and forecast; however these are not addressed in the Governor's Action Team on Energy and Climate Change (Action Team) process. In the forestry sector, since all of the state's forests are managed in some way, all emissions are treated as "anthropogenic," or from human activities. GHG reporting conventions treat all managed forests as anthropogenic sources. Sources such as CO_2 from forest fires and decomposing biomass are captured within the inventory and forecast (as part of the carbon stock modeling performed by the U.S. Forest Service [USFS]). However, methane emissions from decomposition of organic matter/biomass in forests are not currently captured due to a lack of data. This methane is from decomposition in oxygen-free (anaerobic) areas, particularly marshes and bogs.

The CO_2 emissions occurring from the cultivation of organic soils always has been a primary contributor to the state's total agricultural GHG emissions. By 2025, the contribution from this source is estimated to be more than 70 percent of the total agricultural emissions. Methane emissions from digestive processes in ruminant animals, known as enteric fermentation, are declining due to lower animal populations; however, they are estimated to be the second-highest contributor to agriculture sector totals in 2025 at about 13 percent. The next-highest contributor in 2025 is estimated to be livestock manure application to soils at about 6 percent.

Forestry and land use emissions refer to the net carbon dioxide (CO_2) flux[1] from forested lands in Florida, which account for about 47 percent of the state's land area. The inventory is divided into two primary subsectors: the forested landscape, and urban forestry and land use. Both subsectors capture net carbon sequestered in forest biomass, urban trees, landfills, and harvested wood products. In addition, other GHG sources such as nitrous oxide emissions from fertilizer application in urban areas and CH_4 and N_2O emissions from prescribed burns and wildfires are included.

As shown in Table 6-1, USFS data suggest that Florida's forests sequestered about 21 $MMtCO_2e$ per year in 2005 (this excludes estimates of carbon flux from forest soils based on recommendations from the USFS). The negative numbers in Table 6-1 indicate a CO_2 sink rather than a source. Even after accounting for the GHG sources from urban soils and prescribed burns or wildfires, the forestry and land use sector is still estimated to have been a net GHG sink of more than 20 $MMtCO_2e$ in 2005. Hence, during this period, forest carbon losses due to forest conversion, wildfire, and disease were estimated to be smaller than the CO_2 sequestered in forest carbon pools such as live trees, debris on the forest floor, and forest soils, as well as in harvested wood products (such as furniture and lumber) and the disposal into landfills of forest products. The forecast for the sector out to 2025 shows a slightly declining trend in the levels of sequestration due to losses of forested area associated with development.

Figure 6-2 shows estimated historical and projected emissions from the management and treatment of solid waste and wastewater. Emissions from waste management consist largely of CH_4 emitted from landfills, while emissions from wastewater treatment include both CH_4 and N_2O. Emissions are also included for municipal solid waste (MSW) combustion. Overall, the waste management sector accounted for about 5 percent of Florida's total gross emissions in 2005. While emissions are expected to grow significantly by 2025, the contribution to the state's total is expected to remain at about 5 percent.

The Action Team acknowledges that there are higher levels of uncertainty in the GHG emissions and forecasts in the AFW sectors compared with those in other sectors (e.g., those where emissions are tied directly to energy consumption). There is a need for continuing investment in research and measurement to refine the AFW Inventory & Forecast report (details on key uncertainties are presented in the appendices).

Opportunities for GHG mitigation in the AFW sector involve measures that can reduce emissions within the sector or reduce emissions in other sectors. Within the sector, changes in crop cultivation can reduce GHG emissions by building soil carbon (indirectly sequestering carbon from the atmosphere) or through more efficient nutrient application (reducing N_2O

[1] "Flux" refers to both emissions of CO_2 to the atmosphere and removal (sinks) of CO_2 from the atmosphere stored in plant tissue.

emissions and embedded GHG emissions within the nutrients). Reforestation projects can achieve GHG reductions by increasing the carbon sequestration capacity of the forests in Florida.

Figure 6-1. Historical and projected net GHG emissions from the Agriculture Sector, Florida, 1990–2025

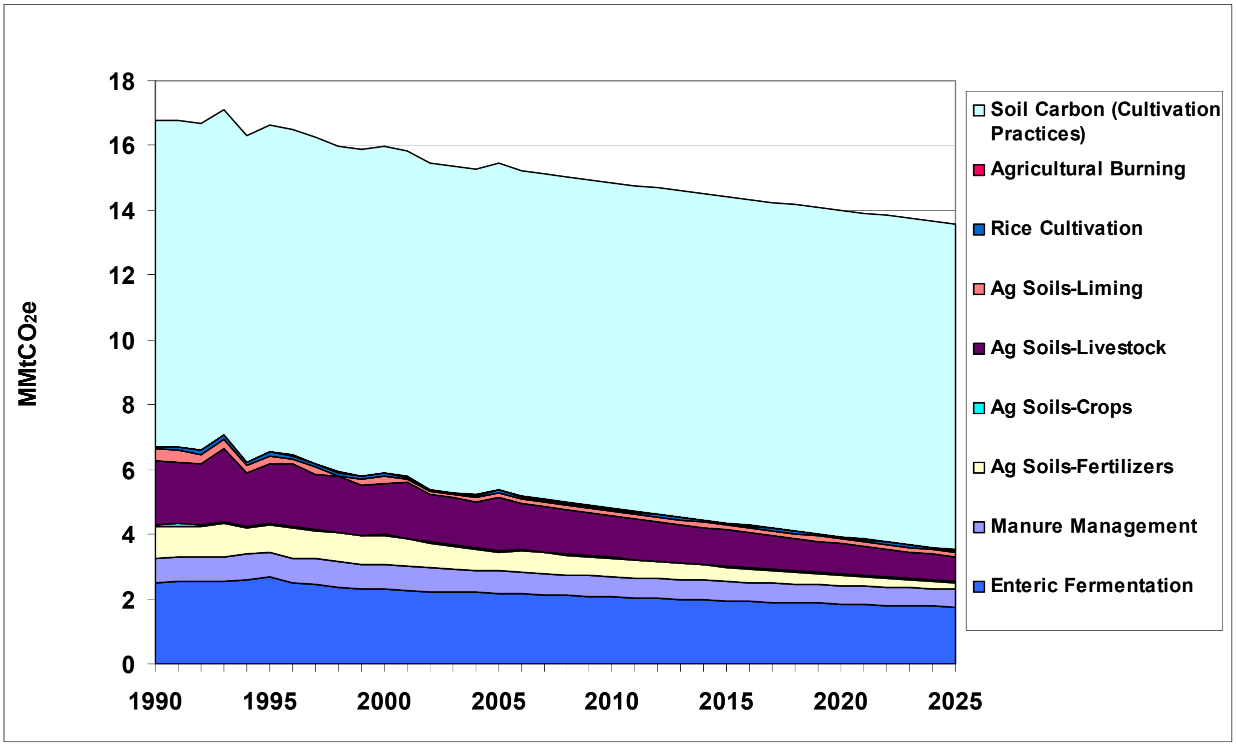
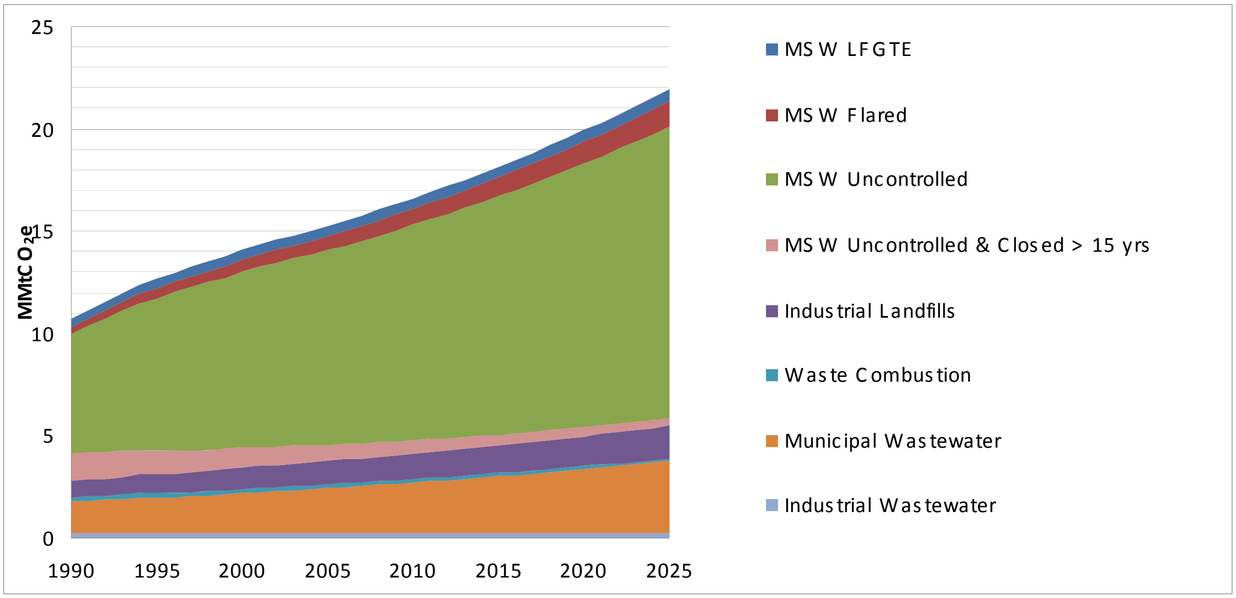


Table 6-1. GHG emissions (sinks) from the Forestry Sector

Subsector	1990	2000	2005	2010	2020	2025
Forested Landscape (excluding soil carbon)	-3.38	-21.1	-21.1	-21.0	-20.9	-20.9
Urban Forestry and Land Use	-14.4	-5.65	-6.23	-6.23	-6.23	-6.23
Forest Wildfires	1.35	1.15	0.16	1.00	1.00	1.00
Forest Prescribed Fires	5.70	4.14	6.66	5.70	5.70	5.70
Sector Total	**-10.8**	**-21.4**	**-20.5**	**-20.5**	**-20.4**	**-20.4**

* Positive numbers indicate net emission. Based on USFS input, emissions from soil organic carbon are left out of the forestry sector summary due to a high level of uncertainty.

Figure 6-2. Estimated historical and projected emissions from waste and wastewater management in Florida



$MMtCO_2e$ = million metric tons carbon dioxide equivalent; MSW = Municipal Solid Waste; LFs = landfills; WW = wastewater.

For GHG reductions outside of the AFW sector, actions taken within the sector such as production of liquid biofuels can offset emissions in the transportation sector, while biomass used to produce electricity or steam can reduce emissions in the Energy Supply and Demand (ESD) sector. Similarly, actions that promote solid waste reduction or recycling can reduce emissions within the sector (future landfill CH_4), as well as emissions associated with the production of recycled products (recycled products often require less energy to produce than similar products from virgin materials). Finally, urban forestry projects can reduce energy consumption within buildings through shading and wind protection.

The following are primary opportunities for GHG mitigation identified by the Action Team:

- **Agricultural crop management:** Implement programs with growers to utilize cultivation practices that build soil carbon and reduce nutrient consumption. By building soil carbon, CO_2 is indirectly sequestered from the atmosphere. New technologies in the area of precision agriculture offer opportunities to reduce nutrient application and fossil fuel consumption. Improved harvesting techniques could also reduce fossil fuel consumption.
- **Agricultural land use management approaches to protect/enrich soil carbon:** Incentive programs are needed to protect crop lands from conversion to developed use or the conversion of lands in conservation programs back to conventional tillage/plowing which releases CO_2. By protecting these areas from development, the carbon in above-ground biomass and below-ground soil organic carbon can be maintained and additional emissions of CO_2e to the atmosphere can be avoided. Indirectly, these measures also support the

objectives of "smart" development by helping to direct more efficient development patterns (see Chapter 5, Policy Option TLU-3—Smart Growth Planning).

- **Production of liquid biofuels:** Production of renewable fuels, such as ethanol from crop residue, forestry biomass, or municipal solid waste, and biodiesel from waste vegetable oils can produce significant reductions when they are used to offset consumption of fossil fuels (for example, gasoline and diesel in transportation and other combustion sources). This is particularly true when these fuels are produced using processes and/or feedstocks that emit much lower GHG emissions than those from conventional sources (sometimes referred to as "advanced" or "next generation" biofuels). The goals to produce more biofuels in-state are linked to the recommendations under TLU-1 for establishing a low-carbon fuel standard and thus consuming more biofuels in-state.
- **Expanded use of forest and agricultural biomass:** Expanded use of renewable energy from biomass removed from the state's managed forests, crop residues, lawn and garden waste, or municipal solid waste can achieve GHG benefits by offsetting fossil fuel consumption (to produce either electricity or heat/steam). Programs to expand sustainably produced biomass fuel production will likely be needed to supply a portion of the fuel mix for the renewable energy goals of ESD Policy Option ESD-5 (see Chapter 3.)
- **Enhancement/protection of forest carbon sinks:** Through a variety of programs, enhanced levels of CO_2 sequestration can be achieved and carbon stored in the state's forest biomass. These include afforestation (establishing forests on lands that have not historically been under forest cover) projects, reforestation programs (restocking of harvested forests), urban tree programs, wildfire risk reduction, and other forest health programs. Programs aimed at reducing the conversion of forested lands to non-forest cover also will be important to retain what is currently a net forest CO_2 sink in Florida.
- **Changes in municipal solid waste (MSW) management practices:** By promoting advanced MSW practices, the "cradle to grave" GHG emissions associated with collecting, transporting, and managing MSW can be reduced. Hence, the emissions addressed here include those from both fossil fuel use and waste management (primarily landfills).

Key Challenges and Opportunities

In the agricultural sector, the Action Team found significant opportunity in promoting biofuels production using feedstocks and production methods with superior GHG benefits (superior to conventional starch-based ethanol). It should be noted that the GHG benefits did not include any indirect impacts associated with emissions resulting from land use change.[2] The recommendations on biofuels production were aimed primarily at production of advanced (cellulosic) biofuels. The production and use of these fuels was found to offer substantial GHG

[2] Recent research (e.g., Searchinger, T., et al., "Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land Use Change," *Sciencexpress*, February 2008) has indicated that incorporating land conversion impacts into GHG analysis may remove any GHG benefits. Due to concerns and uncertainties such as these, the Action Team developed a biofuels production recommendation focused on biomass, not food crops.

reduction potential (more than eight MMtCO_2e by 2025; see AFW-7 in Appendix D). The Action Team quantified two separate goals associated with biofuels production and use: a primary goal of using 20 percent of available biomass to produce biofuels by 2025, and a secondary goal to produce enough biofuel in-state to offset 25 percent of the state's fossil liquid fuels consumption by 2025. Based on the available estimated biomass resources in the state, this secondary goal will be difficult to achieve without significant reductions in fossil fuel use by 2025 (for example, emphasizing the importance of TLU recommendations aimed at reducing vehicle miles traveled).

The Action Team recommendation AFW-4 promotes the expanded use of biomass as an energy source for producing electricity, heat, and steam. Use of biomass to supplant fossil fuels is estimated to reduce about 40 MMtCO_2e by 2025. The Action Team conducted a limited assessment of the available biomass resources in the state that indicated sufficient resources were available through 2025 to achieve the goals for both the liquid biofuels recommendation above and this biomass for energy option. However, the Action Team also recognizes the need for additional research on this issue, so that better estimates of sustainably-produced energy feedstocks are assured. As shown in Table D-1 of Appendix D, the Action Team currently estimates that the policy recommendations and business as usual biomass demand will require about 75 percent of the available biomass supply.

Related to biomass utilization for energy purposes, recommendation AFW-9 seeks to improve commercialization of technologies to utilize biomass feedstocks or to produce bio-products. These technologies could include biomass gasification of wastewater treatment plant biosolids, livestock manure, or other organic wastes for energy use and as a direct GHG reduction measure. These technologies also could include anaerobic digestion of livestock manure, or other wastes to reduce methane emissions, and then utilize the methane for energy purposes. Research and development is needed (pilot-scale projects) in addition to funding or other incentives to build commercial-scale facilities.

AFW-10 seeks to increase the production and consumption of locally-produced (state or regional) agricultural products. To the extent that this can be accomplished, overall energy consumption associated with getting food to consumers is reduced and food security in Florida is strengthened. Due to the complexities of the design considerations needed to achieve a more efficient food production system in the state and a lack of data on current food imports, this recommendation requires additional assessment.

Also, within the agriculture sector, the Action Team recommends programs to promote soil management to increase soil carbon levels, thereby indirectly sequestering carbon from the atmosphere. These programs, combined with additional measures to promote more efficient nutrient application, were estimated to achieve a reduction of more than one MMtCO_2e per year by 2025. Mechanisms that would assist farmers in reaching the goals of these recommendations include consideration of carbon sequestration offsets in any future cap-and-trade program in which the state participates.

Related to terrestrial carbon management, land use management approaches in the agriculture and forestry sectors are recommended to protect existing above and below ground carbon stocks and potentially enhance terrestrial sequestration in the future. By preserving agricultural and forested lands (AFW-1 and AFW-6), the Action Team estimates GHG savings in 2025 of more than one $MMtCO_2e$. To achieve these reductions, the state will need to work closely with local planning agencies, landowners, and other stakeholders to identify lands suitable for acquisition and conservation easements as well as funding mechanisms. Some of the support could come through existing state programs, such as Florida Forever. Another benefit to these options, which was not quantified, is the reduction in vehicle miles traveled due to more efficient development patterns (see TLU-3).

The estimates for GHG reductions for forest preservation above are conservatively low. The assumed losses of forest to development of about 7,400 acres per year are based on total forest area losses between 1995 and 2005 and include forest area gains that occurred as a result of land use change (such as agricultural land converted to forests). Also, due to high levels of uncertainty in existing emission estimates, the benefits estimated for AFW-1 do not include soil carbon; however, significant losses in soil carbon occur when forests are converted to developed use.

Within the forestry sector, forest management programs (AFW-2 and AFW-3) have the potential to deliver more than 24 $MMtCO_2e$/year of GHG reductions in 2025. These programs include reforestation and afforestation (see page 6-10), urban forestry, and wildfire reduction/restocking/other forest health approaches to minimize terrestrial carbon losses, while enhancing carbon sequestration. The urban forestry component also has the potential to reduce fossil fuel consumption through shading and wind protection of homes and commercial buildings.

For the urban forestry component of AFW-2, the goals are to increase canopy cover in Florida communities such that by 2025, 3 percent of total metropolitan GHG emissions will be offset through carbon sequestration and energy reductions. The recommendation includes a secondary goal to increase tree canopy cover in all developed areas with population greater than 500 residents per square mile to 30 percent by 2025.

Action Team recommendation AFW-8 seeks to reduce the "cradle to grave" GHG emissions associated with MSW management. The recommendation recognizes that a holistic approach to developing an efficient solid waste system is needed to reduce GHG emissions associated with waste collection, transport, and final management (such as landfilling). The goal of AFW-8 is to reduce these "cradle to grave" emissions by 25 percent by 2025. The Action Team recognizes that there are a number of different approaches for waste management entities to use in reducing emissions, including the use of more efficient collection and transport vehicles, use of renewable fuels, and landfill gas management (such as greater methane collection at landfills and use of advanced waste management approaches, including bioreactors). Based on the recommendation, more than four $MMtCO_2e$ of GHG emissions are estimated to be reduced annually by 2025.

Overview of Policy Recommendations and Estimated Impacts

As noted above, the 10 policy recommendations for the AFW sector address an array of activities capturing emission reductions, both within and outside of the AFW sectors (such as energy consumption in the ESD and TLU sectors). Taken as a whole, the AFW recommendations offer significant cost-effective emission reductions, as shown in Table 6-2.

Table 6-2. Summary List Policy Recommendations

Option No.	Policy Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2009–2025 (Million $)	Cost-Effective-ness ($/tCO_2e$)	Energy Security Fuel Savings	Level of Support
		2017	2025	Total 2009–2025				
AFW-1	Forest Retention—Reduced Conversion of Forested to Non-Forested Land Uses	0.5	0.6	7.2	$186	$26		Approved
AFW-2	Afforestation and Restoration of Non-Forested Lands							
	A. Forested Landscape							Approved
	Afforestation	1.6	3.1	28	$134	$4.9		
	Reforestation	6.1	11.6	104	$555	$5.3		
	B. Urban Forestry	4.6	8.7	78	$759	$10	3.5 million short tons coal, or 76,000 cubic feet natural gas	Approved
AFW-3	Forest Management for Carbon Sequestration							
	A. Pine Plantation Management	0.5	0.9	7.9	$84	$11		Approved
	B. Non-Federal Public Land Management	0.3	0.4	3.9	$41	$11		Approved
AFW-4	Expanded Use of Agriculture, Forestry, and Waste Management (AFW) Biomass Feedstocks for Electricity, Heat, and Steam Production	21	40	361	$7,432	$21	22 million short tons coal or 486,000 cubic feet natural gas	Approved
AFW-5	Promotion of Farming Practices That Achieve GHG Benefits							
	A. Soil Carbon Management	0.5	0.9	8.0	–$74	–$9	5 million gallons of diesel fuel	Approved
	B. Land-Use Management That Promotes Permanent Cover	N/Q						Approved
	C. Nutrient Management	0.2	0.3	2.6	$68	$26		Approved

	D. Improved Harvesting Methods to Achieve GHG Benefits	N/Q						Approved
AFW-6	Reduce the Rate of Conversion of Agricultural Land and Open Green Space to Development	0.2	0.5	4.2	$394	$93		Approved
AFW-7	In-State Liquid/Gaseous Biofuels Production	4.0	8.2	68	–$532	–$8	4,075 million gallons gasoline and 271 million gallons diesel	Approved
AFW-8	Promotion of Advanced Municipal Solid Waste (MSW) Management Technologies (Including Bioreactor Technology)	1.9	4.4	34	$294	$9	190,000 short tons coal or 4,000 cubic feet NG and 109 million gallons diesel	Approved
AFW-9	Improved Commercialization of Biomass-to-Energy Conversion and Bio-Products Technologies							
	A. Manure Digestion/Other Waste Energy Utilization	0.04	0.09	0.8	–$13	–$17	4,500 short tons coal or 100 cubic feet natural gas	Approved
	B. WWTP Biosolids Energy Production & Other Biomass Conversion Technologies	2.4	5.0	42	$1,848	$44	2.5 million short tons coal or 55,000 cubic feet natural gas	Approved
	C. Bio-Products Technologies and Use	0.2	0.3	2.6	–$161	–$62		Approved
AFW-10	Programs to Support Local Farming/Buy Local	N/Q						Approved
	Sector Totals	**44**	**85**	**752**	**$11,014**	$15		
	Sector Total After Adjusting for Overlaps*	***25***	***58***	***469***	***$5,974***	***$13***		
	Reductions From Recent Actions	**—**	**—**	**—**	**—**	**—**		
	Sector Total Plus Recent Actions	***25***	***58***	***469***	***$5,974***	***$13***		

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; N/Q = not quantified; WWTP = wastewater treatment plant.

* See below for discussion of overlap adjustments.

Note that negative costs represent a monetary savings.

Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings associated with the recommendations. Totals in some columns may not add to the totals shown due to rounding.

Agriculture, Forestry, and Waste Management Sector Policy Descriptions

The AFW sectors include emissions mitigation opportunities related to the use of biomass energy, protection and enhancement of forest and agricultural carbon sinks, control of agricultural N_2O emissions, production of renewable liquid fuels, reforestation/afforestation, and lower MSW emissions.

AFW-1 Forest Retention—Reduced Conversion of Forested to Non-Forested Land Uses

By retaining forest cover in the state, the current levels of carbon dioxide sequestration (more than 20 $MMtCO_2$/yr) are protected. In addition, significant losses in both above-ground carbon and soil carbon occur during conversion to developed use. The goals of this recommendation are to stabilize the state's forest base and to achieve no net loss in forested lands by 2015. The goals will need to be achieved through a variety of mechanisms, which could include additional funding to existing programs such as Florida Forever, incentives to forest landowners to retain their lands as working forests, consideration of forest management carbon offset projects in emerging cap-and-trade programs, and active engagement with non-government organizations and stakeholders to increase lands with perpetual conservation easements or acquisitions.

AFW-2 Afforestation and Restoration of Non-Forested Lands

This recommendation seeks to increase the sequestration potential of the state's forests by increasing the forest base through afforestation projects, increasing sequestration potential through reforestation (re-stocking forests), and aggressive urban tree planting programs. The urban tree element of this recommendation has an additional benefit of reducing energy demand through shading of homes and commercial buildings (producing a greater GHG benefit than the sequestration of carbon in these trees). The afforestation goal is to increase the area of forested lands in the state by 50,000 acres annually through 2025. For reforestation, the goal is to implement reforestation activity on all harvested acres by 2025. For urban forestry there are both primary (based on offsetting metropolitan GHG emissions) and secondary (tree canopy cover) goals; both of these could be met through aggressive tree planting goals of 6.7 million trees on average per year through 2025.

AFW-3 Forest Management for Carbon Sequestration

This recommendation focuses on the state's existing forested lands—both private forests and non-federal publicly-owned lands. The recommendation recognizes the significant role that Florida's forests play in lowering the state's net GHG emissions (about 20 $MMtCO_2e$/yr) and that management could be enhanced to achieve greater net GHG benefits. In the state's plantation forests, the 2025 goal is to increase the levels of productivity by 10 percent annually through enhanced management, thereby increasing sequestration rates and timber, pulp wood, or biomass for energy purposes. For non-federal publicly-owned forests in the state, this recommendation calls for improved management practices to be implemented on 25 percent of these lands by 2025.

AFW-4 Expanded Use of Biomass Feedstocks for Electricity, Heat, and Steam Production

This policy dedicates a sustainable quantity of biomass from agricultural crop residue, wood industry process residues, unused forestry residues, and MSW biomass resources for efficient conversion to energy and economical production of heat, steam, or electricity. This biomass should be used in an environmentally acceptable manner, considering proper facility siting and feedstock use (proximity of users to biomass, impacts on water supply and quality, control of air emissions, solid waste management, cropping management, nutrient management, soil and non-soil carbon management, and impacts on biodiversity and wildlife habitat). The objective is to create concurrent reduction of CO_2 due to displacement of fossil fuels considering life-cycle GHG emissions associated with viable collection, hauling, and energy conversion and distribution systems. The primary goal of this option is to increase the use of biomass feedstocks for energy purposes by a factor of five by 2025.

AFW-5 Promotion of Farming Practices that Achieve GHG Benefits

This recommendation addresses both agricultural soil carbon management, as well as nutrient management to achieve GHG benefits. For soil carbon management, conservation-oriented management of agricultural lands, cropping systems, crop management, and agricultural practices may regulate the net flux of CO_2 from soil. This recommendation has four separate elements:

- soil carbon management, where CO_2 reductions occur indirectly via the building of soil carbon levels;
- nutrient management, where GHG reductions occur through more efficient use of fertilizer (lowering fossil-fuel use though lower application energy requirements, as well as lifecycle GHG reductions associated with the production and transportation of fertilizers in addition to reduced nitrous oxide emissions following application);

- agricultural land conversion to reduce GHG emissions by establishing permanent cover on marginally productive lands (thereby increasing both above- and below-ground carbon stocks);
- an element covering improved harvesting methods, which seeks to produce GHG reductions through the use of more efficient harvesting technologies and practices.

AFW-6 Reduce the Rate of Conversion of Agricultural Land and Open Green Space to Development

By reducing the losses of agricultural lands and open green space, above- and below-ground carbon stocks are protected and more efficient land use is supported (as recommended in TLU-3—Smart Growth Planning). This option seeks to reduce the rates of conversion of these lands to developed use by 50 percent by 2025. Although the levels of estimated direct GHG reductions are moderate (0.5 $MMtCO_2e$/yr by 2025), the indirect benefits achieved through the linkage to smart growth planning and subsequent reductions in vehicle-miles traveled are expected to be substantial (see TLU Appendix C).

AFW-7 In-State Liquid/Gaseous Biofuels Production

This recommendation promotes sustainable in-state production and consumption of transportation biofuels from agriculture, forestry, and MSW feedstocks in order to displace the use of gasoline and diesel. This recommendation also promotes the in-state development of feedstocks, such as cellulosic material and production facilities to produce either liquid or gaseous biofuels with low carbon content. To achieve true gains in reducing GHGs and offsetting fossil fuel use, promoting biofuel production must be coupled with strong policies to reduce overall transportation fuel consumption. Upon successful implementation of this policy, Florida consumption of biofuels produced in-state will produce better GHG reduction benefits than these same fuels obtained from a national or international market due to lower embedded CO_2 (resulting from out-of-state fuels produced using feedstocks/production methods with lower GHG benefits, and from transportation of biodiesel, ethanol, other fuels, or their feedstocks from distant sources).

AFW-8 Promotion of Advanced Municipal Solid Waste Management Technologies (Including Bioreactor Technology)

This recommendation seeks to improve the GHG profile of MSW management in the state by promoting more efficient collection, transport, and waste management technologies and practices. There are a number of ways that the "cradle to grave" GHG profile of MSW management could be improved. The emissions include those from collection and transport of MSW and the final management of MSW, which currently occurs largely at landfills in Florida. These include more efficient collection vehicles, use of biofuels, route optimization, management of MSW in bioreactors, more efficient landfill gas collection systems, and more efficient use of landfill methane.

AFW-9 Improved Commercialization of Biomass-to-Energy Conversion and Bio-Products Technologies

This recommendation recognizes the need for programs to "ramp up" the commercialization of promising technologies to utilize biomass for energy or to produce bio-products with lower net GHG emissions. These could be emerging technologies, including emerging biomass gasification combined cycle (BGCC) electricity production, pyrolysis, and plasma arc technologies, as well as technologies that are farther along in commercial deployment (anaerobic digestion of organic wastes). Bio-products for use as building materials or other products or bio-based chemicals have the potential for reducing the life-cycle GHG emissions associated with the bio-products' fossil-based or higher embodied energy counterparts.

AFW-10 Programs to Support Local Farming/Buy Local

The Action Team approved this policy as a non-quantified recommendation. The recommendation seeks to enhance Florida's food system to produce more of the agricultural products needed by the state's consumers. When locally produced agricultural products supplant those from out-of-state or out-of-country, the embedded GHG emissions associated with transporting those items are reduced. To achieve this reduction, programs are needed to incentivize local production and consumption of fresh produce, dairy, meat, and fish. The Fresh From Florida retail campaign has achieved some success in this area in recent years through engagement with the major retail food outlets in the state. Similar programs will need to be developed and implemented. In addition, a much larger and tougher aspect of this option will be to develop new infrastructure to transport, process, package, store, and distribute locally or regionally produced food. The establishment of this enhanced infrastructure will require a significant amount of study, planning, investment, and promotion to occur.

Chapter 7
Government Policy and Coordination

Overview of Government Policy and Coordination

In Executive Order 07-128, Governor Crist directed the Action Team to develop recommendations for "strategic investments and public-private partnerships in Florida to spur economic development around climate-friendly industries and economic activity that reduces emissions in Florida" as well as "strategies and mechanisms for the long-term coordination of Florida's public policy in the areas of economic development, university-based research and technology development, energy, environmental protection, natural resource management, growth management, transportation, and other areas as needed to assure a future of prosperity for Floridians in reducing greenhouse gas emissions." To address this charge, the Technical Working Group (TWG) of Government Policy and Coordination was formed.

The types of policies considered for this "sector" are not as readily quantifiable in terms of greenhouse gas (GHG) reductions and cost-effectiveness calculations as other TWGs. Nonetheless, if successfully implemented, the recommendations will contribute to GHG emission reductions and enhance economic benefits associated with many other policy recommendations described in Chapters 3 through 6.

The Government Policy and Coordination TWG presented five policies that were ultimately adopted for recommendation by the Action Team. These policies are listed in Table 7-1 and fall into two categories: efforts that enable or enhance the successful implementation of policies recommended for specific sectors, and policies that foster the development and creation of technologies and businesses that mitigate GHGs and promote the creation of jobs and economic growth. Finally, the Government Policy and Coordination TWG examined the multiple planning authorities at all levels of government in Florida, and the Action Team has recommended measures to incorporate GHG considerations into government planning processes and improve coordination among entities with overlapping jurisdiction.

All five policy recommendations were adopted unanimously by the present and voting Action Team members.

Summary List of Policy Recommendations

Policy No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value 2009–2025 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Status of Recommendation
		2015	2025	Total 2009–2025			
GP-1	Targets, Reporting, Funding, and Accountability Measures	*Not to be Quantified*					Approved
GP-2	Public Awareness and Education	*Not to be Quantified*					Approved
GP-3	Inter-Governmental Planning Coordination and Assistance	*Not to be Quantified*					Approved
GP-4	"Green" Business Development Policies	*Not to be Quantified*					Approved
GP-5	Introduce Core Competencies Into Professional Licensing Programs	*Not to be Quantified*					Approved

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/$tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Note: The numbering used to denote the above pending priority policy options is for reference purposes only; it does not reflect prioritization.

Key Challenges and Opportunities

One of the key challenges facing Florida is the uncertainty of future federal policy. As the state seeks to address the challenges of mitigating GHG emissions and anticipates the effects of climate change beyond the reach of achievable emissions reductions, the role that the federal government will play remains a matter of speculation. Recent actions such as those contained within the 2007 Energy Independence and Security Act provide some guidance; however, the nature, timing, and scope of more significant federal actions are not easily predicted. Of particular interest is the potential for a national market-based program limiting GHG emissions or the expansion of the Clean Air Act to incorporate GHG emissions reduction requirements.

Recent Florida actions such as the 2007 Executive Orders and House Bill 7135 passed by the 2008 Legislature put in place an array of measures to reduce emissions and build a regulatory framework for many of the policies recommended.

The Government Policy and Coordination TWG recommendations include a number of suggestions to address fragmented, overlapping, and sometimes contradictory planning and regulatory authority between levels of government and separate agencies. The success with which climate change concerns can be interwoven into planning for future land use, transportation, and water management will be critical to achieving many of the needed long-term emission reductions. Leadership by the state is critical, as demonstrated by recent executive and legislative actions and the current Action Team effort, but inter-jurisdictional cooperation is equally critical to sustain the effort in the long run.

Nearly all of the TWG's recommendations contain language speaking to the need for immediate action. Many of the recommendations address inter-jurisdictional planning and other measures that require the concurrence of entities not directly involved in the Action Team process or subject to direction from the executive branch. It is therefore expected that many of these recommendations will be implemented only through negotiation and agreement, sometimes among multiple parties, or through legislation. The potential for extended discussion and debate has caused the Action Team in some cases to cull a subset of policies and measures that could be implemented in the near-term in order to emphasize the Action Team's sense of urgency.

Overview of Policy Recommendations and Estimated Impacts

The Government Policy and Coordination TWG organized its recommendations around five major initiatives:

- targets, reporting, funding, and accountability measures;
- public awareness and education;
- inter-governmental planning coordination and assistance;
- green business development; and
- a proposal to introduce core competencies into professional licensing.

Within these five are 43 specific actions, initiatives, or programs, which, if successfully implemented, would result in the attainment of the policy goals and significantly contribute to the success of many of the recommendations.

Government Policy and Coordination-Policy Descriptions for Recommendations

GP-1 Targets, Reporting, Funding, and Accountability Measures

This policy recommends specific administrative, goal-setting, and accountability measures necessary to implement many of the policies recommended for other sectors and measure progress over time. The State of Florida is committed to significant reductions in GHG emissions and has established emissions inventory, forecasting, reporting, and registry functions in state agencies.

The following recommendations are offered as guidance on how to implement and manage these administrative, goal-setting, and accountability functions:

(1) periodically review and revise established goals or targets for statewide GHG-emission reductions, renewable portfolio standards (RPS), and energy efficiency targets;

(2) establish RPS and energy efficiency portfolio standard (EEPS) targets and mandatory GHG emissions reporting, inventory, and forecasting functions at state agencies;

(3) develop an inventory and forecast system that is aligned with national protocols and tailored to specific emissions and/or "carbon sinks" found in Florida;

(4) provide technical assistance to emissions reporters and encourage participation;

(5) institute an accountability program to measure and report progress in reducing GHG emissions;

(6) establish GHG reduction targets for local, state, and regional government operations and school districts;

(7) measure and report on research and development (R&D), job creation, and new business investment resulting from related "green" economy programs and review the effectiveness of state funds used to support and/or promote those programs; and

(8) beginning in 2010, the Florida Energy and Climate Commission (FECC) should review progress toward achieving Executive Order 07-127 GHG reduction goals, and review and affirm or propose revisions to the goals every three years, assuming the necessary resources are available to properly complete this review.

GP-2 Public Awareness and Education

Floridians "doing their part" to address climate change assumes that citizens know what can and should be done and are provided the tools and the incentives to do so. To address this need, the Action Team proposes one public awareness and education program with measures tailored to the needs of three major audiences: K-20 education; the public at large; and local, state, and regional government.

The Action Team proposes that the following programs and measures be adopted to effectively reach these audiences:

(1) create and maintain one or more outreach coordinator positions in relevant executive agencies specifically tasked with climate change issues;

(2) assess the level of public understanding of the impacts of climate change and of state-specific actions to deal with climate change;

(3) create a *Florida Climate and Energy Challenge* program by June 2009 that can craft the message of how important it is for all Floridians to pitch in and reduce their energy usage;

(4) establish a recurring awards program to recognize leadership and attainment of goals and objectives of the Florida Climate Change Action Plan;

(5) engage and partner with the Florida business community to coordinate and leverage private sector-sponsored messages and initiatives to help implement the *Florida Climate Challenge*;

(6) educate broadcasters, reporters, editorial boards, and others about climate change, the risks it imposes, and actions Floridians can take;

(7) provide and advertise marketplace incentives to adopt and purchase goods with the minimum carbon footprint;

(8) ensure performance standards for the inclusion of climate change curricula in public education (K–12), identify gaps in climate change education, and provide specific curricula to fill any gaps;

(9) integrate best practices into public school design and construction;

(10) organize groups of educators to identify, assemble, and employ climate change curricula appropriate to specific age groups;

(11) integrate climate change into core college curricula, promote research into climate change and solutions at state universities, and develop university Centers of Excellence on climate issues, new approaches, and technologies;

(12) develop assessment tools to determine the impact of climate change curricula; and

(13) include climate change discussions especially at state-supported venues, such as science centers, zoos, and museums.

The goals of the program would be that, by January 2010, that 50 percent or more of Floridians and Florida businesses will acknowledge by survey the seriousness of climate change impacts and will have reduced their personal usage of energy from carbon-emitting sources by 10 percent, and, by the same date, all governmental agencies at the state, regional, and local levels will have reduced their usage of energy from carbon-emitting sources by 25 percent. Also, by June 2010, the *Florida Climate and Energy Challenge* will be expanded, and additional milestones and energy reduction targets will be established to meet the 80 percent reduction from 1990 levels by the 2050 goal.

GP-3 Inter-Government Planning Coordination and Assistance

Given the high priority of climate change mitigation in the State of Florida, numerous local, state, and regional government agencies are tasked with implementing climate policies or, at a minimum, integrating energy efficiency principles into their operations. Efficient coordination among agencies and between local, state, and regional government will enhance overall effectiveness, reduce overlap, and eliminate barriers to GHG mitigation efforts.

Local governments will be among the state's most vital partners in addressing climate change. Local and regional authorities have primary responsibility for land-use, development, and infrastructure planning, and have major responsibility for building code compliance.

The State of Florida is unique in that it has an existing comprehensive planning framework, which is the foundation of the state's growth management program. It provides for the coordination of state, regional, and local planning decisions. To facilitate and expedite climate change mitigation and adaptation efforts throughout the state, Florida's policymakers should work through the Florida Department of Community Affairs in conjunction with the Regional Planning Councils to use the local government comprehensive planning process to improve coordination and ensure that each level of government is working toward the same goals in a mutually supportive and consistent manner.

State government can help lead the way and build on the existing work that is in progress at local and regional levels by:

(1) collecting and facilitating access to information about best practices;

(2) providing cost-benefit analyses of the various approaches available to local governments in a fiscally constrained environment;

(3) documenting the economic benefits or payoffs for local governments, their constituencies, and businesses that are considering the implementation of green practices;

(4) eliminating state subsidies or favorable tax treatment for programs or policies that are contrary to GHG reduction efforts;

(5) identifying and eliminating state policies that unduly contribute to the generation of GHG emissions;

(6) finding ways to say "yes" to local and regional partnerships and solutions;

(7) funding the Florida Green Governments Grant Program and similar programs that support local and regional government initiatives; and

(8) expediting state-level review and decision-making processes, if applicable, to facilitate implementation of local and regional efforts. Creating a statewide process to achieve GHG reductions will allow all coordinating agencies to work in concert. In addition, determining regional GHG averages and encouraging use of a consistent system for local governments to quantitatively assess their reduction progress would facilitate their engagement in this effort and allow them to gauge their progress and efficacy.

The Action Team proposes the following goal as a measure of success in this area: Contingent upon having available funding and necessary programs in place, all counties with a population of more than 200,000 should develop current GHG emissions inventories and mitigation action plans by the end of 2010.

GP-4 "Green" Business Development Policies

Climate change impacts are likely to have significant effects on all sectors of Florida's economy. Some sectors will face acute challenges, while others will enjoy substantial growth opportunities. GHG mitigation and climate adaptation also are likely to create new economic and employment opportunities. Substantial investment is expected in energy efficiency implementation and renewable energy technologies. These investments hold the promise of diversifying and strengthening the Florida economy.

The intent of this policy is to encourage and facilitate the involvement of funding and investment sources, business interests, and entrepreneurs in quickly seizing business opportunities related to GHG reductions and climate change solutions. Florida should foster research and development associated with GHG emissions reduction, renewable energy, and energy efficient technologies. The state should also promote business, job development, and workforce training in alternative low-carbon fuels and vehicles and other alternative low-carbon technologies, such as energy efficiency.

The Action Team recommends that Florida:

(1) Unify existing resources and entities with those created under House Bill 7135 (FECC and the Florida Energy Systems Consortium) to support businesses in greening their operations and promote business development opportunities in climate protection and adaptation, including seeking or stimulating funding investments;

(2) undertake an analysis of potential opportunities in green industry development and target those technologies for which Florida has an advantage;

(3) analyze targeted incentives to promote private investment in these technologies or industries, such as tax credits, investment in academic programs and research, grant funding, and investment in workforce development;

(4) consider funding opportunities for clean energy technologies through the 33 investment funds managed by the State Board of Administration, among which is the Florida Retirement System Pension Plan Trust Fund;

(5) promote the use of commercially ready technologies through a targeted RPS, an EEPS, building codes, appliance standards, rebates, and tax incentives;

(6) encourage "business incubator" programs at Florida universities and colleges to attract and support new business development related to the new energy economy;

(7) offer incentive points for competitive grant programs for state-to-business economic development for businesses that have undertaken GHG reduction and energy efficiency programs;

(8) create or designate a clearinghouse entity to match technology developers and other climate solution entrepreneurs with necessary financing;

(9) promote the use and development of effective water conservation plans, low-energy water treatment technologies, and water-conserving products and technologies, such as those certified through the Environmental Protection Agency's WaterSense program or the Florida Water Star public education program initiated by the St. Johns River Water Management District;

(10) require the use of applicable "green buildings" standards for the award of state contracts for state-owned and state-funded projects;

(11) favor contracting with firms that undertake green standards in business operations and in proposed contract work; and

(12) define "green jobs" and have Enterprise Florida conduct or commission a study of job opportunities and develop a targeted strategy for Florida.

GP-5 Introduce Core Competencies Into Professional Licensing Programs

Florida has more than 200,000 licensed built-environment professionals, including building contractors, architects, landscape architects, engineers, interior designers, and others involved in the design and construction of Florida's residential and commercial sites and buildings. It is critical that Florida's licensed professionals—who are responsible for the design, development, and construction of Florida's built environment— incorporate climate change and energy efficient technologies, materials, and design into their projects to facilitate the reduction of GHG emissions. Therefore, the state needs to establish core competency provisions for licensed professionals who provide site and architectural design, site engineering, site construction, building construction, and building operations efficiencies services. The state also needs to require professional organizations, in support of their respective professional membership, to develop and administer continuing education programs that address new technologies, standards, and materials designed to reduce GHG emissions and promote energy efficiency.

Additionally, within Florida's State University System, design and engineering programs should establish required courses of study that focus on the issues and importance of climate change mitigation and energy efficiency toward establishing a sustainable Florida. Targeted professions should include architecture, interior design, civil engineering, environmental engineering, building inspectors, code compliance officers, building trades (plumbing and HVAC), general contractors (site and building), real estate, building operators, landscape architecture, and in the training for those pursuing state certification to become teachers.

Specific climate change-related questions would be added to the respective state licensure examinations. To maintain professional licenses within the designated design professions, the state would require the respective professional organizations to develop and administer continuing education programs that reinforce the importance of reducing GHG emissions and promoting energy efficiency.

In addition, the state should develop a Florida Green Building certification program for licensed professionals involved in the design and construction of residential and commercial buildings and development sites.

Chapter 8
Adaptation Strategies

Among the topics considered by the Governor's Action Team on Energy and Climate Change, adaptation is quite distinct from mitigation. Not only is adaptation about coping with the consequences of climate change rather than trying to prevent or limit them, but adaptation itself is a very broad topic, covering the many sectors that may be affected by global climate change. This includes infrastructure; the built environment; coastal resources; water resources; extreme climate events (and emergency response); marine, freshwater, and terrestrial ecosystems; and human health. Adaptation to climate change will be addressed by many state agencies, regional and local entities, non-profit organizations, the private sector, and individuals, thus making adaptation diffuse and diverse. This complicates adaptation policy development and implementation. Accordingly, the approach taken by the Action Team was to review the myriad resources and associated policies that are affected or could be affected by climate change to ensure their robustness and resilience in the face of climate change.

The Adaptation Technical Work Group (TWG) addressed a wide variety of topics in its deliberations. The work of the TWG also is unique among the six TWGs because there is no common metric for measuring success of adaptation measures. GHG reductions can be compared based on such common metrics as dollars per ton of carbon dioxide equivalent. There is no parallel outcome on adaptation. Some adaptations concern human life, others property, and still others are about reducing impacts of climate change on ecosystems and threatened or endangered species.

Science and Impacts of Climate Change[1]

Florida, because of its low-lying topography and geographical location in the sub-tropics, is especially vulnerable to sea level rise and extreme weather.

The Intergovernmental Panel on Climate Change (IPPC) projected a warming in the southeastern United States of approximately 4 to 6°F (2 to 3°C) for a medium scenario of greenhouse gas emissions[2]. Higher emissions scenarios, which are quite possible, would result in larger temperature increases. Temperatures are projected to rise more in the summer than in the winter.

[1] This section is a summary of Florida Atlantic University, "Florida's Resilient Coasts" (Murley et al., 2008)
[2] Christensen, J.H., B. Hewitson, A. Busuioc, A. Chen, X. Gao, I. Held, et al. 2007. "Regional Climate Projections." In: Solomon, S., D. Qin, M. Manning, M. Marquis, K. Averyt, M.M.B. Tignor, et al., eds. Intergovernmental Panel on Climate Change (IPCC). 2007. *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* New York: Cambridge University Press.

The IPCC also projected that precipitation patterns will change. It is difficult to confidently predict precipitation changes on a scale as small as Florida, but the climate models tend to project decreased precipitation over the Southeastern United States. The models show a tendency toward reductions in summer precipitation[3].

The IPCC also projected a sea level rise (SLR) of at least 9 inches to 23 inches by the end of the 21st Century[4]. This projection was based on published reports through 2005 and did not account for dramatically increased rates of land-based glacial melting observed in Greenland and Antarctica since the publication of the latest IPCC assessment[5]. Many scientists have stated that increases in melt rates in Greenland and Antarctica will make significant contributions to sea level rise beyond that projected in the IPCC Assessment[6]. For example, the Science and Technology Committee of the Miami-Dade County Climate Change Advisory Task Force projected a SLR of at least 1.5 feet in the coming 50 years and at least 3-5 feet by the end of the century[7].

In general, elevations of barrier islands are only minimally above sea level and much of Florida's barrier islands have been subject to extensive development of high value oceanfront real estate. These areas are at significant risk from SLR and increased intensity of hurricanes. Beach erosion, which already costs Florida more than $600 million per year,[8] is likely to increase. Coastal wetlands could be inundated by sea level rise. The Everglades represent the largest and most important of Florida's coastal wetlands. As sea levels rise, brackish waters will extend further inland and dramatically change these and other freshwater ecosystems. Unconfined coastal aquifers, such as the Biscayne Aquifer in South Florida, will become more saline because of sea level rise.

Florida was hit by 10 named storms in 2004 and 2005 and, to date, has been hit by several large hurricanes and tropical storms in 2008. The intensity of hurricanes is projected to increase,[9] although there is disagreement in the scientific community about whether the hurricane intensity has changed as a result of climate change. It is documented that wind speeds in the most powerful hurricanes have increased since the mid-1980s.[10]

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[3] Christensen, J.H., B. Hewitson, A. Busuioc, A. Chen, X. Gao, I. Held, et al. 2007. "Regional Climate Projections."

[4] Solomon, S., D. Qin, M. Manning, M. Marquis, K. Averyt, M.M.B. Tignor, et al., eds. 2007. (IPCC). Intergovernmental Panel on Climate Change. 2007. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. New York: Cambridge University Press.

[5] Pfeffer, W.T., J.T. Harper, and S. O'Neel. 2008. "Kinematic Constraints on Glacier Contributions to 21st Century Sea-Level Rise." Science. 321:1340-43.

[6] Oppenheimer, M., B.C. O'Neil, M. Webster, and S. Agrawala. 2007. "The Limits of Consensus." Science 317: 1505-06.

[7] Murley, J., N. Bolman, and B. Heimlich. 2008. "Florida's Resilient Coasts." Florida Atlantic University.

[8] *Ibid.*

[9] *Ibid.*

[10] Elsner, J. B., J.P. Kossin, and T.H. Jagger. 2008. "The increasing intensity of the strongest tropical cyclones." Nature 455: 92-95.

Even if hurricanes do not change, higher sea levels alone will result in higher storm surges. More intense hurricanes will likely lead to even higher storm surges and more damaging wind speeds.

According to Florida Atlantic University's study "Florida's Resilient Coasts," Murley et al. 2008 states:

In addition to sea level rise and hurricanes, there are numerous other potential effects of global warming that could affect Florida's communities and environment physically, economically and socially, including:

- Prolonged drought affecting water supplies, agriculture, and habitat;
- More wildfires due to excessive drought and heat;
- More flooding due to more torrential rains;
- More frequent and lengthy heat waves creating increased energy demands and health hazards to young children, elderly, and infirm;
- Potential insect infestation and insect-borne diseases resulting from increased temperatures combined with increased flooding due to storms;
- Bleaching of coral reefs and adverse effects on marine life and fisheries;
- Ecological changes in the Everglades and other natural systems affecting plant ecology, wildlife, the marine estuaries and coast, and tourism; and
- Economic, environmental, and social impacts.

Framework for Action and Goals

Based on the knowledge about the risks from climate change, the TWG developed a framework of adaptation topics and identified goals and strategies to address each topic. The framework and major objectives are:

ADP-1. Advancing Science Data and Analysis for Climate Change

Scientific data, analyses, and predictive modeling are needed to understand how Florida's climate is likely to change, the consequences of change, and possible solutions.

ADP-2. Comprehensive Planning

Florida's local, state, and regional comprehensive plans should be amended based on the best available data, include goals, objectives, and policies that will prepare the state for adapting to the future impacts of climate change, such as SLR. Future policies should use incentives to encourage desired actions, including encouragement not to repeat past decisions that will leave new development exposed to SLR and other climate change consequences.

ADP-3. Protection of Ecosystems and Biodiversity

Florida's ecosystems should be managed for resiliency by enhancing their ability to naturally adapt to the stresses of climate change and other pervasive threats, including invasive exotic species. In addition, climate change should be incorporated into all aspects of the beach management and coastal construction regulatory programs.

ADP-4. Water Resources Management

In order for Floridians to have adequate water supply available to meet their basic reasonable and beneficial needs while meeting the requirements of natural systems, state and local governments need to pursue intense conservation of all water uses and alternative water sources, and include stakeholder involvement in statewide and regional water supply planning processes. Climate change may impact existing sources due to many factors including altered rainfall patterns and salt water intrusion into coastal aquifer systems. Methods to quantify and plan for uncertainties and risks related to population growth, climate change, and environmental regulations will be needed.

ADP-5. Built Environment, Infrastructure and Community Protection

The reduction of potential damage to the built environment from the impact of natural hazards, especially from those hazards caused or exacerbated by climate change, should be a high priority for all levels of government and the private sector in Florida.

ADP-6. Economic Development

Policies, programs, and implementation mechanisms should be developed to support the ability of Florida's economy to adapt to climate change.

ADP-7. Insurance

Insurance rates should reflect risks from climate and climate change and be equitable and affordable. In addition, policies should discourage high risk development, particularly along the coast.

ADP-8. Emergency Preparedness and Response

Florida's future emergency preparedness and response functions should build on the excellence gained through past experience to ensure sufficient capacity and efficacy in protecting public heath and welfare against the risks from climate change such as more intense hurricanes and floods and potential spread of disease and heat stress.

ADP-9. Human Health Concerns

Florida's health plan should incorporate considerations of climate change to protect the health of its citizens.

ADP-10. Social Effects

Issues of social justice should be addressed. Food, water, and housing security should be protected and behavioral responses to extreme events and climate change need to be better understood.

ADP-11. Organizing State Government for the Long Haul

A single point of focus within state government should be created that can continue assessing the risks posed by climate change, develop increasingly informed adaptation planning, and adjust adaptation planning in Florida as events on the ground change. The Legislature created the Florida Energy and Climate Commission, which appears at present to have sufficient scope, powers, and resources to accomplish the intent of this element of adaptation planning. However, it will be important to assess the effectiveness of the commission in addressing adaptation.

ADP-12. State Funding and Financing

Florida should be prepared to fund the protection of human health and critical infrastructure, as well as address other impacts of climate change, where feasible, within a framework of protection, accommodation – and, in some cases, retreat.

ADP-13. Coordination with Other Regulatory and Standards Entities

Functional collaborative relationships between the State of Florida and selected federal government agencies entities, other states and countries, and key professional societies should be developed on climate change issues of mutual interest. Research agendas and funding sources should be aligned to address common interests and priorities.

ADP-14. Education

Florida should become a national and international leader in the dissemination of climate change information in the process of educating a broad diversity of constituents with cutting-edge and successful public education programs.

Recommended Early Action Items

The following recommendations were identified as Early Action Items for consideration by Florida's policymakers:

- Research
    - Foster and support a climate science research agenda for Florida with broad priorities. Institute a scientific advisory council on climate change to advise state government on this research agenda. Identify and establish long-term funding to support research. Funding should be protected from short-term economic or political cycles.
    - Conduct research needed to support incorporation of climate change into the protection of Florida's ecosystems and biodiversity.
    - Enhance support for mapping, monitoring, and modeling, all of which will be necessary to provide information to support policy-making. In addition, effective monitoring programs are needed to detect impacts of climate change; modeling is also needed to project impacts with more accuracy.
- Comprehensive Planning
    - State and regional agencies should provide financial and technical assistance to local governments to ensure timely updates of local plans.
    - Local governments should review their coastal management elements to determine necessary amendments to make their coastal areas (especially the coastal high-hazard area) resilient to the future impacts of climate change, including sea-level rise.
    - Florida statutes, regulations, policies, and the Florida Administrative Code should be reviewed by the Florida Attorney General to determine potential conflicts between private property rights and the state and local governments' responsibility to protect communities.
- Protection of Ecosystems and Biodiversity
    - Ensure that a representative portfolio of Florida's terrestrial, freshwater, and marine natural communities with redundant representation of habitats and species and connecting corridors is protected and managed in a manner that maximizes the health and resilience of these communities when facing climate change impacts.
    - Reduce and discourage future reliance on bulk-heading/hardening to stabilize estuarine and beach shorelines. Shoreline hardening should be considered only after a full and cumulative assessment of short- and long-term impacts to coastal resources and coastal ecosystems. Establish policies and regulations that clearly define when, how, where, and under what circumstances emergency beach stabilization is allowed.
    - The vulnerability of Florida's fish and wildlife to climate change impacts should be assessed, the most vulnerable species should be identified, and plans prepared to enhance their chances of survival where there is a reasonable likelihood that the species will survive over the next 50 years.
- Water Resources Management

    - Identify and quantify the potential effects of differing climate change scenarios on the vulnerabilities and reliability of existing water supplies with emphasis on source water availability and quality.

- Built Environment
    - Require that the Florida Building Code incorporate building design criteria for resisting future loads that may result from the impact of climate change-exacerbated hazards during a minimum service life of 50 years.
    - Develop required training provisions to educate professionals in relevant fields (such as architecture, engineering, and construction management) on the need to incorporate adaptation to climate change as a basis for establishing design criteria for new infrastructure. Completion of such required training provisions would be a condition for licensing.
- Public Education and Outreach
    - Provide immediate training on climate change adaptation.
    - Initiate a major public education campaign.

Appendix A
Energy Supply and Demand (ESD)

Policy No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value (See Note 2) 2009–2025 (Million $)	Cost-Effective-ness ($/tCO_2e$)	Status of Policy
		2017	2025	Total 2009–2025			
Tier 1							
ESD-5	Promoting Renewable Electricity through Renewable Portfolio Standard (RPS), Incentives and Barrier Removal (20% by 2020)	17	34.5	319	-$9,274	-$29	Approved
ESD-6	Nuclear Power	0.0	7.3	49.4	$1,782	$36	Approved
ESD-7	Integrated Resource Planning (IRP)	Not to be quantified					Approved
ESD-8	Combined Heat and Power (CHP) Systems	1.8	2.2	26.5	$126	$5	Approved
ESD-9	Power Plant Efficiency Improvements	8.4	8.9	111.4	–$1,541	–$14	Approved
ESD-11	Landfill Gas-To-Energy (LFGTE)	3.7	8.7	64.7	$79	$1	Approved
ESD-12	Demand-Side Management (DSM)/Energy Efficiency Programs, Funds, or Goals for Electricity	13.0	21.8	201.4	–$8,566	–$43	Approved
ESD-13a	Energy Efficiency in Existing Residential Buildings	3.4	5.4	50.4	-$1,432	-$28	Approved
ESD-14	Improved Building Codes for Energy Efficiency	0.0	4.9	9.9	-$265	-$27	Approved
ESD-15	Training and Education for Building Operators and Community Association Managers	*Not to be quantified*					Approved
ESD-17	Consumer Education Programs	*Not to be quantified*					Approved
ESD-23	Decoupling	*Not to be quantified*					Approved
Recent Actions							
	Building Codes for Energy Efficiency (HB 697 and Executive Order 127)	8.0	15.4	136.5	-$4,082	-$30	Not applicable
Sector Totals		**47.4**	**93.6**	**832.8**	**-$19,090**	**-$23**	
Sector Totals After Adjusting for Overlaps (see Note 3)		**44.4**	**106.4**	**841.3**	**-$16,143**	**-$19**	
Reductions from Recent Actions		**8.0**	**15.4**	**136.5**	**-$4,082**	**-$30**	
Sector Totals, including recent actions and adjustment for overlaps		**52.4**	**121.8**	**977.8**	**-$20,226**	**-$21**	

Policy No.	Policy Recommendation	Energy Security Fuel Savings (Saved 2009 - 2025)		
		Coal (million short tons)	Natural gas (billion cubic feet)	Petroleum (million gallons)
Tier 1				
ESD-5	Promoting Renewable Electricity through Renewable Portfolio Standard (RPS), Incentives and Barrier Removal (20% by 2020)	37	4,092	654
ESD-6	Nuclear Power	4	733	61
ESD-7	Integrated Resource Planning (IRP)	*Not quantified*		
ESD-8	Combined Heat and Power (CHP) Systems	5	198	431
ESD-9	Power Plant Efficiency Improvements	14	1,383	241
ESD-11	Landfill Gas-To-Energy (LFGTE)	0	27	4
ESD-12	Demand-Side Management (DSM)/Energy Efficiency Programs, Funds, or Goals for Electricity	19	2,266	326
ESD-13a	Energy Efficiency in Existing Residential Buildings	6	650	100
ESD-14	Improved Building Codes for Energy Efficiency	0	171	4
ESD-15	Training and Education for Building Operators and Community Association Managers	*Not quantified*		
ESD-17	Consumer Education Programs	*Not quantified*		
ESD-23	Decoupling	*Not quantified*		
Recent Actions				
	Building Codes for Energy Efficiency (HB 697 and Executive Order 127)	16	1,750	279
Sector Totals		**85**	**9,520**	**1,822**
Sector Totals After Adjusting for Overlaps (see Note 3)		**172**	**6,394**	**68**
Reductions from Recent Actions		**16**	**1,750**	**279**
Sector Totals, including recent actions and adjustment for overlaps		**188**	**8,144**	**347**

Policy No.	Policy Option	GHG Reductions ($MMtCO_2e$)			Net Present Value (See Note 2) 2009–2025 (Million $)	Cost-Effective-ness ($/tCO_2e$)	Status of Option
		2017	2025	Total 2009–2025			
Tier 2							
ESD-1	Technology Research and Development (R&D) with Commercial Opportunities	**The Action Team noted the importance of all options but the focus for analysis and subsequent recommendations was on Tier 1 options.**					
ESD-4	Electricity Transmission and Distribution Improvements						
ESD-13b	Incentives for New Residential Buildings and Master Planned Communities Achieving High Energy Performance Standards						
ESD-16	More Stringent Appliance/Equipment Efficiency Standards						
ESD-18	Incentives to Promote Implementation of Customer-Sited Renewable Energy Systems						
ESD-21	Rate Structures and Technologies to Promote Reduced Greenhouse Gas (GHG) Emissions						
ESD-22	Demand-Side Management (DSM)/Energy Efficiency Programs, Funds, or Goals for Natural Gas						

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/$tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; HB = House Bill.

Note: The numbering used to denote the above priority policy options is for reference purposes only; it does not reflect prioritization among these important policy options.

Note 2: Negative numbers in the "Net Present Value" column denote options for which the discounted value of the monetary **benefits** of the option are greater than the discounted total **costs** of the option.

Note 3: The emissions reduction and cost estimates shown for each individual option presume that each option is implemented alone. Many options interact extensively, as they target the reduction of energy use or emissions from the same sources. Therefore, if multiple options are implemented, the results will not simply be the sum of each individual option result. After individual option assessments were complete, a "combined policies" assessment was conducted to estimate total emission reductions, and to capture the overlaps among policies that are reported here.

Common Assumptions

This section provides the values currently used or suggested for analysis that apply across many options. Other assumptions are listed under the Quantification Methods section of each option.

Levelized, Avoided Costs (2007-2025, 2006$)

Electricity - Sales-Weighted Average	**$67**	$/MWh

Reflect energy credit of $60/MWh (natural gas combined cycle plant) and $7/MWh capacity credits based on calculations by Gulf, Progress Energy, FPL, and TECO and submitted to Florida Public Service Commission as part of Petitions for Approval of a New Standard Offer for Purchase of Firm Capacity and Energy from Renewable Energy Facilities or Small Qualifying Facilities

Electricity - Residential	**$67**	$/MWh
Electricity - Commercial	**$67**	$/MWh
Electricity - Industrial	**$67**	$/MWh

Levelized Costs not differentiated by sector for this analysis.

Natural Gas	**$7.6**	$/MMBtu

Note: In the absence (as of 8/1/08) of specific avoided gas costs, we derive a placeholder estimate for avoided gas costs by starting with average 2007 citygate gas costs and escalating costs based on escalation in weighted-average regional AEO2008 estimates for gas cost by sector. These values should be replaced by state-specific costs when and if available.

Prices

Electricity Price - Sales-Weighted, Levelized	**$100**	$/MWh

Prices are based on DOE data for prices in 2007 http://www.eia.doe.gov/cneaf/electricity/esr/esr_sum.html. Changes from 2008 to 2025 are based on the relative changes in projected Florida ERC reliability Corporation region prices in US DOE Annual Energy Outlook 2008 (same % changes).

Electricity - Residential Prices (Levelized, 2008-2025)	**$112**	$/MWh
Electricity - Commercial Prices (Levelized, 2008-2025)	**$98**	$/MWh
Electricity - Industrial Prices (Levelized, 2008-2025)	**$77**	$/MWh

Natural Gas (Delivered, RCI sales-weighted average)	**$12.8**	$/MMBtu

Natural gas prices are estimated as described for electricity above.

Natural Gas - Residential Prices (Levelized, 2008-2025)	**$19.1**	$/MMBtu
Natural Gas - Commercial Prices (Levelized, 2008-2025)	**$12.5**	$/MMBtu
Natural Gas - IndustrialPrices (Levelized, 2008-2025)	**$10.3**	$/MMBtu

Biomass - All Users	**$3.1**	$/MMBtu

Estimate based on national study of state-by-state biomass resource resource assessments--see worksheet "Biomass_Data" in this workbook. Price equivalent of $47/dry ton at 16 MMBtu/dry ton. This value is in the range of estimates of costs of fuel from different feedstocks shown in the Agriculture, Forestry and Waste Management Appendix (Appendix D) to the Florida Climate Action Team Report, Table D-4-3.

Coal - Industrial Users	**$3.1**	$/MMBtu

Average coal heat content of 26.75 MMBTU/ton, based on 2001 USDOE/EIA data. USDOE/EIA figures for 2006 suggest an average coal price of $84.16 per ton for coal for "Other Industrial Users" in Florida. www.eia.doe.gov/cneaf/coal/page/acr/table34.html

Oil - Distillate/Diesel	**$14.3**	$/MMBtu

USDOE/EIA data gives average annual spot prices for heating oil of $2.03 per gallon in the 2007 heating season. This cost does not include fuel taxes. An appendix to the 2006 Annual Energy Outlook by USDOE/EIA (see http://www.eia.doe.gov/oiaf/aeo/pdf/appendixes.pdf) lists an energy content for distillate oil of 5.799 MMBtu/bbl, or 0.138 MMBtu/gallon.

LPG	**$12.9**	$/MMBtu

USDOE/EIA data gives average annual spot prices for propane of $1.21 per gallon in 2007. This cost does not include fuel taxes. Prices expressed on $/MMBtu basis using a conversion factor of 0.09133 MMBtu/gallon (see "Fuel Data" woksheet)

Emission Rates, etc.	2015	2025	Units
Electricity T&D losses (fraction of total generation)	**8.0%**	**8.0%**	
Avoided electricity emissions rate	**0.625**	**0.411**	tCO_2/MWh

Electricity T&D losses: Input used in Revised Inventory and Forecast, derived from FRCC forecast (Sheet 12, row122)

Avoided electricity emissions rate: Assumes that reductions in electricity generation requirements through 2015 will come from the average emissions rate of then-existing fossil-fueled sources; by 2025 the predominant effect is assumed to be a reduction in reference case new fossil fuel plant builds during the 2015-2025 period.

Costs for New Renewable Power Plants

This subsection presents estimates for power plant cost data for Florida. Florida-specific power plant data are available from the Florida Public Service Commission's (PSC's) Web site.[1] The data were submitted by various stakeholders in response to the PSC's data request, which resulted from a renewable portfolio standard (RPS) workshop held on July 11, 2008. The purpose of the questionnaire was to provide the PSC with information on cost and on the technical potential of renewable energy technologies within the State of Florida. Section 366.92(3)(a), Florida Statutes, directs the PSC to evaluate the current and forecasted installed capacity and levelized cost for each renewable energy generation method through 2020 as part of developing RPS requirements for the state. Both regulated electric utilities and interested parties were invited to provide information to the PSC. Completed questionnaires are available on the PSC Web site.[2]

The RPS workshop included representatives from

- Decker Energy International
- Florida Public Utilities Company
- Orlando Utilities Commission (OUC)
- Progress Energy Florida, Inc.
- Florida Industrial Cogeneration Association
- Tampa Electric Company
- Wheelabrator Technologies, Inc.
- Biomass Gas and Electric, LLC
- Lakeland Electric

[1] http://www.floridapsc.com/utilities/electricgas/RenewableEnergy/07_11_2008_index.aspx

[2] Ibid.

- Regenesis Power, LLC
- Southern Alliance for Clean Energy
- Solid Waste Authority of Palm Beach County
- Florida Power and Light Company (FPL)
- Gulf Power Company
- Professional Timber Harvesting Business Owners in Florida
- Covanta Energy
- Florida Solar Energy Center
- Seminole Electric Cooperative
- City of Clewiston
- City of Tampa
- Pinellas County Resource Recovery Facility
- Integrated Waste Services Association
- Florida Solar Coalition
- Florida Crystals

Participants were provided with a specific data entry form, available at the PSC's Web site.[3] The completed forms yielded several types of data on both renewable energy and some conventional power plants, including capital and operation and maintenance (O&M) costs, levelized cost, capacity rating, capacity factor, and emission factors. Renewable energy sources that were included are solar, wind, biomass, hydro, landfill gas, municipal solid waste, ocean energy, and chemical processing heat.

Table A-1 summarizes median values of the response data combined with input from TWG members. The median values were used in the analysis because capacity rating and/or capital costs for some types of power plants are significantly different among data sources.[4] Levelized costs in Table A-1 are CCS calculations based on the assumptions reported here.

Table A-2 reports the capital cost assumptions and resulting levelized cost calculations for 2025. Changes in capital cost from 2009 to 2025 are based on output from the Assumptions to the

[3] http://www.floridapsc.com/utilities/electricgas/RenewableEnergy/RPS_Data_Collection.pdf

[4] We did not include some data sources for this summary table when they present data in an inconsistent unit such as $/kW/year for capital costs or when the respondents did not provide specific data because such data are not available, unknown, or confidential (e.g., some biomass plants and municipal solid waste plants). We also excluded a few data sources on the grounds that they appear as outliers, presenting extremely low or high values compared with others (e.g., $13,000/kW in one case for offshore wind).

Annual Energy Outlook 2008, Renewable Fuels Module.[5] Chemical processing heat plant assumption is based on the assumptions on natural gas turbines from Annual Energy Outlook 2008.[6] Capital cost reduction for PV is CCS's projection based on a literature review and contact with industry experts.

Shading indicates values that have been supplemented by data from TWG members. See Annex B for input from TWG members on data for renewable energy power plants. Data from TWG members were included in the range of data points from the PSC data request and the median values of the entire range were used in the analysis.

For Solar PV, cost assumptions were derived from the presentation "Solar Energy Industry Forecast: Perspectives on U.S. Solar Market Trajectory", by the United States Department of Energy Solar Energy Technologies Program, dated June 24, 2008[7]. This source quotes levelized costs for actual Residential, Commercial and Utility scale systems in 2005 as \$0.23-\$0.32, \$0.16-\$0.22 and \$0.13-\$0.22 per kWh generated, respectively. The same source (slide 13) shows cost "targets" for 2010 of \$0.13-\$0.18, \$0.09-\$0.12 and \$0.10-\$0.15 per kWh, respectively, for the three scales of systems. Additional calculations were required to estimate costs through 2025, based on continuation of the trends reported in the presentation but leveling out with a minimum price of \$0.05/kWh. The source does not provide assumptions on capital cost or O&M costs, just levelized costs.

[5] Available at: http://www.eia.doe.gov/oiaf/aeo/assumption/pdf/tbl72.pdf

[6] Available at http://www.eia.doe.gov/oiaf/aeo/assumption/pdf/tbl13.pdf

[7] Available at http://www1.eere.energy.gov/solar/solar_america/pdfs/solar_market_evolution.pdf

Table A-1 Summary of Assumptions for Renewable Energy Power Plants used in Analysis, for plants built in 2009

Fuel	Energy Source	Median capital cost (in 2006$)	Median Fixed O&M cost ($/kW-yr) (in 2006$)	Median variable O&M cost ($/kWh) (in 2006$)	Median energy cost ($/kWh) (in 2006$)
Biomass	Biomass–direct combustion and plant matter	$2,794	$85.89	$0.007	$0.04
	Biomass–animal waste	$4,199	$104.99	$0.003	
	Biomass–anaerobic digester	$4,152	$51.65	$0.003	$0.10
	Biomass–gasification	$4,585	$78.32	$0.006	$0.03
Landfill gas	Landfill gas	$1,576	$38.09	$0.008	$0.07
Waste	Municipal solid waste	$6,311	$133.67	$0.019	$0.16
Solar	Photovoltaic–small scale	Not available, see levelized costs in Table E-5-2			
	Photovoltaic–over 1 MW	Not available, see levelized costs in Table E-5-2			
	Solar thermal electric	$5,074	$43.12	$0.008	
Chemical processing heat	Sulfuric acid waste heat	$3,246	$2.20	$0.003	$0.03
Water	Run of river hydro	$2,035	$10.61	$0.005	
	Hydro pumped storage	$1,462	$7.62	$0.004	
Ocean energy	Ocean thermal gradients	$12,455		$0.019	
	Ocean tidal change	$2,573	$100.40		
	Ocean wave action	$4,337	$238.78		
Wind	Wind coastal	$2,722	$32.65	$0.0001	
	Wind inland	$2,438	$32.65	$0.0001	
	Wind offshore	$4,755	$67.19	$0.0001	

MW = megawatt; kW = kilowatt.

Note: All dollar values are converted to 2006$ using 2.5% inflation rate.

Fuel	Energy Source	Median Capacity Factor (%)	Median Economic Life (yrs)	Median Heat Rate (BTU/kWh)	Levelized cost ($/MWh) (in 2006$)*
Biomass	Biomass–direct combustion and plant matter	90%	30	13,000	$85
	Biomass–animal waste	80%	30	13,750	$69
	Biomass–anaerobic digester	80%	23	12,413	$171
	Biomass–gasification	82%	25	10,875	$103
Landfill gas	Landfill gas	83%	15	13,500	$104
Waste	Municipal solid waste	84%	23	17,000	$279

Fuel	Energy Source	Median Capacity Factor (%)	Median Economic Life (yrs)	Median Heat Rate (BTU/kWh)	Levelized cost ($/MWh) (in 2006$)*
Solar	Photovoltaic–small scale	15%	n/a	n/a	$146
	Photovoltaic–over 1 MW	20%	n/a	n/a	$134
	Solar thermal electric	20%	25	n/a	$293
Chemical processing heat	Sulfuric acid waste heat	80%	30	12,332	$72
Water	Run of river hydro	68%	40	n/a	$35
	Hydro pumped storage	49%	40	n/a	$33
Ocean energy	Ocean thermal gradients	90%	n/a	n/a	$173
	Ocean tidal change	48%	20	n/a	$84
	Ocean wave action	28%	n/a	n/a	$274
Wind	Wind coastal	20%	20	n/a	$170
	Wind inland	13%	20	n/a	$247
	Wind offshore	25%	20	n/a	$242

* levelized costs as calculated by Center for Climate Strategies based on assumptions reported in this document.

Table A-2 Summary of Assumptions for Renewable Energy Power Plants used in Analysis, for plants built in 2025

Fuel	Energy Source	Capital cost (in 2006$)	Levelized Cost ($/MWh in 2006$)
Biomass	Biomass–direct combustion and plant matter	$2,383	$81
	Biomass–animal waste	$3,583	$61
	Biomass–anaerobic digester	$3,542	$163
	Biomass–gasification	$3,911	$95
Landfill gas	Landfill gas	$1,510	$103
Waste	Municipal solid waste	$6,046	$275
Solar	Photovoltaic–small scale	n/a	$52
	Photovoltaic–over 1 MW	n/a	$50
	Solar thermal electric	$3,946	$235
Chemical processing heat	Sulfuric acid waste heat	$2,763	$66
Water	Run of river hydro	$1,852	$33
	Hydro pumped storage	$1,330	$31
Ocean energy	Ocean thermal gradients	$8,719	$127
	Ocean tidal change	$1,801	$66
	Ocean wave action	$3,036	$222
Wind	Wind coastal	$2,475	$156

	Wind inland	$2,411	$244
	Wind offshore	$4,324	$223

Approach for Calculating Sector Totals that include Option Overlaps

As noted in Table A-1, the emissions reduction and cost estimates shown for each individual option presume that each option is implemented alone. Many options interact extensively, as they target the reduction of energy use or emissions from the same sources. Additionally, the combined impact of multiple policies leads to different impacts on emissions as systems (such as the electricity generation system) react differently to large changes than they do to small. Therefore, if multiple options are implemented, the results will not simply be the sum of each individual option result. After individual option assessments were complete, a "combined policies" assessment was conducted to estimate total emission reductions, and to capture the overlaps among policies that are reported here.

For the ESD sectors, this combined policies approach required two steps: first estimate the extent that options that are likely to target the same reductions in energy use (the overlap between ESD options) and second estimate the impact of the combined options on the electricity system.

Approach Used for Quantifying the Overlaps between ESD Options

The ESD options most likely to overlap are those targeted at electricity reductions, in particular ESD-12 and ESD-13a. To account for this overlap, it is assumed that if both options were implemented together, the energy savings would be lower than the sum of the two individual options by an amount roughly equivalent to 30% of the energy savings attributed to ESD-13a as a stand-alone option.

No other options appeared to have significant overlap with one another.

Approach Used for Quantifying the Suite of Electricity Demand Options

This section discusses the quantification approach for integrating the ESD options that have an impact on electricity demand. All recommended ESD options result in some change to electricity generation – demand-side efficiency, power system efficiency, renewable energy, or additional generation from on-site combined heat and power systems.

Projecting the impacts of the mix of policy options on electricity emissions differs from estimating the impact of individual options. The avoided emission rate that was used to estimate the emission reductions from individual actions was estimated based on the marginal emission rate – the emissions associated with electricity generation that is most likely to be avoided when electricity demand decreases. For the individual options, it was estimated that reductions in electricity generation requirements through 2015 will come from the average emissions rate of then-existing fossil-fueled sources; by 2025 the predominant effect is assumed to be a reduction in reference case new fossil fuel plant builds during the 2015-2025 period.

However when all options are applied together, the savings in electricity consumption by 2025 exceeds the generation of new fossil fuel plants. Thus the electricity savings from the combined options would need to displace other generation resources – for example, new nuclear generation or existing fossil fuel plants. Displacing new nuclear plants is inconsistent with implementing all ESD options since one of the options (ESD-6) recommends adding new nuclear reactors that are additional to the new nuclear capacity that is added in the reference case. The addition of new nuclear reactors to meet the goals of ESD-6 while avoiding the new nuclear facilities that are currently planned by the utilities is an inconsistent evaluation of likely impacts. Thus for the combined options, we estimated the amount of existing fossil fuel generation that would be displaced. The mix of displaced coal and natural gas consumption was based on the share of generation by fuel type in the reference case. Generation from petroleum sources is relatively low in Florida and projected to decline significantly in the reference case. It is assumed that changes to electricity and generation due to the options would have only minor changes on petroleum use.

ESD-3. Renewable Energy Incentives and Barrier Removal

This option has been combined with ESD-5

ESD-5. Promoting Renewable Electricity Generation through Renewable Portfolio Standard (RPS), Incentives and Barrier Removal

Policy Description

The fundamental policy objectives of encouraging renewable electricity generation are to reduce GHG emissions, provide fuel diversity, and stimulate Florida's economy.

A Renewable Portfolio Standard (RPS) sets the minimum amount of electricity from renewable sources that must be generated and supplied to the electricity grid in a given year. This minimum requirement is applied to each utility, but provisions are often made for utilities to purchase renewable electricity or credits from other utilities.

Renewable energy incentives and barrier removal can complement, or possibly replace, an RPS as the policy tool to increase distributed and central grid-based resources of renewable energy throughout the state. Institutional and market barriers to the development of renewable energy include price distortions, failure of the market to value the public benefits of renewables, and the social cost of fossil fuel technologies, inadequate information, institutional barriers to grid interconnection, high transaction costs due to small project size, high financing costs because of lender unfamiliarity, and perceived risk. These can be overcome through a suite of financial and regulatory redresses, as well as through information and public education campaigns.

Policy Design

Goals: 20% of retail sales are supplied by renewable electricity by 2020.[8]

Timing: Ramp up beginning in 2012 until the final level is reached in 2020 and continues linearly after 2020.

Parties Involved: Florida Energy and Climate Commission (FECC), PSC, DEP, investor-owned utilities, public power, electric cooperatives, and state government. Also renewable energy manufacturers, and local, state, and regional banks and other financial institutions.

Other: For the purposes of this policy, renewable energy is defined as follows, according to Section 366.91, Florida Statutes, created by the 2008 Florida Legislature: "Renewable energy" is defined as electrical energy produced from a method that uses one or more of the following fuels or energy sources: hydrogen produced from sources other than fossil fuels, biomass, solar energy, geothermal energy, wind energy, ocean energy, and hydroelectric power. The term

[8] Alternative goals (20% by 2025 and 30% by 2025) were also considered, and results are included under quantification methods below.

includes the alternative energy resource, waste heat, from sulfuric acid manufacturing operations.[9]

Implementation Mechanisms

The Action Team recommends that the FECC study whether renewable energy providers should be granted priority access to the grid.

An RPS is a requirement that each utility in the State must supply a certain, generally fixed percentage of electricity from eligible renewable energy sources. In some states, and in the draft rulemaking for Florida, utilities can meet their RPS, or environmental portfolio standard (EPS), by purchasing certificates from eligible energy projects, typically referred to as Renewable Energy Certificates (RECs). See Related Policies/Programs in Place section below for more information on the Florida rulemaking process on RPS.

Financial obstacles can be addressed through property tax exemptions, exclusions, and credits; deductions to cover the expense of purchasing and installing renewable energy equipment; loan programs to aid in financing the purchase of renewable energy equipment; and grant programs designed for R&D or to help a project achieve commercialization.

Examples of financial incentives to encourage investment in renewable energy resources include:

- Direct subsidies for purchasing and selling renewable technologies;
- Tax credits or exemptions for purchasing renewable technologies;
- Feed-in tariffs, which provide direct payments to renewable generators for each kWh of electricity generated from a qualifying renewable facility, can be used by utilities (as a rate schedule) to fund renewable energy projects as a means to comply with a RPS;[10]
- Tax credits for each kWh generated from a qualifying renewable facility;

[9] See definition under Florida law at: (http://www.flsenate.gov/Statutes/index.cfm?App_mode=Display_Statute&Search_String=&URL=Ch0366/SEC91.HTM&Title=->2007->Ch0366->Section%2091#0366.91)

[10] Note the following studies on feed-in tariffs:

Gipe, P. December 18, 2006. "Britain's Stern Report Says Feed Laws Work Best for Renewable Energy," available at: http://www.wind-works.org/FeedLaws/Great%20Britain/BritainsSternReportSaysFeedLawsWorkBestforRenewableEnergy.html

Stern Review: The Economics of Climate Change, Chapter 16: "Accelerating Technological Innovation." 2006. ISBN: 0-521-70080-9, page 366, available at: http://www.hm-treasury.gov.uk/media/C/7/Chapter_16_Accelerating_Technological_Innovation.pdf.

European Commission. 2005. "The Support of Electricity from Renewable Energy Sources," see Figures beginning on page 24, available at: http://www.wind-works.org/FeedLaws/

Butler, L., and K. Neuhoff. "Comparison of Feed in Tariff, Quota and Auction Mechanisms to Support Wind Power Development by University of Cambridge—A Review," with link to full report, available at: http://www.wind-works.org/FeedLaws/CambridgePaper70.html

- Regulatory policies that provide incentives or assurance of cost recovery for utilities that invest in central station renewable-energy systems; and
- Incentives for solar/thermal water heating to offset the use of fossil fuels.

The Legislature, the Florida PSC, and other relevant state agencies are encouraged to prioritize the identification and elimination of barriers that impede the development of renewable resources in the state.

Regulatory policies can include solar or wind easements of access rights, development guidelines at the local level to enhance renewable energy generation (for example, requiring proper street orientation), and requirements that utilities provide information and utility leasing programs for renewable energy production to customers in remote regions.

Pricing and metering strategies can provide price signals and revenue streams to support investment in and optimal operations of renewable energy systems. Net metering is a policy that allows owners of grid-connected distributed generation (DG, generating units on the customer side of the meter, often limited to some maximum kW level) that produce excess electricity to sell it back to the grid, effectively "turning the meter backward." Net metering provides several incentives for renewable DG by reducing transaction costs (for example, no need to negotiate contracts for the sale of electricity back to the utility) and increasing revenue by setting compensation at retail electricity rates rather than at utility-avoided costs. In addition to net metering, pricing strategies of relevance to distributed renewable energy systems can include "time-of-use" (TOU) rates. These are fixed rates for different times of the day or for different seasons that reflect the time-varying value of electricity.

Well-designed interconnection rules will ensure that distributed power products meet minimum requirements for performance, safety, and maintenance and, at the same time, significantly advance the commercialization of these technologies. Such rules, generally developed and administered by a state's Public Utilities Commission (PUC), establish clear and uniform processes and technical requirements for connecting DG systems to the electric utility grid. Interconnection standards will reduce barriers to connection of DG systems to the grid. Connecting to the grid enables the facility to (a) purchase power from the grid to supply supplemental power as needed (for example, during periods of planned system maintenance), (b) sell excess power to the utility, and (c) maintain grid frequency and voltage stability, as well as utility worker safety.

Implementation mechanisms should involve manufacturers; producers; local, state, and regional banks; and other financial institutions.

Renewable energy sources should receive subsidies at least equal to nuclear energy sources to level the playing field, noting the current $9/month per household fee for nuclear.

An Integrated Resources Planning (IRP) system should be used to maximize efficient and renewable energy generation. IRP (see option ESD-7) could support development and installation of these technologies, if they meet the stated objectives of the IRP process.

Related Policies/Programs in Place

The PSC is currently engaged in rulemaking that would allow for a utility to meet the RPS either directly through the production of renewable energy or through the trading of renewable energy credits. The percentage must be based on retail sales, and HB 7135 also allows for added weight to those credits for solar and wind. This rule must be presented to the 2009 Legislature for its consideration and ultimate ratification. The Florida PSC and the FECC are working to catalog all available renewable resources in the state.

Section 366.91(b), Florida Statutes, provides the following definition: "renewable energy" means electrical energy produced from a method that uses one or more of the following fuels or energy sources: hydrogen produced from sources other than fossil fuels, biomass, solar energy, geothermal energy, wind energy, ocean energy, and hydroelectric power. The term includes the alternative energy resource, waste heat, from sulfuric acid manufacturing operations.[11]

Florida has taken a multifaceted approach to reducing barriers to renewable generation and bringing those technologies to market. For example, the PSC has approved standard offer contracts to reduce regulatory lag and negotiations between qualifying renewable facilities and utilities. The PSC has also recently approved tariffs to implement one of the nation's most aggressive net-metering laws by expediting interconnection and allowing up to 2 MW for inclusion of offset at the retail rate for 12 consecutive months. Moreover, Florida has a host of state-sponsored financial incentive programs to bring these technologies to market. These programs include the highly successful solar rebate program ($5 million), sales tax deductions for hydrogen and biofuels ($3 million), corporate investment tax credits for hydrogen and biofuels ($11 million), a renewable energy and efficiency grant program ($7 million), Farm-to-Fuel ($8 million), and Florida Energy Systems Consortium ($50 million).

It is important to note that the passage of HB 7135 requires the PSC to view DG under 2 MW as energy efficient. In addition, a housing appraiser cannot financially penalize a Floridian for adding a renewable energy device to his or her home.

The Energy Policy Act of 2005 (EPAct) directs states to consider upgrading their standards for interconnecting small generators within one year of enactment.[12]

Type(s) of GHG Reductions

CO_2, CH_4, N_2O.

[11] See definition under Florida law at: (http://www.flsenate.gov/statutes/index.cfm?mode=View%20Statutes&SubMenu=1&App_mode=Display_Statute&Search_String=Section+366.91&URL=CH0366/Sec91.HTM)

[12] Additional information on this federal requirement at: http://www.epa.gov/CHP/state-policy/interconnection_fs.html

Estimated GHG Reductions and Costs or Cost Savings

Table A-5-1. Estimates based on renewable generation providing 20% of retail electricity sales by 2020

ESD-5. Renewable Portfolio Standard (RPS)	2017	2025	Units
GHG emission savings	17	35	$MMtCO_2e$
Cumulative net costs (present value) (2009–2025)		-$9,274	$million
Cumulative emissions reductions (2009–2025)		319	$MMtCO_2e$
Cost-effectiveness		-$29	$\$/tCO_2e$

Data Sources:

- Renewables definition—2008 Florida Legislature, Section 366.91, Florida Statutes.
- Renewable resource potential
  - Florida Power and Light Company (FPL). January 2007. "Renewable Energy Potential in Florida", available at: www.psc.state.fl.us/utilities/electricgas/RenewableEnergy/Hartman-FPL.ppt
  - Florida PSC. March 2008. *PSC Staff Summary of the Information Gained from Public Service Commission Workshops on a Renewable Portfolio Standard*, available at http://www.psc.state.fl.us/utilities/electricgas/RenewableEnergy/2008_03RPSSummaryFinal.pdf
- Renewable plant costs (2010–2025)
  - State of Florida PSC's renewable energy database.[13]
    - Decker Energy. RPS Data Forms 1 to 6.
    - Florida Phosphate Fertilizer Manufacturers CF Industries, Mosaic, and PCS. RPS Data Forms 1 to 6.
    - Florida Solar Coalition. RPS Data Forms 1 to 6.
    - Florida Crystals. RPS Data Forms 1 to 6.
    - Gulf Power Company. RPS Data Forms 1 to 6.
    - Hillsborough County Resource Recovery Facility–Existing–Covanta Hillsborough. RPS Data Forms 1 to 6.
    - OUC. RPS Data Forms 1 to 6.
    - Progress Energy Florida, Inc. RPS Data Forms 1 to 6. July 21, 2008.
    - Pinellas County Resource Recovery Facility. RPS Data Forms 1 to 6.
    - Regenesis Power LLC. RPS Data Forms 1 to 6.

[13] http://www.floridapsc.com/utilities/electricgas/RenewableEnergy/07_11_2008_index.aspx

– Solid Waste Authority of Palm Beach County. RPS Data Forms 1 to 6.
– FPL. RPS Data Forms 1 to 6.
– Tampa Electric Company. RPS Data Forms 1 to 6.
– Wheelabrator South Broward Inc. RPS Data Forms 1 to 6.

Quantification Methods: Renewable resources are added to the mix according to key assumptions below, based on using lowest cost resources first, up to estimated resource potential. Capacity of each type of plant was added starting in 2009 (except for offshore wind, for which additions start in 2018 under option 2), with linear increases in capacity to meet the target goal for each resource by 2020 or 2025 with the exception of "PV, Over 1 MW". "PV, Over 1 MW" is phased in exponentially to reach the targets, starting at 500 MW in 2009 through 2020, and phased in linearly thereafter. The goals for renewable energy production were interpreted as percentages of forecast retail electricity sales in the target year.

Key Assumptions: The results shown in tables A-5-2 include generation and capacity to meet the alternative goals (options 2 and 3) that were analyzed for this policy. The Action Team based its recommendations on Option 1, generating 20% of Florida's electricity sales from renewable electricity by 2020.

Table A-5-2. Assumed Cost, Capacity, and Generation by Resource and Option

			Option 1 20% by 2020		Option 2 20% by 2025	
Resource	Levelized Costs in 2009 (2006$/MWh)	Levelized Costs in 2025 (2006$/MWh)	Capacity (MW) 2025	Generation (GWH) 2025	Capacity (MW) 2025	Generation (GWH) 2025
Biomass	$85	$81	4,219	33,263	4,219	33,263
Waste Heat From Sulfuric Acid Production	$72	$66	370	2,593	370	2,593
New Hydro	$89	$88	0	0	0	0
Landfill Gas	$103	$103	79	576	79	576
PV, Under 1 MW	$146	$52	3,000	3,942	1,500	1,971
PV, Over 1 MW	$134	$50	24,300	42,574	12,800	22,426
Offshore Wind	$242	$223	0	0	0	0
Coastal Wind	$170	$156	600	1,051	600	1,051

	Option 3: 30% by 2025	
Resource	Capacity (MW) 2025	Generation (GWh) 2025
Biomass	4,219	33,263
Waste Heat From Sulfuric Acid Production	370	2,593
New Hydro	0	0
Landfill Gas	79	576
PV, Under 1 MW	3,800	4,993
PV, Over 1 MW	28,700	50,282
Offshore Wind	0	0
Coastal Wind	600	1,051

Offshore wind available starting in 2018 (not included in Option 1 due to limited generation from source by 2020)

Federal production tax credit and investment tax credit for PV extended to 2015 (these credits are not included in the levelized costs shown above in table A-5-3)

Generation from Municipal Solid Waste are excluded, except for yard waste and landscape waste (which accounts for 1,332 MW of electricity capacity in 2025).

State tax credits are not included.

Avoided costs of electricity: $67/megawatt-hour (MWh) (see Common Assumptions). The avoided cost of solar PV power is assigned a higher avoided cost of $134/MWh based on the estimated incidence of peak power avoided by solar PV. This cost was estimated based on consideration of the coincidence of solar PV generation (timing of solar PV generation based on solar PV output)[14] with a May through October summer peak period from noon to 8 PM daily. Energy produced by solar PV systems during this period (about one-third of the annual output) was ascribed a combined capacity and energy value based on the cost of ownership and operation of gas-fired combustion turbine units. Data for the costs and performance of gas-fired combustion turbines were estimated based on averages of data for seven combustible turbine units planned for Florida for the period 2008-2013.[15]

[14] Provided by Philip Fairey of The Florida Solar Energy Center, 9/19/08
[15] Provided by Mark Futrell of the Florida Public Service Commission, 9/24/08

Avoided GHG emissions for electricity: 0.58 $MtCO_2e$/MWh in 2017, 0.41 $MtCO_2e$/MWh in 2025 (see Common Assumptions).

Additional notes on calculations and data sources used for all plant types are as follows:

All Plant Types: A Weighted Average Cost of Capital of 8.5 percent/yr was used for all plant types. CCS analysts suggest that this figure might be revised to 11 percent/yr, which would increase the annualized capital costs of all plant types somewhat. Data referred to below as derived from "Florida-based sources" are primarily based on data collected by the Florida Public Service Commission, and presented as a series of documents on a "renewable energy data" web page [16], as listed under "Data Sources" above. In some cases, these data have been augmented with information provided by Technical Working Group members or their representatives.

Biomass: Cost and performance data assumptions are as shown in Table A-1 for "Biomass–direct combustion and plant matter." Cost and other data for this plant type were derived based on the composites and averages from a number of largely Florida-based sources, including information provided by Florida Power and Light. The resource potential was provided by the Florida Climate Action Team's Agriculture, Forestry, and Waste Management (AFW) TWG. The resource includes Logging Residue, Urban Wood Waste, Primary Mill Residue, Agricultural Residue and Vegetable and Fruit Waste, Agricultural Energy Crops, Willow and Hybrid Poplar or Other Fast-growing Hardwoods, Other Woody Energy Crops, plus yard and landscape waste (considered a portion of municipal solid waste).

Waste Heat From Sulfuric Acid Production: Cost and performance data assumptions are as shown in Table A-1 for "Chemical processing heat" as provided by The Mosaic Company, which also provided the estimate of the extent of this resource.

New Hydro: Cost and performance data assumptions are as shown in Table A-1 for "Run-of-River hydro," but with a considerably higher Variable O&M estimate based on the average of data provided by two Florida sources. The potential of this resource, however, was judged by in-state experts to be negligible, due to very low hydraulic head, so no additional hydropower was included for this Option.

Landfill Gas: Cost and performance data assumptions are as shown in Table A-1, and are based on several Florida data sources. The capital cost shown is a median estimate of three Florida sources. The resource potential was provided by the AFW TWG.

PV, Under 1 MW: Cost assumptions are based on a report shown on the DOE/EERE website "Costs of Solar Power from Photovoltaics."[17] This report provided costs for residential, commercial, and utility solar PV systems for 2005, plus target costs for 2010 and 2015. Costs for

[16] Available at http://www.floridapsc.com/utilities/electricgas/RenewableEnergy/07_11_2008_Data.aspx
[17] Available at http://www1.eere.energy.gov/tribalenergy/guide/costs_solar_photovoltaics.html

PV under 1 MW were estimated using the average cost of residential and commercial, with capital cost declines after 2015 based on the 2010 to 2015 trend (see table below). A price floor of 5 cents/kWh was used, reflecting the graphs in the presentation that extended cost projections to 2020. It has been noted that the costs of some of the components of solar energy systems, including support structures and ancillary electrical systems, may not decline as fast as the costs of photovoltaic panels themselves (if at all).

Market Sector	Current US Market Price Range (cents/kWh)	Cost (cents/kWh Benchmark 2005	Cost (cents/kWh) Target 2010	Cost (cents/kWh) Target 2015
Residential	5.8 – 16.7	23 – 32	13 – 18	8 – 10
Commercial	5.4 – 15.0	16 – 22	9 – 12	6 – 8
Utility	4.0 – 7.6	13 – 22	10 – 15	5 – 7

Source: "Costs of Solar Power from Photovoltaics – United States Department of Energy"

PV, Over 1 MW: Cost assumptions are based on a report shown on the DOE/EERE website "Costs of Solar Power from Photovoltaics."[18] This report provided costs for residential, commercial, and utility solar PV systems for 2005, plus target costs for 2010 and 2015. Costs for PV over 1 MW were estimated using the utility sector costs, with capital cost declines after 2015 based on the 2010 to 2015 trend (see table above). A price floor of 5 cents/kWh was used, reflecting the graphs in the presentation that extended cost projections to 2020. The capacity factor of 20% assumes that large PV arrays will be located in high solar resource areas of the State. By way of comparison, a June 2008 study by Lazard titled "LEVELIZED COST OF ENERGY ANALYSIS – VERSION 2.0", computes levelized costs of power from utility-scale photovoltaic power systems of approximately 100 to 150 $/MWh, depending on the technology type (thin-film costs are lower) and other parameters. Lazard values are based on capital cost assumptions (the Lazard values range from $3500 to $6000 per kW), capacity factor assumptions (Lazard values vary from 20 to 26 percent), and the inclusion in the Lazard analysis of an investment tax credit of 30 percent. Note that solar thermal power systems have not been included in this analysis. As the costs and capacity factors of stand-alone solar thermal systems are generally considered similar to those of utility-scale solar PV systems, including these systems as options in the analysis would not change the results markedly. Solar thermal power systems that are integrated with fossil fueled generation offer somewhat lower costs, but the prospects for integrating such systems with existing fossil-fired plants in Florida is thought to be fairly limited—in the hundreds of MW. The costs used for solar PV power do not include costs for back-up power systems, which, depending on the utility system configuration at the time of high penetration of intermittent resources into the grid, may be needed. A number of studies, including experience in countries with a high penetration of intermittent resources in

[18] Available at http://www1.eere.energy.gov/tribalenergy/guide/costs_solar_photovoltaics.html

their power grids, suggest that such resources can be accommodated without great difficulty. A number of documents are available that touch on this topic[19].

Offshore Wind: Cost and performance data assumptions are as shown in Table A-1 for "Wind offshore;" capital costs are based on a median of several Florida data sources, as is the assumed capacity factor. It is noted that there are considerable technological and permitting unknowns regarding offshore wind development in Florida, which will also affect the extent of the resource that can be developed. Wind capital costs, both offshore and coastal, are assumed to decline by a total of 9 percent between 2009 and 2025. It has been noted that European sources for the variable operating and maintenance costs of wind power may allow the figures used in this analysis to be updated, though changes in these costs will not markedly effect cost results.

Coastal Wind: Cost and performance data assumptions are as shown in Table A-1 for "Wind coastal"; capital costs are based on a median of several Florida data sources, as is the assumed capacity factor. It is noted that the coastal wind resource in Florida may be limited; one utility estimate suggests that the practically usable resource may be in the range of 600 to 900 MW, with the lower end of this range considerably more likely.

Analysis of Alternative Goals for Renewable Generation

The Action Team asked for analysis of three alternative goals for renewable generation achievements. The Action Team used option 1, 20% of retail sales met by renewable generation in 2020 as the basis for its recommendation but the results of the other options are included below for information purposes.

Table A-5-3. Option 2 20% of retail sales met by renewable electricity by 2025

ESD-5. Renewable Portfolio Standard (RPS)	2017	2025	Units
GHG emission savings	14	25	$MMtCO_2e$
Cumulative net costs (present value) (2009–2025)		-$3,681	$million
Cumulative emissions reductions (2009–2025)		250	$MMtCO_2e$
Cost-effectiveness		-$15	$/tCO_2e$

[19] A selection of documents relevant to the topic of integration on distributed and intermittent resources into utility grids, as provided by a TWG member, include Torsen Lund, Analysis of distribution systems with a high penetration of distributed generation, Technical University of Denmark, September 2007; Jay Apt and Aimee Curtright, The Spectrum of Power from Utility-Scale Wind Farms and Solar Photovoltaic Arrays, Carnegie Mellon Electricity Industry Center Working Paper CEIC-07-12, 2007; J. Paidipati et al, Rooftop Photovoltaics Market Penetration Scenarios, NREL/SR-581-42306, February 2008; and J. Bebic, Power System Planning: Emerging Practices Suitable for Evaluating the Impact of High-Penetration Photovoltaics, NREL/SR-581-42297 February 2008. Recent studies in Texas, which has developed significant wind capacity in recent years, will also be germane.

Table A-5-4. 30% of retail sales met by renewable electricity by 2025

ESD-3 Renewable Energy Incentives and Barrier Removal	2017	2025	Units
GHG emission savings	18	38	$MMtCO_2e$
Cumulative net costs (present value) (2009–2025)		-$11,485	$million
Cumulative emissions reductions (2009–2025)		346	$MMtCO_2e$
Cost-effectiveness		-$33	$/tCO_2e$

Key Uncertainties

Dynamic nature of rapidly shifting marketplace and costs are significant uncertainty factors.

Additional Benefits and Costs

None cited.

Feasibility Issues

None cited.

Status of Group Approval

Approved

Level of Group Support

Unanimous consent

Barriers to Consensus

None

ESD-6. Nuclear Power

Policy Description

Nuclear power has historically presented a low-GHG source of electricity. However, no new commercial reactor has come on line in the United States since 1996 due to extremely high capital costs, the absence of any plan or technology for permanent disposal of nuclear waste, and risks to public safety exemplified by high-profile accidents at Three Mile Island and Chernobyl. The current federal administration has been supportive of nuclear expansion, emphasizing its importance in maintaining a diverse energy supply and its reputation for producing electricity with negligible greenhouse gas emissions during operation. Congress has also offered significant financial subsidies for new nuclear plants in an effort to jump-start the industry, including limitations on liability for nuclear accidents.

Today, nuclear power plants provide about 20% of electric power nationally. The role of existing and new units needs to be considered for a comprehensive climate-change policy process.

Policy Design

Goals: The installation of two additional (relative to the reference case) reactors/units of 1,100 MW each are added in 2020.

The reference case assumes the facilities and capacities shown in Table A-6-1, including four currently planned 1,100 MW reactor units for Turkey Point and Levy.

Timing: New plants operational in 2020.

Parties Involved: U.S. Nuclear Regulatory Commission (NRC), PSC, Progress Energy Florida (PEF), FPL and possibly Gulf Power and the Jacksonville Electric Authority (JEA).

Other: none

Implementation Mechanisms

Integrated Resource Planning (IRP) (see option ESD-7) could support development and installation of these technologies, if they meet the stated objectives of the IRP process.

Related Policies/Programs in Place

With the construction of a traditional electric generator, the utility must assume all the costs of permitting, planning, and construction until the plant is operational, and only when it begins producing electricity may the utility begin collecting cost recovery revenues. The design, permitting, planning, and construction of a nuclear facility may take from 8 to 10 years to complete. The long planning and permitting process for nuclear facility means that a utility would have to assume all costs to develop the project for a decade before it could begin recovering those expenses. In recognition of that burden and to stimulate the development of new nuclear facilities in Florida, during the 2007 session, the Legislature passed, and Governor Crist signed, legislation allowing utilities to begin recovering the expenses associated with nuclear facilities in advance. During the 2008 legislative session, HB 7135 added the recovery of expenses associated with new, expanded, or relocated electric transmission lines needed for the operation of a nuclear power plant. A provision was added to allow an electric utility to obtain a separate permit to begin construction of facilities (such as access roads, rail lines, or electric transmission facilities) on a site in support of a future nuclear generator before the nuclear certification is issued.

The current federal administration has been supportive of nuclear expansion. Congress has also offered significant financial subsidies for new nuclear plants in an effort to jump-start the industry, including limitations on liability for nuclear accidents. Florida utilities may or may not be eligible for these subsidies. The US DOE recently announced submittal of a license application (LA) to the NRC seeking authorization to construct America's first repository for spent nuclear fuel and high-level radioactive waste at Yucca Mountain, Nevada. Currently, the waste is stored at 121 temporary locations in 39 states across the nation.

In Florida, a total of 5,400 MW of nuclear generation is planned through 2020.

Table A-6-1. Florida MW of planned nuclear through 2020

Utility	FPL	FPL	FPL	PEF	PEF	JEA
Location	Miami-Dade	St. Lucie	Miami-Dade	Levy County	Citrus County	Georgia
Name	Turkey Pt. 6 & 7	St. Lucie 1 & 2	Turkey Pt. 3 & 4	Levy Units 1 & 2	Crystal River Unit 3	
Capacity (MW)	1,100–1,520 each	103 each Upgrade	104 each Upgrade	1,100 each	37 and 129 Upgrade	200
In service	June 2018 and June 2020	Fall 2011 and Spring 2012	Spring 2012 and Fall 2012	June 2016 and June 2017	December 2009 (37) and December 2011 (129)	2016

FPL = Florida Power & Light Company; PEF = Progress Energy Florida; JEA = Jacksonville Electric Authority; MW = megawatts.

Type(s) of GHG Reductions

Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O).

Estimated GHG Reductions and Costs or Cost Savings

Table A-6-2.

ESD-6 Nuclear	2017	2025	Units
GHG emission savings	0.0	7.3	$MMtCO_2e$
Cumulative net costs (present value) (2009–2025)		1,782	$million
Cumulative emissions reductions (2009–2025)		49.4	$MMtCO_2e$
Cost-effectiveness		36	$/tCO$_2$e

ESD = energy supply and demand; GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/tCO$_2$e = dollars per metric ton of carbon dioxide equivalent.

Data Sources:

- Nuclear plant costs (2010–2025)
  - FPL. RPS Data Forms 1 to 6. http://www.floridapsc.com/utilities/electricgas/RenewableEnergy/07_11_08_Staff_to_FPL.pdf
  - Moody's Investors Service. October 2007. "New Nuclear Generation in the United States: Keeping Options Open vs. Addressing An Inevitable Necessity."
  - Morris, C., J. Kranowitz, M. Kelly, B. Fascitelli, and M. Hughes. June 2007. *Nuclear Power Joint Fact-Finding*, The Keystone Center, available at: http://www.state.nv.us/nucwaste/news2007/pdf/njff07jun.pdf

Quantification Methods:

Generation from nuclear plants was calculated on the basis of capacity and capacity factor, from option goals. Generation is assumed to start in 2020 and continue at the same level through 2025.

Key Assumptions:

The Action Team recommended that analysis be completed using a mix of costs from PEF and FPL. The results shown assume a total levelized unit cost of nuclear power of about $100 per MWh (all costs in 2006 dollars) generated[20], which assumes a useful life (and life for calculation of annualized capital costs) of 40 years[21], a capacity factor of 92%, an average installed capital

[20] Note that this value is lower than, for example, the range of low to high estimates for the levelized cost of power from Florida Power and Light's (FPL) proposed Turkey Point Six plant, (11 to 14 cents/kWh), but that latter is expressed in year 2018 dollars.

[21] It has been noted that given the current trend toward life extension of nuclear reactors, it may be realistic to assume that new nuclear plants will operate for 60 years. This may affect overall life-cycle costs, but is likely to have a modest impact, if any, on the cost estimates shown here, as financing (and thus levelized payments) will likely be based on the standard lifetime.

cost of $7,091/kW[22], $79/kW-yr fixed O&M costs, $3.1/MWh variable O&M costs, $15/MWh fuel costs[23], and a 8.5%/yr weighted average cost of capital[24].

It should also be noted that the levelized costs of generation for nuclear power (and avoided cost benefits), as for other options considered in this document, has been ascribed to the years in which generation (in this case) occurs. To the extent that some of these costs will need to be paid before—in some cases many years before—the reactors come on line, AND to the extent that the time value of these costs are not reflected in the capital costs above, the process of calculating a discounted value for costs and benefits of power may undercount, perhaps substantially, the actual cost per ton of GHG emissions avoided by ESD-6.

Avoided costs of electricity: $67/megawatt-hour (MWh) (see Common Assumptions).

Avoided GHG emissions for electricity: 0.58 $MtCO_2e$/MWh in 2017, 0.41 $MtCO_2e$/MWh in 2025 (see Common Assumptions).

Key Uncertainties

The construction of nuclear plants is directly tied to the price of oil, and there is significant uncertainty in future oil prices. Also no new commercial reactor has come online in the United States since 1996 due to high capital costs, the uncertainty of Yucca Mountain availability for waste storage, and risks to public safety exemplified by high-profile accidents at Three Mile Island and Chernobyl.

An Action Team member has suggested alternative nuclear power costs, based in part on data provided in an article by authors from the Rocky Mountain Institute[25], that include capital costs that are 25 to 50 percent higher than those above, adds taxes and insurance, decommissioning, and nuclear waste management costs totaling $11/MWh, and applies a lower capacity factor of 80 percent to estimate a levelized cost of nuclear power of about $175/MWh (assumes capital cost 50% higher than the estimate provided above). Using these data (all other assumptions

[22] This figure is derived from the average of cost estimates for the proposed Progress Energy Levy 1 plant, and the FPL Turkey Point Six plant, converted to 2006 dollars. As one of these two plants would be the first plant to be built on a site, and thus more expensive than a subsequent unit this may slightly (a few percent) overstate the cost of the units included in ES-6, as the latter are likely to be units added to existing plant, not the first plants at a new site. On the other hand, nuclear power plant costs have been rising significantly in recent years as commodity prices (steel, cement, copper) and other costs related to reactor construction have risen. As a consequence, additional real escalation in nuclear plant costs, though not included in this analysis, could be possible.

[23] This value is somewhat higher than the approximately $9/MWh figure reported by two Florida utilities, but is consistent with several national and regional studies, which report a range of $12 to $20 per MWh (for example, Jim Harding, Nonproliferation Policy Education Center, Economics of New Nuclear Power and Proliferation Risks in a Carbon-Constrained World, June 2007), and seems more consistent with recent uranium price trends.

[24] As with renewable energy plants, CCS analysts suggest that this figure might be revised to 11 percent/yr, which would increase the annualized capital costs for nuclear power plants somewhat.

[25] Amory B. Lovins and Imran Sheikh, "The Nuclear Illusion", Ambio, 27 May 2008, available (in draft form) as http://www.rmi.org/images/PDFs/Energy/E08-01_AmbioNucIllusion.pdf.

being equal) would reduce the 2025 emissions reductions from ESD-6 to 6.3 $MMtCO_2e$/yr, and increase the net cost of avoided emissions to about \$115/T CO_2e.

Additional Benefits and Costs

There are significant potential risks associated with nuclear power, including unresolved waste disposal issues, negative impacts on human health, cost overruns, and siting and permitting issues that must be considered. The Action Team also recommends vigorous efforts in Florida and across the nation to continue to improve safety standards for nuclear waste material including management, security, transmittal, long-term storage and reprocessing of spent nuclear material.

Feasibility Issues

None cited.

Status of Group Approval

Approved

Level of Group Support

Unanimous consent among those present who voted

Barriers to Consensus

None

ESD-7. Integrated Resource Planning (IRP)

Policy Description

IRP is a planning process that strives to meet needs for electricity services in a manner that meets multiple objectives, such as least cost and meeting emissions standards, fuel diversity, and RPS requirements. An IRP process should include evaluation of all options from the supply and demand sides in a fair and consistent manner, building in flexibility to account for future uncertainties. While originally targeted primarily toward cost minimization, IRP processes have increasingly considered the environmental risks and the potential costs associated with future regulation of GHGs.

With a growing population and increased demand for electricity, Florida must manage and diversify the risk of volatility in energy markets and the need to reduce GHG emissions from the utility sector. In doing so, it must reduce overall costs to ratepayers who are suffering under high gasoline and electricity prices.

In 2007, Florida's residential electricity rates were the 16th highest in the nation.[26] Florida relies on fossil fuel plants for about 85 percent of its electricity, placing it at considerable risk in the new, global markets for fossil fuel electricity. The essential forum to address these concerns is in the planning and acquisition of electric generation resources. In Florida, the Ten-year Site Plan proceeding, a process driven by load forecasting, is viewed as the central planning platform. This assumes the building of additional generation in order to meet growing demand. It affords only marginal consideration for conservation or non-fossil fuel options in meeting demand, while placing its highest priority on minimizing the direct, short-run costs to utilities.

Key electricity planning activities take place in other forums that tend to fracture the overall economic analysis of cost effectiveness in meeting energy demand in Florida. The planning forums include:

(i) determination of need or siting cases;
(ii) review of utility power purchase agreements;
(iii) transmission and distribution planning;
(iv) fuel cost adjustment reviews;
(v) rate case and rate design proceedings; and
(vi) environmental compliance review.

Florida has no comprehensive process which allows regulators to balance the economics and nuances of these planning needs to suit the state's energy objectives, or the consumer's budget.

[26] In 2007, Florida's residential electricity rates were 5% higher than national average, 16th highest rates in the country. Energy Information Administration. Average Retail Price of Electricity to Ultimate Customers by End-Use Sector, by State http://www.eia.doe.gov/cneaf/electricity/epm/table5_6_b.html.

Therefore each of these forums is driven by the traditional process, namely econometric projections of load, and the automatic construction of supply-side resources to meet it. Thus, it is difficult to ensure that ratepayers get reasonable value for the investments they contribute to utilities. For most consumers, this is determined by the value they receive at the end use of electricity. There is little or no attention paid to this metric in planning.

At a time when externalities are deeply affecting the costs to deliver electricity, a true understanding of all the external costs, and how they impact the end use price of electricity is vital. Even more important is an understanding of resources that effectively manage these ultimate costs. The present process can tend to filter or narrow the measurement of actual costs to provide end use energy service. It assumes fossil fuel plants are the standard bearer, requiring all other energy resources to beat this approach to costing. This comparison includes pressure to underestimate the costs of environmental compliance, and distort the benefits of energy efficiency and renewables. These are dangerous policy omissions in a state where natural and physical resources necessary to support fossil fuel plants are quickly diminishing.

A missing element of Florida's present planning is a holistic, economic framework. It is recommended that Florida undertake a true integrated resource planning regime which embraces the idea of "least cost-best fit" as its primary criteria.

Principles of Integrated Resource Planning

Integrated Resource Planning ("IRP"), as it relates to electric utilities, is an economic planning process designed to identify the lowest practical cost at which a utility can deliver reliable energy services to its customers. It differs from traditional resource planning, and from the 10-Year Planning process, in that it requires analytical tools that assess and compare the costs and benefits of demand *and* supply-side energy resources. It should identify and standardize the critical assumptions across each of the varied planning forums which drive utility resource decisions.

The energy service objectives of the State of Florida extend well beyond the individual or collective definition of cost minimization for electric utilities. With the level of uncertainty in energy markets, IRP must be adopted to clearly focus on the state's energy service objectives, in order that oversight of utility resource decisions can ensure consistency and compatibility with the state's needs.

Fundamentally, IRP recognizes that the economic costs customers face are the combination of the price of kilowatt hours (kWh), the efficiency of the generation of those kWhs, and the efficiency of electric devices in converting the kWhs to an end use. In addition, IRP recognizes that in the general cost of the kWhs, consumers ultimately pay for externalities such as environmental compliance, transmission congestion, and market volatility. Consequently, mitigation of these costs has a value which is integral to the planning process. This is a distinct expansion of the planning analysis, looking beyond the short-run costs (and cost minimization) of utilities, to look additionally at the costs, and potential benefits to the consumer.

A key distinction of IRP is its acceptance of the principle that in order to accurately compare and analyze resources, all relevant expenses for existing and new resources options must be included in the analysis. Thus, transmission and distribution costs, environmental compliance costs, risk and reliability impacts, and security costs are key inputs. Likewise, benefits of resources that defer, eliminate, and reduce these costs are key inputs.

Despite widespread scaling back of utility energy efficiency programs during the 1990s, the primary rationale for implementing energy efficiency programs – to reduce electricity costs and lower customer bills – is just as relevant in today's electricity industry as it has been in the past. Consequently, demand-side resources, and particularly energy efficiency, are an important resource in the planning process. The essential benefit of IRP to Florida is that it will allow an analysis of supply-side and demand-side resources on equal footing.

An extensive review of IRP, and the steps to implement it are available in the report "Integrated Resource Planning for State Utility Regulators." [27]

Policy Design

Goals: Nonquantifiable. To develop a comprehensive state resource adequacy plan for Florida that meets the energy reliability, environmental, and economic needs of the state.

Timing: Final plan is to be completed by June 30, 2010.

Parties Involved: FECC, DEP, regulated electric utilities, environmental and consumer advocates, renewable energy industry, energy efficiency industry, and the financial community.

Other: None

Implementation Mechanisms

None cited

Related Policies/Programs in Place

Florida has had a long-range electrical resource planning process in place since 1974.[28] All investor-owned utilities, as well as OUC and JEA, are statutorily required to file Ten-Year Site Plans (TYSP) with the PSC. The TYSP is an annual filing that provides a list of future generation for the next 10 years, and the PSC acknowledges the TYSP. In addition, the PSC determines the need for generation (75 MW of steam or solar) in a determination that is triggered by a utility's TYSP filing. The PSC takes into account availability of efficient and renewable generation prior to approving the necessity of a power plant. Lastly, the power plant must go through the Power Plant Siting Act (PPSA) process, a rigorous multiagency review that requires obtaining all

[27] Harrington, C., Moskovitz, D., Austin, T., Weinberg, C., Holt, E., Integrated Resource Planning for Sate Utility Regulators, Regulatory Assistance Project, June, 1994, www.raponline.org.

[28] Response to Regulatory Assistance Project Electric Resource Long-range Planning Survey. June 2003. http://www.raponline.org/Pubs/IRPsurvey/IRPFLorida.pdf

environmental permits and ultimate approval by the Governor and Cabinet sitting as the Siting Board.

Type(s) of GHG Reductions

CO_2, CH_4, N_2O.

Estimated GHG Reductions and Costs or Cost Savings

Not quantified

Data Sources: Not applicable

Quantification Methods: Not applicable

Key Assumptions: Not applicable

Key Uncertainties

None cited.

Additional Benefits and Costs

None cited.

Feasibility Issues

None cited.

Status of Group Approval

Approved

Level of Group Support

Unanimous consent

Barriers to Consensus

None

ESD-8. Combined Heat and Power (CHP) Systems

Policy Description

Combined heat and power (CHP) is generally considered to refer to the use of a heat engine or a power station to simultaneously generate electricity and useful heat. Conventional power plants emit the heat created as a by-product of electricity generation into the environment through cooling towers, flue gas, or by other means. CHP systems reduce fossil fuel use and GHG emissions through the improved efficiency of the CHP systems, relative to separate heat and power technologies, and by avoiding transmission and distribution losses associated with moving power from central power stations located far away from where the electricity is used.

Here CHP is defined broadly to include large-scale projects for heat and waste heat recovery and is intended to capture all sources of by-product heat generation, including waste heat from exothermic reactions when sulfuric acid is produced such as is generated in phosphate fertilizer manufacturing.

This policy should also address the numerous barriers to CHP processes, including inadequate information; institutional barriers; high transaction costs due to small project size, lender unfamiliarity and perceived risk; "split incentives" between building owners and tenants; and utility-related policies (such as interconnection requirements, high standby rates, and exit fees).

Policy Design

Goals: Ramp up CHP to 5 million MWh of total generation by 2022. This represents about 1000 MW of additional combined heat and power. By way of comparison, a 2005 study estimated that Florida has over 6000 MW of CHP potential, including over 5000 MW of potential applications in the commercial/institutional sector[29].

Timing: Beginning in 2012, ramp up new CHP linearly, until 5 million MWh is reached in 2022.

Parties Involved: State government and regulators, PSC, FECC, electric utilities, and renewable energy and CHP industry.

Other: Coverage should be defined broadly to include waste heat from all sources of by-product heat generation, including waste heat from exothermic reactions when sulfuric acid is produced such as that generated during phosphate fertilizer manufacturing. Coverage will include biomass and natural gas.

[29] Bruce Hedman, Energy and Environmental Analysis, "Southeast Planning Session, CHP Market Review", July 6, 2005.

Implementation Mechanisms

Potential elements of this option include:

- Promotion of the use of gas-fired CHP systems,
- Promotion of the use of biomass-fired CHP systems, and
- Creation and expansion of markets for and incentives designed to promote implementation of CHP units in capacities suitable for residential, commercial, and industrial users.

Specific financial incentives for CHP could include:

- Direct subsidies for purchasing and selling CHP systems given to the buyer or seller;
- Tax credits or exemptions for purchasing and selling CHP systems given to the buyer or seller;
- Tax credits or exemptions for operating CHP systems;
- Feed-in tariffs, which are direct payments to CHP owners for each kWh of electricity or British thermal unit (Btu) of heat generated from a qualifying CHP system;
- Tax credits for each kWh or Btu generated from a qualifying CHP system;
- Targeted financing arrangements; and
- Renewable Energy Credits.

Other supporting measures for this option include training and certification of installers and contractors, net metering and other pricing arrangements, establishment of clear and consistent interconnection standards, and creation and support of markets for biomass fuels.

Pricing and metering strategies can provide price signals and revenue streams to support investment in and optimal operations of CHP systems. Net metering is a policy that allows owners of grid-connected DG (generating units on the customer side of the meter, often limited to some maximum kW level) that generates excess electricity to sell it back to the grid, effectively "turning the meter backward." Net metering provides several incentives for renewable DG by reducing transaction costs (e.g., no need to negotiate contracts for the sale of electricity back to the utility) and increasing revenue by setting compensation at retail electricity rates rather than at utility-avoided costs. In addition to net metering, pricing strategies of relevance to CHP and distributed renewable-energy systems can include TOU rates. These are fixed rates for different times of the day or for different seasons that reflect the time-varying value of electricity.

Policies to remove barriers can include improved interconnection policies; improved policies for rates and fees; streamlined permitting; recognition of the emissions reduction value provided by CHP, clean DG financing packages, and bonding programs; power procurement policies; ability to provide power to third-party consumers; and education and outreach.

An IRP system should be used to maximize efficient and renewable energy generation. IRP (see option ESD-7) could support development and installation of these technologies, if they meet the stated objectives of the IRP process.

Related Policies/Programs in Place

None cited.

Type(s) of GHG Reductions

CO_2, CH_4, and N_2O

Estimated GHG Reductions and Costs or Cost Savings

Table A-8-1.

ESD-8 Combined Heat Power	2017	2025	Units
GHG emission savings	1.8	2.2	$MMtCO_2e$
Cumulative net costs (present value) (2009–2025)		\$126	\$million
Cumulative emissions reductions (2009–2025)		26.5	$MMtCO_2e$
Cost-effectiveness		\$5	$\$/tCO_2e$

ESD = energy supply and demand; GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Data Sources:

- Technical potential for CHP system
  - Bruce Hedman, Energy and Environmental Analysis, "Southeast Planning Session, CHP Market Review," July 6, 2005
- Costs and potential of CHP systems
  - Florida PSC data request, resulting from RPS workshop, 2008.
  - American Council for an Energy Efficient Economy (ACEEE). June 2007. "Potential for Energy Efficiency and Renewable Energy to Meet Florida's Growing Energy Demands."
  - U.S. Environmental Protection Agency (EPA), recent analysis to be posted in early August, contact Katrina Pielli.
  - Gas Research Institute (GRI) and NREL [US DOE]. 2003. "Gas-Fired Distributed Energy Resource Technology Characterizations: Bringing You a Prosperous Future Where Energy Is Clean, Abundant, Reliable, and Affordable," available at: www.eea-inc.com/dgchp_reports/TechCharNREL.pdf

Quantification Methods: See Annex.

Key Assumptions:

Table A-8-2. Key Parameters for Combined Heat and Power Analysis

	2017	2025/all	Units
Estimated future Florida generation from CHP to meet target	**3,214**	**6,071**	**GWh**
Linear growth to meet goal for generation in target year			
CHP capacity installed under program (cumulative from start year)	**643**	**1,214**	**MW**
CHP capacity installed under program (annual installations)	**71**	**71**	**MW**
Calculation based on policy option goals and full-capacity-equivalent hours (see below)			
Average full-capacity-equivalent hours of operation for new CHP units	**5,000**	**5,000**	
(Assumption)			
Fraction of new CHP capacity/energy fueled with			
Natural gas	**60%**	**60.0%**	
Biomass	**20%**	**20.0%**	
Waste heat from sulfuric acid production	**20%**	**20.0%**	
Fraction of new CHP installed in			
Commercial sector	**50%**	**50.0%**	
Industrial sector	**50%**	**50.0%**	

CHP = combined heat and power; GWh = gigawatt; MW = megawatt.

Other assumptions used in evaluating this option are detailed in the Annex at the end of this document, and include assumptions as to capital costs, O&M costs, and the fraction of heat from CHP systems displacing heat produced using other fuels.

Avoided costs of electricity: are based on retail rates for commercial and industrial customers, (see Common Assumptions). Also see key uncertainties below for discussion on use of retail rates.

Avoided GHG emissions for electricity: 0.58 $MtCO_2e$/MWh in 2017, 0.41 $MtCO_2e$/MWh in 2025 (see Common Assumptions).

Key Uncertainties

Estimated costs and GHG reductions reflect aggregation across types of CHP systems and facilities. The costs are not necessarily applicable to individual sites.

Results by type of CHP system are estimated at:

Results for Natural Gas CHP systems

Total Net GHG Emission Savings	**0.21**	**0.83**	$MMtCO_2e$
Net Present Value (2009-2025)		**$352.0**	$million
Cumulative Emissions Reductions (2009-2025)		10.5	$MMtCO_2e$
Cost-Effectiveness		**$33.48**	$/t$CO_2e$

Results for Biomass CHP systems

Total Net GHG Emission Savings	**0.15**	**0.78**	$MMtCO_2e$
Net Present Value (2009-2025)		**-$214.4**	$million
Cumulative Emissions Reductions (2009-2025)		9.8	$MMtCO_2e$
Cost-Effectiveness		**-$21.79**	$/t$CO_2e$

Results for Waste Heat from Sulfuric Acid CHP systems

Total Net GHG Emission Savings	**0.10**	**0.48**	$MMtCO_2e$
Net Present Value (2009-2025)		**-$11.1**	$million
Cumulative Emissions Reductions (2009-2025)		6.2	$MMtCO_2e$
Cost-Effectiveness		**-$1.79**	$/t$CO_2e$

The quantitative analysis uses retail electricity rates as the basis for estimating the cost savings from this option. In addition, retail natural gas prices are used in estimating the costs for running CHP systems that use natural gas. The resulting cost-effectiveness calculations represent the costs from the perspective of the end-user (commercial or industrial customer that installs the CHP system). Costs and benefits from the perspective of other actors in Florida (for example from the utilities that now face lower customer demand and lower need for new generation) are excluded from this analysis. Analyzing the option using methods that include the other actors in Florida, such as through a total resource cost perspective, will yield different results for cost-effectiveness.

Additional Benefits and Costs

None cited.

Feasibility Issues

None cited.

Status of Group Approval

Approved

Level of Group Support

Unanimous consent

Barriers to Consensus

None

ESD-9. Power Plant Efficiency Improvements

Policy Description

Efficiency improvements refer to increasing generation efficiency at power stations through incremental improvements at existing plants (for example, more efficient boilers and turbines, improved control systems, or combined cycle technology). Repowering existing plants refers to switching to lower- or zero-emitting fuels at existing plants or for new capacity additions. This includes use of biomass or natural gas in place of coal or oil. Policies to encourage efficiency improvements and repowering of existing plants could include incentives or regulations as described in other options, with adjustments for financing opportunities and emissions rates of existing plants.

Policy Design

Goals: To improve the heat rates of all existing power plants of the statewide fleet by an average of 10% through efficiency improvements and/or fuel switching or repowering. The cost of HB 7135 is to be included in baseline.

Timing: Improvements begin in 2012, ramping up to a 10% improvement by 2020.

Parties Involved: All power plants in the state.

Other: None

Implementation Mechanisms

An Integrated Resource Planning (IRP) system should be used to maximize efficient and renewable energy generation. IRP (see option ESD-7) could support development and installation of these technologies, if they meet the stated objectives of the IRP process.

Related Policies/Programs in Place

HB 7135 made major revisions to FEECA. Utilities subject to the PSC's rate-making jurisdiction may receive incentives for additional efficiencies. For example, an investor-owned utility may receive up to 50 basis points extra return on its investment, so long as that utility offsets 20% or more of its new load growth through efficiencies to its generating and transmission facilities.

Type(s) of GHG Reductions

CO_2, CH_4, and N_2O.

Estimated GHG Reductions and Costs or Cost Savings

Table A-9-1.

ESD-9 Power Plant Efficiency	2017	2025	Units
GHG emission savings	8.4	8.9	$MMtCO_2e$
Cumulative net costs (present value) (2009–2025)		–$1,541	$million
Cumulative emissions reductions (2009–2025)		111.4	$MMtCO_2e$
Cost-effectiveness		–$14	$/tCO_2e$

ESD = energy supply and demand; GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; \$/tCO_2e = dollars per metric ton of carbon dioxide equivalent.

Data Sources:

- Utility reports to Florida PSC.
- Cost and capacity data used for estimate of cost of efficiency improvements from PSC Memorandum dated August 7, 2008, Docket No. 080203-EI, available at: http://www.psc.state.fl.us/library/filings/08/06938-08/06938-08.pdf

Quantification Methods: See Annex to this document.

Key Assumptions:

Table A-9-2. Assumed Efficiency Improvements and Costs for Option

Goals	2017	2025	Units
Efficiency improvements	**7%**	**10%**	**Average Fractional improvement in output per unit fuel input for plants existing as of 2006**
Costs of efficiency improvements			
All plants		**$54**	**2006$/MWh**

MW = megawatt; $/MWh = dollars per megawatt hour.

Costs for efficiency improvements assume that efficiency is attained through conversions that reflect investment and performance improvements that are similar to the estimates for repowering Riviera and Cape Canaveral plants, as documented by FPL in 2008. The capital costs for these plants average approximately $1000 per final kW of repowered capacity. Though fuel switching, either from oil products to natural gas (for which the additional potential in Florida is fairly limited) or from coal to natural gas (with a larger theoretical potential) is nominally a part of the option design above, the analysis of this option to date has not specifically focused on fuel-switching. Note that some electricity generation fuel switching is already occurring in Florida, and additional fuel switching, at least for power plants originally fueled with residual oil, appears to be included in the Florida Reliability Coordinating Council (FRCC) 2008 Load and Resource Plan through 2017. Fuel switching to convert coal-fired generation to gas-fired generation is likely to more closely resemble power plant replacement than efficiency upgrades or repowering, and thus may be considered a separate analysis.

Given the somewhat limited opportunities for repowering and efficiency improvements per se, the degree to which such measures may already be included in existing forecasts of the operation of generating units in Florida, and the degree to which Florida utilities are already investing in power plant energy efficiency (including taking advantage of the provisions of HB 7135, described above in "Related Policies/Programs in Place"), the current goals for this option may be difficult to attain without some reliance on fuel-switching.

Avoided costs of electricity: $67/MWh (see Common Assumptions).

Avoided GHG emissions for electricity: 0.58 $MtCO_2e$/MWh in 2017, 0.41 $MtCO_2e$/MWh in 2025 (see Common Assumptions).

Other assumptions used in evaluating this option are detailed in the Annex at the end of this document, and include assumptions as to capital costs, O&M costs, and other parameters used to evaluate this option.

Key Uncertainties

None cited.

Additional Benefits and Costs

None cited.

Feasibility Issues

None cited.

Status of Group Approval

Approved

Level of Group Support

Unanimous consent

Barriers to Consensus

None

ESD-11. Landfill Gas -to-Energy (LFGTE)

Policy Description

This policy option focuses on capture of methane gas from landfills and converting landfill gas-to-energy (LFGTE) to reduce direct emissions and to produce electricity. Added policy benefits of converting LFGTE are obviating the need for landfills and producing base-load-like electric generation. Certain components of municipal waste can be used as non-fossil combustion resources for generating electricity. This option could be structured as either a mandate or an incentive program.

Policy Design

Goals: 90% of qualifying landfills in Florida that do not already capture landfill gas and convert it to energy (or sell the gas to a utility for conversion to energy) are doing so by 2025.

Timing: First landfill converted by 2012; by 2025, 90% of all qualifying landfills in the state will be capturing their CH_4 emissions and using or selling the gas for energy.

Parties Involved: Municipal and county governments, private solid waste management companies, local economic development agencies, FECC, state regulatory agencies, PSC, nongovernment organizations, and public interest groups.

Other: Coverage should extend beyond utilities.

Implementation Mechanisms

An IRP system should be used to maximize efficient and renewable energy generation. IRP (see option ESD-7) could support development and installation of these technologies, if they meet the stated objectives of the IRP process.

Related Policies/Programs in Place

Florida defines these technologies as renewable and has a production tax credit of $0.01/kWh currently in place. The program is capped at a total of $5 million. In 2007, Florida did not reach the cap.

Type(s) of GHG Reductions

CO_2, N_2O, and CH_4 from avoided electricity generation**.**

CH_4 from landfill gas (these reductions are credited to the Agriculture, Forestry, and Waste Management [AFW] emission inventory).

Estimated GHG Reductions and Costs or Cost Savings

Table A-11-1.

ESD-11. Landfill Gas To Energy	2017	2025	Units
GHG emission savings	3.71	8.65	$MMtCO_2e$
GHG emission savings from electricity generation	0.14	0.23	$MMtCO_2e$
GHG emission savings from landfill gas capture and use (for AFW accounting)	3.57	8.43	$MMtCO_2e$
Cumulative net costs (present value) (2009–2025)		$79.4	$million
Cumulative emissions reductions (2009–2025)		64.7	$MMtCO_2e$
Cost-effectiveness		$1.23	$/tCO_2e$

ESD = energy supply and demand; GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; AFW = Agriculture, Forestry, and Waste Management; $/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Data Sources:

- Costs and potential of landfill gas systems
  - Analysis by Florida AFW TWG
  - EPA Landfill Methane Outreach Program, available at: http://www.epa.gov/lmop/proj/index.htm.

Quantification Methods: The analysis for this option followed the key assumptions and calculation approach used by the AFW TWG for the landfill gas portion of AFW-4. Changes included later start data. See AFW TWG appendix and Annex to this report.

Key Assumptions:

Table A-11-2. Additional Results of Analysis

Goals	2017	2025	Units
Landfill gas captured	**3,722,949**	**8,425,888**	**tCO_2e**
Electricity generated	**245**	**554**	**GWh**
Levelized costs of landfill gas to energy plant	**102**	**101**	**2006$/MWh**

tCO_2e = metric tons of carbon dioxide equivalent; GWh = gigawatt-hour; MWh = megawatt-hour.

Avoided costs of electricity: $67/MWh (see Common Assumptions).

Avoided GHG emissions for electricity: 0.58 $MtCO_2e$/MWh in 2017, 0.41 $MtCO_2e$/MWh in 2025 (see Common Assumptions).

Other assumptions used in evaluating this option are detailed in the Annex at the end of this document, and include assumptions as to capital costs, O&M costs, and other parameters used to evaluate this option.

Key Uncertainties

None cited.

Additional Benefits and Costs

None cited.

Feasibility Issues

None cited.

Status of Group Approval

Approved

Level of Group Support

Unanimous consent

Barriers to Consensus

None

ESD-12. Demand-Side Management (DSM)/Energy Efficiency Programs, Funds, or Goals for Electricity

Policy Description

DSM/energy efficiency programs, funds, or goals for electricity entail actions that influence the quantity and/or patterns of use of energy consumed by end users. This option focuses on increasing investment in electricity DSM/energy efficiency through programs run by utilities or others, energy efficiency funds, and energy efficiency goals. These options may be designed to work in tandem with other strategies that encourage efficiency gains. For this option, DSM refers to programs implemented by utilities with the objective of reducing electricity consumption. Historically, Florida DSM programs have focused more on peak power demand savings than on electricity savings; thus this option represents a shift in the objectives and therefore application of DSM by Florida utilities.

Policy Design

The policy design includes two key and linked dimensions: achievable/desirable energy savings and policy/administrative mechanisms to achieve these savings.

Goals: In each sector—residential, commercial, and industrial—reduce electricity consumption relative to consumption in the prior year by 1.0% per year through 2012, then by 1.5% per year through 2015, and then 2.0% per year thereafter through 2030.

For the analysis below, the goal is being interpreted such that 1% of projected (forecast) retail electricity sales are saved per year starting in 2012, reaching 1.5% per year by 2015, and 2% per year by 2020. Note that these are annual new savings in each year, not cumulative savings including results from previous years of the program. The total estimated savings and costs reflect cumulative savings from all program years, adjusted to account for the lifetime of program measures.

Timing: 2010 is the first year of compliance.

Parties Involved: All electric utilities (public and private), regulators, municipal utilities and cooperatives, and customers (all sectors).

Other: none cited

Implementation Mechanisms

This electricity savings that are used as goals for this option imply that the energy efficiency programs will need a strong focus on energy savings (as opposed to peak power demand savings). Policy and administrative mechanisms that might be applied include regulator-verified savings targets, public benefit charges, portfolio standards, "energy trusts," IRP, performance-based incentives, decoupling of rates and revenues, and appropriate rate treatment for efficiency. Potential mechanisms include revising existing statutes to enable utility investments in energy efficiency at the levels indicated above and to consider as potentially eligible programs that are cost-effective, taking into account the valuation of carbon dioxide emissions.

Elements that might be considered in designing this option include:

- Implementation and administration by utility (including municipal utilities and cooperatives), state agency, or third-party actors;
- Subsidized energy audits for homeowners, businesses, industries;
- Incentives for specific technologies, potentially including lighting, water heating, plug loads, networked personal computer management, power supplies, motors, pumps, boilers, customer-side transformers, water-use reduction, ground-source heat pumps, and others; and
- Energy efficiency reinvestment funds.

This policy may be broad in focus, or it can focus on specific market segments. Complementary policies include appliance recycling and pickup programs. Measures supporting this option might include consumer education, performance contracting, and energy end-use surveys.

An IRP system should be used to maximize efficient and renewable energy generation. IRP (see option ESD-7) could support development and installation of these technologies and initiatives, if they meet the stated objectives of the IRP process.

Related Policies/Programs in Place

FEECA places emphasis on reducing the growth rates of weather-sensitive peak demand, reducing and controlling the growth rates of electricity consumption, and reducing the consumption of scarce resources such as petroleum fuels. The PSC has adopted rules requiring those electric utilities that are subject to FEECA to implement cost-effective DSM programs.

Section 366.82(4), Florida Statutes, directs the commission to provide an annual report to the Legislature and the Governor with the DSM goals it has adopted under FEECA and the progress it has made toward meeting these goals. Section 553.975, Florida Statutes, requires the commission to prepare a biennial report on the savings derived from the efficiency standards for lighting equipment, showerheads, and refrigerators enumerated in Section 553.963, Florida Statutes—the Energy Conservation Standards Act.

Data included in the FRCC 2008 Regional Load and Resource Plan suggest that expected utility energy efficiency programs will yield approximately 230 to 300 additional GWh of electricity savings per year from 2009 through 2016, an increment of about 0.1 percent of total retail sales annually[30]. A presentation at a Florida Public Service Commission Workshop on Energy Efficiency Initiatives (November 29, 2007) by several officials of Florida utilities reported expected savings at similar, though slightly lower, levels[31].

A quantitative estimate of the savings implied by existing and planned Utility DSM programs, based on data like those above, will be prepared as a "recent actions" contribution to GHG emissions reduction. It is expected that the emissions reductions shown by these programs will be on the order of one tenth of the emissions reductions indicated below for ESD-12.

Type(s) of GHG Reductions

CO_2, CH_4, and N_2O.

Estimated GHG Reductions and Costs or Cost Savings

Table A-12-1.

ESD-12. Demand-Side Management (DSM)/ Energy Efficiency Programs, Funds, or Goals for Electricity	2017	2025	Units
GHG emission savings	13.02	21.82	$MMtCO_2e$
Residential	6.4	10.8	$MMtCO_2e$
Commercial	5.3	8.9	$MMtCO_2e$
Non-government	4.1	6.8	$MMtCO_2e$
Government	1.2	2.0	$MMtCO_2e$
Industrial	0.9	1.5	$MMtCO_2e$
Cumulative net costs (present value) (2009–2025)		–$8,566	$million
Cumulative emissions reductions (2009–2025)		201	$MMtCO_2e$
Cost-effectiveness		–$43	$/tCO_2e$

ESD = energy supply and demand; GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Data Sources:

- Costs and potential of DSM programs
  - ACEEE. June 2007. "Potential for Energy Efficiency and Renewable Energy to Meet Florida's Growing Energy Demands."
- Costs and potential of DSM programs in other states

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[30] FRCC 2008 Regional Load and Resource Plan, July, 2008, page 5.

[31] John Masiello, Dennis Brandt, John Floyd, and Howard Bryant, "Summary of Utility DSM Efforts". MWh savings estimates are reported on Slide 15. This presentation notes an average cost (presumably utility cost) per MWh saved of $9.5 for the Florida Utility programs in 2006. Presentation available at www.psc.state.fl.us/utilities/electricgas/EnergyEfficiency/Masiello-DSM.ppt.

- GDS Associates, Inc. December 2006. "A Study of the Feasibility of Energy Efficiency as an Eligible Resource as Part of a Renewable Portfolio Standard for the State of North Carolina," Report for the North Carolina Utilities Commission, available at: http://www.ncuc.commerce.state.nc.us/reps/NCRPSEnergyEfficiencyReport12-06.pdf
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  - Fry, G. "Massachusetts Electric Utility Energy Efficiency Database," Massachusetts Department of Telecommunications and Energy, 2003 edition. (Not available online.)
  - Heschong Mahone Group, Inc. June 2005. *New York Energy $mart[SM] Program Cost-Effectiveness Assessment*, prepared for New York State Energy Research and Development Authority, available at: http://www.nyserda.org/Energy_Information/ContractorReports/Cost-Effectiveness_Report_June05.pdf
  - Western Governors' Association (WGA). 2006. "Energy Efficiency Task Force Report to the Clean and Diversified Energy Advisory Committee of the Western Governors' Association." *The Potential for More Efficient Electricity Use in the Western United States*. Denver, CO: Western Governors' Association, available at: http://www.westgov.org/wga/initiatives//%20Efficiency-full.pdf
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  - GDS Associates, Inc. 2007. "Electric Energy Efficiency: Potential Study for Central Electric Power Cooperative, Inc.: Final Report," updated September 21, 2007. Available at: www.ecsc.org/newsroom/EfficiencyStudy.ppt
  - Forefront Economics, Inc., H. Gil Peach & Associates LLC, and PA Consulting Group. July 24, 2007. "Duke Energy Carolinas DSM Action Plan: South Carolina Draft Report."

Table A-12-2. Estimated cost of saved energy (CSE) from several sources

State/Utility	CSE ($/kWh)	Program Year	Source
Western Utilities	0.025	1978–2004	WGA 2006[32]
Northwest Energy	0.02	2006	Montana PSC Docket No.: D2005.5.88 July 12, 2006[33]
New York	0.03	2004	Heschong Mahone Group, Inc. 2005[34]
Massachusetts IOUs	0.038	2002	Gene Fry 2003[35]
California	0.03	N/A	ACEEE 20004[36]
Connecticut	0.023	N/A	ACEEE 20004
New Jersey	0.03	N/A	ACEEE 20004
Vermont	0.03	N/A	ACEEE 20004
North Carolina	0.029		GDS Associates, Inc. 2006

CSE = cost of saved energy; $/kWh = dollar per kilowatt-hour; WGA = Western Governors' Association; PSC = Public Service Commission; IOUs = investor-owned utilities; N/A = not applicable; ACEEE = American Council for an Energy Efficient Economy.

Quantification Methods:

Table A-12-3. Electricity sales in reference case and net sales under ESD-12 goals (GWh per year)

Scenario	2010	2015	2020	2025
Reference Case	**240,043**	**261,153**	**284,118**	**309,104**
ESD-12	**240,043**	**250,853**	**256,571**	**263,631**

ESD = energy supply and demand; GWh = gigawatt-hour.

Key Assumptions:

Cost of saved electricity: $30/MWh (ACEEE, June 2007).

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32 Energy Efficiency Task Force Report to the Clean and Diversified Energy Advisory Committee of the Western Governors' Association. January 2006. *The Potential for More Efficient Electricity Use in the Western United States*. Denver, CO: Western Governors' Association, available at: http://www.westgov.org/wga/initiatives/cdeac/Energy%20Efficiency-full.pdf

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34 Heschong Mahone Group, Inc. June 2005. *New York Energy $mart℠ Program Cost-Effectiveness Assessment*, prepared for New York State Energy Research and Development Authority, available at: http://www.nyserda.org/Energy_Information/ContractorReports/Cost-Effectiveness_Report_June05.pdf

35 Fry, G. "Massachusetts Electric Utility Energy Efficiency Database," Massachusetts Department of Telecommunications and Energy, 2003 edition. (Not available online.)

36 Kushler, M., D. York, and P. White. April 2004. *Five Years In: An Examination of the First Half-Decade of Public Benefits Energy Efficiency Policies*, Washington, DC: American Council for an Energy Efficient Economy, available at: http://www.aceee.org/pubs/u041.htm

Avoided costs of electricity: $67/MWh (see Common Assumptions).

Avoided GHG emissions for electricity: 0.58 $MtCO_2e$/MWh in 2017, 0.41 $MtCO_2e$/MWh in 2025 (see Common Assumptions).

Key Uncertainties

Costs for energy efficiency programs are based on national or theoretical values rather than information from historical experiences of Florida utilities   In Florida historically, DSM has been focused on demand reduction rather than energy reductions so the Florida history is less relevant for this policy option.

Additional Benefits and Costs

None cited.

Feasibility Issues

None cited.

Status of Group Approval

Approved

Level of Group Support

Unanimous consent

Barriers to Consensus

None

ESD-13a. Energy Efficiency in Existing Residential Buildings

Policy Description

In 2005 Florida's population was just under 18 million with approximately 7.13 million households. With over 50% of electricity used in homes, focusing attention on energy efficiency improvements to the existing residential home sector has the potential to provide the greatest reduction in electricity usage and associated GHG emissions. Incentives should focus on existing residential buildings.

Policy Design

Goals: Measures implemented with low-interest loans will reduce energy consumption in existing homes by a target percentage each year relative to consumption in the prior year (with a baseline to be established against which actual performance would be measured).

Quantification analysis below is based on energy efficiency measures being implemented starting with 1% of housing units per year in 2011 increasing to 4% of housing units per year in 2015, with each unit reducing energy consumption by 39% on average.

Timing: 10-year program from January 1, 2011, through 2020, with results tracked annually from 2011 through 2030.

Parties Involved: Cities and counties; utilities; building contractors; remodelers; building designers; architects; engineers; retailers of energy-efficient products; manufacturers of alternative building products; social service organizations, including clubs and religious organizations; FECC; DEP; and the Florida Department of Community Affairs (DCA).

Other: Eligible technologies are to be determined.

Implementation Mechanisms

- Improving energy efficiency in low-income units can provide some of the most cost-effective energy savings in the residential sector. Facilitating access to existing grants and providing new low- or zero-interest energy efficiency loans can be effective mechanisms through which to realize those savings. These low-interest loans can often be facilitated through traditional lending mechanisms,[37] as well as through specially designated funds. In a broader loan program, target loans toward areas that are compatible with desired low-carbon land-use patterns.

[37] For instance, see the Nebraska Dollar Energy Saving Loans, through which the Nebraska State Energy Office purchases half of each energy efficiency loan at a 0% interest rate so that the total interest paid by the borrower is half the market rate.

- Encourage and reward alternative business models aimed at increasing efficiency in the marketplace. For example, the creation of Energy Service Companies (ESCO) in the residential retrofit arena should be promoted as a finance mechanism for home energy-efficient retrofits.
- Implement a net metering program modeled after the successful German solar experience.
- Explore incentives to induce owners and remodeling contractors to improve energy efficiency in existing residential buildings. An initial action that can be taken as a way to "measure" gains in residential buildings would be to establish and maintain an energy consumption baseline by community or region for existing homes. Meaningful benchmarks for community building performance could be established using that baseline. In addition, residential owners and remodelers could use that community baseline to compare with their usage.

On an individual home basis, utilities could be encouraged to establish and provide energy consumption histories for existing residences against which meaningful benchmarks for individual households could be established. It may be possible to use the energy histories to link incentives to measured performance improvements, such as CO_2 emissions avoided.

- Make available history review services and associated energy audits for individual household energy consumption to establish benchmarks for household CO_2 emissions avoidance.
- Design and offer incentives modeled on performance contracting with incentives linked to energy use reductions and associated CO_2 emissions avoided. Incentives may be in the form of tax credits, DSM program support, "green mortgages," and others.
- Provide DSM incentives for compliance with improved design and construction certifications (such as the EPA's ENERGY STAR appliance and product programs and other standards). Since these certifications do not guarantee actual performance at the meter, incentives may be linked to demonstrated performance over time (e.g., as a rebate after one year of demonstrated performance), rather than when a certificate is awarded.
- Develop windstorm resistant features; indoor air quality standards; construction waste management; heating, ventilation, and air conditioning (HVAC); and lighting standards including energy efficiency and occupant health and safety to complement energy efficiency codes.
- Maintain the Florida energy code to require upgrades to building envelope components and energy using equipment efficiencies at cost-effective levels when major renovations and equipment replacement are undertaken.

Related Policies/Programs in Place

None cited.

Type(s) of GHG Reductions

CO_2, CH_4, and N_2O.

Estimated GHG Reductions and Costs or Cost Savings

Table A-13a-1.

ESD 13a. Energy Efficiency in Existing Residential Buildings	2017	2025	Units
GHG emission savings	3.40	5.38	$MMtCO_2e$
Cumulative net costs (present value) (2009–2025)		-$1,432	$million
Cumulative emissions reductions (2009–2025)		50.4	$MMtCO_2e$
Cost-effectiveness		-$28	$/t$CO_2e$

ESD = energy supply and demand; GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/t$CO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Data Sources:

- Costs and potential of Demand Side Management (DSM) programs
  - ACEEE. June 2007. "Potential for Energy Efficiency and Renewable Energy to meet Florida's Growing Energy Demands."
  - Additional information provided by Florida Solar Energy Center (Philip Fairey).

Quantification Methods:

See Annex for components of calculations.

Key Assumptions:

Table A-13a-2. Key Assumptions

Fraction of homes improved per year, 2011	1.00%	
Fraction of homes improved per year, 2015	4.00%	
End year of program	2020	
Average energy savings per housing unit per year, for improved units	4,359.14	kWh/year
Weighted-average cost of saved electricity	78	$/MWh

kWh = kilowatt-hour; MWh = megawatt-hour.

Notes: Based on mix of costs and energy savings from packages defined in ACEEE 2007.

Package 1—high-efficiency air conditioner (Seasonal Energy Efficiency Ratio 15 [SEER 15]), reduced leakage in ducts (0.1 to 0.03 in units of Qn out), ceiling insulation (R30), solar hot water, 50% fluorescent lighting replacement, programmable thermostat).

Package 2—package 1 plus cool roof, ENERGY STAR refrigerator, ENERGY STAR ceiling fans, load reduction, window replacement (u = 0.39, SHGC = 0.4 vinyl), white walls).

- **Avoided costs of electricity:** are based on retail rates for commercial and industrial customers (see Common Assumptions). Also see key uncertainties below for discussion on use of retail rates.
- **Avoided GHG emissions for electricity:** 0.58 $MtCO_2e/MWh$ in 2017, 0.41 $MtCO_2e/MWh$ in 2025 (see Common Assumptions).

Key Uncertainties

The quantitative analysis uses retail electricity rates as the basis for estimating the cost savings from this option. The resulting cost-effectiveness calculations represent the costs from the perspective of the end-user (commercial or industrial customer that participate in the energy savings program). Costs and benefits from the perspective of other actors in Florida (for example from the utilities that now face lower customer demand and lower need for new generation or from non-participants who may face electricity rate increases) are excluded from this analysis. Analyzing the option using methods that include the other actors in Florida, such as through a total resource cost perspective, will yield different results for cost-effectiveness.

Key Uncertainties

None cited.

Additional Benefits and Costs

Affordability issues should be addressed.

Feasibility Issues

None cited.

Status of Group Approval

Approved

Level of Group Support

Unanimous consent

Barriers to Consensus

None

ESD-14. Improved Building Codes for Energy Efficiency

Policy Description

Buildings are significant consumers of energy and other resources. Building energy codes can be an effective way to eliminate the least efficient energy approaches in new or renovated buildings. This policy sets a goal for reducing building energy consumption to be achieved by increasing standards for the minimum performance of new and substantially renovated commercial and residential buildings through the adoption and enforcement of building codes. Building codes would be made more stringent via incorporation of aspects of advanced or next-generation building designs and construction standards, such as sustainable design and green building standards.

Policy Design

Goals: HB 697 and HB 7135 call for the energy efficiency requirements of the Florida Energy Efficiency Code to be incrementally scaled up to 50% higher than the 2007 Code by 2019. The goal of ESD-14 is to extend the time frame of HB 697 and HB 7135 beyond 2019 such that energy consumption per square foot of floor space is reduced by 100% from what it was in 2007.

The quantitative analysis assumes that increase in code stringency continues at the rate specified in HB 697, 50% improvement in 2019, followed by 60% improvement in 2022, and 70% in 2026.

TWG members noted that calling for building codes to reach 100% reduction in energy consumption is equivalent to a 50% reduction in total building electricity demand since the building codes only reach about 50% of the electricity consumed in a building. An alternative suggestion for wording is "extend the time frame and (potentially) activity coverage of HB 697 and HB 7135 beyond 2019 and to additional end-uses of electricity such that total energy consumption per square foot of floor space is reduced by 50% from what it was in 2007."

Timing: Operational in 2010.

Parties Involved: Florida Building Commission (FBC), DCA, and FECC.

Other: None

Implementation Mechanisms

Potential elements of a building code policy include the following:

- Require high-efficiency appliances in retrofits.
- Train building code and other officials in energy code enforcement.

- Include potential measures supporting this option such as consumer education, improved enforcement of building codes, training for builders and contractors, and development of a clearinghouse for information on and to provide access to software tools to calculate the impact of energy efficiency and solar technologies on building energy performance.
- Encourage home owners and home buyers to have a home energy rating performed on the home.
- Require white roofs, rooftop gardens, and landscaping (including shade tree programs).
- Provide incentives for white roofs, rooftop gardens, and landscaping, which can lower electricity demand. High summer roof temperatures increase the need for more electricity for air conditioning, and they produce black carbon (BC) from updrafts.
- Promote installation of ductwork and air handlers inside conditioned spaces to reduce the energy costs associated with conduction and leakage (approximately half of the energy demand in Florida's homes is for heating and cooling; air handlers are generally in garages or attic spaces; ductwork is uniformly in attic spaces and exposed to extremes in temperature).
- Create an educational tool for builders that includes the costs and benefits of new and emerging cost-effective technologies for Florida-specific conditions. Such a tool could catalog the costs (including CO_2) and benefits of less commonly used technologies and provide suggestions for innovation that result in lower energy use and help a residence meet the energy code. Some example technologies are insulated concrete forms (which are also excellent in wind load situations), innovative ways to get ducts and air handlers inside conditioned space, designs to keep hot water plumbing central, heat rejection strategies like radiant barriers and low-E glass, and techniques to insulate the outside of concrete block homes. To develop the tool, consult innovative builders and building scientists (who have the numbers) to brainstorm new ways to make residences in Florida more energy efficient and then develop a tool that would describe those technologies and provide information about energy savings (and their code impacts) and cost to implement the technologies. Include these technologies in the energy code compliance computer program.
- Identify all barriers to improved efficiency in existing homes and buildings, and implement government programs and policies to overcome these barriers.

Related Policies/Programs in Place

The Florida Legislature recently passed legislation that sets new energy efficiency standards for the building code. The 2008 Florida Energy Bill HB 7135 directs the FBC to select the most recent International Energy Conservation Code (IECC) as a foundation code. HB 697 targets a 20% increase in building code energy efficiency standards from 2007 levels by 2010. Furthermore, HB 697 and HB 7135 call for the energy efficiency requirements of the Florida Energy Efficiency Code to be incrementally scaled up to 50% higher than requirements in the 2007 Code by 2019.

There is a mandatory review of codes every 3 years to ensure that state and local building codes relating to energy efficiency requirements are always as strict as the more stringent of the IECC or American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standards.

Prior to implementing the goals established in the Florida Energy Efficiency Code for Building Construction, the FBC should adopt by rule and implement a cost-effectiveness test for proposed increases in energy efficiency. This test shall measure cost-effectiveness and ensure that energy efficiency increases result in a positive net financial impact.

Florida Building Energy Rating System (BERS)

Florida Building Code, Building, Chapter 13, and Florida Building Code, Residential, Chapter 11.

Type(s) of GHG Reductions

CO_2, CH_4, and N_2O.

Estimated GHG Reductions and Costs or Cost Savings

Table A-14-1. Savings from Recent Actions

Recent Actions—Energy Efficiency Standards for Building Codes	2017	2025	Units
GHG emission savings	8.00	15.41	$MMtCO_2e$
Cumulative net costs (present value) (2009–2025)		-$4,082	$million
Cumulative emissions reductions (2009–2025)		136.5	$MMtCO_2e$
Cost-effectiveness		-$30	$/tCO_2e$

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Table A-14-2. Savings from Additional Actions

ESD-14. Improved Building Codes for Energy Efficiency	2017	2025	Units
GHG emission savings	0.00	4.88	$MMtCO_2e$
Cumulative net costs (present value) (2009–2025)		-$265	$million
Cumulative emissions reductions (2009–2025)		9.9	$MMtCO_2e$
Cost-effectiveness		-$27	$/tCO_2e$

ESD = energy supply and demand; GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Data Sources:

- Florida Executive Order 07-127, Establishing Immediate Actions to Reduce Greenhouse Gas Emissions Within Florida.
- Florida HB 697, available at: (http://www.myfloridahouse.gov/Sections/Bills/billsdetail.aspx?BillId=38094&SessionIndex=-1&SessionId=57&BillText=&BillNumber=697&BillSponsorIndex=0&BillListIndex=0&BillStatuteText=&BillTypeIndex=0&BillReferredIndex=0&HouseChamber=H&BillSearchIndex=0)
- HB 7135.
- ACEEE. June 2007. "Potential for Energy Efficiency and Renewable Energy to Meet Florida's Growing Energy Demands."
- Fairey, P., and J. Sonne. May 15, 2007. "Effectiveness of Florida's Residential Energy Code: 1979–2007," submitted to the Florida DCA.

Quantification Methods:

See Annex for components of calculations. For recent actions, it was assumed that codes would be fully implemented by January 1 of following year. ESD-14 is modeled as 60% improvement in 2023, and 70% in 2026.

Key Assumptions:

Table A-14-3 shows assumptions as to changes in the cost of electricity savings over time through this option.

Table A-14-3. Cost of electricity savings

Year	Residential	Commercial	Units
2009	$60.0	$66.6	$/MWh
2011	$61.8	$66.6	$/MWh
2014	$65.4	$66.6	$/MWh
2017	$68.8	$66.6	$/MWh
2020	$72.3	$66.6	$/MWh
2023	$75.7	$66.6	$/MWh
2026	$79.2	$66.6	$/MWh

MWh = megawatt-hour.

Note: Cost increases each year for residential are based on increasing code stringency. A similar trend in costs is still to be estimated for commercial-sector improvements.

- Electricity savings are based on code stringency in goals.
- **Avoided costs of electricity:** are based on retail rates for commercial and industrial customers (see Common Assumptions). Also see key uncertainties below for discussion on use of retail rates.

- **Avoided GHG emissions for electricity:** 0.58 $MtCO_2e$/MWh in 2017, 0.41 $MtCO_2e$/MWh in 2025 (see Common Assumptions).

Key Uncertainties

The quantitative analysis uses retail electricity rates as the basis for estimating the cost savings from this option. The resulting cost-effectiveness calculations represent the costs from the perspective of the end-user (commercial or industrial customer that participate in the energy savings program). Costs and benefits from the perspective of other actors in Florida (for example from the utilities that now face lower customer demand and lower need for new generation or from non-participants who may face electricity rate increases) are excluded from this analysis. Analyzing the option using methods that include the other actors in Florida, such as through a total resource cost perspective, will yield different results for cost-effectiveness.

Additional Benefits and Costs

None cited.

Feasibility Issues

None cited.

Status of Group Approval

Approved

Level of Group Support

Unanimous consent

Barriers to Consensus

None

ESD-15. Training and Education for Building Operators and Community Association Managers

Policy Description

Energy Management Training/Training of Building Operators. Energy Management Training provides administrative and technical training for energy managers, school officials, building operators, and others responsible for energy-efficient facility operation. This policy could include:

- Training commercial building energy managers, for example, by making use of the building operator training and certification program developed in the Pacific Northwest;
- Training industrial energy and facility managers in techniques for improving the efficiency of their steam, process heat, pumping, compressed air, motors, and other systems, perhaps dovetailing with the US DOE in this area; and
- Creation of a credentialing program for certification of "green" energy managers that requires both training and examinations to qualify.

Policy Design

Goals: Not quantifiable.

Timing: Programs in place by the end of 2010.

Parties Involved: Energy managers, school officials, building operations, community colleges, universities, and the Florida Department of Education (DOE).

Other: None

Implementation Mechanisms

None cited

Related Policies/Programs in Place

None cited

Type(s) of GHG Reductions

CO_2, CH_4, and N_2O.

Estimated GHG Reductions and Costs or Cost Savings

Not quantified

Data Sources: Not applicable

Quantification Methods: Not applicable

Key Assumptions: Not applicable

Key Uncertainties

None cited.

Additional Benefits and Costs

None cited.

Feasibility Issues

None cited.

Status of Group Approval

Approved

Level of Group Support

Unanimous consent

Barriers to Consensus

None

ESD-17. Consumer Education Programs

Policy Description

In many cases, the ultimate effectiveness of emissions reduction activities depends on providing information and education to consumers regarding the energy and GHG emissions implications of their choices. Public education and outreach is vital to fostering a broad awareness of climate change issues and effects (including co-benefits, such as clean air and public health) among the state's citizens. Such awareness is necessary to engage citizens in actions to reduce GHG emissions in their personal and professional lives. Public education and outreach efforts should integrate with and build on existing outreach efforts involving climate change and related issues in the state. Ultimately, public education and outreach will be the foundation for the long-term success of all of the mitigation actions proposed by the Action Team, as well as those that may evolve in the future.

- Institute mandatory labeling programs for time-of-sale (TOS) energy use for all consumer products, devices, and systems (including all buildings) that can be evaluated by either testing or computer simulation, and educate consumers on the use and implications of these labels.
- Create a public inquiry "information center" where those who are interested can obtain factual answers (vetted by experts in the field) to common energy-efficiency and GHG questions.
- Provide public education materials and energy information collateral that can be used at local levels by minimally trained speakers.
- Create an awards program that recognizes businesses and individuals who exhibit exemplary behavior or performance with respect to local energy and climate public education programs or in local GHG or energy use reduction programs.
- Provide state-sponsored Public Service Announcement (PSA) programs.

Policy Design

Goals: Not quantified. Goals for consumer education are quantifiable, and have been quantified by some utilities. Such quantification was not carried out for this process, due to limited resources.

Timing: Begin outreach programs in 2010.

Parties Involved: FECC, consumers, retailers, manufacturers, K-12 public schools, community colleges, universities, and the Florida DOE.

Other: None

Implementation Mechanisms

None

Related Policies/Programs in Place

A statewide campaign plan on energy efficiency that incorporates radio, television, and the Internet was developed and provided to the Governor's Energy Office.

Type(s) of GHG Reductions

CO_2, CH_4, and N_2O.

Estimated GHG Reductions and Costs or Cost Savings

Not quantified. The Action Team expects that Consumer Education Programs will yield net economic benefits.

Data Sources: Not applicable

Quantification Methods: Not applicable

Key Assumptions: Not applicable

Key Uncertainties

None cited.

Additional Benefits and Costs

None cited.

Feasibility Issues

None cited.

Status of Group Approval

Approved

Level of Group Support

Unanimous consent

Barriers to Consensus

None

ESD-23. Decoupling

Policy Description

Traditional regulatory frameworks tie a utility's recovery of fixed costs of providing service (for example, infrastructure costs) to the quantity of energy sold. Thus, there is a perverse incentive for utilities to increase sales in order to boost revenues and minimize investments in energy efficiency (which will simply lead to lower than anticipated sales). This option includes the implementation of cost recovery rules that "decouple" the level of utility sales from net revenues earned by investor-owned utilities.

Implement rate structures and utility cost-recovery rules that decouple the level of gas and electric utility sales from the net revenues earned by utilities. Decoupling should be geared exclusively to removing barriers to utility investment in programs to increase their customers' energy efficiency and reduce customer loads. Decoupling mechanisms should be carefully designed in order to avoid, as much as possible, adverse economic impacts on ratepayers so that factors other than energy efficiency investments (for example, economic downturns) do not adversely affect rates, and to ensure that the decoupling mechanism is fair to consumers and shareholders.

Policy Design

Goals: Not quantifiable; the resulting declines in energy use will be tied more directly to utility DSM programs (ESD-12 and ESD-22) that should be more successful because of decoupling.

Timing: New regulatory framework in place by January 1, 2010.

Parties Involved: Florida utilities and the PSC.

Other: None

Implementation Mechanisms

The PSC has been tasked by HB 7135 to analyze utility revenue decoupling and provide a recommendation and report to the Governor, President of the Senate and Speaker of the House of Representatives by January 1, 2009.

Related Policies/Programs in Place

During the 2008 legislative session, the Legislature passed and Governor Crist signed HB 7135, which ordered the PSC to analyze utility revenue decoupling and provide a report and recommendation to the Governor, the President of the Senate, and the Speaker of the House of Representatives by January 1, 2009. The PSC began holding workshops on this in early August 2008.

Type(s) of GHG Reductions

CO_2, CH_4, and N_2O

Estimated GHG Reductions and Costs or Cost Savings

Not quantified

Data Sources: Not applicable

Quantification Methods: Not applicable

Key Assumptions: Not applicable

Key Uncertainties

None cited.

Additional Benefits and Costs

None cited.

Feasibility Issues

None cited.

Status of Group Approval

Approved

Level of Group Support

Unanimous consent

Barriers to Consensus

None

Tier 2 Options

The Action Team noted the importance of all options but the focus for analysis, and subsequent recommendations, was on Tier 1 options. The information that follows describes the proposed Tier 2 options as developed by the ESD TWG, but the information was not reviewed by the Action Team.

ESD-1. Technology Research & Development (R&D) With Commercial Opportunities

Policy Description

The State of Florida is committed to a leadership role in commercializing new energy technologies to reduce the state's carbon footprint and to reap benefits for the state's economy. Toward these ends, public and private funding will be mobilized and targeted to support research and development (R&D) of emerging energy technologies. This policy should be seen as enabling and supporting other energy supply and demand (ESD) policies and should target supply- and demand-side opportunities.

R&D funding can be targeted toward a particular technology or group of technologies as part of a state initiative to build an industry around that technology in the state and to set the stage for use of the technology in the state. For example, an agency could be established to develop and deploy energy storage technologies.

R&D funding can be made available to any renewable energy or other advanced technology through an open bidding procedure (driven by bids received rather than by a focused strategy to develop a particular technology). Funding can also be given for demonstration projects to help commercialize technologies that have already been developed but are not yet in widespread use. This funding will eventually lead to commercialization of reasonable cost generation technologies with low or zero greenhouse gas (GHG) emissions. Finally, funding can be targeted to increase collaboration among existing institutions in the state for R&D.

Policy Design

Goals: Achieve 15% emissions reductions from investments in clean and renewable technologies. Establish scenarios for near and long-term technologies and determine which technologies are eligible under each of these categories. Intended to be additive.

Timing: 5% reduction achieved by 2015, 10% by 2020, 15% by 2025.

Parties Involved: Universities, private sector, state agencies, and local governments.

Other: Technologies utilizing tidal, wave, ocean, wind, and solar energy and biofuels are eligible, among others to be identified.

As for longer-term technologies, those that require significant cost developments include carbon capture and storage (for example, in deep saline aquifers or coal seams) for fossil fuel facilities, large-scale infrastructure for base-load renewable energy, and technologies that can transform intermittent renewables into base-load generation (for example, batteries, hydrogen, and compressed air storage). Some of the technologies noted in "other," above, including generation of electricity from ocean energy (which would tap the Gulf Stream off Florida's coast), have considerable potential, but likewise will require a significant research and development effort to overcome technical and economic obstacles to deployment.

Implementation Mechanisms

Given the magnitude of the task, an Apollo-like research program to create and field-test such technologies that are or have high potential to become commercially viable is needed. Presently, such funding is not a significant portion of a rate-regulated utility's budget or the budgets of federal and state government agencies. However, even a small fee per kilowatt-hour (kWh) of electricity could generate significant funding, but funding is only half the equation, and strategies to use such funds to implement a focused program to commercialize generation technologies with low or zero GHG emissions must also be developed.

- Establish an agency or program to support strategic development and deployment of new renewable energy technologies.
- Establish funding mechanisms, for example, a small fee per kWh of electricity.
- Identify mechanisms to encourage private capital investment.
- Establish parameters for eligible projects (for example, 25% or 50% of project financing).
- Link with local government efforts (note existing relationships with biotechnology firms as an example).
- Evaluate and update funding and financing mechanisms at regular intervals.

Related Policies/Programs in Place

Since 2006, Florida has provided financial incentives through sales tax deductions, tax credits, and a robust grant program that has funded renewable technologies such as wind, solar, and bioenergy. Further building on this initiative, HB 7135 pushed R&D to a new level with the creation of the Florida Energy Systems Consortium (FESC). This consortium comprises numerous Florida universities that research a variety of renewable technologies, including cellulosic ethanol, solar energy, and ocean energy. This consortium received $50 million to advanced renewable technologies. In addition, Florida universities and state government enjoy many partnerships with private industries. The programs below total $84 million:

- Solar rebate program ($5 million),
- Sales tax deductions for hydrogen and biofuels ($3 million),

- Corporate investment tax credits for hydrogen and biofuels ($11 million),
- Renewable energy and efficiency grant program ($7 million),
- Farm-to-Fuel ($8 million), and
- FESC ($50 million).

The Florida Legislature has recently provided additional funding for research and development on a range of renewable energy options, including the generation of electricity from ocean energy.

Type(s) of GHG Reductions

CO_2, N_2O, CH_4, possibly SF_6 and HFCs

Estimated GHG Reductions and Costs or Cost Savings

Tier 2 options were not quantified

Data Sources: Not applicable

Quantification Methods: Not applicable

Key Assumptions: Not applicable

Key Uncertainties

None cited.

Additional Benefits and Costs

ESD-1 creates co-benefits in the areas of economic development and fuel diversity.

In the past year, over 4,000 megawatts (MW) of coal have been removed from Florida's fuel forecast and will likely be replaced largely by natural gas. Florida is already top-heavy in terms of its use of natural gas to supply electricity. Florida's long-term strategy may require a large increase of nuclear generation. However, due to the lead time of permitting and construction, Florida can diversify its fuel portfolio more quickly through implementation of renewable generation.

The issue of job creation in clean energy industries is of great interest to states. Although numerical estimates vary, clean energy may create significantly more jobs than fossil energy per dollar invested. In a 2001 study, the Renewable Energy Policy Project (REPP) calculated that wind and solar energy produce 40% more jobs per dollar than coal. A 2004 study by the Renewable and Appropriate Energy Laboratory (RAEL) found that investment in renewable energy created three to five times as many jobs as the same investment in fossil-fuel energy systems (http://www.nga.org/Files/pdf/0807ENERGYRD.PDF)

Feasibility Issues

None cited.

Status of Group Approval

Tier 2 options were not reviewed for approval by the Action Team.

Level of Group Support

Not applicable

Barriers to Consensus

Not applicable

ESD-4. Electricity Transmission and Distribution Improvements

Policy Description

Measures to improve transmission systems to reduce bottlenecks and enhance throughput may be required to satisfy long-term electricity demands and improve the energy efficiency of operations system-wide. Opportunities may exist to substantially increase transmission-line carrying capacity through the implementation of new construction and retrofit activities on the transmission grid, including incorporating advanced composite-conductor technologies, capacitance technologies, and grid management software.

To increase efficiency, new generation must be closer to load. Siting new transmission lines can be a difficult process given their cost and their local impact on the environment, and on the use, enjoyment, and value of property. Policy measures in support of this option could provide incentives to utilities to upgrade transmission systems and reduce barriers to siting of new transmission lines. It should also consider the incorporation of demand response systems and smart grid technologies.

Policy Design

Goals: Reduce system-wide losses from transmission, generation, and distribution by an average of 5% of total energy delivered across Florida by 2018.

Timing: Phase in beginning in 2011, with the goal achieved by 2018.

Parties Involved: FECC, Florida Department of Environmental Protection (DEP), Florida Public Service Commission (PSC), and possibly Florida Reliability Coordinating Council (FRCC).

Other: Coverage of renewable energy sources.

Implementation Mechanisms

There are several energy efficiency measures that can be implemented to reduce the transmission and distribution line losses of electricity. Utilities use a variety of components throughout the transmission and distribution system to manage losses. Increasing the efficiency of these components can further reduce losses and associated GHG emissions. For example, the State of Vermont offers a rebate to encourage the installation of energy-efficient transformers. Regulations, incentives, and support programs can be applied to achieve greater efficiency of transmission and distribution system components.

- Create incentive program to encourage capital investments.

- An IRP system should be used to maximize efficient and renewable energy generation. IRP (see option ESD-7) could support development and installation of these technologies, if they meet the stated objectives of the IRP process.

Related Policies/Programs in Place

The PSC places emphasis on reducing the growth rates of weather-sensitive peak demand, reducing and controlling the growth rates of electricity consumption, and reducing the consumption of scarce resources such as petroleum fuels. The PSC has adopted rules requiring those electric utilities that are subject to Florida Energy Efficiency and Conservation Act (FEECA) to implement demand-side management (DSM) programs that are cost-effective. Section 366.82(4), Florida Statutes, directs the commission to provide an annual report to the Legislature and the Governor with the DSM goals it has adopted under FEECA and the progress toward meeting these goals.

HB 7135 (2008) made major revisions to FEECA. Utilities subject to the PSC's rate-making jurisdiction may receive incentives for additional efficiencies to generating facilities, transmission, and DSM programs. For example, an investor-owned utility (IOU) may receive up to 50 basis points return on its investment if that utility offsets 20% or more of its new load growth through efficiencies. These efficiencies apply to the supply side and the demand side of the equation. Further, the new legislation streamlines the siting of transmission associated with nuclear generation by allowing access to Florida Department of Transportation (FDOT) right-of-ways and state lands. In addition, utilities can receive advanced cost recovery for transmission lines directly associated with a nuclear facility or relocation of transmission as a result of a new nuclear facility.

Type(s) of GHG Reductions

CO_2, CH_4, and N_2O and possible SF6

Estimated GHG Reductions and Costs or Cost Savings

Tier 2 options were not quantified

Data Sources: Not applicable

Quantification Methods: Not applicable

Key Assumptions: Not applicable

Key Uncertainties

None cited.

Additional Benefits and Costs

None cited.

Feasibility Issues

None cited.

Status of Group Approval

Tier 2 options were not reviewed for approval by the Action Team.

Level of Group Support

Not applicable

Barriers to Consensus

Not applicable

ESD-13b. Incentives for New Residential Buildings and Master Planned Communities Achieving High-Energy Performance Standards

Policy Description

Provide incentives to induce building contractors to improve resource and energy efficiency in new residential buildings and master planned residential communities. This option is focused on encouraging developers and builders to significantly exceed building code requirements and incorporate high-energy performance considerations in community design.

Over the last decade more than one million new homes were built in Florida. The majority were in master planned community developments, which are uniquely well equipped to integrate energy efficiency into community designs and housing standards. Master planned community developments also strongly influence ongoing community operations and standards through their organizational design of Home Owner Associations (HOA), or Community Development Districts, and through explicit language in recorded Conditions, Covenants, and Restrictions (CC&R).

Policy Design

Goals: Energy efficiency in a yet-to-be-determined fraction of new homes and planned communities will be 10% higher than that required by building codes by 2015.

Timing: For new homes, ramp up efficiency improvements above code, beginning with 2% in 2010 (21% more stringent than the 2007 Florida Building Code) to 10 % in 2015 (37% more stringent than the 2007 FBC[38]).

Parties Involved: Building contractors, building designers, architects, engineers, developers, retailers of energy-efficient products, manufacturers of alternative building products, utilities to administer benchmark program for CO_2 emissions avoidance, and the FECC.

Other: None

Implementation Mechanisms

- Provide incentives modeled on performance contracting with incentives linked to CO_2 emissions avoided. Incentives can be in the form of tax credits, DSM program support, green mortgages, and others.
- Establish minimum performance standards (e.g., all homes shall be ENERGY STAR–qualified) that affect thousands of homes and strongly influence local standards of product performance and tradecraft.

[38] See ESD-14, Policy Design.

- Provide incentives to induce developers to improve resource and energy efficiency in new master planned residential communities. Establish and maintain "local" energy consumption baselines for newly built houses against which meaningful benchmarks for building performance can be established. Use energy tracking to link incentives to measured performance in terms of CO_2 emissions avoided. Establish protocols that warrant and allow for the sale of CO_2 emissions avoided.
- Provide incentives modeled on performance contracting that are linked to CO_2 emissions avoided. Incentives linked to explicit requirements in the community's legally recorded organizational documents can be in the form of faster permitting, density bonuses, tax credits, community-scale DSM program support, green mortgages, and others.
- Provide incentives for required compliance with improved community design and construction certifications, such as U.S. Green Building Council's Leadership in Energy and Environmental Design Green Building Rating System™ for Neighborhood Development (LEED-ND), Florida Green Building Coalition Green Development Standard, Audubon International's Gold Signature program, and others. Since these certifications do not guarantee actual performance at the meter, incentives should be partially linked to demonstrated performance over time (for example, as a rebate after a year of demonstrated performance), rather than when a certificate is awarded. Furthermore, the value of certifications should be judged against meaningful benchmarks based on community consumption standards developed for similar classes of homes.
- Support local government initiatives to provide incentives for green building.
- Update and integrate the Florida Building Energy Rating System into national programs, and coordinate with the Florida Building Code.

Related Policies/Programs in Place

Prior to implementing the goals established in the Florida Energy Efficiency Code for Building Construction, the Florida Building Commission is required by HB 7135 to adopt by rule and implement a cost-effectiveness test for proposed increases in energy efficiency. This test shall measure cost-effectiveness and ensure that energy efficiency increases result in a positive net financial impact.

Florida Building Energy Rating System (BERS)

Florida Building Code, Building, Chapter 13, and Florida Building Code, Residential, Chapter 11.

Type(s) of GHG Reductions

CO_2, CH_4, and N_2O.

Estimated GHG Reductions and Costs or Cost Savings

Tier 2 options were not quantified

Data Sources: Not applicable

Quantification Methods: Not applicable

Key Assumptions: Not applicable

Key Uncertainties

None cited.

Additional Benefits and Costs

None cited.

Feasibility Issues

None cited.

Status of Group Approval

Tier 2 options were not reviewed for approval by the Action Team.

Level of Group Support

Not applicable

Barriers to Consensus

Not applicable

ESD-16. More Stringent Appliance/Equipment Efficiency Standards

Policy Description

Appliance efficiency standards reduce the market cost of energy efficiency improvements by incorporating technological advances into base appliance models, thereby creating economies of scale. Appliance efficiency standards can be implemented at the state level for appliances not covered by federal standards, or standards can be jointly developed by multiple states. Electrical appliances span all sectors and may include refrigerators, freezers, dishwashers, stoves, ovens, clothes washers and dryers, room air conditioners, and pool heaters.

Policy Design

Goals: In the residential sector, reduce the energy used by appliances by an additional 1.0% every year (relative to consumption in the prior year) from 2010 through 2030. In the commercial and industrial sectors, reduce the energy used by appliances by an additional 0.5% every year (relative to consumption in the prior year) from 2010 through 2030.

Timing: Standards effective January 1, 2010.

Parties Involved: State government agencies, including the Department of Community Affairs, the Florida Energy and Climate Commission (FECC), the Department of Environmental Protection (DEP), the Office of Tourism, Trade and Economic Development (OTTED), Enterprise Florida, Workforce Florida, Inc, the Department of Revenue (DOR), and the Florida Building Commission, as well as appliance manufacturers and appliance/equipment industry representatives.

Other: None

Implementation Mechanisms

To ensure that appliances purchased in Florida maximize the cost-effective potential for energy efficiency and minimize GHG emissions, the following policy prescriptions should be considered:

- Improve appliance standards for appliances not regulated by federal standards.
- Lobby for more stringent appliance standards at the federal level. Require the preferential procurement of ENERGY STAR products if available (for example, equipment, appliance, or technology) if state funds are involved (for example, state purchasing contracts, state grants, or loans).
- Provide exemptions from Florida state sales tax, whether temporary or permanent, for ENERGY STAR-certified products.

- Establish and enforce higher than federal- and state-level appliance and equipment standards (or standards for devices not covered by federal standards).
- Join with other states in adopting higher standards.
- Require high-efficiency appliances in new construction and retrofits.
- Require uniform labeling standards for appliances.
- Set state minimum efficiency standards for appliances not covered by federal standards, as recommended by Appliance Standards Awareness Program (ASAP),[39] by 2010.
- Double the market penetration of ENERGY STAR appliances in purchases made in the residential, commercial, and industrial sectors, where applicable, up to 100%, by 2015.

Consumer education is a potential supporting measure for this option.

Related Policies/Programs in Place

None cited.

Type(s) of GHG Reductions

CO_2, CH_4, and N_2O.

Estimated GHG Reductions and Costs or Cost Savings

Tier 2 options were not quantified

Data Sources: Not applicable

Quantification Methods: Not applicable

Key Assumptions: Not applicable

Key Uncertainties

None cited.

Additional Benefits and Costs

None cited.

[39] See http://www.standardsasap.org/documents/a062_sc.pdf. The analysis recommends standards for the following products: bottle-type water dispensers, commercial boilers, commercial hot-food-holding containers, compact audio products, DVD players and recorders, liquid immersion distribution transformers, medium-voltage dry-type distribution transformers, metal halide lamp fixtures, pool heaters, portable electric spas, residential furnaces and boilers, residential pool pumps, single-voltage external AC-to-DC power supplies, state-regulated incandescent reflector lamps, and walk-in refrigerators and freezers.

Feasibility Issues

None cited.

Status of Group Approval

Tier 2 options were not reviewed for approval by the Action Team.

Level of Group Support

Not applicable

Barriers to Consensus

Not applicable

ESD-18. Incentives to Promote Implementation of Customer-Sited Renewable Energy Systems

Policy Description

Distributed electricity generation sited at residences, commercial, and industrial facilities, and powered by renewable energy sources (typically solar, but also wind, small hydroelectric power sources, or fuels derived from waste biomass) displaces fossil-fueled generation and avoids electricity transmission and distribution losses, thus reducing GHG emissions. This policy can also encourage consumers to switch from using fossil fuels to using renewable fuels in applications such as water, process, and space heating and to provide new energy services using fuels that produce low or no GHG emissions.

Policy Design

Goals: 200,000 MWh of customer-sited renewable energy systems added by 2021.

Timing: 20,000 MWh[40] added every year from 2012 through 2021, for a cumulative amount by the end of 2021 of 200,000 MWh.

Parties Involved: All power producers operating qualifying renewable facilities at residences and commercial and industrial facilities in Florida and the FECC.

Other: None cited.

Implementation Mechanisms

Increasing the use of distributed renewable energy applications in homes, businesses, and institutions in Florida can be achieved through a combination of regulatory changes and financial incentives to overcome barriers posed by high up-front costs and other aspects of distributed renewable energy systems, in order to promote stronger market for Florida. Potential elements of this option include:

- Programs targeted at specific customer sectors (residential, commercial, and industrial), or specific markets within sectors.
- Tax credits and utility or other incentives to lower the first cost of distributed energy systems to users.
- Rewarding innovative financing mechanisms and business models dedicated to fostering the growth of renewable energy implementation.

[40] 20,000 MWh is 5.4 MW using a capacity factor of 42%, which is based on the simple average of 30% for wind, 20% for solar PV, 37% for solar thermal, and 80% for biomass gasification and municipal solid waste. Geothermal is not included due to the lack of geothermal potential in Florida.

- Provision of subsidies to renewable energy generators at $0.005/kWh for each kWh of electricity generated from a qualifying renewable facility.
- Training and certification of installers and contractors.
- German-style net metering and other pricing arrangements. Allow third-party systems for renewable power production that are located on user facilities to be eligible for net metering.
- Creation of interconnection standards.
- Creation and support of markets for biomass fuels.

Examples of customer-sited renewable energy systems include:

- Solar roofs, such as roofing materials with built-in solar photovoltaic (PV) cells, or solar PV panels erected on roofs.
- Solar water heating and solar space heating systems.
- Wind power systems, particularly for rural areas.
- Generation, space, or water heating systems fueled by waste biomass.

IRP (see option ESD-7) could support development and installation of these technologies, if they meet the stated objectives of the IRP process.

Related Policies/Programs in Place

FECC oversees Florida's renewable energy grant program, which has resulted in a 1-MW solar system that is the largest in the Southeast, among other projects. In addition, the FECC administers a solar rebate program ($5 million). This program provides $500 per residential solar hot-water heater, and $4 per watt for PV (up to a cap of $20,000 for residences and $100,000 for commercial establishments**)**. Rebates are released on a first-come, first-served basis. As discussed above, the PSC recently approved tariffs to expedite interconnection for its net metering program. Various utilities provide rebates for solar applications as well as geothermal pumps and cool roofs, among others. For more information see: http://www.dsireusa.org/library/includes/map2.cfm?CurrentPageID=1&State=FL&RE=1&EE=1

Type(s) of GHG Reductions

CO_2, CH_4, and N_2O

Estimated GHG Reductions and Costs or Cost Savings

Tier 2 options were not quantified

Data Sources: Not applicable

Quantification Methods: Not applicable

Key Assumptions: Not applicable

Key Uncertainties

None cited.

Additional Benefits and Costs

None cited.

Feasibility Issues

None cited.

Status of Group Approval

Tier 2 options were not reviewed for approval by the Action Team.

Level of Group Support

Not applicable

Barriers to Consensus

Not applicable

ESD-21. Rate Structures and Technologies to Promote Reduced Greenhouse Gas (GHG) Emissions

Policy Description

Option 1—TOU rates typically price electricity higher at times of greater power demand and thus better reflect the actual cost of generation. TOU rates may or may not have a significant impact on total GHG emissions, but they do affect on-peak power demand and thus both the need for peaking capacity and fuel for peaking plants. Consider pilot programs with real-time pricing that are coupled with "smart-grid" concepts and strategies, including plug-in hybrid vehicle management.

Option 2—Tiered (increasing block) rates for electricity and natural gas use provide affordable rates for base usage for consumers but rise with increasing consumption, thus providing a built-in rate incentive for energy conservation and energy efficiency.

Policy Design

Goals: Not established as part of this process.

Timing: New rate structure will begin on January 1, 2010.

Implementing Parties: All Florida utilities, utility customers, and the PSC.

Other: None cited.

Implementation Mechanisms

IRP (see option ESD-7) could support development and installation of these rate structures and technologies, if they meet the stated objectives of the IRP process.

Related Policies/Programs in Place

According to the PSC, all the investor-owned utilities (FPL, PEF, TECO Energy, Gulf Power, and Florida public utilities) offer TOU rates. Most of these offerings are for the commercial sector, but FPL, PEF, and Gulf Power have tiered rate structures for the residential sector as well.

Type(s) of GHG Reductions

CO_2, CH_4, and N_2O

Estimated GHG Reductions and Costs or Cost Savings

Tier 2 options were not quantified

Data Sources: Not applicable

Quantification Methods: Not applicable

Key Assumptions: Not applicable

Key Uncertainties

None cited.

Additional Benefits and Costs

None cited.

Feasibility Issues

None cited.

Status of Group Approval

Tier 2 options were not reviewed for approval by the Action Team.

Level of Group Support

Not applicable

Barriers to Consensus

Not applicable

ESD-22. Demand-Side Management (DSM)/Energy Efficiency Programs, Funds, or Goals for Natural Gas

Policy Description

This option has most of the same attributes and options for design elements and implementation as ESD-12, but it focuses on increasing investment in DSM programs related to the use of natural gas, propane or liquefied petroleum gas (LPG), and fuel oil through programs run by utilities or others, energy efficiency funds, and energy efficiency goals.

Policy Design

Goals: In each sector—residential, commercial, and industrial—reduce the consumption of natural gas, relative to consumption in the prior year, by 1.0% per year through 2012, then by 1.5% per year through 2015, and then 2.0% per year thereafter through 2030.

Timing: 2010 is the first year of compliance.

Parties Involved: All natural gas utilities (public and private), regulators, and customers (all sectors).

Other: none citied

Implementation Mechanisms

None cited

Related Policies/Programs in Place

None cited

Type(s) of GHG Reductions

CO_2, CH_4, and N_2O

Estimated GHG Reductions and Costs or Cost Savings

Tier 2 options were not quantified

Data Sources: Not applicable

Quantification Methods: Not applicable

Key Assumptions: Not applicable

Key Uncertainties

None cited.

Additional Benefits and Costs

None cited.

Feasibility Issues

None cited.

Status of Group Approval

Tier 2 options were not reviewed for approval by the Action Team.

Level of Group Support

Not applicable

Barriers to Consensus

Not applicable

Annex A
Additional Details on Assumptions and Quantification Steps

Estimate of Mitigation Option Costs and Benefits for Florida for the Energy Supply & Demand (ESD) Technical Work Group

ESD - 6: Nuclear Power

Date Last Modified: *10/03/08*
Modified By:

INPUT specific to this policy option
INPUT from other sheets

Key Inputs (i.e., Data and Assumptions)				**Units**
Retail Sales (GWh)				
From FL Inventory and Forecast				
Goals				
Nuclear Power			2,200	MW in 2020
From FL ESD Policy Options, ESD-6 Nuclear Power				
Costs (2006$/MWh)			100.5	2006$/MWh
Preliminary estimate - Average of costs from FPL and Progress Energy				
Capacity Factor			92%	
From FL ESD Policy Options, ESD-6 Nuclear Power				
Avoided Energy Cost				
Avoided Delivered Electricity Cost			$67	$/MWh
Notes				
Calculation of Energy Production	**Annual In 2017**	**Annual In 2025**	**Cumulative 2009-2025**	**Units**
Total Nuclear Power (GWh)	0	17,730	106,381	GWh
Nuclear Power A (in 2020)	0	17,730	106,381	GWh
Nuclear Power B (in xxxx)	0	0	0	GWh
% of projected sales	0%	6%	n/a	% per projected sales
Total Nuclear Power	0	2,200	n/a	MW
Nuclear Power A (in 2020)	0	2,200	n/a	MW
Nuclear Power B (in xxxx)	0	0	n/a	MW
Calculation of Costs	**Annual In 2017**	**Annual In 2025**	**Cumulative 2009-2025**	**Units**
Nuclear Power Cost	0	1,781	n/a	$million
Nuclear Power A (2017)	0	1,781	n/a	$million
Nuclear Power B (2019)	0	0	n/a	$million
Calculation of Avoided Energy	**Annual In 2017**	**Annual In 2025**	**Cumulative 2009-2025**	**Units**
Nuclear, Avoided Energy Costs	0	-1,181	-7,084	$million
Calculation of GHG Emissions Reductions	**Annual In 2017**	**Annual In 2025**	**Cumulative 2009-2025**	**Units**
Nuclear, Avoided Emissions	0	7	49	MMtCO2
Results	**Annual In 2017**	**Annual In 2025**	**Cumulative 2009-2025**	**Units**
Nuclear Power Scenario				
GHG Emissions Reductions	0.0	7.3	49.42	$MMtCO_2e$
PV, Gross Cost			5,286	Million $
PV, Gross Benefits			-3,504	Million $
Net Present Value (2009-2025)			1,782	Million $
Cost-Effectiveness			36.06	$/tCO_2e$

Estimate of Mitigation Option Costs and Benefits for Florida ESD GHG Analysis
ESD- 8 **Combined Heat and Power (CHP) Systems**

Date Last Modified: 9/23/2008 A Bailie

Key Data and Assumptions	2017	2025/all	Units
First Year Results Accrue		**2009**	
USE AVOIDED COSTS OF SUPPLY (1) OR RETAIL RATES (2)? *Toggle to set the base for cost effectiveness calculations - from societal (avoided costs / total resource cost) or participant (retail cost) perspective.*		**2**	Retail
Avoided Electricity Cost *Weighted average over total 2007-2020 electricity savings for this policy in each sector. See common assumptions ("Common Factors" worksheet in this workbook).*		**$67**	$/MWh
Avoided Natural Gas Cost *See common assumptions ("Common Factors" worksheet in this workbook).*		**$7.6**	$/MMBtu
Avoided Oil Cost *See common assumptions ("Common Factors" worksheet in this workbook). LPG costs used to represent average costs of oil consumed and avoided by CHP systems (which will also include higher-cost distillate/diesel oil, and lower cost heavy fuel oil/residual oil).*		**$12.9**	$/MMBtu
Electricity - Commercial Prices	**$91**	**$91**	$/MWh
Electricity - Industrial Prices *See common assumptions ("Common Factors" worksheet in this workbook).*	**$71**	**$71**	$/MWh
Natural Gas - Commercial Prices	**$12**	**$12**	$/MBTU
Natural Gas - IndustrialPrices *See common assumptions ("Common Factors" worksheet in this workbook).*	**$9**	**$10**	$/MBTU
Biomass - All Users *See common assumptions ("Common Factors" worksheet in this workbook).*		**$3**	$/MBTU
Target Year for Reaching Combined Heat and Power (CHP) Implementation Level		**2022**	
Electricity generation from new Florida CHP units by target year *Option Design states "Ramp up CHP to 5 million megawatt-hours (MWh) of total generation by 2022".*		**5,000**	*GWh*

Other Data, Assumptions, Calculations	2017	2025/all	Units
Commercial and Industrial Combined Heat and Power			
Estimated Future Florida generation from Combined Heat and Power to meet target: *Linear growth to meet the goal for generation in target year.*	3,214	6,071	GWh
CHP capacity Installed Under Program (cumulative from start year)	643	1,214	MW
CHP Capacity Installed Under Program (annual installations) *Calculation based on policy option goals and full-capacity-equivalent hours (see below)*	71	71	MW
Average full-capacity-equivalent hours of operation for New CHP units: *Assumption.*	**5,000**	**5,000**	
Fraction of New CHP Capacity/Energy Fueled With:			
Natural Gas	60%	60.0%	
Biomass	20%	20.0%	
Waste heat from sulfuric acid production *Assumptions.*	20%	20.0%	
Implied Annual New CHP Capacity by Fuel (MW)			
Natural Gas	**42.86**	**42.86**	*MW*
Biomass	**14.29**	**14.29**	*MW*
Waste heat from sulfuric acid production	**14.29**	**14.29**	*MW*

Implied Cumulative New CHP Capacity by Fuel (MW)			
Natural Gas	**385.71**	**728.57**	*MW*
Biomass	**128.57**	**242.86**	*MW*
Waste heat from sulfuric acid production	**128.57**	**242.86**	*MW*
Implied Cumulative New CHP Electricity Output by Fuel (GWh)			
Natural Gas	**1,929**	**3,643**	*GWh*
Biomass	**643**	**1,214**	*GWh*
Waste heat from sulfuric acid production	**643**	**1,214**	*GWh*
Average Net Heat Rate by Fuel (Btu Fuel Input/kWh Electricity Output)			
Natural Gas	10,000	10,000	*Btu/kWh*
Biomass	13,500	13,500	*Btu/kWh*
Waste heat from sulfuric acid production			*Btu/kWh*

Rough estimates, as heat rates vary by installation. Heat rates for natural gas-fueled units consistent with values from ACEEE report provided in ***Note 1*** *, below. Biomass consistent with information provided to FL PSC, see Note 2 below. CHP from waste heat from sulfuric acid production is assumed to require no additional fuel input.*

Implied Fuel Input by Fuel (Billion Btu)			
Natural Gas	**19,286**	**36,429**	*billion BTU*
Biomass	**8,679**	**16,393**	*billion BTU*
Waste heat from sulfuric acid production	**-**	**-**	*billion BTU*
Usable Cogenerated Heat Output as a Fraction of Fuel Energy Input			
Natural Gas	40%	40%	
Biomass	40%	40%	
Waste heat from sulfuric acid production	0%	0%	

Assumption - assumes that sulfuric acid facilities would have heat recovery equipment installed regardless of this policy, so zero incremental increase in heat output.

Implied Usable Heat Output by Fuel (Billion Btu)			
Natural Gas	**7,714**	**14,571**	*billion BTU*
Biomass	**3,471**	**6,557**	*billion BTU*
Waste heat from sulfuric acid production	**-**	**-**	*billion BTU*
Fraction of Usable Heat Output Replacing Space/Water/Process Heat Use	90%	90%	

Assumption.

Fraction of CHP Heat Output Displacing Thermal Energy Produced Using			
Natural Gas	45%	45%	
Biomass	15%	15%	
Coal	0%	0%	
Electricity	15%	15%	
Oil	25%	25%	

Assumptions based roughly on commercial plus industrial sector demand for these fuels as of 2005.

Net Efficiency of Displaced Boiler/Heater Thermal Energy Produced Using			
Natural Gas	85%	85%	
Biomass	80%	80%	
Coal	80%	80%	
Electricity	92%	92%	
Oil	80%	80%	

Assumptions.

Net Displaced Fuel Use (Billion Btu)			
Natural Gas	**5,330**	**10,067**	*billion BTU*
Biomass	**1,888**	**3,565**	*billion BTU*
Coal	**-**	**-**	*billion BTU*
Electricity	**1,641**	**3,100**	*billion BTU*
Oil	**3,146**	**5,942**	*billion BTU*

Inputs to Cost Estimates for CHP Systems

Estimated Average Installed Capital Costs by System Type			
Natural Gas	$ 1,500	$ 1,100	*$2006/kW*
Biomass	$ 2,400	$ 2,000	*$2006/kW*
Waste heat	$ 2,846	$ 2,087	*$2006/kW*

Rough estimates, as costs vary by installation. Costs for natural gas-fueled units consistent with values from ACEEE report provided in ***Note 1*** *, below. Biomass and waste heat from sulfuric acid production consistent with information provided to FL PSC, see Note 2 below.*

Factors for Annualizing Capital Costs (all plant types)

Interest Rate	8.5%	/yr
Economic Life of System	20	years
Implied Annualization Factor	10.57%	%/yr

Estimated Average Non-fuel Operating and Maintenance Costs by System Type ($/MWh)

Natural Gas	$ 12.00	$ 12.00	*$/MWh*
Biomass	$ 25.00	$ 22.00	*$/MWh*
Waste heat	$ 22.00	$ 20.00	*$/MWh*

Rough estimates from ACEEE source (see Note 1) for natural gas, FLPSC (Note 2) for waste heat, CCS estimate for biomass.

Calculations for estimating energy costs and benefits

For Retail Rates, fraction of CHP electricity generated by sector

Commercial	50%
Industrial	50%

Weighted average electricity rate (industrial and commercial)	**$ 81**	**$ 81**	$/MWh
Weighted average natural gas price (industrial and commercial)	**$ 10**	**$ 11**	$/MBTU

Intermediate Results for Cost Estimates

Total Capital Costs for New Systems (thousand 2005 dollars)

Natural Gas	**$ 64,286**	**$ 47,143**
Biomass	**$ 34,286**	**$ 28,571**
Waste heat	**$ 40,657**	**$ 29,815**

Annualized Capital Costs for All Systems (thousand 2005 dollars)

Natural Gas	**$ 60,812**	**$ 108,273**
Biomass	**$ 32,498**	**$ 59,188**
Waste heat	**$ 38,460**	**$ 68,477**

Annual Non-Fuel Operating and Maintenance Costs for All Systems (thousand 2005 dollars)

Natural Gas	**$ 23,143**	**$ 43,714**
Biomass	**$ 16,071**	**$ 26,714**
Waste heat	**$ 14,143**	**$ 24,286**

Total Non-Fuel Costs for All Systems (thousand 2006 dollars)

Natural Gas	**$ 83,955**	**$ 151,988**
Biomass	**$ 48,570**	**$ 85,902**
Waste heat	**$ 52,603**	**$ 92,763**

Total Gross Fuel Costs for All Systems (thousand 2006 dollars)

Natural Gas	**$ 200,980**	**$ 407,669**
Biomass	**$ 26,643**	**$ 50,326**
Waste heat	**$ -**	**$ -**

Evaluated based on either avoided costs estimates or retail rates (for natural gas and electricity), depending on toggle set at top of spreadsheet--See "Common Factors" worksheet in this workbook. Assume CHP systems using waste heat from sulfuric acid production plants have negligible incremental fuel costs.

Total Fuel Cost Savings from Displaced Heating Fuels for All Systems (thousand 2006 dollars)

Natural Gas	**$ 55,541**	**$ 112,661**
Biomass	**$ 5,795**	**$ 10,946**
Coal	**$ -**	**$ -**
Electricity	**$ 38,939**	**$ 73,835**
Oil	**$ 40,535**	**$ 76,566**

Evaluated based on either avoided costs estimates or retail rates (for natural gas and electricity), depending on toggle set at top of spreadsheet--See "Common Factors" worksheet in this workbook.

Intermediate Results: Commercial/Industrial CHP

Electricity

TOTAL Reduction in Electricity Sales (electricity output from CHP plus avoided electricity use in boilers/space heaters/water heaters)	3,695	6,980	GWh (sales)
Reduction in Generation Requirements	4,017	7,588	GWh (generation)
Gross GHG Emission Savings	**2.34**	**3.12**	$MMtCO_2e$

Natural Gas			
Net Change in Gas Use (negative values denote increased use)	-13,956	-26,361	Billion BTU
Net GHG Emissions (negative values denote increased emissions)	-0.16	-0.97	$MMtCO_2e$
Biomass			
Net Change in Biomass Use (negative values denote increased use)	-6,791	-12,827	Billion BTU
Net GHG Emissions (negative values denote increased emissions)	-0.004	-0.025	$MMtCO_2e$
Energy consumption at sulfuric acid production			
Net Change in Natural Gas Use (negative values denote increased use)	0	0	Billion BTU
Net GHG Emissions (negative values denote increased emissions)	0.00	0.00	$MMtCO_2e$
Oil			
Net Change in Oil Use (negative values denote increased use)	3,146	5,942	Billion BTU
Net GHG Emissions (negative values denote increased emissions)	0.05	0.31	$MMtCO_2e$

Intermediate Results: by type of system

Allocate benefits per unit of heat output			
Cost savings per unit heat output	13	13	$/MMBTU
GHG savings per unit heat output	0.07	0.07	MMtCO2e/MMBTU

Assuming that CHP systems displace the average mix of heat systems, regardless of type of CHP system (simplifying assumption for basic calculations by system type).

Results for Natural Gas CHP systems			
Total Net GHG Emission Savings	**0.21**	**0.83**	$MMtCO_2e$
Net Present Value (2009-2025)		**$352.0**	$million
Cumulative Emissions Reductions (2009-2025)		10.5	$MMtCO_2e$
Cost-Effectiveness		**$33.48**	$/tCO_2e$
Results for Biomass CHP systems			
Total Net GHG Emission Savings	**0.15**	**0.78**	$MMtCO_2e$
Net Present Value (2009-2025)		**-$214.4**	$million
Cumulative Emissions Reductions (2009-2025)		9.8	$MMtCO_2e$
Cost-Effectiveness		**-$21.79**	$/tCO_2e$
Results for Waste Heat from Sulfuric Acid CHP systems			
Total Net GHG Emission Savings	**0.10**	**0.48**	$MMtCO_2e$
Net Present Value (2009-2025)		**-$11.1**	$million
Cumulative Emissions Reductions (2009-2025)		6.2	$MMtCO_2e$
Cost-Effectiveness		**-$1.79**	$/tCO_2e$

Final Results	**2017**	**2025/all**	**Units**
Total for CHP Program (All Fuels)			
Total Net GHG Emission Savings	**0.47**	**2.09**	$MMtCO_2e$
Net Present Value (2009-2025)		**$126.5**	$million
Cumulative Emissions Reductions (2009-2025)		26.5	$MMtCO_2e$
Cost-Effectiveness		**$4.77**	$/tCO_2e$

NOTES AND DATA FROM SOURCES

Note 1:

ACEEE June 2007. Potential for Energy Efficiency and Renewable Energy to meet Florida's Growing Energy Demands

Note 2:

Florida specific power plant data are available from the Florida Public Service Commission's (the Commission) website. The data were submitted to the Commission by various stakeholders in response to the Commission's data request resulting from a renewable portfolio standard (RPS) workshop held on July 11, 2008. The purpose of the questionnaire was to provide the Commission with cost and technical potential information of renewable energy technologies within the state of Florida. Section 366.92(3)(a) of Florida Statutes directs the Commission to evaluate the current and forecasted installed capacity and levelized cost for each renewable energy generation method through 2020 as part of developing RPS requirements for the state. Both regulated electric utilities and interested parties were invited to provide information to the Commission. Completed questionnaires are available on the Commission website.
http://www.floridapsc.com/utilities/electricgas/RenewableEnergy/07_11_2008_index.aspx
http://www.floridapsc.com/utilities/electricgas/RenewableEnergy/07_11_2008_Data.aspx

Estimate of Mitigation Option Costs and Benefits for Florida for the Energy Supply & Demand (ESD) Technical Work Group

ESD - 9: **Power Plant Efficiency Improvements**

Date Last Modified:	8/17/2008 A Bailie	DVH Review	8/18/2008

Key Inputs (i.e., Data and Assumptions)	2017	2025/all	Units
Generation from Existing Power Plants in Florida as of 2006		2006	
Coal		65,801	GWh
Natural Gas		96,642	GWh
Petroleum		23,072	GWh
Nuclear		31,604	GWh
From FL Inventory and Forecast			
Goals			
Efficiency Improvements	7%	10%	

From FL ESD Policy Options, ESD-9 Power Plant Efficiency improvements - To improve the heat rates of all existing power plants of the statewide fleet improved by an average of 10% through efficiency improvements/fuel switching or repowering. Improvements begin in 2012, ramping up to a 10% improvement by 2020.

Costs of efficiency improvements ($/MWh)			
Coal		**$54**	2006$/MWh
Natural Gas		**$54**	2006$/MWh
Petroleum		**$54**	2006$/MWh
Nuclear		**$54**	2006$/MWh

INFORMATION REQUIRED placeholders values for Coal, Petroleum, Nuclear, with Natural Gas value estimated very roughly based on FPL costs for repowering of Cape Canaveral and Riviera plants--see *Note 1* below. Costs of improvements will depend on assumptions regarding types of efficiency upgrades chosen, though to achieve 10% improvements system-wide, it is likely that repowering of gas and oil plants will probably dominate the mix.

Avoided Energy Cost			
Avoided Delivered Electricity Cost		**$67**	$/MWh
Notes			

Calculation of Energy Production	Annual In 2017	Annual In 2025	Units
Generation increases from efficiency improvements			
Coal	**4,387**	**6,580**	GWh
Natural Gas	**6,443**	**9,664**	GWh
Petroleum	**1,538**	**2,307**	GWh
Nuclear	**2,107**	**3,160**	GWh
Total	**14,475**	**21,712**	GWh
% of projected sales	**5%**	**7%**	%

Calculation of Costs	Annual In 2017	Annual In 2025	Units
Costs of Efficiency Improvements			
Coal	**237**	**355**	$million
Natural Gas	**347**	**521**	$million
Petroleum	**83**	**124**	$million
Nuclear	**114**	**170**	$million
Total	**780**	**1,171**	$million

Calculation of Avoided Energy Benefits	Annual In 2017	Annual In 2025	Units
Avoided Energy Costs	**964**	**1,446**	$million

Calculation of GHG Emissions Reductions	Annual In 2017	Annual In 2025	Units
Avoided Emissions	**8**	**9**	MMtCO2

Results	2017	2025/all	Units
Power Plant Efficiency			
GHG Emission Savings	**8.42**	**8.93**	MMtCO$_2$e
Net Present Value (2009-2025)		**-$1,540.6**	$million
Cumulative Emissions Reductions (2009-2025)		111.4	MMtCO$_2$e
Cost-Effectiveness		**-$13.83**	$/tCO$_2$e

Notes and Data Sources

Note 1:

Rough estimate of repowering cost per MWh saved based on FPL Cape Canaveral and Riviera Projects
Cost and capacity data below from PSC Memorandum dated 8/7/08, Docket #080203-EI, available as
http://www.psc.state.fl.us/library/filings/08/06938-08/06938-08.pdf

Initial Capacity	1336	MW	
Final Capacity	2426	MW	
Added Capacity	1090	MW	
Weighted Average cost per final kW	$ 985.15		*Assumes costs refer to final capacity*
Power Plant Efficiency before repowering	33%		*Net, Assumption pending receipt of additional data*
Power Plant Efficiency after repowering	48%		*Net, Assumption pending receipt of additional data*
Capacity factor, before and after repowering	65%		*Assumption pending receipt of additional data*
Output of initial capacity, before repowering	7,607	GWh	*Calculated*
Fuel input, before repowering	82,987	TJ	*Calculated*
Output from equivalent fuel, after repowering	11,065	GWh	*Calculated*
Ratio of initial to final output due to repowering of initial capacity	1.455		*Calculated*
Cost of repowered initial capacity	$ 1,914,407,998		*Calculated*
Economic lifetime of repowered unit	20	years	*Assumption*
Assumed interest rate for repowering investment	8.50%	/yr	*Assumption--as for nuclear plan*
Cost recovery factor	9.74%		*Calculated*
Annual cost of plant	$ 186,449,178		*Calculated*
Cost (or savings) on variable O&M as a result of repowering	$0	/MWh total generation	*Assumption*
Implied cost of repowering per additional MWh generated	$54		*Calculated*

Estimate of Mitigation Option Costs and Benefits for Florida
for the Energy Supply & Demand (ESD) Technical Work Group

ESD - 11 **Waste to Energy**

Date Last Modified:	8/17/2008 A Bailie	DVH Review	8/18/2008

Key Inputs (i.e., Data and Assumptions)	2017	2025/all	Units
Goals			
From FL ESD Policy Options, ESD-11 Waste to Energy - 90% of qualifying landfills in Florida that do not already capture landfill gas and convert it to energy (or sell the gas to a utility for conversion to energy) are doing so by 2025.First landfill converted by 2012; by 2025, 90% of all qualifying landfills .			
Assumptions			
Landfill gas captured	3,722,949	8,425,888	t CO2e
Electricity Generated	244,963	554,407	MWh
Landfill Gas Direct Combustion	874,445	1,979,069	MMBTU
Capital Cost of Landfill Gas to Energy Plant	2,135	2,102	$/kW
Levelized Costs of Landfill gas to energy plant	102	101	2006$/MWh
Assumptions taken from AFW TWG analysis of option AFW-4. The goals for AFW-4 lead to increasing the amount of landfill gas capture to a total of 50% of total landfill gas generated in Florida. Analysts for AFW estimate that this goal is very close to the "90% of qualifying landfills." Further information from AFW Policy descriptions.			
Avoided Energy Cost			
Avoided Delivered Electricity Cost		**$67**	$/MWh
Notes			

Calculation of Energy Production	Annual In 2017	Annual In 2025	Units
Generation increases from landfill gas to electricity			
Total	**235**	**554**	GWh
Adjusted AFW to later start date, assume ESD-11 has faster ramp up and meets same electricity generation levels by 2020			

Calculation of Costs	Annual In 2017	Annual In 2025	Units
Costs of Landfill gas capture and generation	**24**	**56**	$million

Calculation of Avoided Energy Benefits	Annual In 2017	Annual In 2025	Units
Avoided Energy Costs	**16**	**37**	$million

Calculation of GHG Emissions Reductions	Annual In 2017	Annual In 2025	Units
Avoided Emissions from Electricity Generation	**0.14**	**0.23**	MMtCO2
Avoided Emissions from landfill methane capture (for AFW accounting)	3.57	8.43	MMtCO2

Results	2017	2025/all	Units
Waste-to-Energy Option			
GHG Emission Savings	**3.71**	**8.65**	$MMtCO_2e$
Net Present Value (2009-2025)		**$79.4**	$million
Cumulative Emissions Reductions (2009-2025)		64.7	$MMtCO_2e$
Cost-Effectiveness		**$1.23**	$\$/tCO_2e$

ESD-12: DSM/Energy Efficiency Programs, Funds, or Goals for Electricity: < All Sector >

Date Last Modified: 9/22/08 12:00 AM
Modified By: A. Bailie/D. Von Hippel

Key Inputs (i.e., Data and Assumptions)			Units
	In 2017	In 2025	
Projected Retail Sales (GWh)	**270,107**	**309,104**	GWh
Goals			
Goals		**0.25%**	in 2010
		1.00%	in 2012
		1.50%	in 2015
		2.00%	in 2025
From ESD TWG policy options document			
Annual Ramp In		0.25%	2010
Notes		0.63%	2011
initial target of 0.25% in 2009 gradually increasing to 1% in 2015 and then to 1.5% in 2020.		1.00%	2012
		1.17%	2013
		1.33%	2014
		1.50%	2015
		1.55%	2016
		1.60%	2017
		1.65%	2018
		1.70%	2019
		1.75%	2020
		1.80%	2021
		1.85%	2022
		1.90%	2023
		1.95%	2024
		2.00%	2025
Annual Increase		0.25%	in 2010
		0.38%	2011 - 2012
		0.17%	2013-2015
		0.05%	2016-2025
Cost of Saved Energy		**30**	$/MWh
Source: ACEEE 2007. Potential for Energy Efficiency and Renewable Energy to Meet Florida's Growing Energy Demand			
Utility Cost of Saved Energy		18	$/MWh
CCS Assumption. See Cell A423 in Cross-Policy tab for "Ratio between Ratepayer Cost and Participant Cost"			
This is not used currently, but could be used if TWG wants to know how much utility has to spend.			
Avoided Energy Cost			
Avoided Delivered Electricity Cost		$67	$/MWh
From Common Factors tab.			
EE Savings Attrition Effects			
Annual reduction of savings from measures applied in a given year		**3.5%**	% per year
Average lifetime of DSM Measures		**14**	years
Source: ACEEE 2007. Potential for Energy Efficiency and Renewable Energy to Meet Florida's Growing Energy Demand			

Annual Average Electricity Consumption by Sector between 2010 and 2025

	Share
Residential	49%
Commercial	41%
Industrial	7%
Other	3%
Total	100%

Based on forecasted consumption data in I&F. We used the average consumption for each sector between 2010 and 2025.

T&D Electricity Loss	8.0%	2015 value used

From Common Factors

Calculated Assumptions				Units
Adjusted Retail Sales	**252,980**	**263,631**		GWh
Adjusted Retail Revenues	**0**	**0**		

Calculation of Energy Savings	Annual In 2017	Annual In 2025	Cumulative 2009-2025	Units
Annual (cumulative) Energy Savings (GWh)	**20,575**	**48,803**	**367,729**	GWh
2009 Single year savings				
2010 Single year savings				
2011 Single year savings				
2012 Single year savings				
2013 Single year savings				
2014 Single year savings				
2015 Single year savings				
2016 Single year savings				
2017 Single year savings				
2018 Single year savings				
2019 Single year savings				
2020 Single year savings				
2021 Single year savings				
2022 Single year savings				
2023 Single year savings				
2024 Single year savings				
2025 Single year savings				
Annual (cumulative) Energy Savings (GWh) at Generation Level	**22,368**	**53,055**	**399,771**	GWh
Note: this includes 5% line loss				
Residential				
Commercial				
Non-gov.				
Gov.				
Industrial				
Savings as % of Projected Sales	**7.6%**	**15.8%**	**-**	

Calculation of Costs	Annual In 2017	Annual In 2025	Cumulative 2009-2025	Units
Total Cost of EE	**617**	**1,464**	**11,032**	$million
Utility Cost of EE	**370**	**878**	**6,619**	$million

Note (Total Cost of EE): the cost to the entire system or society including participant costs.

Note (Utility Cost of EE): these data are used for estimating the impact of DSM investment by utilities relative to utility revenues.

Calculation of Avoided Energy	Annual In 2017	Annual In 2025	Cumulative 2009-2025	Units
Avoided Energy Costs	-1,490	-3,533	-26,621	$million

Calculation of GHG Emissions Reductions	Annual In 2017	Annual In 2025	Cumulative 2009-2025	Units
Avoided Emissions	13	22	201	MMtCO2
Notes				

Results	Annual In 2017	Annual In 2025	Cumulative 2009-2025	Units
Scenario for this sheet:				
GHG Emissions Reductions	13	22	201	$MMtCO_2e$
PV, Gross Cost			6,062	Million $
PV, Gross Benefits			-14,629	Million $
Net Present Value (2009-2025)			-8,566	Million $
Cost-Effectiveness			-43	$/tCO2e

Estimate of Mitigation Option Costs and Benefits for ESD GHG Analysis

ESD-13a **Energy Efficiency for Existing Residential**

Date Last Modified: *9/19/2008 A Bailie/D. Von Hippel*

Key Data and Assumptions	2017	2025/all	Units
First Year Results Accrue		**2011**	
Based on goal set in Mitigation Option Design for ESD-13a (version dated Aug 13 2008) that reads "10-year program from January 1, 2011 through 2020".			
USE AVOIDED COSTS OF SUPPLY (1) OR RETAIL RATES (2)?		**2**	Retail
Toggle to set the base for cost effectiveness calculations - from societal (avoided costs / total resource cost) or participant (retail cost) perspective.			
Levelized Cost of Electricity Savings For Package 1		**$100**	$/MWh
From ACEEE 2007, package includes high efficiency air conditioner (SEER 15), used leakage in ducts (0.1 to 0.03), ceiling insulation (R30), solar hot water, 50% fluorescent lighting replacement, programmable thermostat).			
Levelized Cost of Electricity Savings For Package 2		**$70.0**	$/MWh
From ACEEE 2007, package includes package 1 plus cool roof, ENERGY STAR refrigerator, ENERGY STAR ceiling fans, load reduction, window replacement (u=0.39, SHGC=0.4 vinyl), white walls.			
Avoided Electricity Cost		**$67**	$/MWh
See "AvCost" and "Common Factors" worksheets in this workbook. Use setting above to determine whether to use avoided cost of electricity or electricity rates for cost calculations.			
Electricity Rates, residential	**$105**	**$107**	$/MWh
See "AvCost" and "Common Factors" worksheets in this workbook. Use setting above to determine whether to use avoided cost of electricity or electricity rates for cost calculations.			

Other Data, Assumptions, Calculations	2017	2025/all	Units
Existing Housing units in Florida 2008?		**6,200,000**	
Average energy consumption per existing housing unit per year		**19,462**	kWh/yr
P Fairey, Florida Solar Energy Center, calculations for ACEEE 2007 report.			
Estimated number of residential units that are retired per year		**3%**	
Assumption based on average lifespan of 30 years.			
Total "Existing" Housing Units in Florida	4,569,644	3,484,146	
Calculated based on estimates above.			
Energy savings per housing unit for packages of energy efficiency measures			
Package 1		3,504.00	kWh/yr
Package 2		6,497.00	kWh/yr
Package 1, excluding solar hot water system		1,724.00	kWh/yr
Packages defined in ACEEE 2007			
Package 1- high efficiency air conditioner (SEER 15), reduced leakage in ducts (0.1 to 0.03), ceiling insulation (R30), solar hot water, 50%b fluorescent lighting replacement, programmable thermostat)			
Package 2 - package 1 plus cool roof, ENERGY STAR refrigerator, ENERGY STAR ceiling fans, load reduction, window replacement (u=0.39, SHGC=0.4 vinyl), white walls.			
Reference case improvements in energy efficiency			
Fraction of homes improved per year		**0.05%**	
Average energy savings per housing unit per year, for improved units		1,724.00	kWh/yr
Cost of Saved Electricity		N/A	$/MWh
Placeholder assumptions, energy savings based on Package 1 excluding solar hot water system.			

ESD-13a improvements in energy efficiency			
Fraction of homes improved per year 2011		**1.00%**	
Fraction of homes improved per year 2015		**4.00%**	
End year of program		2,020	
Average energy savings per housing unit per year, for improved units		5,299.80	kWh/yr
Weighted Average Cost of Saved Electricity		78	$/MWh
Placeholder assumptions, energy savings based on mix of package 1 to package 2 of:			
package 1 — 40%			
package 2 — 60%			
Checks, referring to total number of improved/renovated homes			
Fraction of 2008 homes improved by 2025		**36.66%**	
Number of home improved annually	**182,786**	**139,366**	
Total Number of homes improved		**2,272,652**	
Reference case - Implied electricity savings in exisiting housing units	**3.94**	**3.00**	GWh/yr
First-year savings--not cumulative.			
Recent Actions - Implied electricity savings in exisiting housing units	**-**	**-**	GWh/yr
First-year savings--not cumulative. [NOT USED]			
ESD 13a - Implied electricity savings in exisiting housing units	**968.73**	**738.61**	GWh/yr
First-year savings--not cumulative.			
Implied Cumulative Impacts of Option, Existing residential units (Electricity savings)			
Reference case	**40.8**	**67.9**	GWh
Recent Actions	**-**	**-**	GWh
ESD-13a option	**5,371.2**	**12,044.6**	GWh
Annual costs			
Reference case	**N/A**	**N/A**	million $
Recent Actions	**-**	**-**	million $
ESD-13a option	**418.6**	**938.7**	million $
Annual benefits (avoided costs of electricity)			
Reference case	**N/A**	**N/A**	million $
Recent Actions	**-**	**-**	million $
ESD-13a option	**565.2**	**1,292.9**	million $

Results	**2017**	**2025**	**Units**
ESD 13a			
TOTAL Reduction in Electricity Sales	5,371	12,045	GWh (sales)
Reduction in Generation Requirements	5,839	13,094	GWh (generation)
GHG Emission Savings	3	5	MMtCO$_2$e
Economic Analysis			
Net Present Value (2009-2025)		**-$1,432.4**	$million
Cumulative Emissions Reductions (2009-2025)		50.4	MMtCO$_2$e
Cost-Effectiveness		**-$28.39**	$/tCO$_2$e

Summary Results for ESD-13a	**2017**	**2025**	**Units**
Total for ESD 13a Option			
GHG Emission Savings	**3.40**	**5.38**	MMtCO$_2$e
Net Present Value (2009-2025)		**-$1,432.4**	$million
Cumulative Emissions Reductions (2009-2025)		50.4	MMtCO$_2$e
Cost-Effectiveness		**-$28.39**	$/tCO$_2$e

NOTES AND DATA FROM SOURCES

Note 1:

ACEEE June 2007. Potential for Energy Efficiency and Renewable Energy to meet Florida's Growing Energy Demands

Estimate of Mitigation Option Costs and Benefits for ESD GHG Analysis

ESD-14 **Building Energy Codes**

Date Last Modified: 9/19/2008 A Bailie

Key Data and Assumptions			Units
First Year Results Accrue		**2009**	
USE AVOIDED COSTS OF SUPPLY (1) OR RETAIL RATES (2)?		**2**	Retail

Toggle to set the base for cost effectiveness calculations - from societal (avoided costs / total resource cost) or participant (retail cost) perspective.

		Residential	Commercial	
Levelized Cost of Electricity Savings	2009	**$60.0**	**$66.6**	$/MWh
	2011	**$61.8**	**$66.6**	$/MWh
	2014	**$65.4**	**$66.6**	$/MWh
	2017	**$68.8**	**$66.6**	$/MWh
	2020	**$72.3**	**$66.6**	$/MWh
	2023	**$75.7**	**$66.6**	$/MWh
	2026	**$79.2**	**$66.6**	$/MWh

Residential, based on ACEEE report. (See Note, below.) not accounting for tax credits
Commercial - same as avoided electricity cost, since energy savings based on economic potential.

Avoided Electricity Cost		**$67**	$/MWh

Weighted average over total 2007-2020 electricity savings for this policy in each sector. See common assumptions ("Common Factors" worksheet in this workbook). Use setting above to determine whether to use avoided cost of electricity or electricity rates for cost calculations.

Electricity Rates, residential	**$105**	**$107**	$/MWh
Electricity Rates, commercial	**$91**	**$91**	$/MWh

See "AvCost" and "Common Factors" worksheets in this workbook. Use setting above to determine whether to use avoided cost of electricity or electricity rates for cost calculations.

Results	2017	2025	Units
Electricity			
Recent Actions not included in forecast			
Reduction in Electricity Sales: Residential	4,743	12,934	GWh (sales)
Reduction in Electricity Sales: Commercial	7,979	21,762	GWh (sales)
Reduction in Electricity Sales: Industrial	0	0	GWh (sales)
TOTAL Reduction in Electricity Sales	12,722	34,696	GWh (sales)
Reduction in Generation Requirements	13,742	37,477	GWh (generation)
GHG Emission Savings	**8.00**	**15.41**	$MMtCO_2e$
Savings due to Additional Effort in ESD-14			
Reduction in Electricity Sales: Residential	0	4,096	GWh (sales)
Reduction in Electricity Sales: Commercial	0	6,891	GWh (sales)
Reduction in Electricity Sales: Industrial	0	0	GWh (sales)
TOTAL Reduction in Electricity Sales	0	10,987	GWh (sales)
Reduction in Generation Requirements	0	11,868	GWh (generation)
GHG Emission Savings	**0.00**	**4.88**	$MMtCO_2e$
Economic Analysis (for Electricity Savings due to Recent Actions)			
Cost of Saved Electricity			
Residential	326	935	$million
Commercial	531	1,449	$million
Savings from Avoided Electricity Generation	1,223	3,374	$million
Net Present Value (2009-2025)		**-$4,082.5**	$million
Cumulative Emissions Reductions (2009-2025)		136.5	$MMtCO_2e$
Cost-Effectiveness		**-$29.92**	$/tCO_2e$

Economic Analysis (for Electricity Savings due to Additional Effort in ESD-14)

Cost of Saved Electricity			
Residential	0	310	$million
Commericial	0	459	$million
Savings from Avoided Electricity Generation	0	1,068	$million
Net Present Value (2009-2025)		**-$265.2**	$million
Cumulative Emissions Reductions (2009-2025)		9.9	$MMtCO_2e$
Cost-Effectiveness		**-$26.75**	$\$/tCO_2e$

Summary Results for ESD-14	2017	2025	Units
Recent Actions Not Included in Forecast (Current/planned building code changes)			
GHG Emission Savings	**8.00**	**15.41**	$MMtCO_2e$
Net Present Value (2009-2025)		**-$4,082**	$million
Cumulative Emissions Reductions (2009-2025)		136.5	$MMtCO_2e$
Cost-Effectiveness		**-$29.92**	$\$/tCO_2e$
Total for Additional Effort in ESD-14			
GHG Emission Savings	**0.00**	**4.88**	$MMtCO_2e$
Net Present Value (2009-2025)		**-$265**	$million
Cumulative Emissions Reductions (2009-2025)		9.9	$MMtCO_2e$
Cost-Effectiveness		**-$26.75**	$\$/tCO_2e$

NOTES AND DATA FROM SOURCES

Note on Overall Approach to Analysis

The following information was provided in Philip Fairey and Jeff Sonne, May 15, 2007 *Effectiveness of Florida's Residential Energy Code: 1979 – 2007*, submitted to the Florida Department of Community Affairs. This information is based on information in the report, ACEEE June 2007. *Potential for Energy Efficiency and Renewable Energy to meet Florida's Growing Energy Demands*

Table D. Projected Cost-Effective Residential Energy Savings Potential for Florida

New Home Efficiency	kWh Saved per Home per Year (Statewide Average)	2023 Statewide Savings (GWh)	Economic Savings Potential (% of Total Residential Electricity Potential)	Cost per kWh Saved
Energy Star Home (15% savings)	*2,021*	*5,764*	*11%*	*$ 0.06*
Tax Credit Eligible Home (25% savings)[a]	*1,857*	*2,715*	*5%*	*$ 0.03*
40% Savings Home[b]	*1,998*	*584*	*1%*	*$ 0.07*
Total Savings (GWh)		**53,054**	**100%**	**$ 0.049**
% Savings (% of 2023 Projected Sales)		**34%**		

[a] Savings are incremental to Energy Star Homes.

[b] Savings are incremental to Tax Credit Eligible Homes.

% applicable*
100%
50%
10%

Sum of GWh Savings
9,063

* % applicable refers to fraction of homes built between 2008 and 2023 that meet the standard in the ACEEE estimates taken from page 57 of ACEEE June 2007 report. Since these fractions are roughly equivalent to the Building Code improvements called for in HB/SB 697, we assume the total GWh saved are a rough approximation for the residential portion of the existing building code improvements

year	efficiency improvement on 2007 code	kWh per home per year	number of homes	GWh saved in that year	cost per kWh saved	
source of info	*HB/SB 697*	*table above and calculations*	*P. Fairey estimates*	*calculation*	*table above and calculations*	
2009	15%	2021	160000	323	$ 0.0600	
2011	20%	2695	160000	431	$ 0.0618	
	Tax credit eligible	3877	160000	620	$ 0.0650	** ignore tax credits
2014	30%	4042	160000	647	$ 0.0654	
2017	40%	5389	160000	862	$ 0.0688	
	40% savings	5876	160000	940	$ 0.0700	
2020	50%	6737	160000	1078	$ 0.0723	
2023	60%	8084	160000	1293	$ 0.0757	
2026	70%	9431	160000	1509	$ 0.0792	

The ACEEE 2007 report also estimates the following potential economic potential for energy efficiency in new commercial buildings for 2023.

Table 3

	Small Office kWh/year	large office kWh/year	large hotel kWh/year	small retail kWh/year	large retail kWh/year	restaurant kWh/year	school kWh/year	hospital kWh/year
New Building								
baseline energy	60318	1121008	3484331	90149	1431837	241115	119957	8795278
new package savings	21630	319091	957498	41355	643377	75046	42837	2526488
new package savings	35.9%	28.5%	27.5%	45.9%	44.9%	31.1%	35.7%	28.7%
Statewide savings in 2023 GWh	2979	2365	2758	2559	2504	2284	1362	1324
Total (GWH)	18135 ACEEE estimates this to 14% of projected sales in 2023.							

For preliminary estimates, use ACEEE value for 2023 and use the residential calculations to provide an estimate of savings in prior and subsequent years. Assuming the commercial savings in ACEEE report represent similar level of improvement as the residential savings.

New Option - ESD 14

According to the Policy Design "The goal of ESD-14 is to extend the timeframe of HB 697 and 7135 beyond 2019 such that energy consumption per square foot of floor space is reduced by 100% from what it was in 2007". Assume that 'this target continues to advance by 10% every three years to meet the 100% goal by 2035 so that improvement by 2026 is 70% better than 2007. See calculations in table above.

For commercial, use the residential improvements compared to 2023 without expansion of building codes as the basis for estimating commercial savings in 2023 and subsequent years.

Annex B
Input from TWG members on Renewable Assumptions

From Florida Power and Light (email August 18, 2008)

Capital Cost in 2009$ Potential Generation Potential Generation (GWh) Capacity Factor

Solar PV (small scale) $8,500/kW Abundant 9%

Solar PV (over 1 MW) $7,200/kW Abundant 18 to 23%

Solar Thermal $6,800/kW 300 - 500 MW 630 - 1,050 20 to 24%

Wind Coastal $3,7500/kW 900 MW 1,200 12 to 20%

Wind inland $2,500/kW MINIMAL / NOT FEASIBLE WITH CURRENT TECHNOLGY 3 to 5%

Wind Offshore $6,000 to $9,000/kW Unknown due to environmental / siting uncertainties 21 to 26%

Biomass (Direct) $3,100 to $6,700/kW 60 to 80%

Biomass (Gasification) $3,100 to $6,900/kW 70 to 93%

Landfill Gas $1,400 to $2,800/kW 70 to 93%

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From John Wilson, August 18, 2008

On quick review, the only figure I question is the 0% trend for nuclear, coal, etc. construction costs. I believe I have seen some studies (DOE or maybe a Wall Street firm) that estimate trends in construction costs and they project sharply higher costs in the future for these types of plants.

This is not an endorsement of other figures, I haven't had the chance to compare the detailed figures for renewable resource potential . . .

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From Audubon

From: Treshler,Joseph
Sent: Monday, August 11, 2008 2:50 PM
To: 'kwwebb@psc.state.fl.us'
Cc: 'MFutrell@PSC.STATE.FL.US'
Subject: FW: Renewable Energy Data
Importance: High

Dear Karen,

On behalf of the Integrated Waste Services Association (IWSA), and, acting as the team leader identified in the Email below for Municipal Solid Waste (MSW), I am submitting the following data response specific to the future additional electrical power generation potential of Municipal Solid Waste in Florida.

Based on this analysis approximately **1614 MW of additional new electrical generation capacity** can be provided from the MSW that is currently being directed to Class I Landfill operations in the State. This assessment does not include the existing 517 MW of existing installed generating capacity IWSA reported to FLPSC on 7/22/08 or the additional 17 MW of new generating capacity scheduled to come on line in 2009 reported to FLPSC by Covanta Energy on 7/22/08 for the Hillsborough Facility Expansion Project.

When taken together, the existing & in construction MSW electrical generating capacity (534 MW) plus the potential new MSW electrical generating capacity (approximately 1614 MW) represents a total of approximately 2148 MW of installed electrical generation capacity from MSW that could be fully available using demonstrated, environmentally sound technology currently in use today in Florida's 11 WTE facilities.

In making this assessment of future additional electrical generation potential we followed the direction provided verbally by FPSC and state here in the assumptions we have made. The key assumptions are also provided as part of the footnotes included with the Response form. Our assumptions are as follows.

1. We are providing the best case (perfect world) analysis that was suggested, that is, we are assuming that all MSW generated in the State that is currently being directed to an in-state Class I Landfill operation for disposal is available for energy recovery.

2. FDEP 2006 data - Table 5A Final Disposition of Municipal Solid Waste in Florida – has been used as the basis of this analysis and data submittal. Attached.

3. We have adjusted the total quantity of MSW available state wide for energy recovery to reflect the current beneficial use practice of using the ash residue generated by the State's 11 WTE facilities as raw waste landfill "day cover". See Note #5.

4. A copy of the USEPA letter reference in Notes # 10 & 11 is provided as an attachment.

With respect to the costs associated with electrical energy production from MSW, one public IWSA member succinctly expressed the problem we have as an industry trying to respond to your questions in this area - FPSC has asked us to provide a numerical answer to an essay question. WTE facilities are just one component of a community's Integrated Solid Waste Management System and hence the facility's scope, capital cost, operating & maintenance costs and the community revenue stream requirements, which include system tipping/disposal fees and the electrical revenues requirements for the renewable energy being generated, are unique to each community's system. Since the State's existing WTE facilities were initially developed to solve environmental and infrastructure challenges as their first priority and are now being recognized as an excellent means of recovering renewable energy indigenous to this waste system while reducing GHG's, Florida's WTE facilities truly serve a dual public purpose.

Further, we believe that meeting directly with FPSC staff to discuss a logical approach to RPS related evaluation factors for new and existing WTE facilities in Florida is a necessary part of this rule making process. Representatives of IWSA are prepared to meet with FPSC staff at the earliest mutually acceptance date.

We look forward to FPSC's response to our suggested course of action.

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From Mark Kaplan, August 18, 2008

For EXISTING Waste Heat Renewable Generation Facilities Currently Operational In Florida

Fuel	Energy Source	Capital Cost 2009 (2006 $ kW)	Capital Cost 2025 (2006 $ kW)	Levelized Cost 2009 (2006 $ kWh)	Economic Life (years)	Potential Capacity mW	Potential Generation mWh
Chemical Processing **Waste Heat From Sulfuric Acid Manufacturing**		Existing facilities installed over time since the early 1980s 2006 cost is N/A	See data below re: Potential facilities	10 cents/kWh in 2008 plus CPI non-energy	30+ years	370 mW of existing generating capacity from **recovered** waste heat	2,600,000 mWh annual average generation

For POTENTIAL Waste Heat Renewable Generation Facilities That Could Be Installed In Florida

Fuel	Energy Source	Capital Cost 2009 (2006 $ kW)	Capital Cost 2025 (2006 $ kW)	Levelized Cost 2009 (2006 $ kWh)	Economic Life (years)	Potential Capacity mW	Potential Generation mWh
Chemical Processing **Waste Heat From Sulfuric Acid Manufacturing**		$3500 to $4000 in 2008 dollars (range only - can vary significantly	N/A Depends on inflation/deflation in prices over time	10 cents/kWh in 2008 plus CPI non-energy	30+ years	140 mW of potential generating capacity from **unrecovered** waste heat	1,000,000 mWh annual average generation

Appendix B
Cap-and-Trade

C&T-1. Greenhouse Gas Cap-and-Trade

Policy Description

A cap-and-trade system works by setting an overall limit on emissions and either selling or distributing, at no cost, emissions "allowances," or permits, to regulated entities or sources. These regulated entities must periodically surrender enough allowances to match their reported emissions or face a penalty. In a system that freely grants allowances, those sources that are able to reduce their emissions at a lower cost than the allowance price may do so and sell unused allowances to those who cannot achieve reductions as cost-effectively. In a system where allowances are initially sold, cost-effective emissions reductions reduce the number of allowances that must be purchased. Either way, cap-and-trade creates a financial incentive for emitters to continually seek out new emission-reducing technologies and cut their emissions as much as possible. By creating a market for the allowances, regulated entities have the choice of either purchasing allowances or directly reducing emissions and, as a result, resources are directed to the most cost-effective emissions reduction investments. To achieve overall emissions reductions over time, programs gradually lower the emissions "cap" by reducing the total number of available allowances.

Perhaps the best known example of cap-and-trade is the U.S. Environmental Protection Agency (EPA) program to cut sulfur dioxide (SO_2) emissions from power plants. Established under the 1990 Clean Air Act Amendments, this program successfully proved the emissions trading concept by achieving dramatic, cost-effective reductions. More recently, the trading approach has been applied to greenhouse gas (GHG) emissions by the European Union (EU)[1] and proposed by several U.S.-based initiatives including the Northeast Regional Greenhouse Gas Initiative (RGGI),[2] the Western Climate Initiative (WCI),[3] and the Midwestern Regional Greenhouse Gas Reduction Accord.[4]

On July 13, 2007, Governor Charlie Crist signed Executive Order 07-128,[5] which created the Governor's Action Team on Energy and Climate Change (Action Team). The Action Team is

[1] http://ec.europa.eu/environment/climat/emission.htm

[2] http://www.rggi.org

[3] http://www.westernclimateinitiative.org

[4] http://midwesternaccord.org/

[5] http://www.flclimatechange.us/ewebeditpro/items/O12F15075.pdf

charged with identifying means by which Florida can fully achieve or surpass the statewide GHG reductions specified in Executive Order 07-127.[6] These recommendations need to be guided by an evaluation of the possible consequences to Florida's environment, economy, and society from global climate change. During 2007, the Action Team issued its Phase 1 Report. The report offers broad policy guidance in key areas for consideration by the Governor and Legislature or further consideration by the Action Team, including a market-based regulatory approach for utility emissions.

On June 25, 2008, Governor Crist signed House Bill 7135 (HB 7135), a comprehensive energy and economic development package aimed at reducing GHG emissions as well as encouraging investment in alternative and renewable energy technologies. Section 65 of HB 7135 calls for the Florida Department of Environmental Protection (DEP) to propose rules for the creation of a cap-and-trade regulatory program to reduce GHG emissions from major emitters. This policy is the result of the Phase 2 investigation called for in the Phase 1 report and offers pre-rulemaking guidance to the DEP in response to the requirements of HB 7135.

There is growing expectation that Congress will require a federal cap-and-trade program, perhaps during the next Administration. By initiating, joining, or developing a state and/or regional cap-and-trade system in the meantime, Florida would be taking an important step toward potentially influencing the outcome of the federal policy debate in its favor.

Policy Design

Ultimately the pollution-cutting performance of a cap-and-trade program depends largely on how it is structured. Key design parameters are discussed separately below.

The cap-and-trade policy is designed and analyzed to work in concert with non-cap-and-trade policies and measures. The integration of other policies serves to reduce compliance costs and ease attainment of goals and caps. Emissions reductions, costs, and cost savings from many of these other measures help Florida comply with the cap; they also serve as a basis for the cap-and-trade modeling. As a result, the expected operation of the cap-and-trade program is integrated with other policies and policy recommendations, and is not presented as a stand-alone program.

Reduction Targets and Time Frames

Table B-1-1 shows the schedule for GHG emission reductions is pursuant to Executive Order 07-127.

[6] http://www.flclimatechange.us/ewebeditpro/items/O12F15074.pdf

Table B-1-1. Schedule for GHG emission reductions

Year	GHG Reduction Goal
2017	2000 levels
2025	1990 levels
2050	80% below 1990 levels

GHG = greenhouse gas.

Sector Coverage

The regulation of GHG emissions should be economy-wide and should commence as soon as possible; however, a cap-and-trade program may apply only to a limited number of sectors. Sector inclusion in the cap-and-trade program should be guided by cost-effectiveness, administrative efficiency, overall reduction potential, experience by other jurisdictions, and whether alternative policies are preferred. The Florida cap-and-trade program should include the electric sector at the beginning. Rulemaking consideration should be also given to (1) industrial stationary source emissions; (2) residential and commercial fuel use; (3) transportation fuels; and (4) energy extraction, processing, and transportation. These sectors may be better candidates for inclusion in a subsequent phase. The transportation and residential and commercial fuel use sectors could also be considered through rulemaking. They have not been included in prior cap-and-trade programs, although WCI has proposed to include them in its program beginning in 2015. Unlike the electricity, energy extraction, and industrial sectors, these two sectors would most likely have to be regulated upstream of the actual point of emissions. The regulated entity in the transportation, residential, and commercial fuel use sectors may need to be the fuel distributor or importer. Transportation and residential and commercial fuel use should be studied further and considered for inclusion in a subsequent phase or they may be better suited for regulation through non-cap-and-trade market mechanisms. While these and other sectors may not be included in the cap-and-trade program or otherwise regulated at the program start, they should be included or otherwise regulated as soon as possible.

Other sectors may need alternative methods of regulation based on the factors listed above. Land development, forestry, agriculture, and waste management are generally not regulated under a cap-and-trade program due to a lack of historical emissions data, difficulty measuring or verifying current emissions, and for other reasons. Emissions reduction projects or programs within these sectors may, however, be well-suited to participate in an "offsets" program as described below.

There should be a de minimis exemption below which sources within the regulated sectors would be exempt from regulation. The threshold of the exemption could vary by sector.

Regional Programs

First and foremost, a strong national cap-and-trade program is the preferred method for achieving substantial reductions in GHGs, and Florida should advocate for a national program.

As the federal government deliberates on a national program, Florida should join a regional program to advance its GHG reduction goals. Toward that end, Florida should further examine the economics of joining a regional program, but should not join a regional program where analysis indicates that Florida would be disadvantaged.

Initial analysis indicates that Florida would benefit from joining the Regional Greenhouse Gas Initiative (RGGI). RGGI currently comprises 10 northeastern and Mid-Atlantic states and will regulate emissions from fossil fuel–powered electric generation units (EGUs) with a nameplate capacity of 25 megawatts (MW) or greater. Two 100 percent auction-based cap-and-trade scenarios for year 2020 are simulated for Florida joining the RGGI program.[7] The two scenarios correspond to hypothetical allowance prices of \$7/tCO_2e and \$1/tCO_2e, respectively. Preliminary modeling indicates that Florida sources would represent slightly less than half of the total electric generation emissions from the eleven states, and, depending on assumptions used, would mitigate between 70 and 76 MMtCO_2e (million metric tons of carbon dioxide equivalent) in 2020, with the balance of 75 to 80 MMtCO_2e accounted for by allowance purchases. Florida RGGI sources would expect to see a cost savings of between \$1.5 to about \$2.0 billion dollars in 2020 by participating in the cap-and-trade program. Please note any additional savings that might be realized from the recycling of the auction revenues by the government are not included. Complete modeling results and analysis may be found in Annex 1 at the end of this Appendix.

Florida should seek "observer" status with RGGI as soon as possible to examine the program in greater detail, closely monitor progress and prepare for membership if it is desired.

Initial analysis indicates that Florida may benefit from joining the cap-and-trade portion of the Western Climate Initiative (WCI). Further study would be necessary to determine whether participation in the other planned WCI programs (for example, regional low-carbon fuel standard and renewable portfolio standard) would benefit Florida. WCI is currently comprised of seven U.S. states and four Canadian provinces; its proposed cap-and-trade program will cover emissions from multiple sectors representing approximately 90 percent of total regional emissions. WCI just released its design recommendations on September 23, 2008. Analysis is based on the WCI proposed program design. The cap-and-trade simulation for Florida joining WCI covers a much broader range of emission sources than the RGGI simulation (basically all the sectors except the agriculture, forestry, and waste management sectors). The analysis results indicate that Florida would be a permit seller in the market. Florida WCI sources would expect to see a cost savings of \$191 million in 2020 by participating in the cap-and-trade program as opposed to achieving the same reductions without it. Florida sources would be expected to mitigate 18.46 MMtCO2e *more* than required to meet targets due to the relatively low cost of mitigation and the opportunity to sell allowances to other WCI Partner sources. Complete

[7] A 100 percent auction is assumed due to limitations in the model resulting from RGGI's low cost mitigation opportunities (see Annex 1 to Appendix B). As a policy matter, the Action Team is neither recommending nor assuming that Florida will use 100 percent auctions as a means of initially distributing allowances.

modeling results and analysis may be found in Annex 2 at the end of this Appendix. Because WCI is scheduled to begin on January 1, 2012, at the earliest, there is ample opportunity to conduct further economic analysis and observe the early operation of WCI.

Florida should seek "observer" status with WCI as soon as possible to examine the program in greater detail, closely monitor progress, and prepare for membership if it is desired.

These two regional programs may not be mutually exclusive. Florida should explore the economics and potential obstacles, complications, and benefits associated with joining both.

Six Midwestern states and Manitoba are currently engaged in discussions toward the development of a third regional cap-and-trade program. Recently organized, the group expects to release a draft program design this November. Given the newness of the Midwestern effort, the Action Team has been unable to evaluate whether Florida might benefit from participation or membership. Florida should continue to monitor the progress of this program and investigate the advisability of affiliation or membership as the Midwestern program develops.

At the same time, Florida should reach out to the other Southern states in the hope of collaborating with its neighbors to (1) jointly influence the development of a national cap-and-trade program, (2) explore the potential for multiple Southern states joining one or more regional programs, (3) help address "leakage" issues, and (4) explore the creation of a Southern regional climate initiative to reduce GHG emissions, stimulate the development of renewable energy sources, reduce dependence on imported fuels, and stimulate the creation of industries specializing in energy efficiency, renewable energy, and carbon mitigation technologies.

Finally, it is strongly recommended that Florida should not pursue a one-state cap-and-trade program.

Caps and Goals

Florida's GHG reduction cap-and-trade program should be designed to achieve the emission reduction goals set forth in Executive Order 07-127. However, as directed in that Executive Order and the recently enacted HB 7135, Florida should evaluate the conditions under which the state could cost-effectively link its trading system to the systems of other states, or regions, such as the RGGI.

If Florida joins a regional climate initiative, it should accept the regional goal as long as it is consistent with the state's GHG reduction goals. Current modeling indicates that RGGI should bring Florida's electric sector emissions to the state goal; however, if it does not, additional policies and measures would be required to reduce GHG emissions to meet the state goal.

Flexibility and Cost Containment Mechanisms

The mechanisms described below contain a brief description followed by the policy recommendation.

- *Offsets*—Regulated sources can comply with the cap-and-trade program in three ways; they can reduce emissions directly, they can acquire and surrender allowances sufficient to cover their emissions, or they can invest in qualifying offset projects and surrender offset credits. Offset projects are undertaken voluntarily and generate revenue for the project owner through the sale of offset credits, which are equivalent to government-issued allowances. Emission reductions from regulated sources are therefore not eligible as offset projects; otherwise these reductions would be double-counted, once for the benefit of the regulated source under the cap, and again for the benefit of the offset purchaser. To ensure the integrity of the emissions cap, offset projects reduce emissions or sequester carbon from uncapped, out-of-sector projects that are recognized by the program as qualifying for allowance credit. In most cases, any emissions included under any cap-and-trade programs' cap cannot be reduced and also qualify as an offset credit under any other cap-and-trade program. Offsets provide an incentive for low-cost investments in uncapped emission reductions as an alternative to higher-cost, in-sector reductions or allowance purchases.

  Recommendation: The cap-and-trade program should allow offsets without limits; however, the offset program must ensure rigorous quality standards.

- *Safety Valve*—A safety valve is a program feature designed to limit or moderate the cost of allowances for the purpose of ensuring that the program will not have an unacceptable impact on consumer costs. Safety valves can be as direct and conceptually simple as an allowance price cap or as complex and indirect as the RGGI's stepped expansion of offset opportunities triggered by allowance prices[8]. The safety valve can be used in conjunction with other tools to mitigate price volatility (such as banking and borrowing). It should be noted that hitting the safety valve price cap would effectively convert the cap-and-trade program into a carbon tax at that price.

  Recommendation: The cap-and-trade program needs appropriate allowance price containment mechanisms, especially in the early years. Further study is needed before the specific mechanisms can be recommended.

- *Banking*—Banking allows permit holders to withhold unneeded allowances from the market, or from surrender-for-emissions compliance, without expiration. A banked allowance may be used in any compliance period beyond the issuance period without penalty. Banking is seen as a means of mitigating market volatility by allowing holders to hold onto allowances (thereby mitigating supply) when prices are low, and to use or sell them (thereby mitigating demand) when prices are high.

  Recommendation: The cap-and-trade program should allow unlimited banking.

- *Borrowing*—Borrowing of allowances permits emitters to release excess tons of GHGs in the current compliance period in return for greater reductions in a future compliance period.

[8] The Western Climate Initiative employs banking, offsets and three-year compliance periods to mitigate allowance prices but does not have a safety valve.

Recommendation: Borrowing is an important cost containment mechanism and should be allowed, but agreement was not reached on what conditions (for example, Warner-Lieberman–type limits by emitter, time limits, or interest) should be imposed.

Allowance Distribution

One of the most difficult issues confronting cap-and-trade program designers is how the allowances are initially introduced to the market. The two principal methods are free allocation and auction sale. Free allocation is the method used in the EPA SO_2 trading program and was widely used in the first two phases of the EU Emissions Trading Scheme (ETS) program. RGGI will auction nearly 100 percent of their allowances and the EU is gradually moving in the direction of greater reliance on auctions. WCI is still deliberating on the issue, although it is likely that a decision on how best to distribute allowances will ultimately rest with participating jurisdictions.

Under a free allocation system, jurisdictions distribute allowances free of charge to regulated entities according to a formula based upon historical emissions, benchmarked emissions (the expected emissions per unit output for a facility with a preferred technological configuration), or on some other basis. Free allocation systems may include equity features such as a "reserve" for new market entrants to avoid creating a competitive disadvantage. The formula that determines the number of allowances allocated to each source can be challenging to create. Historical emissions are a common approach, but issues such as selecting the time period to use as a basis and various equity adjustments can be difficult to determine. Benchmarking is straightforward in principle but very difficult to achieve in practice.

Under an auction system, allowances are presented to the market by sale at auction. Regulated entities are therefore required to purchase allowances. Revenues are collected by the issuing jurisdiction. Auctioning allowances resolves the "allocation basis" and many equity issues arising from the free allocation method but presents a new set of challenges, including the additional cost imposed on regulated entities and consumers. Emitters in some sectors are able to pass these costs onto their customers, but others are not. The cost passed along to the consumer may be a public policy concern and, in cases where competitive pressure prevents this, the economic impact on the emitter might be a concern. However, these concerns can be addressed by designing the program to be revenue neutral and returning the allowance value from the auction to consumers directly, or through programs implemented for their benefit. In addition, there is the question of what the issuing jurisdiction will do with the auction revenues.

There is also a concern for windfall profits resulting from free allocation, as happened in some instances in the EU. This can be an issue when the emitter is not price regulated but is free to pass the cost along to customers, as is the case among generators in most of the RGGI states. In states where generators are price regulated, such as Florida, the value of the freely allocated allowance can be directed to the benefit of the ratepayer through rate setting.

Free allocation and auctioning are not mutually exclusive. Programs can distribute some percentage of allowances using one method and the balance with the other. Programs may change the ratio of free allocation/auction distribution over time. Programs may distribute allowances to different regulated sectors using different methods or a different mix of methods. Programs may even distribute allowances differently among different classes of sources within a sector (for example, municipal utilities, co-ops, and investor- owned utilities).

The Action Team was unable to reach a consensus recommendation on the central issue of initial Allowance Distribution method. By a 13-5 super majority, the Action Team recommends that strong consideration be given to auctioning a substantial amount of allowances. The Action Team recognizes that as RGGI and WCI evolve additional information will become available to DEP and the Legislature to better evaluate the use of auctions at the beginning of the cap-and-trade program and over time.

Those opposed to this recommendation expressed concern that there has been no Florida-specific analysis of the relative cost to the consumer for allowance distribution by auction or free-of-charge allocation. Without such information, they argue, any recommendation stating a preference would be premature. Other concerns include whether requiring some industries to pay for allowances would put them at a competitive disadvantage. Others were concerned that there was no assurance that revenues from the sale of allowances would be used by the state for related purposes such as those stated below.

Those who supported auctioning pointed out that presentations from representatives of RGGI and the European Union Emissions Trading System (EU ETS) had recommended the use of auctioning. Others stated that the revenues generated by the auctions would be needed to finance other key policies and measures proposed by the Action Team. At least one member observed that given the differences among electric utilities there would be no fair way to allocate allowances between them. It was observed that the formula would likely be the subject of heavy lobbying in the Legislature, and that if allowances were distributed on the basis of historical emissions, customers of utilities with historically higher electric rates and cleaner generation would be disadvantaged, and those with lower rates and higher emissions would be advantaged. Supporters of the position expressed the belief that auctioning is the most fair distribution method.

By unanimous consent the Action Team offers the following general recommendations which could guide future policy makers in answering the question of allowance distribution.

Any allowance distribution system would need to be periodically evaluated to determine whether it is working properly and serving the program goals.

The cap-and-trade program should strive to be revenue-neutral to consumers as much as possible. There are five broad purposes to which allowance value (either the allowances themselves or proceeds from their sale) should be applied. These are not in any priority order:

- Promote energy efficiency investments,
- Mitigate impacts on ratepayers and consumers with particular attention to low-income consumers,
- Accelerate the development and use of emissions mitigation technologies, including renewable or zero-carbon technologies,
- Mitigate impacts of climate change (for example, fund adaptation strategies), and
- Protect regulated emitters from competitive disadvantage.

There are a number of other important uses of allowance value which should also be considered, such as stimulating or rewarding investment in carbon emissions abatement technologies, funding program administration, and protecting regulated emitters from economic disadvantage. One member felt strongly that all allowance value should be used to mitigate the program's impact on ratepayers and consumers.

*It is the Action Team's strong recommendation that if any revenues are generated from the sale of allowances they should never be used to supplement general revenues to the State of Florida***.**

Reporting

The cap-and-trade reporting system should be consistent with any national requirement. Every effort should be made to ensure that regulated entities are required to complete only one report for both state and national efforts. The reporting system should be as broad as possible; a *de minimis* limit may be needed, given administrative and cost concerns.

Mandatory reporting of GHG emissions is now legislatively required at both the state and federal levels. Adoption of reporting rules and collection of emissions data should proceed as quickly as possible in advance of the cap-and-trade program to verify the data from sources and sectors where the historical lack of such requirements injects a significant level of uncertainty into historical emissions estimates and future projections.

Leakage

Leakage occurs when, in response to program incentives, utilities choose to either increase out-of-region fossil-based power purchases or investors choose to construct new generation units in unregulated border jurisdictions. In either case, both the environmental benefits and in-state investment are lost. It is noted that in a national program, leakage is not an issue. Leakage can be addressed through careful design of the point-of-regulation, as in the First Jurisdiction

Deliverer (FJD) plan in WCI. FJD requires compliance from any generator within the region plus any entity that imports fossil-based power from outside the WCI region.[9]

Historically, between 1990 and 2005, electricity imports have contributed between 9 percent and 16 percent of total electricity consumption in Florida. Accordingly, it is critical that the cap-and-trade program baseline include these out-of-state sources and their changes over time to accurately define the reduction requirements under the current generation mix.

The Action Team believes leakage is a potentially serious concern. Based on the initial analysis, projected 2020 business-as-usual GHG emissions from electricity imports represent approximately 10 percent of total electricity emissions, or 19.2 million metric tons of carbon dioxide equivalent ($MMtCO_2e$). This amount is equal to about one-third of the total electric utility sector emissions reductions required by 2020 to meet the Governor's GHG reduction goals. Further, electricity imports and their associated GHG emissions would be expected to increase if Florida's electricity generation sector was subject to a carbon cap and generation in adjacent states was not subject to a similar requirement.

The Action Team recommends that leakage must be addressed by any cap-and-trade program or by Florida through other means if a regional cap-and-trade program does not do so.

Trial Period

The first recommendations under regional programs are that there should be a strong federal cap-and-trade program and that Florida should be an advocate for national action. It is recommended that a new national program should incorporate a trial period to facilitate the transition, verify data, and sort out administrative and other details. The trial period should afford greater flexibility to the regulated community than would be otherwise allowed, but it should nonetheless impose enforceable, binding compliance obligations on regulated sources.

The second recommendation under regional programs is that Florida should join the RGGI, the WCI, or both. The issue of a trial period in these cases is a matter of regional agreement. Florida should support the trial period requirements (or lack of them) of any regional program it might seek to join.

Federal Program

As stated under regional programs, a strong national cap-and-trade program is preferred over a regional approach. However, for the purpose of initiating GHG emissions reductions sooner than would be possible by waiting for federal action, the recommendation is to join one or more regional programs. By having Florida join a regional program now, the state can influence the design and development of regional rules that will likely influence a national program design.

[9] The Regional Greenhouse Gas Initiative does not address the issue of Leakage within the program design. RGGI recognizes the issue and will monitor inter-regional contracts and purchases to assess whether Leakage is occurring. RGGI has indicated that if leakage proves to be a serious issue, action will be taken to address it.

Joining a regional program will prepare Florida's regulated sources for the requirements and opportunities presented by a national program.

As noted under Reporting, the early success of any program depends in large part on the quality and reliability of emissions data. Florida and federal reporting requirements should be harmonized to minimize the burden on reporting entities.

Assuming a federal program is enacted subsequent to Florida's participation in one or more regional programs, it is not the intention that the two programs—regional and federal—would impose separate and overlapping requirements on regulated sources. Instead, there should be a planned transition from the regional to the national program allowing for the integration of the regional program into the national one, including data transfer, full recognition of allowance value and offsets, and recognition of emissions reductions and compliance schemes.

Implementation Mechanisms

As stated above, these recommendations should be reviewed by the DEP and used as a basis for drafting proposed rules in response to the requirements of the HB 7135. Through the rulemaking process, additional program modeling and economic analysis should be performed to more precisely ascertain costs to regulated entities and consumers, as well as economic benefits from reduced consumption of fossil fuel and other co-benefits. Pursuant to HB 7135, rulemaking should be completed by the end of 2009, and proposed rules should be presented to the Legislature for ratification in 2010.

The recommendation that Florida become an observer to both the RGGI and WCI regional cap-and-trade programs will provide the state with direct access to the ongoing development and implementation of these programs. This will not only provide better information for assessing whether Florida should join one or both programs, it will also afford Florida the benefit of access to their knowledge and experience as the state begins to develop its own rules.

Related Policies/Programs in Place

All GHG mitigation policies and measures within capped sectors have the potential to affect cap-and-trade program costs and benefits. Related programs include RGGI, WCI, and the Midwestern Regional Greenhouse Gas Reduction Accord created by the Midwestern Governors Association (MGA).

Type(s) of GHG Reductions

This may depend upon the sectors included and the program design. At a minimum, carbon dioxide (CO_2) will be reduced. However, a multi-sector program, especially one including industrial emissions, could reduce emissions of all six major GHGs.

Estimated GHG Reductions and Costs or Cost Savings

The model scenarios for Florida joining RGGI include:

- Florida State Goal Scenario
  - Auction price equal to \$7/tCO_2e case
  - Auction price equal to \$1/tCO_2e case
- Florida with RGGI Goal Scenario
  - Auction price equal to \$7/tCO_2e case
  - Auction price equal to \$1/tCO_2e case

The model scenarios for Florida joining WCI include;

- Ten WCI Partners Scenario
- Florida with the Ten WCI Partners Scenario

The simulation results given below are intended to provide basic insight to the economic implications of a cap-and-trade system. They are based on the best available data at the time of the writing of this report. The accuracy of the simulations will be enhanced as more primary data become available. Specifically, the most valuable data additions would provide information on GHG reduction capability and cost for mitigation/sequestration options in RGGI states, and in WCI states for which primary data are not available at this time.

Table B-1-2 presents the cap-and-trade simulation results of Florida joining RGGI and Florida joining WCI. Please see the detailed simulation results table and summary of the analysis findings in Annex 1.

Table B-1-2.

Policy No.	Policy Option	GHG Reductions (MMtCO_2e)				Net Present Value 2009–2025 (Million \$)	Cost-Effective-ness (2020) (\$/tCO_2e)	Level of Support
		2015	2020	2025	Total 2009–2025			
C&T-1	Florida Joining RGGI C&T — Auction price equal to \$7/tCO2e case		75.99				-\$19.95	
	Florida Joining RGGI C&T — Auction price equal to \$1/tCO2e case		70.62				-\$28.09	
	Florida Joining WCI C&T		147.60				-\$5.70	

GHG = greenhouse gas; MMtCO_2e = million metric tons of carbon dioxide equivalent; \$/tCO_2e = dollars per metric ton of carbon dioxide equivalent.

In the auction-based cap-and-trade analysis for Year 2020, at a hypothetical allowance price of \$7/tCO_2e, Florida would choose to reduce around 50 percent of its total emissions from the power sector (or 75.99 MMtCO_2e) by the in-state mitigation options (either through supply-side or demand-side options). Florida would purchase the allowances for the remaining emissions from the auctioneer at the price of \$7/tCO_2e. The total net cost for Florida is -\$1.52 billion, which is the sum of -\$2.04 billion mitigation cost and \$0.52 billion auction cost. The cost-effectiveness with respect to the emission reductions of Florida (dividing the total net cost by the total emission reductions by the state) is -\$19.95/tCO_2e. In the \$1 allowance price scenario, Florida would reduce 46.7 percent emissions (or 70.62 MMtCO_2e) by the in-state mitigation options, and buy the allowances from the auctioneer for any additional emissions. The total net cost for Florida in this scenario is -\$1.98 billion, which is the sum of -\$2.06 billion mitigation cost and \$0.08 billion auction cost. The corresponding cost-effectiveness is -\$28.09/tCO_2e.

In the cap-and-trade analysis of Florida joining the 10 WCI partners in 2020,[10] Florida is the biggest permit seller in the market because the state has many cost-saving mitigation options (e.g., improvements in energy efficiency, RPS, etc.), thus has a relatively flatter cost curve than the WCI average level. The permit price in the market is \$65.55/tCO_2e. Florida would mitigate 38 percent of the total emissions (or 147.60 MMtCO_2e) from the capped sectors and sell 18.46 MMtCO_2e permits to WCI. Washington and California are the biggest permit buyers. Please note the equilibrium permit price is the price of the last permit sold, which is also equal to the price of the last ton of CO_2e mitigated (its marginal mitigation cost). It is the same for each state/province for a given case. The average mitigation cost per unit of CO_2 equivalent (or the cost-effectiveness) in the simulation differs for each state/province. For Florida, it is -\$5.70/tCO_2e. Compared with the pre-trading condition, Florida can save \$191 million in 2020 by joining WCI, a cost saving of around 10.26 percent.

Data Sources

Marginal cost curves for states and provinces are developed directly (1) on the basis of assessment of state-level actions developed through state planning processes in Connecticut, Maryland, Maine, New York, Vermont, Rhode Island, Arizona, California, Montana, New Mexico, Washington, and Florida (developed on the basis of mitigation costs of individual policy options presented in Center for Climate Strategies [CCS] reports or other assessments of the respective state climate change action plans); or (2) by approximation methods for other states/provinces based on cost curves of one of their adjacent states with actual data.

Emission projections data for WCI states/provinces come from the Task 0 database established and maintained by CCS (based on the inventory and forecast studies of respective states and provinces). The emission projections data for RGGI states come from the "Reference Case" document on the RGGI website.

Quantification Methods

The modeling of various cap-and-trade scenarios used a nonlinear programming model of emission allowance trading. This model is based on the well-established principles of the ability

[10] Because of the limitation of time and resources, we have not included Ontario, the newly partner of WCI in the simulations at the time we write this report.

of unrestricted permit trading to achieve a cost-effective allocation of resources in the presence of externalities.[11] The model requires equalization of the marginal cost of all trading participants with the equilibrium permit price. This ensures minimization of total net compliance costs for each state and minimization of total abatement costs for the cap-and-trade program as a whole.[12]

In the auction case, there would be no trading among states. According to the basic rationale for permit trading, in equilibrium, each state would choose to mitigate emissions as long as its marginal abatement cost is lower than or equal to the price of allowances, and purchase any remaining allowance (the difference between the state's BAU level and the amount mitigated by autarkic actions) from the auctioneer.

Please see Annex 2 for the detailed summary of the modeling of the cap-and-trade program and the key assumptions adopted in the analysis.

Key Uncertainties

A number of design variables (including the reduction targets, sectoral coverage, allocation methods, flexibility mechanisms, and level of complementary measures) can affect the simulation results, such as permit prices, in-state mitigation volume, trading volume, and cost savings from joining the cap-and-trade program.

Additional Benefits and Costs

As noted above, the cap-and-trade analysis considers the price paid by those purchasing allowances at auction as a cost in the program. The analysis does not consider any benefits or value derived from the use of those revenues by the state for the purposes recommended in the Allowance Distribution section or any other use.

Feasibility Issues

As noted in the discussion.

[11] See, for example, T. Tietenberg (2007), "Tradable Permits in Principle and Practice," *Moving to Markets: Lessons from Twenty Years of Experience*. in J. Freeman and C. Kolstad (eds). New York: Oxford University Press.

[12] See, for example, B. Stevens and A. Rose (2002), "A dynamic analysis of the marketable permits approach to global warming policy: A comparison of spatial and temporal flexibility," *Journal of Environmental Economics & Management* 44(1):45–69; A. Rose, T. Peterson, and Z. Zhang (2006), "Regional Carbon Dioxide Permit Trading in the United States: Coalition Choices for Pennsylvania," *Penn State Environmental Law Review* 14(2):203–229.

Status of Group Approval

Approved.

Level of Group Support

The cap-and-trade policy recommendations were passed without objection by the Action Team, however separate votes were taken on several specific policies and in two cases there were votes cast in opposition. A sub-recommendation under Allowance Distribution was supported by 13 members present and opposed by five, as noted above. The Action Team also chose to delete a proposed recommendation pertaining to a grace period for fossil-fuel fired power plants scheduled for retirement near the start of the program. One member voted against the removal of this recommendation.

Barriers to Consensus

As noted under Allowance Distribution.

Annex 1. Cap-and-Trade Simulation Results

Analysis of cap-and-trade among Power Sectors of RGGI States and Florida in 2020

This study is based on the use of a Non-linear Programming (NLP) Model capable of analyzing various environmental policy instruments, including cap-and-trade, carbon taxes, and regulations, under a variety of conditions. For cap-and-trade, for example, potential policy refinements include: free granting vs. auctioning, upper limits on permit prices, offsets, banking, etc.

We first simulated a cap-and-trade system for RGGI states plus Florida with free granting of allowances. Because of the extensive availability of low-cost mitigation options, the supply of allowances would exceed the demand at all positive allowance prices. Supply and demand would only be equal at a negative price, which would never prevail in a real world situation; hence allowance trading would not take place.

In usual cap-and-trade cases, where the equilibrium point corresponds to a positive allowance price, auction and free granting would reach the same cost-effectiveness level, for example, the auction price would be at the same level as the equilibrium price in the allowance trading market, and the individual and total CO_2 reductions achieved by the partner states in these two allocation cases would be the same, with the overall emission reduction target of the region being met. The only difference between these two allocation cases would be that the auction can generate revenues to the state government, which in turn can be recycled to fund research and development in clean energy technologies, end-use energy efficiencies, etc., and thus lower the impacts to the electricity ratepayers.

Similar to the free granting case, in a 100 percent auction-based cap-and-trade program, the total mitigation undertaken by the 10 RGGI states plus Florida would exceed the overall cap at all positive allowance prices.

Therefore, in this report we analyze two scenarios with hypothetical positive allowance price levels and evaluate the mitigation and allowance purchase choices of the states in a 100 percent auction-based cap-and-trade. This is consistent with the current operation of RGGI, which calls for most permits to be auctioned.

According to the initial RGGI allowance allocation, Maryland, Maine, New Hampshire, Vermont, and Rhode Island do not have any GHG mitigation obligations, since the allocated allowances to these states (see Column 3 of Table 1) exceed their 2020 BAU emission levels (see Column 2 of Table 1). For the remaining five RGGI states and Florida, which have binding mitigation goals, the reduction target (percent) is computed in Column 4 of Table B-1-1. Please note that the 2020 cap for Florida is computed by interpolating the state's 2017 goal (to return to 2000 levels) and 2025 goal (to return to 1990 levels).

Table B-1-1. RGGI States and Florida 2020 Emission Projections and Caps

	2020 BAU Emissions ($MMtCO_2e$)	Cap/Budget ($MMtCO_2e$)	Reduction Target (%)	Allowance beyond BAU ($MMtCO_2e$)	Reduction Target ($MMtCO_2e$)
CT	13.26	9.09	31.45%	0.00	4.17
DE	11.07	6.43	41.94%	0.00	4.65
MD	31.79	31.88	0.00%	0.09	-0.09
ME	1.90	5.06	0.00%	3.15	-3.15
NH	4.93	7.33	0.00%	2.40	-2.40
NJ	23.40	19.46	16.86%	0.00	3.95
NY	56.11	54.66	2.58%	0.00	1.45
VT	0.03	1.04	0.00%	1.01	-1.01
MA	24.97	22.66	9.26%	0.00	2.31
RI	1.78	2.26	0.00%	0.48	-0.48
FL	151.29	109.97	27.31%	0.00	41.32
Total	320.55	269.83	15.82%	7.13	50.71

* The shaded states, MD, ME, NH, VT, and RI, have allocated allowances higher than their projected 2020 BAU emission levels according to the RGGI States allowances allocation table.

Sources: 1. RGGI States GHG Caps by Year from 2009 to 2018 are provided by Jeff Wennberg from CCS. Numbers for year 2019 and year 2020 are estimated by extrapolating 2014 to 2018 numbers.
2. RGGI states 2020 BAU emission projections are obtained from RGGI website http://www.rggi.org/documents.htm, the Reference Case projections. The 2020 values are computed by interpolating 2018 and 2021 projections.
3. The 2020 cap of Florida is computed by interpolating the state's 2017 goal (to return to 2000 levels) and 2025 goal (to return to 1990 levels). The 2020 BAU emission from the power sector (production-based) is from the draft Florida Inventory and Forecast report by CCS. http://www.flclimatechange.us/Inventory_Forecast_Report.cfm.

In the auction case, we assume the 2020 emission caps for Connecticut, Delaware, New Jersey, New York, Massachusetts, and Florida are the same as shown in Table B-1-1. For Maryland, Maine, New Hampshire, Vermont, and Rhode Island which have excess allowances in the free granting case, we assume their caps in the auction case would equal the state BAU 2020 emission levels (for example, there is no reason to purchase any excess allowances at auction). Table B-1-2 shows the revised Table 1 for the auction case.

In the auction case, there would be no trading among states. According to the basic rationale for permit trading, in equilibrium, each state would choose to mitigate emissions as long as its marginal abatement cost is lower than or equal to the price of allowances, and purchase any remaining allowance (the difference between the state's BAU level and the amount mitigated by autarkic actions) from the auctioneer.

Table B-1-2. RGGI States and Florida 2020 Emission Projections and Caps (in Auction Case)

	2020 BAU Emissions (MMtCO2e)	Cap/Budget (MMtCO2e)	Reduction Target (%)	Allowance beyond BAU (MMtCO2e)	Reduction Target (MMtCO2e)
CT	13.26	9.09	31.45%	0.00	4.17
DE	11.07	6.43	41.94%	0.00	4.65
MD	31.79	31.79	0.00%	0.00	0.00
ME	1.90	1.90	0.00%	0.00	0.00
NH	4.93	4.93	0.00%	0.00	0.00
NJ	23.40	19.46	16.86%	0.00	3.95
NY	56.11	54.66	2.58%	0.00	1.45
VT	0.03	0.03	0.00%	0.00	0.00
MA	24.97	22.66	9.26%	0.00	2.31
RI	1.78	1.78	0.00%	0.00	0.00
FL	151.29	109.97	27.31%	0.00	41.32
Total	320.55	262.70	18.05%	0.00	57.85

Next, we analyze a 100 percent auction-based cap-and-trade case with a hypothetical allowance price at \$7/tCO_2e. Table B-1-3 (Column 4) presents the amount of emissions that can be reduced by each state's autarkic (own) mitigation actions associated with a marginal cost of \$7/tCO_2e (these are computed based on the states' marginal abatement cost curves shown in Figure 1). The simulation results of the auction case with an allowance price equal to \$7/tCO_2e are presented in Table B-1-4. A second simulation with the auction price assumed to be at \$1/tCO_2e is presented in Table B-1-5.

In the auction case, each state would utilize all its mitigation potential with marginal cost less than \$7/tCO_2e before purchasing allowances from the auctioneer, because it would be cheaper for them to reduce emissions than to buy allowances from the auctioneer at seven dollars. As a result, the total emission reductions achieved by the 11 states in this case are 117.81 MMtCO_2. As indicated before, the sum of the mitigations undertaken by the states would exceed the mitigation needed to achieve the cap of the 11 states as a whole at all positive allowance prices.

The total cap of the 11 states is 262.70 MMtCO2e in 2020, or 18.05 percent below the BAU emissions of 320.55 MMtCO2e. The total emission reductions in the $7/tCO2e case are 36.75 percent below BAU, 18.71 percent more than the cap requires. Comparing the numbers in the second column and the fourth column of Table B-1-3, we can see that Connecticut and New Jersey will reduce fewer emissions than the state emissions budget requires. The other nine states would mitigate more than their budgets require. Cumulatively, the 11 states would mitigate emissions 59.96 MMtCO2e more than the total cap indicates. The basic rationale is that it is cheaper to mitigate than to buy an auctioned permit for a broad range of emission levels.

As shown in Table B-1-4, because of the availability of large cost saving mitigation potentials, mitigation cost for all the 11 states are negative. The auction cost is computed by multiplying the amount of allowances the state buys from the auctioneer by the allowance price. The total net cost of a state is the sum of its mitigation cost and the auction cost. Most states have negative total net cost, which indicates overall cost savings from joining the auction-based cap-and-trade program. The total cost savings for Florida in the $7/tCO2e auction price case are $1.5 billion.

Comparing the two auction cases with auction prices at seven dollars and one dollar, the amount the states choose to reduce by mitigation options (117.81 MMtCO_2 vs. 110.60 MMtCO_2, respectively) and the amount to be bought from the auctioneer (202.74 MMtCO_2 vs. 209.95 MMtCO_2, respectively) differ slightly. However, the results show that when the allowance price is lower, the states would choose to reduce fewer emissions on their own and purchase more allowances from the auctioneer. The biggest difference between these two cases is the total auction cost. This is due primarily to the difference of the two auction price levels. In addition, Delaware shifts to the list of states that mitigate less than their budget requires. Cumulatively, the 11 states would mitigate emissions 16.46 percent or 52.75 MMtCO2e more than the total cap indicates.

The recycling or use of the auction revenues by the government is not evaluated in this study; therefore the price paid for allowances purchased at auction is treated simply as a cost.

Table B-1-3. Mitigation Potential Associated with MC=$7/tCO2e

	Reduction Target (MMtCO2)	In-state Reduction Potential with MC<= $7 (%)	In-state Reduction Potential with MC<= $7 (MMtCO2)
CT	4.17	5.78%	0.77
DE	4.65	44.17%	4.89
MD	0.00	53.34%	16.96
ME	0.00	39.92%	0.76
NH	0.00	6.78%	0.33
NJ	3.95	8.49%	1.99

NY	1.45	5.44%	3.05
VT	0.00	100.00%	0.03
MA	2.31	47.72%	11.92
RI	0.00	62.95%	1.12
FL	41.32	50.23%	75.99
Total	57.85	36.75%	117.81

Table B-1-4. Simulation Results of an Auction Case among RGGI States and Florida (with assumed auction price at \$7/tCO₂)

State	Total BAU Emissions in 2020 (million tCO2e)	2020 Emissions Cap/Budget (million tCO2e)	Emission Reduction Undertaken by the State[a]		Mitigation Cost (million dollars)	Emission Allowances Bought from Auctioneer (million tCO2e)	Auction Cost (million dollars)[b]	Net Cost (million dollars)[c]
			(percent from BAU)	(million tCO_2e)				
CT	13.26	9.09	5.78	0.77	-49.64	12.50	87.47	37.83
DE	11.07	6.43	44.17	4.89	-164.01	6.18	43.28	-120.73
MD	31.79	31.79	53.34	16.96	-617.74	14.83	103.83	-513.91
ME	1.90	1.90	39.92	0.76	-41.36	1.14	8.00	-33.36
NH	4.93	4.93	6.78	0.33	-25.67	4.59	32.16	6.48
NJ	23.40	19.46	8.49	1.99	-313.93	21.42	149.92	-164.01
NY	56.11	54.66	5.44	3.05	-573.12	53.06	371.43	-201.69
VT	0.03	0.03	100.00	0.03	-2.34	0.00	0.00	-2.34
MA	24.97	22.66	47.72	11.92	-692.28	13.06	91.40	-600.88
RI	1.78	1.78	62.95	1.12	-61.32	0.66	4.61	-56.71
FL	151.29	109.97	50.23	75.99	-2,043.35	75.30	527.08	-1,516.27
Total	320.55	262.70	36.75	117.81	-4,584.78	202.74	1,419.17	-3,165.61

[a] In equilibrium, each state will choose to mitigate to the level at which its marginal abatement cost equals the auction price.

[b] We assume the auction price is \$7/tCO2e in this case.

[c] Sum of Mitigation Cost and Auction Cost.

Table B-1-5. Simulation Results of an Auction Case among RGGI States and Florida (with assumed auction price at \$1/tCO₂e)

State	Total BAU Emissions in 2020 (million tCO2e)	2020 Emissions Cap/Budget (million tCO2e)	Emission Reduction Undertaken by the State[a]		Mitigation Cost (million dollars)	Emission Allowances Bought from Auctioneer (million tCO2e)	Auction Cost (million dollars)[b]	Net Cost (million dollars)[c]
			(percent from BAU)	(million tCO_2e)				
CT	13.26	9.09	5.54	0.73	-49.77	12.53	12.53	-37.24
DE	11.07	6.43	41.46	4.59	-165.20	6.48	6.48	-158.72
MD	31.79	31.79	50.49	16.05	-621.34	15.74	15.74	-605.60
ME	1.90	1.90	38.28	0.73	-41.49	1.17	1.17	-40.31
NH	4.93	4.93	6.54	0.32	-25.72	4.61	4.61	-21.11
NJ	23.40	19.46	8.34	1.95	-314.07	21.45	21.45	-292.62
NY	56.11	54.66	5.35	3.00	-573.31	53.11	53.11	-520.20
VT	0.03	0.03	100.00	0.03	-2.34	0.00	0.00	-2.34

MA	24.97	22.66	45.96	11.48	-694.03	13.50	13.50	-680.54
RI	1.78	1.78	60.81	1.08	-61.47	0.70	0.70	-60.78
FL	151.29	109.97	46.68	70.62	-2,064.65	80.67	80.67	-1,983.98
Total	320.55	262.70	34.50	110.60	-4,613.38	209.95	209.95	-4,403.44

[a] In equilibrium, each state will choose to mitigate to the level at which its marginal abatement cost equals the auction price.

[b] We assume the auction price is $1/tCO2e in this case.

[c] Sum of Mitigation Cost and Auction Cost.

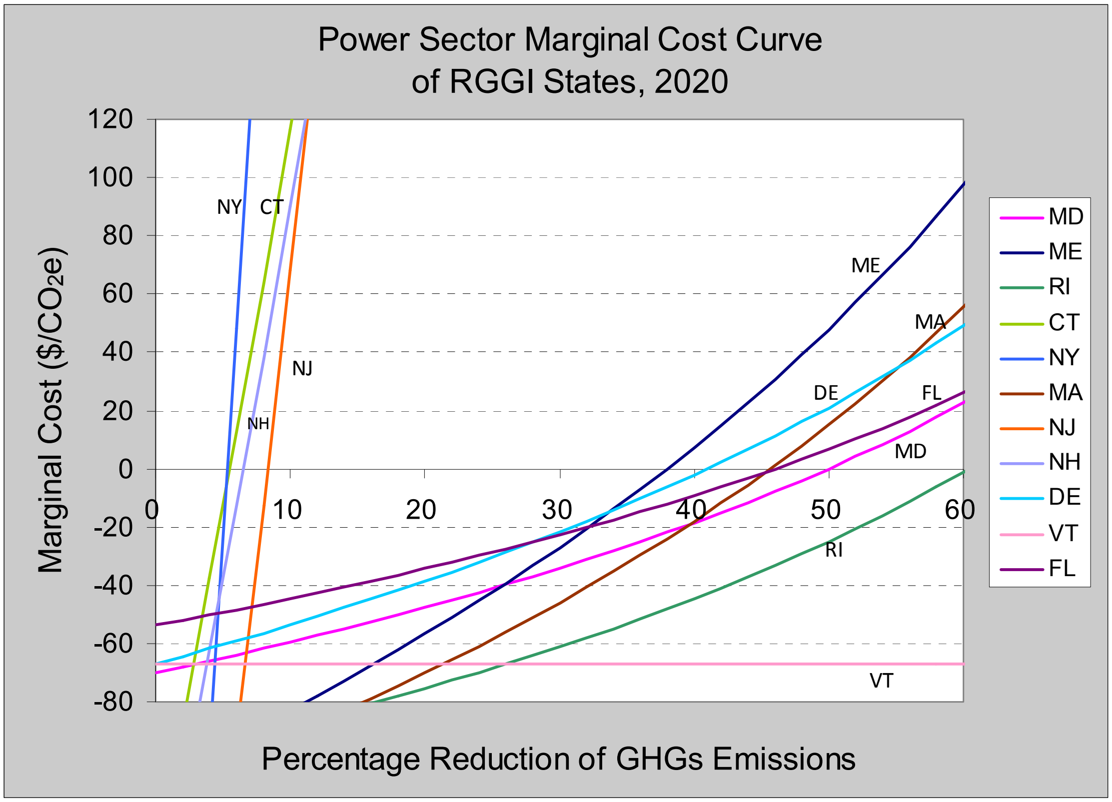

Figure B-1-1. State Marginal Cost Curves of Power Sector, 2020

Notes: 1. Marginal cost curves of CT, MD, ME, NY, VT, RI, and FL are developed based on mitigation options data of these states (from state final or drafted climate action plans).
2. The marginal cost curves of the states are developed based on the reduction potential and mitigation cost/saving data of individual options that contribute to the emission reductions from power sector. These options not only include those designed directly for the electricity supply sector (such as promotion of renewable energy utilization, repowering existing plants, generation performance standards, etc.), but also include options in RCI sectors that contribute to the reduction of electricity consumption (for example demand-side management, energy efficiency appliances, building codes, etc.). The emission reduction potentials of these options are adjusted by multiplying the percentage of electricity consumption to total energy consumption in the RCI sector. RCI options that relate entirely to reduction of other fossil fuels consumption (such as gas, oil) are not included in the cost curves above.
3. There are no direct data for MA, NJ, NH, and DE. Marginal cost curves for these four states are developed based on cost curves of four reference states RI, NY, CT, and MD, respectively. For each of the four states that lack the direct data, mitigation cost/saving data for the reference state is adopted. Emission reduction potential data of the reference state is adjusted by the weights of emissions from the ES and R, C, I sectors of the state under estimation.

Sources: 1. Connecticut Governor's Steering Committee on Climate Change. 2005. *2005 CT Climate Change Action Plan*. http://www.ctclimatechange.com/StateActionPlan.html.
2. Maryland Commission on Climate Change. 2008. *Maryland Climate Change Action Plan*. http://www.mdclimatechange.us/index.cfm.
3. Maine Department of Environmental Protection. 2004. *Final Maine Climate Action Plan 2004*. http://www.maine.gov/dep/air/greenhouse/.
4. Center for Clean Air Policy and New York GHG Task Force. 2003. *Recommendations to Governor Pataki for Reducing New York State Greenhouse Gas Emissions*. http://www.ccap.org/pdf/04-2003_NYGHG_Recommendations.pdf

5. Rhode Island Greenhouse Gas Process. 2002. *Rhode Island Greenhouse Gas Action Plan*. http://righg.raabassociates.org/.
6. Vermont Governor's Commission on Climate Change. 2007. *Final Report and Recommendations of the Governor's Commission on Climate Change*. http://www.anr.state.vt.us/air/Planning/htm/ClimateChange.htm.
7. FloridaGovernor's Action Team on Energy and Climate Change. 2008. *ESD Policy Options Document*. http://www.flclimatechange.us/ee.cfm.

In the above analysis, we have assumed the Florida 2020 cap is equal to its state goal (interpolation of the state 2017 and 2025 goals). Next, we would look at the scenario in which Florida has the same 2020 cap as the RGGI states as whole, which is 10 percent below current (2008) levels. Table B-1-6 is very similar to Table B-1-2, except for the Florida and Total rows. The RGGI goal of 10 percent below 2008 levels translates to 119.44 MMtCO_2e emissions budget to Florida (compared with the 109.97 MMtCO_2e budget in the Florida state goal scenario).

Table B-1-6. RGGI States and Florida 2020 Emission Projections and Caps (in Auction Case, with Florida following RGGI goal)

	2020 BAU Emissions (MMtCO2)	Cap/Budget (MMtCO2)	Reduction Target (%)	Allowance beyond BAU (MMtCO2)	Reduction Target (MMtCO2)
CT	13.26	9.09	31.45%	0.00	4.17
DE	11.07	6.43	41.94%	0.00	4.65
MD	31.79	31.79	0.00%	0.00	0.00
ME	1.90	1.90	0.00%	0.00	0.00
NH	4.93	4.93	0.00%	0.00	0.00
NJ	23.40	19.46	16.86%	0.00	3.95
NY	56.11	54.66	2.58%	0.00	1.45
VT	0.03	0.03	0.00%	0.00	0.00
MA	24.97	22.66	9.26%	0.00	2.31
RI	1.78	1.78	0.00%	0.00	0.00
FL	151.29	119.44	21.05%	0.00	31.85
Total	337.97	274.25	18.86%	0.00	63.72

With the same hypothetical allowance price levels ($7/t$CO_2$e and $1/t$CO_2$e) as in the previous scenario (Florida state goal scenario), the amount of emissions the state chooses to mitigate and the amount of allowances it purchases from the auctioneer are the same as before. Therefore, the simulation results of the scenario in which Florida follows the RGGI goal are same as the results shown in Tables B-1-4 and 5 (except for the third column in Tables B-1-4 and 5 which shows the 2020 emissions cap/budget). The percentages of emissions Florida chooses to mitigate are 50.23 percent (or 75.99 MMtCO_2e) in the $7 case and 46.68 percent (or 70.62 MMtCO_2e) in the $1 case, respectively. These are same in the two scenarios. However, since Florida has less stringent mitigation target in the RGGI goal scenario than in the state goal scenario (21.05 percent vs. 27.31 percent, or 31.85 MMtCO_2e vs. 41.32 MMtCO_2e below 2020 BAU), the only difference in these two scenarios is that Florida would reduce even more emissions than required by its emissions budget in the RGGI goal scenario.

Development of the Power Sector Marginal Cost Curve for Florida

The Florida power sector marginal cost curve is developed based on the reduction potential and mitigation cost/saving data of individual options that contribute to the emission reductions from power sector. These options not only include those designed directly for the electricity supply sector (such as promotion of renewable energy utilization, power plant efficiency improvements, etc.), but also include options in residential, commercial, and industrial sectors that contribute to the reduction of electricity consumption (for example, demand-side management, energy efficiency appliances, building codes, etc.). Therefore, we collected the 2020 GHG reduction potential and mitigation cost/saving data of individual options that are quantitatively analyzed by the ESD (Energy Supply and Demand) Technical Working Group. Table B-1-7 presents the list of these options. Please note these are only preliminary analysis results; they are subject to change with the undergoing concurrent stakeholder process.

Table B-1-7. ESD Sector GHG Mitigation Options of Florida

Sector	Climate Mitigation Actions	Estimated 2020 Annual GHG Reduction Potential (MMtCO2e)	Estimated Cost or Cost Savings per ton GHG Removed	GHG Reduction Potential as Percentage of 2020 Baseline Emissions[1]	Cumulative GHG Reduction Potential	Weights (add-up to 100)
ESD-12	Demand-Side Management (DSM)/Energy Efficiency Programs, Funds, or Goals for Electricity	17.50	-$43.69	11.57%	11.57%	20.45
ESD-14	Improved Building Codes for Energy Efficiency[2]	11.32	-$32.33	7.48%	19.05%	13.23
ESD-5	Renewable Portfolio Standard (RPS) Option 1: 20% by 2020	29.48	-$29.08	19.49%	38.54%	34.46
ESD-13a	Energy Efficiency in Existing Residential Buildings	4.55	-$28.69	3.01%	41.55%	5.32
ESD-9	Power Plant Efficiency Improvements	11.25	-$14.12	7.43%	48.98%	13.14
ESD-11	Waste-To-Energy (WTE)[3]	0.18	$1.45	0.12%	49.10%	0.21
ESD-8	Combined Heat and Power (CHP) Systems	2.09	$5.11	1.38%	50.48%	2.45
ESD-6	Nuclear Power	9.18	$36.41	6.07%	56.55%	10.73

[1] The Florida production-based emissions from power sector in 2020 are 151.3 MMtCO2e.
[2] This is a recent action additional to the recommended policy options. We include this option in the list to develop the cost curve since it is not included in the baseline emission forecast.
[3] The total GHG emission reduction potentials of this option are 5.5 MMtCO2e in 2020. However, only about 4.21 percent or 0.18 MMtCO2e are the avoided emissions from electricity generation. The remaining reductions come from the avoided emissions from landfill methane capture.

In Table B-1-7, Column 3 presents the estimated 2020 annual GHG reduction potential for each option, with reduction potentials translated into percentages of the 2020 BAU emissions level in Column 5. The estimated cost or cost saving per ton of GHG removed by each option in 2020 is presented in Column 4. The options are ordered in ascending sequence in terms of cost, beginning with the cheapest option. Column 6 calculates the cumulative GHG reduction potentials of the first *n* policy options listed in the table. The last column presents the proportion of GHG mitigation contributed by each option.

Based on the data presented in Table B-1-7, the stepwise marginal cost function of Florida power sector in 2020 is first drawn in Figure B-1-2. The horizontal axis represents the percentage of GHG emissions reduction, and the vertical axis represents the marginal cost or savings of mitigation. In the figure, each horizontal segment represents an individual mitigation option. The width of the segment indicates the GHG emission reduction potential of the option in percentage terms. The height of the segment relative to the X-axis shows the average cost (saving) of reducing one ton of GHG with the application of the option.

Next, we fit a smooth curve through the data using statistical analysis (also see Figure B-1-2). We weight each policy option based on its GHG mitigation potential to give relatively greater influence to those options that have the potential for higher levels of application. This fitted curve is then used in our cap-and-trade analysis model.

The fitted curve shown in Figure A1 has the following functional form:

$$MC = a + b \times \ln(1 - R)$$

Where, *MC* is the marginal cost; *R* is the percentage reduction of GHG emissions; *a* and *b* are parameters.

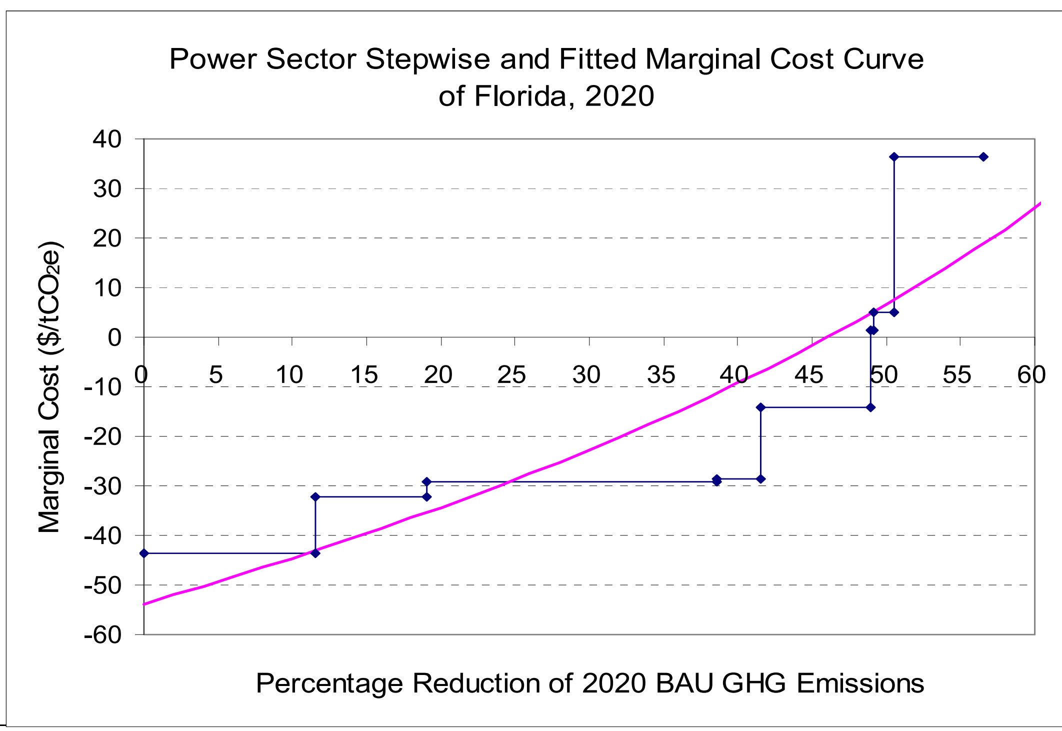

Figure B-1-2. Stepwise and Fitted Marginal Cost Curve of Florida Power Sector, 2020

The logarithmic functional form utilized here is consistent with theoretical expectations and empirical findings on diminishing returns of emission control (Nordhaus, 1991; 1994). As the emission reductions increase along the X-axis, the cost to reduce one additional unit of emission is increasing in an accelerating speed.

The marginal cost curve of Florida power sector has the following specification:

$$MC = -53.77 - 87.09 \times \ln(1 - R)$$

The fitted curve has an intercept with the Y-axis at MC = -$53.77. The curve increases to MC=0 at the emission reduction level of 46 percent, which indicates that Florida power sector has cost-saving mitigation potentials up to the level of about 46 percent of the 2020 BAU emissions.

Analysis of Florida Joining the WCI Cap-and-Trade Program in 2020

This study presents the preliminary simulation results of Florida joining the cap-and-trade program of WCI. For the detailed specification of our cap-and-trade model, the methodology we used to develop the marginal cost curves of states/provinces, and the general assumptions we adopted in the modeling, please refer to the summary "Modeling of cap-and-trade Program" by Adam Rose and Dan Wei.

The eleven WCI partners include seven U.S. states: Arizona, California, Montana, New Mexico, Oregon, Utah, and Washington; and four Canadian provinces: British Columbia, Manitoba, Ontario and Quebec.[13] The WCI cap-and-trade program has a broad sectoral coverage, which includes electric sector, residential/commercial fuel uses, large stationary combustion sources, industrial process, fossil fuel production and processing, and transportation fuels (basically all sectors except agriculture, forestry, and waste management). The WCI 2020 regional reduction target is 15 percent below its 2005 GHG emissions level. According to the findings by the WCI Economic Modeling Team, nearly one-third of the WCI total emission reduction requirement could be achieved by the reductions from the non-WCI WECC power sector (under the First Jurisdictional Deliverer (FJD) approach proposed for the WCI cap and trade program, the portion of emission reductions that relate to the imported electricity to WCI should be reflected as the WCI BAU reductions). Therefore, in our analysis we assumed that for each WCI partner, the in-state (or in-province) emission reduction goal would be 10 percent below 2005 level by year 2020. This regional target is applied to each of the ten WCI partners in our analysis.

We first simulated the cap-and-trade among the current ten WCI partners (see Table B-1-8). The simulation assumes that the permits are grandfathered. The second column in the table shows the mitigation cost for each partner to achieve the reduction target before it enters the cap-and-trade program, for example, the cost of each state's own mitigation activities to achieve the reduction goal. Negative numbers in this column indicate overall cost savings. The next three columns (columns 3 to 5) show the mitigation cost, trading cost, and net cost (the sum of mitigation cost and trading cost) after the partners enter the cap-and-trade program. Partners that have relatively high mitigation costs will accomplish only part of their reduction obligation by their own mitigation activities, and purchase the remaining permits in the market. Partners that have relatively low costs will have the incentive to mitigate more than their reduction targets indicate, so that they can sell their surplus permits to other partners at a profit. In the Trading Cost column, negative numbers represent revenues from selling permits. Next, the difference in the net cost between the before trading and after trading conditions is presented in the Cost Saving column (column 6). The next two columns (columns 7 and 8) show the permits purchased/sold by each partner and the emissions reduced by in-state mitigation activities in

[13] The Province of Ontario recently joined as a WCI Partner. Time did not permit revisions to this analysis to include Ontario, and it is likely that these results will change somewhat when Ontario is added. References to the 'ten' WCI partners therefore indicate the fact that Ontario is not included.

quantity terms. The last two columns (columns 9 and 10) show and compare the emission reductions in percentage terms with and without trading for each partner, respectively.

Table B-1-9 presents the simulation results for Florida joining the WCI cap-and-trade program.

Table B-1-10 presents the 2020 baseline emissions, the emission budget (capped emissions), and reduction target in percentage terms for the WCI partners and Florida in the first three numerical columns. Please note that the 2020 emission budget for Florida is computed by interpolating the state's 2017 goal (to return to 2000 levels) and 2025 goal (to return to 1990 levels). The last column in this table shows the autarkic (own) marginal mitigation cost level for each state/province to meet the emission budget.

Figure B-1-3 shows the marginal cost curves for all the states and provinces included in this study.

Summary of the findings from the simulations:

1. The factors that have the greatest influence on all simulations are the absolute levels and the relative levels of the marginal mitigation cost curves. The former has the greatest influence on the potential for cost savings, while the latter has the greatest influence on the extent of permit trading across trading states/provinces, including whether each state/province is a permit buyer or seller.

2. For many WCI partners and Florida, the total cost of achieving the carbon emission caps is negative. This means that compliance with the caps will result in overall cost savings. This result is due to the existence of an extensive range of cost-saving options, such as improvements in energy efficiency.

3. Before Florida joins WCI, the permit price of the cap-and-trade program among the 10 WCI partners is $78.18/tCO2e. Washington is the biggest permit buyer in the market, followed by California. New Mexico is the biggest permit seller.

4. Because Florida has a marginal cost curve flatter than the WCI average level, when it joins the WCI, the permit price decreases to $65.55/tCO2e. Florida is the biggest permit seller in the market, followed by New Mexico. Again, Washington is the biggest permit buyer in the market, followed by California.

5. The Florida 2020 state emission reduction goal (which is the interpolation of the state 2017 and 2025 goals) translates to 33.57 percent below the 2020 baseline emissions level of the cap-and-trade covered sectors. Since Florida is projected to be a permit seller in the market, the state will mitigate more emissions (around 18.46 MMtCO2e) than the state goal indicates. The surplus permits are sold in the open market and Florida would earn profits from the trading.

6. In both simulation cases, if we compare the net cost of each state/province after trading with the corresponding element in the column before trading, we find that all states/provinces are better off as a result of participating in trading, since all the post-trading net costs are smaller than the pre-trading costs. The cost saving amount is shown in the Cost Saving column in the result tables (Table B-1-8 and Table B-1-9). Compared with the pre-trading condition, Florida can save $191 million in 2020 by joining WCI, a cost saving of around 10.26 percent.

TABLE B-1-8. EMISSION TRADING SIMULATION AMONG WCI PARTNERS IN YEAR 2020[a,b] (million dollars or otherwise specified)

State	Before Trading	After Trading			Cost Saving	Permits Traded	Emission Reduction w/ Trading		Emission Reduction Goal
	Mitigation Cost ($)	Mitigation Cost	Trading Cost	Net Cost		(million tCO_2e)	(million tCO_2e)	(percent from BAU)	(percent from BAU)
AZ	-789	-669	-124	-793	4	-1.59	72.61	46.92	45.89
CA	-17,613	-18,400	669	-17,731	118	8.56	143.40	25.68	27.21
MT	-213	34	-459	-425	212	-5.88	13.61	40.59	23.06
NM	-372	301	-1,068	-767	395	-13.66	37.91	45.96	29.40
OR	635	-164	514	350	285	6.57	15.05	19.19	27.57
UT	-100	104	-227	-123	23	-2.91	32.41	37.56	34.19
WA	1,781	-387	1,111	724	1,056	14.21	20.92	18.36	30.84
BC	-451	-310	-168	-478	27	-2.15	17.85	26.06	22.92
MB	-345	-261	-148	-409	64	-1.89	7.31	42.76	31.69
QC	-4,010	-3,935	-99	-4,034	24	-1.27	20.24	24.41	22.88
Total	-21,479	-23,687	0	-23,687	2,208	29.34[c]	381.30	29.87	29.87

tCO_2e = metric tons of carbon dioxide equivalent; BAU = business as usual.

Permit Price = $78.18/$tCO_2e$.

[a] Sector coverage: Electric sector (Consumption-based) + Residential/Commercial fuel use + Large stationary combustion sources + Industrial process + Fossil fuel production and processing + Transportation fuels. AFW (Agriculture, Forestry, and Waste Management) sector is excluded from the sector coverage.
[b] The cap for WCI partners is 15 percent below 2005 level by year 2020. According to the findings by the WCI Economic Modeling Team, nearly one third of the WCI total emission reduction requirement could be achieved by the reductions from the non-WCI WECC power sector. Therefore, in our analysis we assumed that for each WCI partner, the in-state (or in-province) emission reduction goal would be 10 percent below 2005 level by year 2020.
[c] Represents number of permits bought or sold.

TABLE B-1-9. EMISSION TRADING SIMULATION AMONG WCI PARTNERS AND FLORIDA IN YEAR 2020[a,b] (million dollars or otherwise specified)

State	Before Trading	After Trading			Cost Saving	Permits Traded	Emission Reduction w/ Trading		Emission Reduction Goal
	Mitigation Cost	Mitigation Cost	Trading Cost	Net Cost		(million tCO_2e)	(million tCO_2e)	(percent from BAU)	(percent from BAU)
AZ	-789	-975	175	-800	10	2.67	68.35	44.16	45.89
CA	-17,613	-18,685	821	-17,864	251	12.53	139.43	24.97	27.21
MT	-213	-35	-322	-357	144	-4.91	12.64	37.72	23.06
NM	-372	100	-712	-612	240	-10.86	35.11	42.57	29.40
OR	635	-236	496	260	374	7.57	14.05	17.92	27.57
UT	-100	-65	-36	-101	1	-0.55	30.06	34.83	34.19
WA	1,781	-479	1,016	537	1,244	15.50	19.64	17.24	30.84
BC	-451	-387	-71	-458	7	-1.08	16.78	24.50	22.92
MB	-345	-285	-102	-387	43	-1.56	6.97	40.79	31.69
QC	-4,010	-3,965	-55	-4,021	10	-0.84	19.81	23.89	22.88
FL	-1,860	-841	-1,210	-2,051	191	-18.46	147.60	38.37	33.57
Total	-23,339	-25,853	0	-25,853	2,515	17.13[c]	510.45	30.73	30.73

tCO_2e = metric tons of carbon dioxide equivalent; BAU = business as usual.

Permit Price = \$65.55/tCO_2e. This is the price of the last permit sold, which is also equal to the price of the last ton of CO_2e mitigated (its *marginal* mitigation cost). It is the same for each state/province for a given case. The *average* mitigation cost per unit of CO_2 equivalent in the simulation differs for each state/province. For FL, for example, it is -\$5.7/tCO_2e. Please note that the average mitigation cost is related to mitigation level of a state/province, which for this case is 38.37 percent below the baseline level in 2020 for FL. Multiplying the average mitigation cost by the number of tons of CO_2 mitigated will equal the *total* mitigation cost for each state/province shown in the second numerical column in the table.

[a] Sector coverage: Electric sector (Consumption-based) + Residential/Commercial fuel use + Large stationary combustion sources + Industrial process + Fossil fuel production and processing + Transportation fuels. AFW (Agriculture, Forestry, and Waste Management) sector is excluded from the sector coverage.
[b] The cap for WCI partners is 15 percent below 2005 level by year 2020. According to the findings by the WCI Economic Modeling Team, nearly one third of the WCI total emission reduction requirement could be achieved by the reductions from the non-WCI WECC power sector. Therefore, in our analysis we assumed that for each WCI partner, the in-state (or in-province) emission reduction goal would be 10 percent below 2005 level by year 2020.
[c] Represents number of permits bought or sold.

TABLE B-1-10. DATA TABLE

State	2020 BAU Gross Emissions (Consumption-based)[a] ($MMtCO_2e$)	Emissions Cap in 2020[b] ($MMtCO_2e$)	GHG Mitigation Goal in 2020 (relative to BAU emissions)	Autarkic Marginal Mitigation Cost ($\$/tCO_2e$)
AZ	154.8	83.7	45.89%	73.4
CA	558.5	406.5	27.21%	105.8
MT	33.5	25.8	23.06%	9.0
NM	82.5	58.2	29.40%	22.8
OR	78.4	56.8	27.57%	166.6
UT	86.3	56.8	34.19%	62.7
WA	113.9	78.8	30.84%	231.0
BC	68.5	52.8	22.92%	53.1
MB	17.1	11.7	31.69%	12.1
QC	82.9	63.9	22.88%	40.9
FL	384.7	255.5	33.57%	45.1
Total	1,661.1	1,150.6	30.73%	

BAU = business as usual; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; GHG = greenhouse gas; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

[a] Sector coverage: Electric sector (Consumption-based) + Residential/Commercial fuel use + Large stationary combustion sources + Industrial process + Fossil fuel production and processing + Transportation fuels. AFW (Agriculture, Forestry, and Waste Management) sector is excluded from the sector coverage.
[b] The cap for WCI partners is 15 percent below 2005 level by year 2020. According to the findings by the WCI Economic Modeling Team, nearly one third of the WCI total emission reduction requirement could be achieved by the reductions from the non-WCI WECC power sector. Therefore, in our analysis we assumed that for each WCI partner, the in-state (or in-province) emission reduction goal would be 10 percent below 2005 level by year 2020. The 2020 cap for Florida is computed by interpolating the state's 2017 goal (to return to 2000 levels) and 2025 goal (to return to 1990 levels).

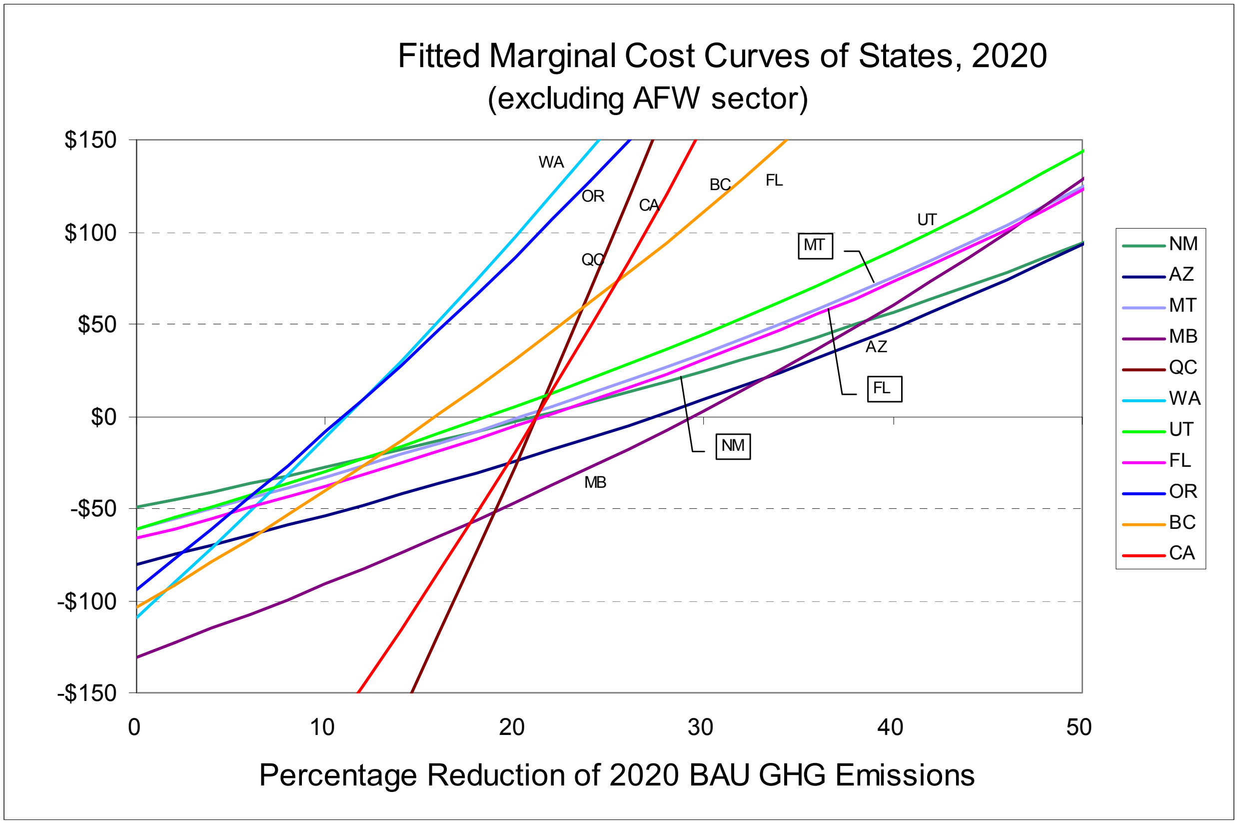

Figure B-1-3.

AFW = agriculture, forestry, and waste management; BAU = business as usual; GHG = greenhouse gas.

Notes: 1. Marginal cost curves of AZ, CA, MT, NM, WA, and FL are developed based on mitigation options data of these states (from state final or draft climate action plans).
2. Marginal cost curves of OR, BC, MB, and QC are developed based on WA, WA, MN, and CT 2020 curves, respectively. UT only has mitigation options data available for residential/commercial/industrial sector and the transportation sector. The state emission mitigation potentials and costs for the energy supply sector are approximated from New Mexico data.
3. The following assumptions are adopted when we develop the cost curve for one state based on the data from one of its adjacent states. We assume that the list of mitigation options for the adjacent state (state A) is applicable to the state without direct data (state B). Second, for state B, the estimated cost or cost savings per unit GHG removed for each option is assumed to be at the same level as that of state A. Third, the mitigation potentials of each option are assumed to be proportional to the total mitigation potential in each state; this requires that each option be adjusted by the ratio of emissions from the relevant sector of the two states. For example, if the emissions from the power sector are 50 MMtCO2e and 100 MMtCO2e in state A and state B, respectively, the mitigation potentials of the ES options for state A are multiplied by a factor of 2 (100/50=2) for application to state B.

Data Sources:

GHG Mitigation Options Data:
1. Arizona Climate Change Advisory Group. 2006. *Climate Change Action Plan*. http://www.azclimatechange.gov/.
2. California Air Resources Board. 2008. *Climate Change Draft Scoping Plan (June 2008 Discussion Draft)*. http://www.arb.ca.gov/cc/scopingplan/document/draftscopingplan.pdf.

3. Montana Climate Change Advisory Committee. 2007. *Montana Climate Change Action Plan*. http://www.mtclimatechange.us/CCAC.cfm.
4. New Mexico Climate Change Advisory Group. 2006. *NM Climate Change Action Plan*. http://www.nmclimatechange.us/.
5. Washington Climate Advisory Team. 2008. *2008 Climate Change Interim Report—Leading the Way on Climate Change: The Challenge of Our Time*. http://www.ecy.wa.gov/climatechange/interimreport.htm.
6. Geller, H., Baldwin, S., Case P., Emerson, K., Langer, T., and Wright, S. 2007. *Utah Energy Efficiency Strategy: Policy Options*. http://www.swenergy.org/pubs/UT_Energy_Efficiency_Strategy.pdf.
7. Florida Governor's Action Team on Energy and Climate Change. 2008. *ESD Policy Options Document*. http://www.flclimatechange.us/ee.cfm.

Emissions Inventory and Forecast Data:
For WCI Partners: Williams and Roe. 2008. "Task 0 State-Provincial GHG Summaries Tech Memo 1-31-08.doc" and associated Excel workbooks (including data from Western State GHG plans and WRAP database), as updated by Partner feedback through 6-19-08.
For Florida: Draft Florida Inventory and Forecast Analysis by CCS. http://www.flclimatechange.us/Inventory_Forecast_Report.cfm.

Development of the Marginal Cost Curve for Florida

The Florida marginal cost curve is developed based on the reduction potential and mitigation cost/saving data of individual mitigation options in the sectors that are covered by the cap-and-trade program. Since the sectoral coverage of the WCI cap-and-trade program includes basically all sectors except agriculture, forestry, and waste management sectors, we collected the 2020 Florida GHG reduction potential and mitigation cost/saving data of individual options that are quantitatively analyzed by the ESD and TLU TWGs. Please note, at the time we undertook this research, only 8 out of the 12 ESD Tier 1 options had been quantified with respect to their range of applications and costs. Therefore, we could not formally include the 4 un-quantified ESD Tier 1 options and 7 options listed, but not quantified, as ESD Tier 2 options in the ESD TWG Policy Description Document. Three TLU options are not quantified by their TWG as well, and are therefore also not formally included in the list below. Table B-1-11 presents only the list of options that have been analyzed by the TWGs in a quantitative manner. The options not quantified by their TWGs would further enhance the State's mitigation potential and likely at costs within the range presented below.

Based on the data presented in Table B-1-11, the stepwise marginal cost function of Florida in 2020 is first drawn in Figure B-1-11. Next, we fit a smooth curve through the data using statistical analysis (also see Figure B-1-4). The same functional form is used:

$$MC = a + b \times \ln(1 - R)$$

Where, MC is the marginal cost; R is the percentage reduction of GHG emissions; a and b are parameters.

Table B-1-11. ESD and TLU Sectors GHG Mitigation Options of Florida

Sector	Climate Mitigation Actions	Estimated 2020 Annual GHG Reduction Potential (MMtCO2e)	Estimated Cost or Cost Savings per ton GHG Removed	GHG Reduction Potential as Percentage of 2020 BAU Emissions[1]	Cumulative GHG Reduction Potential	Weights (add-up to 100)
TLU 2	Add-on Technologies for Existing Vehicles and New Vehicles	1.21	-$90.00	0.31%	0.31%	1.137
ESD-12	Demand-Side Management (DSM)/Energy Efficiency Programs, Funds, or Goals for Electricity	17.50	-$43.69	4.55%	4.86%	16.440
ESD-14	Improved Building Codes for Energy Efficiency	11.32	-$32.33	2.94%	7.81%	10.640
ESD-5	Renewable Portfolio Standard (RPS) Option 2: 20% by 2025	29.48	-$29.08	7.66%	15.47%	27.699
ESD-13a	Energy Efficiency in Existing Residential Buildings	4.55	-$28.69	1.18%	16.65%	4.279
ESD-9	Power Plant Efficiency Improvements	11.25	-$14.12	2.92%	19.58%	10.567
TLU-1a	Develop and Expand Alternative and Renewable Fuels	8.61	-$14.00	2.24%	21.81%	8.088
ESD-11	Waste-To-Energy (WTE)	5.54	$1.45	1.44%	23.26%	5.210
ESD-8	Combined Heat and Power (CHP) Systems	2.09	$5.11	0.54%	23.80%	1.966
TLU 4	Improving Transportation System Management	4.55	$12.91	1.18%	24.98%	4.275
ESD-6	Nuclear Power	9.18	$36.41	2.39%	27.37%	8.629
TLU-8	Increase Freight Movement Efficiencies	0.63	$48.00	0.16%	27.53%	0.592
TLU 5	Increasing Choices in Modes of Transportation	0.51	$256.71	0.13%	27.67%	0.479

Note: Table B-1-11 only includes climate change mitigation options that are analyzed by the TWGs thus far. Not all the options recommended by the TWGs have been quantified for emission reduction potentials and cost-effectiveness. However, there is no question that these options would attain additional 10 percent CO2e reductions with respect to the state baseline emissions. Moreover, the cost of these un-quantified options would fall into the cost range for the options that have been analyzed. Therefore, we anticipate that Florida would have higher total emission reduction potentials from the cap-and-trade covered sectors than the cumulative reduction potential number indicated in Table B-1-11.

[1] 2020 projected consumption-based gross CO2e emission level is 384.69 Million Metric Tons CO2e (excluding AFW sector).

[2] The GHG reduction potential of 2020 is computed as the average of the 2015 and 2025 reduction potentials.

[3] This is a recent action additional to the recommended policy options. We include this option in the list to develop the cost curve since it is not included in the baseline emission forecast.

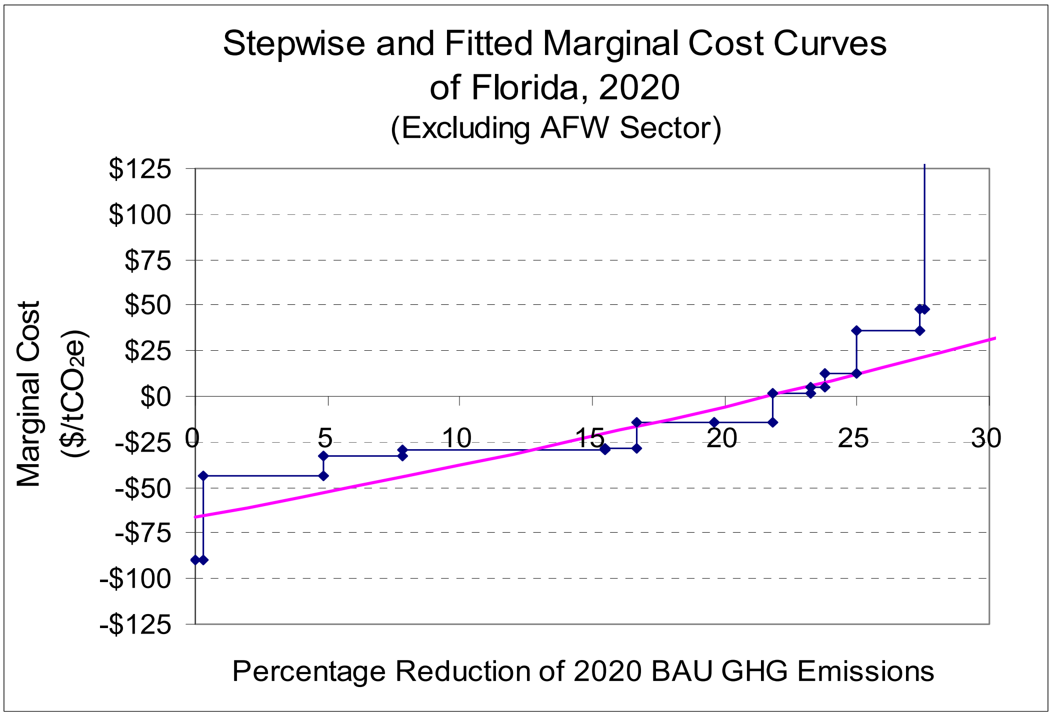

Figure B-1-4. Stepwise and Fitted Marginal Cost Curve of Florida, 2020

The marginal cost curve of Florida has the following specification:

$$MC = -66.35 - 272.53 \times \ln(1 - R)$$

The fitted curve has an intercept with the Y-axis at MC = -$66.35. The curve increases to MC=0 at the emission reduction level of 21.61 percent which indicates that Florida has cost-saving mitigation potentials up to the level of about 21.61 percent of the 2020 BAU emissions.

Annex 2. Modeling of Cap-and-Trade Program

I. INTRODUCTION OF THE CAP-AND-TRADE MODEL

A cap-and-trade system has many desirable features for implementing pollution emission reductions. The cap limits emissions. The trading ensures that the reduction will be achieved at the lowest possible cost (economic efficiency). The initial allocation of permits can be used to address issues of fairness (equity).

The model we use for the cap-and-trade analysis has been previously developed and successfully applied to simulate the workings of interregional (and international) C&T systems. It is based on established economic principles (equilibrium and optimization). The model can be solved either as a system of simultaneous equations or as a non-linear programming model. It has been applied to the analysis of cap-and-trade associated with the Kyoto Protocol, emissions trading within the European Union, the Regional Greenhouse Gas Initiative (RGGI), ten EPA regions covering all states of the U.S, Midwestern Governors Association (MGA) region, Minnesota internal state trading, Western Climate Initiative (WCI), and Pacific Rim states and countries (see Rose et al., 1998; Rose and Zhang, 2004; Rose et al., 2006; CCS, 2008; Rose and Wei, 2008).

This model is based on the ability of unrestricted permit trading to achieve a cost-effective allocation of resources in the presence of externalities (see, e.g., Tietenberg, 2007). For permit purchasing states (or sectors), compliance costs are equal to own abatement cost plus the cost of permits, whereas for selling states (or sectors), compliance costs are equal to abatement cost minus the revenues from selling permits. The model can readily be adapted to include such alternative design features as: variations in sector and source coverage, implications of the cap on emission reduction requirements over time, offsets, variations on auctioning, upstream vs. downstream application, borrowing and banking, and any explicit constraints on the permit price or trading (see Stevens and Rose, 2002; CCS, 2008).

The model yields the following general results:

- GHG emission reductions (abatement and sequestration) for each entity (sector and/or state) before and after permit trading
- Cost (or cost savings) of GHG emission reductions for each trading entity before and after trading
- Number of permits traded (bought and sold) by each entity
- Equilibrium permit price
- Cost savings for each entity of joining the cap-and-trade program
- Auction revenues if the allowances are auctioned among trading entities instead of grandfathered

The model uses as inputs (all the following input data are collected from the state's Climate Change Action Plans):

- Projections of baseline GHG emissions for each trading entity
- Caps on GHG emissions for each entity (translated from the state reduction goals in target years)
- Marginal cost curve of GHG emission reduction for each entity based on the cost of all relevant mitigation/sequestration options

II. DEVELOPMENT OF MARGINAL COST CURVES

Many states have developed State Climate Change Action Plans. The following data for each mitigation option (that has been quantitatively analyzed) of these states are first collected:

- The range of the mitigation option's application (maximum percentage of total emissions that can be reduced by the option)

- The cost per ton of CO_2 that can be reduced (this is specified in terms of a cost-effectiveness, including the possibility of cost savings per unit GHG removed)

For each state, the mitigation options are then ordered from lowest cost to highest cost. A step function is developed based on the mitigation potential and cost per ton of CO_2 reduction for each policy option. Such a step function is illustrated in Figure B-2-1. Next, a smooth curve is developed to fit the step function, which would be used as the marginal cost curve of the state in cap-and-trade policy analysis.

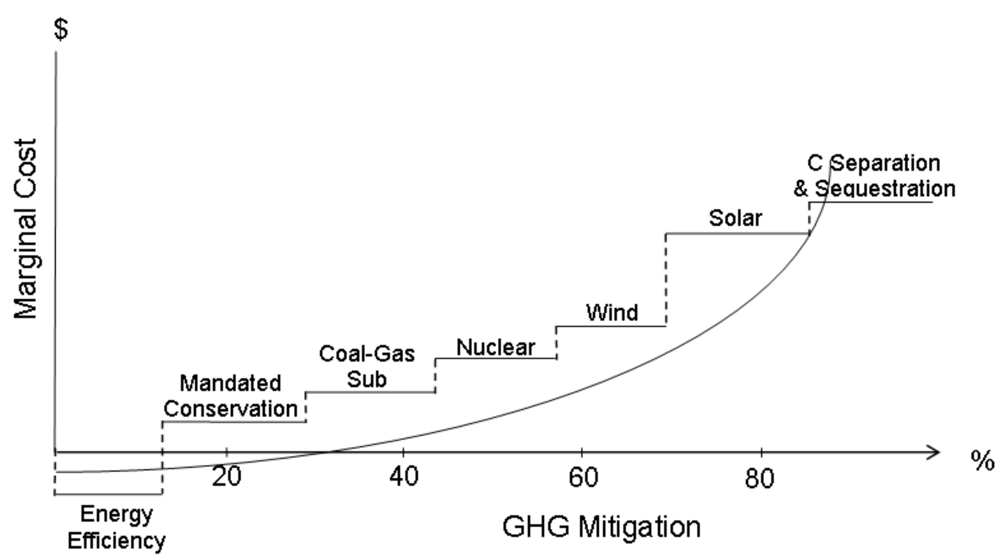

Figure B-2-1. Illustrative Marginal Cost Step Function and Curve for GHG Mitigation

Prior CCS analysis for Minnesota can serve as an example of the construction of the mitigation marginal cost curve. Table B-2-1 presents 8 example climate mitigation options out of the 37 options analyzed in a quantitative manner for Minnesota by CCS. Column 2 of the table presents the estimated 2025 annual GHG reduction potential for each option, with reduction potentials translated into percentages of the 2025 BAU emissions level in Column 4. The estimated cost or cost saving per ton of GHG removed by each option in 2025 is presented in Column 3. The options are ordered in ascending sequence in terms of cost, beginning with the cheapest option. Column 5 calculates the cumulative GHG reduction potentials of the first *n* policy options listed in the table. The last column presents the proportion of GHG mitigation contributed by each option.

Table B-2-1. GHG Mitigation Options of Minnesota

Climate Mitigation Actions	Estimated 2025 Annual GHG Reduction Potential ($MMtCO_2e$)	Estimated Cost or Cost Savings per ton GHG Removed	GHG Reduction Potential as Percentage of 2025 Baseline Emissions[1]	Cumulative GHG Reduction Potential	Weights (add-up to 100)
……					
RCI-6: Non-Utility Strategies and Incentives To Encourage Energy Efficiency and Reduce GHG Emissions	1.3	-$37.00	0.65%	9.91%	1.48
……					
AFW-1: Agricultural Crop Management--A. Soil Carbon Management	1.3	-$2.00	0.65%	15.42%	1.48
TLU-5: Climate-Friendly Transportation Pricing / Pay as You Drive	2.1	-$1.00	1.05%	16.46%	2.39
AFW-8: End of Life Waste Management Practices--A. Landfilled Waste Methane	0.73	$1.00	0.36%	16.98%	0.83
AFW-4: Expanded Use of Biomass Feedstocks for Electricity, Heat, or Steam Production	3.8	$3.00	1.90%	18.87%	4.32
……					
ES-3: Efficiency Improvements, Repowering and other Upgrades to Existing Plants--Biomass co-firing	0.4	$12.00	0.20%	29.38%	0.46
AFW-5: Forestry Management Programs to Enhance GHG Benefits--A. Forestation	2.2	$13.00	1.11%	30.48%	2.50
……					
ES-5: Renewable and/or Environmental Portfolio Standard	15.7	$56.40	7.83%	43.53%	17.86
……					

[1] Minnesota 2025 projected consumption-based gross GHG emission level is 200.46 Million Metric Tons of CO_2e.

Based on the data presented in Table B-2-1, the stepwise marginal cost function for Minnesota in 2025 is first drawn in Figure B-2-2. The horizontal axis represents the percentage of GHG emissions reduction, and the vertical axis represents the marginal cost or savings of mitigation. In the figure, each horizontal segment represents an individual mitigation option.

The width of the segment indicates the GHG emission reduction potential of the option in percentage terms. The height of the segment relative to the x-axis shows the average cost (saving) of reducing one ton of GHG with the application of the option. The figure indicates that, collectively, the reduction potential of options from all economic sectors can avoid about 44 percent of 2025 baseline emissions in Minnesota. Our approach to develop the marginal cost curve based on state specific climate change action plans directly includes any introduction of new emission reduction technologies (such as carbon capture and storage) of the state. Furthermore, sensitivity analyses of mitigation options, for example, to account for different learning and penetration effects or technological innovations, can be readily reflected in the cost curve by variations in the width (usually lengthening) and height (usually lowering), as well as the sequencing of the corresponding segments of the options.

Next, we fit a smooth curve through the data using statistical analysis (see Figure B-2-2). We weight each policy option based on its GHG mitigation potential to give relatively greater influence to those options that have the potential for higher levels of application. This fitted curve will then be used in our cap-and-trade analysis model.

The fitted curve shown in Figure 2 has the following functional form:

$$MC = a + b \times \ln(1 - R)$$

Where, MC is the marginal cost; R is the percentage reduction of GHG emissions; a and b are parameters.

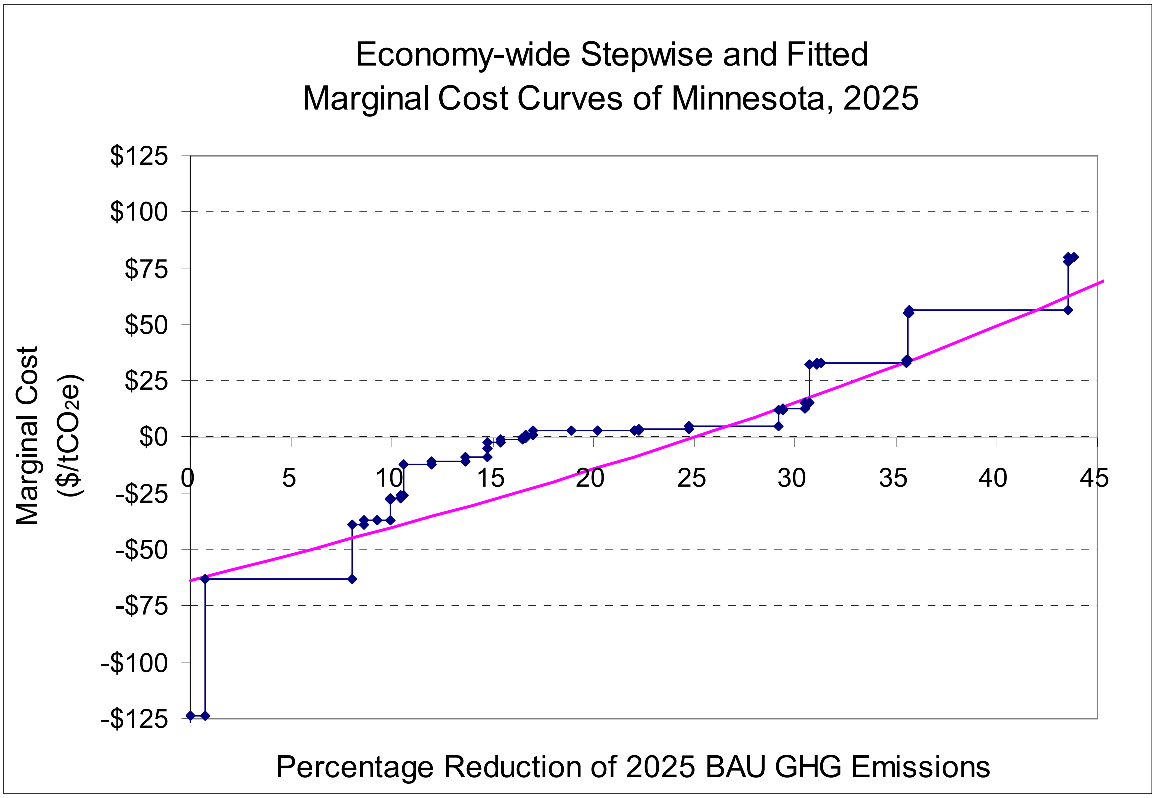

Figure B-2-2. Stepwise and Fitted Marginal Cost Curve of Minnesota, 2025

The logarithmic functional form utilized here is consistent with theoretical expectations and empirical findings on diminishing returns of emission control (Nordhaus, 1991; 1994). As the emission reductions increase along the X-axis, the cost to reduce one additional unit of emission is increasing in an accelerating speed.

The marginal cost curve for Minnesota has the following specification:

$$MC = -63.37 - 220.25 \times \ln(1 - R)$$

The fitted curve has an intercept with the Y-axis at MC = -$63.37. The curve increases to MC=0 at the emission reduction level of 25 percent, which indicates that Minnesota has cost-saving mitigation potentials (such as energy efficiency) up to the level of about 25 percent of the 2025 BAU emissions.

III. GENERAL ASSUMPTIONS ADOPTED IN THE ANALYSIS

The general assumptions we adopted in the cap-and-trade analysis and our modeling can be summarized as follows:

Emissions:

- All six GHGs — CO_2, methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6) — from the covered sectors are included in the analysis.
- The gross emissions (excluding forestry and agriculture soils sinks) are considered.

Marginal Cost Curves:

- Marginal cost curves embody direct mitigation costs only.
- Marginal cost curves do not include various transactions costs.
- Marginal cost curves do not distinguish between producer vs. consumer allocation of permits.
- For states that lacks direct cost data, the cost curve is approximated based on the data of one of its adjacent states that has quantified cost data available. We assume that the list of mitigation options for the adjacent state (state A) is applicable to the state without direct data (state B). Second, for state B, the estimated cost or cost savings per unit GHG removed for each option is assumed to be at the same level as of state A. Third, the mitigation potentials of each option are assumed to be proportional in each state; this requires that each option be adjusted by the ratio of emissions from the relevant sector of the two states. For example, if the emissions from the power sector are 50 $MMtCO_2e$ and 100 $MMtCO_2e$ in state A and state B, respectively, the mitigation potentials of the ES options for state A are multiplied by a factor of 2 (100/50=2) for application to state B.
- For analysis of cap-and-trade among power sectors, the power sector marginal cost curves of the states are developed based on the reduction potential and mitigation cost/saving data of individual options that contribute to the emission reductions from power sector. These options not only include those designed directly for the electricity supply sector (such as promotion of renewable energy utilization, repowering existing plants, generation performance standards, etc.), but also include options in RCI sectors that contribute to the reduction of electricity consumption (e.g., demand-side management, energy efficiency appliances, building codes, etc.). Also, for those options that apply to the use of both electricity and other fuel types, the emission reduction potentials are adjusted by multiplying the percentage of electricity consumption to total energy consumption in the RCI sector. RCI options that relate entirely to reduction of other fossil fuels consumption (such as gas, oil) are not included in the power sector cost curve development.

Basic model (can be included in advanced versions):

- Offsets are not included.
- No safety valve (permit price limit) is included.
- Recycling of auction revenues is not analyzed in the simulations.

- Banking and borrowing are not considered.

IV. SPECIFICATION OF THE CAP-AND-TRADE MODEL

The cap-and-trade model is based on well-established principles of the ability of unrestricted permit trading to achieve a cost-effective allocation of resources in the presence of externalities (see Tietenberg, 2007). Where a strict cap implies unique GHG emission reduction requirements, the individual state and overall regional optimization can be accomplished without explicit consideration of the benefits side of the ledger (i.e., it yields "efficiency without optimality"). Therefore, the model simply requires equalization of marginal costs of all entities with the equilibrium permit price (see, Zhang, 2000; Loeschel and Zhang, 2002; Rose and Zhang, 2004). This ensures minimization of total net compliance costs for each state and minimization of total abatement costs for the region as a whole. For selling states (high cost states), they will reduce emissions up to the point where their marginal cost equals the prevailing market permit price, and accomplish their remaining reduction responsibility by purchasing available permits in the market. For purchasing states (low cost states), they would have the incentive to do more than their reduction targets indicate, so that they can sell their surplus permits on the open market to obtain profit. For the region as a whole, permit sales and purchases cancel out, simplifying the overall objective functions.

We assume that the marginal abatement cost function for state *i* is of the logarithmic form, similar to Nordhaus (1994):[14]

$$MC_i = a_i + b_i \times \ln(1 - R_i) \qquad i = 1\,,\ \ldots\,,\ n \qquad (1)$$

where MC_i is the marginal cost of abatement for state *i*, R_i is the percentage of greenhouse gas abatement undertaken by state *i* in million tons of carbon dioxide equivalent (MMtCO2e), and a_i and b_i are cost parameters. This functional form has the desired property of positive and increasing marginal cost for $b_i < 0$. When $a_i = 0$, the cost curve starts from the origin. When $a_i < 0$, the curve can show the cost-saving mitigation range of the state. These cost parameters also capture technological and other distinctions that cause mitigation costs to differ across regions. By integration, the total cost of abatement for region *i*, TC_i, is:

$$TC_i = \int_0^{R_i} \left[a_i \cdot R_i - b_i \cdot (1 - R_i) \cdot \ln(1 - R_i) - b_i \cdot R_i \right] \cdot E_i \qquad i = 1\,,\ldots,\,n \qquad (2)$$

[14] The shape of the cost function for mitigating carbon emissions has been studied extensively. For example, Nordhaus (1994) found that the logarithmic functional form provided the best fit for the estimates of the marginal costs of mitigating a specific amount of carbon emissions among a number of economic modeling studies that he surveyed (a type of meta-analysis). Nordhaus (1994) used an analytical model to further derive a logarithmic relationship between the marginal costs and the percentage reduction.

where E_i is each state's gross (unabated) emissions in MMtCO2e. Denoting the total required percentage reduction of emissions in region *i* in the absence of emissions trading as $\overline{R}_i$, the total abatement cost for each state in the absence of trading, $TC\overline{R}_i$, is calculated as:

$$TC\overline{R}_i = \int_0^{\overline{R}_i} \left[\left(a_i + b_i \cdot \ln(1 - r_i) \right) dr_i E_i \right] = \left[a_i \cdot \overline{R}_i - b_i \cdot (1 - \overline{R}_i) \cdot \ln(1 - \overline{R}_i) - b_i \cdot \overline{R}_i \right] \cdot E_i$$

$$i = 1, \ldots, n \qquad (3)$$

Emissions trading helps a region with relatively high marginal abatement cost to lower its compliance cost by avoiding the undertaking of autarkic actions. To minimize compliance costs, a purchasing state undertakes only some of its abatement requirement itself, R_iE_i, $R_iE_i \quad \overline{R}_iE_i$, up to the point where the marginal cost of doing so is equal to the endogenously determined permit price, *P*:

$$MC_i = a_i + b_i \times \ln(1 - R_i) = P \qquad i \quad N \qquad (4)$$

where *N* is the set of all states.

The state meets the remaining demand, $\left(\overline{R}_iE_i - R_iE_i\right)$, via purchasing the "right to emit" at the regional market price, *P*. So, the total demand for emission permits of all purchasing states, *TD*, is:

$$TD = \sum_i \left(\overline{R}_iE_i - R_iE_i \right) \qquad i \quad N \qquad (5)$$

On the other hand, for state *j*, with relatively low marginal cost, emissions trading provides it an incentive to undertake abatement and sell permits to those higher-cost states at the equilibrium permit price, *P*:

$$MC_j = a_j + b_j \times \ln(1 - R_j) = P \qquad j \quad N \qquad (6)$$

The total amount of emissions permits available for sale in a given regional trading coalition *TS*, is:

$$TS = \sum_j \left(R_jE_j - \overline{R}_jE_j \right) \qquad j \quad N \qquad (7)$$

The sum of total number of purchasing states *i* and total number of selling states *j* will be equal to *n*. At the equilibrium, the total demand for emissions permits in the region is equal to the total supply:

$$TD = TS \qquad (8)$$

Substituting Eq. (5) and Eq. (7) into Eq. (8) and rearranging terms yields the condition that the total emissions actually abated equal the total emission abatement requirement:

$$\sum_i R_i E_i = \sum_i \overline{R}_i E_i \qquad i = 1, \ldots, n \qquad (9)$$

We solve the model by minimizing total abatement costs of all states $\sum_i TC_i$ subject to Eq. (4), (6), and (9), using GAMS, an algebraic modeling system for linear, nonlinear, and integer programming problems (Brooke et al., 1996).[15] The solution yields the equilibrium permit price (P),

each state's own abatement after trading $R_i E_i$, and each state's marginal abatement cost (MC_i). Because we focus on unrestricted emissions trading, in equilibrium the marginal cost of abatement for each region is the same and is equal to the permit price, indicated in Eq. (4) and Eq. (6).

This completes the description of the general model by which the permit price, MC_i, and R_iE_i are determined endogenously in a competitive market. In the case where the permit price is set exogenously, as in the case of some auctions, the situation becomes simpler because MC_i and hence R_iE_i follows suit. There is no need for Eqs. (5), (7), (8), and (9) because the total sales of selling states to purchasing states are not equal to the total purchases, except by chance (when the specified permit price equals the equilibrium price).

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[15] The market equilibrium solution of our model is unique, so the same solution could be obtained without optimizing. The reason why we specify an objective function is that we use GAMS/MINOS, a solver mainly for optimization problems. The minimization of the total cost is a logical choice for an objective in the case of "cost-effectiveness" analysis here (i.e., when a policy target is set and decision units seek to attain it at least cost). Had we used a software package that is specifically designed to solve a simultaneous equation system, then there would have been no need for an objective function.

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Appendix C
Transportation and Land Use (TLU)

Summary List of Policy Recommendations

Policy No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value 2009–2025 (Million $)	Cost-Effective -ness ($\$/tCO_2e$)	Energy Security Fuel Savings (Gallons Saved 2009–2025) (million gallons)	Level of Support
		2017	2025	Total 2009-2025				
TLU-1	Develop and Expand Low-GHG Fuels	6.20	12.62	106.41	–$15,161	–$142	37,290	Approved
TLU-2	Low Rolling Resistance Tires and Other Add-On Technologies	0.80	1.84	13.99	-$1,259	-$90	1,665	Approved
TLU-3	Smart Growth Planning	Not Quantified Separately; Included in Other Analyses						Approved
TLU-4	Improving Transportation System Management (TSM)	3.94	6.98	63.91	-$5,106	-$80	7,858	Approved
TLU-5&6	Land Use Planning Processes and Increasing Choices in Modes of Transportation	1.77	3.54	28.29	NQ	NQ	3,200	Approved
TLU-7	Incentive Programs for Increased Vehicle Fleet Efficiency	0.84	1.56	13.14	NQ	NQ	1,564	Approved
TLU-8	Increasing Freight Movement Efficiencies	0.59	1.10	11.52	$21	$2	1,302	Approved
	Sector Totals	**14.14**	**27.64**	**237.26**	**-$21,505**	**-$110**	**52,879**	
	Sector Total After Adjusting for Overlaps	**12.73**	**25.14**	**214.35**	**-$18,400**	**-$106**	**48,786**	
	Reductions from Recent Actions	**19.10**	**34.11**	**307.24**				
	Sector Total Plus Recent Actions	**31.83**	**59.25**	**521.59**				

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Note: The numbering used to denote the above recommended priority policy recommendations is for reference purposes only; it does not reflect prioritization among these important recommended policies.

Common Assumptions

Policy analysis of transportation and land use issues is inherently complex, given the interrelationships between transportation systems, land use, and other important aspects of societal well-being. Policy analysis methods for transportation and land use, as conducted by consultants for the Center for Climate Strategies, (CCS), is based upon many years of well-established professional practice and methods that are widely accepted in the fields of public policy analysis, urban and transportation planning, transportation engineering, and environmental sciences.

Underlying Premises and Methodology

As much as possible, the analysis is conducted using simple spreadsheet modeling techniques in which assumptions are transparent. To ensure consistent results across recommendations, common factors and assumptions are used for the following items:

- ***Independent and integrated analyses***—Each recommendation is first analyzed individually and then addressed as part of an overall integrated analysis.
- ***Fuel costs and projected escalation***—Fuel cost estimates are based on common sources wherever possible. For example, fossil fuel price escalation is indexed to the U.S. Department of Energy (US DOE) projections as indicated in their most recent Annual Energy Outlook (AEO).
- ***Consumption-based approach***—The analysis uses a consumption-based approach where emissions are calculated on the basis of the consumption of transportation fuels to provide energy to Florida consumers, as opposed to a production-based approach, which considers the emissions from in-state production of transportation fuels.
- ***Life cycle GHG approach***—Life cycle GHG emissions are considered on a case-by-case basis. The primary focus of the analysis of Transportation and Land Use issues is upon the direct combustion of transportation fuels to provide energy.
- ***Overlap with other Sectors***—Where Transportation and Land Use (TLU) recommendations overlap with recommendations being considered in other Sectors, the analysis for these recommendations is conducted in close coordination with the assumptions and other inputs used in other CCS analyses.

Data Sources

Technical Working Group (TWG) members are often in a good position to obtain and provide data sources that are specific to Florida, and these are used as much as possible. Where Florida-specific information cannot be readily obtained from the TWG, the analysis relies on published data from the DOE, national laboratories, and other state climate change processes as follows:

1. ***Baseline Historical Energy Consumption by Sector***

Historical energy consumption in the State, by sector, is from the DOE Energy Information Administration (EIA) State Energy Data, available at http://www.eia.doe.gov/emeu/states/_seds.html.

2. ***Baseline Historical Vehicle Fleet, Fuel Use, and Travel Activity Data***

   Baseline data on the State vehicle fleet is incorporated from the MOBILE model, as specified in the Florida Inventory and Reference Case Projection report. Baseline fuel use is obtained from the most recent US DOE Energy Information Administration (EIA) reports, as described in the Florida Inventory and Reference Case Projection report. Baseline travel activity data in the form of vehicle miles traveled were developed by the Florida Department of Transporation (DOT) from linear extrapolation of historical Florida vehicle miles traveled (VMT) data, per the Florida Inventory and Reference Case Projection report. State-specific vehicle registration data was available and incorporated into the analysis of TLU-2 and TLU-7.

3. ***Baseline Forecast GHG Emissions***

   Baseline forecasts of future GHG emissions for the transportation and land use sector, data sources, and methods of analyses for these forecasts are described in the Florida Inventory and Reference Case Projection report.

4. ***Energy Price Projections through 2030***

   Energy prices by region are from the EIA Supplemental Tables to the AEO 2007, with projections through 2030. Adjustments to the EIA projections are made on a case-by-case basis.

The Energy Independence and Security Act of 2007 contains a provision to increase the corporate average fuel economy (CAFE) of light-duty vehicles (passenger cars and light trucks) to 35 miles per gallon by 2020. The Florida Inventory and Reference Case Projection does not include the CAFE or biofuels provisions (or any other provisions) of the Energy Independence and Security Act of 2007. Increases in vehicle fuel economy resulting from this Act would lead to reduced CO_2 emissions from onroad vehicles. While adjustment of the reference case projection to account for the Act was deferred to a later date, the effect of the new CAFE standards was accounted for in the estimates of GHG reductions from the various TLU policy recommendations discussed below.

Cost Inclusion

The analytical methods being used can incorporate a wide variety of costs, depending on the availability of cost state. Fuel costs are incorporated into all analyses where relevant. Other types of costs are explicitly considered in the analysis if they can be readily estimated.

Types of costs that **are incorporated** include:

- Annualized capital costs levelized (amortized),

- Operations and maintenance costs, and
- Administrative costs.

Types of costs that **are not incorporated** include:

- External costs, such as the monetized environmental or social benefits and impacts (e.g., the cost of damage by air pollutants on structures and crops), quality-of-life improvements, and health impacts and benefits (e.g., improved road safety);
- Energy security benefits; and
- Macroeconomic impacts related to reduced or increased consumer spending, and shifting of cost and benefits among different sectors of the economy.

Cumulative (Overlap) Analysis

In addition to estimating the impacts of each individual policy recommendation, the combined impacts of the TLU policy recommendations was estimated, assuming that all policies were implemented together. This involved eliminating any overlaps in coverage that would occur to avoid double counting of impacts. Also, overlaps between policy recommendations in the TLU sector and policies in other sectors were identified. The following section identifies where these overlaps occurred and explains the methods used to adjust the impacts analysis to avoid double counting of impacts.

Method for Analyzing Cumulative Impacts of Combined TLU Policies

It is widely accepted that there are three general categories of factors that impact the emission of GHGs from the transportation sector. These three general categories are often described as "the three-legged stool." The three categories (or three legs of the stool) are vehicle characteristics, fuels, and travel activity.

These three factors interact in a complex fashion to have an effect on GHG emission levels. The following formula summarizes this interaction in a simplified fashion: Vehicle Miles Traveled divided by Miles per Gallon multiplied by $MMtCO_2e$/gallon yields $MMtCO_2e$. Thus, the GHG emissions reductions resulting from individual stand alone policies are not additive. For example, a policy that reduces vehicle-miles traveled (VMT) will reduce the GHG benefits of a policy that improves fuel economy or reduces fuel carbon intensity.

The cumulative GHG emissions reductions that would result if all eight TLU policies described below were to be implemented as a package was estimated by identifying the potential for overlap between the policies as follows:

- TLU Policies 1 through 7 affect the light-duty vehicle fleet, while TLU Policy 8 affects the heavy-duty vehicle fleet. Thus, there is no overlap between TLU Policies 1-7 and TLU Policy 8.

- TLU Policies 1 through 7 were grouped into three categories: policies affecting VMT, policies affecting vehicle fuel economy, and policies affecting the carbon intensity of fuels used. TLU Policies 3, 4, 5, and 6 all affect VMT. TLU Policies 2 and 7 affect vehicle fuel economy. TLU Policy 1 affects the carbon intensity of fuels used. The overlap within each of these three groups was determined.
- As a final step, the overlap between each of the three categories was estimated and applied.

The net cumulative GHG reductions from implementation of all eight TLU policies was found to be approximately 9 to10 percent lower than the sum of the individual policy impacts. The overlap amongst policies affected the cumulative costs, as well as the GHG reductions. The net cumulative costs were found to be approximately 12 percent lower than the sum of the individual policy costs.

Overlap of TLU Policies with Other Sectors

TLU Policy 1 overlaps with policies related to biomass/biofuels in the Agriculture, Forestry and Waste (AFW) sector. Adjustments were made to the AFW policies to account for the overlap. There are no additional overlaps between TLU policies, and policies in other sectors.

TLU-1. Develop and Expand Low-GHG Fuels

The 10 billion gallons of imported transportation fuel used annually in Florida is responsible for 40 percent of the greenhouse gas (GHG) production, creates a significant imbalance in trade, and contributes to our strategic dependence. Oil prices increased by 100 percent between July 2, 2007, and July 1, 2008, with no end in sight, increasing the cost of gasoline and damaging the economy of Florida as well as that of other states. Increased efficiency and the development of alternatives could mitigate these adverse effects. Development of large-scale, domestic, alternative fuels will provide a cost-competitive alternative that can stabilize the value of automotive fuels and other petroleum-derived products and stimulate local economies.

Alternative fuels from biomass, cellulosic residues, and energy crops have been identified by the U.S. Department of Agriculture (USDA) and the U.S. Department of Energy (US DOE) as our best near-term opportunity to reduce oil dependence and GHG emissions. The Sunshine State of Florida ranks near the top in potential production of energy crops and residues (agricultural, forest, and municipal) for ethanol fuel. Development of this new industry in Florida will require substantial commercial investment and could result in more than 200 advanced biofuels plants that would directly employ more than 12,000 individuals around the state.

The 2008 Federal Farm Bill (HR-2419) has an excellent program (Biomass Crop Assistance Program) to mitigate farming risks for energy crops which has not been sufficiently publicized in Florida and will greatly assist the development of this new industry. This Farm Bill also defines "advanced biofuels" very broadly to include liquid and gaseous fuels made from any renewable biomass except the starch from corn (to include the most current definition for advanced biofuel from the recently passed Farm Bill.)

The existing federal legislation and the 2006 Florida Energy Act provide incentives in the form of income and sales tax credits for investments in the production, storage, and distribution of biodiesel and ethanol. However, the Florida credits terminate on June 30, 2010, and are subject to relatively low statewide caps on the amount of credits allowable.

Alternative fuels can have a key role in the transformation of the energy sector, climate stabilization, and the renaissance of rural areas. There are "good" and "bad" alternative fuels depending on how they are produced, used, and traded which, in turn, determines their ultimate economic, environmental, and social impacts. Alternative fuel production, trade, and use must be cost-effective, equitable, and sustainable.

TLU-1 recommends the following to develop and expand low-GHG and alternative fuels:

- Integrate and better coordinate policy frameworks.
- Assess and monitor benefits and impacts of alternative fuels production, trade, and use.

- Address negative indirect effects of alternative fuels production, trade, and use.
- Reward positive impacts and investments attained through carbon management.
- Build consensus for new projects by supporting informed and continuous dialogue engaging all relevant stakeholders.
- Increase investments in research, development, and demonstration.

Public policy with regard to investment in research and development (R&D) should focus on the production of cost-effective, second-generation alternative fuels; build on sustainability lessons learned from first-generation alternative fuels to be used for second-generation alternative fuels; increase conversion technology performance; and maximize climate change mitigation. In addition, public policy should:

- Build capacity to enable producers to manage carbon and water,
- Make sure that trade policies and climate change policies work together, and
- Open competition in the transport sector to all recommendations and methods that can displace carbon and imported oil, including demand reduction.

Policy Description

This recommendation seeks to reduce GHG emissions by decreasing the carbon intensity of vehicle fuels sold in Florida. A low-carbon fuel standard (LCFS) would require all fuel providers in Florida to ensure that the mix of fuel they sell into the Florida market meets, on average, a declining standard for GHG emissions measured in carbon dioxide equivalent (CO_2e) per unit of fuel energy. The state should develop, with industry and stakeholder input, a set of standards for low-carbon fuels, which include biodiesel, cellulosic ethanol, hydrogen, compressed natural gas, liquefied petroleum gas, electricity, and low-carbon blends such as E10 or E85. The standard would be measured on a life cycle basis in order to include all emissions from fuel production to consumption.

Fuel providers (defined as refiners, importers, and blenders of on-road vehicle fuels) will need to report on an annual basis that the fuel mixtures they provide to the market meet the LCFS. Fuel retailers should be encouraged to provide this information to consumers at the point of sale to the extent that the information is available.

Policy Design

Goals: Create an LCFS for transportation fuels (gasoline and diesel) sold in Florida that would reduce the carbon intensity of Florida's on-road vehicle fuels. In addition to the reduction standard and program timing, life cycle model and boundary conditions should be addressed in creating the program.

Timing: Following the design period, the program proposal for standards would be reviewed, discussed, and decided upon in the appropriate legislative venue.

Parties Involved: Florida Energy and Climate Commission (FECC), fuel providers, Florida Department of Economic Development, and the Florida Department of Environmental Protection.

Table C-1-1 shows life cycle ("well-to-wheels") GHG impacts of various biofuels recommendations.

Table C-1-1. Estimated alternative fuels impacts on GHG emissions

Fuel/Technology	Blend	Feedstock	Reduction (GHGs per mile)*
Ethanol	E10	Corn†	1.4%
Ethanol	E10	Sugarcane	4.6%
Ethanol	E10	Cellulosic	7.4%
Ethanol	E85	Corn	15.9%
Ethanol	E85	Sugarcane	51.7%
Ethanol	E85	Cellulosic	83.8%
Liquid natural gas	n/a	n/a	15.2%
Compressed natural gas	n/a	n/a	15.3%
Biodiesel	B20	Soy	17.7%

* Ethanol reductions estimated relative to gasoline; biodiesel reductions estimated relative to diesel fuel. Actual reductions depend on many factors in the production, distribution, and use of fuels.

† Corn ethanol estimations assume a fossil-fuel boiler.

Source: GREET v1.8 outputs.

Implementation Mechanisms

A Governor's Executive Order would initiate the process for development of the LCFS, followed by a detailed report. The appropriate state agencies will undertake a study to develop the framework for the LCFS. Once the study is completed, it would be introduced to the state's legislative proceedings, at which point the appropriate state agency will conduct public hearings on the proposal. Once adopted, an appropriate state agency will initiate a rulemaking proceeding that establishes and implements the LCFS.

The LCFS is market-based and performance-based, allowing averaging, banking, and trading to achieve the lowest cost and consumer-responsive solutions. An LCFS is also fuel-neutral, where fuel providers will choose which fuels to sell and in what volumes.

Fuel providers—defined as refiners, importers, and blenders of passenger vehicle fuels—would demonstrate on an annual basis that the fuel mixtures they provide to the market meet the target by using credits previously banked or purchased.

- Amend the 2006 Florida Energy Act by extending the expiration date for the credits and increasing the statewide cap (currently $6.5 million) on the credits allowed for investments in the production, storage, and distribution of biodiesel (B10–B100) and ethanol (E10–E100).
- Provide a production incentive to ethanol producers for ethanol that is produced in Florida from Florida-grown biomass and used in Florida automotive fuel, with a set maximum for cumulative annual production incentives.
- Provide the opportunity to lease public lands for the production of nonfood energy crops consistent with the purposes for which land was acquired and consistent with the identified management plan for the public land.
- Increase awareness of the USDA Biomass Crop Assistance Program designed to mitigate risk to farmers who produce energy crops.
- Provide the opportunity for public bonds to be used to finance advanced biofuels production in Florida.
- Provide favorable land taxation not to exceed agricultural rates for facilities that convert renewable feedstocks grown in Florida into advanced biofuels that are used in Florida.
- Develop a comprehensive marketing package to help recruit advanced biofuel industries into Florida and compare with opportunities provided in other states.
- Modify one of Florida's energy grant programs to promote and expand the use of advanced biofuels such as ethanol and biodiesel as clean, alternative transportation fuels. Accelerate the commercialization of new alternative fuel technologies and products by providing grants of up to $100,000 each for the development of business plans, engineering studies, design studies, permit applications, and legal work for potential new biofuels facilities in Florida (based on the Renewable Fuels Research, Development, and Demonstration Program administered by the Illinois Department of Commerce and Economic Opportunity). This may overlap with the new Florida program described in Florida Statutes 377.804.
http://www.flsenate.gov/Statutes/index.cfm?mode=View%20Statutes&SubMenu=1&App_mode=Display_Statute&Search_String=377.804&URL=CH0377/Sec804.HTM

Related Policies/Programs in Place

Florida's state Renewable Fuel Standards (RFS) is among the most progressive standard in the country.

Florida Grant Programs

Alternative Fuels Production Incentive

The Innovation Incentive Program is created within the Office of Tourism, Trade, and Economic Development (OTTED) to provide resources for business projects that allow the state to effectively compete for high-value research and development, including alternative and renewable energy projects. To qualify, an alternative and renewable energy project must involve collaboration with an institution of higher education, provide the state a minimum full return on investment within a 20-year period, include matching funds provided by the applicant or other available sources, and be located in Florida. Additional criteria may apply. For the purposes of this incentive, alternative and renewable energy means electrical, mechanical, or thermal energy produced by a method that uses one or more of the following energy sources: ethanol, cellulosic ethanol, hydrous ethanol, bio-butanol, biodiesel, biomass, biogas, hydrogen fuel cells, ocean energy, hydrogen, solar, hydro, wind, or geothermal (reference HB 7135, 2008, and Florida Statutes 377.804).

http://www.myfloridahouse.gov/Sections/Bills/billsdetail.aspx?BillId=39607&SessionId=57&SessionIndex=-1&BillText=&BillNumber=7135&BillSponsorIndex=0&BillListIndex=0&BillTypeIndex=0&BillReferredIndex=0&HouseChamber=H&BillSearchIndex=0

Renewable Energy Grants

The *Renewable Energy Technologies Grants Program* (http://www.dep.state.fl.us/energy/energyact/grants.htm) provides matching grants for demonstration, commercialization, research, and development projects relating to renewable energy technologies, including those that generate or use hydrogen or biomass resources (reference Florida Statutes 377.804).

The potential interaction between federal and state policy actions related to the Renewable Fuel Standard (RFS) at the national level and various state and regional GHG mitigation policies is worth understanding to most effectively formulate state and regional policies within the existing context of federal policies regarding transportation fuels.

The most recently passed federal law, the Energy Independence and Security Act (EISA) of 2007, expanded the federal Renewable Fuel Standard significantly. Under the new law, fuel suppliers are required to blend nine billion gallons of renewable fuel into gasoline in 2008. Fuel suppliers must increase the amount of renewable fuel blended into transportation fuels annually to reach a level of 36 billion gallons in 2022.

In the United States, a significant amount of gasoline is currently being blended with a relatively small portion of alternative fuel in the form of ethanol. Virtually all light-duty motor vehicles in a fleet can handle gasoline blended with ethanol when ethanol makes up 10 percent or less of the volume of the fuel. The nation is quickly moving toward a standard of a minimum of 10 percent ethanol blended into gasoline to serve multiple goals: increasing use of alternative fuels, reducing reliance upon imported petroleum and petroleum products, reducing air pollution by producing cleaner burning fuel, and reducing GHG emissions from the combustion of transportation fuels.

In comparison with the nine billion gallon renewable fuel requirement for 2008, the United States consumed roughly fi ve billion gallons of biofuels in 2006. The U.S. ethanol industry has successfully increased the amount of production from an estimated 1.8 billion gallons in 2001 to an estimated 6.5 billion gallons in 2007.

The 2022 RFS goal of 36 billion gallons is not likely to be achievable through corn ethanol alone, and the EISA limits the amount of corn ethanol that may be credited toward the RFS goals at 15 billion gallons beginning in 2015. The remainder of the RFS goal—21 billion to 36 billion gallons—is expected to be reached through "advanced biofuels." As a result, the federal policy expects that advanced, or "second-generation" biofuels, will be commercially available in 2015 and will provide the majority of the fuel to meet the federal RFS in the longer term.

State governments and regional associations of state governments are considering and adopting a range of policies to reduce GHG emissions from the combustion of transportation fuels. Included in this set of policies are those that overlap or interact to some extent with the federal RFS as formulated in the 2007 EISA. The low-carbon fuel standard (LCFS) is the policy most often considered by individual states as a means to reduce the carbon intensity of transportation fuels being used.

There are two other sets of policies considered by states that may complement the federal policies. One set of policies would incentivize or provide for increased capacity for production and blending of alternative fuels and distribution of those fuels to fuel stations. The other set of policies would incentivize or provide for increased capacity of motor vehicle fleets to use blends of fuel that reduce the portion of petroleum-based products below the 90 percent threshold for gasoline and the 95 percent threshold for diesel fuel; these policies would also increase the percentage of alternative fuels (corn ethanol, advanced biofuels, and other renewables) above the 10 percent (E10) threshold for gasoline blends and the 5 percent (B5) threshold for diesel blends. Some policies that fall into this second category include promotion of flex-fuel vehicles that can safely and effectively use the higher blends of fuels and provision of the fuel station infrastructure necessary for pumping these higher blends.

Estimated GHG Reductions and Net Costs or Cost Savings

Table C-1-2. Effect on GHG Emissions, Fuel Consumption, and Costs

	2017	2025	Units
GHG emission savings	6.2	12.62	$MMtCO_2e$
Net present value (2009–2025)	N/A	–$15,161	$ Million
Cumulative reductions (2009–2025)	N/A	106.41	$MMtCO_2e$
Cost-effectiveness	N/A	–$142	$/MtCO_2e$
Gallons saved (fuel displaced by alternative fuels)	2,272	3,687	Million gallons
Gallons saved (2009–2025)	N/A	37,290	Million gallons

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; N/A = not applicable; $/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Data Sources:

Life cycle impacts of biofuels were obtained from the Argonne National Laboratory 's (ANL) Gases, Regulated Emissions, and Energy Use in Transportation (GREET) model (v1.8).

Fuel consumption, fuel economy, and gasoline and ethanol prices were obtained from EIA's AEO, June 2008 release.

Price of biodiesel and conventional diesel was obtained from US DOE Alternative Fuels Price Report, July 2008.

Quantification Methods: In order to estimate potential GHG emission reductions, a scenario was developed that is intended to reflect current Federal law (per the 2007 Renewable Fuel Standard) and Florida state law (minimum 10 percent ethanol content by December 31, 2010). Table C-1-3 shows the assumptions used for this scenario.

Table C-1-3. Title

Time Period	E85 Ethanol Market Share	E10 Ethanol Market Share	% Ethanol in Gasoline	Ethanol Feedstocks			% Biodiesel in Diesel	% Renewable Fuels
				% Corn	% Sugarcane	% Cellulosic		
2010	0%	100%	10%	95%	5%	0%	1%	8%
2011–2015	3%	97%	12%	90%	10%	0%	2%	10%
2016–2020	10%	90%	18%	75%	15%	10%	5%	15%
2021–2025	17%	83%	23%	65%	20%	15%	10%	20%

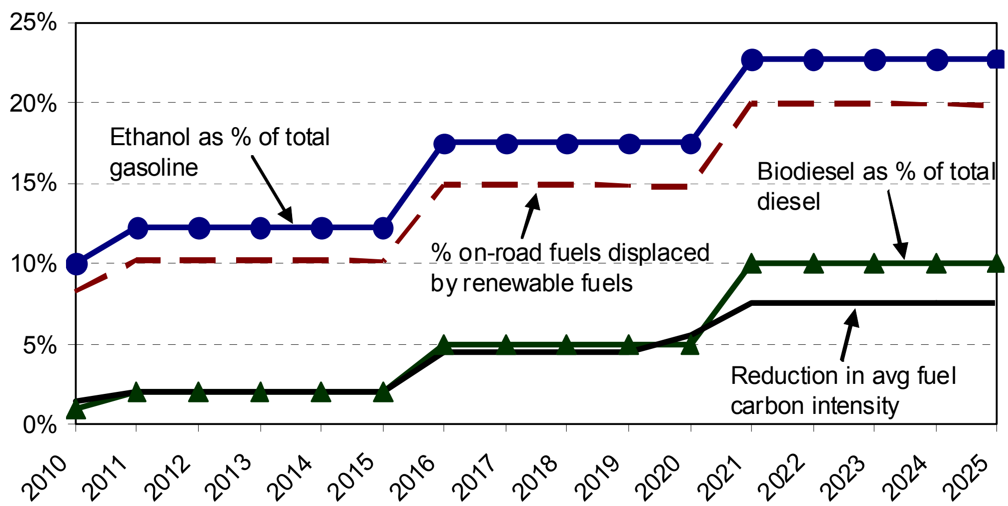
In this scenario (Table C-1-3), by 2025, ethanol sales in Florida would represent 23 percent of gasoline sales. For analysis purposes, ethanol was assumed to be used in the form of either E10 or E85. In reality, flex-fuel vehicles will be able to operate on any blend of ethanol up to 85 percent. The analysis assumptions are intended to reflect that range of blends. In addition, 95 percent of ethanol is assumed to come from corn feedstocks, with 5 percent from sugarcane in 2011, with a 90 percent corn/10 percent sugarcane mix assumed from 2011 to 2015. Starting in 2016, it is assumed that cellulosic ethanol would begin to make up a significant portion of the ethanol market. Biodiesel (from soy) is assumed to make up 10 percent of total Florida diesel sales by 2025.

Figure C-1-1 illustrates the assumed blends of ethanol and biodiesel as percentages of gasoline and diesel, respectively, as well as the overall renewable fuel blend and estimated resulting reduction in average fuel carbon intensity. The cumulative impact of this increase in biofuels is anticipated to be approximately a 6 percent reduction in average fuel carbon intensity in 2020 and approximately an 8 percent reduction in 2025.

Cost is calculated as the incremental cost of biofuels per gallon of gasoline equivalent (for ethanol) or diesel equivalent (for biodiesel) multiplied by total consumption of each fuel. Ethanol and gasoline prices in future years are drawn from the Energy Information Administration's Annual Energy Outlook, June 2008. Based on information from the U.S.

Department Energy's Alternative Fuels Price Report, July 2008, the difference in the average price of biodiesel compared with conventional diesel in the Lower Atlantic region is approximately $0.05 per gallon (less for biodiesel). Note that the cost calculation does not include Federal subsidies in the form of tax credits for ethanol or biodiesel. In addition, costs related to any vehicle upgrades (for example, flex-fuel vehicles that can operate on ethanol blends up to E85) are not included. The market for inputs into biofuels production and also for the biofuels themselves exhibit a significant level of volatility. There is a significant level of uncertainty about the likely future costs of production and the market price of biofuels, although it has been argued that biodiesel will be priced competitively with diesel in the future in order to maintain market viability.[1]

Figure C-1-1. Scenario Analysis for Potential Achievement of Low Carbon Fuels Standards Goals



Key Assumptions:

- Program starts in 2010, first year of emission reduction.
- Program applies to all on-road vehicles, "replacing" current gasoline and diesel fuel.
- Baseline accounts for
  - 0 percent ethanol existing market share.
  - 0 percent existing biodiesel market share.

[1] John Ferris, Michigan State University, "Agriculture as a Source of Fuel: Prospects and Impacts, 2007 to 2017", USDA Conference on Biofuels, Food & Feed Tradeoffs, St. Louis, Missouri, April 12-13, 2007.

Key Uncertainties

Transportation fuel providers would need to undertake changes in their production and distribution methods in order to achieve the goals. Because the policy does not prescribe particular technology pathways, there is uncertainty surrounding which fuels and technologies fuel providers will use to meet the standard. The program assumes that providers will use the most cost-effective recommendations to meet the standard, but costs are unknown at this time. The market for inputs into biofuels production and also for the biofuels themselves exhibit a significant level of volatility. There is a significant level of uncertainty about the likely future costs of production and the market price of biofuels.

Additional Benefits and Costs

Use of biodiesel reduces diesel particulate matter emissions, which have adverse public health effects. Use of ethanol also reduces air pollutant emissions.

Feasibility Issues

There are feasibility issues associated with transporting large volumes of biofuels to and within the state, as well as distributing biofuels to consumers. For example, ethanol has historically not been moved in the pipeline network used for transport gasoline and diesel fuel. However, the pipeline industry is currently in the process of adapting technology for pipeline distribution of ethanol.

Status of Group Approval

Complete.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

TLU-2. Low Rolling Resistance Tires and Other Add-On Technologies

Low-rolling-resistance (LRR) tires can reduce vehicle fuel use and associated carbon dioxide (CO_2) emissions. A 10 percent reduction in rolling resistance improves fuel economy by approximately 1-2 percent for an average passenger car. The theoretical limit for fuel savings (assuming 100 percent reduction in rolling resistance) has been estimated at about 14 percent for passenger cars. Differentials of 20 percent or more in rolling resistance have been found among currently available new tires having the same size, traction characteristics, and speed ratings.

Manufacturers currently use LRR tires on new vehicles, but they are not easily available to consumers as replacement tires. When installing original equipment (OE) tires, carmakers use LRR tires as a way to contribute to meeting the federal corporate average fuel economy (CAFE) standards. When replacing the original tires, consumers often purchase less efficient tires. For example, while the majority of OE passenger tires have rolling resistance coefficients (RRC) between 0.006 and 0.010, the range for replacement passenger tires tends to be higher with the RRC's between 0.007 and 0.014. An average passenger tire has an RRC of 0.01, the high end of the range for OE passenger tires.

Both design and operation characteristics affect the rolling resistance of tires. A tire's construction, geometric dimension, material types, formulation, and volume all affect its rolling resistance. A tire's tread has a particularly major affect on rolling resistance, but can also affect tire life and the resultant number of scrap tires, and therefore may not be a desirable means for improving rolling resistance. On the operations side, load, inflation pressure, alignment, and temperature all affect a tire's rolling resistance.

Thus, there are three avenues by which the rolling resistance of tires may be reduced, and fuel economy improved as a result:

- Consumers could purchase more tires that are now available and have lower rolling resistance;
- Tire designs could be modified and new technologies could be introduced to reduce rolling resistance;
- Vehicle operations could be improved, especially through improved maintenance of tire inflation.

Currently, tire manufacturers and retailers are not required to provide information about the fuel efficiency of replacement tires. In addition, there is no current minimum standard for fuel efficiency that all replacement tires must meet. State policy and action can help bridge this gap through a variety of mechanisms. State policy can improve the fuel economy of the light duty vehicle (LDV) fleet by setting minimum energy efficiency standards for replacement tires and requiring that greater information about LRR replacement tires be made available to consumers at the point of sale. Information can also be provided to consumers about fuel efficiency and cost in relation to the purchase, maintenance, and operation of their vehicles. State policy can encourage or provide information on complementary add-on technologies that could facilitate vehicle operation practices that improve fuel efficiency.

One example of these technologies would be the addition of 'real-time' indicators of miles per gallon (mpg) for those vehicles that do not already provide such information to motor vehicle operators. The installation of technologies that provide drivers with current fuel efficiency (mpg) information has the potential to increase driver awareness of fuel consumption rates under different vehicle operating conditions.

In addition to receiving real-time information on mpg while their vehicles are in operation through mpg indicators, drivers could also receive alerts when tire pressure is too low through devices such as the Air Alert Valve Caps. Generally, a set of four light-emitting diode (LED) self-calibrating tire pressure valve caps such as Air Alert cost about $22.00, and real-time mpg monitoring systems such as ScanGauge are about $100.00.

Policy Design

Goals: Require that replacement tires be LRR tires that achieve an average 4.0 percent gain in fuel economy for the light-duty vehicle (LDV) fleet, including light-duty trucks, without reducing tire lifetime or otherwise increasing the lifecycle carbon footprint of the tires.

Timing: The requirement would phase in beginning in 2011, reaching the 4 percent gain no later than 2030. Intermediate targets may be set as necessary to ensure achievement of the policy goal as soon as feasible.

Parties Involved: State government; automobile and industries.

Implementation Mechanisms

An appropriate state agency would initiate a fuel-efficient tire replacement program. The program could include consumer education, product labeling, and minimum standards elements. The program would include consideration of the technical feasibility and cost of such a program, the relationship between tire fuel efficiency and tire safety, potential effects upon tire life, and impacts on the potential for tire recycling. In addition, the program may determine it necessary to exempt certain classes of tires that sell in low volumes, including specialty and high-performance tires.

The minimum standard is likely to be less stringent than the standard for energy efficiency of original equipment tires. Such a regulation would improve the fuel efficiency of the overall LDV fleet but not necessarily the fuel efficiency of all tires since consumers would still make choices in the marketplace. The replacement tires in the future would be on average more fuel efficient than those historically purchased, but are likely to be, on average, not as fuel efficient as the tires included as original equipment by the automobile manufacturers.

Information and Education

Provide information to the general public and commercial businesses (for example, taxi and food delivery services) that use LDVs for daily business explaining that improved fuel efficiency is directly related to the decreased rolling resistance of a vehicle's tires. Information on the potential annual cost savings of using LRR tires would also be provided. For example, a car averaging 15,000 miles/year would have annual fuel savings of about $100. A chart of recommended tire models would be included with information on product labeling and minimum standards elements. Best scientific information, including the results from tests conducted by the tire manufacturers, the California Energy Commission, and the National Academy of Sciences (NAS), would be reviewed and incorporated.

The manufacturers of the LRR tires would be contacted to encourage the promotion of their products through regional newspaper and television advertising. The producers of LRR tires may freely provide promotional materials.

Promotion and Marketing

State lead by example—The state will lead by example by initiating a fuel-efficient replacement tire program. This would include all-weather fuel-efficient tires and would require legislative approval for rental rates for vehicles, both owned and leased.

Over time, all state fleet tires in need of replacement will be changed to LRR tires, if available for the vehicle type and season.

- Encourage procurement of LRR tires for other vehicle fleets. Encourage local/county governments to act consistently with standards and support state procurement on their behalf.
- Encourage federal agencies located within the state to act in accordance with and support state actions.
- Encourage businesses that depend on vehicles to conduct their daily business to act in accordance with and support state actions.

Voluntary LRR standards—Establish voluntary LRR standards that achieve an average 4.0 percent gain in fuel economy.

Marketing program—Develop a marketing program for tire dealers and consumers to encourage the purchase of LRR tires. This effort might include a voluntary labeling program for tire fuel efficiency.

University research—Encourage the Florida University System to conduct research on alternative noncombustible applications for used tires.

Web site—All state-supported programs would have dedicated detailed Web sites. In addition to information and materials, program participation and success stories by the various governmental agencies and individual businesses would also be documented and extolled.

Technical assistance—Contact the LRR manufacturers and tire distributors to coordinate objectives and obtain technical support for outreach materials.

Funding mechanisms and/or incentives—Replacement of tires on state fleet vehicles is already budgeted through the Florida Department of Transportation (FDOT) annual funding processes.

Voluntary and/or negotiated agreements—Work with the manufacturers and affected parties to achieve objectives with flexibility in their timelines.

Codes and standards—The State of California and Germany have developed substantial information pertaining to LRR tires because of legislative actions that require tires to be replaced with more efficient ones. Their documentation identifies testing methods and LRR standards. The appropriate state agency can review the information and establish suitable Florida standards.

Pilots and demonstrations—Coordinate with product developers to help them promote their technologies.

Reporting—The state will develop a system for tracking purposes so it can eventually determine the turnover to LRR tires and the benefits achieved from the conversion. A simple tracking system would be established relatively easily by contacting the primary tire distributors of the major Florida cities on an annual basis, and estimates can be gathered from their inventories.

Enforcement—No enforcement actions will be necessary when the program is instituted as a voluntary program. After mandatory labeling is in effect, spot checks at the primary tire distributors in the main Florida cities would be conducted annually by the county health departments and state staff.

Related Policies/Programs in Place

In October 2003, California adopted the world's first fuel-efficient replacement tire law (AB 844 [Assembly Bill 844]). This law directed the California Energy Commission to develop a State Efficient Tire Program that includes the following elements: (1) develop a consumer education program, (2) require that retailers provide labeling information to consumers at the point of sale, and (3) promulgate through a rule development process a minimum standard for the fuel efficiency of replacement tires sold. The California rule development process began in January 2007. More information about the California Fuel Efficient Tire Program may be found at: http://www.energy.ca.gov/tires/

Estimated GHG Reductions and Net Costs or Cost Savings

It was assumed that this policy would have the effect of improving the fuel economy—by 4 percent on average—of all light-duty gasoline and diesel vehicles (including light-duty trucks) that installed replacement tires in 2030. It was assumed that this improvement would be phased in linearly over a 20-year time frame starting in 2011 and ending in 2030. For example, fuel economy is assumed to improve by 0.20 percent in 2011, by 0.40 percent in 2012, and so on until the maximum 4 percent improvement is attained in 2030. The improvement applies to all vehicles scheduled to replace tires during a given year. It is assumed that vehicles are scheduled to replace tires approximately every 45,000 miles.

Table C-2-1. Effect on GHG Emissions, Fuel Consumption, and Costs

	2010	2017	2020	2025	Units
Gallons of Gasoline/Diesel Saved	0	195	284	402	Million Gallons
Cumulative Fuel Savings (2008 & forward)	0	661	1,428	3,209	Million Gallons
GHG emission savings	0	0.80	1.21	1.84	$MMtCO_2e$
Cumulative Net present value (2008 & forward)	$0	-$253	-$544	-$1,259	$ Million
Cumulative emissions reductions (2008 & forward)	0	2.81	6.04	13.99	$MMtCO_2e$
Cost-effectiveness	N/A	-$90	-$90	-$90	$/MtCO_2e$

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; N/A = not applicable; $/MtCO_2e$ = dollars per metric tons of carbon dioxide equivalent.

Data Sources:

- Tires and Passenger Vehicle Fuel Economy, Transportation Research Board/National Research Council (NRC), 2006. This report may be accessed on the web at: http://onlinepubs.trb.org/Onlinepubs/sr/sr286.pdf
- California State Fuel-Efficient Tire Report, California Energy Commission, January 2003. This report may be accessed on the web at: http://www.energy.ca.gov/reports/2003-01-31_600-03-001F-VOL1.PDF and at http://www.energy.ca.gov/reports/2003-01-31_600-03-001CRVOL2.PDF.

Quantification Methods:

In order to quantify the LRR tire policy for the State of Florida, CCS used the Vehicle Energy and Greenhouse Gas Assessment Tool (VEGA Tool), in conjunction with data available from two existing assessments reference above: *Tires and Passenger Vehicle Fuel Economy* (2006 TRB Report) and *California State Fuel-Efficient Tire Report* (2003 California Study). In addition, CCS assumed a cost-effectiveness of $90 per metric ton for this policy based on previous experiences with this type of policy. The sections below summarize the major conclusions form the 2006 TRB Report and the 2003 California Study, as well as the VEGA Tool methodology.

2006 TRB Report

At the request of the United States Congress, the National Research Council of the National Academy of Sciences (NRC/NAS) conducted a study of the feasibility of reducing rolling resistance in replacement tires titled "Tires and Passenger Vehicle Fuel Economy" published in 2006 by the Transportation Research Board (2006 TRB Report). The study made the following conclusions that are relevant to the quantification of this policy:

- "Reducing the average rolling resistance of replacement tires by a magnitude of 10 percent is technically and economically feasible."
- "In the committee's view, there is much evidence to suggest that reducing the average rolling resistance of replacement tires by a magnitude of 10 percent is feasible and attainable within a decade."
- "Tires and their rolling resistance characteristics can have a meaningful effect on vehicle fuel economy and consumption."

The report's conclusions listed above guided development of this policy's goal level and timing.

2003 California Study

CCS also evaluated the 2003 California study. The 2003 California Study, commissioned by the California Energy Commission, found that about 300 million gallons of gasoline per year can be saved in that state with LRR tires. The study also found that a set of four LRR tires would cost consumers an estimated $5 to $12 more than conventional replacement tires. The fuel-efficient tires would reduce gasoline consumption by 1.5 percent to 4.5 percent, saving the typical driver up to $145 over the approximately 50,000-mile life of the tires, assuming a $1.53/gallon gasoline price, according to the study. Consumers would save more than $470 million annually at current retail prices or approximately $1.4 billion over the 3-year lifetime of a typical set of replacement tires.

VEGA Tool Methodology

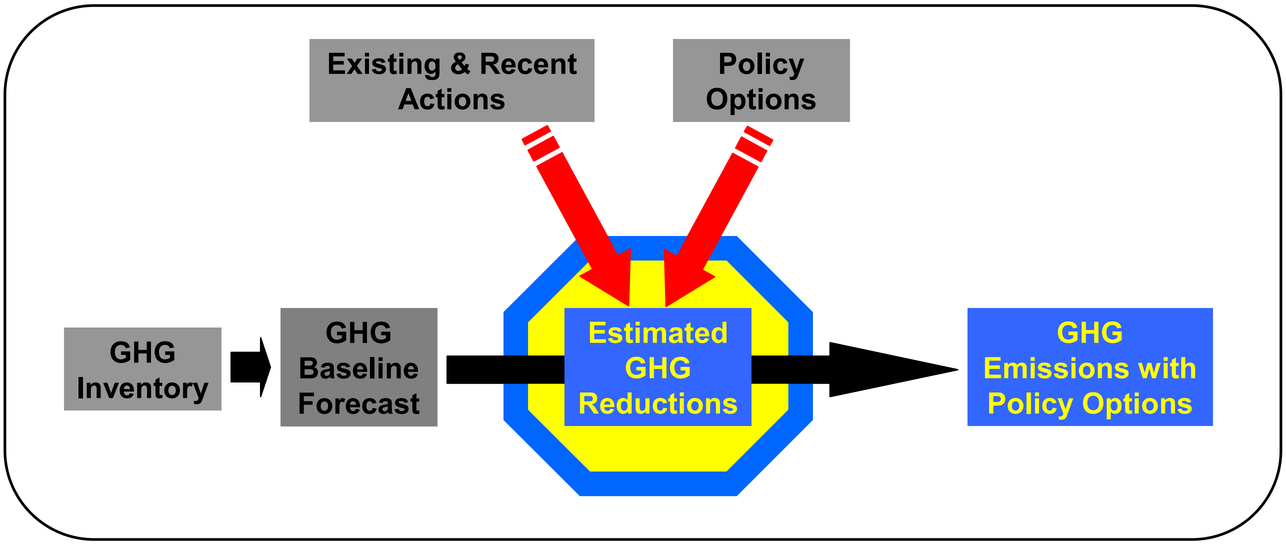
The VEGA Tool was developed by the CCS team to support their role in the Florida State Climate Action Plan process, to conduct analysis of various policies affecting GHG emissions from the on-road transportation sector.

Figure C-2-1 illustrates schematically how the VEGA Tool operates. The grey boxes represent the inputs required: State GHG Inventory and Forecast data, existing actions, recent actions, and the policy recommendations to be analyzed. The tool helps the analyst quantify the existing actions, recent actions, and policy recommendations by translating them into three aspects of on-road transport that affect on-road vehicle emissions of greenhouse gases:

1. Fleet Characteristics: Types of vehicles being driven?
    - Fuel Economy: The average miles per gallon for each model year and vehicle class
    - Vehicle Class Distribution: The portion of the vehicle fleet falling into each of the 28 vehicle classes defined by the Mobile6 model (light-duty gas vehicles, light-duty gas trucks – type 1, …)
    - Fleet Turnover Rate: The rate at which new cars are introduced and older cars are retired from the vehicle fleet

2. Fuel Characteristics: Types of fuel these vehicles use?
   - Fuels Used
   - Emission Rates of Fuels: Greenhouse gas emitted per unit of fuel?
3. Travel Habits (VMT): How much are the vehicles being driven?

Figure C-2-1. Vega Tool Overview



The above parameters, also illustrated in figure C-2-2, can be adjusted by the analyst to best reflect a given action or policy recommendation. The VEGA Tool then combines these parameters to estimate what the greenhouse gas emissions would be should the policy be implemented.

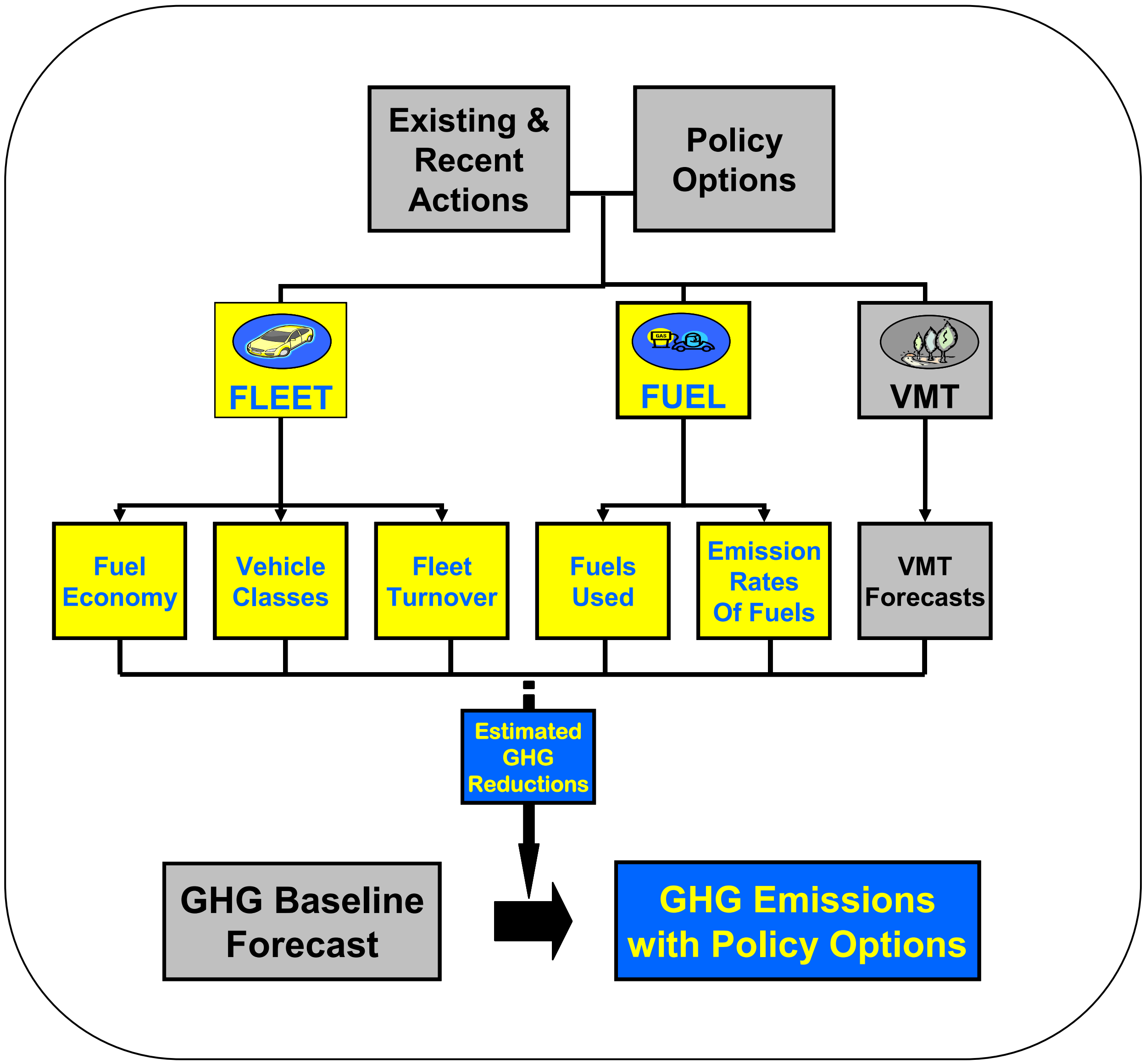
The LRR tire policy affected the fuel economy parameter. It was assumed that the improvements in fuel economy resulting from the LRR tire policy would phase in linearly over a 20 year timeframe starting in 2011 and ending in 2030. For example, fuel economy was assumed to improve by 0.20 percent in 2011, by 0.40 percent in 2012, and so on until the

maximum 4 percent improvement was attained in 2030. Only vehicles scheduled to replace tires during a given year would have improved fuel economy. A tire replacement schedule was estimated for each vehicle class based on average mileage accumulation rates available from EPA's Mobile6 model and assuming that vehicles replace tires approximately every 45,000

Figure C-2-2. Vega Tool Analysis Parameters

miles. In addition, fuel economy improvements were calculated for each vehicle class and model year affected by the policy. It was assumed that the policy would affect all light duty vehicles and trucks.

Figure C-2-2. Vega Tool Analysis Parameters



Once all of the parameters have been defined, the tool uses the following general methodology to estimate fuel savings and GHG reductions. The vehicle miles traveled (VMT) and fuel economy (mpg) are combined to estimate fuel consumption (gallons). The difference between fuel consumption under baseline and policy recommendation conditions is the estimate change in fuel consumption which would result from implementation of the policy recommendation.

The estimated change in fuel consumption is translated into an estimated change in greenhouse gas emissions.

For this analysis, the baseline fuel consumption assumed that the new Federal CAFE standards were in effect.

Key Assumptions:

The estimate of costs associated with LRR replacement tires accounts for faster tire wear (assuming that tires have lower tread) and an increase in the cost of production that is passed through to consumers. According to the 2006 TRB Report, consumers would pay an additional $12.00 per year to replace tires (including installation), and they would pay an additional $1.00 per tire due to increased production costs. This is a conservative assumption regarding consumer costs. The 2006 TRB Report policy points out that "…if tire life is shortened by as little as five percent, all or a significant portion of the annual fuel savings associated with lower rolling resistance would be offset."

On the other hand, the GHG reductions estimated for this policy assume that there would be no reduction in average tire life as a result of this policy. A reduction in tire wear life would increase the number of tires purchased, as well as the number of scrap tires, thus increasing the overall carbon footprint associated with tire use. In terms of GHG reductions, it is preferable that tire wear life be maintained (not be reduced) as a result of implementation of this policy.

Key Uncertainties

The LRR fuel-efficient tires program could begin to be implemented based upon existing off-the-shelf technologies and products that already exist in the consumer marketplace.

Additional Benefits and Costs

This analysis focused on the effects on tailpipe emissions resulting from the LRR tire policy. Additionally, costs or benefits may accrue from changes to the life cycle costs associated with tire production and tire scraps depending on the methods employed to improve the average rolling resistance of the replacement tire population. For example, some methods for reducing rolling resistance would reduce tire life offsetting a portion of the greenhouse gas reductions and cost savings. But, there are technically and economically feasible ways to improve rolling resistance without degrading tire life. Policies and regulations can be crafted to ensure that tire life is maintained. This policy should be implemented so as to minimize negative impacts on life cycle costs and weigh them against the benefits of improved fuel economy and reduced GHG emissions.

Feasibility Issues

None noted.

Status of Group Approval

Complete.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

TLU-3. Smart Growth Planning

Policy Description

Smart Growth Planning looks at how land use planning, site planning, and urban design at the community level can help achieve carbon and GHG emission reduction goals. The essence and intention of smart growth within the context of climate change is to establish a policy framework, clear guidelines, and measurement parameters for the development of new (and the redevelopment of older) human habitat communities that will have a net-zero-carbon effect on the general environment and reduce overall GHG emissions. This can be accomplished through the complex interactions of the three primary elements of community development that have a direct impact on GHG emissions and affect climate change:

- Construction energy and building lifetime energy use—measured by the protocols of Leadership in Energy and Environmental Design (LEED™) Green Building Rating System, Green Globes, or the Florida Green Building Coalition (FGBC);
- Individual vehicle miles traveled (VMT) generation and other transportation energy use (for example, deliveries, maintenance, buses, security, health, fire, and safety) necessary to support human communities; and
- The changing of land uses from carbon-sequestering land uses (for example, forests, agriculture, parks, and wetlands) to carbon-releasing land uses (for example, building sites and roadways) and development patterns.

Taken singularly in isolated policies, these three factors—land use changes, individual VMT and transportation energy use in necessary daily lifestyle support, and the life cycle energy use of buildings—may not be able to achieve the necessary reductions in GHG emissions to meet climate change goals. Considered together in an integrated set of policies and guidelines, however, they can accomplish the goal of a carbon-neutral footprint for human community activities.

There are multiple levels at which VMT generation can be managed. This section focuses on VMT generation from land use planning, site planning, and an urban design perspective at the community level. In addition to this, the following policies focus on reducing VMT by transportation system management (TSM; covered in TLU-4), increasing mode choices (TLU-5), and land use–transportation coordination (TLU-6). Smart growth planning also helps reduce VMT.

In the aggregate, measured at various levels of development from small to large, the balance of carbon-sequestering and carbon-releasing land uses must *at least* balance and eventually become negative in releasing carbon to reduce GHG emissions and reverse existing adverse trends in our atmosphere.

In accordance with Florida's schedule for increasing standards for both building energy efficiency and appliance energy efficiency outlined in HB 697 and HB 7135, community development and redevelopment patterns should follow a similar schedule of reduced overall energy use and increased efficiencies, thereby reducing GHG emissions and the energy and resources necessary to provide all the requisites for human lifestyle support.

Policy Design

Goals:

- Require that municipalities increase the penetration of green initiatives into all aspects of their operations and programs by adopting an approach that encourages internal and external stakeholders to work together to develop integrated energy and environmental solutions to reduce GHG emissions through multi-pollutant prevention, environmental improvements, greater operational efficiency, and expanded public acceptance of green initiatives.
- Require that community development proposals submitted for review are certified by LEED, Green Globes, FGBC, or other approved certification to ensure that the new development results in a net reduction in GHG emissions relative to a business as usual (BAU) baseline scenario.
- Encourage and incentivize communities to adopt programs requiring buildings larger than a certain number of square feet (sq ft)—for example, 25,000 sq ft or 50,000 sq ft—to have LEED Silver, Green Globes, or the FGBC certification.
- Develop and adopt a State of Florida minimum set of Green Building Standards (as has been developed in California and is being considered in other states).
- Work with LEED, Green Globes, and FGBC to establish both standards and a review methodology to ensure that new development and its location results in a net reduction in GHG emissions relative to a BAU baseline scenario.
- Minimize GHG emissions from development through a phased-in approach with both short-term and long-term goals.
- Encourage compact urban development and mixed use development.
- Maximize the ability to appropriately retrofit existing buildings using development standards. Address the retrofitting and remediation of existing buildings through consideration of both existing development and redevelopment as appropriate.
- Encourage pedestrian-friendly development and urban infill development.
- Encourage and incentivize communities to adopt and support LEED-ND (LEED-Neighborhood Development), Green Globes neighborhood design, or the FGBC neighborhood design standards, currently in the pilot project testing phase.

- Require that local governments adopt site planning and urban design standards that help reduce VMT and GHG emissions, such as:
  - Encourage communities to adopt design standards that increase street network density and connectivity in new development and redevelopment projects (for example, reduce cul-de-sacs and increase street network densities)
  - Encourage pedestrian friendly environments by
    - Create design guidelines that require main entries of all residential, retail, and commercial buildings to be directly accessible from sidewalks;
    - Incentivize greater sidewalk coverage in all future residential, commercial, and retail developments (meaning that all streets within such developments should have sidewalks);
    - Provide incentives to design or locate residential projects consistent with LEED, Green Globes, or the FGBC standards to encourage a greater proportion of dwelling units to be developed within a one-half mile walking distance of at least two or more commercial, retail, or entertainment centers.
  - Encourage mixed use development that increases the job–housing balance by giving incentives to increase floor area ratio (FAR) for mixed use projects
  - Encourage or require compact development. Encourage counties and municipalities to adopt incentive programs that allow building owners to exceed building height and density limits if a building meets the LEED, Green Globes, or the FGBC standards. This will help reduce emissions from VMT as well as from building operations

Timing: Establish a consortium of universities to provide both research and training to local, state, and regional officials as they implement the goal that new development does not increase GHG emissions.

Parties Involved: Local, state, and regional governments, private property owners, development companies, and investors.

Implementation Mechanisms

Maximize the opportunities to retrofit existing buildings to meet LEED, Green Globes, FGBC, or other approved certification programs to reduce energy consumption and thus reduce GHG emissions.

Establish incentives and promote redevelopment projects that establish more energy-efficient land use patterns. Redevelopment should result in a mix of uses that result in a reduction of VMT when compared with the existing land use pattern.

Related Policies/Programs in Place

Potential overlap with ESD-13a [Energy Supply and Demand 13-a], ESD-13b, and ESD-14.

Governments and government agencies are beginning to require that all new buildings meet certain LEED, Green Globes, and the FGBC certification threshold standards. In 2003, for example, the U.S. General Services Administration, which manages 1,800 federal buildings, began requiring all new building projects to strive for the LEED Silver, Green Globes, or the FGBC standards and, at a minimum, to meet the LEED, Green Globes, or the FGBC standards for basic certification.

State-Level Initiatives: Governors in Arizona, California, Colorado, Maryland, New Mexico, and Rhode Island have signed recent executive orders requiring all new construction to meet LEED requirements. Other state and local governments have enacted similar requirements.

Financial Incentive Programs: Governments are also creating financial incentives to build green. In July 2005, the Pennsylvania Legislature created incentives rewarding new schools that were built to meet LEED Silver, Green Globes, or the FGBC certification requirements.

Development Incentives: In Arlington, Virginia, innovative incentive programs allow building owners to exceed building height and occupant density limits if a building meets LEED, Green Globes, or the FGBC standards. The permissible zoning variances increase for buildings that meet even higher standards—LEED Silver, Gold, and Platinum. In addition, buildings that fail to meet the LEED, Green Globes, or the FGBC standards are asked to contribute $0.03/sq ft to a Green Building Fund, that educates the public about the value of green building.

Tax Incentives: Other states, including Maryland, New York, and Oregon, provide tax incentives to encourage builders to meet LEED requirements. Santa Monica, California, and Issaquah, Washington, provide for the accelerated review of building permits to boost green construction.

Estimated GHG Reductions and Net Costs or Cost Savings

Potential levels of GHG emissions reductions are not estimated at this time. Many development characteristics are location-dependent and, as a result, are complex to aggregate to a statewide level. Some portions of the GHG emissions reduction potential are incorporated into complementary policy actions in TLU, AFW, and ESD sectors.

An important indication of the potential for savings comes from analyses of LEED-certified buildings. The most obvious benefits from green buildings relate to lower environmental and operating costs, that result from improved energy and water efficiency. Green buildings have documented energy-efficiency improvements ranging from 25 percent to 65 percent, and water-efficiency improvements up to 90 percent. The resulting financial savings are sufficient to offset any concerns about potential small increases in initial cost.

It is recommended that the State of Florida undertake a study to estimate the potential energy savings and GHG emissions reductions associated with different scenarios for development, with a focus on the numerous urban metropolitan areas within the state.

Key Uncertainties

Patterns of development are subject to economic cycles and many private investment decisions.

Additional Benefits and Costs

Smart Growth can result in additional co-benefits, including health benefits, economic development benefits, and accessibility benefits.

Feasibility Issues

None noted.

Status of Group Approval

Complete.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

TLU-4. Improving Transportation System Management (TSM)

Policy Description

Transportation System Management is the concept of pairing transportation demand with transportation supply to help transportation networks serve the demand in an effective and efficient manner. Effective system management may utilize a variety of strategies based on advanced technologies, market-based incentives, regulations, and design standards. Each strategy provides a relatively small benefit to GHG reduction, but when applied in concert, substantial gains can be achieved. TSM strategies attempt to reduce the number of trips being taken by single-occupant vehicles (SOVs), shorten trip lengths, reduce vehicle delay, increase the reliability of the transportation network, and reduce idling and other transportation actions that result in increased GHG emissions. The goal of TSM is to reduce the daily VMT per capita on the transportation network. Effective TSM will also reduce vehicle hours traveled (VHT) per capita, which measures the amount of traffic congestion delay. Reduction of either VMT or VHT is highly correlated with a reduction in GHG emission.

TSM attempts to both improve transportation system performance and alter travel behavior through a combination of technological improvements, incentives, design, and restrictions. Technological improvements include traffic signal coordination, lane management, traveler information displays, and other intelligent transportation system applications. Incentives can include policies that financially favor desired behavior or allow users to gain a time advantage and include value pricing and smart parking strategies. System design is also important since infrastructure and technology can be adapted to encourage less driving, and it includes access management applications and intersection improvements. Finally, users can be barred from performing certain actions that would negatively impact the efficiency of the transportation system. TSM policies can be instituted at every level of government. Some can have a virtually instant effect, while others require many decades to reap full benefits.

Policy Design

Goals: Develop and implement policies and strategies that include program funding, financial and development incentives, infrastructure investment, and regulatory requirements to promote transportation system management improvements that result in reduced VMT and/or VHT which, in turn, result in reduced GHG emissions. These actions, taken in concert with other aggressive transportation and land use policy actions, should be designed to reduce urban area VMT by 7–10 percent by 2020 and by 9–12 percent by 2050; VHT can be reduced by amounts that are associated with these VMT reductions. VHT reduction is recognized as a means of reducing driver delay while also reducing excess fuel consumption in congested traffic.

- Reduce existing and future trips and trip lengths in an effort to reduce both VMT and VHT. Driving less, in terms of both hours and miles driven, will result in a decrease of GHG emissions. This can be achieved through the aggressive implementation of specific transportation demand management strategies and coordinated transportation and land use decision making.
- Distribute existing and future trips in terms of both time and geography—when trips are taken and where trips are taken—in order to reduce congestion and smooth traffic flow. Reducing congestion and smoothing traffic flow by changing people's driving patterns—either by changing the time of day they drive or the route they take—will result in less idling and stop-and-go driving. This will reduce VHT and GHG emissions and can be achieved through increased investment in supporting transportation infrastructure, implementation of specific TSM strategies, and the aggressive implementation of specific transportation demand management strategies.
- Improve transportation system operations to improve travel conditions on the transportation network. This includes traffic signal coordination, real-time traveler information, advanced computerized lane and parking space management, value pricing at toll locations, intersection improvements such as roundabout conversions, advanced incident management, and other traffic operations applications. This will reduce the frequency of transportation actions that contribute to high levels of GHGs (for example, jackrabbit starts, idling, and excessive braking). It will require an increased investment in TSM-related infrastructure and aggressive implementation of non-capacity operational strategies that improve the flow of vehicles on the transportation network.

Timing: TSM strategies have a variety of implementation time frames. Some, such as workplace-based strategies, can begin implementation almost immediately. Others that are based on infrastructure construction will have an implementation timeline of four to 10 years. Systemic changes to the urban landscape have the longest horizon—up to 25 years.

Parties Involved: State government agencies (FDOT, Florida Department of Community Affairs [DCA], and the Florida Department of Environmental Protection [DEP]), regional government (metropolitan planning organizations [MPOs], regional planning councils [RPCs], and regional transportation authorities [RTAs]), local transportation providers (public transit agencies, airports, seaports, and expressway/bridge authorities), and local governments.

Implementation Mechanisms

Collectively, the implementation mechanisms recommended under this policy attempt to reduce GHG emissions by enhancing system efficiency and modifying travel behavior and conditions through TSM strategies. Those strategies will require a combination of program funding, financial and development incentives, infrastructure and technology investment, and regulatory requirements implemented at the local, state, and regional levels.

Reduce Existing and Future Trips and Trip Lengths: These implementation mechanisms are intended to result either in the reduction of trip lengths or the complete elimination of certain trips. This will result in a reduction of both VMT and VHT that will reduce GHG emissions. Implementation mechanisms intended to reduce trips and trip lengths include

- Encourage and/or incentivize public and private sector employers to implement *telework programs* for eligible employees. This will result in fewer work-based vehicle trips.
- Encourage and/or incentivize public and private sector employers to implement *job-sharing* programs for eligible employees. This will result in fewer work-based vehicle trips.
- Encourage and/or incentivize public and private sector employers to implement *carpooling/vanpooling* programs for eligible employees. This will result in fewer work-based vehicle trips.
- Require and/or incentivize enhanced *coordination between land use and transportation decision making* to reduce distances between clusters of affordable housing and employment opportunities. This will reduce work-based vehicle trip lengths.

Distribute Existing and Future Trips in Terms of Both Time (When a Trip Is Taken) and Geography (Where a Trip Is Taken): These implementation mechanisms are intended to change peoples driving patterns and behaviors (either by changing the time of day that they drive or the route that they take), resulting in reduced congestion and smoother traffic flows. Reducing congestion and smoothing traffic flow will result in less idling and stop-and-go driving which, in turn, will result in fewer GHG emissions. Implementation mechanisms intended to change people's driving patterns and behaviors include

- Encourage and incentivize transportation facility operators to implement *value-pricing (variable-pricing) policies.* This will encourage travelers to change the time of day they make various types of trips and result in fewer vehicle trips during peak operating hours. Alternatively, this will encourage travelers to change the routes by which they make various types of trips and will result in a more even distribution of vehicle trips across the transportation network.
- Encourage and incentivize public and private parking facility operators to implement *smart parking policies.* This will encourage travelers to change the time of day they make various types of trips and will result in fewer vehicle trips during peak hours.
- Encourage and incentivize local governments and private developers to build up the *supporting transportation network* (e.g., lower functional class street network), improve local transit routes that support express bus routes and premium transit options, and construct more sidewalks and bike paths). This will encourage travelers to make appropriate route and mode choices and result in a more even distribution of vehicle trips across the transportation network.

- Encourage and/or incentivize public and private sector employers to implement *flex time and compressed time programs* for eligible employees. This will result in fewer work-based vehicle trips during peak hours and, in the case of compressed time programs, fewer work-based trips overall.

Improve transportation system operations to reduce occurrences of transportation actions that contribute to high levels of GHGs (e.g., jackrabbit starts, idling, and excessive braking). These implementation mechanisms are intended to maximize the efficiency of the transportation system through the application of technology and advanced design. Management of the supply of transportation capacity through the application of various technologies and design strategies will result in reduced congestion and smoother traffic flows which, in turn, will result in less idling and stop-and-go driving and reduced GHG emissions. Implementation mechanisms intended to change people's driving patterns and behaviors include

- Increase investment in *intelligent transportation system* (ITS) technologies at all levels. In particular, investment should be focused on technologies that smooth the flow of traffic (e.g., reducing congestion, braking, and idling), resulting in a reduction of VHT and GHG emissions.
- Increase investment in *incident management programs* and technologies. Quickly responding to incidents will reduce the negative impacts that incidents have on the smooth flow of traffic. Incident management can also include roadside assistance programs such as FDOT's "Road Rangers." Incident management will result in a reduction in incident-related stop-and-go traffic, in turn reducing VHT and GHG emissions.
- Increaseinvestment in *traffic signal coordination.* This will smooth the flow of traffic on the roadway network and result in reduced idling, braking, and jackrabbit starts, in turn reducing VHT and GHG emissions.
- Encourage and/or incentivize *access management programs* at all levels, particularly those that coordinate land use and transportation decision making. This will reduce conflicts on the roadway and make vehicular movements more predictable (including for transit vehicles, bicyclists, and pedestrians). It will also result in smoother traffic flows and reduced stop-and-go traffic conditions, reducing VHT and GHG emissions.
- Increase investment in *traveler information technologies* will provide travelers with a more predictable travel experience and let them make rational choices that maximize their efficient use of the transportation network. This will result in less congestion and VHT and, in some cases, reduced VMT.
- Increase investment in *managed lanes technology.* Real-time lane management allows for the more efficient flow of vehicles through the transportation network, maximizing available capacity and smoothing traffic flow. This will result in less congestion and VHT and, in some cases, reduced VMT.

Related Policies/Programs in Place

None cited.

Estimated GHG Reductions and Net Costs or Cost Savings

Table C-4-1. Effect on GHG Emissions, Fuel Consumption, and Costs

	2010	2017	2020	2025	Units
GHG emission savings	**0.52**	**3.94**	**5.25**	**6.98**	$MMtCO_2e$
Net present value (2009–2025)				**-$5,106**	$ Million
Cumulative emissions reductions (2009–2025)				**63.91**	$MMtCO_2e$
Cost-effectiveness				**-$80**	$\$/MtCO_2e$

Data Sources:

Reducing Oil Use and CO_2 Emissions in the Transport Sector, International Energy Agency.

Improving Transportation Choices, Natural Resources Defense Council (NRDC).

Online TDM Encyclopedia, Victoria Transportation Policy Institute.

Saving Oil in a Hurry, International Energy Agency.

Quantification Methods:

Based on the implementation mechanisms and goals stated above, the recent literature was reviewed to identify appropriate effectiveness rates for the selected measures. Effectiveness rates were ramped up over an implementation period, typically 10 years, before full effectiveness was reached. Data were compiled using phase-in implementation periods and lagged penetration rates, as appropriate. Cost information was collected where available and applied on an annual basis consistent with ramp-up and penetration rates. In order to achieve the mode shift and VMT reduction that result from some of the measures, the cost of providing additional transit service to allow this mode shift was included. Fuel cost savings from the measures were also calculated and applied to the total net cost. The specific measures that were quantified were:

- Telework programs
- Jobshare/compressed work week

- Carpool/vanpool
- Parking freezes
- Value pricing
- Incident management
- Signal synchronization
- Traveler information
- Managed lanes
- Other ITS
- Smart parking policies
- Eco-driving

Key Uncertainties

The effectiveness of the operational and ITS strategies, particularly in the context of potential future technological changes, is by its nature somewhat speculative.

Additional Benefits and Costs

Transportation system management provides significant co-benefits, most particularly in congestion reduction. Other co-benefits include improved air quality and facilitating land use patterns such as smart growth.

Feasibility Issues

None noted.

Status of Group Approval

Complete.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

TLU-5 and TLU-6. Increasing Choices in Modes of Transportation and Factoring GHG Emissions into Transportation and Land Use Planning Processes

Policy Description

A. Factoring GHG Emissions into Transportation and Land Use Planning Processes

This recommendation seeks to ensure that local and state land use and transportation planning considers the impact of land use and transportation decisions on the reduction of GHG emissions. Transportation accounts for the second largest contributor to GHG emissions in Florida and represents approximately 40 percent of emissions in Florida.

Florida has a long history of comprehensive planning by local governments, the cornerstone of which was the enactment and amendment of the Local Government Comprehensive Plan (LGCP) and Land Development Regulation Act. Each local government is required to adopt a comprehensive plan that contains certain required elements: a capital improvements element; a future land use plan; a traffic circulation element; a general sanitary sewer, solid waste, drainage, potable water, and natural groundwater aquifer recharge element; a conservation element; a recreation and open space element; a housing element; a coastal management element (where appropriate); and an intergovernmental coordination element. Local zoning codes and land development regulations must be consistent with the policies articulated in the comprehensive plan.

In addition to the comprehensive plan, Florida has adopted as the cornerstone of its growth management transportation framework, a policy called concurrency. The policy is based on the premise that public facilities shall be in place concurrent with or prior to the impacts of a particular development. "Concurrency in Florida is tied to provisions in the state growth management act, requiring the adoption of level of service standards, elimination of existing service deficiencies, and provision of infrastructure to accommodate new growth reflected in the comprehensive plan. Plans and development regulations must aim at achieving and maintaining the desired level of service, and comprehensive plans are reviewed by the state for consistency between the capital improvement element and the various elements of the plan, including the future land use plan."[2]

With respect to transportation facilities, the general rule is that transportation facilities needed to serve new development shall be in place or under construction within three years after the local government approves a building permit or its functional equivalent that results in traffic generation. The implementation of transportation concurrency has been problematic, and the Florida Legislature has adopted a number of exceptions to the general policy. First, in 2005, proportionate fair share mitigation, or "pay and go" option for concurrency, was adopted that "allows developments to proceed under certain circumstances, notwithstanding a failure to

[2] Transportation Concurrency—Best Practices Guide, Florida Department of Community Affairs, p.6.

meet transportation concurrency, where applicants contribute their fair share of the cost of improving the transportation facility."[3] The improvement must be financially feasible within a 10-year time frame and be in or added to the five-year capital improvements element. Second, specific exceptions from the concurrency requirement are provided for certain public transportation facilities, infill or redevelopment projects, and projects whose impacts are considered insignificant or de minimis.

It is generally accepted that the implementation of the concurrency policy in Florida has had the unintended consequence of encouraging developers to build outside existing urban cores because of the lack of excess transportation capacity within these areas, thereby requiring expensive transportation improvements to meet concurrency standards. Development outside of the urban core results in longer trips (both commuting and non-commuting) that yield more VMT. Lower density development at the urban fringe and ex-urban development contributes to the premature conversion of natural and agricultural lands, thereby reducing the GHG buffering capacity of the landscape.

During the 2008 session of the Florida Legislature, the Legislature adopted HB 697, which was signed into law on June 17, 2008. The new law requires local governments to include in their local government comprehensive plans policies that address energy efficiency and the reduction of GHGs. The following elements of the comprehensive plan are amended to require

- Future Land Use Element—includes energy-efficient land use patterns and GHG reduction strategies.
- Traffic Circulation Element—includes strategies to reduce GHG reductions.
- Housing Element—addresses energy efficiency in design and construction of new homes.

HB 7135, amends the State Comprehensive Plan to include goals related to energy and global climate change. The bill also provides that each metropolitan planning organization (MPO) is encouraged to consider strategies that integrate transportation and land use planning "to provide for sustainable development and reduce greenhouse gas emissions."

On a broader scale, long-range visioning activities being conducted at the community and regional levels in Florida are identifying alternatives to current growth practices. Regional visioning enable communities to develop a comprehensive approach to planning for future land use, transportation, conservation, economic development, housing, and other community needs. It provides an opportunity for regions to alter current growth patterns, thus modifying future transportation needs and associated energy consumption by enabling people to make fewer trips, make shorter trips, or use alternative transportation modes.

In addition, FDOT produces the Florida Transportation Plan (FTP), a long-range plan that identifies the goals and objectives for the next 20 years to address the needs of the state

[3] Ibid.

transportation system. The FTP is a plan for all of Florida, not just FDOT, and establishes a policy framework to guide investment in the transportation system by all public and private partners.

A metropolitan planning organization (MPO) is made up of local elected and appointed officials responsible for coordinating transportation planning in a metropolitan area of at least 50,000 people. The 26 MPOs in Florida are responsible for developing long-range transportation plans (LRTPs) and programs, and for setting transportation funding priorities for the metropolitan areas (s. 339.179, F.S.). These LRTPs are developed based upon future land use and growth assumptions contained in the LGCPs. FDOT's five year work program is developed based on the project priorities submitted annually by the MPOs and county commissions from counties not included in MPO areas.

B. Increasing Choices in Modes of Transportation

An important strategy in reducing GHG emissions produced from transportation sources is reducing the growth rate in VMT per capita. Providing modal alternatives to the single-occupancy vehicle (SOV) can reduce the number of trips on the highway system and VMT per person. Modal alternatives can include bus transit, rail transit, paratransit, ridesharing, greenways, on and off-road bicycle facilities, and all types of pedestrian facilities.

Public transit vehicles generate much lower levels of GHGs per person-mile than SOVs. The challenge is that transit (bus and rail) accounts for only two percent of trips made in the United States today, compared with percent percent in Canada and 10 percent in Western Europe.[4] An expansion of transit services will require a substantial increase in funding for both infrastructure and operations. Increased transit use is key to reducing the growth rate of VMT. A higher rate of transit use can be achieved by expanding transit services, increasing transit's competitiveness with other modes, ensuring safety and security of transit systems, and educating the public about transit options available in their community.

Many employers partner with local governments and nonprofit agencies to promote and fund local carpooling and vanpooling programs. These rideshare alternatives, combined with employee incentives, telecommuting, and parking strategies are often effective in reducing travel demand and ultimately, VMT. High-occupancy vehicle (HOV) lanes or high-occupancy toll (HOT) lanes on major transportation corridors can encourage ridesharing by providing reduced travel times and/or tolls for vehicles carrying multiple passengers.

Bicycling and walking do not generate GHGs. A convenient and comprehensive bicycle and pedestrian network can be a pleasant, stress-free option to driving on congested roadways. Although each modal alternative by itself may not significantly reduce GHGs, an integrated system of bicycle, pedestrian, and public transportation facilities could provide a significant benefit in enhancing mobility while reducing the growth rate in VMT.

[4] Transportation Research Board. 2001. "Making Transit Work: Insight from Western Europe, Canada, and the United States—Special Report 257, Washington, D.C.

Policy Design

A. Factoring GHG Emissions into Transportation and Land Use (TLU) Planning Processes

Goals:

6.1—All local government comprehensive plans shall be revised to include policies and objectives that address energy-efficient land use and GHG reduction strategies, including policies that:

- Increase density within the urban service area;
- Prioritize compact development and maximize internal trips within the development;
- Prioritize transit-oriented development within urban service areas and encourage the use of transit;
- Prioritize affordable workforce housing in proximity to major employment centers;
- Prioritize targeted infrastructure investments in GHG-efficient locations;
- Encourage the reduction of trip length and vehicle hours of delay; and
- Prioritize the preservation of green space, natural, and agricultural areas.

Florida DCA is initiating a rulemaking process to comply with recently passed state law on these issues.

6.1(a)—Any future plan amendment must be supported by data and analysis to demonstrate how the amendment is based upon energy-efficient land use patterns and GHG reduction strategies.

6.1(b) — Require local governments to adopt minimum densities that apply within the urban development boundary or urban service area.

6.2—By December 31, 2009, all local governments shall adopt land development regulations that implement the amended policies that address energy efficiency and GHG reduction strategies.

6.3—By July 1, 2009, amend the LGCP and Land Development Act to allow local governments to enact mobility fee structures as an alternative to transportation concurrency.

6.4—By December 31, 2010, amend the FTP to develop goals, objectives, and strategies for addressing climate change, reducing GHG emissions, and providing modal alternatives to highways for travel.

6.5—By July 1, 2010, review state law to identify programs that fund capacity improvements and should be amended to include GHG emissions in the funding criteria.

6.6—By July 1, 2010, modify the Efficient Transportation Decision Making (ETDM) process to include climate change considerations (for example, VMT and GHG emissions) in the evaluation of candidate projects for long-range transportation plans and the five-year transportation work program.

6.7—All MPOs should address expanding transit options and reducing GHG emissions during the update of LRTPs and subsequent development of project priorities.

6.8—By July 1, 2009, require all transportation authorities to give priority to projects that reduce VMT and consider the GHG impact of constructing new roads.

6.9—By date 2020, reduce VMT and associated VHT within urban service areas by 10 percent on a per capita basis, through land use and other supportive travel reduction strategies. Start goal levels with 10 percent and then project out for the other milestones in the Governor's Executive Order until at least 2025. The Florida GHG emissions targets established under the Governor's Executive Order 07-126 are 10 percent below current levels by 2012, 25 percent below current levels by 2017, and 40 percent below current levels by 2025.

6.10—By July 1, 2009, establish growth policies that provide incentives for developing regional visions that integrate transportation and land use planning to provide for sustainable growth and reduce GHG emissions.

6.11—Assess Impact Fees Programs for effectiveness and suggest improvements to incentivize reductions in GHG emissions impacts.

6.12—Reevaluate level of service (LOS) standards for local governments.

6.13 Federal, state, regional and local governments should seek to leverage and expand funding opportunities to meet current and future public transportation needs(for example, expand authority to levy the Charter County Transit Surtax to all counties).

6.14 — FDOT and DEP should work with the US Department of Transportation and Environmental Protection Agency to improve modeling tools for assessing GHG emissions for transportation plans and projects. Once developed, these modeling tools should be used to evaluate the GHG emissions impact of transportation choices.

6.15— Maximize the use of existing transportation infrastructure before building new roads.

B. Increasing Choices in Modes of Transportation

Goals: Double transit ridership to equal levels found in Canada. The scenario for analysis shows a doubling of ridership by the year 2025. Increase the percentage of people that walk, bicycle, carpool, vanpool, or telecommute. Develop and implement policies and strategies that include program funding and financial incentives that expand non-automobile infrastructure and provide modal alternatives to SOV travel.

Timing: 1–30 years.

Parties Involved: Public transit agencies, local governments, MPOs, RTAs, FDOT, and local businesses.

Implementation Mechanisms

A. Factoring GHG Emissions into Transportation and Land Use (TLU) Planning Processes

To assist local governments in implementing the requirements of HB 697, the Florida DCA should prepare model comprehensive plan policies to address the new policies required in the Future Land Use Element, Traffic Circulation Element, and the Housing Element. Provisions in Florida law that govern the Florida Transportation Planning Process should be amended to require consideration of GHG reduction in setting and prioritizing transportation projects. Priority should be given to projects that reduce GHG emissions or encourage compact development in urban areas. RTAs should also be required to consider GHG reduction in the setting of project priorities.

B. Increasing Choices in Modes of Transportation

Improve Availability and Accessibility of Service

- Create new public transportation systems and options, including bus rapid transit (BRT). New transit systems and routes can serve areas presently without transit, or they can add new destinations from areas currently served.
- Encourage local governments and developers to provide and expand bicycle and pedestrian networks. A more complete infrastructure will entice travelers to shift from SOVs to walking or bicycling for appropriate trips. Better bicycle and pedestrian access also promotes transit use, since all transit trips begin and end as pedestrian trips.
- Create new rail systems for passengers and freight. Work with rail companies to expand intercity passenger services. Partner with ports and rail lines to expand freight rail facilities to reduce the need for trucks on the roadways and incorporate rail services in the planning and design of new transportation corridors.
- Construct new and/or expand existing HOV or HOT lanes. This will encourage travelers to shift from SOVs to HOVs for all types of trips, particularly during peak hours. Transit vehicles can also use HOV/HOT lanes to gain a time advantage over using standard traffic lanes.

Increase the Competitiveness of Alternative Modes

- Increase investment in public transit systems to provide more frequent service and longer service hours, making transit more time competitive with SOV travel. This will encourage travelers to shift from automobiles because their wait time for their needed bus or train will be shorter.
- Hold steady or decrease the user cost of transit, making transit more cost competitive with SOV travel. As fuel prices increase, people will find significant cost savings in moving to alternative modes. Group discounts and employer pass programs can also reduce the cost to the user.
- Increase capital investment and management procedures to ensure reliability of transit service. Users, particularly those who can afford a car, will be more likely to use transit if the service is reliably on time.
- Simplify and streamline the use of transit by requiring fewer transfers.
- Allocate preferred and discounted parking spaces to vanpools and carpools.
- Offer "guaranteed ride home" programs to those who regularly use transit, vanpools, or carpools. Under these programs, people who must work beyond their usual shift ending time receive free or discounted taxis or door-to-door transit. This gives flexibility to the worker's schedule and encourages the use of alternative modes.

Ensure That Alternative Modes Are Safe and Secure

- Public transportation must be secure. Patrons should be able to observe law enforcement and counterterrorism procedures and feel safe while using public transportation services. The public is mindful of the vulnerability of mass transit systems, and people are more likely to ride if they feel secure.
- Crime must be kept to minimum on the streets and on transit. If the streets are not safe, people will not walk or ride a bicycle. Similarly, if transit vehicles and stations are unsafe, everyone who can drive will do so.
- Passengers must be safe from injury on the transportation system. This includes traffic control measures, intersection markings, and proper signage.

Educate the Public and Market the Availability of Alternative Modes

- The benefits of alternative modes must be promoted to the public. Direct mail, traditional advertising, schools, and employers can distribute information on transit and bicycle/pedestrian facilities to the public. The more knowledge the public has about their options, the more interested they will be in using alternative modes of transportation.

Related Policies/Programs in Place

Significant transit programs already exist around the state and major investments are planned and under study.

Estimated GHG Reductions and Net Costs or Cost Savings

The uncertainty associated with projections and assumptions for cost and cost savings caused the Action Team to decide not to include cost projections for this policy in the overall total for Phase 2. GHG reduction benefits are seen as being both significant and credible, therefore these reductions are included in the totals.

Table C-5&6-1. Effect on GHG Emissions, Fuel Consumption, and Costs

	2010	2017	2020	2025	Units
GHG emission savings	0.01	1.77	0.51	3.54	$MMtCO_2e$
Net present value (2009–2025)	Not Quantified	Not Quantified	Not Quantified	Not Quantified	$ Million
Cumulative emissions reductions (2009–2025)	-	-	-	28.29	$MMtCO_2e$
Cost-effectiveness	Not Quantified	Not Quantified	Not Quantified	Not Quantified	$\$/MtCO_2e$

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

Data Sources:

Total population and population density by Census tract, 1990 and 2000.

Per-capita VMT by Census tract population density in Florida, from Center for Urban Transportation Research (CUTR) VMT forecasting model.

Forecast statewide population growth.

Making Transit Work: Insight From Western Europe, Canada, and the United States—Special Report 257. Transportation Research Board: Washington, DC, 2001.

Current and historical transit ridership, by mode type (urban/rural, bus, or paratransit) from National Transit Database.

Annual Energy Outlook, Energy Information Agency, US DOE, 2008.

Transit elasticities from Improving Travel Choices, Natural Resources Defense Council, 2007.

Quantification Methods:

Stand-alone analyses were conducted for Land Use Planning Processes and Increasing Choices in Modes of Transportation as described in the quantification methods below. The results were then combined to reflect the strong interaction between these two measures and the support and facilitation they provide to each other. In order to avoid double-counting of GHG reductions, the tonne reduction by transit as a stand alone measure, which were only 13 percent as large as the land use reductions, were assumed to double-count mode shifts to transit already incorporated in the land use effectiveness rates.

A. Factoring GHG Emissions into Transportation and Land Use (TLU) Planning Processes

This analysis considers potential GHG reductions from fewer personal (noncommercial) VMT as a result of a shift toward more compact development patterns. The analysis relies on estimates of per capita VMT by Census tract population density range, as developed by Polzin, et al., for the CUTR VMT forecasting model. The CUTR model is based on analysis of 2001 Nationwide Household Travel Survey data. The model provides estimates of per capita VMT by state for five density ranges. The model is currently set up for years 2005, 2035, and 2055; for this analysis, results were interpolated for CCS analysis years.

The observed relationship between per capita VMT and population density is a rough proxy for the effects of Smart Growth development as described above. Higher levels of population density are associated with overall shorter trips because destinations are closer together. In addition, areas with higher population densities are more likely to have pedestrian-friendly design (for example, walkability and mixed-use development) and to support transit service. It is difficult to separate the individual effects of the various Smart Growth strategies at this aggregate level of analysis, but the analysis should provide an indicator of what can be achieved through a combined set of Smart Growth policies.

The specific method used to estimate GHG benefits of Smart Growth strategies is as follows:

- Total population in 2000 is identified by five Census tract density ranges as identified in the CUTR model (<500, 500–1,999, 2000–3,999, 4,000–9,999, and 10,000 or more persons per square mile).
- The change in population from 1990 to 2000, and associated share of change by density range, is identified from Census data.
- For the Baseline scenario, new population growth between 2000 and 2020 (as determined from CCS baseline assumptions) is allocated to tract density ranges based on the share of growth in the 1990–2000 timeframe.
- The proportion of existing housing stock (population) that would be redeveloped over this time frame is estimated at 15 percent, of which two-thirds is redeveloped in place and one-third is redeveloped elsewhere, with this redevelopment allocated to tract density ranges based on the 1990–2000 share of population growth. (The 15 percent and two-thirds figures

come from the 2007 Growing Cooler report Section 1.7.3, citing analysis of Census data by Nelson [2006]).

- For the Climate Action scenario, a significant shift in the proportion of new development and relocated redevelopment is assumed to take place; with higher-density tracts (> 4,000 persons per square mile) receiving over 75 percent of new development under this scenario compared with only 55 percent under the Baseline scenario. Total population by tract density under this scenario is then calculated. The net effect is a per-capita reduction in VMT of 11 percent for the average new resident under the Climate Action scenario, compared to the BAU scenario.
- Total personal-travel VMT is calculated under the Baseline and Climate Action scenarios, based on VMT per capita (from the CUTR model) and total 2025 population by tract density range and the percent reduction in personal-travel VMT is calculated.

The percent reduction in VMT is adjusted by 90 percent to estimate the percent reduction in GHG emissions. This factor is the same as that used in the Growing Cooler report to account for the fact that higher-density areas may experience somewhat lower travel speeds and therefore slightly reduced fuel economy.

B. Increasing Choices in Modes of Transportation

This analysis examines the reductions in GHGs possible by shifting from personal motor vehicles to transit, which emits fewer GHGs per passenger-mile. The calculation of GHG reductions must account for the reduction in the number of private VMT and also account for the partially offsetting increase in transit VMT. In addition to these direct reductions from individuals' shift of modes, two more long-term, indirect effects are estimated: (1) the shifting of trips from personal vehicles to transit can reduce the number of vehicles on the road, and thus the amount of congestion in urban areas, and (2) reducing congestion improves traffic flow and can improve actual average vehicle fuel economy. Studies have also demonstrated that increased transit service can help shape land-use patterns, enabling densities and proximity to the center of urban areas. This has been shown to result in reduced VMT by those living in transit corridors, even if they never use transit.

Direct quantification was undertaken for improvements in service frequency, reductions in travel time, and the introduction of new and expansion of existing routes and services for bus, BRT, commuter rail, and vanpools.

Travel time improvements provide a well-documented means of improving transit service and ridership. There is a direct benefit to riders because the improved service reduces the "generalized cost" (time cost plus financial cost) of their trip. In addition to co-benefits in improving service frequency, there is about a –0.4 elasticity for transit travel time.

Service frequency increases ridership by existing riders and attracts new riders. As waiting time between vehicles has been shown to be valued about two times more strongly on average than actual travel time, this mechanism can prove very effective. There is a reported 0.5 elasticity for service frequency alone (time between buses), while the aggregate impacts for service improvements in time between vehicles and travel time have shown an elasticity of between 0.6 and 1.0, incorporating the time and frequency impacts of aggregate increases in service miles provided. The aggregate elasticity, using a value of 0.9, was applied to the total increase in vehicle revenue service miles to capture both factors together.

For service expansions and introduction, both the literature and a first-order statistical analysis show a long run elasticity for service expansion of between 0.6 and 1.0. An elasticity of 0.9 was applied to service increases.

Key Assumptions:

Fraction of new population growth and redevelopment by Census tract density, under Baseline scenario.

Assumed shift in the fraction of new population growth and redevelopment from lower-density to higher-density Census tracts, under Climate Action vs. Baseline scenario.

Percent of residential building stock redeveloped (off-site) over the analysis time frame.

Transit ridership is analyzed as a scenario doubling ridership by 2025.

New or improved services will be able to attract ridership in a manner consistent with service improvements in other similar areas of the country (if the Florida transit market is not at saturation). Current fuel price increases provide a strong argument for this assumption.

Key Uncertainties

Smart Growth scenario analysis depends upon patterns of development that involve decisions of many individual property owners and private capital investors. As result, the scenarios show what is possible under a development scenario but should not be considered as predicted outcomes.

The estimates developed using this methodology are consistent with results found in meta-analysis in the published literature, such as the recent *Growing Cooler* report from the Urban Land Institute (ULI).

The availability of funding for the provision of additional transit service is speculative.

Additional Benefits and Costs

Smart Growth generally has very low direct costs to implement; the costs consist of governmental costs of altering regulations and zoning and costs providing education and technical assistance. Tax incentives are an income transfer that results in a public sector cost but offsets developer revenue. As most Smart Growth policies (for example, allowing higher density and mixed use, reducing parking requirements) are deregulatory in nature, they are opening the development market and have significant indirect benefits. An exception is growth boundaries, which restrict the land market use and have an indirect cost.

Alternative patterns of development have a large number of additional impacts, which may provide both benefits and costs. Smart Growth provides a range of co-benefits that are well documented in other places. Prominent among these is the reduced cost of providing utilities and infrastructure, because Smart Growth makes better use of existing facilities and infrastructure and, on average, has lower demand. Improved air quality, public health (due to walking), and quality of life are also notable benefits.

Transit services have a large number of additional impacts which provide additional benefits. Transit service provides mobility, accessibility, and safety benefits that are not included in the analysis above. Other important benefits include improved air quality, public health (due to walking), and quality of life. Transit benefits in reducing congestion and facilitating land use patterns such as transit-oriented development and Smart Growth are very significant and as noted are partially reflected in the analysis above.

Feasibility Issues

Smart growth policies are being considered and implemented around the country in a wide range of communities. Because most policies are deregulatory in nature, this significantly lowers political barriers.

Status of Group Approval

Complete.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

TLU-7. Incentive Programs for Increased Vehicle Fleet Efficiency

Policy Description

Florida can reduce its GHG emissions by improving the fuel economy of the LDV fleet. The first policy step would be to charge a state agency with tracking the fuel economy of the state's entire fleet. Once a baseline for Florida's fuel economy is established, the state could then establish goals for improving the fleet's fuel economy.

Policy recommendations for meeting a goal of higher fuel economy include consumer education about vehicle purchases, monetary incentives through a feebate system or tax credits, investment in a plug-in hybrid infrastructure, and a state policy for scrapping older vehicles that do not have good fuel economy. Information about vehicle fuel economy and benefits to consumers from higher fuel economy are available at www.fueleconomy.gov. For example, as the federal agencies responsible for that Web site explain, "The difference between a car that gets 20 mpg and one that gets 30 mpg amounts to $775 per year (assuming 15,000 miles of driving annually and a fuel cost of $3.10/per gallon)."

This recommendation includes several policies and programs to encourage the purchase of low-GHG-emission vehicles through monetary and convenience rewards and incentives throughout the state:

- Procurement of efficient fleet vehicles.
- Tax credits for efficient vehicles.
- Incentive programs for major corporate fleet owners, including rental car and taxi companies.
- CO_2-based registration fees and vehicle licensing fees.
- Procurement of efficient fleet vehicles (public, private, or other).
- *Feebates*—This is a study option rather than an implementation recommendation. The state would participate in a multistate study of the feasibility and effectiveness of a regional feebate system with other eastern states.
- *Tax Credits for Low-GHG Vehicles*—Amend the current income tax credit program for hybrid, alternative fuel, and low-emission vehicles so that it continues in its present form beyond 2010.
- *Operating Incentives for Low-GHG Vehicles*—Provide for preferential state-controlled (for example, state highways) and local-government controlled (for example, parking) infrastructure and access for alternative-fuel vehicles (E10, E85, natural gas, propane, 100 percent electric, and others).

- *Excise Taxes*—Change new vehicle excise taxes so that they increase taxes for relatively high-emitting vehicles and reduce taxes for relatively low-emitting vehicles. Overall, excise tax revenue would remain the same.
- *Labeling*—Promote a consumer labeling program that provides buyers with better information on the GHG emissions of new vehicles.

Policy Design

This policy would have the effect of improving the average fuel economy of all new light-duty gasoline and diesel vehicles (including light-duty trucks) in a given model year by two percent on average. This improvement would be phased in linearly over a five-year time frame starting with Model Year 2011 and reaching the full targeted two percent for Model Year 2015 vehicles. For example, the average fuel economy of Model Year 2011 light-duty vehicles (LDVs) is assumed to improve by 0.40 percent, Model Year 2012 vehicles by 0.80 percent, and so on until the maximum two percent improvement is attained for Model Year 2015 and later vehicles.

Parties Involved: Florida DEP, consumer organizations, Florida Automobile Dealers Association.

Implementation Mechanisms

The proposed policies and programs in this recommendation will need to be passed through the legislative process and be implemented by state and local government agencies in partnership with affected parties.

Related Policies/Programs in Place

While feebates are set as a new proposal, they are not completely unlike the application of existing taxes such as vehicle sales tax and gas guzzler tax. The difference is the method of calculation. In the case of feebates, the calculation will be on a vehicle's "green rating" and can adopt the GHG scores for vehicles as determined by the U.S. Environmental Protection Agency (US EPA) (http://www.epa.gov/greenvehicle/).

Some European countries have implemented feebate programs, and some U.S. states are considering both the rebate portion and the gas guzzler tax elements of feebate-type programs. Canada introduced the Vehicle Efficiency Incentive (VEI) program, which took effect in March 2007. The program includes both rebate and tax components.

Estimated GHG Reductions and Net Costs or Cost Savings

It was assumed that this policy would have the effect of improving the average fuel economy of all new light-duty gasoline and diesel vehicles (including light-duty trucks) in a given model year by two percent on average. It was assumed that this improvement would be phased in linearly over a 5-year time frame starting with Model Year 2011 and reaching the full targeted two percent for Model Year 2015 vehicles. For example, the average fuel economy of Model

Year 2011 light-duty vehicles is assumed to improve by 0.40 percent, Model Year 2012 vehicles by 0.80 percent, and so on until the maximum two percent improvement is attained for Model Year 2015 and later vehicles.

Table C-7-1. Effect on GHG Emissions, Fuel Consumption, and Costs

	2010	2017	2020	2025	Units
Gallons of Gasoline/Diesel Saved	0	100	141	186	Million Gallons
Cumulative Fuel Savings (2008 & forward)	0	328	715	1,564	Million Gallons
GHG emission savings	0	0.84	1.19	1.56	$MMtCO_2e$
Net present value (2008 & forward)	0	N/A	N/A	N/A	$ Million
Cumulative emissions reductions (2008 & forward)	0	2.76	6.01	13.14	$MMtCO_2e$
Cost-effectiveness	N/A	N/A	N/A	N/A	$/MtCO_2e$

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/MtCO_2e = dollars per metric ton of carbon dioxide equivalent; N/A = not available.

Data Sources:

CCS conducted a review of the most relevant research and analysis on feebate proposals with these findings:

- There has been significant conceptual development of the feebate idea, especially at the national level;
- There is a need for a greater understanding of potential benefits and costs of state-level and multistate coordinated feebate programs; and
- There has not been sufficient pilot testing of feebate programs in the United States to provide implementation experience.

CCS assessed recent studies of potential GHG emission reductions from a national feebate program based on modeling work conducted by the US DOE's Oak Ridge National Laboratory (ORNL). CCS also reviewed other relevant recent studies and analyses of feebates conducted by the Canadian government, the State of California, and public interest research groups (PIRGs). The ORNL and other studies assume a national feebate rate high enough to produce responses from both consumers and manufacturers. ORNL's estimate of the national potential for reduction in CO_2 emissions is approximately 11 million metric tons of carbon dioxide equivalent ($MMtCO_2e$) in 2010 and 66 $MMtCO_2e$ in 2020.

Some attempts have recently been made to estimate the GHG emissions reduction potential from individual state feebate programs, such as those proposed for Arizona and California. For example, a recent PIRG analysis suggests that a single state feebate program for Arizona would result in an estimated reduction of 0.1 $MMtCO_2e$ GHG emissions in 2020.

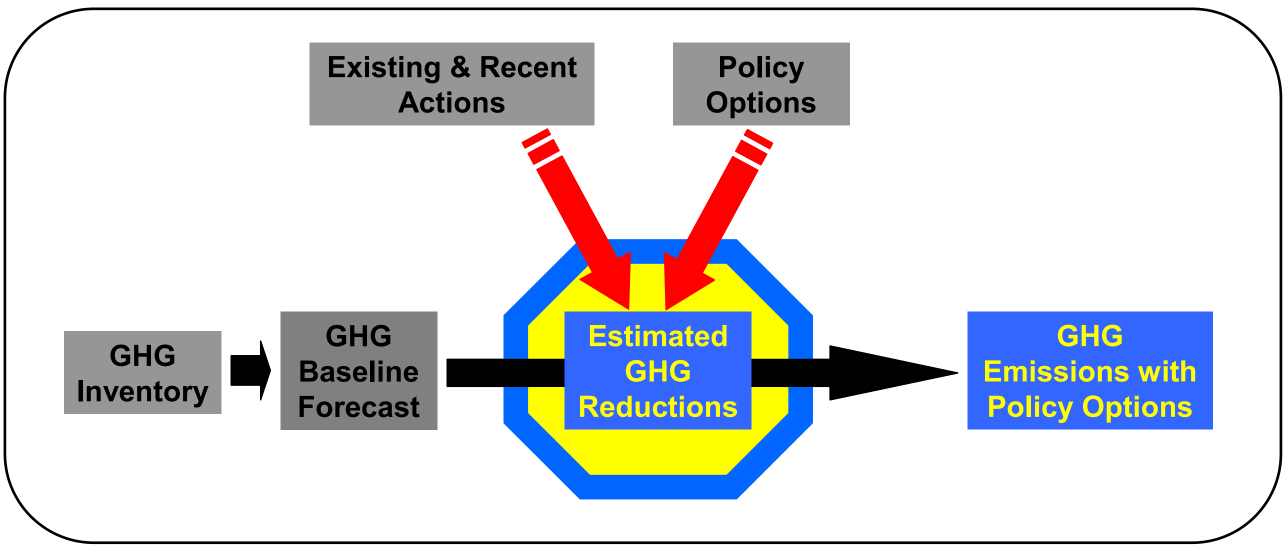
These recent estimates of the potential impacts of individual state programs are contingent on assumptions and analytical methods that have not undergone thorough peer review. Therefore, the results of these analyses are preliminary and should be interpreted with some caution. Further analysis and study of the potential benefits and costs of individual state and multistate feebate programs would greatly increase confidence in projected results.

Quantification Methods:

In order to quantify the GHG reductions and fuel savings which would result from implementation of TLU-7 for the state of Florida, CCS used the Vehicle Energy and Greenhouse Gas Assessment Tool (VEGA Tool). The VEGA Tool was developed by the CCS team to support its role in the Florida State Climate Action Plan process, to conduct analysis of various policies affecting GHG emissions from the on-road transportation sector.

Figure C-7-1 illustrates schematically how the VEGA Tool operates. The grey boxes represent the inputs required: state GHG Inventory and Forecast data, existing actions, recent actions, and the policy recommendations to be analyzed.

Figure C-7-1. VEGA Tool Overview



The tool helps the analyst quantify the existing actions, recent actions, and policy recommendations by translating them into three aspects of on-road transport that affect on-road vehicle emissions of greenhouse gases:

1. Fleet Characteristics: Types of vehicles being driven
    - Fuel Economy: The average miles per gallon for each model year and vehicle class

   - Vehicle Class Distribution: The portion of the vehicle fleet falling into each of the 28 vehicle classes defined by the Mobile6 model (light-duty gas vehicles, light-duty gas trucks – type 1, …)
   - Fleet Turnover Rate: The rate at which new cars are introduced and older cars are retired from the vehicle fleet

2. Fuel Characteristics: Types of fuel these vehicles use
   - Fuels Used
   - Emission Rates of Fuels: Greenhouse gas emitted per unit of fuel

3. Travel Habits (VMT): How much are the vehicles being driven?

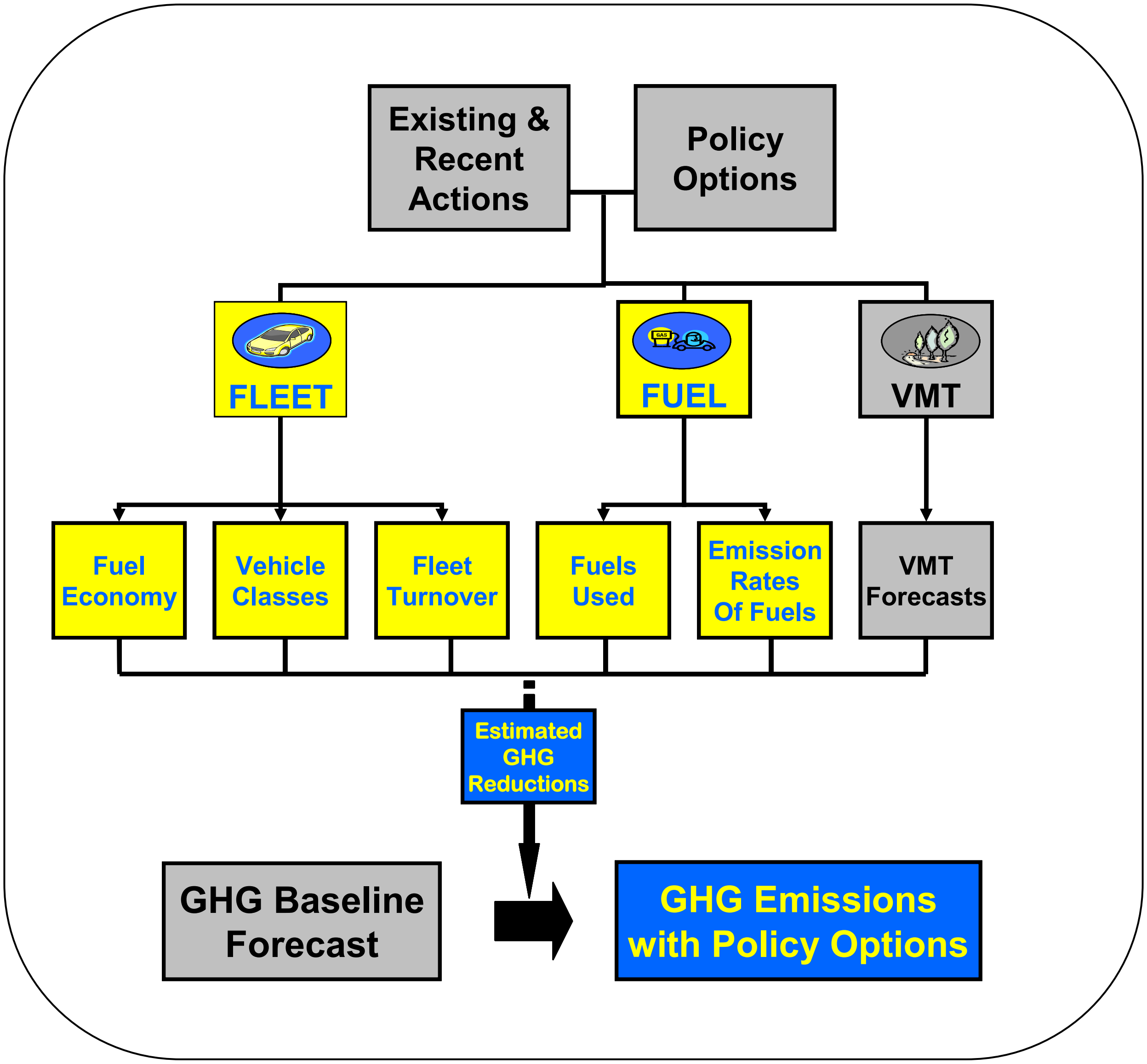
The above parameters, also illustrated in Figure C-7-2, can be adjusted by the analyst to best reflect a given action or policy recommendation. The VEGA Tool then combines these parameters to estimate what the greenhouse gas emissions would be should the policy recommendation be implemented.

Policy TLU-7 affected the fuel economy parameter. It was assumed that this improvement would be phased in linearly over a 5-year time frame starting with Model Year 2011 and reaching the full targeted two percent for Model Year 2015 vehicles. Specifically, the average fuel economy of Model Year 2011 light-duty vehicles was assumed to improve by 0.40 percent, Model Year 2012 vehicles by 0.80 percent, and so on until the maximum two percent improvement was attained for Model Year 2015 and later vehicles. Fuel economy improvements were calculated for each vehicle class and model year affected by the policy. It was assumed that the policy would affect all light-duty vehicles and trucks.

Once all of the parameters have been defined, the tool uses the following general methodology to estimate fuel savings and GHG reductions. The vehicle miles traveled (VMT) and fuel economy (mpg) are combined to estimate fuel consumption (gallons). The difference between fuel consumption under baseline and policy recommendation conditions is the estimated change in fuel consumption which would result from implementation of the policy recommendation. The estimated change in fuel consumption is translated into an estimated change in greenhouse gas emissions.

For this analysis, the baseline fuel consumption assumed that the new Federal CAFE standards were in effect.

Figure C-7-2. VEGA Tool Analysis Parameters



Key Uncertainties

Consumer reaction to incentive programs varies.

Additional Benefits and Costs

Incentive programs that significantly reduce GHG emissions through vehicle fuel efficiency also have the potential to significantly reduce the amount of transportation fuel consumed from imported sources, thus reducing the dependency of the United States on foreign sources of fuels.

Feasibility Issues

The feasibility of vehicle efficiency incentive programs may be affected by the availability of vehicles in the marketplace provided by the limited number of automobile manufacturing firms.

Related Policies/Programs in Place

New federal CAFE standards are under development. Rulemaking documents are available at: http://www.nhtsa.dot.gov/portal/site/nhtsa/menuitem.43ac99aefa80569eea57529cdba046a0/.

The Florida DEP is undertaking a rulemaking process related to adoption of state clean car GHG standards. State law requires that the Legislature approve such clean car regulations before they go into effect. Rulemaking documents are available at: http://www.floridadep.org/air/rules/ghg/california.htm.

The results shown in Table C-7-2 compare the estimated GHG emissions reduction potential from two sets of new car standards:

- The federal "CAFE -35"standard for new passenger cars and light trucks.
- The state "Clean Cars 1 & 2" standard for new passenger cars and light trucks.

The numbers in Table C-7-2 represent a summary of analyses conducted by the California Air Resources Board (CARB), available at: http://www.arb.ca.gov/cc/ccms/ccms.htm.

Table C-7-2. State of Florida Results for CARB Analysis of the Impact of State Clean Car Standards

Year(s) of Analysis	Estimated GHG Reduction From Proposed Federal CAFÉ-35 Standards ($MMtCO_2e$)	Estimated GHG Reduction From Expected State Clean Car 1 & 2 Standards ($MMtCO_2e$)	Estimated Additional GHG Benefit From State Standards Over and Above Federal Standards ($MMtCO_2e$)
2016 single-year results	5.8	7.4	1.6
2020 single-year results	11.7	15.9	4.2
2009–2020 cumulative results	56.9	79.5	22.5

GHG = greenhouse gas; CAFÉ = corporate average fuel economy; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

Additional Benefits and Costs

None Noted.

Feasibility Issues

None Noted.

Status of Group Approval

Complete.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

TLU-8. Increase Freight Movement Efficiencies

Policy Description

Currently in the United States, nearly 70 percent of all freight (by weight) is delivered by truck. Existing infrastructure makes it unlikely that this distribution will be significantly changed at any point in the near future, but the State of Florida can make significant strides in improving the efficiency and environmental impact of the necessary freight movements within its boundaries and current infrastructure. The expansion of the Panama Canal will dramatically increase the number and frequency of goods passing through Florida's 14 deep-water ports in the next decade, increasing the need for an established, efficient freight transportation system within the State of Florida.

There has been tremendous growth in freight traffic, and national freight forecasts estimate an 89 percent increase in tons of freight by 2035 ("Transportation Invest in our Future—America's Freight Challenge," American Association of State Highway and Transportation Officials [AASHTO], May 2007).To meet this increased demand while minimizing GHG emissions will require many simultaneous actions in both the trucking and rail industries.

Within the trucking industry, market forces are creating new technology aimed at cutting the GHG emissions of large trucks spurred in part by widespread anti-idling laws and the price of diesel fuel), particularly in conjunction with the US EPA's SmartWay®. This program provides a wide array of fuel-saving techniques and actions for truck and rail companies as well as measures for states to adopt. According to the American Trucking Association, Inc. (ATA), a new 2008 truck produces one-tenth the fine particulate emissions and about one-half the smog-forming nitrogen oxides (NO_x) emissions as a similar truck manufactured just two years ago. The ATA estimates that through a variety of measures, the trucking industry nationally could save 86.1 billion gallons of diesel fuel and reduce the carbon output of the industry by 904.7 $MMtCO_2$ over a 10-year period while maintaining the level of freight movement the country relies on.

The trucking industry has the ability to reduce its carbon footprint and GHG emissions in a very short period of time through measures such as installing auxiliary power units, using wide-base tires, and limiting the speed trucks can travel, thereby lowering fuel consumption and emissions.

There is a need for increased public support for these measures, because about 97 percent of motor carriers have fewer than 20 trucks, and many smaller trucking companies are simply unable to afford the upgrades and add-ons that would make a significant impact on their fuel efficiency and consumption.

From an energy consumption and GHG emission perspective, the use of intermodal transportation to haul freight can be more efficient than moving that same freight by a single mode of transport, depending on the distance, weight, and time sensitivity of the shipment.

Domestic rail intermodal traffic grew—for the first time in three years—by 5.4 percent during the second quarter of 2008. In response, rail companies have been investing in increased capacity at record levels with major intermodal capacity expansions in the South that will increase and improve rail intermodal service for Florida. This investment includes major expansions by both CSX Corporation (CSX)and Norfolk Southern (NS) railroad companies into Florida on high-volume intermodal corridors from the Midwest and also includes a current project to nearly double the capacity on the major intermodal corridor between Jacksonville and Miami.

This policy recommendation should focus on reducing the trucking industry's carbon footprint and GHG emissions, while maintaining the current level of service to the state and nation, and encouraging the development and expansion of intermodal and long-distance rail capacity to support both local and transcontinental rail service into and out of Florida. The U.S. Department of Transportation's Federal Highway Administration (FHWA) lists two major categories of emissions-reducing strategies that Florida can utilize in these goals:

- Technical strategies, which modify a piece of equipment or its fuel to reduce emissions; and
- Operational strategies, which change the way a piece of equipment is used, resulting in lower emissions.

Policy Design

Goals: Reduce overall GHG emissions generated by freight movement through combinations of the following technical and operational strategies:

Technical Strategies

- Reduce road freight bottlenecks in known urbanized, congested areas and assess the feasibility and costs associated with increased and appropriately sited inland port development in Florida.
- By 2010, FDOT and its partners will assess the feasibility and costs associated with inland port development in Florida.
- Support the reduction of emissions by railroads through increased deployment of innovative US EPA–approved reduced carbon emissions from hybrid and genset locomotives.
- Support incentives for shippers to use rail for freight movements.
- Encourage increased participation in the SmartWay® program for both truck and rail industries.
- Assess the level of advancements in global positioning system (GPS) and other technologies for all modes of freight movement.

- Provide tax incentives, grant programs, or other reliable funding sources to trucking companies to encourage:
  - The purchase and installation of devices that eliminate the need to idle, including battery-electric auxiliary power systems, vehicle battery systems, thermal energy storage systems, and fueled auxiliary power systems. In addition, provide an exemption for the additional weight caused by the installation of these units with respect to highway weigh stations.
  - Investment in hybrid truck and alternative fuel technologies as they become available in class 7 and class 8 trucks over the next 3 years and beyond.
- Assess the possibility of changes in truck weight and configuration restrictions to maximize trip efficiency.
- Purchase and use wide-base tires, which reduce drag and thereby increase fuel efficiency.
- Consider supporting a national reduced speed limit and/or national fuel economy standards for trucks.
- By 2015, FDOT will develop a plan to convert all weigh stations in Florida to weigh-in-motion stations and will continue to pursue new technologies that improve efficiency at weigh stations and truck stops, including truck stop electrification.
- Purchase and install equipment so that trucks can utilize the technologies at electrified truck stops.
- Continue development of idling reduction standards for all heavy-duty diesel engines, pursuant to Governor Crist's Executive Order 07-127.
- Promote other GHG-emissions-reducing technologies as they are developed.

Operational Strategies

- Through the FDOT Strategic Intermodal System (SIS) Plan, the Florida Rail System Plan, and continued participation in multi-partnered coalitions among states, railroads, and freight industries—exemplified by the I-95 Corridor Coalition—the State of Florida will continue its efforts to identify and remove physical and operational freight-related bottlenecks for efficient movement of freight by all modes of transportation.
- By 2015, FDOT and its partners will develop a plan to seek additional funding for implementing improvements that will remove identified freight bottlenecks, including funding improvements to SIS connector routes.
- Reconvene the Freight Stakeholders Task Force to identify actions that support the efficient movement of freight and identify opportunities for intermodal freight movement.
- To encourage railroad capital investment and to increase capacity and efficiency, FDOT will continue to support and expand initiatives such as

- SIS program,
- Florida rail plans and rail programs,
- Federal tax credits to short-line railroads,
- American Association of Railroads (AAR) GO21 program,
- The increase of federal tax credits to Class I railroads, and
- The promotion of public–private partnerships to expand freight rail capacity

- FDOT and its partners will continue to support and identify opportunities for increased intermodal freight movements through the Intermodal Strategic Plan and other local, state, and regional planning activities.

Timing: Implementation during the time period 2010 to 2015.

Parties Involved: FDOT, local governments, Florida Legislature, MPOs, RPOs, the Florida Trucking Association, railroads, shippers, developers, US DOT, and other state DOTs.

Implementation Mechanisms

As noted.

Related Policies/Programs in Place

Florida DEP is undertaking rulemaking related to idling reduction for heavy-duty vehicles.

62-285.420 FAC Heavy-Duty Vehicle Idling Reduction.

(1) Applicability. This rule applies to any heavy-duty diesel engine powered motor vehicle. For the purposes of this rule:

(a) Heavy-duty diesel engine powered motor vehicle means a motor vehicle:

1. With a gross vehicle weight rating equal to or greater than 8,500 pounds;
2. Used on roads for the transportation of passengers or freight; and
3. Serving a commercial, governmental, or public purpose.

(b) Gross vehicle weight rating means the value specified by the manufacturer as the maximum design loaded weight of a single vehicle.

(2) Requirement. Owners or operators of heavy-duty diesel engine powered motor vehicles are prohibited from idling for more than five consecutive minutes. Idling is the continuous operation of a vehicle's main drive engine while the vehicle is stopped.

Additional rulemaking information and documents may be found at: http://www.floridadep.org/air/rules/heavy_duty.htm.

Estimated GHG Reductions and Net Costs or Cost Savings

Table C-8-1. Effect on GHG Emissions, Fuel Consumption, and Costs

	2012	2020	Units
GHG emission savings	0.39	0.63	$MMtCO_2e$
Net present value (2008–2050)	–$11	$30	$ Million
Cumulative emissions reductions (2008–2050)	1.6	5.9	$MMtCO_2e$
Cost-effectiveness	–$29	$48	$/$MtCO_2e$

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/$MtCO_2e$ = metric tons of carbon dioxide equivalent.

Data Sources:

Federal Highway Statistics 2006.

Florida DOT.

US EPA SmartWay Partnership.

AAR's *National Rail Freight Infrastructure Capacity and Investment Study.*

AASHTO's *Freight Demand and Logistics Bottom Line Report.*

American Trucking Association's *"Sustainability Task Force: Strategies for Further Reduction of the Trucking Industry's Carbon Footprint (October 2007).*

Quantification Methods:

Estimate the reduction in CO_2 emissions from reduced idling by (1) estimating the portion of emissions and fuel consumption in the Florida inventory that is attributable to Class 8 diesel trucks traveling on long-haul trips, (2) estimating the portion of total fuel consumption that would be consumed during idling, and (3) applying a targeted reduction of 80 percent to this amount starting in 2008 and a reduction of 90 percent starting in 2015.

Estimate the mode shift potential from long-haul trucking to intermodal rail by estimating the amount of heavy-duty truck traffic on long-haul trips, the commodity mix share that is amenable to an intermodal shift, the investment costs necessary to upgrade intermodal terminals and rail bottlenecks, and the expected mode shift that is likely based on logistics cost cross-price elasticities.

Key Assumptions:

This analysis assumes that idle reductions are achieved only by Class 8 diesel trucks, these trucks idle for an average of six hours per day, they consume 0.8 to 1.2 gallons of diesel fuel per hour during idling, and that an 80 percent (by 2010) or 100 percent (by 2020) reduction of diesel idling from these Class 8 trucks will be achieved. The cost analysis will assume a 5-year lifetime for idling technology equipment, applied to 80 percent of Class 8 vehicles starting in 2008 and

90 percent of Class 8 vehicles starting in 2015, at a cost of $6,000 per vehicle and a cost of $4.80/gallon for diesel fuel. Program administration costs, enforcement costs, and fines have not been factored into the cost analysis. Reduced vehicle maintenance costs have not been factored into the analysis. Track improvements and intermodal terminal expansion will occur over 10 years beginning in 2009.

Key Uncertainties

None noted.

Additional Benefits and Costs

None noted.

Feasibility Issues

None noted.

Status of Group Approval

Complete.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

Appendix D
Agriculture, Forestry, and Waste Management (AFW)

Summary List of Policy Recommendations—2017 and 2025

Policy No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$) 2017	2025	Total 2009–2025	Net Present Value 2009–2025 (Million $)	Cost-Effectiveness ($/t$CO_2$e)	Energy Security Fuel Savings	Level of Support
AFW-1	Forest Retention—Reduced Conversion of Forested to Non-Forested Land Uses	0.5	0.6	7.2	$186	$26		Unanimous
AFW-2	Afforestation and Restoration of Non-Forested Lands							
	A. Forested Landscape							Unanimous
	Afforestation	1.6	3.1	28	$134	$4.9		
	Reforestation	6.1	11.6	104	$555	$5.3		
	B. Urban Forestry	4.6	8.7	78	$759	$10	3.5 million short tons coal, or 76,000 cubic feet natural gas	Unanimous
AFW-3	Forest Management for Carbon Sequestration							
	A. Pine Plantation Management	0.5	0.9	7.9	$84	$11		Unanimous
	B. Non-Federal Public Land Management	0.3	0.4	3.9	$41	$11		Unanimous
AFW-4	Expanded Use of Agriculture, Forestry, and Waste Management (AFW) Biomass Feedstocks for Electricity, Heat, and Steam Production	21	40	361	$7,432	$21	22 million short tons coal or 486,000 cubic feet natural gas	Unanimous
AFW-5	Promotion of Farming Practices That Achieve GHG Benefits							
	A. Soil Carbon Management	0.5	0.9	8.0	–$74	–$9	5 million gallons of diesel fuel	Unanimous
	B. Land-Use Management That Promotes Permanent Cover	N/Q						Approved
	C. Nutrient Management	0.2	0.3	2.6	$68	$26		Unanimous
	D. Improved Harvesting Methods to Achieve GHG Benefits	N/Q						Approved

AFW-6	Reduce the Rate of Conversion of Agricultural Land and Open Green Space to Development	0.2	0.5	4.2	$394	$93		Unanimous
AFW-7	In-State Liquid/Gaseous Biofuels Production	4.0	8.2	68	–$532	–$8	4,075 million gallons gasoline and 271 million gallons diesel	Unanimous
AFW-8	Promotion of Advanced Municipal Solid Waste (MSW) Management Technologies (Including Bioreactor Technology)	1.9	4.4	34	$294	$9	190,000 short tons coal **or** 4,000 cubic feet NG **and** 109 million gallons diesel	Unanimous
AFW-9	Improved Commercialization of Biomass-to-Energy Conversion and Bio-Products Technologies							
	A. Manure Digestion/Other Waste Energy Utilization	0.04	0.09	0.8	–$13	–$17	4,500 short tons coal or 100 cubic feet natural gas	Unanimous
	B. WWTP Biosolids Energy Production & Other Biomass Conversion Technologies	2.4	5.0	42	$1,848	$44	2.5 million short tons coal or 55,000 cubic feet natural gas	Unanimous
	C. Bio-Products Technologies and Use	0.2	0.3	2.6	–$161	–$62		Unanimous
AFW-10	Programs to Support Local Farming/Buy Local	N/Q						Unanimous
	Sector Totals	**44**	**85**	**752**	**$11,014**	**$15**		
	Sector Total After Adjusting for Overlaps*	**25**	**58**	**469**	**$5,974**	**$13**		
	Reductions From Recent Actions	**—**	**—**	**—**	**—**	**—**		
	Sector Total Plus Recent Actions	***25***	***58***	***469***	***$5,974***	***$13***		

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; N/Q = not quantified; WWTP = wastewater treatment plant.

* See below for discussion of overlap adjustments.

Note that negative costs represent a monetary savings.

The Center for Climate Strategies
Helping States and the Nation Tackle Climate Change

www.climatestrategies.us

Memo-Draft

To: Florida Agriculture, Forestry, and Waste Technical Working Group

From: The Center for Climate Strategies

Subject: Assumptions for AFW Mitigation Policy Options Quantification

Date: July 22, 2008

This memo summarizes key assumptions used to estimate the greenhouse gas (GHG) impacts and cost effectiveness for draft Agriculture, Forestry, and Waste (AFW) policy options. The quantification process is intended to support custom design and analysis of draft policy options, and provide both consistency and flexibility. The purpose of this memo is to present the assumptions used as part of the quantification process in order to ensure consistency between options and between subcommittees.   Feedback on the assumptions is encouraged.

Quantifying reductions of GHG (particularly future reductions) is an inherently complex process and assumptions are important inputs into the quantification methodologies and models used to estimate policy costs and benefits. Models are representations of reality, and require the best available data on likely futures. An emphasis should be placed on using assumptions that are based on the best available data using local or regional data (when available) rather than national level data.

Unless directed otherwise by the Florida Action Team, the Center for Climate Strategies (CCS) will estimate the lifecycle GHG reductions for each policy option, where data and methods are available to do so. In the Florida GHG Inventory and Forecast (I&F), the only sector for which consumption-based emissions data are provided is the electricity consumption sector. In all other sectors of the inventory, the GHG emissions are strictly those that occur within the state as a result of energy consumption or other GHG emission process (for example, methane from landfilled waste). For example, for fuel combustion in the RCI and Transportation sectors, only the emissions associated with fuel combustion are provided, not those associated with the extraction, transport, processing, and distribution of each fuel. Similarly, for waste management, only emissions associated with waste management processes in Florida are included in the I&F (for example, landfilling or waste combustion), not those associated with production and transportation of the initial packaging or product that became a component of the solid waste stream.

Development of consumption-based emission estimates (including embedded GHG from lifecycle assessments) for all sectors of the inventory are beyond the scope of this process. Indeed, in many cases, these types of inventory estimates would involve significant technical and data availability challenges. However, for some policy options, lifecycle emission reductions can be estimated, and it should be recognized that the portion of emission reductions that occur out of state as a result of in-state policies are not captured in the I&F. Some might see these methodological differences in emissions and emission reductions accounting as a disconnect; however, CCS believes that the Action Team should consider taking credit for reductions that occur out of state as a result of actions taken within the state of Florida. Some common examples of where this accounting occurs are:

- Fossil fuel consumption: inventory estimates are based only on the GHG emissions associated with the combustion of each fuel; lifecycle emission reductions are estimated using GHGs from combustion plus the embedded GHGs from extraction, transportation, processing, and distribution;
- Solid waste management: landfill methane emissions or total GHG emissions are associated only with waste combustion and decomposition; lifecycle emission reductions include the landfill/waste combustion emissions plus those associated with production of the packaging or product (for example, net difference of use of virgin materials versus recycled materials);
- Biofuels consumption: for fossil fuel displacement benefits, the inventory includes only GHGs from fossil fuel combustion; lifecycle emission reductions are estimated using the lifecycle gasoline/diesel emission factors compared to lifecycle biofuel emission factors (captures total GHGs from fuel production, processing, and distribution).

Biomass Supply

The table below indicates the biomass availability in Florida. The source/reference for the value is indicated in the notes section. The AFW Subcommittee will work to refine this initial assessment during the process. **[Note: this table has been updated in the material that follows this memorandum].**

Biomass Resource	Annual Biomass Supply (Dry Tons)	Notes
Logging Residue	12,200,000	Source: Bioenergy at UF/IFAS, Advisory Council Meetgins, Powerpoint prepared by Mary Duryea, May-June 2008, see slide 3.
Urban Wood Waste	5,000,000	Source: Bioenergy at UF/IFAS, Advisory Council Meetgins, Powerpoint prepared by Mary Duryea, May-June 2008, see slide 3.
Forest Understory Species	TBD	
Primary Mill Residue (Unused)	4,000	2005 NREL Report. Derived from the USDA Forest Service's Timber Product Output database for 2002, includes mill residues burned as waste or landfilled.
Agricultural Residue and Vegetable and Fruit Waste	3,597,000	2005 NREL Report. Estimated using 2002 total grain production, crop to residue ratio, moisture content, and taking into consideration the amount of residue left on the field for soil protection, grazing, and other agricultural activities. 0.4 million dry tons of veg/fruit waste from Bioenergy at UF/IFAS, Advisory Council Meetgins, Powerpoint prepared by Mary Duryea, May-June 2008, see slide 3.
Energy Crops	TBD	
Willow and Hybrid Poplar or Other Fast-growing Hardwoods		2005 NREL Report estimates a potential 389,000 tons of willow or hybrid poplar could be grown on CRP lands.
Other Woody Energy Crops	64,000,000	Pine, eucalyptus, and cottonwood from Bioenergy at UF/IFAS, Advisory Council Meetings, Powerpoint prepared by Mary Duryea, May-June 2008, see slide 3. Potential to grow 2,080,000 tons on marginal mining lands. Estimated based on 160,000 acres (from Southeastern Regional Biomass Energy Program 2003 Annual Report*) and 13 dry tons/acre.†
Poultry Litter	TBD	
Municipal Solid Waste (MSW) Fiber	42,662,000 by 2025	Forecast to 2025 based on average annual change between 2001-2006 from http://www.dep.state.fl.us/waste/categories/recycling/pages/06_data.htm
Wood Pulp	TBD	
Yard and Landscape Waste Debris	TBD	
Total Annual Biomass Supply	**127,463,000**	

[Note: this table has been updated in the material that follows this memorandum].

Land Value and Conservation Easement Costs

The AFW options assume Conservation Reserve Program (CRP) annual payments as a proxy for easement costs.

Total continuous CRP land annual payments for Florida were $46 per acre as of March 2008. This payment includes annual incentive and maintenance allowance payments, but not one-time signing and practice incentive payments or payment reductions, such as for lands enrolled less than a full year and lands hayed or grazed (see http://www.fsa.usda.gov/Internet/FSA_File/mar2008.pdf).

Land Use

The reduction in fossil diesel fuel use from changing land use from intensive agriculture to alternative land use or practices is estimated at 3.5 gallons/acre.[1] The life-cycle fossil diesel GHG emission factor is 12.3 $MtCO_2e$/1,000 gallons.[2]

Fertilizer

The following fertilizer cost information is taken from U.S. Department of Agriculture, Economic Research Service's U.S. fertilizer use and price information (see http://www.ers.usda.gov/Data/fertilizeruse/).

Month/Year	Average U.S. farm prices of selected fertilizers					
	Anhydrous ammonia	Nitrogen solutions 30%	Urea 45-46% nitrogen	Ammonium nitrate	Sulfate of ammonium	Average
Apr 2007	523	277	453	382	288	385

The assumed emissions factor for nitrogen applied is 4.76 kg CO_2e / kg N applied (on-farm). This is obtained from the inventory and forecast. The avoided life cycle GHG emissions (emissions associated with the production, transport, and energy consumption during application) were taken from Wood and Cowie[3]. The estimate provided for the U.S. (taken from West and Marland, 2001[4]) was 858 grams (g) CO_2e per kilogram of nitrogen (kgN)[5]. This provides a total emissions factor of 5.61 kg CO2e / kg N applied.

[1] Reduction associated with less intensive land use (for example, fewer passes). The estimate is based on conservation tillage compared with conventional tillage, at http://www.conservationinformation.org/Core4Brochures/CTBrochure.pdf, accessed May 2008.

[2] Life-cycle emissions factor for fossil diesel from J. Hill et al., "Environmental, Economic, and Energetic Costs and Benefits of Biodiesel and Ethanol Biofuels," *Proceedings of the National Academy of Sciences*, 103(30):11206–11210. From the assessment used to evaluate U.S. soybean-based biodiesel life-cycle impacts. See http://www.pnas.org/cgi/content/full/103/30/11099

[3] Sam Wood and Annette Cowie (2004) *A Review of Greenhouse Gas Emission Factors for Fertiliser Production* Research and Development Division, State Forests of New South Wales, Cooperative Research Centre for Greenhouse Accounting.

[4] West, T. O. and Marland, G. 2001. *A Synthesis of Carbon Sequestration, Carbon Emissions and Net Carbon Flux in Agriculture: Comparing Tillage Practices in the United States.* Agriculture, Ecosystems and Environment 1812, 1-16.

[5] These emission factors provide an estimate of the typical life cycle GHG emissions (including resource extraction, the transport of raw materials and products, and the fertilizer production processes) per unit weight of fertilizer produced (i.e., gCO_2e/kg fertilizer).

Emission Factors

Standard emissions factors for fuel feedstocks are calculated from the Florida GHG Emissions Inventory and summarized below (note that these emission factors include methane (CH_4) and nitrous oxide (N_2O) emissions, in addition to carbon dioxide (CO_2) emissions).

Feedstock	(tCO2e/mmbtu)
Subbituminous coal	0.096
Natural gas	0.054
Residual oil	0.078
Diesel oil	0.073
Petroleum coke	0.100
LPG	0.063
Refuse derived fuel (fossil)	0.043
MSW (fossil)	0.043
Refuse derived fuel (biomass)	0.002
MSW (biomass)	0.002
Wood, waste wood, and sawdust	0.002
Nuclear	0.000
Landfill gas[6]	0.054
Wind	0.000
Solar/PV	0.000
Other	0.054
Oil	0.078
Waste solvent	0.073

The emissions factor for grid electricity was also taken from the Florida I&F, derived by dividing total electricity consumption emissions in 2005 by electricity sales in 2005. This provided an Electricity Emissions Factor of 0.643 Metric Tons CO2-e per MWh.

Fuel Prices

The following table shows fuel prices (in $/MMBTU) for costs taken from Annual Energy Outlook 2008 (Early Release)[7].

	Distillate Fuel (in $/MMBTU)	Natural Gas (in $/MMBTU)	Coal (in $/MMBTU)	Coal (in $/ton)
2009	$13.25	$6.82	$1.20	$30.10

[6] Assumed to be biogenic.
[7] Fuel cost (in $/MMBTU) come from Figure 1. Energy Prices 2006 dollars per million BTU From EIA AEO 2008. see http://www.eia.doe.gov/oiaf/aeo/prices.html.

2010	$12.65	$6.36	$1.24	$30.99
2011	$12.11	$6.07	$1.24	$31.11
2012	$11.33	$5.86	$1.23	$30.67
2013	$10.68	$5.60	$1.22	$30.56
2014	$10.41	$5.43	$1.23	$30.66
2015	$9.83	$5.32	$1.22	$30.47
2016	$9.42	$5.29	$1.21	$30.28
2017	$9.43	$5.34	$1.22	$30.39
2018	$9.57	$5.39	$1.25	$31.21
2019	$9.71	$5.42	$1.25	$31.30
2020	$9.81	$5.24	$1.26	$31.51

Assumed cost of electricity is based on Future Mid-Continent Area Power Pool prices from the Energy Information Administration (EIA) Annual Energy Outlook (see http://www.eia.doe.gov/oiaf/aeo/supplement/index.html), illustrated below:

Florida Reliability Coordinating Council - Sector 08	
Year	All Sector Average Electricity Price (2005$ per kWh)
2009	0.10
2010	0.11
2011	0.10
2012	0.10
2013	0.10
2014	0.10
2015	0.10
2016	0.09
2017	0.09
2018	0.09
2019	0.09
2020	0.10
2021	0.09
2022	0.09
2023	0.10
2024	0.10
2025	0.10

Capital costs and capacity factors

Estimates of capital costs and capacity factors for new generating capacity vary tremendously. The following table from the *Annual Energy Outlook* 2007 shows the capital cost and operation and maintenance (O&M) costs used by the National Energy Modeling System (NEMS) model.

Table 39. Cost and Performance Characteristics of New Central Station Electricity Generating Technologies

Technology	Online Year[1]	Size (mW)	Leadtimes (Years)	Base Overnight Costs in 2006 ($2005/kW)	Contingency Factors: Project Contingency Factor	Contingency Factors: Technological Optimism Factor[2]	Total Overnight Cost in 2006[3] (2005 $/kW)	Variable O&M[5] ($2005 mills/kWh)	Fixed O&M[5] ($2005/kW)	Heatrate in 2006 (Btu/kWhr)	Heatrate nth-of-a-kind (Btu/kWr)
Scrubbed Coal New[7]	2010	600	4	1,206	1.07	1.00	1,290	4.32	25.91	8,844	8,600
Integrated Coal-Gasification Combined Cycle (IGCC)[7]	2010	550	4	1,394	1.07	1.00	1,491	2.75	36.38	8,309	7,200
IGCC with Carbon Sequestration	2010	380	4	1,936	1.07	1.03	2,134	4.18	42.82	9,713	7,920
Conv Gas/Oil Comb Cycle	2009	250	3	574	1.05	1.00	603	1.94	11.75	7,163	6,800
Adv Gas/Oil Comb Cycle (CC)	2009	400	3	550	1.08	1.00	594	1.88	11.01	6,717	6,333
ADV CC with Carbon Sequestration	2010	400	3	1,055	1.08	1.04	1,185	2.77	18.72	8,547	7,493
Conv Combustion Turbine[5]	2008	160	2	400	1.05	1.00	420	3.36	11.40	10,807	10,450
Adv Combustion Turbine	2008	230	2	379	1.05	1.00	398	2.98	9.91	9,166	8,550
Fuel Cells	2009	10	3	3,913	1.05	1.10	4,520	45.09	5.32	7,873	6,960
Advanced Nuclear	2014	1350	6	1,802	1.10	1.05	2,081	0.47	63.88	10,400	10,400
Distributed Generation -Base	2009	2	3	818	1.05	1.00	859	6.70	15.08	9,500	8,900
Distributed Generation -Peak	2008	1	2	983	1.05	1.00	1,032	6.70	15.08	10,634	9,880
Biomass	2010	80	4	1,714	1.07	1.02	1,869	2.96	50.18	8,911	8,911
MSW - Landfill Gas	2009	30	3	1,491	1.07	1.00	1,595	0.01	107.50	13,648	13,648
Geothermal[6,7]	2010	50	4	1,790	1.05	1.00	1,880	0.00	154.92	36,025	30,641
Conventional Hydropower[6]	2010	500	4	1,364	1.10	1.00	1,500	3.30	13.14	10,107	10,107
Wind	2009	50	3	1,127	1.07	1.00	1,206	0.00	28.51	10,280	10,280
Solar Thermal[7]	2009	100	3	2,675	1.07	1.10	3,149	0.00	53.43	10,280	10,280
Photovoltaic[7]	2008	5	2	4,114	1.05	1.10	4,751	0.00	10.99	10,280	10,280

Source: Assumptions to the AEO 2007, p. 77.[8]

Renewable Incentives

Inclusion of the federal production tax credit (PTC) in the levelized cost estimates for renewables in the Policy Options needs to be considered. The federal Renewable Electricity Production Tax Credit has been around in some form since 1992 but seems to always be about to expire (currently December 2008). The existing incentive for wind, closed-loop biomass, and geothermal is 2.0¢/kWh. Electricity from open-loop biomass, small irrigation hydroelectric, landfill gas, municipal solid waste resources receives a 1.0¢/kWh credit.

Biofuels

Fuel Life-Cycle Emission Factors

The fuel life-cycle emission factors are derived from the Argonne National Laboratory Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) 1.8b model

[8] http://www.eia.doe.gov/oiaf/aeo/assumption/pdf/electricity.pdf

for the year 2010 and utilize the model's default assumptions except where noted (downloadable from http://www.transportation.anl.gov/software/GREET/). The factors assume an average fuel economy of 100 miles/4.3 gallons (23.2 mpg) for gasoline-powered vehicles and 100 miles/3.6 gallons (27.8 mpg) for diesel-powered engines, based on the 2005 model year average. The life-cycle emission factor for gasoline is 11.3 metric tons CO_2e/1,000 gallons. This number assumes a mix of 50 percent conventional gasoline and 50 percent reformulated gasoline. The life-cycle emission factor for low-sulfur diesel is 11.3 metric tons CO_2e/1,000 gallons.

The life-cycle emission factor for 100 percent corn ethanol is 9.1 metric tons CO_2e/1,000 gallons. This value includes 195 g CO_2e /bushel emissions for land use change due to corn farming.

The life-cycle emission factor for cellulosic ethanol is 1.51 metric tons CO_2e/1,000 gallons. This number assumes a mix of 25 percent herbaceous biomass, 25 percent forest residue, 25 percent corn stover, and 25 percent woody biomass (from farmed trees).

The life-cycle emission factor for soybean-based biodiesel is 0.667 metric tons CO_2e/1,000 gallons.

Carbon emissions from land use change

Recent publications such as Searchinger, et al., 2008 (Searchinger et al., *Sciencexpress,* "Use of U.S. Croplands for Biofuels Increases Greenhouse Gases through Emissions from Land Use Change," February 7, 2008), have attempted to estimate the carbon emissions that result from land use being converted to cropland to grow crops for fuel. This is based on the argument that the conversion of current cropland from food/feed/fiber production in one part of the world will drop the food/feed/fiber supply on the market and drive grassland or forest conversion to cropland in other parts of the world. There is still significant uncertainty regarding the value of carbon emissions due to land use change so at this juncture emissions from land use change are not incorporated into the quantification except those already included in the GREET model.

Overlap Discussion

The amount of GHG emissions reduced or carbon sequestered and the costs of a policy option within the Agriculture, Forestry, and Waste Management (AFW) sector may overlap with some of the quantified benefits and costs of policy options within other sectors.

Every effort will be made to determine where those overlaps occur and to eliminate double counting. As displayed in the Summary List above, the AFW sector totals will be reduced accordingly.

AFW-4 calls for energy production from biomass. The Energy Supply and Demand (ESD) Technical Working Group also quantified the use of biomass for energy production (for example, ESD-5 and ESD-8). AFW-4 has a higher demand for biomass than the combined ESD options post 2010. To avoid double counting, the biomass demand requirements for ESD (in MMBtu) were removed from the AFW sector totals as these were considered to be accounted for under the ESD analyses. The costs associated with the use of those units of biomass were also removed from the AFW sector totals (these were also assumed to be accounted for under the ESD analyses).

AFW-7 calls for the amount of biofuels produced in the state of Florida to increase. The Transportation and Land Use (TLU) Technical Working Group also quantified the use of biofuels to decrease the carbon content of fuels (in TLU-1). AFW-7 was quantified assuming higher levels of cellulosic ethanol production and use than TLU-1 in 2025. The GHG benefits from gallons of biofuels consumed through TLU-1 were subtracted from the calculation of gallons produced in AFW-7, so as to avoid double-counting these reductions. The costs associated with the production of these gallons were also removed from the AFW totals (because these production costs are also assumed to be captured under the TLU-1 cost estimate).

Biomass Supply

Several options call for a supply of in-state biomass. The supply and demand for state biomass resources are assessed in Table D-1 below to ensure there are sufficient resources to meet the policy option goals.

Table D-1. Florida Climate Action Team policies: biomass supply and demand assessment

Biomass Resource	Annual Biomass Supply (Dry Tons)	Annual Biomass Supply** (MMBtu)	Notes
Logging residue	1,863,000	22,354,000	US Forest Service, Forestry Inventory & Analysis, Southern Research Station 2005 Timber Product Output Reports, http://srsfia2.fs.fed.us/php/tpo2/tpo.php, SRS TPO Reports, Florida, Table 10 (57 green lb/ft^3 for softwoods, 60 green lb/ft^3 for hardwoods).
Urban wood waste	5,000,000	60,000,000	Source: Bioenergy at UF/IFAS, Advisory Council Meetings, PowerPoint prepared by Mary Duryea, May-June 2008, see slide 3.[9] Potentially overlaps with MSW fiber below (left out of totals).
Forest understory species	Not quantified	Not quantified	Tony Johnson of the FIA Southern Research Station said that the amount has not been quantified but includes species such as fedderbush and wax myrtle.[10]
Existing forests: – Current Use - Net Surplus Growth	 9,000,000 3,300,000	 108,000,000 39,600,000	FL Division of Forestry[11]. "Current Use" represents the total amount of timber harvested. The amount of biomass available for energy production will be market driven. "Net Surplus Growth" represents the net of estimated growth minus removals (excluding understory species).
Primary mill residue (unused)	4,000	48,000	2005 NREL Report. Derived from the USDA Forest Service's Timber Product Output database for 2002; includes mill residues burned as waste or landfilled.
Agricultural residue and vegetable and fruit waste	3,597,000	29,855,000	2005 NREL Report. Estimated using 2002 total grain production, crop to residue ratio, moisture content, and taking into consideration the amount of residue left on the field for soil protection, grazing, and other agricultural activities. 0.4 million dry tons of vegetable/fruit waste from Bioenergy at UF/IFAS, Advisory Council Meetings, PowerPoint prepared by Mary Duryea, May-June 2008, see slide 3.[12]
Agricultural energy crops	3,450,000	50,715,000	Secondary goal of AFW-4 calls for an additional 300,000 acres of energy crops by 2025, in addition to an increased production of 10% in sweet sorghum and sugar cane over current yields. Supply potential based only on 300,000 new acres assuming switchgrass production.

[9] Communicated to R. Anderson, CCS via email, by Joe Joyce, University of Florida, July 2008.

[10] Communicated to R. Anderson, CCS via telephone, August 2008.

[11] Steve Jennings, Jarek Nowak, communicated to AFW TWG via telephone, August 2008. For net surplus growth, estimate provided by M. Branch, AFW TWG, based on FL Division of Forestry data.

[12] Communicated to R. Anderson, CCS via email, by Joe Joyce, University of Florida, July 2008.

Biomass Resource	Annual Biomass Supply (Dry Tons)	Annual Biomass Supply** (MMBtu)	Notes
Willow and hybrid poplar or other fast-growing hardwoods	Potential	Potential	2005 NREL Report estimates a potential 389,000 tons of willow or hybrid poplar could be grown on CRP lands.
Other woody energy crops	Potential	Potential	Potential to grow 2,080,000 tons on marginal mining lands, based on 160,000 acres (from Southeastern Regional Biomass Energy Program 2003 Annual Report*) and 13 dry tons/acre.[†]
Poultry litter	505,947	4,654,708	See AFW-9 for documentation of methods used to estimate Poultry litter inventory.
Municipal solid waste (MSW) fiber	42,662,000	511,944,000	Estimated to be available by 2025 based on biomass disposed in landfills in 2025. Projection based on average annual change between 2001 and 2006. Material breakdown based on 2005 MSW Composition from EPA Waste Characterization Fact Sheet,[13] consistent with ES TWG MSW characterization. Yard and Landscape Waste: 8,611,000 Food Waste: 7,822,000 Paper Waste: 22,481,000 Wood Waste: 3,747,000
Wastewater treatment plant solids	1,161,329	3,600,121	Estimated from FL DEP's *Summary of Class AA Biosolids*. See AFW-9 for full documentation.
Total annual biomass supply	**97,500,000**	**1,355,000,000**	Urban wood waste kept out of the totals due to potential overlap with MSW fiber.
Business as usual biomass demand from Inventory and Forecast	13,893,826	166,725,915	12% of estimated supply. Taken from CCS Energy Supply and RCI Inventory and Forecast in MMBtu. The annual tonnage was estimated based on 12 MMBtu per dry ton.
Business as usual timber and pulpwood removals	9,000,000	108,000,000	8% of estimated supply. Taken from supply assessment above; assumes timber/pulpwood removal remain static.
AFW-4. Expanded Use of Agriculture, Forestry, and Waste Management (AFW) Biomass Feedstocks for Electricity, Heat, and Steam Production	41,448,702	483,103,135	36% of estimated supply. Utilize biomass feedstocks in proportion to their availability.
AFW-7. In-State Liquid/Gaseous Biofuels Production	7,300,000	87,600,000	6% of estimated supply. Utilize 20% of available biomass by 2025. [Option also includes potential fast-growing hardwoods and other woody energy crops that have not been included in the supply assessment above].

[13] *Municipal Solid Waste in the United States, 2005 Facts and Figures*, US EPA, Office of Solid Waste, EPA530-R-06-011, October 2006. Accessed on July 20, 2008 from: http://www.epa.gov/garbage/pubs/mswchar05.pdf.

Biomass Resource	Annual Biomass Supply (Dry Tons)	Annual Biomass Supply** (MMBtu)	Notes
AFW-9. Improved Commercialization of Biomass-To-Energy Conversion and Bio-Products Technologies	16,043,376	166,901,167	12% of estimate supply. Utilize 20% of methane (including poultry litter). Only includes the WWTP biosolids aspect of this option.
ESD-5 (Renewable Portfolio Standards: biomass, yard and landscape waste) and ESD-8 (combined heat and power).	0	0	Note: no incremental biomass is needed for the ESD-5 and -8 that is already not captured under AFW-4.
TLU-1. Low Carbon Fuel Standard	0	0	Note: no incremental biomass is needed for biofuels production under the TLU option is not already included under AFW-7.
Total annual biomass demand	**87,700,000**	**1,012,000,000**	Does not include the AFW-9 element to utilize 50% of remaining biomass supply after AFW-4 and AFW-7 have been fully implemented due to the need for additional study of sustainable annual biomass supply in Florida.

MMBtu = million British thermal units; NREL = National Renewable Energy Laboratory; UF/IFAS = University of Florida/Institute of Food and Agricultural Sciences; USDA = U.S. Department of Agriculture; CRP = Conservation Reserve Program. Note: The above analysis specifically excludes current non-energy uses of biomass from both the supply and demand estimates.

** Assuming the following values for average heat content in MMBtu/dry ton:

Agricultural residues = 8.3 (Average Heat Content of Selected Biomass Fuels, Table 10, EIA 2008 Annual Electric Generator, http://www.eia.doe.gov/cneaf/solar.renewables/page/trends/table10.html);

Energy crops = 14.7 (Heat Content of Selected fuels, ORNL, 7,341 Btu/lb, http://cta.ornl.gov/bedb/appendix_a/Approximate_Heat_Content_of_Selected_Fuels_for_Electric_Power_Generation.xls);

Forest feedstocks = 12 (Heat Content of Selected fuels, ORNL, 6,000 to 8,000 Btu/lb for solid wood products, http://cta.ornl.gov/bedb/appendix_a/Approximate_Heat_Content_of_Selected_Fuels_for_Electric_Power_Generation.xls);

Switchgrass biomass yield assumption = 11.5 dry tons/acre/year, http://bioenergy.ornl.gov/papers/misc/switgrs.html.

* Southern States Energy Board, Southeastern Regional Biomass Energy Program. October 2003. 3rd year field operations & maintenance support for Central Florida short rotation woody crop (SRWC) tree farm, http//www.treepower.org/papers/annualreport-2003.doc

† Midpoint between high (16 dry tons/acre) and low (10 dry tons/acre), estimates from University of Florida, http://www.treepower.org/yields/main.html.

AFW-1. Forest Retention—Reduced Conversion of Forested to Non-Forested Land Uses

Policy Description

Florida has one of the highest growth rates in the nation. By 2060, it is projected that approximately seven million acres of additional land will be converted from rural to urban uses in Florida, including almost 2.7 million acres of current agricultural lands and 2.7 million acres of existing habitat. This growth will create enormous pressure to develop the landscape. Developed areas contain lower amounts of biomass and its associated carbon. Developed areas also sequester less CO_2 than forested areas. Much of the carbon stored in forest biomass and soils can be lost as a result of such land-use conversion.

When landowners don't have incentives to retain ownership, they often sell for development and also sell forested tracts by smaller parcels, making effective forest management impractical. Managed stands sequester carbon faster than non-managed stands. Carbon is sequestered on a long-term basis in durable products.

This policy seeks to reduce the rate at which existing forests are cleared, fragmented, and converted to developed uses, while also providing mechanisms that ensure healthy forest management. There are a variety of public and private conservation programs that can be used to halt this landscape conversion. This policy will emphasize the value of existing forest cover and its importance as carbon stock.

Note that this policy overlaps with AFW-2: Afforestation and Restoration of Non-Forested Lands and AFW-3: Forest Management for Carbon Sequestration.

Policy Design

Goals: Stabilize current statewide forest-cover acres and achieve no net loss in carbon stocks by 2015.

Timing: See Goals above.

Parties Involved: Florida private forestland owners, Florida Division of Forestry (DOF), Florida Forestry Association (FFA), Florida Fish and Wildlife Conservation Commission (FWC), University of Florida (UF) Institute of Food and Agricultural Sciences (IFAS) extension, Natural Resources Conservation Service (NRCS), nongovernmental agencies, Regional Planning Councils (RPCs), other state land management agencies, U.S. Forest Service (USFS), U.S. Fish and Wildlife Service (US FWS), U.S. Army Corp of Engineers (USACE), other federal land management and technical assistance agencies, The Nature Conservancy, forest industry, real estate investment trusts (REITs), timber investment management organizations (TIMOs), private landowners, state government, and the federal government.

Other: Based on the USFS Forest Inventory and Analysis (FIA) data, Florida lost 74.3 thousand acres of forestland from 1995 to 2005 (from 16,221.2 down to 16,146.9 million acres), resulting in a 0.5 percent reduction in forestland. During the same time period, the timberland (forestland capable of producing merchantable timber) acreage increased by 901.2 thousand acres (from 14,650.7 to 15,551.9 million acres), which corresponds to a 6.2 percent increase over a 10-year period. However, that does not mean forestland conversion to development is not occurring in Florida. It means that, for this period of time, acreage was planted with trees, offsetting almost all of the forestland converted to other land uses throughout the state, and that some of the acreage previously classified as forestland is now classified as timberland.

Implementation Mechanisms

Achieve "no net loss" or an increase in forest carbon stocks through local land-use planning, conservation easements, federal and state incentive programs available to family forest landowners, outreach, favorable tax incentives and disincentives, and other relevant forest retention mechanisms (for example, carbon trading).

Continue purchasing acres through the *Florida Forever* program.

Provide technical and material assistance to forest land owners to encourage them to keep forest land in forest cover. This can be accomplished by maintaining and, whenever possible, increasing ongoing forestry assistance programs. The following are current forest assistance programs:

- **Forest Stewardship Program—**Provides resource management plans and technical guidance to encourage multiple-use management of private lands. Multiple-use includes production of a variety of forest products, improved wildlife habitat, increased recreational opportunities, improved aesthetics, and cleaner air and water. This program is partially funded by federal dollars that are expected to continue to decline.
- **Conservation Reserve Program—**Provides incentives to reduce soil erosion and protect water quality by returning lower quality farm ground to forest cover. This program is federally funded, with DOF foresters providing technical guidance on reforestation practices.
- **Environmental Quality Incentive Program—**Provides incentives to reduce soil erosion and protect water quality through a wide variety of practices. This program is federally funded, with DOF foresters providing technical guidance on reforestation and forest productivity enhancement practices. The 2008 federal Farm Bill includes language to increase the emphasis on forestry practices. Support is required to ensure that the forestry language remains a priority and a new Farm Bill is passed.
- **Forest Land Enhancement Program—**This program provided federal cost-share dollars to private landowners to improve current forest condition and provide assistance in reforestation. These practices reduced threats from wildfire, insects, and disease while

increasing forest productivity. This program has expired and is not likely to receive federal funding in the future.

- **Cooperative Forestry Assistance**—County foresters are available to assist landowners in forest management planning. County foresters provide technical guidance on how to improve and protect forest health and productivity.
- **Forest Health, Southern Pine Beetle Program**—The DOF offers technical and financial assistance to landowners to reduce risks associated with insect and disease problems. This program is partially funded with federal dollars.
- **Urban and Community Forests**—Provides federal dollars to encourage cities to develop tree planting and maintenance programs. Urban trees reduce heat buildup in cities and reduce energy consumed for cooling by providing shade, cleaning air, producing oxygen, improving aesthetics, and storing carbon. Blocks of trees near cities can serve many of the above functions as well as provide recreational areas, storm water retention and filtration, groundwater recharge, reduced water treatment costs, and increased water supply.

Related Policies/Programs in Place

Florida has aggressively pursued the acquisition of conservation lands over the past 25 years, preserving more than 2 million acres with more than $6 billion in funding for the *Preservation 2000* program and its successor, the *Florida Forever* program.

The NRCS's Farm Bill programs (Conservation Reserve Program [CRP], GRP, Wildlife Habitat Incentives Program [WHIP], and Environmental Quality Incentives Program [EQIP]) provide financial incentives to landowners to maintain forestlands.

The US FWS's Partners for Fish and Wildlife program supports restoration and conservation of high priority habitats by forming partnerships with private landowners.

Florida FWC's Landowner Assistance Program provides habitat management recommendations aimed at forming long-term partnerships with private landowners that lead to the restoration and conservation of high-priority habitats identified in Florida's Wildlife Action Plan (http://myfwc.com/wildlifelegacy/). Recommendations include restoring native groundcover and overstory species, planting new pine stands at low densities, and thinning existing stands to benefit carbon sequestration, wildlife habitats, and forest health.

Florida Farm Bureau's Carbon Trading Program is now in effect and offers financial incentives to landowners for maintaining forestlands.

Florida's proposed Amendment 4 would provide additional tax incentives to landowners who retire development rights through a conservation easement.

In 2006, Florida had 16.7 million acres of forest land, of which nearly 16.0 million acres were classified as timberland. The Florida Division of Forestry (DOF) manages 1.0 million acres of forest land in 34 state forests, and provides technical assistance to other state and local agencies which manage an additional 1.9 million acres of forest land. Through various other programs (see below) DOF provides technical assistance to individual and family landowners who control nearly five million acres of Florida's forest lands. Federal forest lands constitute 2.1 million acres, forest industry owns 1.6 million acres, non-industrial private forests in corporate ownership constitute nearly five million acres, and other ownership equals 0.1 million acres of forest lands in Florida.

Besides managing state forests, DOF is working with family and individual forest landowners, who control five million acres (30 percent) of Florida's forest lands, to advocate forest management aimed at well stocked forests for the duration of a rotation from tree planting to final harvest. Well stocked forests have a basal area of 60 to 80 square feet per acre. When forests reach a merchantable basal area of approximately 100 to 150 square feet per acre, they are thinned back to the 60 to 80 square feet range to sustain optimal tree growth and forest health. After final harvest, pine forests should be replanted at a minimum of 605 or 726 trees per acre to ensure adequate survival, tree growth, tree form, and subsequently timber quality and quantity. Planting at the recommended densities provides an opportunity for thinning in the middle of a 25- to 30-year rotation, making wood available for energy production or traditional forest products. More trees at planting and adequate forest stocking means more CO_2 sequestered by rapidly growing young trees and more opportunities for woody biomass harvest for energy production and other uses.

Type(s) of GHG Reductions

Avoided CO_2 emissions in case of retained forests; and maintained carbon sequestration in forests that are not cleared.

When forests are harvested and not replanted, most of the biomass is converted back to CO_2. For some long lived products it takes decades to revert back to CO_2, but for other like paper and packaging materials the "decaying" process can be measured in months or years. Therefore, whenever the forest is retained "on the stump" CO_2 emissions are avoided.

Estimated GHG Reductions and Net Costs or Cost Savings

- Estimated GHG reductions (MMtCO_2e/year): 2017 = 0.48; 2025 = 0.63
- Estimated costs ($/t$CO_2$e): 36

Data Sources:

Smith, J.E., L.S. Heath, K.E. Skog, and R.A. Birdsey. *Methods for Calculating Forest Ecosystem and Harvested Carbon With Standards Estimates for Forest Types of the United States*. General Technical Report NE-343. USDA/USFS, Northern Research Station, 2006. Available at: http://www.treesearch.fs.fed.us/pubs/22954.

Data for rates of forest area change are from USDA Forest Service Forest Inventory and Analysis Unit, using publicly-available information on forest area change between 1987 and 2003 inventories. These forest area estimates are also included in the Inventory and Forecast for Florida (Appendix H). Data available online at: http://fia.fs.fed.us/tools-data/default.asp.

Quantification Methods:

Carbon savings from this recommendation were estimated from two sources: (1) the amount of carbon that would be lost as a result of forest conversion to developed uses (known as "avoided emissions") and (2) the amount of annual carbon sequestration potential that is maintained by protecting the forest area.

1. Avoided Emissions

Carbon savings from avoided emissions were calculated using statewide average estimates of total standing forest carbon stocks in Florida, provided by the USFS as part of the Forest Inventory and Forecast for Florida (Appendix H).

Loss of forests to development results in a large one-time surge of carbon emissions. In this case, it was assumed that 100 percent of the vegetation carbon stocks would be lost in the event of forest conversion to developed uses, with no appreciable carbon sequestration in soils or biomass following conversion. While soil carbon may be lost on forest conversion to developed use, soil carbon loss was excluded from this analysis because soil carbon dynamics are not included in the baseline calculations for the Inventory and Forecast. A comparison of data from the American Housing Survey with land use conversion data from the Natural Resources Inventory (NRI) suggests that, on average, two thirds of the land area in residential lots is cleared during land conversion. Thus, it was assumed that, during forest conversion to developed use, 100 percent of the forest vegetation would be lost on 67 percent of the converted acreage. Using the statewide average carbon densities from the Florida FIA results, roughly 13.7 metric tons of carbon (tC) emissions are avoided for every acre of forest not converted to another use in Florida.

Between 1995 and 2005, roughly 7,420 acres of forest were lost annually in Florida (USDA Forest Service Forest Inventory and Analysis, FL Inventory and Forecast (Appendix H)). To reach the no-net-forest-loss target by 2015, this recommendation therefore assumes that 7,420 acres must be preserved each year beginning in 2015. The number of acres targeted for policy implementation between 2009 and 2015 was calculated by dividing 7,420 by seven and implementing the recommendation gradually and linearly over the seven-year period between 2009 and 2015 (Table 1-1).

Each year, the number of acres estimated to remain forested as a result of the program was multiplied by 13.7 tC to estimate total avoided emissions due to forest preservation in that year. Table 1-1 shows the annual and total acres targeted by the program and associated avoided emissions that would be generated between 2009 and 2025.

Table D-1-1. Acres protected from conversion and associated avoided emissions

Year	Acres Protected From Development	Avoided Emissions From Development (tC/year)
2009	1,060	14,528
2010	2,120	29,057
2011	3,180	43,585
2012	4,240	58,114
2013	5,300	72,642
2014	6,360	87,171
2015	7,420	101,699
2016	7,420	101,699
2017	7,420	101,699
2018	7,420	101,699
2019	7,420	101,699
2020	7,420	101,699
2021	7,420	101,699
2022	7,420	101,699
2023	7,420	101,699
2024	7,420	101,699
2025	7,420	101,699
Cumulative Totals	103,880	1,423,789

tC/year = metric tons of carbon per year

2. Annual Sequestration Potential in Protected Forests

The calculations in this section of the analysis used default carbon sequestration values for the forest types most common in Florida. The default values apply to forests in the Southeast (USFS GTR-343, Tables A41, A43, A44, and A45; see data sources listed above). Average annual carbon sequestration for these forest types was calculated over 45 years, assuming a typical forest age distribution statewide. An average annual sequestration rate was calculated by subtracting non-soil carbon stocks in 45-year-old stands from non-soil carbon stocks in new stands and dividing by average stand age and are summarized in Table 1-2. Soil carbon density was assumed constant and is not included in the calculation.

Table D-1-2. Forest carbon sequestration rates

	tC/ha (0 year)	tC/ha (45 years)	tC/ha/year (average)	Proportion of Florida Forests
Longleaf-slash pine (NE-GTR-343 Table A41)	26.1	91.9	1.5	0.38
Oak-gum-cypress (NE-GTR Table A43)	18.1	98.3	1.8	0.20
Oak-hickory (NE-GTR Table A44)	21.0	104.7	1.9	0.20
Oak-pine (NE-GTR Table A45)	25.8	104.2	1.7	0.11
Loblolly-shortleaf pine (NE-GTR Table A39)	26.3	104.4	1.7	0.11

tC/ha = metric tons of carbon per hectare

In Florida, longleaf-slash pine makes up about 35 percent of forested lands, oak-gum-cypress makes up 18 percent, oak-hickory comprises 17 percent, and oak-pine and loblolly-shortleaf pine are each roughly 9 percent of forested land. All other forest types make up less than 4 percent each of the state's forests (Florida Inventory and Forecast, Appendix H). The proportion of Florida forests summarized in Table 1-2 were rounded up to account for all other forest types. This analysis assumes that forests will be protected in roughly equal proportion to their occurrence statewide (Table 1-2). Carbon sequestration in the average acre of protected Florida forest was calculated at roughly 1.67 metric tons of carbon per hectare per year (0.67 tC/ha).

The results for annual sequestration potential under policy implementation are given in Table 1-3. Forests preserved in one year continue to sequester carbon in subsequent years. Thus, annual sequestration potential includes benefits from acres preserved cumulatively under the program.

Table D-1-3. Annual and cumulative carbon sequestration in forests protected from conversion between 2009 and 2025

Year	Acres Protected From Development		Cumulative Carbon Sequestration for Land Protected in All Years (tC/year)
	This Year	In Prior Years	
2009	1,060	0	715
2010	2,120	1,060	2,145
2011	3,180	3,180	4,290
2012	4,240	6,360	7,149
2013	5,300	10,600	10,724
2014	6,360	15,900	15,014

Year	Acres Protected From Development		Cumulative Carbon Sequestration for Land Protected in All Years (tC/year)
	This Year	In Prior Years	
2015	7,420	22,260	20,018
2016	7,420	29,680	25,023
2017	7,420	37,100	30,027
2018	7,420	44,520	35,032
2019	7,420	51,940	40,036
2020	7,420	59,360	45,041
2021	7,420	66,780	50,045
2022	7,420	74,200	55,050
2023	7,420	81,620	60,055
2024	7,420	89,040	65,059
2025	7,420	96,460	70,064
Cumulative totals		**103,880**	**235,214**

tC/year = metric tons of carbon per year

3. Overall GHG Benefit of Avoided Land Conversion

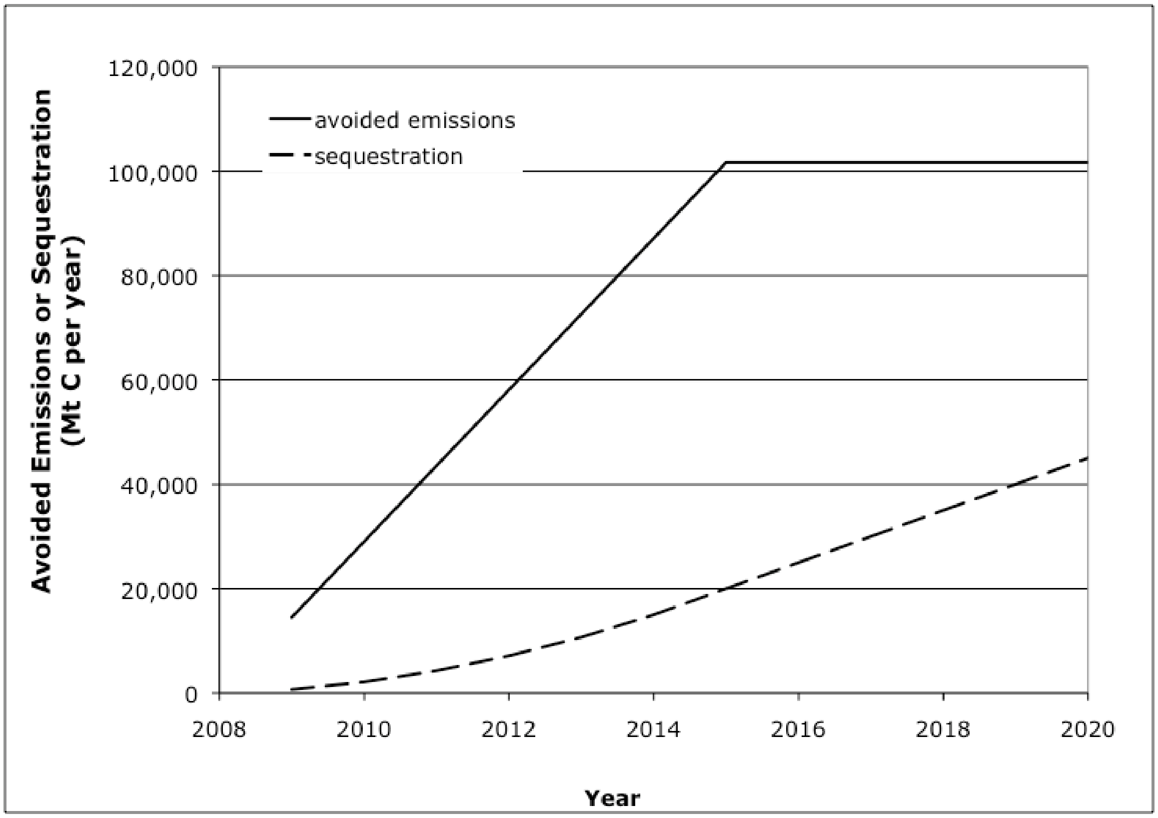
The cumulative GHG benefit of avoided forest land conversion (including avoided emissions from reduced conversion as well as annual sequestration in protected forest) was calculated in units of $MMtCO_2e$ (Table 1-4). Figure 1-1 shows the relative impact of avoided emissions and sequestration in protected acreage.

Table D-1-4. Combined GHG impact of avoided forest land conversion under policy implementation

Year	tC/year	$MMtCO_2e$/year
2009	15,243	0.06
2010	31,202	0.11
2011	47,875	0.18
2012	65,263	0.24
2013	83,366	0.31
2014	102,184	0.37
2015	121,717	0.45
2016	126,722	0.46
2017	131,727	0.48
2018	136,731	0.50
2019	141,736	0.52
2020	146,740	0.54
2021	151,745	0.56
2022	156,749	0.57
2023	161,754	0.59
2024	166,758	0.61
2025	171,763	0.63
Cumulative total		**7.18**

tC/year = metric tons of carbon per year; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

Figure D-1-1. Relative impact of avoided emissions from protecting forest and annual sequestration on protected acreage for AFW-1



4. Economic analysis

Economic costs of protecting forestland were assumed to be equivalent to the one-time cost of land protection at $3,836/acre. This estimate was calculated by dividing the total investment in the *Florida Forever* program (2001-2008) by the cumulative acreage protected under that program.[14]

Net economic costs of protecting forestland are presented in Table 1-5. Discounted costs were calculated using a five percent discount rate, with a total NPV of $186 million. The cost-effectiveness of this recommendation is $36/t$CO_2$e avoided.

[14] Data on acreage protected and total costs incurred under the recent *Florida Forever* Program (2001-2008), as well as its predecessor, *P-2000*, available at: http://www.dep.state.fl.us/secretary/stats/land.htm

Table D-1-5. Economic costs of protecting forestland under AFW-1

Year	Total Cost	Discounted Costs
2009	$4,066,135	$4,066,135
2010	$8,132,269	$7,745,018
2011	$12,198,404	$11,064,312
2012	$16,264,539	$14,049,920
2013	$20,330,673	$16,726,095
2014	$24,396,808	$19,115,538
2015	$28,462,943	$21,239,486
2016	$28,462,943	$20,228,082
2017	$28,462,943	$19,264,840
2018	$28,462,943	$18,347,467
2019	$28,462,943	$17,473,778
2020	$28,462,943	$16,641,693
2021	$28,462,943	$15,849,232
2022	$28,462,943	$15,094,506
2023	$28,462,943	$14,375,720
2024	$28,462,943	$13,691,162
2025	$28,462,943	$13,039,202
Totals		**$185,962,364**

Key Assumptions: As outlined in text. The largest of these is the rate of forest conversion that would occur through 2025 without this policy being implemented. The current assumption of around 7,400 acres per year is based on the difference in state-wide forested acres measured between 1995 and 2005. Because some change in forested area during this period is likely due to conversion of lands without forest cover (for example, agricultural lands) to forest cover, the current assumption could significantly underestimate the amount of forest acres lost due to development. On the other hand, the current poor economic situation has certainly affected the rate of forest loss in the last year or two and could continue to affect conversion rates further into the policy period.

Key Uncertainties

Due to a lack of information, the benefits of forest soil carbon saved through land protection are not included in the analysis above, but are potentially significant. This should be a key area of future related research in Florida.

Additional Benefits, Costs and Energy Security Fuel Savings

None identified.

Feasibility Issues

None identified.

Status of Group Approval

Complete.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

AFW-2. Afforestation and Restoration of Non-Forested Lands

Policy Description

Establish forests on land that has not historically been forested (for example, agricultural land, "afforestation"). Promote forest cover and associated carbon stocks by regenerating lands previously forested ("reforestation"). In addition, implement practices (for example, soil preparation, erosion control, and stand stocking) to ensure conditions that support forest growth. Additional benefits include public recreation, water quality, wildlife habitat, and enhanced biodiversity.

Maintain and improve the health and longevity of tree canopy cover in urban and residential areas to protect and enhance the carbon stored in tree biomass, to absorb air pollution and increase oxygen supplies, and to reduce heating and cooling needs as a result of increased shading. Promote use of software programs that can be used by cities and communities to track and assess the ecological and economic benefits of urban forestry.

Note that this policy has overlap with AFW-1: Forest Retention—Reduced Conversion of Forested to Non-Forested Land Uses and AFW-3 Forest Management for Carbon Sequestration.

Policy Design

Goals:

- *Forested Landscape (Afforestation)*—Increase the area of forested lands in Florida by 50,000 acres annually between 2009 and 2025.
- *Forested Landscape (Reforestation)* – Implement reforestation activity on all harvested acreage from 2009 through 2025.
- *Urban Forestry (Primary Goal)*—Plant and maintain enough trees in urban areas to offset 2008 metropolitan carbon emissions by 3 percent by 2025.
- *Urban Forestry (Secondary Goal)*—Increase the tree canopy coverage in all developed areas [with a population greater than 500 residents per square mile] to 30 percent by 2025.

Timing: See above.

Parties Involved: Florida private forestland owners, DOF, Florida Forestry Association, FWC, UF IFAS, NRCS, nongovernmental agencies, RPCs, other state land management agencies, USFS, US FWS, USACE, other federal land management and technical assistance agencies, the Nature Conservancy, forest industry, REITs, TIMOs, and private landowners, state government, and federal government.

Other: For urban forestry, the two goals overlap in terms of GHG benefits. Each will be quantified, and the goal with the largest benefit included in the summary table at the front of this document.

Intensifying reforestation and afforestation efforts in Florida’s forests could increase the amount of greenhouse gas (GHG) reduction. According to 2006 data, approximately 152,000 acres are reforested annually in Florida by deliberate efforts, and an additional 34,000 acres are reforested annually by naturally occurring forest self-regeneration. The total of 186,000 acres reforested and afforested annually represents 1.2 percent of all forestlands in Florida. Artificial reforestation (planting trees after final forest harvest) and afforestation (planting trees on agricultural and other lands) should be performed to establish adequate tree densities. Pine forests should be planted at a minimum of 605 or 726 trees per acre to assure adequate survival, tree growth, tree form and subsequent timber quality and quantity. Rapidly growing young pine trees sequester large quantities of CO_2; stands that are not adequately stocked provide only a fraction of potential GHG reduction and woody biomass production for renewable energy production and other uses.

Implementation Mechanisms

Landowner assistance and/or incentive programs are needed to encourage reforestation and afforestation in Florida.

Discourage clear-cutting of forests when building housing developments. Protect a percentage of native cover when developing land.

Tax exemptions or tax relief for land in conservation.

Change the acreage minimum that so small landowners can receive incentives for land conservation as well as large landowners.

Establish a baseline for urban forest carbon storage and sequestration rates in Florida’s top 10 metropolitan areas (based on population). By quantifying carbon storage and sequestration rates in these areas, it will be possible to establish appropriate long term goals to determine the number of trees required to offset carbon emissions and reduce energy consumption in urban areas. Currently in Tampa, the urban forest only offsets approximately one percent of carbon emissions associated with human activity. A goal should be set for urban forests to offset carbon emissions at the 2008 population levels by 10 percent by 2025.

Increased tree canopy coverage can be accomplished by a combination of tree planting projects, delineating natural areas in new developments, preservation of suitable specimen and groups of specimen trees on parcels during development, and adequate care of existing trees in developed areas.

Related Policies/Programs in Place

The Natural Resources Conservation Service's Farm Bill programs [Conservation Reserve Program (CRP), Grassland Reserve Program (GRP), Wildlife Habitats Incentive Program (WHIP), and Environmental Quality Incentives Program (EQIP)] support reforestation.

The U.S. FWS's Partners for Fish and Wildlife supports reforestation of high-priority habitats.

The Florida FWC's Landowner Assistance Program provides habitat management recommendations aimed at forming long-term partnerships with private landowners that lead to the restoration and conservation of high priority habitats, identified in Florida's Wildlife Action Plan http://myfwc.com/wildlifelegacy/. Recommendations include restoring native groundcover, overstory species, planting new pine stands at low densities, and thinning existing stands to benefit carbon sequestration, wildlife habitats, and forest health.

The Urban and Community Forestry Program in DACS helps promote urban forestry and provides grants. City Green and I-Tree are programs that cities and communities can use to measure urban trees.

DOF is working with family and individual forest landowners, who control 5 million acres (61 percent) of Florida's forest lands, to advocate forest management aimed at well stocked forests for the duration of a rotation from tree planting to final harvest. Well stocked forests have a basal area of 60 to 80 square feet per acre. When forests reach a merchantable basal area of approximately 100 to 150 square feet per acre, they are thinned back to the 60 to 80 square feet range to sustain optimal tree growth and forest health. After final harvest, pine forests should be replanted at a minimum of 605 or 726 trees per acre to ensure adequate survival, tree growth, tree form, and subsequently timber quality and quantity. Planting at the recommended densities provides an opportunity for thinning in the middle of a 25- to 30-year rotation making wood available for energy production or traditional forest products. More trees at planting and adequate forest stocking means more CO_2 sequestered by rapidly growing young trees and more opportunities for woody biomass harvest for energy production and other uses.

Type(s) of GHG Reductions

Forested Landscape: Additional sequestered CO_2 in above- and belowground biomass by growing trees on afforested/reforested acres that would not have been planted or self-regenerated under BAU conditions.

Urban Forestry: Additional sequestered CO_2 in planted trees; indirect savings of CO_2, CH_4, and N_2O as a result of energy savings achieved where trees are planted to achieve shading and windbreak benefits.

Estimated GHG Reductions and Net Costs or Cost Savings

Estimated GHG reductions ($MMtCO_2e$/year):

A.	Forested Landscape	Afforestation: 2017 = 1.7; 2025 = 3.1
		Reforestation: 2017 = 6.1; 2025 = 11.6
B.	Urban Forestry	Primary goal: 2017 = 4.9; 2025 = 9.2
		Secondary goal: 2017 = 4.6; 2025 = 8.7

Estimated cost (\$/tCO_2e):

A.	Forested Landscape	Afforestation: 5
		Reforestation: 5
B.	Urban Forestry	Primary goal: 10
		Secondary goal: 10

Data Sources:

Forested landscape:

Smith, J.E., L.S. Heath, K.E. Skog, and R.A. Birdsey. *Methods for Calculating Forest Ecosystem and Harvested Carbon With Standards Estimates for Forest Types of the United States*. General Technical Report NE-343. USDA/USFS, Northern Research Station, 2006. Available at: http://www.treesearch.fs.fed.us/pubs/22954.

Brown, M.J. 2007. Florida's Forests—2005 Update. USDA Forest Service, Southern Research Station, Resource Bulletin SRS-118. Available at: http://www.treesearch.fs.fed.us/pubs/28996

Urban forestry:

Data on urban tree canopy and gross carbon sequestration from USDA Forest Service, Northern Research Station, (D. Nowak), available at: http://www.fs.fed.us/ne/syracuse/Data/State/data_FL.htm

Population estimates in Metropolitan Statistical Areas (MSAs) from Table 1. Annual Estimates of the Population of Metropolitan Statistical Areas: April 1, 2000, to July 1, 2007 (CBSA-EST2007-01). Source: U.S. Census Bureau, Population Division. Release Date: March 27, 2008. Available at: http://www.census.gov/population/www/estimates/CBSA-est2007-annual.html

Nowak, D.J. and D.E. Crane. "Carbon Storage and Sequestration by Urban Trees in the USA." *Environmental Pollution* March 2002;116(3):381-389. Available at: http://www.treesearch.fs.fed.us/pubs/15521

U.S. Environmental Protection Agency. April 2008. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2006*. USEPA #430-R-08-005. Available at: http://www.epa.gov/climatechange/emissions/usinventoryreport.html

McPherson, E.G. and J.R. Simpson. 1999. "Carbon Dioxide Reduction Through Urban Forestry: Guidelines for Professional and Volunteer Tree Planters." Appendix A, Table V.5. PSW-GTR-171. U.S. Department of Agriculture, U.S. Forest Service, Washington, DC. Available at: http://www.treesearch.fs.fed.us/pubs/6779

McPherson, E.G., J.R. Simpson, P.J. Peper, S.L. Gardner, K.E. Vargas, S.E. Maco, et al. 2006. "Coastal Plains Tree Guide: Benefits, Costs, and Strategic Planting." USDA Forest Service Pacific Southwest Research Station, PSW-GTR-201. Available at: http://www.fs.fed.us/psw/publications/gtrs.shtml

Quantification Methods:

A. Forested Landscape

This component of the policy recommendation seeks to increase the area of land in forest cover using two mechanisms: first, adding acreage to the land area currently in forested use (afforestation) and second, replanting forest land following harvest (reforestation).

1. Afforestation

This policy recommendation seeks to increase the area of land in forest cover by 50,000 acres annually between 2009 and 2025. Forests grown or planted on land not currently in forest cover will most likely accumulate carbon at a rate consistent with the accumulation rates of average forests in the region. Therefore, carbon sequestered by afforestation activities can be assumed to occur at the same rate as carbon sequestration in average Florida forests.

A weighted-average annual rate of carbon sequestration for young-aged forests in Florida was calculated as 0.997 tC/acre/year, using data on carbon stocks by age class published by USFS for the five most dominant forest groups, which together total nearly 93 percent of forestland in Florida (Table 2-1; Smith et al citation noted above). For each forest type group, annual carbon sequestration rates were calculated by subtracting carbon stocks in new stands (0 years-old) from carbon stocks in 15-year-old stands and dividing by 15 years. An average rate was calculated, weighted by area of each forest type to take into account variation in carbon sequestration across forest types. A 15-year rate was used to reflect the average age of forested stands during the timeframe of analysis. Young stands typically sequester carbon at faster rates than older stands.

Table D-2-1. Data on carbon stocks, 15-year annual average sequestration rates, and area by forest type, used to calculate a weighted average annual sequestration rate for afforestation

Forest Type	Carbon Stocks at Age 0 Years (tC/acre)	Carbon Stocks at Age 15 Years (tC/acre)	Average Annual Sequestration (tC/acre/year)	Area in 2005 (acres)
Longleaf-slash pine (Table B41)	35.1	48.5	0.89	5,743,100
Soils	33.4	34.4		
Biomass*	1.7	14.4		
Oak-gum-cypress (Table B43)	48.7	64.4	1.05	2,886,600
Soils	48.0	49.3		
Biomass*	0.7	15.1		
Oak-hickory (Table B44)	15.4	30.7	1.02	2,827,900
Soils	13.7	14.1		
Biomass*	1.7	16.6		
Loblolly-shortleaf pine (Table B39)	23.9	41.5	1.17	1,546,600
Soils	22.2	22.8		
Biomass	1.7	18.7		
Oak-pine (Table B45)	20.3	36.5	1.08	1,458,600
Soils	18.6	19.2		
Biomass	1.7	17.3		
Area weighted average			**0.997**	

tC/acre/year = metric tons of carbon per acre per year.

* Includes live trees, standing dead wood, understory, down dead wood, and litter/debris on the forest floor.

Source: Smith et al. 2006.

While AFW-1 seeks to reverse the current decreasing trend in Florida's existing forests, the afforestation component of AFW-2 aims to increase forested acreage each year by creating new forest cover in areas that would have otherwise remained under non-forest cover. Thus all of the planted acreage represents a net addition to the forested land base. The goal level of an additional 50,000 acres per year requires that 850,000 additional acres of forest be planted over the 17-year policy implementation period. This would increase forestland area by roughly 5.5 percent over the 2005 forest area estimate.

A forest continues to accumulate carbon each year after it is planted. Thus, to calculate the carbon sequestration attributed to this policy, the weighted-average annual carbon sequestration rate was multiplied by the cumulative acres of additional forestland planted each year since 2009. Forested acres (annual and cumulative) and annual total carbon sequestration are shown in Table 2-2. Reductions are calculated in metric tons of carbon (tC) and converted to standard units of $MMtCO_2e$.

Table D-2-2. Calculation of annual carbon sequestration from and costs to implement afforestation: 2009–2025

Year	Acres Planted This Year	Acres Planted in Prior Years	Carbon Sequestration (tC/year)	Carbon Sequestration ($MMtCO_2e$/year)	Cost (2005$)	Discounted Cost (2005$)
2009	50,000	0	49,874	0.18	$13,750,000	$11,312,159
2010	50,000	50,000	99,747	0.37	$13,750,000	$10,773,485
2011	50,000	100,000	149,621	0.55	$13,750,000	$10,260,462
2012	50,000	150,000	199,494	0.73	$13,750,000	$9,771,868
2013	50,000	200,000	249,368	0.91	$13,750,000	$9,306,541
2014	50,000	250,000	299,242	1.10	$13,750,000	$8,863,373
2015	50,000	300,000	349,115	1.28	$13,750,000	$8,441,307
2016	50,000	350,000	398,989	1.46	$13,750,000	$8,039,340
2017	50,000	400,000	448,862	1.65	$13,750,000	$7,656,514
2018	50,000	450,000	498,736	1.83	$13,750,000	$7,291,919
2019	50,000	500,000	548,609	2.01	$13,750,000	$6,944,684
2020	50,000	550,000	598,483	2.19	$13,750,000	$6,613,985
2021	50,000	600,000	648,357	2.38	$13,750,000	$6,299,033
2022	50,000	650,000	698,230	2.56	$13,750,000	$5,999,079
2023	50,000	700,000	748,104	2.74	$13,750,000	$5,713,409
2024	50,000	750,000	797,977	2.93	$13,750,000	$5,441,342
2025	50,000	800,000	847,851	3.11	$13,750,000	$5,182,230
Total		**850,000**		**30.0**		**$133,910,732**

tC/year = metric tons of carbon per year; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

The cost of $275/acre is estimated based on estimates from the DOF.[15] In reality costs will vary, depending on specific goals of the tree-planting project, species planted, and site conditions. Potential future cost savings from forest products (for example, merchantable timber or bioenergy feedstocks) are not taken into account. These cost savings would most likely not be realized during the time frame of this analysis.

Annual costs of afforestation activity were calculated by multiplying the number of acres planted each year by $275/acre (Table 2-2). Annual costs were discounted using a five percent rate to convert future dollars to present values. The sum of annual discounted costs from 2009 to 2025 yields an estimate of the a cumulative cost (NPV) of this policy, which is on the order of $134 million. The cost-effectiveness is calculated by dividing the NPV by the cumulative GHG

[15] Personal communication, Steve Jennings and Jarek Nowak, FL Division of Forestry with J. Jenkins, CCS, August 26, 2008.

benefit of 28 $MMtCO_2e$ over the same time frame, yielding a cost-effectiveness of $4.79/$tCO_2e$ saved.

2. Reforestation

The reforestation component of AFW-2 seeks to encourage regeneration on acreage that is harvested. In Florida, between 1995 and 2005, 336.2 thousand acres were harvested annually while only 188.3 thousand acres experienced natural or artificial regeneration (Table 2-3).[16] The acreage available for reforestation under AFW-2 is thus the acreage that is harvested but not regenerated, totaling 147.9 thousand acres annually (Table 2-3). It was assumed that this acreage would be reforested each year, from 2009 through 2025, resulting in a total of 2.5 million acres reforested over and above BAU by 2025.

Table D-2-3. Forest acreage harvested and reforested in FL annually, 1995–2005

Type of activity	Treatment or disturbance	Acreage treated annually (all ownership classes) (thousands of acres)
Harvest	Final harvest	189.1
Harvest	Partial harvest	64.3
Harvest	Seed tree/shelterwood	3.5
Harvest	Commercial thinning	56.7
Harvest	Other stand improvement	22.6
Regeneration	Artificial regeneration	150.1
Regeneration	Natural regeneration	38.2
Total of harvest activity (thousand acres)		336.2
Total of regeneration activity (thousand acres)		188.3
Difference (harvest minus regeneration: acreage available for reforestation activity) (thousand acres)		147.9

Source: Brown 2007.

It was assumed that carbon sequestered by reforestation occurs at the same rate as carbon sequestration in average Florida forests. A weighted-average annual rate of carbon sequestration for young reforested stands in Florida was calculated as 1.25 tC/ha/year (0.51 tC/acre/year), using data on carbon stocks by age class published by USFS for the five most dominant forest groups, which together total nearly 93 percent of forestland in Florida (Table 2-4). For each forest type group, annual carbon sequestration rates were calculated by subtracting carbon stocks in new stands (0-years-old) from carbon stocks in 15-year-old stands and dividing

[16] Brown, Mark J. 2007. Florida's Forests—2005 Update. USDA Forest Service Southern Research Station Resource Bulletin SRS-118. Available at: http://www.treesearch.fs.fed.us/pubs/28996

by 15 years. An average rate was calculated, weighted by area of each forest type to take into account variation in carbon sequestration across forest types. A 15-year rate was used to reflect the average age of forested stands during the timeframe of analysis. Young stands typically sequester carbon at faster rates than older stands.

Table D-2-4. Forest carbon sequestration rates in reforested stands

	tC/ha (0 year)	tC/ha (15 years)	tC/ha/year (average)	Proportion of Florida Forests
Longleaf-slash pine (NE-GTR-343 Table A41)	26.1	39.4	0.9	0.38
Oak-gum-cypress (NE-GTR Table A43)	18.1	39.1	1.4	0.20
Oak-hickory (NE-GTR Table A44)	21.0	43.1	1.5	0.20
Oak-pine (NE-GTR Table A45)	25.8	47.9	1.5	0.11
Loblolly-shortleaf pine (NE-GTR Table A39)	26.3	50.7	1.6	0.11

tC/ha = metric tons of carbon per hectare

A forest continues to accumulate carbon each year after it is reforested. Thus, to calculate the carbon sequestration attributed to this policy, the weighted-average annual carbon sequestration rate was multiplied by the cumulative acres of additional reforested land each year since 2009. Reforested acres (annual and cumulative) and annual total carbon sequestration are shown in Table 2-5. Reductions are calculated in metric tons of carbon (tC) and converted to standard units of $MMtCO_2e$.

Table D-2-5. Calculation of annual carbon sequestration from and costs to implement reforestation: 2009–2025

Year	Acres Reforested This Year	Acres Reforested in Prior Years	Carbon Sequestration (tC/year)	Carbon Sequestration ($MMtCO_2e$/year)	Cost (2005$)	Discounted Cost (2005$)
2009	147,900	0	185,260	0.68	$56,941,500	$46,845,913
2010	147,900	147,900	370,519	1.36	$56,941,500	$44,615,155
2011	147,900	295,800	555,779	2.04	$56,941,500	$42,490,624
2012	147,900	443,700	741,038	2.72	$56,941,500	$40,467,261
2013	147,900	591,600	926,298	3.40	$56,941,500	$38,540,249
2014	147,900	739,500	1,111,557	4.08	$56,941,500	$36,704,999
2015	147,900	887,400	1,296,817	4.75	$56,941,500	$34,957,142
2016	147,900	1,035,300	1,482,076	5.43	$56,941,500	$33,292,516
2017	147,900	1,183,200	1,667,336	6.11	$56,941,500	$31,707,158
2018	147,900	1,331,100	1,852,595	6.79	$56,941,500	$30,197,293

Year	Acres Reforested This Year	Acres Reforested in Prior Years	Carbon Sequestration (tC/year)	Carbon Sequestration ($MMtCO_2e$/year)	Cost (2005$)	Discounted Cost (2005$)
2019	147,900	1,479,000	2,037,855	7.47	$56,941,500	$28,759,327
2020	147,900	1,626,900	2,223,114	8.15	$56,941,500	$27,389,835
2021	147,900	1,774,800	2,408,374	8.83	$56,941,500	$26,085,557
2022	147,900	1,922,700	2,593,634	9.51	$56,941,500	$24,843,388
2023	147,900	2,070,600	2,778,893	10.2	$56,941,500	$23,660,369
2024	147,900	2,218,500	2,964,153	10.9	$56,941,500	$22,533,685
2025	147,900	2,366,400	3,149,412	11.6	$56,941,500	$21,460,652
Total		**2,514,300**		**104**		**$554,551,123**

tC/year = metric tons of carbon per year; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

The cost of $385/acre is estimated based on estimates from the DOF.[17] In reality costs will vary, depending on specific goals of the reforestation project, species planted, and site conditions. Potential future cost savings from forest products (for example, merchantable timber or bioenergy feedstocks) are not taken into account. These cost savings would most likely not be realized during the time frame of this analysis.

Annual costs of reforestation activity were calculated by multiplying the number of acres planted each year by $385/acre (Table 2-5). Annual costs were discounted using a 5 percent rate to convert future dollars to present values. The sum of annual discounted costs from 2009 to 2025 yields an estimate of the NPV of this policy, which is on the order of $555 million. The cost-effectiveness is calculated by dividing the NPV by the cumulative GHG benefit of 104 $MMtCO_2e$ over the same time frame, yielding a cost-effectiveness of $5.34/$tCO_2e$ saved.

B. Urban Forestry

The urban forest recommendation was calculated in two ways: the Primary goal expresses GHG reductions due to urban forestry in terms of per capita emissions for metropolitan residents, and the Secondary goal is expressed in terms of increased percent of canopy cover in urban areas. Both goals are roughly equivalent in terms of the number of trees planted, at 6.7 million trees annually (Primary goal) and 6.3 million trees annually (Secondary goal).

Primary Goal—Plant and maintain enough trees in urban areas to offset 2008 metropolitan carbon emissions by 3 percent by 2025.

The following explains the step by step quantification of the cumulative impact on carbon sequestration and avoided fossil fuel emissions of incrementally increasing the existing tree canopy cover in Florida to offset 3 percent of 2008 metropolitan carbon emissions, the AFW-2

[17] Personal communication, Steve Jennings and Jarek Nowak, FL Division of Forestry with J. Jenkins, CCS, August 26, 2008.

Primary Goal. This would require the planting and maintenance of an additional 6.7 million trees per year between 2009 and 2025.

1. 2008 Florida metropolitan emissions calculations

July 2007 U.S. Census Metropolitan Statistical Area (MSA) data were used to calculate the total metropolitan population in Florida.[18] In 2007, Florida had a total of 17.2 million people living in MSA regions (Table 2-6), which is more than 92 percent of Florida's 2007 population of 18.6 million.[19] Total metropolitan emissions were calculated by multiplying the 2005 statewide per capita emissions (18 tCO_2e per person per year)[20] by the total metropolitan population, resulting in a total estimated 2008 metropolitan emission of 309 $MMtCO_2e$. To offset 3 percent of these emissions by 2025, urban tree plantings would need to offset roughly 9.3 $MMtCO_2e$ in that year.

[18] Table 1. Annual Estimates of the Population of Metropolitan Statistical Areas: April1, 2000 to July 1, 2007 (CBSA-EST2007-01). Source: U.S. Census Bureau, Population Division. Release Date: March 27, 2008. Available at: http://www.census.gov/population/www/estimates/CBSA-est2007-annual.html

[19] From the Florida Office of Economic and Demographic Research, http://edr.state.fl.us/conferences/population/demographic.htm.

[20] From the Demographic Estimating Conference Database, updated August 2007, available at: http://edr.state.fl.us/population.htm

Table D-2-6. List of MSAs and corresponding populations in Florida from the U.S. Census Bureau (2007)

Geographic Area	Population Estimate (July 1, 2007)
Cape Coral-Fort Myers	590,564
Deltona-Daytona Beach-Ormond Beach	500,413
Fort Walton Beach-Crestview-Destin	181,499
Gainesville	257,099
Jacksonville	1,300,823
Lakeland	574,746
Miami	
Fort Lauderdale-Pompano Beach-Deerfield Beach	1,759,591
Miami-Miami Beach-Kendall	2,387,170
West Palm Beach-Boca Raton-Boynton Beach	1,266,451
Naples-Marco Island	315,839
Ocala	324,857
Orlando-Kissimmee	2,032,496
Palm Bay-Melbourne-Titusville	536,161
Palm Coast	88,397
Panama City-Lynn Haven	163,984
Pensacola-Ferry Pass-Brent	453,451
Port St. Lucie	400,121
Punta Gorda	152,814
Sarasota-Bradenton-Venice	687,181
Sebastian-Vero Beach	131,837
Tallahassee	352,319
Tampa-St. Petersburg-Clearwater	2,723,949
Total	**17,181,762**

2. GHG calculations

This recommendation quantifies the urban forest planting needed to reduce 2008 metropolitan emissions by 3 percent by 2025. GHG benefits are twofold: direct carbon sequestration by planted trees, and avoided GHG emissions from strategic tree planting to reduce energy demand due to heating and cooling.

A. Direct Carbon Sequestration by Urban Trees

The average annual per-tree gross carbon sequestration value for urban trees was found by dividing the total estimated annual carbon sequestration in Florida urban trees (1,016,000 tons of carbon/year, equating to 3.73 million tCO_2e/year) by the total number of urban trees (169, 587,000).[21] Annual gross carbon sequestration per urban tree was thus calculated as 0.006 metric tons of carbon (0.022 tCO_2e) per tree per year. Gross sequestration as calculated above does not account for the emissions resulting from tree mortality, disposal, and decomposition. To account for these emissions, the estimated gross carbon sequestration per tree was multiplied by 0.72, which is the ratio of gross to net sequestration for urban trees reported by Nowak and Crane (2002)[22] and used in EPA's *Inventory of U.S. Greenhouse Gas Emissions and Sinks*.[23] Annual net carbon sequestration per urban tree in Florida is 0.004 metric tons of carbon (0.015 tCO_2e) per tree per year.

Since trees planted in one year continue to accumulate carbon in subsequent years, annual carbon sequestration in any given year was calculated as the sum of carbon stored in trees planted in that year, plus sequestration by trees that were planted in prior years. It was assumed that new trees planted in urban areas in Florida would sequester carbon at a rate consistent with sequestration by the average urban tree statewide.

B. Avoided GHG Emissions

The total avoided GHG benefits are a function of three different types of impacts: reduced cooling demand, reduced demand for heating due to wind reduction, and increased demand for heating due to wintertime shading. An average potential GHG reduction factor of 0.0651 tCO_2e/tree/year for trees in the Gulf Coast/Hawaii climate region was calculated from data in McPherson and Simpson in GTR-PSW-171 (Table 2-7; Appendix A, Table V.8).[24] The estimate assumed that the trees planted are split among residential settings with pre-1950, 1950–1980, and post-1980 homes using the default distribution for the Gulf Coast/Hawaii climate region provided by McPherson and Simpson: 19 percent, 63 percent, and 18 percent, respectively. This estimate further assumes a default distribution of trees planted around buildings, based on measured data from existing urban canopy in the region.

To calculate potential avoided GHG emissions due to increased shading, it was assumed that all of the new trees would be planted where they would have shading effects. It was further assumed that medium-sized evergreen trees would be planted, with average tree distribution around buildings. Note that these fossil fuel reduction factors are average for existing buildings, and do not necessarily assume that trees are optimally placed around buildings to maximize

[21] Data on urban tree cover and carbon storage from USDA Forest Service Northern Research Station, found at: http://www.fs.fed.us/ne/syracuse/Data/State/data_FL.htm

[22] D.J. Nowak and D.E. Crane. "Carbon Storage and Sequestration by Urban Trees in the USA." *Environmental Pollution* March 2002;116(3):381-389. Available at: http://www.treesearch.fs.fed.us/pubs/15521

[23] U.S. Environmental Protection Agency. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2006*. USEPA #430-R-08-005. April 2008. Available at: http://www.epa.gov/climatechange/emissions/usinventoryreport.html

[24] E.G. McPherson and J.R. Simpson. *Carbon Dioxide Reduction Through Urban Forestry: Guidelines for Professional and Volunteer Tree Planters*. Appendix A, Table V.5. Gen. Tech. Rep. PSW-GTR-171. Washington, DC: U.S. Department of Agriculture, U.S. Forest Service, 1999. Available at: http://www.treesearch.fs.fed.us/pubs/6779

energy efficiency. These factors are also dependent on the electricity fuel mix (coal, hydroelectric, nuclear, etc.) in the regions of interest, and may thus change if the mix changes.

Table D-2-7. Factors used to calculate CO_2e savings (tCO_2e/tree/year) from reduced need for fossil fuel for heating and cooling and from windbreak effect of urban trees

Housing Age	Proportion of Urban Trees in This Housing Age Category	Cooling (tCO_2 saved per tree)	Heating (tCO_2 emitted per tree)	Wind (tCO_2 saved per tree)	Net Effect (tCO_2e/tree)
pre-1950	19%	0.0384	–0.0082	0.0214	0.0516
1950–1980	63%	0.0644	–0.0096	0.0232	0.078
post-1980	18%	0.0473	–0.0136	0.0318	0.0655
Weighted average (tCO_2e/tree/year)					**0.0651**

tCO_2e = metric tons of carbon dioxide equivalent.

Source: McPherson et al., 1999.

C. Overall GHG Benefit of Urban Tree Planting

Total GHG benefits are calculated as the sum of direct carbon sequestration plus fossil fuel offset from reduced cooling demand and wind reduction (Table 2-8). If 6.7 million new urban trees are planted in Florida every year, the combined carbon sequestration and fossil fuel offset impact would be roughly 9.2 MMtCO2e in 2025, which meets the target of reducing 3 percent of 2008 metropolitan carbon emissions statewide by 2025.

Table D-2-8. Overall GHG benefit (MMtCO2e/year) of urban tree planting in Florida

Year	Trees Planted This year	Trees Planted in Previous Years	GHG Sequestered ($MMtCO_2e$/year)	GHG Avoided ($MMtCO_2e$/year)	Overall GHG Savings ($MMtCO_2e$/year)
2009	6,700,000	0	0.11	0.44	0.54
2010	6,700,000	6,700,000	0.21	0.87	1.08
2011	6,700,000	13,400,000	0.32	1.31	1.63
2012	6,700,000	20,100,000	0.42	1.75	2.17
2013	6,700,000	26,800,000	0.53	2.18	2.71
2014	6,700,000	33,500,000	0.64	2.62	3.25
2015	6,700,000	40,200,000	0.74	3.05	3.80
2016	6,700,000	46,900,000	0.85	3.49	4.34
2017	6,700,000	53,600,000	0.95	3.93	4.88
2018	6,700,000	60,300,000	1.06	4.36	5.42
2019	6,700,000	67,000,000	1.17	4.80	5.96
2020	6,700,000	73,700,000	1.27	5.24	6.51
2021	6,700,000	80,400,000	1.38	5.67	7.05
2022	6,700,000	87,100,000	1.48	6.11	7.59
2023	6,700,000	93,800,000	1.59	6.54	8.13
2024	6,700,000	100,500,000	1.70	6.98	8.68
2025	6,700,000	107,200,000	1.80	7.42	9.22
Total		**113,900,000**	**16.2**	**66.7**	**83.0**

GHG = greenhouse gas; $MMtCO_2e$/year = million metric tons of carbon dioxide equivalent per year.

D. Cost Analysis

Data are available on the costs and cost savings of urban tree planting in the Coastal Plains Community Tree Guide (McPherson et al., 2006). Economic costs of tree planting take into account the cost of tree planting and annual maintenance, including the costs of program administration and waste disposal. Economic benefits of tree planting include the cost avoided from reduced energy use. Data are also available on the estimated economic benefits of services such as provision of clean air, hydrologic benefits such as stormwater control, and aesthetic enhancement; however, these co-benefits are not explicitly included in this analysis.

Costs and cost savings were estimated from published average annual costs and cost savings over 40 years, provided by public and private parties, for a range of tree sizes. The cost estimate used in this analysis, $15.65 per tree, was calculated as the average of four common tree species (southern live oak, southern magnolia, dogwood, and loblolly pine) under public and private management. Costs include tree and planting, pruning, removal and disposal, pest and disease, infrastructure repair, irrigation, cleanup, liability and legal, administration, and other. A cost savings due to reduced energy costs of -$14.35 per tree per year was also calculated as the average of the same four tree species under public and private management. The average cost and cost savings values yield a net cost of $1.30 per tree (costs minus cost savings). Table 2-9 shows estimated economic costs and cost savings for all categories.

Table D-2-9. Cost data for public and private entities in the Coastal Plains planting four different tree species (40-year annual averages)

Tree Species	Private ($/tree)	Public ($/tree)	Average of Public and Private ($/tree)
Live oak			
Cost savings (energy saved)	28.57	23.52	26.05
Costs*	19.24	23.24	21.24
Southern magnolia			
Cost savings (energy saved)	10.15	8.02	9.09
Costs*	14.84	17.89	16.37
Dogwood			
Cost savings (energy saved)	8.67	6.51	7.59
Costs*	11.56	13.62	12.59
Loblolly pine			
Cost savings (energy saved)	16.9	12.42	14.66
Costs*	10.48	14.31	12.40
Average across 4 tree species ($ per tree)			
Cost savings (energy saved)			14.35
Costs*			15.65
Net costs			**1.30**

* Includes tree and planting, pruning, removal and disposal, pest and disease, infrastructure repair, irrigation, cleanup, liability and legal, administration, and other.

The cost savings is estimated using 40-year averages; thus, it represents lifetime costs applicable in the year planted and every year thereafter during the time frame of this analysis (for example, planting costs $80/tree in the year the tree is planted; however, the 40-year average cost is $10/tree). To estimate total costs, $1.30/tree/year was multiplied by the cumulative number of trees planted each year (Table 2-10). This corresponds to a cumulative cost (or net present value) of nearly $850 million from 2009 to 2025, with an estimated economic cost of $10.23/t$CO_2$e.

Table D-2-10. Net cost of enhanced urban canopy in Florida (primary goal)

Year	Trees Planted This Year	Trees Planted in Previous Years	Net Cost	Discounted Net Cost
2009	6,700,000	0	$8,710,000	$9,145,500
2010	6,700,000	6,700,000	$17,420,000	$17,420,000
2011	6,700,000	13,400,000	$26,130,000	$24,885,714
2012	6,700,000	20,100,000	$34,840,000	$31,600,907
2013	6,700,000	26,800,000	$43,550,000	$37,620,127
2014	6,700,000	33,500,000	$52,260,000	$42,994,431
2015	6,700,000	40,200,000	$60,970,000	$47,771,590
2016	6,700,000	46,900,000	$69,680,000	$51,996,289
2017	6,700,000	53,600,000	$78,390,000	$55,710,309
2018	6,700,000	60,300,000	$87,100,000	$58,952,708
2019	6,700,000	67,000,000	$95,810,000	$61,759,980
2020	6,700,000	73,700,000	$104,520,000	$64,166,213
2021	6,700,000	80,400,000	$113,230,000	$66,203,236
2022	6,700,000	87,100,000	$121,940,000	$67,900,755
2023	6,700,000	93,800,000	$130,650,000	$69,286,484
2024	6,700,000	100,500,000	$139,360,000	$70,386,270
2025	6,700,000	107,200,000	$148,070,000	$71,224,202
Cumulative Totals		**113,900,000**	**$1,332,630,000**	**$849,024,717**

Secondary Goal—Increase the tree canopy coverage in all developed areas with a population greater than 500 residents per square mile to 30 percent by 2025.

The following quantifies the cumulative impact on carbon sequestration and avoided fossil fuel emissions of incrementally increasing the existing tree canopy cover in Florida. Specifically, AFW-2 Secondary Goal seeks to achieve a goal of 30 percent tree canopy cover in all developed areas with a population greater than 500 residents per square mile by 2025. Currently, Florida's urban areas are 18.4 percent forested.[25] This goal thus recommends an incremental 63 percent increase over existing urban canopy cover by 2025.

1. GHG calculations

Currently, Florida contains 169,587,000 million urban trees; this recommendation quantifies the effect of adding a total of approximately 107 million new trees by 2025. The number of trees planted each year is constant at roughly 6.3 million/year, with the target number of trees planted by 2025.

[25] USDA USFS data (D. Nowak). Available at http://www.fs.fed.us/ne/syracuse/Data/State/data_FL.htm. Note: Nowak uses US Census definition of "urban," which are not designated as densities. See: http://www.census.gov/population/censusdata/urdef.txt for more information on "urban" definitions.

GHG benefits are twofold: direct carbon sequestration by planted trees, and avoided GHG emissions from strategic tree planting to reduce energy demand due to heating and cooling.

A. Direct Carbon Sequestration by Urban Trees

The average annual per-tree gross carbon sequestration value for urban trees was found by dividing the total estimated annual carbon sequestration in Florida urban trees (1,016,000 tons of carbon/year, equating to 3.73 $MMtCO_2e$/year) by the total number of urban trees. Annual gross carbon sequestration per urban tree was thus calculated as 0.006 metric tons of carbon (0.022 tCO_2e) per tree per year. Gross sequestration as calculated above does not account for the emissions resulting from tree mortality, disposal, and decomposition. To account for these emissions, the estimated gross carbon sequestration per tree was multiplied by 0.72, which is the ratio of gross to net sequestration for urban trees reported by Nowak and Crane (2002)[26] and used in EPA's *Inventory of U.S. Greenhouse Gas Emissions and Sinks*.[27] Annual net carbon sequestration per urban tree in Florida is 0.004 tC (0.015 tCO_2e) per tree per year.

Since trees planted in one year continue to accumulate carbon in subsequent years, annual carbon sequestration in any given year was calculated as the sum of carbon stored in trees planted in that year, plus sequestration by trees that were planted in prior years. It was assumed that new trees planted in urban areas in Florida would sequester carbon at a rate consistent with sequestration by the average urban tree statewide.

B. Avoided GHG Emissions

The total avoided GHG benefits are a function of three different types of impacts: reduced cooling demand, reduced demand for heating due to wind reduction, and increased demand for heating due to wintertime shading. An average potential GHG reduction factor of 0.0651 tCO_2e/tree/year for trees in the Gulf Coast/Hawaii climate region was calculated from data in McPherson and Simpson in GTR-PSW-171 (Table 2-11; Appendix A, Table V.8).[28] The estimate assumed that the trees planted are split among residential settings with pre-1950, 1950–1980, and post-1980 homes using the default distribution for the Gulf Coast/Hawaii climate region provided by McPherson and Simpson of 19 percent, 63 percent, and 18 percent, respectively. This estimate further assumes a default distribution of trees planted around buildings, based on measured data from existing urban canopy in the region.

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[26] D.J. Nowak and D.E. Crane. "Carbon Storage and Sequestration by Urban Trees in the USA." *Environmental Pollution* March 2002;116(3):381-389. Available at: http://www.treesearch.fs.fed.us/pubs/15521

[27] U.S. Environmental Protection Agency. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2006*. USEPA #430-R-08-005. April 2008. Available at: http://www.epa.gov/climatechange/emissions/usinventoryreport.html

[28] E.G. McPherson and J.R. Simpson. *Carbon Dioxide Reduction Through Urban Forestry: Guidelines for Professional and Volunteer Tree Planters*. Appendix A, Table V.5. Gen. Tech. Rep. PSW-GTR-171. Washington, DC: U.S. Department of Agriculture, U.S. Forest Service, 1999. Available at: http://www.treesearch.fs.fed.us/pubs/6779

To calculate potential avoided GHG emissions due to increased shading, it was assumed that all of the new trees are planted where they can have shading effects. It was assumed that medium-sized evergreen trees would be planted, with average tree distribution around buildings. Note that these fossil fuel reduction factors are average for existing buildings, and do not necessarily assume that trees are optimally placed around buildings to maximize energy efficiency. These factors are also dependent on the electricity fuel mix (coal, hydroelectric, nuclear, etc.) in the regions of interest, and may thus change if the mix changes.

Table D-2-11. Factors used to calculate CO_2e savings (tCO_2e/tree/year) from reduced need for fossil fuel for heating and cooling and from windbreak effect of urban trees

Housing Age	Proportion of Urban Trees in This Housing Age Category	Cooling (tCO_2 saved per tree)	Heating (tCO_2 emitted per tree)	Wind (tCO_2 saved per tree)	Net Effect (tCO_2e/tree)
pre-1950	19%	0.0384	–0.0082	0.0214	0.0516
1950–1980	63%	0.0644	–0.0096	0.0232	0.078
post-1980	18%	0.0473	–0.0136	0.0318	0.0655
Weighted average (tCO_2e/tree/year)					**0.0651**

tCO_2e = metric tons of carbon dioxide equivalent.

Source: McPherson et al., 1999.

C. Overall GHG Benefit of Urban Tree Planting

Total GHG benefits are calculated as the sum of direct carbon sequestration plus fossil fuel offset from reduced cooling demand and wind reduction (Table 2-12).

Table D-2-12. Overall GHG benefit ($MMtCO_2e$/year) of urban tree planting in Florida

Year	Trees Planted This year	Trees Planted in Previous Years	GHG Sequestered ($MMtCO_2e$/year)	GHG Avoided ($MMtCO_2e$/year)	Overall GHG Savings ($MMtCO_2e$/year)
2009	6,289,032	0	0.099	0.41	0.51
2010	6,289,032	6,289,032	0.20	0.82	1.0
2011	6,289,032	12,578,064	0.30	1.2	1.5
2012	6,289,032	18,867,096	0.40	1.6	2.0
2013	6,289,032	25,156,128	0.50	2.0	2.6
2014	6,289,032	31,445,160	0.60	2.5	3.0
2015	6,289,032	37,734,192	0.70	2.9	3.6
2016	6,289,032	44,023,224	0.80	3.3	4.1
2017	6,289,032	50,312,256	0.90	3.7	4.6
2018	6,289,032	56,601,288	1.0	4.1	5.1
2019	6,289,032	62,890,320	1.1	4.5	5.5
2020	6,289,032	69,179,352	1.2	4.9	6.1

2021	6,289,032	75,468,384	1.3	5.3	6.6
2022	6,289,032	81,757,416	1.4	5.7	7.1
2023	6,289,032	88,046,448	1.5	6.1	7.6
2024	6,289,032	94,335,480	1.6	6.6	8.1
2025	6,289,032	100,624,512	1.7	6.7	8.7
Total		**106,913,543**	**15.2**	**63**	**78**

GHG = greenhouse gas; $MMtCO_2e$/year = million metric tons of carbon dioxide equivalent per year.

D. Cost Analysis

Data are available on the costs and cost savings of urban tree planting in the Coastal Plains Community Tree Guide (McPherson et al., 2006). Economic costs of tree planting take into account the cost of tree planting and annual maintenance costs, including the costs of program administration and waste disposal. Economic benefits of tree planting include the cost avoided from reduced energy use. Data are also available on the estimated economic benefits of services such as provision of clean air, hydrologic benefits such as storm water control, and aesthetic enhancement; however, these co-benefits are not explicitly included in this analysis.

Costs and cost savings were estimated from published average annual costs and cost savings over 40 years, provided by public and private parties, for a range of tree sizes. The cost estimate used in this analysis, $15.65 per tree, was calculated as the average of four common tree species (southern live oak, southern magnolia, dogwood, and loblolly pine) under public and private management. A cost savings of -$14.35 per tree per year was also calculated as the average of the same four tree species under public and private management. The average cost and cost savings values yield a net cost of $1.30 per tree (costs minus cost savings). Table 2-13 shows estimated economic costs and cost savings for all categories.

Table D-2-13. Cost data for public and private entities in the Coastal Plains planting four different tree species (40-year annual averages)

Tree Species	Private ($/tree)	Public ($/tree)	Average of Public and Private ($/tree)
Live oak			
Cost savings (energy saved)	28.57	23.52	26.05
Costs*	19.24	23.24	21.24
Southern magnolia			
Cost savings (energy saved)	10.15	8.02	9.09
Costs*	14.84	17.89	16.37
Dogwood			
Cost savings (energy saved)	8.67	6.51	7.59
Costs*	11.56	13.62	12.59
Loblolly pine			

Cost savings (energy saved)	16.9	12.42	14.66
Costs*	10.48	14.31	12.40
Average across 4 tree species ($ per tree)			
Cost savings (energy saved)			14.35
Costs*			15.65
Net costs			**1.30**

* Includes tree and planting, pruning, removal and disposal, pest and disease, infrastructure repair, irrigation, cleanup, liability and legal, administration, and other

The cost savings are estimated using 40-year averages, thus this represents lifetime costs applicable in the year planted and every year thereafter during the timeframe of this analysis (for example, planting costs $80/tree in the year the tree is planted; however, the 40-year average cost is $10/tree). To estimate total costs, $1.30/tree was multiplied by the cumulative number of trees planted each year (Table 2-14). This corresponds to a NPV of $759 million from 2009 - 2025, with an estimated economic cost of $9.75/t$CO_2$e.

Table D-2-14. Net cost of enhanced urban canopy in Florida

Year	Trees Planted This Year	Trees Planted in Previous Years	Net Cost	Discounted Net Cost
2009	6,289,032	0	$8,175,742	$8,175,742
2010	6,289,032	6,289,032	$16,351,483	$15,572,841
2011	6,289,032	12,578,064	$24,527,225	$22,246,916
2012	6,289,032	18,867,096	$32,702,966	$28,250,052
2013	6,289,032	25,156,128	$40,878,708	$33,631,014
2014	6,289,032	31,445,160	$49,054,449	$38,435,445
2015	6,289,032	37,734,192	$57,230,191	$42,706,050
2016	6,289,032	44,023,224	$65,405,932	$46,482,775
2017	6,289,032	50,312,256	$73,581,674	$49,802,973
2018	6,289,032	56,601,288	$81,757,416	$52,701,559
2019	6,289,032	62,890,320	$89,933,157	$55,211,157
2020	6,289,032	69,179,352	$98,108,899	$57,362,241
2021	6,289,032	75,468,384	$106,284,640	$59,183,265
2022	6,289,032	81,757,416	$114,460,382	$60,700,784
2023	6,289,032	88,046,448	$122,636,123	$61,939,576
2024	6,289,032	94,335,480	$130,811,865	$62,922,744
2025	6,289,032	100,624,512	$138,987,607	$63,671,824
Cumulative Totals		**106,913,543**	**$1,250,888,459**	**$758,996,957**

Key Uncertainties

Cities and communities would need to conduct canopy surveys to establish a baseline of current canopy cover. The costs of such a survey and continued monitoring are variable and may exceed available resources. The longevity of urban trees may be affected by climate perturbations.

Additional Benefits, Costs, and Energy Security Fuel Savings

In addition to the numerous benefits articulated in the policy description, urban trees contribute to improved property values, add aesthetic value for residents and visitors, provide humidity balancing, and reduce the intensity of storm water runoff. Sociological studies suggest that more attractive and comfortable neighborhoods have lower crime rates.

Total GHG emissions avoided is 62.649 $MMtCO_2e$/year.

Total fossil fuel displaced during the policy period is 3.5 million short tons coal or 76,000 cubic feet natural gas.

Feasibility Issues

None identified.

Status of Group Approval

Complete.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

AFW-3. Forest Management for Carbon Sequestration

Policy Description

Encourage management activities that promote forest productivity and increase the amount of carbon sequestered in forest biomass, soils, and in long-lived wood products. Practices may include thinning and density management, prescribed burning and risk reduction, and management of insects and disease. Reduce the severity of wildfires to reduce GHG emissions by lowering the forest carbon lost during a fire and by maintaining carbon sequestration potential. Similarly, reducing damage from insects, disease, and invasive plants reduces GHG emissions by maintaining the carbon sequestration potential of healthy forests.

Note that this policy has overlap with AFW-1, Forest Retention—Reduced Conversion of Forested to Non-Forested Land Uses and AFW-2, Afforestation and Restoration of Non-Forested Lands.

Policy Design

Goals:

Practice improved forest management for carbon sequestration to achieve an increase of at least 10 percent in productivity for the state's forestry plantations by 2025.

Practice improved forest management for carbon sequestration on 25 percent of non-Federal publicly managed upland forest lands.

Timing: Assume linear ramp-up

Parties Involved: Florida private forestland owners, DOF, Florida Forestry Association, FWC, UF IFAS, NRCS, nongovernmental agencies, RPCs, other state land management agencies, USFS, US FWS, USACE, other federal land management and technical assistance agencies, the Nature Conservancy, forest industry, REITs, TIMOs, and private landowners, state government, and U.S. federal government.

Other: Management intensity for carbon sequestration on publicly owned forested lands should be consistent with biodiversity and other goals within the acquisition and management plans for those lands.

Implementation Mechanisms

The Action Team encourages the Florida Energy and Climate Commission to continue assessment and recommendations for appropriate implementation mechanisms for this policy.

Related Policies/Programs in Place

For silviculture, best management practices (BMPs) developed by DACS, DEP, and IFAS relate to water quality protection and water conservation. Note: Florida currently has very high compliance with BMPs.

The FWC's Landowner Assistance Program provides wildlife-related habitat management recommendations towards long-term partnerships with private landowners that lead to the restoration and conservation of high priority habitats, identified in Florida's Wildlife Action Plan (http://myfwc.com/wildlifelegacy/). Recommendations include restoring native groundcover, overstory species, planting new pine stands at low densities, and thinning existing stands to benefit carbon sequestration, wildlife habitats, and forest health.

Type(s) of GHG Reductions

Incremental carbon storage in forests subjected to enhanced management.

Estimated GHG Reductions and Net Costs or Cost Savings

Estimated GHG reductions (MMtCO2e/year):

A. Improved pine plantation management: 2017 – 0.46; 2025 – 0.86 (2009-2025: 7.85 MMtCO2e cumulative)

B. Non-federal public land management: 2017 – 0.27; 2025 – 0.42 (2009-2025: 3.85 MMtCO2e cumulative)

C. Estimated cost ($/tCO2e):

- A. Improved pine plantation management: $10.65
- B. Non-federal public land management: $10.65

Data Sources:

Improved management in pine plantations:

Brown, M.J. 2007. "Florida's forests – 2005 update." USDA Forest Service, Southern Research Station, Resource Bulletin RB-SRS-118. Available at: http://www.treesearch.fs.fed.us/pubs/28996

Mulkey S., J. Alavalapati, A. Hodges, A.C. Wilkiw, and S. Grunwald. 2008. "Opportunities for Greenhouse Gas Reduction Through Agriculture and Forestry in Florida." University of Florida School of Natural Resources and Environment. Available at: http://www.snre.ufl.edu

Non-federal public land management:

Data on forest area and ownership classes obtained from publicly available USDA Forest Service Forest Inventory and Analysis Mapmaker (ver 3.0). Available at: http://fia.fs.fed.us/

Quantification Methods:

This policy recommendation seeks to quantify the impact of enhanced management intensity on a portion of Florida's upland forest land. The goal is described in two parts: enhanced management intensity in privately-owned pine plantations, and enhanced management intensity on non-Federal publicly owned lands. Since the methodology for both types of land ownerships is identical but only the target acreage differs, the two types of land area are combined in the methodology that follows.

1. Carbon sequestration due to enhanced management intensity

Pine plantations make up roughly 32 percent of total forest area in Florida, covering a total of 4.6 million acres as of 2005 (Brown, 2007). Of these, most are in longleaf-slash pine forest (3.6 million acres) with the remaining 1.0 million acres in loblolly-shortleaf pine forest. Mulkey et al. (2008) describe scenarios for improving management in pine plantations, suggesting that carbon sequestration gains averaging 29 to35 percent are possible in these forest types. As the goal statement describes improving productivity "at least 10 percent," and there is published evidence to support productivity gains even larger than this, the recommendation was quantified using methods and data presented in Mulkey et al. (2008). It was assumed that similar carbon sequestration gains were possible on publicly-owned upland forests.

Improved management practices such as fertilization, irrigation, and enhanced thinning regimes can enhance the carbon sequestration possible in pine plantations in Florida (Mulkey et al. 2008). Switching an acre of plantation from low to medium intensity management results in a net C sequestration gain of 0.25 tons/acre/year, while switching from medium to high intensity management results in a net gain of 0.39 tons/acre/year (Table 3-1).

Table D-3-1. Carbon accumulation under low, medium, and high management intensity in Florida pine plantations

Management Intensity	Percent of Land in Each Category	Carbon (tons/acre)	Rotation Age	Carbon Accumulation (tons/acre/year)
Low	0.37	25.42	30	0.85
Medium	0.58	27.42	25	1.10
High	0.05	37.14	25	1.49

Source: Mulkey et al. 2008.

A. Enhanced management intensity: privately-owned pine plantations

Of the softwood plantation area totaling 4.6 million acres in 2005, it was assumed that 37 percent of this (1.7 million acres) is currently under low-intensity management, and that 58 percent (2.7 million acres) is currently under medium intensity management (Table D-3-2), based on results presented by Mulkey (2008). No change was assumed for the five percent of plantation acreage already under high intensity management in 2005. For quantification of

GHG benefits for this recommendation based on recommendations of the TWG, 33 percent of the acreage currently in low intensity management would move to medium intensity, and a maximum of 10 percent of pine plantation area would be under a high management regime at any one time. A summary of the current acreage and the target acreage under each management intensity category appears in Table D-3-2.

Table D-3-2. Summary of current (2005) and target acreage under each management intensity category for pine plantations in Florida under AFW-3.

Management Intensity	Current (2005)		Target (in 2025)	
	Total Acreage	Percent of Total Acreage	Total Acreage	Percent of Total Acreage
Low	1713544	37%	1142363	25%
Medium	2686096	58%	3025717	65%
High	231560	5%	463120	10%
Total Acreage	4631200	100%	4631200	100%

For each incremental increase in management intensity, the number of acres that would be moved into the new management category were multiplied by the expected resultant gain in C sequestration (0.25 tons per acre per year from low to medium intensity, and 0.39 tons per acre per year for medium to high intensity) (Table D-3-1). As acreage would continue to be managed according to the new regime in subsequent years, the incremental C gain was quantified for the cumulative acreage under the new management regime (Table D-3-3). Carbon stored in harvested wood products (HWP) was added to the cumulative total (see below for HWP methodology).

Table D-3-3. Carbon sequestration in pine plantations as a result of switching from low to medium and from medium to high intensity management

Year	Low->Medium Intensity		Medium->High Intensity		Cumulative Carbon Sequestration in Managed Acreage (tC/year)	Cumulative Carbon Sequestration ($MMtCO_2e$/year)	Cumulative Carbon Sequestration With HWP ($MMtCO_2e$/year)
	Acres This Year	Acres In Prior Years	Acres This Year	Acres In Prior Years			
2009	33,599	0	13,621	0	13,678	0.05	0.06
2010	33,599	33,599	13,621	13,621	27,355	0.10	0.11
2011	33,599	67,198	13,621	27,242	41,033	0.15	0.16
2012	33,599	100,797	13,621	40,864	54,711	0.20	0.21
2013	33,599	134,396	13,621	54,485	68,389	0.25	0.26
2014	33,599	167,995	13,621	68,106	82,066	0.30	0.31
2015	33,599	201,593	13,621	81,727	95,744	0.35	0.36
2016	33,599	235,192	13,621	95,348	109,422	0.40	0.41
2017	33,599	268,791	13,621	108,969	123,099	0.45	0.46

2018	33,599	302,390	13,621	122,591	136,777	0.50	0.51
2019	33,599	335,989	13,621	136,212	150,455	0.55	0.56
2020	33,599	369,588	13,621	149,833	164,133	0.60	0.61
2021	33,599	403,187	13,621	163,454	177,810	0.65	0.66
2022	33,599	436,786	13,621	177,075	191,488	0.70	0.71
2023	33,599	470,385	13,621	190,696	205,166	0.75	0.76
2024	33,599	503,984	13,621	204,318	218,844	0.80	0.81
2025	33,599	537,582	13,621	217,939	232,521	0.85	0.86
Cumulative totals		**571,181**		**231,560**		**7.6**	**7.8**

B. Enhanced management intensity: non-Federal publicly owned forests

Roughly 18 percent of forest land in Florida – 2.9 million acres – is owned by non-Federal entities (Table D-3-4A). Of this, roughly 1.6 million acres are upland forest types (including longleaf-slash pine, loblolly-shortleaf pine, oak-pine, and oak-hickory types) (Table D-3-4B). This policy recommendation seeks to enhance management intensity on 25 percent of this non-Federal upland forest area (413,687 acres) by 2025.

Table D-3-4A. Distribution of forest land by ownership in Florida.

Ownership class	forest area (acres)
Total	16,718,501
National Forest	1,080,560
Other Forest Service	7,070
National Park Service	226,482
Fish and Wildlife Service	160,474
Dept of Defense	501,771
Other federal	108,785
State	2,468,409
County and Municipal	453,786
Other non-federal public	7,070
Private	11,704,095
sum of non-Federal public ownerships	2,929,265
% of total forest in non-Federal public category	18%

Table D-3-4B. Distribution of Forest Types in non-Federal public land ownership in Florida.

Forest Type Group	Forest Area in non-Federal Public Ownership (acres)	Percentage in non-Federal Ownership by Forest Type
Longleaf-Slash PIne	927,266	32%
Loblolly-Shortleaf Pine	130,551	4%
Pinyon-Juniper	8,951	0%
Oak-Pine	247,327	8%
Oak-Hickory	349,602	12%
Oak-Gum-Cypress	798,775	27%
Elm-Ash-Cottonwood	20,131	1%
Tropical Hardwoods	291,106	10%
Exotic Hardwoods	39,219	1%
Nonstocked	116,335	4%
Total	2,929,265	100%
Upland forests only (Longleaf-Slash Pine, Loblolly-Shortleaf Pine, Oak-Pine, and Oak-Hickory)	1,654,747	56%

As with the pine plantation sub-recommendation quantified above, it was assumed that five percent of the forest is currently being managed with a high intensity regime, 58 percent is currently under medium intensity management, and 37 percent is currently under a low intensity regime (Table D-3-5). Also consistent with the approach above, it was assumed that only 10 percent of the upland forests would be managed using high-intensity techniques.

Table D-3-5. Summary of current (2005) and target acreage under each management intensity category for non-Federal publicly-owned upland forests in Florida under AFW-3

	Current (2005)		Target (by 2025)	
Management Intensity	Total Acreage	Percent of Total Acreage	Total Acreage	Percent of Total Acreage
Low	612,256	37%	281,307	17%
Medium	959,753	58%	1,207,965	73%
High	82,737	5%	165,475	10%
Total	1,654,747	100%	1,654,747	100%

It was assumed that the incremental gain realized from enhanced management intensity calculated above for pine plantations was available to all non-Federal upland timberland, regardless of forest type. Results of this analysis for non-Federal upland forests appear below.

Table D-3-6. Carbon sequestration in non-federal public timberlands as a result of switching from low- to medium- and from medium- to high-intensity management

Year	Low->Medium Intensity		Medium->High Intensity		Cumulative C Sequestration In Managed Acreage (tC/year)	Cumulative C Sequestration ($MMtCO_2e$/year)	Cumulative C Sequestration with HWP ($MMtCO_2e$/year)
	Acres This Year	Acres In Prior Years	Acres This Year	Acres In Prior Years			
2009	19,468	0	4,867	0	6,749	0.02	0.02
2010	19,468	19,468	4,867	4,867	13,498	0.04	0.05
2011	19,468	38,935	4,867	9,734	20,246	0.07	0.07
2012	19,468	58,403	4,867	14,601	26,995	0.09	0.10
2013	19,468	77,870	4,867	19,468	33,744	0.12	0.12
2014	19,468	97,338	4,867	24,335	40,493	0.14	0.15
2015	19,468	116,806	4,867	29,201	47,241	0.17	0.17
2016	19,468	136,273	4,867	34,068	53,990	0.19	0.20
2017	19,468	155,741	4,867	38,935	60,739	0.22	0.22
2018	19,468	175,209	4,867	43,802	67,488	0.24	0.25
2019	19,468	194,676	4,867	48,669	74,236	0.27	0.27
2020	19,468	214,144	4,867	53,536	80,985	0.29	0.30
2021	19,468	233,611	4,867	58,403	87,734	0.32	0.32
2022	19,468	253,079	4,867	63,270	94,483	0.34	0.35
2023	19,468	272,547	4,867	68,137	101,232	0.37	0.37
2024	19,468	292,014	4,867	73,004	107,980	0.39	0.40
2025	19,468	311,482	4,867	77,870	114,729	0.42	0.42
Cumulative totals		**330,949**		**82,737**		**3.7**	**3.8**

2. Estimated Increases in Carbon Sequestration Rates and Growing-Stock Volumes

To quantify the increment in growing-stock volume (and storage in harvested wood products (HWP)) due to enhanced management, a standard approach based on USDA Forest Service (USDA FS) methodology was used. For some regions and forest types, USDA-FS provides estimates of carbon and volume growth increments for both average- and high-productivity stands. Such tables are available for loblolly-shortleaf pine and longleaf-slash pine in the Southeast region.[29] Growing-stock volume data in the USDA-FS tables were used to calculate growing stock volume for average- and high-productivity longleaf-slash pine and loblolly-shortleaf pine forests in Florida. These USFS-published tables were not used above to calculate incremental C storage due to enhanced management, because it was assumed that State-specific

[29] Smith, J.E., L.S. Heath, K.E. Skog, and R.A. Birdsey. *Methods for Calculating Forest Ecosystem and Harvested Carbon With Standards Estimates for Forest Types of the United States*. General Technical Report NE-343. USDA/USFS, Northern Research Station, 2006. Available at: http://www.treesearch.fs.fed.us/pubs/22954.

data related to particular classes of management intensity were preferable to the broad "productivity classes" referred to in the USDA-FS methodology.

An average over 30 years is assumed to encompass the range of age classes for this forest type, though in reality, growth rates vary by stand age. A comparison of expected growing stock volumes for average longleaf-slash and loblolly-shortleaf pine stands with volumes expected on high productivity sites[30] shows that, on average, 30-year-old stands growing on high-productivity sites will have a growing-stock volume that is about 3,409 cubic feet per acre larger than average stands.

USFS HWP accounting methods were used to convert the 3,409-cubic-feet-per-acre (cf/acre) incremental increase in growing-stock volume into the equivalent carbon volume of 25.5 tC/acre. Note that this is the carbon stored in the incremental increase in growing stock, only a portion of which is removed during harvest (this analysis assumes 35 percent is removed, see below).

3. Calculation of Net Carbon Stock Change in HWP

The incremental increase in carbon removed during harvest is calculated by multiplying the number of acres harvested each year by 35 percent of the carbon increase in growing-stock volume (i.e., 35 percent of 25.5 tC/acre = 8.9 tC/acre). This assumes that 35 percent of the growing-stock volume is removed during a harvest (based on a study of carbon removals at different harvest levels, 35 percent is roughly the proportion removed from moderate harvest levels).[31] The number of acres harvested was calculated by assuming 2.8 percent of the acres treated each year are harvested the following year for pine plantations, and two percent of the acres treated each year are harvested the following year on non-federal public lands (Table D-3-7).

Table D-3-7 Timberland harvest rates in upland forests, listed by forest type.

Timberland Forest Type	Public Harvest Rate	Forest Industry Harvest Rate	Private Harvest Rate
Longleaf-slash pine	0.008	0.011	0.041
Loblolly shortleaf	0.028	0.039	0.151
Oak pine	0.030	0.042	0.161
Oak hickory	0.015	0.021	0.083
Average	**0.020**	**0.028**	**0.109**

Source: Brown, 2007, 2005 Florida Forest's update.

[30] Ibid., See Tables A39 through A42 for source data.
[31] T.F. Strong. "Harvesting Intensity Influences the Carbon Distribution in a Northern Hardwood Ecosystem." USFS Research Paper NC-329. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station, 1997. Available at: http://www.ncrs.fs.fed.us/pubs/812 - 20k

Standard USFS HWP accounting methods were used to estimate the incremental increase in harvested carbon that remains stored in HWP indefinitely. The amount of carbon stored in HWP carbon stocks is time-dependent relative to the year of harvest (carbon stocks are high initially and decrease over time as a result of disposal and decay), making carbon stock accounting for HWP complex. Therefore, an approach has been developed to standardize and simplify HWP carbon accounting, which applies the amount of carbon still stored in HWP 100 years after harvest as the estimated net increase in HWP carbon stocks; this gain is attributed to the year of harvest.

Table D-3-8. Incremental increase in C stored in harvested wood products due to enhanced management on pine plantations and non-Federal publicly-owned forestland.

Year	Acres Enrolled in Management	Acres Harvested	Carbon Stocks Remaining Stored in HWP 100 Years Post Harvest (tons C)	Carbon Stocks Remaining Stored in HWP 100 Years Post Harvest ($MMtCO_2e$)
2009	66,688	1,823	3,782	0.014
2010	66,688	1,823	3,782	0.014
2011	66,688	1,823	3,782	0.014
2012	66,688	1,823	3,782	0.014
2013	66,688	1,823	3,782	0.014
2014	66,688	1,823	3,782	0.014
2015	66,688	1,823	3,782	0.014
2016	66,688	1,823	3,782	0.014
2017	66,688	1,823	3,782	0.014
2018	66,688	1,823	3,782	0.014
2019	66,688	1,823	3,782	0.014
2020	66,688	1,823	3,782	0.014
2021	66,688	1,823	3,782	0.014
2022	66,688	1,823	3,782	0.014
2023	66,688	1,823	3,782	0.014
2024	66,688	1,823	3,782	0.014
2025	66,688	1,823	3,782	0.014
Cumulative	**1,133,691**	**30,986**	**64,297**	**0.24**

The USFS methods from Smith et al. were applied to coefficients for longleaf-slash pine stands in the Southeast region to estimate that approximately 20 percent of harvested carbon remains stored in HWP 100 years after harvest.[32] Therefore, the long-term storage of carbon in HWP increases by approximately 2.1 tC/acre when stands increase management intensity (for example, an additional 8.9 tC/acre are harvested, of which 20 percent remains stored indefinitely). The results of this combined HWP analysis, for both pine plantations and upland non-Federal public ownerships, are shown in Table D-3-8. (Results are separated by ownership category in Tables D-3-3 and D-3-7).

4. Economic costs and benefits

The cost of enhanced forest management in Florida was estimated based on regional data for low, medium, and high intensity management[33]. Costs were originally separated by initiation costs and maintenance costs (Table D-3-9). These per-acre costs were assumed to be the lifetime cost for stand management under each type of management regime, and were divided by rotation age (Mulkey et al. 2008; Table D-3-1) to derive an estimate of management costs per year at each level of management intensity (Table D-3-10). It was assumed that only the incremental costs of switching to the higher intensity management regime would apply, as management costs at current intensity are included in "business as usual" practices. Costs for road construction and fire line construction were not included in the calculations. These annual incremental costs ($/acre/year) were applied to each acre in each year of the policy implementation period (Tables D-3-11 and D-3-12).

[32] J.E. Smith, L.S. Heath, K.E. Skog, and R.A. Birdsey. *Methods for Calculating Forest Ecosystem and Harvested Carbon With Standards Estimates for Forest Types of the United States*. General Technical Report NE-343. USDA/USFS, Northern Research Station, 2006. Available at: http://www.treesearch.fs.fed.us/pubs/22954

[33] Personal communication with Jarek Nowak, Forest Utilization Specialist, Florida Division of Forestry, August 28, 2008.

Table D-3-9. Initiation and maintenance costs of enhanced forest management, separated by intensity

Management Practice	Low Intensity ($/acre)	Medium Intensity ($/acre)	High Intensity ($/acre)
	Initiation costs		
Prescribed burning	32	32	32
Natural regeneration: site prep costs	32		
Average regeneration (machine and hand)	96	113	148
Disking		56	56
Chopping: single drum		50	
Chopping: single/double drum			70
Raking		85	85
Mowing		75	75
Herbicide		70	70
Scalping			45
Sub soiling			60
Bedding			57
Post plant fertilization			75
Mulch mowing			250
Total	**160**	**481**	**1,023**
	Maintenance costs		
Prescribed burning	32	32	32
Thin-pre-merchantable	50	50	50
Thin merchantable administrative	18	18	18
Herbicide		70	70
Straw raking		4	4
Mowing		45	
Mulch mowing			250
Mid-age fertilization			75
Total	**100**	**219**	**499**

Table D-3-10. Annualized incremental costs of enhanced management regimes on forestland in Florida. (source: Steve Jennings and Jarek Nowak, DOF)

Management Intensity	Lifetime Management Costs ($/acre)	Annualized Management Costs ($/acre/yr)	Incremental increase in Lifetime Enhanced Management Costs ($/acre)	Incremental Increase in Annual Enhanced Management Costs ($/acre/yr)
Low Intensity	$260.00	$8.67	-	-
Medium Intensity	$700.00	$28.00	$440.00	$19.33
High Intensity	$1,522.00	$60.88	$822.00	$32.88

Annual costs of implementing AFW-3 in pine plantations and on non-federal publicly owned land were discounted using a five percent rate to convert future dollars to present values. The sum of annual discounted costs from 2009 to 2025 yields an estimate of the NPV of this policy, which is roughly $84 million for enhanced management of pine plantations, and $41 million for enhanced management of non-Federal publicly owned forests (Tables D-3-11 and D-3-12). The cost-effectiveness is calculated by dividing the NPV by the cumulative GHG benefit, yielding a cost-effectiveness of $10.65/t$CO_2$e saved.

Table D-3-11. Net economic costs of implementing improved forest management on pine plantations in Florida

Year	Cumulative Acres Enrolled in Low->Medium Intensity Management	Cumulative Acres Enrolled in Medium->High Intensity Management	Incremental Economic Cost of Enhanced Management	Discounted Cost (2005$)
2009	33,599	13,621	$1,097,443	$902,869
2010	67,198	27,242	$2,194,886	$1,719,751
2011	100,797	40,864	$3,292,329	$2,456,787
2012	134,396	54,485	$4,389,772	$3,119,729
2013	167,995	68,106	$5,487,215	$3,713,963
2014	201,593	81,727	$6,584,658	$4,244,529
2015	235,192	95,348	$7,682,101	$4,716,144
2016	268,791	108,969	$8,779,544	$5,133,218
2017	302,390	122,591	$9,876,987	$5,499,876
2018	335,989	136,212	$10,974,431	$5,819,975
2019	369,588	149,833	$12,071,874	$6,097,116
2020	403,187	163,454	$13,169,317	$6,334,666
2021	436,786	177,075	$14,266,760	$6,535,767
2022	470,385	190,696	$15,364,203	$6,703,351
2023	503,984	204,318	$16,461,646	$6,840,154
2024	537,582	217,939	$17,559,089	$6,948,728
2025	571,181	231,560	$18,656,532	$7,031,451
Cumulative totals				**$83,818,074**

Table D-3-12. Net economic costs of implementing improved forest management on non-federal upland timberlands in Florida.

Year	Cumulative Acres Enrolled in Low->Medium Intensity Management	Cumulative Acres Enrolled in Medium->High Intensity Management	Incremental Economic Cost of Enhanced Management	Discounted Cost (2005$)
2009	19,468	4,867	$536,398	$441,296

2010	38,935	9,734	$1,072,795	$840,563
2011	58,403	14,601	$1,609,193	$1,200,804
2012	77,870	19,468	$2,145,590	$1,524,831
2013	97,338	24,335	$2,681,988	$1,815,275
2014	116,806	29,201	$3,218,386	$2,074,600
2015	136,273	34,068	$3,754,783	$2,305,111
2016	155,741	38,935	$4,291,181	$2,508,965
2017	175,209	43,802	$4,827,578	$2,688,176
2018	194,676	48,669	$5,363,976	$2,844,631
2019	214,144	53,536	$5,900,374	$2,980,090
2020	233,611	58,403	$6,436,771	$3,096,197
2021	253,079	63,270	$6,973,169	$3,194,489
2022	272,547	68,137	$7,509,566	$3,276,399
2023	292,014	73,004	$8,045,964	$3,343,264
2024	311,482	77,870	$8,582,362	$3,396,332
2025	330,949	82,737	$9,118,759	$3,436,764
Cumulative totals				**$40,967,787**

Key Assumptions: As identified in the text above.

Key Uncertainties

The estimate of costs estimated above does not include any additional future value of the incremental timber/pulpwood that is available as a result of the implementation of this recommendation. For the most part, these additional economic benefits would be realized after the end of the policy period (2030). If the methods for estimating net costs and cost effectiveness were to take into consideration the additional future value of this biomass, then the costs for the recommendation could be considerably lower.

Additional Benefits, Costs and Energy Security Fuel Savings

None identified.

Feasibility Issues

None identified.

Status of Group Approval

Complete.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

AFW-4. Expanded Use of Agriculture, Forestry, and Waste Management (AFW) Biomass Feedstocks for Electricity, Heat, and Steam Production

Policy Description

Increase the amount of biomass available from agriculture, forestry, and municipal solid waste (MSW) for generating electricity and displacing the use of fossil energy sources. Local electricity or steam production yields the greatest net energy payoff. This biomass should be used in an environmentally acceptable manner, considering proper facility siting and feedstock use (for example, proximity of users to biomass, impact on water supply and quality, control of air emissions, solid waste management, cropping management, nutrient management, soil and non-soil carbon management, and impact on biodiversity and wildlife habitat). The objective is to create concurrent reduction of CO_2 due to displacement of fossil fuel, considering life cycle GHG emissions associated with viable collection, hauling, energy conversion, and energy distribution systems.

Develop a long-term sustainable supply of reasonable cost biomass for generating electricity, heat, and steam. Promote enhanced growth of long rotation, short rotation, and dedicated energy crops, as well as collection of biomass residues.

Provide incentives that will result in an increase in the use of waste-to-energy (WTE) and other waste-based energy technologies, and the recovery of landfill methane (CH_4) gas. These technologies make a two-fold contribution to climate protection: the discharge of CH_4 and other GHG into the atmosphere is reduced, and the burning of fossil fuels is replaced with recovered energy.

Note that this recommendation is linked to recommendations in ESD-3 and ESD-5a which will have biomass demand requirements.

Policy Design

Goals:

Primary: Increase the use of renewable energy from biomass feedstocks by 500 percent by 2025.

Secondary: By 2025, energy crops should increase by 10 percent. The acres of land producing ecologically sustainable energy crops are to increase up to an additional 300,000 acres by 2025, increase the current generation of renewable energy from WTE facilities by 20 percent by 2025, and increase the number of uncontrolled MSW landfills recovering CH_4 as an energy source, such that 50 percent of the landfill gas generated is controlled by 2020.

Timing: see goals above.

Parties Involved: Municipal and county governments, private solid waste management companies, local economic development agencies, Florida Department Environmental Protection (DEP), the Florida Energy Commission (FEC), nongovernmental organizations, public interest groups, Public Service Commission (PSC), private and public landowners, electrical utilities, DOF, Florida Department of Agriculture and Consumer Services (FDACS), and water management districts.

Other: Out of approximately 200 open and closed landfills in the state, only about 13 sites are currently recovering landfill CH_4 for energy use. Currently, 11 WTE plants are operating in Florida, generating 513 megawatts (MW) of electricity.

Overall, policies need to decrease the risk and uncertainties associated with having sustainable supplies of good quality biomass at reasonable costs for the planned lifetime of the electrical, heat, or steam producing facility. It is likely that a wide array of policies will be needed that influence land and conversion facility owners to dedicate themselves to using biomass feedstocks to produce renewable power.

Note the strong linkage to the energy supply sector, since WTE plants are active in the state. Also may consider new technologies, such as plasma arc.

Implementation Mechanisms

Provide incentives for biomass production.

Provide purchase guarantees to biomass producers.

Provide grants or incentives to develop Florida-based projects to utilize landfill gas.

Provide landowner incentives for energy crops to be planted on marginal agricultural land or reclaimed mining land and incentives for reforestation.

Provide incentives such as renewable energy credits for diverting waste from landfills to waste-to-energy.

Improve the ability/opportunity for producers to connect to the grid.

Consider the following feedstock sources:

- *Long-rotation forests*—Need to promote the use of wood for electricity, steam, and heat in Florida by providing subsidies, tax credits, or payment schemes that enable landowners to conduct proper thinning and removals that benefit the health of the forest and decrease the chances of catastrophic wild fire. Promote the development of biomass utilizing facilities in appropriate locations that contain sufficient biomass, but do not already contain commercial conversion facilities, by providing the infrastructure needed to support the development and transport of woody biomass. Promote development and deployment of advanced forest management practices (for example, faster growing genetic stock with improved wood properties for conversion to electricity, steam, and heat) that sustainably increases yields of biomass across the rotation.

- *Short-rotation forests*—Need to promote the development and commercial deployment of select and dedicated-forest tree species in Florida by providing the following possibilities: (1) establish guarantees or give subsidies for converting land near enough to facilities to short rotation forests, offering low cost loans (to help overcome initial lack of cash flow); (2) create landowner technical assistance programs; (3) promote stable and efficient markets for wood and residues from short rotation forests by creation of incentives for producing electricity, steam, and heat from this source of biomass; (4) create opportunities for conversion facility owners to partner with existing landowners to establish long-term supply agreements; and (5) develop equipment and methods that can efficiently harvest and transport stems and residues to facilities that produce electricity, steam, and heat.

Other Energy Crops

- *MSW biomass*— Promote the use of MSW biomass as defined in 366.91 F.S. for production of electricity by improving the market value through inclusion in a Renewable Portfolio Standard (RPS). Enhanced revenue from electrical generation that will result from sales of credits in an RPS may encourage the construction of new MSW biomass facilities as an alternative to landfilling, and offset the production of methane (a more powerful GHG than CO_2) that may occur if the waste is disposed of in a landfill. As an indigenous and sustainable fuel, MSW biomass can best be utilized by avoiding long-distance transport of the material, and instead developing appropriately sized local facilities to use this energy source. Local facilities also assist in electrical reliability by providing distributed generating capacity.
- *Agriculture and forestry residues*—Promote the use of forest residues by developing the technical means and improving the financial returns that make use of these residues commercially viable. Possibilities include promoting research into harvesting, collection and compaction for transportation, and subsidies to promote their use at conversion facilities.

Related Policies/Programs in Place

Executive Order 07-127 includes a request to the Public Service Commission (PSC) to establish an RPS that would require utilities to obtain 20 percent of generation from renewable sources. Presumably this would create demand for biomass feedstocks.

DOF promotes the development of woody biomass.

Existing statutory prohibitions promote the separate collection of yard waste biomass.

A recent shift in demand for pine biomass may result in increased availability of biomass from pine for the use of energy production. The demand for pulpwood in Florida has been decreasing due to the loss of pulp and paper mills in the state. A consequence could be a shift in end use of biomass from pine away from pulp and paper industries and towards biofuel and energy industries.

Type(s) of GHG Reductions

CO_2, N_2O, CH_4: Displaces emissions from fossil fuel combustion.

CH_4: Capture and utilization or preventing the creation of methane.

Estimated GHG Reductions and Net Costs or Cost Savings

Estimated GHG reductions ($MMtCO_2e$/year):

- Total: 20.6 and 39.8 in 2017 and 2025, respectively
- Biomass: 19.2 and 33.6 in 2017 and 2025, respectively
- LFGTE: 1.07 and5.63 in 2017 and 2025, respectively.
- WTE: 0.31 and 0.65 in 2017 and 2025, respectively.

Estimated cost (\$/tCO_2e):

- Total: 21
- Biomass: 23
- LFGTE: 1
- WTE: 1

Data Sources:

See footnotes in documentation below for data sources. CCS consulted experts from the Solid Waste Authority of Palm Beach County, Wheelabrator Technologies, Inc. (WTI), and Waste Management, Inc. (WM).

Quantification Methods:

The primary goal was quantified based on the quantity of biomass supplied as an energy feedstock in the baseline year 2005. In 2005, biomass utilization was estimated to be approximately 84 trillion BTUs in the residential, commercial and industrial (RCI) sector and approximately 49 trillion BTUs in the energy supply sector. This provides a total biomass feedstock utilization baseline of approximately 133 trillion BTUs in 2005. Achieving an increase to 500 percent of this 2005 level would require an additional[34] 499 trillion BTUs of biomass supply by 2025 from energy crops, forestry, agriculture residues, waste to energy, and landfill gas feedstocks. The goal quantification is outlined in table 4-1.

[34] This is the amount required above business as usual projections and is shown in column 5 of Table 4-1.

Table D-4-1. Expanded use of biomass goal quantification

Year	Policy Implementation (%)	Policy Implementation (MMBtu)	BAU Projected Biomass (MMBtu)	Required Additional Biomass Energy Under Policy (MMBtu)	Additional Energy From MSW/LFG[35] (MMBtu)	Additional Energy From Biomass (MMBtu)
2008	100%	133,091,516	139,926,402	—	—	—
2009	124%	164,407,167	142,406,691	22,000,477	—	22,000,477
2010	147%	195,722,818	145,927,855	49,794,963	875,904	48,919,060
2011	171%	227,038,469	147,300,255	79,738,215	1,763,852	77,974,363
2012	194%	258,354,120	148,936,694	109,417,426	2,664,126	106,753,301
2013	218%	289,669,771	150,458,507	139,211,264	3,577,013	135,634,252
2014	241%	320,985,422	151,815,456	169,169,966	4,502,806	164,667,160
2015	265%	352,301,073	153,092,159	199,208,914	5,441,805	193,767,109
2016	288%	383,616,724	154,492,278	229,124,446	6,394,315	222,730,131
2017	312%	414,932,375	155,607,589	259,324,786	7,360,648	251,964,138
2018	335%	446,248,026	156,619,908	289,628,118	8,341,122	281,286,996
2019	359%	477,563,677	157,911,146	319,652,531	9,336,062	310,316,469
2020	382%	508,879,328	159,342,262	349,537,066	10,345,800	339,191,266
2021	406%	540,194,979	160,796,790	379,398,189	11,370,672	368,027,516
2022	429%	571,510,629	162,219,649	409,290,981	12,411,026	396,879,955
2023	453%	602,826,280	163,661,189	439,165,091	13,467,213	425,697,878
2024	476%	634,141,931	165,129,683	469,012,248	14,539,593	454,472,655
2025	500%	665,457,582	166,725,915	498,731,667	15,628,532	483,103,135

MMBtu = million British thermal units; MSW = municipal solid waste; LFG = landfill gas.

This analysis focuses on the incremental GHG benefits associated with the utilization of additional biomass to offset the consumption of fossil fuels. It assumes that biomass will be used to replace a combination of coal, natural gas and oil based on the relative generation from each feedstock in Florida (36 percent Coal, 43 percent Natural Gas and 21 percent oil; it is assumed that biomass would not replace nuclear).[36]

The GHG benefits were calculated by the difference in emissions associated with each of the input fuels (0.0959 tCO_2e/MMBtu for sub-bituminous coal, 0.0539 tCO_2e/MMBtu for natural gas,

[35] See LFG and WTE analysis below.

[36] Based on eGRID data: coal 29 percent, nuclear 15 percent, oil 17 percent, natural gas 35 percent, biomass 2 percent, hydro 0.1 percent, and wind 0 percent. U.S. Environmental Protection Agency. "Emissions & Generation Resource Integrated Database (eGRID). Data for Florida." Available at: http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html

0.0783 tCO_2e/MMBtu for oil, and 0.0019 tCO_2e/MMBtu for biomass, including non-CH_4 and non-N_2O emissions).[37]

The GHG benefits and the amount of biomass utilized under this recommendation are illustrated in Table 4-2.

Table D-4-2. Expanded use of biomass goal quantification

Year	Additional Energy From Biomass (MMBtu)	Avoided Emissions ($MMtCO_2e$)	Approximate Biomass Required To Meet Policy Goal (short tons)[38]
2009	22,000,477	1.83	1,887,570
2010	48,919,060	3.87	4,197,602
2011	77,974,363	6.06	6,690,974
2012	106,753,301	8.24	9,160,650
2013	135,634,252	10.4	11,639,095
2014	164,667,160	12.6	14,130,594
2015	193,767,109	14.8	16,627,862
2016	222,730,131	17.0	19,113,400
2017	251,964,138	19.2	21,622,206
2018	281,286,996	21.4	24,138,653
2019	310,316,469	23.6	26,629,948
2020	339,191,266	25.8	29,107,991
2021	368,027,516	28.0	31,582,746
2022	396,879,955	30.2	34,058,911
2023	425,697,878	32.3	36,532,135
2024	454,472,655	34.5	39,001,679
2025	483,103,135	33.6	41,458,863
	Cumulative	**323**	

MMBtu = million British thermal units; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

Energy from Biomass Costs

The cost calculation has two main components: fuel costs and capital/operational/maintenance costs. The fuel component is based on the difference in costs between supply of biomass fuel and the assumed fossil fuel that it is replacing (for instance, coal, natural gas, or oil). The assumed biomass fuel cost used in this analysis is indicated in Table 4-3.

[37] Emission factors obtained from the Center for Climate Strategies' (FL GHG I&F energy fuel emission factors.==

[38] Assumes the following Heat content (MMBtu/ton): Agriculture Residue, 8.3 MMBtu/ton; Energy Crop 14.7 MMBtu/ton; Forest Feedstocks 12 MMBtu/ton.

Table D-4-3. Assumed costs of biomass feedstocks

Biomass Fuel Type	Cost $/ton Delivered	Heat Content (MBtu/ton)	Cost $/MMBtu delivered	Source
Total agriculture residue	$42.50	8.30	$5.12	Brechbill, S.C. and W.E. Tyner. April 2008. "The Economics of Biomass Collection, Transportation, and Supply to Indiana Cellulosic and Electric Utility Facilities," Department of Agricultural Economics, Purdue University. Total per ton costs for transporting biomass 30 miles range between $39 and $46 for corn stover and between $57 and $63 for switchgrass. Average Heat Content of Selected Biomass Fuels, Table 10 EIA (2008) Annual Electric Generator.[39]
Energy crop (switchgrass)	$60.00	14.68	$4.09	Brechbill, S.C. and W.E. Tyner. April 2008. "The Economics of Biomass Collection, Transportation, and Supply to Indiana Cellulosic and Electric Utility Facilities," Department of Agricultural Economics, Purdue University. Total per ton costs for transporting biomass 30 miles range between $39 and $46 for corn stover and between $57 and $63 for switchgrass. Heat Content of Selected Fuels, ORNL (7,341 Btu/lb).[40]
Forest feedstocks	$28.16	12	$2.35	Mulkey, S. et al. April 2008. "Opportunities for Greenhouse Gas Reduction in Florida," University of Florida, School of Natural Resources and Environment. Full report available at: snre.ufl.edu. Heat Content of Selected Fuels, ORNL (6,000 to 8,000 Btu/lb for solid wood products).[41]

MMBtu = million British thermal units.

Note that the proportion of each biomass feedstock used to meet the goal was based on the proportion of availability for each feedstock. Note that current estimates indicate that there is insufficient supply to meet the biomass goal for the listed feedstocks, and that other biomass sources would be needed to meet the goal (for example, municipal solid waste biomass; see Table 1 at the front of this appendix).

The cost is calculated by assuming the replacement of fossil fuel with biomass. The difference in costs (dollars per million British thermal units [$/MMBtu]), is multiplied by the amount of energy (coal, natural gas, or oil in MMBtu) being replaced by biomass (taken from AEO Supplemental tables[42]). The assumed incremental capital costs are based on the capital costs

[39] http://www.eia.doe.gov/cneaf/solar.renewables/page/trends/table10.html

[40] See http://cta.ornl.gov/bedb/appendix_a/Approximate_Heat_Content_of_Selected_Fuels_for_Electric_Power_Generation.xls

[41] Ibid.

[42] Fuel cost ($/MMBtu). Fossil fuel costs from The AEO Supplemental tables were generated for the reference case of the Annual Energy Outlook 2008 (AEO2008) using the National Energy Modeling System, a computer-based model which produces annual projections of energy markets for 2005 to 2030. Available at: http://www.eia.doe.gov/oiaf/aeo/supplement/index.html

associated with establishing a biomass plant compared to a conventional fossil fuel plant. Capital costs and operational and maintenance costs were taken from Table 38 of the EIA AEO 2007[43] for the fossil fuel plants and from Taylor Energy Center analysis for biomass[44]. The incremental costs for biomass are outlined in table 4-4. While use of biomass may be pursued through other technology types (for example, gasification) or end uses (for example, heat or steam), this methodology was used to provide an estimate of possible additional capital and operational costs required to enable the utilization of biomass (Table 4-5).[45]

Table D-4-4. Incremental capital, operational, and maintenance costs for biomass

Cost Component	Additional Cost	Units
Additional capital costs for biomass compared with coal	$1,358	$/kW of biomass capacity
Additional variable O&M for biomass compared with coal	$6	($2005 mills/kWh)
Additional fixed O&M for biomass compared with coal	$46	($2005/kW)
Additional capital costs for biomass compared with natural gas and oil	$2,136	$/kW of biomass capacity
Additional variable O&M for biomass compared with natural gas and oil	$8	($2005 mills/kWh)
Additional fixed O&M for biomass compared with natural gas and oil	$60	($2005/kW)

kW = kilowatt; O&M = operation and maintenance; mills = one thousandth of a dollar; kWh = kilowatt-hour.

In the Key Uncertainties section below, the results of a separate assessment on biomass utilization are presented which assume that the biomass will be used strictly as co-fired fuel in existing coal-fired equipment. That assessment assumes no significant outlay of capital costs are needed to utilize the biomass; hence the results are based just on the difference in supplied fuels (coal versus biomass).

[43] U.S. Department of Energy, Energy Information Administration. "Electricity Market Module." In *Assumptions to the Annual Energy Outlook 2007*. DOE/EIA-0554(2007). April 2007. Available at: http://www.eia.doe.gov/oiaf/aeo/assumption/pdf/electricity.pdf

[44] Taylor Energy Center *Need for Power Application Supply-Side Alternatives* September 14, 2006 A.6-73 Black & Veatch. Cost and performance characteristics of a 30 MW stoker boiler biomass plant with Rankine cycle using wood waste as a fuel.

[45] The capital costs associated with using biomass as an alternative to fossil-based generation are dependent on many factors, including the end use (i.e., electricity, heat, or steam), the design and size of the system, the technology employed, and the configuration specifications of the system. Each system implemented under this policy would require a detailed analysis (incorporating specific engineering design and costs aspects) to provide a more accurate cost estimate of the system.

Table D-4-5. Estimated costs for biomass displacing fossil-based electricity generation

Year	Total Biomass Utilization (Agriculture Residue, Forest Feedstocks, and Energy Crops) (MMBtu)	Approximate Cumulative Capacity (MW)	Annualized Additional Biomass Plant Capital Costs (2005$)	Estimated Additional Variable Operation and Maintenance Costs (2005$)	Estimated Additional Fixed Operation and Maintenance Costs (2005$)	Fuel Costs (Agriculture Residue, Forest Feedstocks, and Energy Crops)	Cost/Savings (Million $2005)
2009	22,000,477	332	$40,055,922	$18,517,640	$18,300,588	–$67,844,710	$9.0
2010	48,924,930	737	$89,076,851	$41,179,755	$40,697,071	–$135,613,363	$35.3
2011	77,986,287	1,175	$141,988,406	$65,640,486	$64,871,088	–$195,001,561	$77.5
2012	106,771,465	1,609	$194,397,127	$89,868,759	$88,815,372	–$252,049,585	$121
2013	135,658,849	2,045	$246,991,931	$114,183,058	$112,844,674	–$282,442,896	$192
2014	164,698,385	2,482	$299,863,758	$138,625,422	$137,000,540	–$314,751,244	$261
2015	193,805,162	2,921	$352,858,010	$163,124,384	$161,212,339	–$332,236,554	$345
2016	222,775,218	3,358	$405,603,336	$187,508,267	$185,310,410	–$350,982,112	$427
2017	252,016,469	3,798	$458,842,420	$212,120,413	$209,634,067	–$396,473,623	$484
2018	281,346,785	4,240	$512,243,666	$236,807,526	$234,031,812	–$446,870,785	$536
2019	310,383,936	4,678	$565,111,150	$261,247,882	$258,185,694	–$508,389,972	$576
2020	339,266,636	5,113	$617,697,428	$285,558,239	$282,211,100	–$549,334,005	$636
2021	368,111,019	5,548	$670,213,942	$309,836,345	$306,204,632	–$589,008,494	$697
2022	396,971,825	5,983	$722,760,357	$334,128,273	$330,211,826	–$662,677,448	$724
2023	425,798,357	6,417	$775,244,369	$358,391,354	$354,190,509	–$736,376,048	$751
2024	454,581,987	6,851	$827,650,273	$382,618,325	$378,133,506	–$826,382,119	$762
2025	483,221,572	7,283	$879,793,915	$406,724,053	$401,956,682	–$922,634,069	$766
Cumulative							**$7,401**

MMBtu = million British thermal units; MW = megawatts.

The capital infrastructure lifespan is assumed to be 30 years, and the interest rate is assumed to be five percent giving a capital recovery factor of 0.065 (i.e., a $1 million plant is assumed to cost approximately $65,000 per year over the life of the project).

Landfill Gas-to-Energy (LFGTE) GHG Benefit

This section quantifies the benefits of the secondary goal of methane capture from landfills. As the goal stated in the above Policy Design section requires control of methane emissions specifically from uncontrolled landfills, CCS is able to use the emission estimates for uncontrolled landfills from the Florida I&F as the baseline emission scenario. The goal was adjusted to account for emissions already controlled through LFGTE projects and landfill methane flares, yielding an incremental goal that—coupled with the BAU LFGTE activities—would lead to 50 percent control of all landfill methane through LFGTE projects. Table 4-6 displays the projected BAU emissions from uncontrolled, flared, and LFGTE landfills, as well as the incremental LFG utilized for energy generation.

Table D-4-6. BAU emissions projections and LFG utilized for energy

Year	A. Methane Control for LFGTE Goal (%)	B. BAU CH_4 Emissions From MSW Landfills (tCO_2e)	C. BAU CH_4 Controlled for Flaring (tCO_2e)	D. BAU CH_4 Controlled for LFGTE (tCO_2e)	E= A × (B+C+D). Incremental CH_4 Utilized for LFGTE (tCO_2e)	Electricity Generated (MWh)	LFG Direct Combustion (MMBtu)
2009	0	12,220,277	2,923,086	2,183,401	—	12,220,277	—
2010	2	12,410,617	2,968,615	2,217,409	411,307	12,410,617	96,608
2011	5	12,603,922	3,014,854	2,251,947	835,427	12,603,922	196,225
2012	7	12,800,238	3,061,812	2,287,023	1,272,659	12,800,238	298,921
2013	9	12,999,611	3,109,502	2,322,645	1,723,309	12,999,611	404,770
2014	12	13,202,090	3,157,935	2,358,822	2,187,688	13,202,090	513,843
2015	14	13,407,723	3,207,122	2,395,562	2,666,115	13,407,723	626,216
2016	16	13,616,558	3,257,076	2,432,875	3,158,916	13,616,558	741,965
2017	19	13,828,646	3,307,807	2,470,769	3,666,421	13,828,646	861,167
2018	21	14,044,038	3,359,329	2,509,253	4,188,970	14,044,038	983,903
2019	23	14,262,785	3,411,653	2,548,337	4,726,907	14,262,785	1,110,254
2020	26	14,484,939	3,464,792	2,588,029	5,280,585	14,484,939	1,240,301
2021	28	14,710,553	3,518,759	2,628,340	5,850,364	14,710,553	1,374,131
2022	30	14,939,681	3,573,566	2,669,278	6,436,612	14,939,681	1,511,829
2023	33	15,172,378	3,629,227	2,710,854	7,039,704	15,172,378	1,653,482
2024	35	15,408,699	3,685,755	2,753,078	7,660,020	15,408,699	1,799,182
2025	37	15,648,701	3,743,164	2,795,959	8,297,953	15,648,701	1,949,019
Totals		**235,761,455**	**56,394,056**	**42,123,581**	**65,402,957**	**235,761,455**	**15,361,816**

LFGTE = landfill gas to energy; BAU = business as usual; CH_4 = methane; MSW = municipal solid waste; tCO_2e = metric tons of carbon dioxide equivalent; MWh = megawatt-hours; LFG = landfill gas; MMBtu = million British thermal units.

As emissions from uncontrolled landfills are controlled, three GHG benefits are realized: the conversion of landfill methane to CO_2, the displacement of grid-based electricity, and the displacement of fossil fuel combustion for direct heat.[46] The first benefit is calculated by multiplying the baseline CH_4 emissions from uncontrolled landfills from the Florida I&F by the LFG control goal set by the Action Team. This benefit does not apply to LFG that is flared under BAU. The second benefit (offset electricity) is found by converting the methane captured from tCO_2e units to cubic meters of gas, then calculating the electricity generated and the emissions offset through avoided grid-based generation.[47] The third GHG benefit is calculated by multiplying the fraction of captured LFG combusted for direct use by the quantity of LFG captured under this policy, assuming that an equal amount of natural gas is not combusted for direct heat use. The estimated GHG benefits in 2017 and 2025 are 1.07 and 5.63 $MMtCO_2e$, respectively. The cumulative GHG benefit through 2025 is estimated to be 32.0 $MMtCO_2e$. Table 4-7 depicts the results of these calculations.

Table D-4-7. LFGTE Overall policy results—GHG benefit

Year	GHG Benefit				Notes
	CH_4 Reduction From Incremental CH_4 Utilization ($MMtCO_2e$)	Avoided Electricity Production ($MMtCO_2e$)	Avoided Natural Gas Combustion for Direct Use ($MMtCO_2e$)	Total Avoided Emissions ($MMtCO_2e$)	
2009	—	—	—	—	Assumes implementation begins in 2010.
2010	—	0.02	0.07	0.09	Assumes incremental utilization for first 7 years is largely conversion of flared to LFGTE sites.
2011	—	0.03	0.14	0.17	
2012	—	0.05	0.22	0.27	
2013	—	0.07	0.29	0.36	
2014	—	0.09	0.37	0.46	
2015	—	0.10	0.45	0.56	
2016	—	0.12	0.54	0.66	
2017	0.30	0.14	0.62	1.07	
2018	0.71	0.17	0.71	1.58	
2019	1.12	0.19	0.80	2.11	
2020	1.54	0.21	0.90	2.65	
2021	1.98	0.24	0.99	3.22	
2022	2.43	0.27	1.09	3.79	
2023	2.90	0.30	1.20	4.39	
2024	3.38	0.32	1.30	5.00	
2025	3.87	0.35	1.41	5.63	
Totals	**18.2**	**2.7**	**11.1**	**32.0**	

[46] Assumed to be natural gas.

[47] Emission factor derived from the Energy Supply Inventory and Forecast.

GHG = greenhouse gas; CH_4 = methane; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; LFG = landfill gas;.

LFGTE Cost-Effectiveness

Using the results from a previous LFGcost model run, the costs of this policy are estimated based on whether the methane is converted to usable energy by a small engine, through direct use, or a by large engine (800 kW and greater).[48,49,50] CCS assumes that the current share of each of the three energy conversion techniques remains constant as uncontrolled sites are converted to control sites to meet the policy goal (Table 4-8), based on the national average share of each technology.

The average cost-effectiveness ($1.57/$tCO_2e$) is multiplied by the GHG benefit calculated in the above GHG Benefits section for each year to determine the cost-effectiveness of this policy (Table 4-9). The NPV of costs incurred through the policy's implementation is $28 million, and the discounted cost-effectiveness is $1/$tCO_2e$ (assumes no escalation of costs during the policy period).

Table D-4-8. LFGcost modeling results

EPA LFGcost Modeling Data	Scenario 1 Direct Use (0.5-mi. pipeline)	Scenario 2 Small Engine (< 800 kW)	Scenario 3 Standard Engine (> 800 kW)
Total capital	$621,573	$753,365	$2,612,674
Average annual O&M	$105,474	$102,141	$335,475
Annualized costs	$198,088	$214,392	$724,763
Annual revenue	$219,870	$70,020	$631,620
Annual average reductions ($MMtCO_2e$)	0.02	0.02	0.09
Project reductions ($MMtCO_2e$)	0.4	0.3	1.3
Cost-effectiveness ($/$tCO_2e$)	–$0.8	$2.7	$0.2
Net present value	–$296,892	$923,637	$200,660
Blended cost-effectiveness (Florida)			
Baseline share of methane control in Florida	20%	63%	17%
Fractional cost-effectiveness ($/$tCO_2e$)	–$0.16	$1.71	$0.03
Average cost-effectiveness ($/$tCO_2e$)	$1.57		

[48] U.S. EPA, Landfill Methane Outreach Program. Landfill Gas Energy Cost Model (LFGcost), Version 1.4. "Summary Report, Pechan for NC GHG Mitigation Plan—Scenario 4, LFGE Project Type: Standard Reciprocating Engine-Generator Set." March 2, 2007.

[49] U.S. EPA, Landfill Methane Outreach Program. Landfill Gas Energy Cost Model (LFGcost), Version 1.4. "Summary Report, Pechan for NC GHG Mitigation Plan—Scenario 2, No Section 45 Tax Credit LFGE Project Type: Small Engine-Generator Set." March 2, 2007.

[50] U.S. EPA, Landfill Methane Outreach Program. Landfill Gas Energy Cost Model (LFGcost), Version 1.4. "Summary Report, Pechan for NC GHG Mitigation Plan—Scenario 1, LFGE Project Type: Direct Use (0.5 mile pipeline)." March 2, 2007.

EPA = U.S. Environmental Protection Agency; LFG = landfill gas; kW = kilowatts; O&M = operation and maintenance; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/$tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Table D-4-9. LFGTE overall policy results—cost-effectiveness

Year	Avoided Emissions ($MMtCO_2e$)	Annual Costs (MM$)	Discounted Costs (MM$)	Cost Effectiveness ($/$tCO_2e$)
2009	—	$0.0	$0.0	
2010	0.09	$0.1	$0.1	
2011	0.17	$0.3	$0.2	
2012	0.27	$0.4	$0.4	
2013	0.36	$0.6	$0.5	
2014	0.46	$0.7	$0.6	
2015	0.56	$0.9	$0.7	
2016	0.66	$1.0	$0.7	
2017	1.07	$1.7	$1.1	
2018	1.58	$2.5	$1.6	
2019	2.11	$3.3	$2.0	
2020	2.65	$4.2	$2.4	
2021	3.22	$5.1	$2.8	
2022	3.79	$6.0	$3.2	
2023	4.39	$6.9	$3.5	
2024	5.00	$7.9	$3.8	
2025	5.63	$8.9	$4.1	
Totals	**32.0**	**$16**	**$28**	**$1**

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; MM$ = million dollars; $/$tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Waste-to-Energy (WTE) GHG Benefits

This section quantifies the benefits of the secondary goal of waste-to-energy utilization. The baseline WTE utilization in Florida was based on the average tonnage of waste combusted in Florida between 2001 and 2006.[51] This number was multiplied by the energy content and heat rate of MSW[52] to yield the baseline electricity generation. Both the baseline tonnage of waste combusted and electricity generated were multiplied by the Action Team goal of a 20 percent increase in WTE electricity generated to yield the incremental tonnage combusted and electricity generated for the year 2025. The electricity generated is multiplied by the emissions

[51] Florida Department of Environmental Protection. "Table 4A-2: Total Tons of MSW Managed in Florida Facilities by Descending Population Rank (CY2006)." Data reported for years 2001-2006. Accessed on July 20, 2008 from: http://appprod.dep.state.fl.us/www_rcra/reports/WR/Recycling/2006AnnualReport/AppendixA/4A-2.pdf

[52] Emission factor derived from the Energy Supply Inventory and Forecast.

factor of grid-based electricity to yield the GHG benefit from WTE electricity generation. The GHG benefit of avoided landfill emplacement is calculated using the EPA Waste Reduction Model (WARM).[53] Table 4-10 displays the GHG benefits of additional WTE in Florida. The GHG benefit in 2017 and 2025 is 0.31 and 0.65 MMtCO2e, respectively. The cumulative GHG benefit is 5.43MMtCO2e.

Table D-4-10. WTE Overall policy results—GHG benefit

Year	Policy WTE Electricity Generation Target (%)	Incremental Biomass WTE Electricity Generation (MWh)	Additional Biomass Combusted for WTE (tons)	Electricity Emissions Factor from I&F (tCO_2e/MWh)	GHG Benefit		
					Avoided Electricity Production ($MMtCO_2e$)	Avoided Landfilling of Biomass ($MMtCO_2e$)	Total Benefit ($MMtCO_2e$)
2009	0.0	—	—	0.59	—		—
2010	1.3	46,596	48,970	0.59	0.03	0.01	0.04
2011	2.5	93,193	97,940	0.59	0.05	0.02	0.08
2012	3.8	139,789	146,910	0.59	0.08	0.03	0.12
2013	5.0	186,385	195,881	0.60	0.11	0.04	0.16
2014	6.3	232,982	244,851	0.60	0.14	0.06	0.20
2015	7.5	279,578	293,821	0.59	0.17	0.07	0.23
2016	8.8	326,174	342,791	0.59	0.19	0.08	0.27
2017	10	372,771	391,761	0.60	0.22	0.09	0.31
2018	11	419,367	440,731	0.60	0.25	0.10	0.35
2019	13	465,963	489,701	0.61	0.28	0.11	0.39
2020	14	512,560	538,671	0.61	0.31	0.12	0.44
2021	15	559,156	587,642	0.62	0.35	0.13	0.48
2022	16	605,752	636,612	0.63	0.38	0.14	0.53
2023	18	652,349	685,582	0.64	0.42	0.16	0.57
2024	19	698,945	734,552	0.64	0.45	0.17	0.61
2025	20	745,541	783,522	0.64	0.47	0.18	0.65
Totals		**6,337,102**	**6,659,937**		**3.9**	**1.5**	**5.4**

WTE = waste to energy; MWh = megawatt-hours; I&F = Inventory and Forecast; tCO_2e = metric tons of carbon dioxide equivalent; GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

[53] WAste Reduction Model (WARM)." Version 8, May 2006. Available at: http://www.epa.gov/climatechange//wycd/waste/calculators/WARM_home.html. EPA created WARM to help solid waste planners and organizations track and voluntarily report GHG emission reductions from several different waste management practices. WARM is available both as a Web-based calculator and as a Microsoft Excel spreadsheet. WARM calculates and totals GHG emissions of baseline and alternative waste management practices—source reduction, recycling, combustion, composting, and landfilling. The model calculates emissions in tCe, tCO_2e, and energy units (MMBtu) across a wide range of material types commonly found in MSW. For an explanation of the methodology, see the EPA report *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks*, EPA530-R-02-006, available at http://epa.gov/climatechange/wycd/waste/SWMGHGreport.html.

WTE Cost-effectiveness

Based on an additional net cost of $0.79 per ton of waste processed at a WTE facility,[54] the NPV of this target was estimated to be $3 million, with a cost-effectiveness of $1/tCO_2e$. This incremental cost figure is based on the average difference in MSW gate rates in different waste management districts across Florida.

Another estimate of the incremental cost of diverting additional waste from landfills to WTE facilities is based on a facility in Palm Beach County. The incremental cost between disposing waste in the county's landfill system and WTE facility is $18.56/ton MSW.[55] However, as Palm Beach County's incineration facility is a refuse derived fuel facility (also known as an RDF), the Action Team did not feel that this cost is representative of the true incremental cost of waste incineration in Florida. Rather, it was suggested that future WTE facilities will likely be of the "mass burn" variety, rather than RDF facilities.

Table D-4-11. WTE overall policy results—cost-effectiveness

Year	Total GHG Benefit ($MMtCO_2e$)	Net Cost of Incremental Incineration ($MM)	Discounted Cost ($MM)	Cost-Effectiveness ($/$tCO_2e$)
2009	—	$0.0	$0.0	
2010	0.04	$0.0	$0.0	
2011	0.08	$0.1	$0.1	
2012	0.12	$0.1	$0.1	
2013	0.16	$0.2	$0.1	
2014	0.20	$0.2	$0.2	
2015	0.23	$0.2	$0.2	
2016	0.27	$0.3	$0.2	
2017	0.31	$0.3	$0.2	
2018	0.35	$0.3	$0.2	
2019	0.39	$0.4	$0.2	
2020	0.44	$0.4	$0.2	
2021	0.48	$0.5	$0.3	
2022	0.53	$0.5	$0.3	
2023	0.57	$0.5	$0.3	
2024	0.61	$0.6	$0.3	

[54] Personal communication from A. Boyson of Waste Management, Inc. to B. Strode. Submitted via e-mail on August 1, 2008. Includes gate rates for Pinellas WTE, Hillsborough Landfill, Marion County Landfill, Covanta WTE, Panama City Incinerator, Panama City Landfill, Broward County Wheelabrator, Orange County Landfill, and Central County Landfill.

[55] Solid Waste Authority of Palm Beach County. "2008 Cost Component Summary: A Full Cost Analysis of the SWA Solid Waste Management and Recycling Programs for Fiscal Year 2007." Accessed on July 20, 2008 from: http://www.swa.org/pdf/ccs.pdf

Year	Total GHG Benefit ($MMtCO_2e$)	Net Cost of Incremental Incineration ($MM)	Discounted Cost ($MM)	Cost-Effectiveness ($/$tCO_2e$)
2025	0.65	$0.6	$0.3	
Totals	**5.43**	**$5**	**$3**	**$1**

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $MM = million dollars; $/$tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

The combined results from all components under this recommendation are indicated in Table 4-12.

Table D-4-12. Combined GHG benefits and costs

Year	GHG Benefit from Biomass (MMtCO2e)	GHG Benefit from LFG (MMtCO2e)	GHG benefit from WTE (MMtCO2e)	Total GHG Benefit from biomass, LFG and WTE (MMtCO2e)	Net Cost of Biomass (2005$ MM)	Net Cost of LFG (2005$ MM)	Net Cost of WTE (2005$ MM)	Discounted Cost (2005$ MM)
2008	0	0	0	0	$0	$0	$0.000	$0
2009	1.83	0.000	0.000	1.83	$9.03	$0.000	$0.000	$9.03
2010	3.87	0.086	0.039	4.00	$35.3	$0.129	$0.037	$35.5
2011	6.07	0.174	0.077	6.32	$77.5	$0.249	$0.070	$77.8
2012	8.24	0.266	0.116	8.62	$121	$0.361	$0.100	$121
2013	10.4	0.361	0.156	10.94	$192	$0.467	$0.127	$192
2014	12.6	0.458	0.196	13.27	$261	$0.565	$0.151	$261
2015	14.8	0.557	0.233	15.6	$345	$0.654	$0.172	$346
2016	17.0	0.660	0.270	17.9	$427	$0.737	$0.191	$428
2017	19.2	1.07	0.313	20.6	$484	$1.14	$0.208	$485
2018	21.4	1.58	0.351	23.4	$536	$1.60	$0.223	$538
2019	23.6	2.11	0.394	26.1	$576	$2.04	$0.236	$578
2020	25.8	2.65	0.436	28.9	$636	$2.44	$0.247	$639
2021	28.0	3.22	0.482	31.7	$697	$2.82	$0.257	$700
2022	30.2	3.79	0.527	34.5	$724	$3.16	$0.265	$728
2023	32.3	4.39	0.571	37.3	$751	$3.49	$0.272	$755
2024	34.5	5.00	0.614	40.1	$762	$3.78	$0.278	$766
2025	33.6	5.63	0.653	39.8	$766	$4.06	$0.282	$770
Totals	**323**	**32.0**	**5.43**	**361**	**$7,401**	**$28**	**$3**	**$7,432**

Key Assumptions:

Biomass

The analysis assumes that biomass will be used to replace a combination of coal, natural gas, and oil based on the relative generation from each feedstock in Florida (36 percent Coal, 43 percent Natural Gas and 21 percent oil; it is assumed that biomass would not replace nuclear). A separate assessment is presented in the Key Uncertainties section below that looks at the potential difference in costs, if the recommendation was implemented strictly as a biomass co-firing recommendation.

LFGTE

The analysis does not factor in the closure of specific landfills or the adoption of LFG controls at specific landfills. Modeling GHG emissions and reductions at individual sites is beyond the scope of this analysis; however, the approach used is consistent with the methods used to develop the GHG forecast for the waste management sector.

Each of the cost inputs above contains key assumptions; additional study of these inputs could reduce the associated uncertainty in the cost estimates.

WTE

The two key assumptions regarding the analysis of the WTE goal are that the BAU tonnage of waste treated at WTE facilities will not increase over time and that the incremental waste treated at WTE facilities is 100 percent biomass, thus having no net GHG emissions.

It was also assumed that all additional waste treated at WTE facilities will be treated at mass burn facilities, rather than RDF facilities. Based on the information provided to CCS by the TWG, mass burn facilities will have a lower net cost than RDF facilities.

Key Uncertainties

The capital costs associated with using biomass as an alternative to fossil-based generation are dependent on many factors, including the end use (i.e., electricity, heat, or steam), the design and size of the system, the technology employed, and the configuration specifications of the system. Each system implemented under this policy would require a detailed analysis (incorporating specific engineering design and costing aspects) to provide a more accurate cost estimate of the system. Co-firing coal and biomass in existing conventional coal-fired power stations presents a significant opportunity. Demonstrations and tests indicate that biomass can provide up to 15 percent of the total energy input (i.e. replace up to 15 percent of the coal feedstock) with only minor modifications to the existing system.[56] The analysis conducted above assumes that biomass replaces a combination fuel mix of coal, natural gas, and oil. The analysis below indicates possible GHG emission reductions and costs if all biomass displaced coal

[56] National Renewable Energy Laboratory Biopower Fact sheet (see http://www.nrel.gov/docs/fy00osti/28009.pdf).

through co-firing and new capital costs were not required (for example, only includes feedstock displacement costs).

Table D-4-13. GHG benefits and costs under a co-firing scenario

Year	Biomass displacement costs if Agriculture Residue displacing coal through co-firing (million 2005$)	Biomass displacement costs if Forestry Residue displacing coal through co-firing (million 2005$)	Biomass displacement costs if Energy Crops displacing coal through co-firing (million 2005$)	Total Biomass displacement costs for replacing coal through co-firing (million 2005$)	GHG savings from biomass co-firing replacing coal ($MMtCO_2e$)
2009	$11.7	-$3.10	$11.4	$20.0	2.07
2010	$25.2	-$8.33	$24.1	$40.9	4.60
2011	$42.2	-$9.36	$41.9	$74.8	7.33
2012	$59.7	-$9.26	$60.5	$111	10.0
2013	$77.4	-$8.93	$79.4	$148	12.7
2014	$95.2	-$8.39	$98.7	$186	15.5
2015	$113	-$8.94	$117	$221	18.2
2016	$132	-$6.14	$138	$264	20.9
2017	$150	-$4.72	$158	$304	23.7
2018	$172	$3.56	$185	$360	26.4
2019	$190	$4.26	$204	$398	29.2
2020	$208	$5.33	$224	$437	31.9
2021	$225	$3.79	$241	$469	34.6
2022	$242	$2.75	$259	$503	37.3
2023	$259	$2.47	$277	$538	40.0
2024	$277	$2.79	$296	$575	42.7
2025	$294	$3.59	$315	$613	45.4
			Cumulative	**$5,263**	**403**

The amount of biomass used of each type is based on the availability of each feedstock (22 percent, 41 percent forestry, 37 percent energy crops). As can be seen above, the GHG benefits increase and the costs decrease if the analysis assumes biomass replaces coal through co-firing due to coal having greater emissions and lower cost than other feedstocks such as natural gas. These results indicate a cost effectiveness of $13/t$CO_2$e versus $23/t$CO_2$e for the analysis above which included the consideration of capital costs for new capacity.

The future price of electricity will affect the analysis.

The incremental cost of diverting additional waste from landfills to WTE facilities is based on current gate rates, which may be subsidized in some counties. Therefore, the estimated cost of this target may not represent the true social cost. However, as most cost information at privately-run facilities is proprietary, CCS was unable to base their estimates on more specific cost data. Rather, CCS utilized publicly available information (MSW gate rates) to estimate the cost effectiveness of the WTE goal.

Additional Benefits, Costs and Energy Security Fuel Savings

The expansion of crops as an energy feedstock needs to ensure that the energy crops are grown on appropriate land and in ways that do not damage terrestrial or aquatic resources nor displace food production.

Consideration of recycling, source reduction, and organics management was suggested during a public comments session. The Florida Action Team notes that HB 7135 (Section 95. Section 403.7032, Florida Statutes,) includes a provision for 75 percent recycling as follows:

"By the year 2020, the long-term goal for the recycling efforts of state and local governmental entities, private companies and organizations, and the general public is to reduce the amount of recyclable solid waste disposed of in waste management facilities, landfills, or incineration facilities by a statewide average of at least 75 percent. However, any solid waste used for the production of renewable energy shall count toward the long term recycling goal as set forth in this section."

Another concern expressed in comments from the public is that combustion of MSW in waste-to-energy plants produces non-GHG air emissions, including criteria and toxic air pollutants. The Florida Action Team acknowledges this concern and notes that existing federal and state regulatory programs are in place that require the Maximum Achievable Control Technology (for example, waste sorting, combustion processes, pollution controls) to reduce emissions and to provide reasonable assurance that both the existing and any future waste-to-energy facilities are designed and operated to minimize these emissions. These regulations can be amended in the future to lower emission limits if control technologies improve. It should also be noted that MSW waste-to-energy offers the potential to offset emissions from other sources, such as mercury emissions from coal-fired power plants, while also lowering GHG emissions. Consideration of new waste-to-energy facilities should carefully consider net benefits of MSW waste-to-energy and the energy sources they displace.

Total fossil fuel displaced during the policy period is 22 million short tons coal **or** 486,000 cubic feet natural gas.

Feasibility Issues

Availability, collection, and distribution will be key issues that will affect the implementation of this recommendation, particularly on the cost side. Collection and distribution are particularly important for the utilization of agriculture and forest residues.

Status of Group Approval

Complete.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

AFW-5. Promotion of Farming Practices That Achieve GHG Benefits

Policy Description

The amount of carbon stored in the soil can be increased by the adoption of practices, such as conservation, no-till cultivation, and crop rotation. Provide incentives to farmers for using production practices that achieve net GHG benefits, such as no-till cultivation or biotechnology crops requiring reduced chemical or fuel use. Other benefits include reduced wind and water erosion, reduced fuel consumption, and improved wildlife habitat.

Convert marginal agricultural land used for annual crops to permanent cover (for example, grassland/rangeland, grove, or forest) where the soil carbon or carbon in biomass is higher under the new land use. Provide incentives to producers to prevent grassland from returning either to conventionally tilled production or to suburban/urban development.

Improve the efficiency of fertilizer use and other nitrogen-based soil amendments through implementation of FDACS Best Management Practices (BMPs) manuals and support of biotechnology crops. Excess nitrogen not metabolized by plants can leach into groundwater and be emitted to the atmosphere as nitrous oxide (N_2O). Better nutrient utilization can lead to lower N_2O emissions from runoff.

This recommendation has potential linkages with the Cap and Trade Technical Working Group (provision for carbon offsets).

Policy Design

Goals:

- *Soil Carbon Management*—By 2025, implement cultivation practices to enhance soil carbon levels on 40 percent of the acreage not already using these practices.
- *Agriculture Land Conversion*—Promote conversion of marginal agricultural land to higher sequestration permanent cover.
- *Nutrient Management*—Increase efficiency of fertilizer use by 25 percent in 2025, compared with business as usual (BAU).
- *Improved Harvesting Methods*—Promote increased efficiency of energy use in harvesting.

Timing: Meet intermediate goals by 2015 if appropriate incentives are in place.

Parties Involved: UF IFAS, Florida Farm Bureau (FFB), all commodity groups, FDACS, USDA-NRCS, and DEP.

Other: Numeric goals for agricultural land conversion and harvesting to be set after initial analysis of reduction potentials for these goals.

- Voluntary, incentive-based programs are preferred over command and control regulation.
- Also water quality/quantity, economics, and other environmental benefits need to be taken into consideration when adopting certain practices.
- Research, extension, technology, and biotechnology must be embraced for increased yields and improved harvesting techniques.

Implementation Mechanisms

Cap-and-Trade—This recommendation has links to Cap-and-Trade policy recommendations of the Action Team Process. A Cap-and-Trade program may provide incentives for adoption of improved farming techniques provided that appropriate offset programs are developed as part of the program.

Conservation Tillage—Provide low-interest loans for conversion to no-till or low-till.

Cost Share and Incentive Programs—Promote FDACS-BMP cost-share programs. Provide incentives for early adopters of improved farming techniques.

Marginal Agriculture Land—The Action Team did not feel comfortable setting a goal for this recommendation without a better idea of the amount of marginal agricultural land in the state. Research should be done to determine a useable definition of marginal agricultural land for the state of Florida and the number of marginal acres in the state. Then, the state can reassess the best methods for increasing the carbon sequestration and other benefits of this land.

Nutrient Management—The rising cost of fertilizer has provided an immediate incentive to farmers to improve their nutrient efficiency. Improved timing of application can allow for greater uptake of nitrogen (N), thus requiring less overall N application.

Consultation with Dr. Brian Boman at the University of Florida provided some clarification on the feasibility of improved N efficiency in the state. He recommended a variety of recommendations that could potentially improve nitrogen efficiency. Nitrogen loss comes from intense rainfall, which can happen at any time of the year in Florida, so improved timing of N application has fewer benefits than it does in most states. Controlled release fertilizers could improve the efficiency of N uptake, but these are more expensive than typical fertilizers. Improved fertigation (combined fertilization-irrigation systems) helps to reduce N leaching and runoff. Precision application equipment can improve efficiency in tree based agriculture (citrus, dates) by 30 percent. With regard to vegetable crops, because of the relatively low costs of fertilizer compared to other farming costs, many farmers over apply N to avoid the possibility of running out. Improved education and N management could reduce the need for N application in some cases.

The State should look for opportunities to implement additional nutrient management practices for this policy in combination with the Best Management Farming Practices implemented for Florida's Total Maximum Daily Loadings (TMDL) Program. The TMDL program is concerned with limiting nitrogen and other pollutants into lakes and other water bodies.

Improved Harvesting—

It was decided by the Action Team that the differences in harvesting methods between crops was too large to quantify as one item. Instead, the state should investigate the potential for energy savings through improved harvesting methods across all major crops. Then the state should assess which crops are most attractive for investment when potential energy savings and likely costs/ton.

Related Policies/Programs in Place

FDACS-BMP cost-share programs.

Type(s) of GHG Reductions

CO_2, CH_4, N_2O: CO_2 is indirectly sequestered from the atmosphere when soil carbon levels are raised. Reductions of all three GHGs also occur through avoided use of fossil fuels during tilling. Embedded GHGs associated with the production and transport of fertilizers are also avoided when nutrient management programs achieve lower levels of nitrogen application. Nutrient management also reduces N_2O emissions that follow the application of nitrogen-based fertilizers.

Estimated GHG Reductions and Net Costs or Cost Savings

Estimated GHG reductions (MMtCO_2e/year): 0.7 and 1.2 in 2017 and 2025, respectively.

Estimated cost (\$/tCO_2e): –0.6

The estimates above are the sum of policy elements A and C (B and D were not quantified due to a lack of data). Estimates for each policy element are provided below.

Data Sources: See Quantification Methods below.

Quantification Methods:

Soil Carbon

Total cropland in Florida was estimated at about 3.7 million acres[57] in 2002. For the purposes of this analysis, it is assumed that conservation practices include conservation till (no-till and strip-till), and other conservation farming practices that provide enhanced ground cover, or other

[57] USDA. Florida Fact Sheet. http://www.ers.usda.gov/statefacts/fl.htm

crop management practices that achieve similar soil carbon benefits. Conservation tillage is defined as any system that leaves 50 percent or more of the soil covered with residue.[58]

Based on the policy design parameters, the schedule for acres to be put into conservation tillage/no-till cultivation is displayed in Table 5-1. This table represents the percentage of cropland required by the policy. The Florida data came from the Conservation Technology Information Center's National Crop Residue Management Surveys.[59] This data indicated that no-till practices are not common in Florida, accounting for only a little over 55,000 acres in 1998. If more recent figures for the number of no-till acres in Florida could be found, that would help improve the analysis.

Assume that this rate of accumulation occurs for 20 years which extends beyond the policy period. It is assumed that the sequestration rate provided by the Chicago Climate Exchange for the carbon credit program is reliable for the state of Florida. Also assume that while only some of Florida is in Zone A (0.6 tCO_2/acre/year), this is where the majority of no-till practices are likely to be adopted, so this figure is used for the state as a whole. [60]

Additional GHG savings from reduced fossil fuel consumption are estimated by multiplying the fossil diesel emission factor and diesel fuel reduction per acre estimate. The reduction in fossil diesel fuel use from the adoption of conservation tillage methods is 3.5 gallons (gal)/acre.[61] The life-cycle fossil diesel GHG emission factor of 12.31 tCO_2e/1,000 gal was used.[62] Results are shown in Table 5-1, along with a total estimated benefit from both carbon sequestration and fossil fuel reductions.

[58] The definitions of tillage practices from the Conservation Technology Information Center are used under this policy. However, only no-till/strip-till and ridge-till are considered "conservation tillage" practices. No-till means leaving the residue from last year's crop undisturbed until planting. Strip-till means no more than one-third of the row width is disturbed with a coulter, residue manager, or specialized shank that creates a strip. If shanks are used, nutrients may be injected at the same time. Ridge-till means that 4–6-inch-high ridges are formed at cultivation. Planters using specialized attachments scrape off the top 2 inches of the ridge before placing the seed in the ground.

[59] Sourced from the Conservation Technology Information Center, National Crop Residue Management Surveys. "1998 FL Search." http://www.conservationinformation.org/index.asp?site=1&action=crm_results Accessed August 7, 2008.

[60] Chicago Climate Exchange. Agricultural Soil Carbon Offsets. Available at: http://www.chicagoclimatex.com/content.jsf?id=781

[61] Reduction associated with conservation tillage compared with conventional tillage. See: Conservation Technology Information Center. "Reductions Associated With Conservation Tillage Compared With Conventional Tillage." Available at: http://www.ctic.purdue.edu/Core4/CT/CRM/Benefits.html

[62] Life-cycle emissions factor for fossil diesel from J. Hill et al. "Environmental, Economic, and Energetic Costs and Benefits of Biodiesel and Ethanol Biofuels." *Proceedings of the National Academy of Sciences* July 25, 2006;103(30):11206–11210. From the assessment used to evaluate U.S. soybean-based biodiesel life-cycle impacts. See: http://www.pnas.org/cgi/content/full/103/30/11099

Table D-5-1. GHG reductions from conservation tillage practices

Year	Percentage of Available Cropland in Program	New Acres Under "No Till"	$MMtCO_2e$ Sequestered	Diesel Saved (1,000 gallons)	$MMtCO_2e$ From Diesel Avoided	Total $MMtCO_2e$ Saved per Annum
2008	0%	—	—	—	—	—
2009	2%	521	0.000	2	0.000	0.00
2010	5%	124,521	0.075	436	0.005	0.08
2011	7%	212,050	0.127	742	0.009	0.14
2012	10%	299,579	0.180	1,049	0.013	0.19
2013	12%	387,109	0.232	1,355	0.017	0.25
2014	14%	474,638	0.285	1,661	0.020	0.31
2015	17%	562,168	0.337	1,968	0.024	0.36
2016	19%	649,697	0.390	2,274	0.028	0.42
2017	21%	737,226	0.442	2,580	0.032	0.47
2018	24%	824,756	0.495	2,887	0.036	0.53
2019	26%	912,285	0.547	3,193	0.039	0.59
2020	28%	999,815	0.600	3,499	0.043	0.64
2021	31%	1,087,344	0.652	3,806	0.047	0.70
2022	33%	1,174,874	0.705	4,112	0.051	0.76
2023	35%	1,262,403	0.757	4,418	0.054	0.81
2024	38%	1,349,932	0.810	4,725	0.058	0.87
2025	40%	1,432,599	0.860	5,014	0.062	0.92
Total Reductions						**8.0**

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

The reduction in fossil diesel fuel use from the adoption of conservation tillage methods is 3.5 gallons/acre.[63]

The costs of adopting soil management practices (e.g., conservation tillage/no-till practices) are based on cost estimates from the Minnesota Agriculture Best Management Practices program.[64] This program provides farmers a low-interest loan as an incentive to initiate or improve their current tillage practices. The equipment funded is generally specialized tillage or planting implements that leave crop residues covering at least 15 to 30 percent of the ground after planting. The average total cost for this equipment is $23,000, though the average loan for tillage equipment is $16,000. The average-size farm using an agricultural BMP loan to purchase conservation tillage equipment is 984 acres. The average loan size was determined based on the

[63] Reduction associated with conservation tillage compared with conventional tillage, at http://www.ctic.purdue.edu/Core4/CT/CRM/Benefits.html, accessed August 2006.

[64] Minnesota Department of Agriculture (2006), Agricultural Best Management Practices Loan Program State Revolving Fund Status Report, February 28, 2006.

average size of a farm in Florida (250 acres)[65] and the amount of a loan per acre as estimated in the Minnesota Agriculture Best Management Practices program ($16.26/acre).[66] This put the average loan size at $4,065 to finance no-till/conservation tillage practices. This loan payment was applied to each new acre entering the program to determine an approximate cost of encouraging the use of soil management practices. See Table 5-2 for more details.

Table D-5-2. Costs of conservation tillage program

Year	Cost of Loan	Cost Savings of Program	Total Costs of Program	Discounted Costs of Program
2008	$0	$0	$0	$0
2009	$8,464	–$7,393	$1,072	$882
2010	$2,016,240	–$1,768,324	$247,916	$194,249
2011	$1,423,228	–$3,011,334	–$1,588,106	–$1,185,069
2012	$1,423,228	–$4,254,344	–$2,831,116	–$2,012,021
2013	$1,423,228	–$5,497,355	–$4,074,126	–$2,757,529
2014	$1,423,228	–$6,740,365	–$5,317,137	–$3,427,474
2015	$1,423,228	–$7,983,375	–$6,560,147	–$4,027,361
2016	$1,423,228	–$9,226,385	–$7,803,157	–$4,562,344
2017	$1,423,228	–$10,469,396	–$9,046,168	–$5,037,245
2018	$1,423,228	–$11,712,406	–$10,289,178	–$5,456,571
2019	$1,423,228	–$12,955,416	–$11,532,188	–$5,824,539
2020	$1,423,228	–$14,198,427	–$12,775,198	–$6,145,089
2021	$1,423,228	–$15,441,437	–$14,018,209	–$6,421,903
2022	$1,423,228	–$16,684,447	–$15,261,219	–$6,658,419
2023	$1,423,228	–$17,927,457	–$16,504,229	–$6,857,848
2024	$1,423,228	–$19,170,468	–$17,747,239	–$7,023,185
2025	$1,344,160	–$20,344,422	–$19,000,262	–$7,160,999
Total				**–$74,362,465**

Marginal Agricultural Land GHG Benefits

This policy element was approved as non-quantified recommendation. A baseline study is needed to identify marginal agricultural lands in the state and their potential for supporting different land cover with higher levels of above and below-ground carbon.

[65] NASS. "Florida State Agriculture Overview—2007," 2008, available at: http://www.nass.usda.gov/Statistics_by_State/Ag_Overview/AgOverview_FL.pdf Accessed July 17, 2008.

[66] Minnesota Department of Agriculture (2006), Agricultural Best Management Practices Loan Program State Revolving Fund Status Report, February 28, 2006.

Nutrient Efficiency

The GHG benefits of this recommendation are quantified by calculating the CO_2e emissions per kilogram (kg) of nitrogen (N) applied in Florida. This uses an estimate of the nitrogen emissions from fertilizer (4.77 kg CO_2e per kg of N applied), calculated from the Florida I & F. This is then combined with a figure for the life-cycle emissions of nitrogen fertilizer to account for the rest of the emissions associated with fertilizer manufacturing, transport, and application (0.857 kg CO_2e/kg of N).[67] Thus, the total CO_2e emissions in Florida are 5.62 kg CO_2e/kg of N applied. The BAU estimate of nitrogen fertilizer use in the Inventory and Forecast assumes constant rates of nitrogen application from 2005. To increase nutrient efficiency by 25 percent, nitrogen fertilizer use is then reduced from the BAU estimate. This reduction of nitrogen application is then multiplied by the nitrogen emissions factor to determine the GHG benefits of this policy. Table 5-5 presents the nitrogen reductions and the GHG benefits of the proposed nutrient efficiency policy.

Table D-5-3. GHG reductions from the proposed nutrient efficiency policy

Year	FL Fertilizer Used (baseline) (metric tons of nitrogen)	Efficiency Improvement (%)	Nitrogen Fertilizer Used With Policies (metric tons)	Nitrogen Fertilizer Reduction (metric tons)	Emission Reductions ($MMtCO_2e$)
2008	204,675	0.0	204,675	0	0.00
2009	204,675	1.5	201,665	3,010	0.02
2010	204,675	2.9	198,655	6,020	0.03
2011	204,675	4.4	195,645	9,030	0.05
2012	204,675	5.9	192,635	12,040	0.07
2013	204,675	7.4	189,625	15,050	0.08
2014	204,675	8.8	186,615	18,060	0.10
2015	204,675	10	183,606	21,069	0.12
2016	204,675	12	180,596	24,079	0.14
2017	204,675	13	177,586	27,089	0.15
2018	204,675	15	174,576	30,099	0.17
2019	204,675	16	171,566	33,109	0.19
2020	204,675	18	168,556	36,119	0.20
2021	204,675	19	165,546	39,129	0.22
2022	204,675	21	162,536	42,139	0.24
2023	204,675	22	159,526	45,149	0.25
2024	204,675	24	156,516	48,159	0.27

[67] West, T.O. and G. Marland. 2001. "A Synthesis of Carbon Sequestration, Carbon Emissions, and Net Carbon Flux in Agriculture: Comparing Tillage Practices in the United States." *Agriculture, Ecosystems & Environment* September 2002:91(1-3):217-232. Available at: http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6T3Y-46MBDPX-10&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=4bf71c930423acddffbcef6d46d763c3

2025	204,675	25	153,506	51,169	0.29
Total Reductions					**2.6**

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

The costs of the nutrient efficiency policy were estimated based on the implementation of a soil testing policy to optimize fertilizer application. This policy assumes $20 cost to test a 75 acre field, with the field tested every five years, across all of Florida. There are also staffing costs for the testing and information program ($250,000/year) and costs of preparing a guidance document ($75,000). In addition to the costs of a program aimed at improved fertilizer efficiency, the costs of using slow release fertilizers were also calculated. According to a study on the Florida citrus industry, slow release fertilizers can improve nitrogen efficiency. The study found that because plants have better uptake of N from controlled release fertilizers, overall N application can be reduced by 50 percent.[68] However, these controlled release fertilizers cost approximately 3.37 times as much as conventional fertilizers, and therefore are not cost effective, even with the efficiency improvement over conventional fertilizers.[69] This analysis considers the additional cost of controlled release fertilizers as a way of demonstrating the likely costs of improving overall Nitrogen efficiency. While not all of the nitrogen efficiency improvement will come from the use of controlled efficiency fertilizers, this analysis assumes that other efficiency improvements (center pivot applicators, soil amendments to reduce leaching, etc) will have similar costs. Subtracted from these costs are the savings from reduced fertilizer use. See Table 5-6 for more details.

[68] T.A. Obreza, R. Rouse, and E.A. Hanlon "Advancements with Controlled-Release Fertilizers for Florida Citrus Production: 1996 -2006". July 2006. Florida Cooperative Extension Service. http://edis.ifas.ufl.edu/SS463

[69] Ibid.

Table D-5-4. Costs of nutrient efficiency program

Year	Target Fertilizer Reduction (kg nitrogen)	Annual Cost of Fertilizer Information Program ($MM)	Annual Cost of Slow Release Fertilizers ($MM)	Avoided Cost of Fertilizer ($MM)	Costs+Savings ($MM)	Discounted Costs+Savings ($MM)
2008	0	$0.82	$0.00	$0.00	$0.82	$0.70
2009	3,010	$0.74	$1.95	–$1.16	$1.53	$1.26
2010	6,020	$0.74	$3.90	–$2.32	$2.33	$1.82
2011	9,030	$0.74	$5.85	–$3.47	$3.12	$2.33
2012	12,040	$0.74	$7.80	–$4.63	$3.91	$2.78
2013	15,050	$0.74	$9.75	–$5.79	$4.70	$3.18
2014	18,060	$0.74	$11.70	–$6.95	$5.50	$3.54
2015	21,069	$0.74	$13.65	–$8.10	$6.29	$3.86
2016	24,079	$0.74	$15.60	–$9.26	$7.08	$4.14
2017	27,089	$0.74	$17.55	–$10.4	$7.88	$4.39
2018	30,099	$0.74	$19.50	–$11.6	$8.67	$4.60
2019	33,109	$0.74	$21.45	–$12.7	$9.5	$4.78
2020	36,119	$0.74	$23.40	–$13.9	$10.3	$4.93
2021	39,129	$0.74	$25.35	–$15.0	$11.0	$5.06
2022	42,139	$0.74	$27.30	–$16.2	$11.8	$5.17
2023	45,149	$0.74	$29.26	–$17.4	$12.6	$5.25
2024	48,159	$0.74	$31.21	–$18.5	$13.4	$5.31
2025	51,169	$0.74	$33.16	–$19.7	$14.2	$5.36
Total						**$68**

$MM = million dollars

Improved Harvesting Methods

This policy element was approved as non-quantified recommendation. A baseline study is needed to identify applicable improved harvesting methods for Florida's primary crops, their potential for adoption, their potential for energy and GHG reductions, and their costs.

Key Assumptions:

Nutrient Efficiency—Assumes that the costs of improved nutrient efficiency are comparable to the additional costs of slow release fertilizers. In addition, it is assumes that improved nutrient management practices can reduce the over N application without having a negative impact on crop yield.

Soil Carbon Management—Assumes that the effective use of no-till can be applied in Florida without an adverse impact on crop yield.

It is also assumed that no-till practices can be implemented without an increase in nutrient application. This can depend on the type of crop in which no-till is implemented, but some no-till practices may require increased nutrient application.

Assumes that the land being used for no-till will not be changed back to conventional or other uses in the near future. Future land use change away from no-till practices could result in a decrease in soil carbon levels.

Key Uncertainties

Increasing labor costs and uncertain future labor supply may make harvesting more energy intensive rather than less energy intensive as farmers replace human labor with mechanized harvesting methods.

As mentioned under Quantification Methods above, baseline studies are needed to address the GHG reduction potential and costs for the policy elements for Land Use Management that Promotes Permanent Cover (on marginal agricultural lands) and Improved Harvesting Methods. The Action Team encourages the FL Energy and Climate Commission to continue study of these elements.

Additional Benefits, Costs and Energy Security Fuel Savings

Soil Carbon Management – the quantification described above estimated annual fuel savings of about five million gallons of diesel fuel by 2025.

Nutrient Management - Reduced nutrient application may have additional benefits in terms of local water quality. The nutrient efficiency practices implemented under this policy directly tie into Best Management Farming Practices implemented as part of the State's Total Maximum Daily Loading program.

Feasibility Issues

None identified.

Status of Group Approval

Complete.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

AFW-6. Reduce the Rate of Conversion of Agricultural Land and Open Green Space to Development

Policy Description

Reduce the rate at which agricultural lands and open green space are converted to developed uses, while protecting private property rights and responsibilities. This retains the above- and belowground carbon on these lands, as well as their carbon sequestration potential. Transportation emissions will be reduced indirectly through more efficient development and lower vehicle use. Agricultural land and open green space conversion may be prevented through fee title acquisitions or conservation easements.

Policy Design

Goals: By 2015, achieve a 15 percent reduction in the level of losses that would have otherwise occurred. By 2025, achieve a 50 percent reduction in the level of losses that would have otherwise occurred.

Timing: Achieve the goal throughout the policy period.

Parties Involved: FDACS; USDA, DEP, FWC, DCA; water management districts, and nongovernmental organizations.

Other: Existing and estimated future agricultural and forested land loss is shown in the FDCAS presentation available at: http://www.dca.state.fl.us/fdcp/dcp/gmw/2008/Scott.pdf.

Implementation Mechanisms

Preserve working lands.

Implement net preservation of "one acre saved per one acre converted."

Educate general public and landowners to protect lands rather than sell them for development.

Carbon impacts need to be considered as part of the planning process in land use development.

Related Policies/Programs in Place

A number of programs already exist under Florida Law that provide incentives for the preservation of conservation, agricultural lands and open space. First, Florida has an aggressive natural lands acquisition program, the Florida Forever program, which has spent close to $2 billion and has acquired more than 535, 643 acres of natural lands since July of 2001. The program authorizes the issuance of bonds to fund land acquisition and is funded at the level of $300 million each fiscal year. In 2008, the Legislature allocated a percentage of the revenue available for land acquisition, approximately $10 million, to fund the purchase of permanent agricultural easements under the Rural and Family Lands Act, s. 570.71, Florida Statutes. In addition to programs providing funding for the purchase of fee or easements over conservation and agricultural lands, several land use planning tools are available that provide incentives for placing agricultural and conservation lands under protective easements. The Rural Lands Stewardship Program set forth in § 163.3177(11), Florida Statutes, provides for the adoption of a comprehensive plan amendment creating a rural land stewardship area and providing for the transfer of credits from agricultural and conservation areas to receiving areas designated for development. The land from which the credits are transferred must be placed under an agricultural or conservation easement running with the land in favor of the county where the land is located and in favor of one of the following entities: DEP, DACS, a water management district, or a recognized statewide land trust.

In addition to the tools listed above, a proposed constitutional amendment on the ballot on November 4, 2008, Amendment 4, provides for a property tax exemption of perpetually conserved land as well as authorizing the Florida Legislature to create a tax assessment category for land used for conservation purposes that is not perpetually encumbered. The goal of these provisions is to provide landowners with an incentive to maintain their land for a conservation purpose rather than converting the land to development.

The Florida Rural and Family Lands Protection Act was passed in 2001 with the goal of reducing the conversion of agricultural land to urban use. An important part of this act was the Rural and Family Lands Protection Program (RFLPP). Funding for the RFLPP was provided during the 2008 legislative session as part of the re-authorization of the Florida Forever Program. The RFLPP focuses on maintaining the integrity and function of working agricultural landscapes and ensuring opportunities for viable agricultural activities on working agricultural lands. RFLPP will focus on acquiring development rights using permanent easements from qualified and willing agricultural land owners. This program, through permanent easement acquisitions, will protect agricultural lands in the path of development so that Florida will continue to maintain a viable agricultural sector as part of the State's economy, while allowing its citizens the opportunity to continue to enjoy rural landscapes and open space.

Information on the RFLPP came from the Florida Department of Agriculture and Community Services, Division of Forestry, at: http://www.fl-dof.com/forest_management/rural_family_lands_index.html Accessed on August 27, 2008.

Type(s) of GHG Reductions

CO_2: Preventing release of carbon from conversion of forests, wetlands, and agricultural lands to development. Maintain annual carbon sequestration from forest growth, thriving wetlands and productive agricultural lands. Reduce urban sprawl thus avoiding additional emissions from vehicle miles traveled.

Estimated GHG Reductions and Net Costs or Cost Savings

Estimated GHG reductions (MMtCO_2e): 0.23 in 2017 and 0.53 in 2025.

Estimated cost (\$/tCO_2e): \$93.

Data Sources: as specified under Quantification Methods below.

Quantification Methods:

Studies are lacking on the changes in below and above-ground carbon stocks when agricultural land is converted to developed uses. For some land use changes, carbon stocks could be higher in the developed use relative to the agricultural use (for example, parks). In other instances, carbon stocks are likely to be lower (graded and paved surfaces). CCS assumed that the agricultural land would be developed into typical tract-style suburban development. It was further assumed that 50 percent of the land would be graded and covered with roads, driveways, parking lots, and building pads. The final assumption was that 75 percent of the soil carbon in the top eight inches of soil for these graded and covered surfaces would be lost and not replaced. CCS also assumed no change in the levels of above-ground carbon stocks.

The benefit in each year was determined by:

- Estimating the amount of land protected in each year by estimating the annual rate of agricultural land lost (70,820 acres/year, determined from NRI Florida data[70]) and assuming that agricultural land is protected at an increasing rate up to 2025, where it is assumed that net loss of agricultural land is reduced 50 percent.
- Multiplying the soil carbon content (assumed to be 0.011 MMtC/1,000 acres[71]) on the protected land by 50 percent (representing graded and covered areas) and by 75 percent (fraction of soil carbon lost);
- Converting the soil carbon lost to CO_2 by multiplying by 44/12.

The GHG benefits are indicated in Table 4-1. Note that the GHG benefits only include changes to below ground soil carbon and the quantification does not include emissions caused by activities associated with the various land uses (for example, emissions from tractor activities on agriculture land or urban vehicle activity on developed land).

[70] The most recent NRI data available at the detailed state level is for 1982 to 1997. It is expected that data up to 2003 will be available later in 2008.

[71] Based on Personal Communication with Kevin Robertson on 8/28/08, who provided studies of Florida's agricultural soil C levels. Florida soil carbon levels ranged from 22 to 32 metric tons C per hectare in the first thirty centimeters of the soil, which averaged to be a soil carbon level of .011 MMtC/1,000 acres.

Agriculture Lands Cost

To estimate program costs in each year, the estimated agricultural acres protected from development were multiplied by the conservation cost. The conservation costs were assumed based on the average easement acquisition cost per acre from the USDA ($4,935/acre). This cost of conservation is assumed to remain constant across the policy period. It is further assumed that subsidies are available through the FRPP[72] for a 50 percent cost-share. The resulting cost effectiveness is $60/Mt$CO_2$e. This estimate only accounts for the direct reductions associated with soil carbon losses estimated above and does not include potentially much larger indirect benefits associated with reductions in vehicle miles traveled. The GHG benefits and program costs are summarized in Table 4-1.

Table D-6-1. Acreage protected annually and associated avoided emissions and costs under policy implementation

Year	Assumed Percentage of Goal Achievement	Agriculture Acres Protected	MMtCO_2e Saved	Costs (Million $)	Discounted Costs (Million $)
2008	0%	—	0.000	$0	$0
2009	2%	1,518	0.023	$4	$4
2010	4%	3,035	0.046	$7	$7
2011	6%	4,553	0.068	$11	$10
2012	9%	6,070	0.091	$15	$12
2013	11%	7,588	0.114	$19	$15
2014	13%	9,105	0.137	$22	$17
2015	15%	10,623	0.160	$26	$19
2016	18%	12,646	0.190	$31	$21
2017	21%	15,176	0.228	$37	$24
2018	25%	17,705	0.266	$44	$27
2019	29%	20,234	0.304	$50	$29
2020	32%	22,764	0.342	$56	$31
2021	36%	25,293	0.380	$62	$33
2022	39%	27,822	0.418	$69	$35
2023	43%	30,351	0.456	$75	$36
2024	46%	32,881	0.494	$81	$37
2025	50%	35,410	0.532	$87	$38
Total			**4.25**		**$394**

MMtCO_2e = million metric tons of carbon dioxide equivalent.

[72] The Farm and Ranch Lands Protection Program [FRPP] provides matching funds (up to 50%) to keep productive farm and ranchland in agricultural uses. Working through existing programs, USDA partners with State, tribal, or local governments and nongovernmental organizations to acquire conservation easements or other interests in land from landowners.

Key Assumptions:

The rate of agricultural land conversion is a key assumption. Also, the analysis assumes that while some urban land use recommendations (such as parks) may have higher sequestration than agricultural use, overall sequestration is lower in urban rather than agricultural land use.

Key Uncertainties

Additional study of the benefits of this recommendation could provide a clearer picture of potential benefits and costs. The rate of agricultural land conversion is a key issue. Action Team members noted that a recent UF geographic information system study on land conversion by 2050 could help to gain additional understanding of this issue.

Additional Benefits, Costs and Energy Security Fuel Savings

Reducing agricultural land conversion can encourage densification of urban development, which can have benefits in terms of reduced vehicle miles traveled. Hence, this recommendation has direct implementation ties to smart development policy in the Transportation and Land Use sector.

Feasibility Issues

None identified.

Status of Group Approval

Complete.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

AFW-7. In-State Liquid/Gaseous Biofuels Production

Policy Description

Increase production of ethanol, bio-diesel, and transportation fuel (compressed natural gas) from agriculture, forestry feedstocks or MSW and other waste (raw materials) to displace the use of fossil fuel. Promote the development of technologies and production systems that use MSW biomass to produce liquid or gaseous biofuels, and the use of biomass in conjunction with other resources to produce ethanol. Bio-diesel and compressed natural gas use will offset fuel derived from petroleum and will lead to decreased fossil fuel-based CO_2 emissions. Provide market incentives to develop biofuels technologies from the multiple feedstocks.

Note that this recommendation is linked to the TLU Low-Carbon Fuel Standards recommendation. This recommendation focuses on in-state production of biofuels.

Policy Design

Goals:

Primary: Maximize the production of liquid and gaseous biofuels in Florida, such that by 2025 the state utilizes 20 percent of available biomass supply per year to produce biofuels with significantly lower embedded GHG emissions compared with conventional fuel products.

Secondary: Produce enough in-state biofuel to offset 25 percent of Florida's consumption of liquid fuels that are fossil fuel-based by 2025, using GHG-superior feedstocks. Replace two percent of petro-diesel with biofuel by 2012 and 10 percent of gasoline with ethanol by 2010.

Timing: See above.

Parties Involved: Municipal and county governments, private solid waste management companies, local economic development agencies, Florida Department of Environmental Protection, Florida Energy Commission, nongovernmental organizations, public interest groups, and Public Service Commission.

Other: Primary and secondary goals are to be achieved. However, some revision to either goal might be needed after some initial analysis of feedstock availability and the quantities of biofuels necessary to offset forecast consumption.

Consider the following feedstock sources:

- *Long-Rotation Forests*—Need to promote the use of wood for liquid biofuels in Florida by providing subsidies, tax credits, or payment schemes that enable landowners to conduct proper thinning and removals that benefit the health of the forest and decrease the chances of catastrophic wild fire. Promote the development of biomass utilizing facilities in appropriate locations that contain sufficient biomass, but don't already contain commercial conversion facilities, by providing infrastructure needed to support the development and transport of woody biomass. Promote development and deployment of advanced forest management practices (for example, faster growing genetic stock with improved wood properties for conversion to electricity, steam, and heat) that sustainably increases yields of biomass across the rotation.

- *Short-Rotation Forests*—Need to promote the development and commercial deployment of select and dedicated-forest tree species in Florida by providing the following possibilities: (1) establish guarantees or give subsidies for converting land near enough to facilities to short rotation forests, offering low cost loans to first time growers (to help overcome initial lack of cash flow); (2) landowner technical assistance programs; (3) promote stable and efficient markets for wood and residues from short rotation forests by creation of incentives for producing electricity, steam, and heat from this source of biomass; (4) create opportunities for conversion facility owners to partner with existing landowners to establish long-term supply agreements; and (5) development equipment and methods that can efficiently harvest and transport stems and residues to facilities that produce liquid biofuels.
- *Other Energy Crops*—The state should not incur costs and impacts associated with invasive plant species by encouraging, permitting, or incentivizing use of these species for carbon feedstocks. Crops should have high yields with low to moderate inputs (perhaps even much lower than the same crop grown as a food crop-especially for fertilizer, pesticides, and water), energy dense, high energy conversion, can be grown on poorer soils, etc. Peanut (biodiesel) and sweet potato (ethanol) might fit this description.
- *MSW Biomass*—Promote the use of MSW biomass for production of electricity by improving the market value of through inclusion in a Renewable Portfolio Standard (RPS). Enhanced revenue from electrical generation that will result from sales of credits in an RPS may encourage the construction of new MSW biomass facilities as an alternative to landfilling, and offset the production of methane (a more powerful greenhouse gas than CO_2) that may occur if the waste is disposed of in a landfill. As an indigenous and sustainable fuel, MSW biomass can best be utilized by avoiding long-distance transport of the material, and instead developing appropriately sized local facilities to use this energy source. Local facilities also assist in electrical reliability by providing distributed generating capacity.
- *Agriculture and Forestry Residues*—Promote the use of forest residues by developing the technical means and improving the financial returns that make use of these residues commercially viable. Possibilities include: promoting research into harvesting, collection and compaction for transportation, and subsidies to promote their use at conversion facilities.

Overall, policies need to decrease the risk and uncertainties associated with having sustainable supplies of good quality biomass at reasonable costs for the planned lifetime of the electrical, heat, or steam producing facility. It is likely a wide array of policies will be needed that influence land and conversion facility owners to dedicate themselves to using biomass feedstocks to produce renewable power.

Utilization of liquid and gaseous biofuel plants in close proximity to energy crops will cause reduction in the amount of energy required for feedstock transportation and fossil fuel use.

Combine technologies to enable ethanol production by utilizing cellulosic biomass extracted from solid waste streams, and agricultural and forestry crops and residues.

Implementation Mechanisms

Links to demand-side measure in the TLU low-carbon fuel standard recommendation.

Provide grants or incentives to develop small-scale biorefinery projects to convert woody wastes to cellulosic ethanol or other fuels.

Provide grants or incentives to develop Florida-based projects to convert landfill gas to liquefied natural gas.

Pilot new technologies to process organic wastes from agriculture wastes and manure, food and yard wastes, and industrial sludges to produce renewable fuels.

Provide incentives for the production of biomass.

Provide purchase guarantees for producers of biomass.

Related Policies/Programs in Place

Currently some biofuel production facilities are already planned for Florida.

Type(s) of GHG Reductions

Lifecycle GHG emissions of advanced biofuels are lower than the lifecycle emissions of the petroleum-based fuels that they replace.

Estimated GHG Reductions and Net Costs or Cost Savings

- Estimated GHG reductions (MMtCO_2e/year): 3.95 in 2017, 8.18 in 2025
- Estimated cost ($/t$CO_2$e): = –7.8

Data Sources:

Argonne National Laboratories GREET Model.

Mulkey, S. et al. April 2008. "Opportunities for Greenhouse Gas Reduction Through Forestry and Agriculture in Florida," University of Florida

National Renewable Energy Laboratory. June 2002. *Lignocellulosic Biomass to Ethanol Process Design and Economics Utilizing Co-Current Dilute Acid Prehydrolysis and Enzymatic Hydrolysis for Corn Stover*, NREL/TP-510-32438, Golden, CO.

Brechbill, S.C. and W.E. Tyner. April 2008. "The Economics of Biomass Collection, Transportation, and Supply to Indiana Cellulosic and Electric Utility Facilities," Working Paper #08-03, Department of Agricultural Economics, Purdue University

EIA. February 2007. *Biofuels in the U.S. Transportation Sector*. AEO 2008.

Quantification Methods:

Biofuel GHG Reductions

For ethanol the benefits for this recommendation are dependent on developing in-state production capacity that achieves benefits beyond petroleum fuels.

The incremental benefit of cellulosic ethanol produced from MSW biomass is equal to the lifecycle CO_2e emission factor of gasoline (11.30 t/1,000 gallons).[73] The incremental benefit of cellulosic production over gasoline from all other feedstocks targeted by this policy is 9.74 tCO_2e reduced/1,000 gallons, based on the difference between the life cycle CO_2e emission factor of gasoline and the life cycle CO_2e emission factor of cellulosic ethanol (1.51 t/1,000 gallons).[74]

The incremental benefit of starch-based ethanol is 2.16 tCO_2e reduced/1,000 gallons, based on the difference between the life cycle CO_2e emission factor of gasoline and the life cycle emission factor of corn-based ethanol (9.09 t/1,000 gallons).[75] The incremental benefit of biodiesel is 8.11 tCO_2e reduced/1,000 gallons, based on the difference between the life cycle CO_2e emission factor of diesel (11.3 t/1,000 gallons) and the life cycle emission factor of soy-based biodiesel (0.667 t/1,000 gallons).[76] Emission factors listed are based on the ANL GREET Model.[77] The incremental benefit values will be used along with the production in each year to estimate GHG reductions. Annual cellulose production is multiplied by the estimated ethanol yield per ton biomass, based

[73] ANLGreet model 1.8b emission factor for 50% conventional gasoline, 50 percent reformulated gasoline blend in g/mi x GREET model average fuel economy (100 mi/4.3 gal).

[74] ANLGreet model 1.8b emission factor for mixed feedstock cellulosic E100 for flex-fuel vehicle in g/mi x GREET model average fuel economy (100 mi/4.3 gal).

[75] ANLGreet model 1.8b emission factor for corn E100 for flex-fuel vehicle in g/mi x GREET model average fuel economy (100 mi/4.3 gal).

[76] ANLGreet model 1.8b emission factor for low sulfur diesel for CIDI engine in g/mi × GREET model average fuel economy (100 mi/4.3 gal); ANLGreet model 1.8b emission factor for soy-based biodiesel in CIDI engine in g/mi × GREET model average fuel economy (100 mi/4.3 gal).

[77] Downloadable from http://www.transportation.anl.gov/software/GREET

on the projection that ethanol yield will increase from 70 gallons/ton biomass to 90 gallons/ton biomass by 2012 and to 100 gallons/ton biomass by 2020.[78]

Table 7-1 shows the number of 70-million-gallon/year cellulosic plants that will need to go online in Florida to achieve the goal of using 20 percent of available biomass feedstock annually by 2025, and summarizes the quantity of other biofuels that can be produced with the Florida feedstock supply assuming that food crops will not be utilized for fuel. It is assumed that ramp-up in production of biofuels will not start until 2012. In Table 7-1 the starch-based ethanol production is from excess citrus molasses and biodiesel production is from waste (yellow) grease.[79] The emissions reductions from this plan are calculated by multiplying the number of gallons of ethanol or biodiesel produced in a given year by the emissions reduction per gallon.

Table D-7-1. Projected biofuel production and emission reductions

Year	Cellulosic Ethanol Plants in Operation	Cellulosic Feedstock Needed (MM dry tons/year)	Cellulosic Ethanol Production (MMgal/year)	Starch-Based Ethanol Production—Citrus Molasses (MMgal/year)	Biodiesel Production—Waste Grease (MMgal/year)	Total Emissions Reduction ($MMtCO_2e$)
2009	—	—	—	—	—	—
2010	—	—	—	—	—	—
2011	—	—	—	—	—	—
2012	3	2.3	204	0.13	3.1	2.30
2013	4	2.6	232	0.24	5.8	2.62
2014	4	2.9	261	0.35	8.4	2.94
2015	5	3.2	290	0.47	11.1	3.27
2016	5	3.6	320	0.58	13.8	3.61
2017	6	3.9	350	0.69	16.5	3.95
2018	6	4.2	381	0.80	19.2	4.31
2019	6	4.6	413	0.92	21.9	4.67
2020	8	5.0	495	1.03	24.5	5.57
2021	8	5.3	533	1.14	27.2	5.99

[78] J. Ashworth, NREL, personal communication, April 2007.

[79] Quantity of citrus molasses from "Opportunities for Greenhouse Gas Reduction Through Forestry and Agriculture in Florida," Stephen Mulkey, et al, April 2008, University of Florida.

Waste grease estimated based on per capita generation according to http://media.cleantech.com/node/376, accessed July 2008.

Waste grease conversion factor of 7.6 lb/gallon from California Grain & Feed Association, "Evaluate the Cost and Usage of Various Fuels," accessed January 8, 2008, at http://www.cgfa.org/news.html

Florida 2025 population estimate from U.S. Census Bureau, "Population Projections to 2030," available at: http://quickfacts.census.gov/qfd/states/12000lk.html, accessed July 2008.

2022	9	5.7	571	1.25	29.9	6.42
2023	9	6.1	610	1.37	32.6	6.86
2024	10	6.5	650	1.48	35.3	7.31
2025	11	7.3	728	1.80	43.0	8.18
					Total	**68.0**

MMgal = million gallons; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

Biofuel Costs

The cellulosic ethanol costs of this recommendation are estimated based on the capital and operating costs of cellulosic ethanol production plants. A study by the National Renewable Energy Laboratory estimated total capital costs for a 70 million gallon/year cellulosic ethanol plant would be $200 million.[80] An EIA study cited a major biofuels manufacturer who estimated the costs of a first of its kind 50 million gallon/year cellulosic ethanol plant to be $375 million.[81] An average of these costs was used in the estimate of capital costs. A new plant will need to be built for every 70 million gallons of annual ethanol production needed based on this assumption[82]. The annualized capital costs were estimated using a capital cost recovery factor that assumed a 20 year lifetime for the plant and a seven percent interest rate. Operational and maintenance costs were also taken from the NREL study.

The cost of biomass feedstocks made up a significant portion (approximately 60 percent) of variable costs. Therefore, the NREL estimate of feedstock costs ($30/ton) was replaced with more current estimates of the cost of delivered biomass: $70/ton for bunch grasses (such as switchgrass) and $51/ton for agricultural residues, based on a recent publication from Purdue University,[83] $45/ton for forestry crops and residues,[84] and a net revenue of $47/ton for MSW biomass feedstock.[85] The plant proposed by the NREL study produces some excess electricity,

[80] National Renewable Energy Laboratory, *Lignocellulosic Biomass to Ethanol Process Design and Economics Utilizing Co-Current Dilute Acid Prehydrolysis and Enzymatic Hydrolysis for Corn Stover*, NREL/TP-510-32438, Golden, CO, June 2002, available at: www. nrel.gov/docs/fy02osti/32438.pdf, accessed June 2008.

[81] EIA, *Biofuels in the U.S. Transportation Sector*. February 2007, available at: http://www.eia.doe.gov/ oiaf/analysispaper/biomass.html accessed July 2008

[82] Note that many recent planned cellulosic ethanol plants have been in the capacity range of 1 to 10 MMgal/year.

[83] For bunch grasses (switchgrass), average product $52.23/ton. For agricultural residues (corn stover), average product $33.41/ton. For each ton, assume transportation of 100 miles - $15.00 for 50 miles + $3.00 for 50 marginal miles, from "The Economics of Biomass Collection, Transportation, and Supply to Indiana Cellulosic and Electric Utility Facilities," by S.C. Brechbill and W.E. Tyner, Working Paper #08-03, April 2008, Department of Agricultural Economics, Purdue University.

[84] "Opportunities for Greenhouse Gas Reduction Through Forestry and Agriculture in Florida," S. Mulkey, et al, April 2008, University of Florida, page 30.

[85] $50 revenue tipping fee per gross MSW ton from Taylor Energy Center, Need for Power Application, A.6.0 Supply Side Alternatives, available at: http://www.psc.state.fl.us/library/filings/06/08611-06/Volume%20A/, accessed July 2008), minus $30 processing cost per ton usable biomass.

so the projected price of electricity from the Florida common assumptions document is used to show the value of electricity sold to the grid by the plant. Another revenue source for the ethanol plant is the value of the ethanol produced. The wholesale price of ethanol was taken from AEO 2008, and this is multiplied by the number of gallons produced annually.[86] Table 7-2 outlines the estimated cost and revenue streams for the cellulosic ethanol portion of this policy.

Table D-7-2. Capital and operating costs of cellulosic ethanol plants

Year	Cellulosic Ethanol Produced (million gallons annually)	Sale Price/Gallon Ethanol (2005$)	Annual Operating Costs ($MM)	Annualized Capital Costs ($MM)	Annual Revenue ($MM)	Net Costs/Revenue ($MM)
2009	—	1.91	—	—	—	—
2010	—	1.72	—	—	—	—
2011	—	1.95	—	—	—	—
2012	204	1.96	$189	$91.2	$418	$-137.6
2013	232	1.59	$231	$103.7	$391	$-56.1
2014	261	1.68	$273	$116.4	$461	$-71.0
2015	290	1.63	$316	$129.5	$499	$-54.0
2016	320	1.62	$359	$142.8	$547	$-44.9
2017	350	1.60	$403	$156.4	$593	$-33.9
2018	381	1.61	$447	$170.3	$649	$-31.6
2019	413	1.83	$492	$184.5	$796	$-118.9
2020	495	1.91	$604	$221.3	$992	$-166.2
2021	533	1.81	$656	$237.9	$1,015	$-121.0
2022	571	1.83	$708	$255.0	$1,097	$-134.1
2023	610	1.74	$761	$272.5	$1,117	$-83.3
2024	650	1.59	$815	$290.6	$1,091	$14.6
2025	728	1.57	$936	$325.1	$1,207	$54.5

$MM = million dollars.

The costs for advanced starch-based ethanol (non-corn) and biodiesel are estimated based on a per gallon incentive of $1.18 and $0.30 per gallon, respectively. The starch-based incentive is based on the difference between producing ethanol from switchgrass and corn.[87] The biodiesel incentive is based on the Missouri Biodiesel Incentive Program.[88] It is assumed that incentives

[86] AEO 2008. Table A12.

[87] Mulkey, S. et al. April 2008. "Opportunities for Greenhouse Gas Reduction Through Forestry and Agriculture in Florida," University of Florida, pp. 23.

[88] See Missouri Revised Statutes: Chapter 142 Motor Fuel Tax, § 142.031, available at: http://www.newrules.org/agri/mobiofuels.html#biodiesel, accessed July 2008.

for advanced starch-based ethanol and biodiesel will not be required after 2015 as advanced biofuels become competitive with fossil-based fuels. Table 7-3 summarizes the incentive costs and total policy costs.

The total cost of the policy for 2008–2020, discounted to 2005 dollars, is estimated to be a net revenue of $532 million.

Table D-7-3. Total biofuel costs

Year	Cellulosic Ethanol Net Costs/Revenue ($MM)	Starch-Based Ethanol Incentives ($MM)	Biodiesel Incentives ($MM)	Total Net Costs/Revenue ($MM)	Total Discounted Net Costs/Revenue (Million 2005$)
2009	—	—	—	—	—
2010	—	—	—	—	—
2011	—	—	—	—	—
2012	$-137.6	$0.15	$0.92	$-136.5	$-97.0
2013	$-56.1	$0.28	$1.73	$-54.1	$-36.6
2014	$-71.0	$0.42	$2.53	$-68.0	$-43.9
2015	$-54.0	$0.55	$3.34	$-50.1	$-30.8
2016	$-44.9	—	—	$-44.9	$-26.3
2017	$-33.9	—	—	$-33.9	$-18.9
2018	$-31.6	—	—	$-31.6	$-16.8
2019	$-118.9	—	—	$-118.9	$-60.0
2020	$-166.2	—	—	$-166.2	$-79.9
2021	$-121.0	—	—	$-121.0	$-55.4
2022	$-134.1	—	—	$-134.1	$-58.5
2023	$-83.3	—	—	$-83.3	$-34.6
2024	$14.6	—	—	$14.6	$5.8
2025	$54.5	—	—	$54.5	$20.5
				Total	**$-532**

Table 7-4 summarizes the business-as-usual (BAU) Florida gasoline and diesel consumption and the quantity that would be displaced with in-state biofuels production from this policy.

Table D-7-4. Displacement of Florida fuel consumption with biofuels

Year	Florida Gasoline Consumption (million gallons)	Percent Gasoline Displaced With Ethanol	Florida Diesel Consumption (million gallons)	Percent Diesel Displaced With Biodiesel
2009	9,494	0.00%	2,147	0.00%
2010	9,767	0.00%	2,253	0.00%
2011	9,979	0.00%	2,335	0.00%
2012	10,161	1.35%	2,411	0.12%
2013	10,337	1.51%	2,488	0.21%
2014	10,513	1.67%	2,567	0.30%
2015	10,686	1.83%	2,646	0.39%
2016	10,823	1.99%	2,711	0.47%
2017	10,958	2.16%	2,776	0.55%
2018	11,092	2.32%	2,842	0.63%
2019	11,227	2.48%	2,909	0.70%
2020	11,376	2.94%	2,982	0.76%
2021	11,510	3.12%	3,058	0.83%
2022	11,666	3.30%	3,141	0.88%
2023	11,846	3.48%	3,232	0.93%
2024	12,050	3.64%	3,332	0.98%
2025	12,275	4.00%	3,439	1.16%

Key Assumptions: The most important assumption is the future wholesale price of ethanol. When the price falls much below about $1.70/gallon, the current information on capital and operating costs suggests that the cellulosic plants will not be profitable. The assumed capital and operating costs for cellulosic ethanol plants are also key assumptions. Some of the newer plants being constructed in the US are smaller (~10 MMgal/yr or less) than the assumed 70 MMgal/yr plants here. Finally, the costs of biomass feedstocks are also key input assumptions. The operating costs for cellulosic plants assume the price of electricity to be sold is $0.04/kWh.

Key Uncertainties

Algae and jatropha may be able to serve as sustainable feedstocks for biodiesel production; it is unknown how much of these feedstocks will be cultivated in Florida.

This recommendation's costs are highly dependent on the price of feedstock, which for many types of feedstock is still relatively unclear. If feedstock prices prove higher on a per ton basis than currently estimated then this recommendation may had a net cost rather than a net revenue.

This recommendation's revenue is also highly dependent on the wholesale price of ethanol as this is the primary source of revenue for biofuel production plants. The AEO 2008 predicts ethanol wholesale prices under $2 for the next several years. Currently the state average rack price for ethanol is $2.85 (as of July 31, 2008; see http://www.ethanolmarket.com/fuelethanol.html). If future wholesale prices of ethanol stay in that range, then this recommendation has the potential to have a higher net revenue.

Additional Benefits, Costs and Energy Security Fuel Savings

Total fossil fuel displaced during the policy period is 4,075 million gallons gasoline and 271 million gallons diesel.

Feasibility Issues

None identified.

Status of Group Approval

Complete.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

AFW-8. Promotion of Advanced Municipal Solid Waste (MSW) Management Technologies (Including Bioreactor Technology)

Policy Description

Promote the development and implementation of solid waste management technologies and practices that minimize or reduce GHG emissions. These technologies include those that improve fuel efficiency in the collection, transport, and disposal of solid waste, including procurement of more fuel-efficient vehicles, to reduce the consumption of fossil fuels and related CO_2 emissions. Waste management technologies are needed that will enhance landfill gas collection and production, such as bioreactor technology, to accelerate landfill gas production and waste stabilization.

There is some level of overlap between this recommendation and the MSW landfill gas goal under AFW-4.

Policy Design

Goals: Decrease GHG emissions from cradle-to-grave (CTG) solid waste management practices by 25 percent (collection, transportation and disposal) from BAU by 2025.

Timing: See above.

Parties Involved: Local governments conducting solid waste collection and disposal, private solid waste management companies, vehicle and equipment suppliers, fuel suppliers, state regulatory agencies (DEP, PSC), federal agencies (US EPA), regulated electrical utilities, public interest groups, and the public-at-large (rate-paying public).

Other: A substantial component of the carbon footprint of solid waste management is the fuel consumed in collecting and transporting waste. Because the amounts of fuel consumed are significant from an economic standpoint, many public and private sector operations are already trying to maximize their efficiency. Nevertheless, there may be opportunities to seek further improvement, and because of the magnitude, even small improvements will yield substantial reductions. Software providing modern computer-aided routing may not be available to all entities collecting waste, particularly local governments collecting waste with their own forces. Creating a mechanism to assist those entities that do not have, and perhaps cannot afford, routing software may yield benefits.

The fleets of solid waste collection vehicles are managed to maximize their operating hours, and these vehicles may have a typical useful life of seven to 10 years. As vehicle and equipment manufacturers develop more fuel-efficient stock, it may be helpful to examine a program to incentivize early replacement of vehicles with more fuel-efficient models. An opportunity may arise to do a life cycle and carbon footprint analysis of tax incentives for replacing older collection vehicles with newer more efficient ones.

Smaller landfills, and landfills that closed prior to the regulatory requirements that mandated the installation of collection systems for landfill gas, may still be creating impacts on GHG levels through the uncontrolled release of landfill gas. The collection and management of this landfill gas will be an environmental benefit, even if the quantities collected are not sufficient to support a viable landfill gas to energy project. A combination of incentives that produce GHG-reduction credits for collecting and managing the gas at sites that would otherwise be exempt, together with a review to determine if additional regulation is required, can quantify the costs and benefits of collecting gas at these types of facilities.

A bioreactor landfill is essentially an in-landfill activity conducted at a standard Subtitle D sanitary landfill in which liquid, temperature, and air and landfill gas collection are managed in a controlled manner to achieve a more rapid stabilization of the biogenic waste constituents (food, greenwaste, and paper). A bioreactor landfill will produce more landfill gas over a shorter period of time than a standard Subtitle D landfill. This may make the economic viability of landfill gas to energy projects more attractive. To optimize the rapid waste stabilization of these wastes, moisture, gas composition, gas flow, and temperature must be carefully maintained and monitored.

Whether a landfill is managed as a standard Subtitle D landfill, or as a bioreactor, the efficiency of landfill gas collection should be maximize to limit release of CH_4 to the atmosphere. This would include installing collection systems for landfill gas earlier than the time frames required in current regulations, which stipulate installation after waste has been in place for five years. Economic factors that make the production of energy from landfill gas attractive may be as important in encouraging the maximum efficiency of collection systems as regulatory requirements.

Implementation Mechanisms

Promote the use of enhanced routing analysis techniques to reduce the amount of fuel consumed during waste collection and transport.

Encourage the accelerated replacement of collection and transport vehicles with more fuel efficient vehicles.

Deploy enhanced landfill gas collection systems, including bioreactor technology, where appropriate, to accelerate production of landfill gas generation and efficiency of collection at 50 percent of new or currently operating landfills by 2025.

Install landfill gas collection systems at uncontrolled landfills and/or closed municipal solid waste landfills, to reduce the amount of uncontrolled release of methane from these facilities by 50 percent by 2020.

The proposed cap-and-trade system for greenhouse gas emission will create incentives for more efficient collection and utilization of landfill gas.

The establishment of Renewable Energy Credits (RECs) for the generation of electricity from landfill gas, combined with a Renewable Portfolio Standard will add more value to the power generated by landfill gas and make more projects economically viable.

Tax incentives for the replacement of older vehicles with newer more fuel efficient ones could be developed based on life cycle benefits and carbon footprint impacts.

Related Policies/Programs in Place

Existing regulations require the collection of landfill gas, testing the efficiency of collection systems, and reporting quantities of gas collected to DEP. It may take some modification to existing Subtitle D landfill regulations to effectively implement bioreactor technology.

Existing regulatory programs for small and closed landfills may help identify sites that have potential for reducing GHG emissions by installing landfill gas collection systems.

DEP and the UF Hinkley Center for Solid and Hazardous Waste Management are currently funding three bioreactor demonstration projects in Florida (see www.bioreactor.org).

Type(s) of GHG Reductions

CO_2, CH_4, and N_2O: Emissions reduced from increased collection and transport efficiency. These emissions are a result of a reduction in the amount of diesel fuel needed to collect and transport MSW. CH_4 may also be reduced by improved landfill gas collection efforts and the application of bioreactor technologies.

Estimated GHG Reductions and Net Costs or Cost Savings

Estimated GHG reductions ($MMtCO_2e$): 1.9 in 2017 and 4.4 in 2025.

Estimated cost effectiveness: \$9/tCO_2e.

Data Sources:

Palm Beach County Solid Waste Authority

Florida Department of Environmental Protection Waste Management, Inc. Weitz et al. "The Impact of Municipal Solid Waste Management of Greenhouse Gas Emissions in the United States." *Journal of the Air and Waste Management Association*. 52: 1000–1011. 2002.

Quantification Methods:

GHG Benefit

The baseline cradle-to-grave emissions from the waste management sector were estimated by multiplying the tons of waste managed by the emission factors in Table 8-1. These factors were based on information provided by the Palm Beach County Solid Waste Administration and Waste Management, Inc.[89]

The MSW collection emission factor is based on the number of gallons consumed by curbside collection vehicles for a service area in North Florida with a population of 534,359.[90] Based on the resulting fuel consumption of 2.3 gallons/person/year and the 2008 projected FL population from the Florida Inventory and Forecast (FL I&F), CCS computed the 2008 fuel use by collection vehicles to be about 43 million gallons. This number, divided by the 2008 projected waste generation (see discussion for Table 8-2, below) and multiplied by the life-cycle diesel emission factor of 0.01125 tCO_2e/gallon, yields the emission factor of 0.0123 tCO_2/ton MSW.

The MSW transport emission factor represents emissions due to the transportation of waste from transfer facilities to landfills. The Solid Waste Authority of Palm Beach County (SWA) submitted data that show a miles-travelled-per-ton ratio of 2.15 miles/ton for waste transferred. SWA also estimates a fuel efficiency of 4.5 miles per gallon for transfer vehicles. Based on the these numbers and the life-cycle diesel emission factor of 0.01125 tCO2e/gallon, the MSW transport emission factor is estimated to be 0.00538tCO2e/ton MSW. DEP estimates that about 18,250,000 tons MSW is processed on transfer stations annually (based on 50,000 tons per day).[91] The emission factor is multiplied by the tons expected to be processed at transfer stations to yield the expected annual MSW transport emissions.

SWA reports that heavy equipment used at transfer stations are responsible for the emission of 2.17 lb CO2e for each ton of waste processed at these facilities.[92] This converts to 0.000986 tCO2e/ton MSW processed at transfer facilities.

[89] Palm Beach County Solid Waste Administration: Microsoft Excel spreadsheets with data for waste transportation and heavy equipment emissions. Provided by M. Bruner via e-mail communication with B. Strode and R. Anderson on July 22, 2008.

Waste Management, Inc. Microsoft Excel spreadsheet with data for waste collection emissions. Provided by A. Boysen via e-mail communication with B. Strode on July 28, 2008.

[90] Waste Management, Inc. Microsoft Excel spreadsheet with data for waste collection emissions. Provided by A. Boysen via e-mail communication with b. Strode on July 28, 2008.

[91] Personal communication from L. Martin to B. Strode via e-mail on August 15, 2008.

[92] Palm Beach County Solid Waste Administration: Microsoft Excel spreadsheets with data for waste transportation and heavy equipment emissions. Provided by M. Bruner via e-mail communication with B. Strode and R. Anderson on July 22, 2008.

Waste Management, Inc. provided CCS with a range of 0.26 to 0.45 gallons of fuel used per ton of waste deposited at landfills.[93] Multiplying the midpoint of this range by the life-cycle diesel emission factor of 0.01125 tCO2e/gallon yields a heavy equipment (landfills) emission factor of 0.00399 tCO2e/ton MSW.

Table D-8-1. Emission factors from key components of waste management sector

Emission Type	Emission Factor (tCO_2e/ton MSW)
MSW collection emissions	1.27E-02
MSW transport emissions	5.38E-03
Heavy equipment emissions (transfer station)	9.86E-04
Heavy equipment emissions (landfills)	3.99E-03

tCO_2e = metric tons of carbon dioxide equivalent; MSW = municipal solid waste.

These factors were multiplied by the number of tons projected to be managed in the state of Florida in the years 2009 to 2025 to develop a business-as-usual time series.[94] It is assumed that any policy implementation would begin in 2010. The historic emissions from landfills were taken from the Waste Management Appendix of the Florida Emissions Inventory and Forecast. The amount of solid waste disposed (landfilled and incinerated) was projected through the end of the policy period in 2025 using the average annual growth rate of from 2001-2006 DEP waste generation data.[95] Table 8-2 displays the estimated waste management sector emissions.

[93] Personal communication from A. Boysen to B. Strode via e-mail on August 1, 2008.

[94] Florida Department of Environmental Protection. "Table 4A-2: Total Tons of MSW Managed in Florida Facilities by Descending Population Rank (CY2006)." Data reported for years 2001–2006. Accessed on July 20, 2008, available at: http://appprod.dep.state.fl.us/www_rcra/reports/WR/Recycling/2006AnnualReport/AppendixA/4A-2.pdf

[95] Ibid.

Table D-8-2. Estimated historic waste management emissions

Year	MSW Disposed (Landfill) (tons)	MSW Disposed (WTE) (tons)	MSW Processed at Transfer Stations (tons)	MSW LF Emissions (tCO_2e)	MSW Collection Emissions (tCO_2e)	MSW Landfill Heavy Equipment Emissions ($MMtCO_2e$)	MSW Heavy Equipment Emissions at Transfer Stations (tCO_2e)	MSW Transport Emissions (tCO_2e)	Net WTE MSW Emissions (tCO_2e)	Total Baseline MSW Management Emissions (tCO_2e)
2009	26,680,365	3,917,610	21,138,381	12.2	0.390	0.107	0.02	0.11	0.738	13.5
2010	28,294,586	3,917,610	22,253,554	12.4	0.410	0.113	0.02	0.12	0.738	13.7
2011	29,993,968	3,917,610	23,427,559	12.6	0.432	0.120	0.02	0.13	0.738	13.9
2012	31,783,001	3,917,610	24,663,499	12.8	0.455	0.127	0.02	0.13	0.738	14.1
2013	33,666,416	3,917,610	25,964,642	13.0	0.479	0.134	0.03	0.14	0.738	14.4
2014	35,649,192	3,917,610	27,334,429	13.2	0.504	0.142	0.03	0.15	0.738	14.6
2015	37,736,572	3,917,610	28,776,479	13.4	0.530	0.151	0.03	0.15	0.738	14.9
2016	39,934,073	3,917,610	30,294,606	13.6	0.558	0.159	0.03	0.16	0.738	15.1
2017	42,247,504	3,917,610	31,892,823	13.8	0.588	0.169	0.03	0.17	0.738	15.4
2018	44,682,983	3,917,610	33,575,355	14.0	0.619	0.178	0.03	0.18	0.738	15.6
2019	47,246,948	3,917,610	35,346,651	14.3	0.652	0.189	0.03	0.19	0.738	15.9
2020	49,946,176	3,917,610	37,211,392	14.5	0.686	0.199	0.04	0.20	0.738	16.1
2021	52,787,805	3,917,610	39,174,510	14.7	0.722	0.211	0.04	0.21	0.738	16.4
2022	55,779,346	3,917,610	41,241,194	14.9	0.760	0.223	0.04	0.22	0.738	16.7
2023	58,928,708	3,917,610	43,416,907	15.2	0.800	0.235	0.04	0.23	0.738	17.0
2024	62,244,217	3,917,610	45,707,402	15.4	0.843	0.249	0.05	0.25	0.738	17.3
2025	65,734,639	3,917,610	48,118,734	15.6	0.887	0.263	0.05	0.26	0.738	17.6
Totals										

MSW = municipal solid waste; WTE = waste to energy; LF = landfill; tCO_2e = metric tons of carbon dioxide equivalent; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

The GHG reduction potential from the policy goal of 25 percent cradle to grave emissions reduction is shown in Table 8-3. The emission reduction is relative to the BAU scenario shown in Table 8-2. The following suite of strategies may be utilized to achieve the 25 percent emission reduction goal: additional active gas collection efficiency at LFGTE sites, optimized collection routes, trucks fueled by biodiesel, liquefied natural gas (LNG) or liquefied LFG, or the installation of microturbines at smaller landfill sites. Bioreactors (anaerobic), suited for use at larger sites, re-circulate leachate within a landfill to increase the rate of methane generation and the potential for enhanced collection over conventional landfills. However, while bioreactor projects produce more methane in the short-run, they tend to have a steep decline in production after most of the waste has been digested.[96] As cost and GHG benefit information on bioreactors was not available to CCS at the time this document was written, bioreactors were not assumed to be a mitigation technology. The GHG reductions and costs for each strategy/technology will be discussed in the remainder of this section. Note that the implementation of these strategies and technologies are assumed for modeling purposes. This model has been prepared by CCS with input from the TWG and is by no means intended to be strictly prescriptive of the manner in which the goal for AFW-8 may be reached. The level to which each is assumed to be implemented is presented in the Cost-Effectiveness section, below.

[96] For more information on Bioreactors, visit the EPA Bioreactor home page, available at: http://www.epa.gov/garbage/landfill/bioreactors.htm

Table D-8-3. Overall Policy Results—GHG Reduction

Year	CTG GHG Emission Reduction Goal	AFW-8 GHG Benefit: CTG MSW Management Reduction ($MMtCO_2e$)
2009	0%	—
2010	2%	0.21
2011	3%	0.44
2012	5%	0.66
2013	6%	0.90
2014	8%	1.14
2015	9%	1.39
2016	11%	1.65
2017	13%	1.92
2018	14%	2.20
2019	16%	2.48
2020	17%	2.78
2021	19%	3.08
2022	20%	3.40
2023	22%	3.72
2024	23%	4.06
2025	25%	4.40
Total		**34.4**

CTG = cradle to grave; GHG = greenhouse gas; AFW – Agriculture, Forestry, and Waste Management; MSW = municipal solid waste; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

Cost-Effectiveness

As mentioned above, four potential waste management emission reduction strategies are considered for the quantification of this goal. The four strategies are:

1. Additional Active Gas Recovery
2. Route Adjustment
3. Alternative Fuels/Hybrid Technology
4. Microturbines

This list of strategies is not intended to be comprehensive or prescriptive, nor is the timing and rate at which each strategy is applied. This cost quantification represents a rough estimate of the potential cost of implementing this goal. Therefore, the cost-effectiveness of each strategy has also been presented individually. Individually, the implementation of these strategies, are not projected to reach the CTG emission reduction goal of 25 percent. Therefore, these strategies are assumed to be implemented in the order listed above, with the remainder of the emission reduction goal carrying over to the next strategy until the goal has been met.

Additional Active Gas Recovery

One of the goals of AFW-4 was to control 50% of landfill emissions for energy utilization by 2025. It is assumed that all landfill gas (LFG) collection systems currently in place will achieve 75 percent collection efficiency, while LFG collection systems installed as a result of the implementation of AFW-4 will achieve 85 percent efficiency. Through the *Additional Active Gas Recovery* strategy, CCS assumes that all landfills with active gas collection (both currently and under full AFW-4 implementation) will achieve a 90 percent collection efficiency. Emissions will be reduced not only from the additional capture of LFG and the conversion of the methane in the LFG to CO_2, but the additional energy that may be generated through the additional collection. Table 8-4 displays the GHG reduction from *Additional Active Gas Recovery*. This strategy is projected to meet the AFW-8 targets through 2015.

Table D-8-4. GHG reductions from additional active gas recovery

Year	Additional Recovery From AFW-4 LFGTE Goal ($MMtCO_2e$)	Maximum Recovery From BAU Flares and LFGTE ($MMtCO_2e$)	Electricity Generated From Maximum Recovery (MWh)	Electricity Emissions Factor From I&F (tCO_2e/MWh)	GHG Benefit			Remainder of Goal To Be Met ($MMtCO_2e$)
					Avoided Electricity Production ($MMtCO_2e$)	Avoided Natural Gas Combustion for Direct Use ($MMtCO_2e$)	Assumed Benefit From Additional Active Gas Recovery ($MMtCO_2e$)	
2009	0.00	0.00	—	0.59	—	—	—	—
2010	0.00	1.04	80,290	0.59	0.05	0.21	0.21	—
2011	0.00	1.05	81,540	0.59	0.05	0.21	0.43	—
2012	0.00	1.07	82,810	0.59	0.05	0.21	0.66	—
2013	0.00	1.09	84,100	0.60	0.05	0.22	0.90	—
2014	0.00	1.10	85,410	0.60	0.05	0.22	1.14	—
2015	0.00	1.12	86,740	0.59	0.05	0.22	1.39	—
2016	0.02	1.14	89,479	0.59	0.05	0.23	1.44	0.21
2017	0.04	1.16	92,674	0.60	0.06	0.24	1.49	0.43
2018	0.07	1.17	95,947	0.60	0.06	0.25	1.54	0.65
2019	0.09	1.19	99,300	0.61	0.06	0.26	1.60	0.88
2020	0.12	1.21	102,734	0.61	0.06	0.27	1.66	1.12
2021	0.14	1.23	106,250	0.62	0.07	0.27	1.71	1.37
2022	0.17	1.25	109,851	0.63	0.07	0.28	1.77	1.62
2023	0.20	1.27	113,539	0.64	0.07	0.29	1.83	1.88
2024	0.23	1.29	117,315	0.64	0.08	0.30	1.89	2.16
2025	0.45	1.31	136,107	0.64	0.09	0.35	2.20	2.20
Total	**1.5**	18.7	**1,564,086**		**1.0**	**4.0**	**21.9**	**12.5**

The capital cost for *Additional Active Gas Recovery* is estimated to be $400,000 per site.[97] Utilizing information from the FL I&F, CCS determined that this strategy would likely apply to 31 sites. The annualized cost of this capital is $1.8 million per year. The value of the utilized energy is consistent with the value used in AFW-4: $0.045 per kWh and $4.50 per MMBtu of direct energy. Table 8-5 displays the total annualized cost quantification. The cost-effectivness of this strategy is estimated to be a savings of -$1/t$CO_2$e.

Table D-8-5. Cost-effectiveness of additional active gas collection

Year	GHG Benefit From Additional Active Gas Recovery (MMtCO_2e)	Annualized Capital Cost ($MM)	Cost Savings Electricity ($MM)	Cost Savings Direct Use ($MM)	Net Program Cost ($MM)	Discounted Cost ($MM)	Cost Effectiveness ($/t$CO_2$e)
2009	—	$0.0	$0.0	$0.0	$0.0	$0.0	
2010	0.21	$1.8	$0.6	$0.2	$1.0	$1.0	
2011	0.43	$1.8	$1.2	$0.4	$0.2	$0.2	
2012	0.66	$1.8	$1.9	$0.7	–$0.7	–$0.6	
2013	0.90	$1.8	$2.5	$0.9	–$1.6	–$1.3	
2014	1.14	$1.8	$3.2	$1.1	–$2.5	–$1.9	
2015	1.39	$1.8	$3.9	$1.4	–$3.4	–$2.6	
2016	1.44	$1.8	$4.0	$1.4	–$3.6	–$2.6	
2017	1.49	$1.8	$4.2	$1.5	–$3.8	–$2.6	
2018	1.54	$1.8	$4.3	$1.5	–$4.0	–$2.6	
2019	1.60	$1.8	$4.5	$1.6	–$4.2	–$2.6	
2020	1.66	$1.8	$4.6	$1.7	–$4.4	–$2.6	
2021	1.71	$1.8	$4.8	$1.7	–$4.6	–$2.6	
2022	1.77	$1.8	$4.9	$1.8	–$4.9	–$2.6	
2023	1.83	$1.8	$5.1	$1.8	–$5.1	–$2.6	
2024	1.89	$1.8	$5.3	$1.9	–$5.3	–$2.6	
2025	2.20	$1.8	$6.1	$2.2	–$6.5	–$3.0	
Total	**21.9**	**$30**	**$61**	**$22**	**–$53**	**–$31**	**–$1**

Route Adjustment

CCS estimated that a reasonable target for fuel consumption reduction through collection route adjustment would be 15 percent. This reduction potential is inferred from an EPA publication that outlines route adjustment successes from the 1990's.[98] Table 8-6 shows the projected

[97] J. Ketchum, Waste Management, personal communication with S. Roe, CCS, December 5, 2007. This is the midpoint of a range of estimated costs of $300,000–$500,000 per site.

[98] U.S. EPA. 1999. "Collection Efficiency Strategies for Success." Report No. EPA 530-K-99-007. Retrieved on August 15, 2008 from: http://www.epa.gov/garbage/coll-eff/k99007.pdf.

emission reduction from *Route Adjustment*. Note that this strategy is assumed to not be implemented beyond the remaining CTG GHG emission reductions necessary to reach the annual targets.

Table D-8-6. GHG Benefits from Route Adjustment

Year	CTG GHG Emissions Reductions Remaining ($MMtCO_2e$)	MSW Collection Emissions ($MMtCO_2e$)	Maximum GHG Benefit From Route Adjustment ($MMtCO_2e$)	Assumed GHG Benefit From Route Adjustment ($MMtCO_2e$)	GHG Emissions Reductions Remaining After Route Adjustment ($MMtCO_2e$)
2009	—	0.39	0.06	—	—
2010	—	0.41	0.06	—	—
2011	—	0.43	0.06	—	—
2012	—	0.45	0.07	—	—
2013	—	0.48	0.07	—	—
2014	—	0.50	0.08	—	—
2015	—	0.53	0.08	—	—
2016	0.21	0.56	0.08	0.08	0.13
2017	0.43	0.59	0.09	0.09	0.34
2018	0.65	0.62	0.09	0.09	0.56
2019	0.88	0.65	0.10	0.10	0.78
2020	1.12	0.69	0.10	0.10	1.02
2021	1.37	0.72	0.11	0.11	1.26
2022	1.62	0.76	0.11	0.11	1.51
2023	1.88	0.80	0.12	0.12	1.76
2024	2.16	0.84	0.13	0.13	2.03
2025	2.20	0.89	0.13	0.13	2.07
Total	**12.5**	**10.3**	**1.5**	**1.1**	**11.4**

Another EPA publication cited the start-up costs for a route-optimization program in Charlotte, NC to be $75,000.[99] The population of Charlotte, North Carolina, in 2008 was estimated to be 540,828.[100] Averaging this cost out across the 2008 projected population of Florida and annualizing the cost over the policy period yields an average annual cost of $400,000. The annual fuel savings is determined by using the life cycle diesel emission factor to determine the fuel savings from the GHG benefit of this strategy, then multiplying this fuel savings by the estimated diesel fuel cost. This cost is assumed to be $4.00/gallon[101] This cost is intentionally

[99]US EPA. 1999. "Getting More for Less: Improving Collection Efficiency." Report No. 530-R-99-038. Retrieved on August 23, 2008 from: http://www.epa.gov/epaoswer/non-hw/muncpl/coll-eff/r99038.pdf

[100] City-data.com, Charlotte, North Carolina. Retrieved on August 23, 2008 from: http://www.city-data.com/city/Charlotte-North-Carolina.html

[101] AAA. Daily Fuel Gauge Report. Updated on August 23, 2008. Retrieved August 23, 2008 from: http://www.fuelgaugereport.com/FLavg.asp

conservatively low to prevent overstating the cost savings. Table 8-7 portrays the cost-effectiveness of this recommendation, which is estimated to be a savings of –\$199/tCO_2e.

Table D-8-7. Cost-effectiveness of route adjustment

Year	Assumed GHG Benefit from GPS/Route Adjustment ($MMtCO_2e$)	Annualized Cost for Route Adjustment (\$MM)	Fuel cost Savings (\$MM)	Net Program Cost (\$MM)	Discounted Cost (\$MM)	Cost Effectiveness (\$/tCO_2e)
2009	—	\$0.0	\$0.0	\$0.0	\$0.0	
2010	—	\$0.0	\$0.0	\$0.0	\$0.0	
2011	—	\$0.0	\$0.0	\$0.0	\$0.0	
2012	—	\$0.0	\$0.0	\$0.0	\$0.0	
2013	—	\$0.0	\$0.0	\$0.0	\$0.0	
2014	—	\$0.0	\$0.0	\$0.0	\$0.0	
2015	—	\$0.0	\$0.0	\$0.0	\$0.0	
2016	0.08	\$0.4	\$29.8	–\$29.4	–\$20.9	
2017	0.09	\$0.4	\$31.4	–\$31.0	–\$21.0	
2018	0.09	\$0.4	\$33.0	–\$32.6	–\$21.0	
2019	0.10	\$0.4	\$34.8	–\$34.4	–\$21.1	
2020	0.10	\$0.4	\$36.6	–\$36.2	–\$21.2	
2021	0.11	\$0.4	\$38.5	–\$38.1	–\$21.2	
2022	0.11	\$0.4	\$40.5	–\$40.2	–\$21.3	
2023	0.12	\$0.4	\$42.7	–\$42.3	–\$21.4	
2024	0.13	\$0.4	\$44.9	–\$44.5	–\$21.4	
2025	0.13	\$0.4	\$47.3	–\$46.9	–\$21.5	
Total	**1.07**	**\$3.9**	**\$379**	**–\$376**	**–\$212**	**–\$199**

GHG = greenhouse gas; GPS = global positioning system; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; \$MM = million dollars; \$/tCO_2e = dollars per metric ton of carbon dioxide equivalent.

Alternative Fuels/Hybrid Technology

The two elements to this strategy are to turn over the existing fleet of garbage trucks to hybrid trucks and utilize B20 biodiesel fuel, which can be substituted for diesel without engine upgrades.[102] The fleet is expected to turnover at 20 percent per year until all trucks are hybrids.[103] The fuel savings for hybrid vehicles is assumed to be 40 percent. The lower emission

[102] A barrier to the adoption of B20 on a widespread basis is that manufacturers may not honor warranties on traditional diesel engines burning B20.

[103] Institute for Local Self-Reliance. 1996. "The Five Most Dangerous Myths About Recycling." Retrieved on August 23, 2008, from: http://www.grn.com/library/5myths.htm.

reduction from Hybrid trucks in the years 2015 through 2020 shown in Table 8-8 are indicative of the time it takes for the fleet to turn over.

The emission savings realized by the switch to hybrid trucks was subtracted from the total liquid fuel emissions in each year. From this result, the 17.6 percent GHG benefit realized from the switch to B20 is applied to yield the GHG benefit from the *Alternative Fuels/Hybrid Technology* strategy. The B20 emission benefit is adjusted for the differences in heat content between biodiesel and fossil diesel. The diesel heat content is 0.139 MMBtu/gallon and the biodiesel heat content is 0.129 MMBtu/gallon.[104] The B20 life cycle emission factor (9,133 tCO2e/MMgal) is based on the soy biodiesel life cycle emission factor (667 tCO_2e/MMgal) and the low-sulfur diesel life cycle emission factor (11,250 tCO_2e/MMgal) used in AFW-7. The GHG benefit from this strategy is shown in Table 8-8.

Table D-8-8. GHG Benefit from Alternative Fuels/Hybrid Technology

Year	GHG Emissions Reductions Remaining ($MMtCO_2e$)	Emissions from Transpor-tation ($MMtCO_2e$)	Emissions from Heavy Equipment ($MMtCO_2e$)	Total Liquid Fuel Emissions ($MMtCO_2e$)	Assumed GHG Benefit from Hybrid Trucks ($MMtCO_2e$)	Total Liquid Fuel Emissions after Hybrids ($MMtCO_2e$)	Assumed GHG Benefit from B20 Substitu-tion ($MMtCO_2e$)	CTG GHG Emissions Reductions Remaining after Alternative Fuels/ Hybrids ($MMtCO_2e$)
2009	—	0.50	0.13	0.63	—	0.63	—	—
2010	—	0.53	0.13	0.67	—	0.67	—	—
2011	—	0.56	0.14	0.70	—	0.70	—	—
2012	—	0.59	0.15	0.74	—	0.74	—	—
2013	—	0.62	0.16	0.78	—	0.78	—	—
2014	—	0.65	0.17	0.82	—	0.82	—	—
2015	—	0.69	0.18	0.86	—	0.86	—	—
2016	0.13	0.64	0.19	0.83	0.05	0.78	0.08	—
2017	0.34	0.67	0.20	0.87	0.05	0.82	0.14	0.14
2018	0.56	0.71	0.21	0.92	0.06	0.86	0.15	0.35
2019	0.78	0.74	0.22	0.97	0.06	0.91	0.16	0.56
2020	1.02	0.78	0.24	1.02	0.06	0.96	0.17	0.79
2021	1.26	0.82	0.25	1.07	0.33	0.74	0.13	0.80
2022	1.51	0.87	0.26	1.13	0.35	0.78	0.14	1.02
2023	1.76	0.91	0.28	1.19	0.37	0.83	0.15	1.25
2024	2.03	0.96	0.29	1.26	0.38	0.87	0.15	1.49
2025	2.07	1.01	0.31	1.32	0.41	0.92	0.16	1.50
Total	**11.5**	**12.2**	**3.5**	**15.8**	**2.1**	**13.7**	**1.4**	**7.9**

[104] US DOE EIA. 2007. "Biofuels in the U.S. Transportation Sector." Retrieved on August 23, 2008, from: http://www.eia.doe.gov/oiaf/analysispaper/biomass.html

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; B20 = a blend of diesel fuel with 20% biodiesel by volume; CTG = cradle to grave.

The Vehicle Inventory and Use Survey states that there were 4,000 garbage trucks in FL in 2002.[105] Based on this figure, there were 86.5 tCO_2e/truck/year in 2002, meaning that for each hybrid truck substituted for a conventional truck, 34.6 tCO_2e/year are avoided. CCS divided the total benefit from hybrid substitution by the 34.6tCO_2e benefit to yield the total number of hybrid trucks needed to achieve that benefit. The number of trucks purchased in each year is multiplied by the assumed $160,000 cost premium.[106] The cost of these trucks are annualized over the remainder of the policy period. It is assumed that once the fleet has turned over to hybrid technology, there is no incremental cost for hybrid garbage trucks.

The B20 cost premium is estimated to be $0.20/gallon.[107] The number of gallons needed was found by dividing the total GHG benefit by the B20 life cycle emission factor of 9,133 tCO_2e/MMgal. The resulting estimated cost-effectiveness of this strategy is $128/$tCO_2e$ (Table 8-9).

[105] U.S. Census Bureau. 2004. "2002 Economic Census: Vehicle Inventory and Use Survey, Geographic Area Series. Florida." Retrieved on August 15, 2008, from: http://www.census.gov/prod/ec02/ec02tv-fl.pdf

[106] Boyles, D. 2008. "Fresno's New Trash Truck a Treasure." *The Fresno Bee*, Friday, May 16, 2008, retrieved on August 23, 2008, from: http://www.valleyair.org/recent_news/News_Clippings/2008/In%20The%20News%2005-16-08.pdf

[107] Noon, J. (n.d.) "Sarasota County Biodiesel Program Recommendations for Phase 1 and 2." *Green Fleet Stakeholder Group, Sustainable Sarasota.* Retrieved on August 23, 2008, from: www.sustainablesarasota.com/ssDocuments/6/SarasotaCountyBiodieselProgam.doc

Table D-8-9. Cost-effectiveness of alternative fuels/hybrid technology

Year	GHG Benefit from Hybrid Trucks ($MMtCO_2e$)	GHG Benefit from B20 Substitution ($MMtCO_2e$)	Annualized Hybrid Vehicle Cost ($MM)	Fuel Savings from Hybrid Vehicles ($MM)	B20 Fuel Premium ($MM)	Hybrid Net Program Cost ($MM)	B20 Net Program Cost ($MM)	Total Net Program Cost ($MM)	Discounted Cost ($MM)	Cost-Effectiveness ($/$tCO_2e$)
2009	—	—	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
2010	—	—	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
2011	—	—	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
2012	—	—	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
2013	—	—	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
2014	—	—	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
2015	—	—	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
2016	0.05	0.08	$35.2	$18.1	$7.3	$17.0	$7.3	$24.3	$12.1	
2017	0.05	0.14	$72.2	$19.1	$13.6	$53.1	$13.6	$66.7	$35.9	
2018	0.06	0.15	$111	$20.1	$14.3	$91.0	$14.3	$105	$58.7	
2019	0.06	0.16	$152	$21.2	$15.1	$131	$15.1	$146	$80.4	
2020	0.06	0.17	$195	$22.3	$15.9	$173	$15.9	$189	$101	
2021	0.33	0.13	$195	$117	$12.4	$78.1	$12.4	$90.4	$43.5	
2022	0.35	0.14	$195	$124	$13.0	$71.9	$13.0	$84.9	$38.1	
2023	0.37	0.15	$195	$130	$13.8	$65.4	$13.8	$79.1	$33.0	
2024	0.38	0.15	$195	$137	$14.5	$58.5	$14.5	$73.0	$28.1	
2025	0.41	0.16	$195	$144	$15.3	$51.3	$15.3	$66.5	$23.5	
Total	**2.1**	**1.4**	**$1,543**	**$753**	**$135**	**$790**	**$135**	**$925**	**$455**	**$128**

Microturbines

CCS assumed that microturbines (small engines capable of economically producing electricity at smaller sites) would make up the remainder of the CTG emission reduction goal set forth in this recommendation [note that other landfill gas utilization methods are also potentially applicable here including direct use and small engine/generator sets that would achieve GHG reductions at lower cost. CCS selected microturbines as the energy utilization technology to provide a more conservative (high) estimate of potential costs]. CCS consulted the FL I&F to ensure that there was sufficient landfill gas that was not already controlled or projected to be controlled under AFW-4. This was accomplished by taking the difference of the projected uncontrolled landfill emissions for each year and the uncontrolled landfill emissions assumed to be captured in the future as a result of the implementation of AFW-4. Table 8-10 displays the assumed GHG benefit from the adoption of microturbines.

Table D-8-10. GHG Benefit from Application of Microturbines

Year	GHG Emissions Reductions Remaining ($MMtCO_2e$)	GHG Emissions From Uncontrolled Landfills ($MMtCO_2e$)	GHG Benefit from Microturbines ($MMtCO_2e$)
2009	—	5.41	—
2010	—	5.50	—
2011	—	5.58	—
2012	—	5.67	—
2013	—	5.76	—
2014	—	5.85	—
2015	—	5.94	—
2016	—	6.03	—
2017	0.14	5.77	0.14
2018	0.35	5.39	0.35
2019	0.56	5.00	0.56
2020	0.79	4.60	0.79
2021	0.80	4.18	0.80
2022	1.02	3.75	1.02
2023	1.25	3.31	1.25
2024	1.49	2.85	1.49
2025	1.50	2.38	1.50
Total	**7.9**	**83**	**7.9**

The cost of the *microturbine* strategy was estimated with the LFGCost model.[108] The model predicts a cost effectiveness of $1.31/tCO2e, assuming an electricity value of $0.045/tCO2e. This

[108] U.S. EPA, Landfill Methane Outreach Program. Landfill Gas Energy Cost Model (LFGcost), Version 1.4. Model run performed by B. Strode on August 23, 2008. For more information on LFGcost, visit http://www.epa.gov/lmop/res/index.htm.

factor was applied to the GHG benefit from microturbines. Once discounted, the net present value of the cost of this recommendation is estimated to have a $5 million through 2025 for a cost-effectiveness of $0.7/t$CO_2$e (Table 8-11).

Table D-8-11. Cost-effectiveness for microturbines

Year	GHG Benefit from Microturbines ($MMtCO_2e$)	Net Program Cost ($MM)	Discounted Cost ($MM)	Cost-Effectiveness ($/t$CO_2$e)
2009	—	$0.0	$0.0	
2010	—	$0.0	$0.0	
2011	—	$0.0	$0.0	
2012	—	$0.0	$0.0	
2013	—	$0.0	$0.0	
2014	—	$0.0	$0.0	
2015	—	$0.0	$0.0	
2016	—	$0.0	$0.0	
2017	0.14	$0.2	$0.1	
2018	0.35	$0.5	$0.3	
2019	0.56	$0.7	$0.5	
2020	0.79	$1.0	$0.6	
2021	0.80	$1.0	$0.6	
2022	1.02	$1.3	$0.7	
2023	1.25	$1.6	$0.8	
2024	1.49	$1.9	$0.9	
2025	1.50	$2.0	$0.9	
Total	**7.9**	**$10**	**$5**	**$0.7**

Table 8-12 displays the overall cost-effectiveness estimate for AFW-8. The estimated NPV is $294 million, for a cost-effectiveness of $8.5 million.

Table D-8-12. Overall Policy Results

Year	GHG Benefit: CTG MSW Management Reduction ($MMtCO_2e$)	Net Program Cost ($MM)	Discounted Cost ($MM)	Cost-Effectiveness ($/t$CO_2e$)
2009	—	$0.0	$0.0	
2010	0.21	$1.0	$1.0	
2011	0.43	$0.2	$0.2	
2012	0.66	–$0.7	–$0.6	
2013	0.90	–$1.6	–$1.3	
2014	1.14	–$2.5	–$1.9	
2015	1.39	–$3.4	–$2.6	
2016	1.65	–$8.7	–$6.2	
2017	1.92	$32.1	$21.7	
2018	2.20	$69.2	$44.6	
2019	2.48	$108.3	$66.5	
2020	2.77	$149.4	$87.4	
2021	3.08	$48.7	$27.1	
2022	3.39	$41.2	$21.9	
2023	3.72	$33.4	$16.9	
2024	4.05	$25.1	$12.1	
2025	4.40	$15.1	$6.9	
Total	**34**	**$507**	**$294**	**$8.5**

GHG = greenhouse gas; CTG = cradle to grave; MSW = municipal solid waste; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $MM = million dollars; $/t$CO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Key Assumptions: See text above. A key assumption affecting quantification is the timing of the implementation of the four strategies to meet this goal. Other strategies may be used to meet the goal that may have different cost implications.

Key Uncertainties

The strategies assumed to be implemented to meet the goal of AFW-8 may or may not be the most cost-effective CTG emission reduction strategies. Therefore, as this is recommendation requires a suite of mitigation strategies, regulation (if included as an implementation mechanism) and market forces would dictate the actual manner in which this goal would be implemented.

A plausible technology that may be implemented to decrease net emissions from CTG waste management would be bioreactors at landfill sites. Bioreactors (anaerobic) re-circulate leachate within a landfill to increase the rate of methane generation and the potential for enhanced collection over conventional landfills. However, while bioreactor projects produce more methane in the short-run, they tend to have a steep decline in production after most of the waste has been digested.[109]

Additional Benefits, Costs, and Energy Security Fuel Savings

See additional costs and benefits of waste-to-energy listed under AFW-4.

Total fossil fuel displaced during the policy period is 190,000 million short tons coal **or** 4,000 cubic feet natural gas. 109 million gallons of diesel fuel also displaced.

Feasibility Issues

None identified.

Status of Group Approval

Complete.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

[109] For more information on Bioreactors, visit the EPA Bioreactor home page at: http://www.epa.gov/garbage/landfill/bioreactors.htm

AFW-9. Improved Commercialization of Biomass to Energy Conversion and Bio-Products Technologies

Policy Description

Improved commercialization of biomass to energy conversion and bio-products technologies in this recommendation include the following four elements:

- Manure digestion/other waste energy utilization,
- Wastewater treatment plant (WWTP) biosolids energy production,
- Other biomass conversion technologies, and
- Bio-products technologies and use.

The CH_4 emissions inherent from the anaerobic decomposition process of manure and other wastes may be captured and used as an energy source. In so doing, it is possible to both reduce CH_4 emissions and to offset fossil-based energy. However, the cost of emission capture and energy production may be higher than the value of the energy collected, making this recommendation cost prohibitive for producers operating in a tight margin business. This recommendation covers programs to increase the number of CH_4 capture and energy recovery projects using manure or other waste. CH_4 digesters could be on-farm or a regional-type digester could be employed.

Develop and implement methods for WWTP biosolids processing and use as a renewable energy and nutrient source, including but not limited to, co-firing with other fuels in existing or new combustion units for the purpose of generating electricity, heat, or steam, and application of WWTP biosolids to agricultural soils.

Improve the rate of technology development and market deployment of biomass and MSW conversion technologies, including biomass gasification combined cycle (BGCC) electricity generation, pyrolysis, and plasma arc technologies.

Increase the amount of renewable products and chemicals produced and used (including building materials that reduce GHG emissions) over conventional petroleum-based products. Promote the use of crop residues and MSW as a source of material for reuse (e.g., in building materials, packaging, or other materials).

Policy Design

Goals:

- A. Utilize 20 percent of available CH_4 from livestock manure for energy production by 2025.[110]
- B. Maintain the current level of available WWTP solids used for soil application. Explore potential for WWTP bio-solids and other organic wastes[111] as feedstock for energy or fertilizer production. Utilize 50 percent of available biomass and MSW as energy sources (after accounting for biomass needs under AFW-4 and AFW-7) by 2025.[112] Develop emerging technologies, including BGCC, pyrolysis, and plasma arc, for more efficiency by 2025.
- C. Annually produce and utilize 150,000 tons of bio-based products by 2025.

Timing: See above.

Parties Involved: Livestock producers, FFB, Sunbelt Milk Producers, Florida Cattlemen's Association (FCA), Florida Electric Cooperatives Association (FECA), UF IFAS, FDACS, DEP, and USDA-NRCS, food processors, other livestock organizations (for example, FL Thoroughbred Breeders & Owners Association).

Other: It should be noted that CH_4 digesters are a proven technology, but Florida does present some specific challenges. Also any digester that would be constructed must ultimately be managed, which could cause an additional burden on livestock producers without the proper assistance.

A range of renewable products can be developed from these biomass conversion processes, including gaseous and liquid fuels, biochar, chemical products, and CH_4 to methanol. Existing processes include waste combustion and energy recovery (as electricity, steam, or both) or ethanol plants using co-products for heating and drying, rather than relying on outside energy sources.

Improve the utilization and development of bio-products for insulation and packaging material. Significant increase of bio-product technology is to be made available by 2017 for commercial, industrial and residential use.

Increased development of emerging technologies will ultimately increase commercialization of such technologies.

[110] The quantification of benefits and costs for this option also assessed a goal of 50% utilization (see Quantification Methods section).
[111] Other organic wastes could include manure from beef cattle feedlots, horse operations (e.g. race tracks), food processing facilities, etc.
[112] An analysis of this aspect of the policy element was not performed, since AFW-4 and AFW-7 were estimated to use a significant fraction of the State's available biomass resources; however, the overall policy element was approved as a non-quantified recommendation.

Implementation Mechanisms

Cap-and-Trade—This recommendation has links to Cap-and-Trade policy recommendations of the Action Team Process. A Cap-and-Trade program may provide incentives for adoption of improved organic waste management provided that appropriate offset programs are developed as part of the program.

Research and Development programs are needed to identify centralized approaches for management of the organic wastes covered by this recommendation, as well as specific waste feedstocks. These centralized approaches can assure that sufficient economies of scale are achieved to make digester or gasification projects economically sustainable. For gasification projects, a variety of waste feedstocks are often needed in order to attain and maintain moisture content into the gasifier.

Ensure biosolids application is safe and avoid watershed areas.

Educate public and local jurisdictions on potential utilization of WWTP biosolids.

Related Policies/Programs in Place

E.O. 07-127 RPS request may create additional demand for methane digesters; further recent rulemaking by the PSC would enable net-metering for up to two megawatts (MW) in capacity and standard interconnection for all distributed renewables, thus furthering the likelihood of this technology.

Type(s) of GHG Reductions

CH_4: methane is captured and typically combusted in an energy recovery system or flared. Small amounts of N_2O and CO_2 are emitted from the combustion process.

CO_2: carbon dioxide is reduced when the methane is converted to energy and that energy is used to offset fossil-based energy (e.g., coal-fired electricity, natural gas, etc.). Small amounts of N_2O and CH_4 are also reduced from the fossil-based energy that is offset.

Also, displacement of coal, natural gas, and other fossil fuels reduces emissions of fossil carbon. Increased energy efficiency decreases the amount of carbon emitted per unit of economic productivity. On-farm capture or production of renewable energy reduces the need for consumption of fossil energy, and displaces the associated fossil carbon emissions. Carbon is sequestered in bioproducts. If these products later biodegrade, the carbon is from renewable sources, so there is no net increase in atmospheric CO_2.

Estimated GHG Reductions and Net Costs or Cost Savings

- Estimated GHG reductions:
  - A. Manure Digesters: 0.04 and 0.09 $MMtCO_2e$ in 2017 and 2025, respectively.

- B. Additional Biomass Energy and WWTP Solids: 2.4 and 5.0 $MMtCO_2e$ in 2017 and 2025, respectively.
- C. Bio-products: 0.15 and 0.31 $MMtCO_2e$ in 2017 and 2025, respectively.

- Estimated cost-effectiveness:
  - A. Manure Digesters : -$17/$tCO_2e$.
  - B. Additional Biomass Energy and WWTP Solids: $44/$tCO_2e$.
  - C. Bio-products: -$61/$tCO_2e$.

Data Sources:

Beddoes, Bracmort, Burns, and Lazarus. 2007. *An Analysis of Energy Production Costs from Anaerobic Digestion Systems on U.S. Livestock Production Facilities*, NRCS, Technical Note No. 1, October 2007.

Additional data sources are cited in the quantification methodology below.

Quantification Methods:

A. Manure Digesters

The quantification of the manure digester goal was limited to the control of methane/manure from dairy and poultry farms, as information developed for the Florida I & F showed these farms to account for 88 percent of livestock manure emissions in 2025. As electricity generation at dairy and poultry farms is executed through a different mechanism, the components will be quantified separately.

GHG Benefits from Dairy Manure

Methane emissions (in $MMtCO_2e$) data from the Florida Agriculture Inventory and Forecast was used as the starting point to estimate the GHG benefits of capturing and controlling the volumes of methane targeted by the policy. The available methane was also used to calculate the additional benefit of electricity generation using this captured methane (through offsetting fossil-based generation). The first portion of GHG benefit was obtained through reduced methane emissions through the capture of emissions from manure. An assumed collection efficiency of 75 percent[113] was applied to methane emissions from animal manure which was then multiplied by the assumed policy target ramping up to achieve 20 percent collection by 2025.

The second portion of the GHG benefit is through the offsetting of fossil-based electricity generation. This was estimated by converting the captured methane in each year to its heat content (in Btu) and then multiplying by an energy recovery factor of 17,100 Btu/kWh to estimate the electricity produced (assumes a 25 percent efficiency for conversion to electricity in

[113] The collection efficiency is an assumed value based on engineering judgment. No applicable studies were identified that provided information on methane collection efficiencies achieved using manure digesters (as it relates to collection of entire farm-level emissions).

an engine and generator set). The CO_2e associated with this amount of electricity in each year was estimated by multiplying the megawatt hours (MWh) by the Florida-specific emission factor for electricity production from GHG Inventory and Forecast.

The total GHG benefit was estimated as the sum of both portions of the benefit described above and indicated in Table 9-1.

Costs for Dairy Manure

The costs for this component were estimated using an analysis by Natural Resources Conservation Service (NRCS), *An Analysis of Energy Production Costs from Anaerobic Digestion Systems on U.S. Livestock Production Facilities.*[114] The electricity production costs were assumed to be $0.05 for dairy anaerobic digesters.[115] The electricity production cost includes capital expenses for the digester and generator. [116] The O&M cost for dairy farms is stated in the aforementioned report to be $3.82 per 1000 kWh, or $0.00382/kWh. These costs are in 2006 dollars and assume a 30 percent thermal efficiency. The value of electricity produced was assumed to be equal to the rate received by producers from the utilities. In many cases this is lower than the retail rate. CCS used the same default rate of $0.045/kWh as used in AFW-4 (LFGTE). This price is assumed to escalate at a rate of two percent per year. This price represents the value to the farmer for the electricity produced (as an offset of on-farm use) and is netted out from the production costs to estimate net costs.

[114] Beddoes, Bracmort, Burns and Lazarus. 2007. *An Analysis of Energy Production Costs From Anaerobic Digestion Systems on U.S. Livestock Production Facilities*, NRCS, Technical Note No. 1, October 2007.

[115] It was assumed that the technology employed for dairy anaerobic digesters was covered anaerobic lagoon. Cost were obtained from table 1 of the NRCS paper sited above.

[116] The economic analysis conducted for this publication does not include feedstock and digester effluent transportation costs. The technical note does not address the economics of centralized digesters where biomass is collected from several farms and then processed in a single unit.

Table D-9-1. GHG benefits from dairy manure digestion

Year	Methane Emissions From Dairy ($MMtCO_2e$)	Policy Utilization Objective (%)	Methane Captured and Utilized ($MMtCO_2e$)	$MMtCH_4$	CH_4 (million Btu)	CO_2e Offset as Electricity (tCO_2e)	Total Emission Reductions ($MMtCO_2e$)
2009	0.30	0	0.000	0.000	—	—	––
2010	0.30	1	0.003	0.000	6,532	224	0.003
2011	0.29	2	0.005	0.000	12,809	436	0.006
2012	0.28	4	0.008	0.000	18,837	649	0.008
2013	0.28	5	0.010	0.000	24,625	850	0.011
2014	0.27	6	0.012	0.001	30,179	1,040	0.013
2015	0.27	7	0.014	0.001	35,507	1,204	0.015
2016	0.26	8	0.016	0.001	40,615	1,369	0.018
2017	0.26	9	0.018	0.001	45,510	1,550	0.020
2018	0.25	11	0.020	0.001	50,197	1,700	0.022
2019	0.25	12	0.022	0.001	54,684	1,866	0.024
2020	0.24	13	0.024	0.001	58,976	2,017	0.026
2021	0.24	14	0.025	0.001	63,080	2,178	0.027
2022	0.23	15	0.027	0.001	67,000	2,335	0.029
2023	0.23	16	0.028	0.001	70,743	2,479	0.031
2024	0.22	18	0.030	0.001	74,314	2,613	0.032
2025	0.22	20	0.033	0.002	82,576	2,887	0.036
Total			**0.29**	**0.014**	**736,186**	**25,398**	**0.32**

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $MMtCH_4$ = million metric tons of methane; Btu = British thermal unit.

Table D-9-2. Cost-effectiveness of dairy manure digestion

Year	Policy Utilization Objective (%)	Total Emission Reductions ($MMtCO_2e$)	Production Costs (Dairy)	Cost Savings From Electricity	Net Costs	Discounted Costs ($2006)
2009	0	—	$0	$0	$0	$0
2010	1	0.003	$20,559	–$17,884	$2,675	$2,547
2011	2	0.006	$40,313	–$35,770	$4,543	$4,121
2012	4	0.008	$59,287	–$53,658	$5,630	$4,863
2013	5	0.011	$77,504	–$71,548	$5,957	$4,901
2014	6	0.013	$94,986	–$89,439	$5,546	$4,346
2015	7	0.015	$111,754	–$107,333	$4,421	$3,299
2016	8	0.018	$127,831	–$125,229	$2,602	$1,849
2017	9	0.020	$143,236	–$143,127	$109	$74
2018	11	0.022	$157,989	–$161,027	–$3,038	–$1,958
2019	12	0.024	$172,111	–$178,929	–$6,817	–$4,185
2020	13	0.026	$185,620	–$196,832	–$11,212	–$6,555
2021	14	0.027	$198,535	–$214,738	–$16,203	–$9,022
2022	15	0.029	$210,875	–$232,646	–$21,771	–$11,546
2023	16	0.031	$222,655	–$250,556	–$27,900	–$14,092
2024	18	0.032	$233,895	–$268,468	–$34,573	–$16,630
2025	20	0.036	$259,897	–$304,280	–$44,383	–$20,332
Total		**0.32**	**$2,317,047**	**–$2,451,462**	**–$134,415**	**–$58,322**

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

GHG Benefits from Poultry Litter

For the poultry litter component, it was assumed that the use of poultry litter for energy production at larger sites would occur through a combination of gasification and direct combustion. The amount of available litter was taken from Flora and Riahi-Nezhad (2006).[117] The amount of poultry litter utilized is illustrated in Table 9-3 and expressed in MMBtu.

The assumed energy content of poultry litter is 4,600 Btu/lb, and the assumed heat rate is 18,000 Btu/kWh.[118] A capacity factor of 85% was assumed to approximate the installed electrical capacity required at large facilities.

[117] Flora, J.R.V. and C. Riahi-Nezhad. *Availability of Poultry Manure as a Potential Bio-Fuel Feedstock for Energy Production: Final Report*. Columbia, SC: University of South Carolina, Department of Civil and Environmental Engineering, August 31, 2006. Available at: http://www.scbiomass.org/Publications/Poultry Litter Final Report.pdf

[118] Ibid.

It was assumed that the energy produced would be offsetting emissions that would have otherwise been generated from traditional sources. The emission factor for electricity in Florida is consistent with the FL I&F. The resulting GHG emission savings is represented in Table 9-3.

Table D-9-3. GHG benefits from poultry litter

Year	Policy Utilization Objective	Poultry Litter/ Energy Utilized (MMBtu)	Approximate Electricity Generated (MWh)	Methane Reduced/ Utilized Under Policy ($MMtCO_2e$)	Electricity Emissions Offset ($MMtCO_2e$)	Total Emission Reductions ($MMtCO_2e$)
2009	0%	0	—	0.000	—	0.000
2010	1%	58,184	227	0.003	0.000	0.003
2011	3%	116,368	463	0.006	0.000	0.006
2012	4%	174,552	709	0.009	0.000	0.009
2013	5%	232,735	964	0.012	0.001	0.012
2014	6%	290,919	1,229	0.015	0.001	0.016
2015	8%	349,103	1,504	0.018	0.001	0.019
2016	9%	407,287	1,790	0.021	0.001	0.022
2017	10%	465,471	2,086	0.024	0.001	0.025
2018	11%	523,655	2,394	0.027	0.001	0.028
2019	13%	581,838	2,713	0.030	0.002	0.032
2020	14%	640,022	3,044	0.033	0.002	0.035
2021	15%	698,206	3,387	0.036	0.002	0.038
2022	16%	756,390	3,743	0.039	0.002	0.042
2023	18%	814,574	4,111	0.043	0.003	0.045
2024	19%	872,758	4,493	0.046	0.003	0.049
2025	20%	930,942	4,888	0.049	0.003	0.052
Total				**0.41**	**0.023**	**0.43**

MMBtu = million British thermal units; MWh = megawatt-hours; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

Costs for Poultry Litter

The cost of production of poultry litter as a feedstock was assumed to be $38/ton (or $4.08/MMBtu, assuming 4,600 Btu/lb). This was based on an average between gasification and combustion provided in Flora and Riahi-Nezhad (2006), which provided a value of poultry litter as a co-firing feedstock and a gasification feedstock.

The assumed incremental capital costs are based on the capital costs associated with the biomass component of a coal/biomass (poultry litter) co-fired plant. A capital cost of $100/kW was assumed, based on a pulverized coal plant co-fired with three percent biomass.[119] While use

[119] In Table 3 of U.S. DOE, EERE, Federal Energy Management Program. *Biomass Co-firing in Coal-Fired Boilers*, DOE/EE-0288. June, 1, 2004. Available at: http://www.nrel.gov/docs/fy04osti/33811.pdf

of poultry litter may be pursued through other technology types (for example, gasification, anaerobic digestion) or other end uses (for example, heat or steam), the capital costs of co-firing were used to provide an estimate of possible capital costs required to enable the utilization of biomass.[120] The life of the loan was assumed to be 15 years (covering the policy period for this goal), and the interest rate was assumed to be five percent, giving a capital recovery factor of 0.096. For the purposes of this analysis, it is assumed that plants utilizing poultry litter do not require additional O&M costs (e.g., no additional emission control measures and ash disposal required).

The net cost of production was estimated by subtracting the price of electricity from the cost of production, illustrated in Table 9-4. The levelized cost-effectiveness is a savings of -\$25/tCO_2e.

Table D-9-4. Costs/savings of poultry litter

Year	Poultry Litter Annualized Capital Costs Cost/Savings (2005\$)	Poultry Litter Cost/Savings, Including Annualized Capital Costs and Fuel Costs (2005\$)	Discounted Cost/Savings (2005\$)
2009	\$0	\$0	\$0
2010	\$6,274	–\$114,482	–\$89,700
2011	\$12,547	–\$238,044	–\$177,632
2012	\$18,821	–\$370,959	–\$263,633
2013	\$25,094	–\$513,506	–\$347,561
2014	\$31,368	–\$665,972	–\$429,291
2015	\$37,641	–\$828,652	–\$508,721
2016	\$43,915	–\$1,001,849	–\$585,761
2017	\$50,189	–\$1,185,874	–\$660,339
2018	\$56,462	–\$1,381,044	–\$732,397
2019	\$62,736	–\$1,587,688	–\$801,890
2020	\$69,009	–\$1,806,141	–\$868,785
2021	\$75,283	–\$2,036,747	–\$933,057
2022	\$81,556	–\$2,279,862	–\$994,696
2023	\$87,830	–\$2,535,847	–\$1,053,697
2024	\$94,104	–\$2,805,075	–\$1,110,063
2025	\$100,377	–\$3,087,929	–\$1,163,808
Total			**–\$10,721,031**

[120] The capital costs associated with using biomass as an alternative to fossil-based generation are dependent on many factors, including the end use (i.e., electricity, heat, or steam), the design and size of the system, the technology employed, and the configuration specifications of the system. Each system implemented under this policy would require a detailed analysis (incorporating specific engineering design and costs aspects) to provide a more accurate cost estimate of the system.

Table 9-5 represents the combined GHG benefit and cost analysis for the "Manure Digester" goal to capture and utilize 20% of the methane generated in Florida for energy production. The combined cumulative GHG emissions for dairy and poultry farms are estimated to be 0.75 $MMtCO_2e$ and the cost effectiveness is projected to be a savings of about -\$17/tCO_2e.

Table D-9-5. Combined results for manure digester goal

Year	Avoided Emissions ($MMtCO_2e$)	Annual Costs (MM\$)	Discounted Costs (MM\$)	Cost-Effectiveness (\$/tCO_2e)
2009	—	\$0.0	\$0.0	
2010	0.006	–\$0.1	–\$0.1	
2011	0.012	–\$0.2	–\$0.2	
2012	0.017	–\$0.4	–\$0.3	
2013	0.023	–\$0.5	–\$0.4	
2014	0.029	–\$0.7	–\$0.5	
2015	0.034	–\$0.8	–\$0.6	
2016	0.039	–\$1.0	–\$0.7	
2017	0.045	–\$1.2	–\$0.8	
2018	0.050	–\$1.4	–\$0.9	
2019	0.055	–\$1.6	–\$1.0	
2020	0.061	–\$1.8	–\$1.1	
2021	0.066	–\$2.1	–\$1.1	
2022	0.071	–\$2.3	–\$1.2	
2023	0.076	–\$2.6	–\$1.3	
2024	0.081	–\$2.8	–\$1.4	
2025	0.088	–\$3.1	–\$1.4	
Totals	**0.75**	**–\$23**	**–\$13**	**–\$17**

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; MM\$ = million dollars; \$/tCO_2e = dollars per metric ton of carbon dioxide equivalent.

Analysis for the assessment of 50 percent capture of manure methane.

Based on Florida agricultural statistics from USDA, more than 80 percent of dairy cattle are at operations with greater than 500 head, while only around 15 percent of swine are at operations with greater than 500 head. Since such a large proportion of dairy cattle are in large animal feeding operations (AFOs) suited for anaerobic digester technology, this recommendation was also analyzed assuming a goal of 50 percent of methane captured and utilized by 2025. This higher goal resulted in a cumulative emission reduction of 1.9 $MMtCO_2e$ by 2025 and a net present value of –\$33 million. The cost-effectiveness was the same as the 20 percent goal (–\$17/tCO_2e).

B. WWTP Solids, Biomass, and MSW Energy

The following analysis represents the combination of two goals under this proposed recommendation: Utilize 50 percent of available biomass and MSW as energy sources and maintain the current level of WWTP solids (biosolids) for land application (also open to include other uses such as fertilizer substitute and energy utilization). These two goals were combined as a result of research that showed the possibility of locating a biomass gasification electricity generation plant near a WWTP for the purpose of co-gasifying biosolids with other biomass and generating electricity with the resulting biogas. Due to the high moisture content of biosolids, the heat value for these materials is low, making it more beneficial to locate such a facility at or near a WWTP. Biomass may also be gasified to ensure that the plant runs as close to capacity as possible.

Biosolids gasification is an emerging technology. CCS is aware of two specific projects that have been planned: MaxWest Energy (http://www.maxwestenergy.com) has a facility planned in Sanford, Florida, and a site in Banning, California, called "Liberty XXIII" (http://www.liberty23.com/). Although this is likely not a comprehensive list, these are the two projects of which CCS has been made aware. The Liberty XXIII facility will gasify both WWTP biosolids and biomass. An Environmental Impact Statement (EIS),[121] as well as an Economic Impact Report,[122] has been completed and posted on the Web for the Liberty XXIII project, and therefore will serve as a case study for this analysis. According to *Summary of Class AA Residuals: 2007* from Florida DEP,[123] about 83 percent of wastewater residuals are either distributed and marketed as Class AA residuals products to be used as soil amendment or directly land applied as Class A or Class B residuals. This same document provides the total amount of Class AA residuals marketed in 2007 to be 197,426 dry tons. The *Domestic Wastewater Residuals Fact Sheet for Florida's Farmers and Ranchers* from Florida DEP states that 66 percent of all biosolids are applied to land as Class B residuals (CCS is assuming that Class A and Class B make up this 66 percent).[124]

Using the information above, CCS estimated the total quantity of Class B WWTP solids that are land-applied to be 766,477 dry tons. Based on communication with DEP, CCS assumed that all Class B solids will need to find an alternative disposal method to land application by 2025. For the purposes of quantifying this recommendation, the quantity of Class B solids currently land-

[121] Liberty Energy. 2006. "Liberty XXIII, Environmental Impact Statement." Appendix D. Greenhouse Gas Emission Estimate. Retrieved on August 1, 2008 from: http://www.ci.banning.ca.us/DocumentView.asp?DID=480

[122] Liberty Energy. 2006. "Community and Governmental Economic Impact/Benefit Analysis." Retrieved on August 1, 2008, from: http://www.liberty23.com/EconomicReport/LibertyXIII_Economic_Report.pdf

[123] Florida Department of Environmental Protection. "Summary of Class AA Residuals: 2007. Retrieved on July 23, 2008, from: http://www.dep.state.fl.us/water/wastewater/dom/docs/ClassAA_Annual_Summary_07.pdf

[124] Florida Department of Environmental Protection. 2005. "Domestic Wastewater Residuals Fact Sheet for Florida's Farmers and Ranchers." Retrieved on August 1, 2008, from: http://www.dep.state.fl.us/water/wastewater/dom/docs/ResidualsFS.pdf

applied are assumed to be gasified for energy generation in 2025 (it is recognized that there could be other least cost methods for Class B solids management and that it isn't assured that Class B application will be banned post-2025).

Not counting the demand for poultry litter in AFW-9, CCS assumed that 50 percent of the remaining biomass in 2025 would be utilized via co-gasification with WWTP biosolids. The quantity of biomass that would be utilized under this goal, based on the biomass supply table at the beginning of this document, is 15,175,709 tons.

GHG Benefit from WWTP Solids, Biomass, and MSW Energy

According to the Liberty XXIII EIS, the heat value for biomass is 5,390 Btu/lb, while the heat value for biosolids is 1,550 Btu/lb. The combined heat rate is calculated in the EIS to be 30,722 Btu/kWh, after the assumed 85 percent capacity factor is applied. The EIS for the Liberty XXIII project also provides a detailed GHG benefit analysis. Based on the results of that analysis, the GHG benefit from the facility is inferred to be 0.29 tCO_2e/MWh. This benefit includes reduced transportation costs, reduced composting and landfilling emissions, as well as anthropogenic emission increases due to the release of N_20 during the gasification and combustion process. The emission benefit from avoided electricity is determined by multiplying the annual electricity generation by the projected Florida electricity generation emission factor (derived from the FL I&F). Table 9-6 displays the results of the GHG benefit analysis. The gasification of the quantities of biomass and biosolids stated above (including a linear ramp-up from zero in 2009 to full implementation in 2025), yields a cumulative GHG benefit of 41.7 $MMtCO_2e$.

Table D-9-6. GHG benefits from biomass/biosolids gasification

Year	Additional Biomass Utilized for Energy (tons)	Biosolids Utilized for Energy (dry tons)	Additional Biomass Utilized for Energy (MMBtu)	Biosolids Utilized for Energy (MMBtu)	Electricity Produced (MWh)	GHG Benefit: Avoided Electricity Production ($MMtCO_2e$)	Direct GHG Emission Benefit ($MMtCO_2e$)	Total GHG Benefit ($MMtCO_2e$)
2009	—	—	—	—	—	—	—	—
2010	948,482	47,905	10,224,634	148,505	337,641	0.20	0.10	0.30
2011	1,896,964	95,810	20,449,268	297,010	675,282	0.40	0.20	0.59
2012	2,845,445	143,715	30,673,902	445,515	1,012,923	0.60	0.29	0.90
2013	3,793,927	191,619	40,898,536	594,020	1,350,564	0.81	0.39	1.20
2014	4,742,409	239,524	51,123,171	742,525	1,688,205	1.01	0.49	1.50
2015	5,690,891	287,429	61,347,805	891,030	2,025,845	1.20	0.59	1.79
2016	6,639,373	335,334	71,572,439	1,039,535	2,363,486	1.39	0.69	2.08
2017	7,587,855	383,239	81,797,073	1,188,040	2,701,127	1.62	0.79	2.41
2018	8,536,336	431,144	92,021,707	1,336,545	3,038,768	1.82	0.88	2.70
2019	9,484,818	479,048	102,246,341	1,485,050	3,376,409	2.05	0.98	3.03
2020	10,433,300	526,953	112,470,975	1,633,555	3,714,050	2.27	1.08	3.35
2021	11,381,782	574,858	122,695,609	1,782,060	4,051,691	2.52	1.18	3.70
2022	12,330,264	622,763	132,920,243	1,930,565	4,389,332	2.77	1.28	4.04
2023	13,278,746	670,668	143,144,878	2,079,070	4,726,973	3.01	1.37	4.39
2024	14,227,227	718,573	153,369,512	2,227,575	5,064,614	3.24	1.47	4.72
2025	15,175,709	766,477	163,594,146	2,376,080	5,402,255	3.44	1.57	5.01
Totals						**28**	**13**	**42**

MMBtu = million British thermal units; MWh = megawatt-hours; GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent;

Costs for WWTP Solids, Biomass, and MSW Energy

The combined capital cost over the first four years of the Liberty XXIII project totals $126.8 million. Assuming a five percent interest rate, 15-year loan period, a 85 percent capacity factor and a 15 MW installed capacity, the annual capital cost per MWh is $109/kWh. The annual O&M cost per kWh is $9.[125] Based on the annual increase in O&M expenditures estimated by Liberty Energy, CCS assumes an O&M escalator of 4.5%. Applying these cost parameters to the projections in Table 9-6 yields a cost-effectiveness of $44/tCO2e (see Table 9-7).

Table D-9-7. Cost analysis for biosolids, biomass, and MSW energy

Year	Total GHG Benefit ($MMtCO_2e$)	Capital Cost ($MM)	O&M Cost ($MM)	Electricity Sales Revenue ($MM)	Net Policy Cost ($MM)	Discounted Cost ($MM)	Cost-Effective-ness ($/t$CO_2$e)
2009	—	$0	$0	$0	$0	$0.0	
2010	0.30	$37	$3	$16	$24	$23.2	
2011	0.59	$74	$7	$32	$48	$43.9	
2012	0.90	$111	$11	$49	$72	$62.2	
2013	1.20	$148	$15	$67	$95	$78.5	
2014	1.50	$185	$19	$86	$118	$92.7	
2015	1.79	$222	$24	$105	$141	$105	
2016	2.08	$259	$29	$125	$163	$116	
2017	2.41	$295	$35	$145	$185	$125	
2018	2.70	$332	$41	$167	$207	$134	
2019	3.03	$369	$48	$189	$228	$140	
2020	3.35	$406	$55	$212	$249	$146	
2021	3.70	$443	$63	$236	$270	$151	
2022	4.04	$480	$71	$261	$291	$154	
2023	4.39	$517	$80	$286	$311	$157	
2024	4.72	$554	$90	$313	$331	$159	
2025	5.01	$591	$100	$340	$351	$161	
Totals	**42**					**$1,848**	**$44**

C. Bio-Products

While numerous bio-based products have become commercially available over the past few years, the life cycle GHG emissions of the bio-based product and the petroleum based product being replaced are have only been analyzed for a few of these products. Life cycle analysis (LCA) for several corn-based polylactic acid (PLA) products and the alternative petroleum based products was recently conducted for Athena Institute International (AII). [126] The LCA

[125] Liberty Energy. 2006. "Community and Governmental Economic Impact/Benefit Analysis." Retrieved on August 1, 2008, from: http://www.liberty23.com/EconomicReport/LibertyXIII_Economic_Report.pdf

[126] *Life Cycle Inventory of Five Products Produced From Polylactide (PLA) and Petroleum-Based Resins, Summary Report*, prepared for Athena Institute International, prepared by Franklin Associates, A Division of ERG, November, 2006.

includes production of product materials, including extraction of raw materials through production of resin; transportation of product resins to fabrication; fabrication of products from resins, and postconsumer disposal of products, including landfill and combustion of mixed MSW. Recycling and composting were not considered as part of the AII LCA. Of the products analyzed, only the 12-ounce PET bottle has a recycling rate of over two percent. Also, while PLA can be composted, this must be done in a commercial composting facility. PLA is not suitable for backyard composting.

Cradle-to-grave GHG emissions from three products made from PLA (16-ounce drink cup, 16-ounce deli container, 12-ounce water bottle) were compared to those of the PET-based products, as shown in Table 9-8. The mass for 10,000 product units is also shown. The GHG benefit of replacing the PET with a PLA product was estimated by taking the difference between the PET and PLA product GHG emissions and dividing by the PLA product mass. The GHG benefit of this policy was estimated using the average of the GHG emissions benefits for the three products. The resulting GHG benefits from producing 100,000 tons of PLA products are shown in Table 9-9.

Table D-9-8. Life cycle GHG emissions of PLA and PET products

Product	Mass (kg)	GHG Emissions (tCO_2e)	Avoided Emissions (tCO_2e/ton PLA product)
16-ounce drink cup			
PLA 2005	118	0.51	2.15
PET	125	0.79	
16-ounce deli container			
PLA 2005	160	0.669	2.84
PET	205	1.17	
12-ounce water bottle			
PLA 2005	168	0.744	1.17
PET	162	0.961	
		Average	**2.06**

kg = kilograms; PLA = polylactic acid; PET = polyethylene terephthalate.

Table D-9-9. GHG benefits of bio-plastic production

Year	Increase in Bio-Products (tons)	Avoided Emissions ($MMtCO_2e$)
2009	0	0.00
2010	9,375	0.02
2011	18,750	0.04
2012	28,125	0.06
2013	37,500	0.08
2014	46,875	0.10
2015	56,250	0.12
2016	65,625	0.13
2017	75,000	0.15
2018	84,375	0.17
2019	93,750	0.19
2020	103,125	0.21
2021	112,500	0.23
2022	121,875	0.25
2023	131,250	0.27
2024	140,625	0.29
2025	150,000	0.31
Total		**2.6**

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

Costs for Increased Bio-Products Production and Use

With the rising cost of petroleum and advancements in production technology for PLA, PLA has become cost competitive with PET. Recent prices for PLA are between $0.90/lb and $1.00/lb[127], recent prices for PET are between $0.9275/lb and $0.9775/lb[128]. Using the midpoint of each price range and adjusting for the difference in density, the cost difference for replacing PET with PLA was estimated, as shown in Table 9-10. Using the total discounted costs in Table 9-10 and the cumulative GHG reductions in Table 9-9, the cost effectiveness for this recommendation element was estimated to be -$62/t$CO_2$e.

[127] Close-Up on Technology: Materials, Biopolymers Strive to Meet Price/Performance Challenge, Plastics Technology, available at: http://www.ptonline.com/articles/200703cu1.html

[128] Polyethylene Terephthalate (PET) Prices and Pricing Information, International Chemical Information Service, August 2008.

Table D-9-10. Cost analysis for bio-products

Year	Increase in Bio-Products (tons)	Cost ($)	Discounted Costs ($)
2009	0	$0	0
2010	9,375	–$1,992,293	–$1,897,422
2011	18,750	–$3,984,585	–$3,614,136
2012	28,125	–$5,976,878	–$5,163,052
2013	37,500	–$7,969,170	–$6,556,256
2014	46,875	–$9,961,463	–$7,805,067
2015	56,250	–$11,953,756	–$8,920,076
2016	65,625	–$13,946,048	–$9,911,196
2017	75,000	–$15,938,341	–$10,787,696
2018	84,375	–$17,930,633	–$11,558,246
2019	93,750	–$19,922,926	–$12,230,948
2020	103,125	–$21,915,219	–$12,813,374
2021	112,500	–$23,907,511	–$13,312,597
2022	121,875	–$25,899,804	–$13,735,219
2023	131,250	–$27,892,096	–$14,087,404
2024	140,625	–$29,884,389	–$14,374,902
2025	150,000	–$31,876,682	–$14,603,075
Total		**–$270,951,794**	**–$161,370,668**

Aggregate AFW-9 Results

Table 9-11 displays the combined results for all AFW-9 recommendations quantified thus far. The cumulative GHG benefit is estimated at 45.1 $MMtCO_2e$, and the cost-effectiveness is approximately $37/$tCO_2e$.

Table D-9-11. Combined AFW-9 results

Year	Avoided Emissions ($MMtCO_2e$)	Annual Costs (MM$)	Discounted Costs (MM$)	Cost-Effectiveness ($/$tCO_2e$)
2009	0.0	0	0	
2010	0.3	22	21	
2011	0.6	44	40	
2012	1.0	66	57	
2013	1.3	86	72	
2014	1.6	107	84	
2015	1.9	128	96	
2016	2.3	148	106	
2017	2.6	168	114	
2018	2.9	188	121	
2019	3.3	206	127	
2020	3.6	225	132	
2021	4.0	244	136	
2022	4.4	263	139	
2023	4.7	280	142	
2024	5.1	298	144	
2025	5.4	316	145	
Total	**45**	**2,788**	**1,675**	**37**

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; MM$ = million dollars; $/$tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Key Assumptions:

The assumed electricity price is the assumed value to the farmer for the electricity produced (to offset on-farm use).

It is assumed that the gas produced can be utilized on site. While the gas cannot be stored, it is assumed that sufficient opportunities exist to utilize the gas immediately.

For the purposes of quantification, it is assumed that certain technologies are employed. While deployment may occur through other technology pathways, the assumed technologies are necessary to estimate the costs associated with implementing this recommendation. The costs associated with using manure as an alternative to fossil-based generation are dependent on many factors, including the end use (i.e. electricity, heat or steam), the design and size of the systems, the technology employed, and the configuration specifications of the system. Each system implemented under this policy would require a detailed analysis (incorporating specific engineering design and costs aspects) to provide a more accurate cost estimate of the system.

Production costs for PLA and PET plastics where not available, so the costs of this recommendation where based on the price of the plastics. The GHG benefits and costs for increased utilization of bioproducts was based on current production technology for PLA. With improvements in the production process, GHG emissions and costs from PLA production may be decreased. Another key assumption for the bioplastics estimates is that PLA products will replace PET products. The AII analysis found that the GHG benefits of using PLA over other types of plastic for some of the products was smaller than the benefit of replacing PET with PLA.

Key Uncertainties

It is uncertain how willing and able farmers will be to develop on site projects (i.e. the technical expertise of farmers in energy utilization or electricity production). The future price of electricity is another uncertainty affecting the estimated costs. Also, the future costs of producing PLA and PET are uncertain. PLA and PET prices are likely to fluctuate to changes in production technology and changes in the prices of petroleum and biomass feedstocks.

For element B of this recommendation, the push for alternative management approaches for WWTP biosolids hinges on future considerations of whether land application (for example, Class B biosolids) will continue to be an recommendation. Gasification is one recommendation for managing these and other organic wastes; however, it might not end up as the most economic method (for instance, where biosolids or other wastes could be landfilled). Hence, the quantification above on biosolids utilization could overstate the potential for management via gasification.

Also for element B of this recommendation covering WWTP biosolids, other biomass and organic wastes, and commercialization of emerging utilization technologies, the GHG benefits and costs were only partially quantified, since WWTP biosolids were the only feedstock captured in the analysis above. Additional study is needed on the potential for application of these emerging technologies for other feedstock sources, such as beef cattle manure, horse manure, other organic wastes, and potentially other biomass feedstocks that are not utilized under AFW-4 and AFW-7.

Additional Benefits, Costs and Energy Security Fuel Savings

Anaerobic digesters reduce odor and the need for waste treatment. The dried fiber from the digestion process can be used as fertilizer, feed supplement, bedding, or other uses.

For energy utilization of poultry litter, arsenic remaining in the digester sludge, combustor ash, or gasifier residuals could present issues in the management of this material (e.g if levels are too high for land application). Additional study of this issue is needed.

While PLA bio-based plastic is biodegradable, it does not readily break down in a landfill. The high heat in a commercial composting facility is needed to degrade PLA. In addition, PLA can contaminate recycled PET if mixed into the PET recycling stream and have the potential to harm existing recycling infrastructure.

See additional costs and benefits for waste-to-energy listed under AFW-4.

Total fossil fuel displaced during the policy period is 2.5 million short tons coal **or** 55,000 cubic feet natural gas.

Feasibility Issues

None identified.

Status of Group Approval

Complete.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

AFW-10. Programs to Support Local Farming/Buy Local

Policy Description

Promote the production and consumption of locally produced agricultural goods, including transportation and heating fuel and plastics, which displace the consumption of those transported from other states or countries.

Policy Design

Goals: Encourage the production of locally produced agricultural goods by 2025. Promote the education of consumers on the consumption of local and seasonal goods.

Timing: Ongoing

Parties Involved: FDACS, producers, retailers, farmer's markets

Other:

The FDACS Division of Marketing and Development has promoted the production and consumption of locally grown or produced goods through the Florida Agricultural Promotional Campaign, and through support to local Community Farmers' Markets.

Over the last eight years the Florida retail campaign has focused considerable resources to promote the Fresh from Florida agricultural products in local markets, including more than 1,250 retail outlets in Florida: Publix, Winn Dixie, Albertson's, Sweet Bay, Harvey's, and Sedano. Retailers strategically place local stores to serve customers normally within a five to 10 mile radius. This system is the best means of moving sufficient quantities of fresh product into an efficient distribution system already in existence.

The campaign supports the Community Farmers' Markets by providing a kit on "How to Organize, Operate and Market Farmers' Markets in Florida." This kit offers resources, including sample market rules, vendor applications, and a sample questionnaire for farmers. Marketing and management advice to these organizations are provided as requested. These farmers' markets are promoted through the maintenance of a directory and Web site. There is also a Web site being developed that list Community Supported Agriculture operations. The Farmers' Market Nutrition programs provide monetary support to these markets in the participating 16 counties.

Implementation Mechanisms

Educate public on benefits of consumption of local and seasonal goods.

Related Policies/Programs in Place

Florida Agricultural Promotional Campaign (FAPC) promotes local farming and agricultural products in Florida.

Type(s) of GHG Reductions

GHG reductions occur from reduced transportation-related emissions and reduced embedded energy.

Estimated GHG Reductions and Net Costs or Cost Savings

Data Sources:

Food, Fuel, and Freeways: An Iowa Perspective on How Far Food Travels, Fuel Usage, and GHG Emissions. Leopold Center for Sustainable Agriculture, Iowa State University, available at: http://www.leopold.iastate.edu.

C.L. Weber and H.S. Matthews. 2008. "Food-Miles and the Relative Climate Impacts of Food Choices in the United States," *Environmental Science & Technology* 42:10.

Quantification Methods: Not quantified.

Key Assumptions: Not applicable.

Key Uncertainties

It is likely that the fuel savings accrued through reduced ton-miles will offset the potential increases in production costs associated with increased localized food production. While the exact interaction of these competing economic factors is uncertain, locally produced and consumed food products will become more cost-effective as fuel costs increase.

Additional Benefits, Costs, and Energy Security Fuel Savings

In addition to emission reductions due to reduced transportation, other environmental and economic benefits associated with localizing packaging, refrigeration, storage, and processing may also be realized through the implementation of this recommendation.

There are a plethora of additional direct and indirect social, health and economic benefits accrued from marketing local goods.

Shortening the supply chain and distance between producer and consumer puts more money directly in the pocket of producers within the community. The community benefits from this localized exchange by keeping dollars circulating within the community instead of being a net-exporter of capital.

Research suggests that fresh produce can contain higher nutritional content than older produce contributing to more robust health. Consumers concerned about food growing practices and handling can inquire directly from producers.

Feasibility Issues

The ability to produce some goods locally may be limited given the local conditions such as local land quality (e.g. soil fertility), local climate (e.g. precipitation), available infrastructure (e.g. transportation network) and/or the willingness of consumers to buy local produce.

Status of Group Approval

Complete.

Level of Group Support

Unanimous

Barriers to Consensus

None.

Appendix E
Government Policy and Coordination (GP)

Summary List of Policy Recommendations

Policy No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value 2009–2025 (Million $)	Cost-Effective-ness ($/t$CO_2$e)	Level of Support
		2015	2025	Total 2009–2025			
GP-1	Targets, Reporting, Funding, and Accountability Measures	*Not to be Quantified*					Approved
GP-2	Public Awareness and Education	*Not to be Quantified*					Approved
GP-3	Inter-Governmental Planning Coordination and Assistance	*Not to be Quantified*					Approved
GP-4	"Green" Business Development Policies	*Not to be Quantified*					Approved
GP-5	Introduce Core Competencies Into Professional Licensing Programs	*Not to be Quantified*					Approved

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/t$CO_2$e = dollars per metric ton of carbon dioxide equivalent.

Note: The numbering used to denote the above pending priority policy recommendations is for reference purposes only; it does not reflect prioritization among these important draft policy recommendations.

GP-1. Targets, Reporting, Funding, and Accountability Measures

Policy Description

The State of Florida is committed to significant reductions in greenhouse gas (GHG) emissions and has established emissions inventory, forecasting, reporting, and registry functions in state agencies, specifically in the Florida Department of Environmental Protection (DEP). Through House Bill 7135 (HB 7135, the 'Energy Bill'), the 2008 Florida Legislature directed the Public Service Commission (PSC) to promulgate a rule implementing a Renewable Portfolio Standard (RPS), and the PSC has issued a draft rule for comment. HB 7135 established the Florida Energy and Climate Commission (FECC), demonstrating the state's long-term commitment to reduce its carbon footprint. The Legislature also considered an Energy Efficiency Portfolio Standard (EEPS) in 2008.It is strongly recommended that the state develop a dedicated funding source, such as a system benefits charge (SBC) to provide funding to help achieve targets for renewable energy and energy efficiency. This will be a key policy step towards achieving significant GHG emissions reductions.

The following are further descriptions of the above-mentioned functions:

- Florida set GHG emissions reductions targets, as established under Executive Order 07-127. Specifically, the targets are 2000 levels by 2017, 1990 levels by 2025, and 80 percent of 1990 levels by 2050. The following policy recommendations support these targets but recognize that, in the future, revisions may be needed because of scientific and technological advances. A process will be necessary to periodically review and revise targets.
- GHG emissions inventories and forecasts are essential for understanding the magnitude of all emission sources and sinks (natural and those created by human activities), the relative contribution of various types of emission sources and sinks to total emissions, and the factors affecting trends over time. Inventories and forecasts help to inform policy makers and the public on statewide trends and on opportunities for mitigating emissions or enhancing sinks; they also help verify GHG reductions associated with implementation of GHG reduction action plans and other initiatives.
- GHG reporting supports the tracking and management of emissions over time. GHG reporting can help sources identify emission reduction opportunities and reduce risks associated with possible future GHG mandates. Tracking and reporting of GHG emissions can also help in the construction or revision of periodic state GHG inventories. GHG reporting is a prerequisite for sources to participate in GHG reduction programs, opportunities for recognition, and a GHG emission registry, as well as to secure "baseline protection" (i.e., credit for early reductions).
- An RPS is a requirement that utilities must supply a certain, generally fixed percentage of electricity from an eligible renewable energy source(s). More than two dozen states have an

RPS in place. About 25 states currently have some sort of SBC in place. The following is a table summarizing the various SBCs and RPSs in effect around the nation. Funds are typically generated as a charge on the electric bill and are used to ensure that the RPS and related energy efficiency portfolio standards (EEPS) are met. A clearly defined value for a renewable energy target (for example, 20 percent by 2020, as the Governor has suggested) and a clearly defined value for the energy efficiency target must be specified. The funding for each of these two important, yet distinct, ways to meet GHG reduction targets must also be separated. Once RPS and EEPS targets have been set, they must be measured and verified continually along with their impact on GHG reductions. Developing a mechanism for cataloging the GHG reductions in a registry is imperative to securing the veracity of the reductions and the value of those reductions as a tradable financial instrument. The Government Policy (GP) Technical Working Group (TWG) suggests that consideration also be given to a broader environmental attributes registry that may be linked to water pollution trading credits as well as GHG reductions.

System Benefits Charge, Renewable Portfolio Standard and Energy Efficiency Standards by State

Table E-1-1

State	State System Benefits Charge (SBC)	State Renewable Portfolio Standard (RPS)	State Energy Efficiency Standards (A = Appliance; PB = Public Buildings; BC = Building Codes)
Alabama	None	None	PB, BC
Alaska	None	None	PB, BC
Arizona	None	15% by 2025	PB, BC
Arkansas	None	None	BC
California	Rates vary by utility and customer type: Renewables: ≈1.6 mills/kWh Efficiency: ≈5.4 mills/kWh RD&D: ≈1.5 mills/kWh	Legislative mandate to increase the percentage of renewable retail sales by at least 1% per year to reach at least 20% by end of 2010; goal of 33% by end of 2020	PB, BC
Colorado	None	Investor-owned utilities: 20% by 2020 Electric cooperatives: 10% by 2020 Municipal utilities serving more than 40,000 customers: 10% by 2020	PB, BC
Connecticut	Clean Energy Fund: $0.001/kWh for Connecticut Light and Power (CL&P) and United Illuminating (UI) customers. Energy Efficiency Fund: $0.003/kWh for CL&P and UI customers.	27% by 2020 20% Class I resources 3% Class I or Class II resources 4% Class III resources by 2010	BC

State	State System Benefits Charge (SBC)	State Renewable Portfolio Standard (RPS)	State Energy Efficiency Standards (A = Appliance; PB = Public Buildings; BC = Building Codes)
Delaware	Incentives for Renewables and Efficiency:$0.000356/kWh (0.356 mills/kWh) for renewables; $0.000095/kWh (0.095 mills/kWh) for low-income assistance. Green Energy Fund: $0.000178/kWh (0.178 mills/kWh); Delaware Electric Cooperative Green Energy Fund (GEF) : $0.000178/kWh (exempt from RPS)	20% by 2019	BC
District of Columbia	Non-bypassable surcharge based on kWh use	11% by 2022	PB, BC
Florida	None	The Florida PSC is to adopt a rule for an RPS requiring each provider, including investor-owned utilities but not municipal electric utilities or rural electric cooperatives, to supply renewable energy to customers directly, or indirectly, through the purchase of Renewable Energy Credits. The PSC is to present a draft rule for legislative consideration by February 1, 2009, and the rule may not be implemented until ratified by the Legislature.	BC
Georgia	None	None	PB, BC

State	State System Benefits Charge (SBC)	State Renewable Portfolio Standard (RPS)	State Energy Efficiency Standards (A = Appliance; PB = Public Buildings; BC = Building Codes)
Hawaii	None	10% by December 31, 2010; 15% by December 31, 2015; and 20% by December 31, 2020 (including existing renewables)	PB, BC
Idaho	None	None	PB, BC
Illinois	None	25% by 2025	A, PB, BC
Indiana	None	None	A, PB, BC
Iowa	None	None	PB, BC
Kansas	None	None	PB, BC
Kentucky	None	None	BC
Louisiana	None	None	PB, BC
Maine	Varies by utility and year (maximum charge of 1.45 mills/kWh)	30% by 2000; 10% new resources by 2017 (and for each year thereafter)	BC
Maryland	None	Tier 1: 20% in 2022 and beyond; Tier 2: 2.5% in 2006 through 2018	BC
Massachusetts	Energy Efficiency Fund: $0.0025/kWh (2.5 mills/kWh); Renewable Energy Trust Fund: $0.0005.kWh (0.5 mill/kWh) in 2003 and in each following year	Class I standard: 4% of sales by December 31, 2009, and an additional 1% of sales each year thereafter, with no stated expiration date	A, PB, BC
Michigan	Low-Income Energy Efficiency Fund: Varies by utility ($83.8 million annually in total)	None	PB, BC

State	State System Benefits Charge (SBC)	State Renewable Portfolio Standard (RPS)	State Energy Efficiency Standards (A = Appliance; PB = Public Buildings; BC = Building Codes)
Minnesota	Assessed on nuclear power only. $16 million annually; Additional $350,000 per dry cask annually when storage begins at Monticello (≈2010)	Xcel Energy: 30% by 2020 Other utilities: 25% by 2025	A, PB, BC
Mississippi	None	None	PB, BC
Missouri	None	11% by 2020	A, BC
Montana	Electricity suppliers contribute 2.4% of 1995 revenue	5% in 2008; 10% in 2010; 15% in 2015	PB, BC
Nebraska	None	None	BC
Nevada	None	6% in 2005, rising to 20% by 2015	PB, BC
New Hampshire	1.8 mills/kWh ($0.0018/kWh)	23.8% by 2025	BC
New Jersey	Per-kWh surcharge (varies annually by funding target)	22.5% by 2021 (2.12% from solar; 17.88% from other Class I renewables; 2.5% from Class II or additional Class I renewables)	A, PB, BC
New Mexico	The programs may be funded through a tariff rider for energy-efficiency and load management programs.	Investor-owned utilities: 20% by 2020; Rural electric cooperatives: 10% by 2020	BC
New York	Each utility must collect a sum equal to 1.42% of its 2004 revenue and submit this sum to the New York State Energy Research and Development Authority (NYSERDA) annually. The percentage may be adjusted slightly each year based on updated utility revenue.	24% by 2013	A, PB, BC

State	State System Benefits Charge (SBC)	State Renewable Portfolio Standard (RPS)	State Energy Efficiency Standards (A = Appliance; PB = Public Buildings; BC = Building Codes)
North Carolina	None	12.5% of 2020 retail sales by 2021 for investor-owned utilities; 10% of 2017 retail sales by 2018 for electric cooperatives and municipal utilities	PB, BC
North Dakota	None	10% by 2015 (objective)	PB, BC
Ohio	None	Varies by utility (fund authorized to collect $15 million per year from 2001 to 2005 and $5 million per year from 2006 to 2011)	BC
Oklahoma	None	None	PB, BC
Oregon	3% charge for Pacific Power and Portland General Electric customers; 1.25% charge for NW Natural Gas customers; 1.5% charge for Cascade Natural Gas customers, of which 80% goes to Energy Trust	Large utilities: 25% by 2025 Small utilities: 10% by 2025 Smallest utilities: 5% by 2025	PB, BC
Pennsylvania	Varies by utility territory	18% during compliance year 2020–2021 (8% Tier I and 10% Tier II)	A, BC
Rhode Island	$0.0023/kWh (2.3 mills/kWh)	16% by 2020	PB, BC
South Carolina	None	None	A, PB, BC
South Dakota	None	10% by 2015 (objective)	BC
Tennessee	None	None	PB, BC
Texas	None	2,280 megawatts (MW) by January 1, 2007, increasing to 5,880 MW by January 1, 2015	BC

State	State System Benefits Charge (SBC)	State Renewable Portfolio Standard (RPS)	State Energy Efficiency Standards (A = Appliance; PB = Public Buildings; BC = Building Codes)
Utah	None	20% of adjusted retail sales by 2025	PB, BC
Vermont	Varies by year, utility, and customer type	Three separate goals: (1) total increase in retail electricity sales between 2005 and 2012 to be met using qualifying renewables; (2) 20% of total statewide electric retail sales generated by qualifying renewables by 2017; (3) 25% of all energy consumed within the state produced through the use of renewables by 2025	PB, BC
Virginia	None	12% of base year (2007) sales by 2022	PB, BC
Washington	None	15% renewables by 2020 and all cost-effective conservation	BC
West Virginia	None	None	PB, BC
Wisconsin	Beginning July, 1, 2007, each utility is required to spend 1.2% of its annual operating revenue on efficiency and renewables.	Requirement varies by utility (statewide goal of 10% by December 31, 2015)	PB, BC
Wyoming	None	None	BC

mill = one-thousandth of a dollar; kWh = kilowatt hours; RD&D = research, development, and demonstration; MW = megawatt.

source: Database of State Incentives for Renewables & Efficiency, North Carolina State University

- A GHG registry enables the recording of GHG emission reductions in a central repository with "transaction ledger" capacity to support tracking, management, and "ownership" of emission reductions; establish baseline protection; enable recognition of environmental leadership; and provide a mechanism for regional, multistate, and cross-border cooperation. Properly designed registry structures also provide a foundation for possible future trading programs. Florida is a member of The Climate Registry (TCR) and as such can take advantage of the programs and protocols offered by TCR to member jurisdictions.

Policy Design

To support these initiatives, mechanisms must be created to:

- Periodically review and revise established goals or targets for statewide GHG-emission reductions, RPSs, and energy efficiency targets and review the effectiveness of using the SBC to meet goals or targets.
- Establish RPS and EEPS targets and mandatory GHG emissions reporting, inventory, and forecasting functions at state agencies. In addition, develop an inventory and forecast system that is aligned with national protocols and tailored to specific emissions and/or sinks found in Florida.
- Provide technical assistance to emissions reporters and encourage participation.
- Institute an accountability program to measure and report progress in reducing GHG emissions. This program would allow the state to keep track of emission reductions and help determine what is and is not working.
- Measure and report on research and development (R&D), job creation, and new business investment resulting from related "green" economy programs and review the effectiveness of state funds used to promote those programs.

The Action Team recommends that Florida establish GHG reduction targets for local, state, and regional government operations and school districts, with an emphasis on energy efficiency for transportation and non-transportation uses to meet the targets. The establishment of these targets will be helpful in setting an example for nongovernmental entities and will help agencies to focus on performing the necessary analysis. Reductions should be reported at the agency level. Thus, local, state, and regional government agencies or departments would first need to develop GHG emissions inventory data that are agency- or department-specific, ideally building on existing energy-use reporting data. This would become the baseline data for ongoing emission reduction activities and measurement, which could be included in annual reporting for all entities. Agency or department reports would be aggregated into a summary report reflecting state GHG emissions. A multiagency group should oversee the ongoing climate efforts of the government's agencies or departments; review their performance; and provide guidance, resources, shared approaches, and recognition to agencies or departments and their employees working to reduce the government's GHG emissions.

Goals:

Beginning in 2010, the FECC should review progress toward achieving the Florida Executive Order 07-127 GHG reduction goals and review and affirm or propose revisions to the goals every three years, assuming the necessary resources are available to properly complete this review.

Timing:

- Implementation of a GHG inventory for previous years shall continue.
- Timing of the current GHG inventory and forecasting efforts shall proceed as initiated under the Action Team process. Future efforts will be based on the timing of the U.S. Environmental Protection Agency (EPA) reporting rule.

Parties Involved: DEP, FECC, the PSC, state agencies, local and regional governments, Florida Association of Counties (FAC), Florida League of Cities (FLC), Florida League of Mayors (FLM), regional leagues of cities, and the Regional Planning Councils (RPCs).

Various other state agencies will need to provide assistance with the forecast.

Other: None

Implementation Mechanisms

The FECC, in coordination with the DEP, should create a clearinghouse function in the appropriate department to work with, coordinate, and aggregate local and regional goals, programs, and reporting on the GHG mitigation progress. This clearinghouse should be developed with the participation of the FAC, FLC, FLM, local governments, regional leagues of cities, and the RPCs.

In conjunction with the programs and policies described in GP-2, Public Awareness and Education, the clearinghouse or the FECC should periodically issue reports for the Legislature and general public consumption regarding recent and longer-term trends of Florida's electricity consumption and liquid fuels consumption and the efficiency of Florida's personal and commercial vehicle fleet. These reports should convey these trends in simple, easy to replicate and grasp graphics, like the United Way "thermometer."

- The DEP should coordinate with EPA and TCR on the development of a mandatory federal GHG reporting rule (see FY2008 [fiscal year 2008] Consolidated Appropriations Amendment).[1]

[1] 110th U.S. Congress, First Session, H.R. 2764: Consolidated Appropriations Act, 2008, http://www.govtrack.us/congress/billtext.xpd?bill=h110-2764, see Title II, Administrative Provisions, US EPA (Including Rescission of Funds), pp. 284–285.

  - This GHG rule will define sources, thresholds for reporting, and frequency of reporting. The GHG rule can be used to define reporting standards for the previous year's emissions.
  - The rule will apply to the following gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).
  - Forecasting of GHG emissions will be included as part of the state responsibilities. In forecasting future GHG emissions, treatment of uncertainties should be transparent, be as consistent as possible across sectors and time and, to the extent possible, reflect multiple scenarios.
- Inventory and other related information shall be gathered for all previous years through 1990.

Progress reports should be made available to the public by every reporting period, at a minimum.

Related Policies/Programs in Place

Governor's Executive Order 07-126 established GHG reduction goals for state agencies of a 10 percent reduction from current emission levels by 2012, a 25 percent reduction from current levels by 2017, and a 40 percent reduction from current levels by 2025.

Governor's Executive Order 07-127 established goals for reduction to 2000 levels by 2017, to 1990 levels by 2025, and to 80 percent of 1990 levels by 2050. This Order also required adoption of the California motor vehicle emission standards. The standard is a 22 percent reduction in vehicle emissions by 2012 and a 30 percent reduction by 2016. Under HB 7135, if DEP adopts this rule, it must be ratified by the Legislature to become effective.

The Executive Office of the Governor is tracking and reporting financial savings and emissions reductions associated with Executive Order 07-126 via the Florida Government Carbon Scorecard. Executive Order 07-128 directs the state to provide "Policies for emission reporting and registry that measures and documents emissions reductions."

Recent Actions in Florida

As a result of Executive Order 07-127 and the mandate in HB 7135, the PSC held a series of workshops on RPSs in 2007, and in August of 2008, they released a draft rule for public comment.

Florida Energy Bill—HB 7135 (see Policy Description above)

Type(s) of GHG Reductions

All six statutory GHGs (CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6)

Estimated GHG Reductions and Costs or Cost Savings

This policy is not quantified.

Data Sources: Not applicable

Quantification Methods: Not applicable

Key Assumptions: Not applicable

Key Uncertainties

The future federal requirements under the required EPA reporting rule are unknown, and there is a possibility that the rule will be inadequate to support the Florida program.

Additional Benefits and Costs

None

Feasibility Issues

None

Status of Group Approval

Approved

Level of Group Support

Unanimous consent

Barriers to Consensus

None

GP-2. Public Awareness and Education

Policy Description

Focusing on public awareness and education is predicated on the fact that if Florida wants to be recognized as an eco-literate state, it can do so only if efforts are embraced and actions are taken by everyone—from high-level policy makers at one end of the citizenry, to individuals at the other.

The goal is for every man, woman, and child in Florida—young and old, those in Florida's cities and those on the beaches, those in the research labs and those in the orange groves—to know that Florida will be recognized for its commitment to the environment at all levels. Accordingly, there must be an expectation for all Floridians to do their part to protect, to sustain, to restore and, most importantly, to re-engage in a dialogue with the state's most precious resources: our land, our water, and the air we breathe.

The efforts Florida undertakes to educate its citizens will be a reflection of the urgency with which it views climate change, the precariousness of the environment, and the need to dramatically reduce existing energy use in order to avoid the worst effects of climate change. Education at all levels must begin immediately if Florida is to take the next critical steps to become a national leader.

Policy Design

Floridians doing their part assumes that individual citizens know what can and should be done and are provided the tools and the incentives to do it. This is the core role of public awareness and education, and policy design in this area is a three-step process: (1) identify the relevant audiences and sectors for purposes of optimal communication; (2) determine what to communicate and how to begin what, if designed correctly, will be perceived as a dialogue; and (3) gather feedback via that dialogue to determine the extent to which the information, tools, assistance, and incentives provided are understood, useful, and worthwhile. If these assumptions are correct, then magnitude is increased; if they are not, then corrections need to be made before proceeding further.

Because the second and third steps are more operative than policy-driven, they will need to be addressed in greater detail at a later point in time. They move beyond policy design and into policy implementation. Once entertained, the individual strategies will ultimately populate a toolbox of potential actions—large and small, general and specific—to sub-audiences. However, it is not too early at the policy formation stage to consider the general audience clusters that will need to be considered.

Traditional Education as a Target Audience

The traditional audience of a K–20 education system is entirely relevant and must be given due attention. Learning the alphabet of eco-literacy must begin in preschool and kindergarten, with successive and increasingly sophisticated lessons, applications, and connections throughout the formative years so that, as a by-product, more middle and high school students are comfortable exploring the possibilities of science, technology, engineering, and mathematics as professions. Progress in this area will entail ensuring that eco-literacy curricula and performance standards are created for science and social studies programs, and that "eco-literacy-across-the-curriculum" is explored and rewarded.

Similarly, the state's colleges and universities need to make the cultural shift away from viewing eco-literacy as synonymous with environmental science programs. Rather, eco-literacy should be a component that traverses the traditional boundaries of the academy—into programs in architecture and building construction, throughout regional planning and health care administration degrees and, most assuredly, through our business schools—so that graduates can begin to challenge the unspoken financial argument currently being made for *not* addressing the environmental and energy issues of today. In summation, a sustained and comprehensive eco-literacy component for K–20 must be a part of the twenty-first century curriculum.

Also of relevance in postsecondary education is the appreciation and support for the R&D that will help create Florida's green economy. Alternate energy sources, as well as the many forms that energy efficiency may take—from the creation of composite materials to the planning necessary for transportation configurations—must continue to be valued and recognized as central to the larger issue of eco-literacy.

Other Target Audiences

Beyond the audience afforded by traditional education, Florida must devote its time, energy, and resources to increasing awareness and engaging the public-at-large with regard to the good decisions in personal and professional lives that can be made to favorably impact climate change and reduce energy usage. These include the decisions of individuals and groups of community-based organizations, religious leaders, business leaders, institutions, visitors and, most importantly, average Floridians. Florida must determine how to market the savings associated with reducing the carbon footprint of all of these constituents.

All across the wide range of corporate and economic activities, education and awareness efforts can help incorporate climate change efforts into business plans and best practices. Among these sectors are Florida's growing high-tech industry, its agricultural base, and its historical strength in tourism, all three of which will be enormously impacted by climate change and energy crises.

One concept that is recommended is a "Florida Climate Challenge" to mobilize all Floridians to reduce energy usage in their homes, vehicles, and places of work. It would encourage citizens to voluntarily sign up and accept the challenge of reducing their energy by measuring their "footprint" and then reducing their footprint by some target level with measurement tools, information, incentives, advice, and encouragement from the Governor, Legislature, and the FECC.

Target Audience: Local, State, and Regional Government Entities

While attention must be placed on the general public as a critical audience for education and public awareness; government at all levels will be a key to ramping up and building on individual successes. In the same manner that good governments coordinate, communicate, share, and incent one another in times of emergencies such as hurricanes, Florida needs the same communicative network to focus on and assist with energy and climate issues. One strategy at the state level, for example, might be to form a climate change education and outreach council to coordinate information and efforts regarding climate change action plans, best practices, and associated policies. In turn, local and regional government entities need to consider strategies that will enhance education and public awareness.

To conclude, good policy design regarding education and public awareness will be fleshed out in these areas:

- Audience and sub-audience identification;
- Message, tools, and incentives creation;
- Communication systems developed or adapted and tested; and
- Feedback assessment, corrections made as necessary, and magnitude increased.

Goals:

By June 2009, the State of Florida in cooperation with federal, regional, and local governments, the business community, nongovernmental organizations (NGOs), the faith community, and other interested parties will have implemented a state-wide Florida Climate Challenge to inform and motivate all Floridians on the importance of reducing their usage of energy from carbon-emitting sources and the most efficient and effective ways to do it.

By January 2010, 50 percent or more of Floridians, when surveyed, will acknowledge the seriousness of climate change impacts and will have reduced their personal usage of energy from carbon- emitting sources by 10 percent.

By January 2010, 50 percent of businesses, when surveyed, will acknowledge the seriousness of climate change impacts and will have reduced their usage of energy from carbon-emitting sources by 10 percent.

By January, 2010, 100 percent of governmental agencies at the regional, state, and local levels, when surveyed, will have reduced their usage of energy from carbon-emitting sources by 25 percent.

By June 2010, the "Florida Climate and Energy Challenge" will be expanded, and additional milestones and energy reduction targets will be established out to the year 2050 for citizens, the business community, and all governmental agencies, based on the initial survey results and needed carbon emission reductions to meet the 80 percent reduction from 1990 levels by 2050.

Timing: Education and Outreach Committee appointed by the Governor by October 1, 2009.

Parties Involved: Office of the Governor; FECC; Florida Department of Education; Florida Board of Governors; Florida Chamber of Commerce; Florida Association of Businesses and Industry; Florida Council of 100; religious organizations; regional government coordinating agencies; FLM; Florida Department of Agriculture; DEP; the Office of Tourism, Trade, and Economic Development (OTTED); Florida Department of Transportation (FDOT); and the press.

Other: None.

Implementation Mechanisms

The Governor should form a climate change education and outreach committee (coordinated by FECC) to educate the public and other audiences regarding the climate change action plan and its associated policies and to oversee outreach activities. The committee should be formed of appointees and supported by outreach coordinators from relevant state agencies (e.g., energy supply, forestry, and agriculture). The committee should:

- Create and maintain one or more outreach coordinator positions in relevant executive agencies specifically tasked with climate change issues.
- Assess the level (establish a baseline) of public understanding of the impacts of climate change and of (proposed) state-specific actions to deal with climate change.
- Create the "Florida Climate and Energy Challenge program" with a public relations firm that can craft the message of how important and urgent it is for all Floridians to work to reduce their energy usage. The program would be implemented through the FECC and the DEP. A Web site could function as a clearinghouse of climate change information and resources specific to Florida. The Challenge would ask Floridians to sign up; pledge to measure (through a Web-based survey tool) their carbon footprint; make changes to lifestyle and appliances or make other changes to reduce emissions; and register the reductions on the site.
- Establish a recurring awards program to recognize leadership and attainment of goals and objectives of the Florida Climate Change Action Plan.
- Engage and partner with the Florida business community to coordinate and leverage private sector–sponsored messages and initiatives to help implement the "Florida Climate Challenge."

Increase awareness and engage in climate change actions in personal and professional lives through the following actions:

- Educate broadcasters, reporters, editorial boards, and others about climate change, the risks it imposes, and actions Floridians can take. Work with state broadcasters and print media associations to develop and run public service announcements (PSAs) concerning climate change.
- Work with existing business outreach efforts to customers to enhance awareness of climate change issues and opportunities.
- Provide and advertise marketplace incentives to adopt and purchase goods with the minimum climate change footprint.

Integrate climate change into educational curricula, post-secondary degree programs, and professional licensing (see policy GP-5) to address the multidisciplinary approach to reduce adverse climate-change effects.

- Ensure performance standards for the inclusion of climate change curricula in public education (K–12), identify gaps in climate change education, and provide specific curricula to fill any gaps.
- Integrate best practices into public school design and construction and use this as a means to educate the public about how to educate students (and parents) firsthand in their communities and colleges.
- Organize groups of educators to identify, assemble, and employ climate change curricula appropriate to specific age groups. Make curricula and associated materials available to educational courses that are not publicly funded.
- Integrate climate change into core college curricula, promote research into climate change and solutions at state universities, and develop university Centers of Excellence on climate issues, new approaches, and technologies.
- Develop assessment tools to determine the impact of climate change curricula.
- Include climate change discussions at state-funded venues, such as science centers, zoos, and museums.

Related Policies/Programs in Place

Climate Change Instructional Materials (Lesson Plans and Curricula):

1. World Wildlife Fund (WWF), Climate Curriculum for Teachers—This high school–level curriculum is divided into 15 lessons that include handouts, a glossary of terms, and additional resources for ongoing discussions and research.

2. Union of Concerned Scientists, Confronting Climate Change in the Gulf Coast Region: Prospects for Sustaining Our Ecological Heritage—This science-based program is geared toward college-level studies.

3. Union of Concerned Scientists—Florida-specific information to supplement existing document, available at: http://www.ucsusa.org/gulf/gcstateflo.html

4. The University Corporation for Atmospheric Research (UCAR), LEARN: Atmospheric Science Explorers—Originally a series of modules for teacher professional development, these modules have now been modified for the Web and are available at: http://www.ucar.edu/learn/

5. The Keystone Center, Climate Status Investigations (CSI)—In partnership with the U.S. Department of Energy and the National Energy Technology Laboratory (NETL), CSI presents interdisciplinary curricula modules for middle school and high school students on the topic of global climate change, available at: http://www.keystonecurriculum.org/

6. GEMS (Great Explorations in Math and Science), Global Warming and the Greenhouse Effect—Activities for students in grades 7–8 (with hands-on activities and experiments) investigate a crucial environmental issue and help students see environmental problems from different points of view. Students can play simulation games and hold a "world conference" on global warming and acid rain, available at: http://www.lawrencehallofscience.org/gems/GEM322.html

7. WWF: Your Climate, Your Future—An interdisciplinary approach to incorporating climate change in the classroom, available at: http://www.worldwildlife.org/climate/curriculum/WWFBinaryitem5977.pdf

8. NOAA (National Oceanic and Atmospheric Administration) Climate Program Office, Climate Literacy Essential Principles and Fundamental Concepts—http://www.climate.noaa.gov/index.jsp?pg=/education/edu_index.jsp&edu=climate_literacy.html

The following is a partial list of the categories of organizations engaged in climate change awareness and education activities in Florida. Note that this is only a sample listing:

Businesses
Business Associations
Civic Organizations
Colleges
Community Colleges
Faith-Based Organizations
Non-Government Organizations
Universities

Type(s) of GHG Reductions

All six statutory GHGs (CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6) should be reduced.

Estimated GHG Reductions and Costs or Cost Savings

This policy is not quantified.

Data Sources: Not applicable

Quantification Methods: Not applicable

Key Assumptions: Not applicable

Key Uncertainties

Availability of funding to support the education and outreach effort; support from third-party agencies and entities (e.g., schools and businesses)

Additional Benefits and Costs

None

Feasibility Issues

As stated above

Status of Group Approval

Approved

Level of Group Support

Unanimous consent

Barriers to Consensus

None

GP-3. Inter-Governmental Planning Coordination and Assistance

Policy Description

Given the high priority of climate change mitigation in the State of Florida, numerous local, state, and regional government agencies are tasked with implementing climate policies or, at a minimum, integrating energy efficiency principles into their operations. Efficient coordination among agencies and between local, state, and regional government will enhance overall effectiveness, reduce overlap, and eliminate barriers to GHG mitigation efforts. Fortunately, many of Florida's cities and counties have embraced the mission; at least 70 mayors have signed the U.S. Conference of Mayors' (USCM's) Climate Protection Agreement and agree with its ambitious reduction goals. Eight or more counties have joined the International Council for Local Environmental Initiatives (ICLEI), the Cool Counties program, or similar efforts. Many Florida local jurisdictions, large and small, embarked on GHG reduction efforts more than a decade ago and therefore have wisdom and best practices worthy of replication.

Local governments will be among the state's most vital partners in addressing climate change. Decisions regarding land use, transportation, land conservation efforts, landscaping requirements, solid waste management, water distribution and, in public power communities, energy supply, are all made at the local level. Planning agencies will need to coordinate, especially those with a role in transportation infrastructure, because transit offers among the most potent reduction opportunities. The built environment and its building efficiency are also significant contributors to GHG emissions; that sector is an immediately accessible and active sector that could benefit from policy support. Development patterns present another key area because denser land-use patterns and smaller homes help reduce trips and save energy.

The State of Florida is unique in that it has an existing comprehensive planning framework, which is the foundation of the state's growth management program. It provides for the coordination of state, regional, and local planning decisions. This Local Government Comprehensive Planning Act is administered by the Florida Department of Community Affairs (DCA). As part of this framework, the RPCs are tasked with planning and coordinating intergovernmental solutions to issues of state and regional concern. Therefore, to facilitate and expedite climate change mitigation and adaptation efforts throughout the state, Florida's policy makers should work through the DCA in conjunction with the RPCs to use the local government comprehensive planning process to improve coordination and ensure that each level of government is working toward the same goals in a mutually supportive and consistent manner.

"Leading-by-Example" is one of the most effective ways for governments to convey the importance of climate response to the broader public. State government can help lead and build on the existing work that is underway at local and regional levels by (1) collecting and facilitating access to information about best practices; (2) providing cost-benefit analyses of the various approaches available to local governments in a fiscally constrained environment; (3) documenting the economic benefits or payoffs for local governments, their constituencies, and businesses that are considering the implementation of green practices; (4) eliminating state subsidies or favorable tax treatment for programs or policies that are contrary to GHG reduction efforts; (5) identifying and eliminating state policies that unduly contribute to the generation of GHG emissions; (6) finding ways to say yes to local and regional partnerships and solutions; (7) funding the Florida Green Governments Grant Program and similar programs that support local and regional government initiatives; and (8) expediting state-level review and decision-making processes, if applicable, to facilitate implementation of local and regional efforts. Creating a statewide infrastructure or action plan to achieve GHG reductions will allow all coordinating agencies to be on the same page. In addition, determining regional GHG averages and encouraging use of a consistent system for local governments to quantitatively assess their reduction progress would facilitate their engagement in this effort and allow them to gauge their progress and efficacy.

As documented in the "Plans and Planners" document prepared for this process and available at http://www.flclimatechange.us/ewebeditpro/items/O12F16370.pdf , there are multiple agencies and jurisdictions with overlapping authority to plan and regulate a wide range of activities that directly or indirectly impact emissions. The Action Team proposes to directly improve coordination and consistency between these agencies and jurisdictions relative to GHG issues.

In its "States Guidance Document: Policy Planning to Reduce Greenhouse Gas Emissions" (Second Edition, 1998), EPA addresses the process of planning, implementing, and administering climate change mitigation programs. Specific topics addressed include the actors who affect climate change program design, political considerations related to climate change program development, treatment of time perspectives, interactions between various agencies that are internal and external to state governments, general program administration, and program financing. While primarily focused on implementation efforts by states, the key points highlighted by EPA can be applied to all levels of governments and organizations pursuing climate change program development and implementation. A key point of the document discusses the coordination of climate change programs and interaction between agencies. In its report, EPA identifies coordination among various state agencies, as well as between federal, state, and local governments, as a critical factor for success.

Policy Design

To accomplish the goals set forth above, the following are recommended:

- Coordinate federal, regional, state, and local government roles and policy with regard to climate change impacts and response. Coordinate activities and programs to facilitate rapid and meaningful actions on the part of government decision makers.

- Integrate the comprehensive planning process as administered by DCA in conjunction with the RPCs with transportation and land-use planning by regional, state, and local governments to reduce GHG emissions as guided by the new provisions in House Bill 697.
- Work through the RPCs to improve coordination and collaboration among local governments to develop agreed upon strategies and regional implementation goals and benchmarks addressing GHG emission reduction and climate change adaptation.
- Establish incentives, provide technical support, and fund mandated programs that enable local governments to access federal and state funding to undertake inventories; develop GHG reduction initiatives for planning, facilities, and operations; and promote consistent reporting and information sharing.
- Work with the FAC, FLC, FLM, local governments, regional leagues of cities, metropolitan planning organizations (MPOs), water management districts (WMDs), and the RPCs to reach agreement on one or more standardized methodologies for emissions measurement and reporting (e.g., the ICLEI method) and fund software licenses. Encourage regional collaborations.
- Celebrate successes and publicize demonstrated and documented "best practices" for other local governments. Provide educational opportunities and information to public, private, and nonprofit policy makers at the local, state, and regional levels.
- Coordinate overlapping planning authorities to promote consistent regard for energy use and emissions reduction efforts.
- Link the broad range of state infrastructure investments to improved and integrated transportation and land uses that encourage a reduction in vehicle miles traveled (VMT) and GHG emissions, improved energy efficiency, affordable housing proximate to urban work centers, and progress toward other sustainability and quality of life measures. Utilize performance-based methodologies that promote the reduction of GHG emissions, for example, transportation methodologies that support alternatives to automobile travel, including transit.
- Review and examine the integration of energy, climate, and water policy. Recognizing the nexus between energy and water, the FECC should draw together recommendations to integrate policies across these three critical issues.

Goals: Contingent upon having available funding and necessary programs in place, all counties with a population of more than 200,000 need to have current GHG emissions inventories and mitigation action plans completed by the end of 2010.

Timing: See Goals, above.

Parties Involved: FAC, FLC, FLM, FDOT, local governments, regional leagues of cities, WMDs, RPCs, MPOs, DCA, DEP, the Legislature, and FECC.

Other: A number of policy recommendations involving the relationship between water and energy are being offered across working groups through the Action Team Phase II process. The Action Team or the FECC should examine integrating these policy recommendations to bring forward consistent and coordinated water/energy/climate proposals.

Implementation Mechanisms

Tier 1—Near-term actions:

Offer incentives or programs for local governments to undertake inventories and GHG reduction initiatives for local government planning, facilities, and operations. The following are specific incentives:

- Solicit input from local governments on what incentives would assist them in implementing GHG reductions efforts.
- Provide financial and technical assistance for planning.
- Assemble, evaluate, and distribute a database of local government programs and actions that have proven to substantially and cost-effectively reduce emissions.
- Provide technical support to local governments to enable them to access federal funding for inventories and GHG reductions; publicize and reward best practices for governments.
- Sponsor a local government and state agency recognition program for successful mitigation efforts.

Tier 2—Longer-term actions:

- DCA, in cooperation with the FECC, should convene a working group with representatives of DCA, FDOT, DEP, local governments, MPOs, RPCs, and others as appropriate to study and recommend changes in practice, agreement, rule, or law that are needed to incorporate climate change considerations, facilitate coordination, and minimize inconsistent and overlapping authority between departments and levels of government; these changes would help facilitate and expedite climate change mitigation and adaptation efforts throughout the state.
- Require state and regional agencies and departments to review policies and funding programs. Fund these activities through state appropriations.
- The Executive Office of the Governor and executive agencies need to work closely with the Florida Legislature and the United States Congress to encourage proposals which may promote greater coordination and consistency between levels of government and agencies on matters affecting GHG emissions.
- DEP and the five WMDs should review the State Water Use Plan and regional water supply plans as well as Chapter 373, Florida Statutes, “Stormwater Policy” to evaluate and determine their energy impacts and make recommendations to the FECC for measures to reduce GHG emissions and energy uses in Florida.

Related Policies/Programs in Place

It is anticipated that the EECBG, which has been passed by both houses of Congress and is currently in the appropriations process, will establish a program similar to the Community Development Block Grant (CDBG). Local governments will be eligible for federal grants, based on population, to address local opportunities to save energy and reduce emissions. The initial year's grant requirements will incorporate planning and forecasting efforts. The State of Florida would be well served to assist cities and counties in their efforts to obtain these funds, coordinate efforts with nongovernmental partners, and apply them toward the most fruitful emission reduction opportunities.

HB 697 provides significant direction in the area of transportation, comprehensive planning, and GHG-emissions reduction.

The Volunteer Florida program provides assistance to Florida municipalities.

The Florida Legislature passed HB 7135, which establishes, in part, a "Florida Green Governments Grants Act" that provides for grants to be awarded "to local governments in the development of programs that achieve green standards." Although it was not funded this year, establishment of the program and the statement of legislative support is an important step forward.

A number of Florida cities and counties have adopted the USCM's Climate Protection Agreement, the ICLEI, and the Cool Counties program.

Type(s) of GHG Reductions

All six statutory GHGs (CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6) should be reduced.

Estimated GHG Reductions and Costs or Cost Savings

This policy is not quantified.

Data Sources: Not applicable

Quantification Methods: Not applicable

Key Assumptions: Not applicable

Key Uncertainties

The speed and success with which this policy can be adopted depends upon the degree to which the governments and entities involved share the priority for coordination expressed here.

Additional Benefits and Costs

None

Feasibility Issues

With the full support of the Legislature and other key parties, these recommendations are fully feasible.

Status of Group Approval

Approved

Level of Group Support

Unanimous consent

Barriers to Consensus

None

GP-4. "Green" Business Development Policies

Policy Description

Climate change impacts are likely to have significant effects on all sectors of Florida's economy. Some sectors will face acute challenges, while others will enjoy substantial growth opportunities. GHG mitigation and climate adaptation are also likely to create entirely new economic and employment opportunities. Substantial investment is expected in energy efficiency implementation and renewable energy technologies. These investments hold the promise of diversifying and strengthening the Florida economy.

While there are economic opportunities, there will be costs associated with the transition to a low-carbon economy. However, the Action Teamconsiders the costs associated with inaction to be far greater than the investments associated with GHG reductions. The sooner actions are undertaken, the lower the costs to society. The result is an increasing sense of urgency, as well as an informed understanding that successful responses must be scaled to meet the challenge at hand.

Successful state GHG reduction efforts are highly dependent on active participation of the business community, particularly in the energy, agriculture, transportation, development, construction, and manufacturing sectors. Efforts must also be made to prepare and train the skilled workforce to enable new technologies to rapidly assimilate into the marketplace. All of these investments hold the promise of diversifying and strengthening Florida's economy. The intent of this policy is to encourage and facilitate the involvement of funding and investment sources, business interests, and entrepreneurs in quickly seizing business opportunities related to GHG reductions and climate change solutions.

The state will benefit by early identification of business opportunities associated with climate change by increasing its global competitive advantage and job creation within the state.

The state may also consider providing strategic support to existing critical economic sectors, such as tourism and other natural resource-based industries that may experience stress.

Potential funding sources include philanthropic organizations or individuals, or others interested in supporting innovative market solutions that are environmentally effective. Recognizing that fortunes are likely to be made in the "new energy economy," for-profit investors, pension funds, mutual funds, and venture capitalists may be looking to fund similar business opportunities. Although technology entrepreneurs are often cited as offering potential climate change solutions, equally progressive solutions may lie in the fields of law, accounting, marketing, production, and even government relations and lobbying. The objective of this policy recommendation is to leverage the state's specific talents and natural resources for climate change solutions into securing the business opportunities and market advantages that well-supported, early efforts are likely to reap in a carbon-constrained world. This policy also intends to ensure that Florida has a qualified workforce with the appropriate skill sets within these existing and emerging sectors to capture these investments as effectively as possible.

Policy Design

Successful state GHG-reduction efforts are highly dependent on active participation of the business community, particularly in the energy, agriculture, transportation, development, construction, and manufacturing sectors. The intent of this policy is to encourage and facilitate the involvement of funding and investment sources, business interests, and entrepreneurs in pursuing business opportunities associated with GHG reductions and climate change solutions as quickly and as significantly as possible.

Florida should foster R&D associated with GHG emission reductions, renewable energy, and energy efficiency technologies. The State of Florida should consider whole life cycle costs of potential energy technologies. The state should also promote business, job development, and workforce training in alternative low-carbon fuels and vehicles and other alternative low-carbon technologies, such as energy efficiency.

The Office of Tourism Trade and Economic Development (OTTED) and Enterprise Florida—in conjunction with the FECC—should undertake an analysis to look at new opportunities and at economic sectors that may be negatively impacted. Particular attention should be paid to the potential impact on Florida's tourism and other natural resource–based economic sectors.[2]

Florida should commit to a comprehensive process of mapping labor resources (traditional and nontraditional) and assets capable of implementing workforce solutions to provide much needed awareness of the scope and scale of the challenge. An assessment should be made of key skilled trades, manufacturing, and other energy-related educational programs, from secondary to post-secondary, to determine whether sufficient programs are in place to meet the need ahead. Industry-recognized certifications associated with greening Florida's economy should be identified and supported as stipulated in Florida's Career and Professional Education Act. Further, Florida should strengthen, encourage, and guide, when necessary, the integration of workforce and economic development efforts distributed among industry, economic development organizations, educational institutions, and labor organizations that will ensure maximum mutual benefit, align public and private resources, and heighten cooperation toward the common goal of GHG emission reductions.

The state should unify existing resources and entities with those created under HB 7135 (FECC and the Florida Energy Systems Consortium [FESC]) to support businesses in greening their operations and promote business development opportunities in climate protection and adaptation, including seeking or stimulating funding investments. This can be accomplished by:

- Undertaking an analysis of potential opportunities in green industry development and targeting those technologies for which Florida has an advantage. Examples include energy

[2] See Draft Florida Adaptation Catalog.)

efficiency implementation from building retrofits to waste heat recovery and renewable technologies, such as ocean wave and current energy, wind power, solar thermal and photovoltaics (PV), biomass, and biofuels.

- Analyzing targeted incentives to promote private investment in these technologies or industries, such as tax credits, investment in academic programs and research, grant funding, and investment in workforce development.
- Considering funding opportunities for clean energy technologies through the 33 investment funds managed by the State Board of Administration (with total assets valued at $154 billion), among which is the Florida Retirement System Pension Plan Trust Fund, the fourth largest public retirement plan in the United States.
- Promoting the use of commercially ready technologies through a targeted RPS, an EEPS, building codes, appliance standards, rebates, and tax incentives (sales, property, or investment).

Other measures to accomplish this might include encouraging "business incubator" programs at Florida universities and colleges to attract and support new business development related to the new energy economy.

Florida should offer incentive points for competitive grant programs for state-to-business economic development for businesses that have undertaken GHG reduction and energy efficiency programs.

The designation or creation of a clearinghouse entity would enable the matching of technology developers and other climate solution entrepreneurs with necessary financing more effectively and expeditiously. As a result, the state's ability to identify and secure early business opportunities associated with climate change may be enhanced, increasing its global competitive advantage and increasing job creation within the state. This clearinghouse function might be performed by Florida's network of Small Business Development Centers, or perhaps coordinated through them.

The state should promote low-carbon fuels and vehicles through government actions with public education campaigns, tax and other incentives, and encouragement.

Recognizing the nexus between water treatment use and reuse and energy production and consumption, the state should promote the use and development of effective water conservation plans, low-energy water treatment technologies, and water-conserving products and technologies, such as those certified through EPA's WaterSense program or the Florida Water Star public education program initiated by the St. Johns River Water Management District and being adopted around the state.

Having a government focal point for promoting the development of climate protection businesses would enhance the efficiencies of such an effort.

Goals:

- Meet the GHG reduction goals set out in the 2007 executive orders (80 percent below 1990 levels by 2050, with interim goals of 2000 levels by 2017 and 1990 levels by 2025);
- Determine funding resources to best manage and accomplish target goals;
- Review, determine, and encourage green investing opportunities, including the state treasury and pension fund; and
- Review and determine workforce needs for greening Florida's economy.

Timing: As soon as possible.

Parties Involved: FECC (Office of the Governor), DEP, FDOT, PSC, Florida Fish and Wildlife Conservation Commission (FWC), Florida Building Commission (FBC), the OTTED (Office of the Governor), Enterprise Florida, Workforce Florida, the State Board of Administration, and the Chief Financial Officer.

Implementation Mechanisms

Some implementation mechanisms are described in the Policy Design, above. Many of these will require state agency rulemaking by FBC, DEP, and PSC. In addition to these proposals, the state should require the use of applicable "green buildings" standards for the award of state contracts for state-owned and state-funded projects.

Florida Department of Management Services is required by HB 7135 to develop guidelines for determining what represents a green product and to produce a list of approved products for use by state departments. Beyond this, state agencies should favor contracting with firms that undertake green standards in business operations and in proposed contract work.

Florida should also define "green jobs." Enterprise Florida should conduct or commission a study of job opportunities and develop a targeted strategy for Florida, perhaps modeled after the "Green Pathways" report from Wisconsin. That report offered the following policy implementation principles:

- Target specific sectors within the green jobs universe.
- Use good data on labor market opportunities and skill gaps to drive green jobs initiatives.
- Measure and evaluate green jobs programs and make them better.
- Employ energy standards as green job creation tools.
- Promote green industry clusters.
- Design green jobs initiatives to save existing jobs and to create new ones.
- Link green economic and workforce development.
- Construct green industry partnerships.

- Integrate green jobs initiatives into existing workforce systems.
- Build greener career pathways.
- Extend green ladders to build real pathways out of poverty.

Related Policies/Programs in Place

The Action Team, in their Phase 1 deliberations, recommended further examination of ways the state can support public and private efforts to develop alternative fuels and technologies in Florida. The Action Team also recommended that policies be developed that promote the use of low-carbon vehicles. There are several state and federal grant programs, some administered through the Florida Energy Office (FEO), that attempt to incentivize the use of these fuels and vehicles. The following is a list of current state programs in place:

- 10 percent target for renewable fuels;
- PSC—RPS;
- Florida Energy Efficiency and Conservation Act (FEECA);
- 2008 Florida Energy Bill (HB 7135);
- Grants and incentives—DEP, Florida Department of Agriculture and Consumer Services (FDACS);
- Workforce development;
- Florida Water Star and related water conservation programs;
- Best practices from other states and regions; and
- The Florida Institute for Sustainable Energy (FISE) housed at the University of Florida.

GP-5, Introduce Core Competencies Into Professional Licensing Programs, contains the recommendation to "encourage professional organizations associated with building trades and design professions to develop continuing education programs that include training directly addressing new technologies and materials, and design, development, and construction standards that can be used to reduce GHG emissions, improve energy efficiency, and reduce dependence on fossil fuels."

The following describes in general terms the classes of policies that are in place or proposed and the opportunities and obstacles they face.

- **Improving energy efficiency in buildings and appliances:** This type of reduction represents a large grouping of negative-cost recommendations and includes lighting retrofits; improved heating, ventilation, and air conditioning (HVAC) systems; building envelope and building control systems; and higher performance standards for consumer and office electronics and appliances, among other options. While this category of abatement options would cost the least from a societal point of view, persistent barriers to market efficiency need to be overcome.

- **Increasing fuel efficiency in vehicles and reducing carbon intensity of transportation fuels:** Much of this form of GHG reduction would come from fuel economy packages (e.g., lightweight, aerodynamic, turbo-charging, drive-train efficiency, and reductions in rolling resistance) and increased use of diesel for light-duty vehicles (LDVs). Though the savings from fuel efficiency may offset incremental costs of the abatement option over a vehicle's 12- to 15-year life cycle, these options require up-front investment by automakers and, thus, higher vehicle costs for consumers. Low-carbon fuels, such as cellulosic biofuels, could abate significant levels of GHG emissions (100–370 megatons, if undertaken nationally), though this potential is highly dependent on innovation rates and near-term commercialization of these technologies. Plug-in hybrid vehicles offer longer-term potential if vehicle cost and performance improves and the nation moves to a lower-carbon electricity supply.
- **Pursuing various options across energy-intensive portions of the industrial sector:** This involves a multitude of fragmented opportunities within specific industries (e.g., equipment upgrades and process changes) and across the sector (e.g., motor efficiency and combined heat and power [CHP] applications). Despite offering direct bottom-line benefit, these options must compete for capital and, without clear incentives to control GHG emissions, may not receive funding.
- **Expanding and enhancing carbon sinks:** Increasing forest stocks and improving soil management practices are relatively low-cost options. Capturing them would require linkages to carbon-offset mechanisms to access needed capital plus improved monitoring and verification.
- **Reducing the carbon intensity of electric power production:** This potential derives from a shift toward renewable energy sources (primarily wind and solar), additional nuclear capacity, improved efficiency of power plants, and eventual use of carbon capture and storage technologies on coal-fired electricity generation. Options in the power sector are among the most capital-intensive. These options also tend to have the longest lead times, given bottlenecks to permitting and materials and equipment manufacturing, as well as design, engineering, and construction.

Type(s) of GHG Reductions

All six statutory GHGs (CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6) should be reduced.

Estimated GHG Reductions and Costs or Cost Savings

This policy is not quantified.

Data Sources: Not applicable

Quantification Methods: Not applicable

Key Assumptions: Not applicable

Key Uncertainties

Energy costs; the rate of development of technologies such as carbon capture and storage or reuse (CCSR); the rate of adoption of state, regional, and federal mandates for the use of new and alternative technologies; and competition from other jurisdictions.

Additional Benefits and Costs

Additional Benefits:

Increased tax revenues.

Costs:

None

Feasibility Issues

These measures involve actions and decisions by agencies and entities that are not directly involved in this process or that necessarily see their potential for a role in addressing climate change. If these recommendations are adopted, these agencies and entities would have to be engaged through outreach from Florida's leaders.

Status of Group Approval

Approved

Level of Group Support

Unanimous Consent

Barriers to Consensus

None

GP-5. Introduce Core Competencies Into Professional Licensing Programs

Policy Description

Florida has more than 200,000 licensed built-environment professionals, including building contractors, architects, landscape architects, engineers, interior designers, and others involved in the design and construction of Florida's residential and commercial sites and buildings. All of these professionals must earn continuing education units (CEUs) to maintain their licenses. In addition to required CEUs, built-environment professionals have access to rater and certification training associated with certification programs such as the Home Energy Rating System (HERS), U.S. Green Building Council (USGBC), Leadership in Energy and Environmental Design-Accredited Professional (LEED-AP), and the Florida Green Building Council (FGBC). Additional training opportunities are available through Florida's universities and community colleges.

Many professional associations are already providing continuing education or educational opportunities to their constituencies on climate change, GHG emissions, and energy efficiencies. It is critical that Florida's licensed professionals, who are responsible for the design, development, and construction of Florida's built environment, incorporate climate change and energy efficient technologies, materials, and design into their projects to facilitate the reduction of GHG emissions. Therefore, the state needs to establish and administer core competency requirements for licensed professionals who provide site and architectural design, site engineering, site construction, building construction, and building operations efficiencies services. The state also needs to require professional organizations, in support of their respective professional membership, to develop and administer continuing education programs that specifically address new technologies, standards, and materials designed to reduce GHG emissions and promote energy efficiency.

Additionally, within Florida's university system, design and engineering programs should establish required courses of study that specifically focus on the issues and importance of climate change mitigation and energy efficiency toward establishing a sustainable Florida.

Policy Design

Introduce core competencies on climate change into professional licensing programs (e.g., energy efficiency in site and architectural design, engineering design, building construction, operation and maintenance, use of recycled materials, use of local materials, and environmental design practices).

Targeted professions should include

- Architecture,
- Interior design,

- Civil engineering,
- Environmental engineering,
- Building inspectors,
- Code compliance officers,
- Building trades (e.g., plumbing and HVAC),
- General contractors (site and building),
- Real estate,
- Building operators,
- Landscape architecture, and
- State-certified teachers.

Specific climate change-related questions will be added to the respective state licensure examinations. To maintain professional licenses within the designated design professions, the state will require the respective professional organizations to develop and administer continuing education programs that reinforce the importance of reducing GHG emissions and promoting energy efficiency.

In addition, the state will work with energy-related certification and rater programs to promote greater access to training and education for built-environment professionals to enhance their ability to effectively apply building science principles to reduce energy consumption and GHG emissions.

To ensure that the state's universities educate and prepare our future design and engineering professionals about the urgency and importance of designing and developing for a sustainable Florida, the state's university design and engineering programs will develop and administer required courses of study within the respective disciplines that specifically focus on the issues and importance of GHG emission reduction, climate change mitigation, and energy efficiency. The State of Florida will expand its relationship with professional associations, universities, and other educational institutions to encourage and enable the development of curricula to carry out this mandate.

Goals: To enhance the ability of licensed, built-environment and design professionals to effectively apply building science principles to reduce energy consumption, dependence upon the use of fossil fuels, and GHG emissions.

To reduce energy consumption, dependence on the use of fossil fuels, and GHG emissions by applying best practices of climate change mitigation and by ensuring that Florida's licensed professionals (who are largely responsible for the design, development, and construction of the Florida built environment) are knowledgeable and current on GHG emission reduction and climate change technologies, building materials and design, and development and construction standards. Through ongoing education of licensed professionals, current and new technologies, materials, design, and development and construction standards will be applied to new and redeveloped projects in Florida's communities.

Timing: By 2010, all professional license testing and exams for the professionals described above shall be modified to address policies and best practices for reduction of GHG emisions and energy efficiencies.

Parties Involved: Florida Department of Business and Professional Regulation (DBPR), Workforce Florida, DEP, FECC, statewide professional organizations, local code enforcement agencies, and state universities and community colleges. Involve the Conserve Florida Clearinghouse, which was developed for improving water use efficiency in public water supply, in the evaluation of building program measures to save energy.

Other: None.

Implementation Mechanisms

Mandate that State Boards of Licensing for building and design professionals include core competencies on climate change in licensing exams. The exams should cover knowledge of the improved building codes; energy performance requirements; energy efficient site and architectural design; engineering design; building construction, maintenance, and operation; use of recycled materials; use of local materials; and environmental design practices.

Encourage professional organizations associated with building trades and design professions to develop continuing education programs that include training directly addressing new technologies and materials, along with design, development, and construction standards that can be used to reduce GHG emissions, improve energy efficiency, and reduce dependence on fossil fuels.

Develop education and certification training programs for builders and contractors on efficient heating and air conditioning sizing and installation.

Develop a Florida Green Building certification program for licensed professionals involved in the design and construction of residential and commercial buildings and development sites. (An example could be the Certified Green Building Professionals [CGBP] program administered by Build It Green for California building professionals.)

Include required courses of study at the state universities and community colleges within the respective disciplines that specifically focus on the issues surrounding and importance of GHG emission reduction, climate change mitigation, energy efficiency improvements, and reduced dependence on fossil fuels.

Related Policies/Programs in Place

Certification programs such as HERS, USGBC, LEED-AP, and FGBC.

Training courses through Florida's universities, community colleges, and technical schools.

Continuing education programs offered through professional associations.

Some of the education programs proposed under GP-4, "Green Business Development Policies."

Type(s) of GHG Reductions

All six statutory GHGs (CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6) should be reduced.

Estimated GHG Reductions and Costs or Cost Savings

This policy is not quantified.

Data Sources: Not applicable

Quantification Methods: Not applicable

Key Assumptions: Not applicable

Key Uncertainties

The support of the state boards of licensing and related professional associations has not been tested by this process. The speed and success with which this policy can be implemented will depend in part on the degree to which these parties support the changes proposed here.

Additional Benefits and Costs

None

Feasibility Issues

None

Status of Group Approval

Approved

Level of Group Support

Unanimous consent

Barriers to Consensus

None

Appendix F
Adaptation (ADP) Planning Framework for Florida

Summary List of Florida's Adaptation Planning Framework

Framework Identifier.	Planning Framework Element	Status
ADP-1	Advancing Science Data and Analysis for Climate Change	Approved
ADP-2	Comprehensive Planning	Approved
ADP-2.1	Local Government Level	Approved
ADP-2.2	Regional Government Level	Approved
ADP-2.3	State Government Level	Approved
ADP-3	Protection of Ecosystems and Biodiversity	Approved
ADP-3.1	Uplands, Freshwater and Marine Systems	Approved
ADP-3.2	Beaches and Beach Management	Approved
ADP-3.3	Species Protection	Approved
ADP-4	Water Resource Management	Approved
ADP-5	Built Environment, Infrastructure and Community Protection	Approved
ADP-5.1	Building Codes and Regulation	Approved
ADP-5.2	Flood Protection	Approved
ADP-5.3	Beaches as Infrastructure	Approved
ADP-5.4	Transportation and Other Infrastructure	Approved
ADP-6	Transportation and Other Infrastructure (moved into ADP-5)	Approved
ADP-7	Economic Development	Approved
ADP-7.1	Tourism	Approved
ADP-7.2	Other Resource-based Industries	Approved
ADP-7.2.1	Agriculture	Approved
ADP-7.2.2	Forests	Approved
ADP-7.2.3	Marine	Approved
ADP-7.2.4	Aquaculture	Approved
ADP-7.2.5	Mining	Approved
ADP-7.3	Construction	Approved
ADP-8	Insurance (Property and Casualty)	Approved
ADP-9	Emergency Preparedness and Response (Extreme Events)	Approved
ADP-10	Human Health Concerns	Approved
ADP-10.1	Health Care	Approved
ADP-10.2	Air Quality	Approved
ADP-10.3	Wastewater Treatment	Approved
ADP-10.4	Disaster Response	Approved
ADP-10.5	Medical Treatment and Biomedicine Development	Approved
ADP-11	Social Effects	Approved

Framework Identifier.	Planning Framework Element	Status
ADP-11.1	Social Justice Issues	Approved
ADP-11.2	Food and Water Security	Approved
ADP-11.3	Housing	Approved
ADP-11.4	Intersection of Climate Change and Human Behavior	Approved
ADP-12	Organizing State Government for the Long Haul	Approved
ADP-13	State Funding and Financing	Approved
ADP-14	Coordinating with Other Regulatory and Standards Entities	Approved
ADP-14.1	Federal Government	Approved
ADP-14.2	Professional Societies	Approved
ADP-15	Public Education and Outreach	Approved

Note: The numbering used to denote the framework elements is for reference purposes only; it does not reflect prioritization among these important draft policy options.

Introduction

The Governor's Action Team on Energy and Climate Change (Action Team) charged the Adaptation Technical Working Group with providing two deliverables. The first deliverable was an adaptation planning framework enumerating the multiple elements for which planning should occur in order to better ready Florida for the changes likely to occur over the next century as global mean temperatures increase consistent with the best available science from the United Nations' Intergovernmental Panel on Climate Change, the National Academy of Sciences, and other sources. Secondly, the Action Team charged the working group with providing early policy actions related to climate change adaptation in advance of more substantive policy development by the Florida Energy and Climate Commission using the planning framework outlined here.

This technical appendix provides the planning template in the full detail as developed by the Adaptation Technical Working Group. It also identifies early policy actions proposed by the Technical Working Group and approved by the Action Team. These early policy actions are denoted as "strategies."

ADP-1. Advancing Science Data and Analysis Climate Change

Description of Issues

Florida is one of the most vulnerable areas in the world to the consequences of climate change, especially sea level rise (SLR), and the possibility of increased hurricane activity.[1] Regardless of the underlying causes of climate change, glacial melting and expansion of warming oceans are causing SLR, although the extent or rate for Florida cannot be predicted with certainty. In addition, hurricane activity in the North Atlantic Basin has increased significantly in recent years, but there is controversy over whether the primary cause is global warming or natural weather cycles, making the long-term trend indeterminate at this time. Not knowing which of Florida's barrier islands, floodplains, and what portions of major cities will be inundated, or when are among the factors that make planning for adaptation to climate change difficult. However, there is sufficient information to justify implementing many adaptations. Climate change and the length of time needed to implement some adaptations further justify the need for action in spite of these uncertainties. However, in all cases, adaptation should be guided by good science.

Objectives

Scientific data, analyses, and predictive modeling are needed to understand how Florida's climate is likely to change, the consequences of change, and possible solutions. Focusing on four key issues will help advance the science.

- Reducing uncertainty in climate projections and enhancing predictive power of climate models for Florida is critical, especially their temporal and spatial resolution. Improving models requires addressing considerations specific to Florida: strong marine influence and peninsula effect; the wide climate gradient from the temperate northern region to subtropical southern region of the state; lack of long-term physical climate measurements for historical trends (although some proxies are available); huge climate variability; complicating effects of the interaction of land-use change (e.g., wetland loss); and climate change.
- Given climate modeling limitations for Florida, the current planning template focuses on SLR and the potential for increasing hurricane strength. Scientific data and analyses to predict other potential effects of global warming that could affect Florida are still extremely underdeveloped. There is no data available at this time that adequately assess potential effects, such as increased drought, wildfires, flooding, and invasive species. Until models improve, appropriate risk management and adaptive management will be challenging.

[1] For recent review, see Florida Atlantic University. 2008. "Florida's Resilient Coasts: A Store Policy Framework for Adaptation to Climate Change." Fort Lauderdale, FL: Florida Atlantic University.

- Recognize that adaptability refers to the ability of humans to manage the resilience and capacity of the system (e.g., ecological, economic, social) to absorb the disturbance of climate change. Our science needs to address three crucial aspects of resilience: the amount of change Florida can withstand before switching over to another state or condition from which it cannot recover its former function, the ease or difficulty of making changes, and how close the current system is to a switching threshold.
- Improving our understanding of socioeconomic responses to alternative climate predictions will better guide public policy and incentive programs. New approaches and tools, such as agent-based models (ABMs) will provide a better framework to examine interactions of socioeconomic and climate change.

Assets at Risk

Not applicable.

Existing Actions

House Bill (HB) 7135, passed in the 2008 Legislative Session, directly addressed collecting and acquiring better emissions data, as well as ensuring improved analysis of all emissions data. Among other actions, the bill created the Florida Energy Systems Consortium (FESC) as a "supercenter of excellence" within the State University System (SUS) to better coordinate energy-related research in support of Florida's energy and climate change policy objectives. The bill did not address research that can support adaptation.

Goals and Strategies

Goal 1: Provide a measurable outcome and scientific evaluation for each of the goals and strategies outlined in the Adaptation Policy Options to assess whether they have been met. Evaluation should be science-based, using the complementary skills of climate scientists, ecologists, hydrologists, social scientists, and economists. Test programs and pilots to measure and assess alternative outcomes are encouraged.

Strategy A: HB 7135 in the 2008 Florida Legislative Session created the FESC as a "supercenter of excellence" within the SUS. The center should consider, as a priority order of business, the appointment of a scientific advisory council composed of members from identified disciplines which are relevant to adaptation to climate change and representatives of each participating institution to better coordinate research in support of Florida's adaptation and climate change policy objectives.

Strategy B: The Florida Energy and Climate Research Trust Fund should be created by the Legislature and a dedicated revenue stream should be provided.

Goal 2: Foster and support a climate science research agenda for Florida with broad priorities as outlined below. Consider instituting a new scientific advisory council on climate change to advise state government on this research agenda. Identify and establish long-term funding to support research. Funding should be protected from short-term economic or political cycles.

Strategy A: HB 7135 in the 2008 Florida Legislative Session created the Florida Energy Systems Consortium as a "super center of excellence" within the State University System. The center should consider, as a priority order of business, the appointment of a scientific advisory council composed of members from identified disciplines adaptive to climate change and representative of each participating institution to better coordinate research in support of Florida's adaptation and climate change policy objectives.

Strategy B: The Florida Energy and Climate Research Trust Fund should be created by the Legislature, and a dedicated revenue stream should be provided.

Goal 3: Conduct research needed to support incorporation of climate change into the protection of Florida's ecosystems and biodiversity.

Strategy A: Calculate the economic value and services provided by Florida's natural communities and associated species to inform decisions regarding state budget and policy requirements. Disseminate information broadly.

Strategy B: Define the likely new "states" of Florida ecological systems to determine state budget and policy requirements. Identify species and habitats that are not likely to migrate naturally and craft strategies to assist migration or re-create habitat elsewhere to facilitate this shift.

Strategy C: Expand the newly developed Critical Lands & Waters Identification Project (CLIP) v1.0 database to incorporate impacts and adaptation to climate change. CLIP updates, unifies, and prioritizes existing geographic information systems (GIS) databases. Completed July 1, 2008, CLIP identifies and prioritizes statewide natural resource landscapes, biodiversity, and water and serves as a starting point for the Cooperative Conservation Blueprint project.

Goal 4: Enhance support for mapping, monitoring, and modeling will be necessary to provide information to support policy making. For example, the state is supporting use of light detection and ranging (LIDAR) to improve mapping of Florida's coastlines. Such mapping should be done for the entire coastline of the state. In addition, effective monitoring programs are needed to detect impacts of climate change, as well as modeling to better project impacts.

Strategy: Create a new center to coordinate and align data from proxy data sets to build a more precise picture of climate change in Florida over the last few thousand years and predict the effects of climate change in the future. This data center could also track associated responses in vegetation, sea level, and disturbances such as fire.

Goal 5: Support projection of climate change at smaller scales to forecast state and local impacts and to pinpoint risks.

Goal 6: Collaborate to the greatest extent possible with other similar research efforts by the federal government, the private sector, and non-state research institutions and universities.

Priorities for Further Research and Analysis

A number of plans and proposals for research that will support adaptation to climate change, among other things, have been published, including the "Annual Science and Research Plan" prepared by the Florida Oceans and Coastal Research Council and "A Strategic Implementation Plan for Florida COOS: 2008–2010" written by the Florida Coastal Ocean Observing System (FLCOOS). Such plans can be consulted for specific ideas on research that will enhance Florida's ability to manage marine and coastal resources vulnerable to climate variability and change. It is not known whether there is an integrated research priority list counterpart to this for Florida's terrestrial and freshwater systems; one research priority might be to initiate such a process and to cross-reference these lists for areas of synergy.

There are already a number of cross-cutting priorities for research and analysis that Florida should consider, including the following:

- Emphasize collaborations with international climate scientists, to refine climate predictions for Florida. The state, in partnership with federal agencies, international efforts, and Florida universities, should (a) undertake review of current studies and models, (b) consider updating model development to more precisely forecast changes in Florida's weather patterns, and (c) undertake specific analysis of uncertainties and contingencies in climate scenarios for Florida.
- Place special emphasis on establishing or enhancing programs to follow developments regarding the climate-related impacts of SLR and hurricane activity, considering that Florida is particularly vulnerable to potential impacts.
- Establish or enhance existing programs to monitor and determine trends in other climate-related impacts that could have consequences in Florida including increased drought, wildfires, flooding, storm water runoff, heat waves, problems with invasive species and insect-borne disease resulting from changes in temperature and rainfall regimes, adverse effects on native terrestrial species, natural communities and marine life, saltwater intrusion into aquifers, more frequent and intense storms, storm surges, tidal regimes, and coastal erosion. Build a decision support structure to guide and prioritize an ongoing Florida-specific research agenda.
- Deploy a "Florida Land and Sea Mesonet" to serve as a world-class network of integrated environmental monitoring stations, drawing from and contributing to existing terrestrial and marine networks, capitalizing and building on deployed meteorological stations, evapotranspiration (ET) stations, micro-meteorology towers, flow gauges and well/aquifer

monitoring, and other critical monitoring networks to meticulously track changes in Florida's climate and hydrology and fill gaps in statewide network coverage. The existing FLCOOS should include climate impacts.

- Support scientists working on availability of remote sensing data and methods for gathering it to provide actual continuous statewide coverage (and for coverage of the associated surrounding oceanographic area of influence), with consistent spatial grids and measurements, for common inputs for climate and hydrologic models.
- Link climate scientists with ecologists, economists, and social scientists. Issue a request for proposal (RFP) from interdisciplinary teams of social scientists, economists, and climate scientists to build interactive models that include non-linearities and feedbacks to better predict Florida's responses to anticipated changes. ABMs are appropriate here because of the complexity of climate change models and responses.
- Build socioeconomic models to evaluate the effectiveness of alternative incentives and policies. Select pilot areas and locations in the state to test policy programs. Evaluate effectiveness of adaptation strategies at regular intervals
- Build better decision tools to incorporate total cost accounting for local and regional planning decisions, so that proposed land-use changes, agricultural policy shifts, water-use policies, transportation decisions, siting of major new industries, and other changes will have a full assessment of all public costs, including the likely carbon or greenhouse gas (GHG) footprint and water use. Decision tools should also include assessments of proposals for land-use changes in light of the predicted climate changes.

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ADP-2. Comprehensive Planning

Description of Issues

Florida has an integrated planning process that local, state, and regional governments can use to prepare plans that direct future growth and development, conservation of natural resources, and provision of public facilities. Under state law, planning in Florida is guided by standards that require a consistent policy direction and coordination among plans.

The framework for the integrated planning process starts with Florida's State Comprehensive Plan (SCP), which contains goals and policies that set broad directions on energy, land use, and other issues relevant to future adaptation to climate change. At the state level, there is a transportation plan and a water plan. At the regional level, there are 11regional planning councils (RPCs), each of which has adopted a strategic policy plan. In addition, at the regional level, there are five water management districts (WMDs) and seven transportation districts, each with planning documents that guide programs and decision making. At the local level, each county and municipality in Florida has adopted a comprehensive plan that includes goals, objectives, and policies that address future land use, conservation, coastal management (where applicable), transportation, public facilities, parks and recreation, housing, intergovernmental coordination, and capital improvements. Local land development regulations and permits must be consistent with the comprehensive plan.

The 2008 Florida Legislature amended the SCP to address GHG reduction strategies with attention to facilities that generate electrical power. The 2008 requirements for local comprehensive plans represent an important initial step but are oriented more toward energy use and GHG emission reductions than on adaptation to changing climatic conditions.

Objectives

Chapter 187 of the Florida Statutes requires that, "The State Comprehensive Plan shall provide long-range policy guidance for the orderly social, economic, and physical growth of the state." It also states that the plan is a "direction setting document" that should be "reasonably applied where they are economically and environmentally feasible, not contrary to the public interest, and consistent with the protection of private property rights."

Florida's local, state, and regional comprehensive plans should be amended, based on best available data, to include goals, objectives, and policies that will prepare the state for adapting to the future impacts of climate change, such as SLR. Future policies should use incentives to encourage desired actions, including encouragement not to repeat past decisions that will leave new development exposed to SLR and other climate change consequences.

Assets at Risk

Florida may be one of the states most at risk to climate change. It is surrounded by water on three sides, and its relatively flat terrain means that large areas of the coast are at risk of inundation from SLR or coastal storm exposure, particularly tropical storms and hurricanes.

SLR will affect Florida's valuable shoreline resources, including the beach, coastal vegetation and habitat, and significant public and private built investment. Decisions will need to be made about relocation, redevelopment and, where appropriate, retreat from the shoreline.

The projected consequences from climate change, such as SLR, may lead to future questions about reducing risks in hazard-prone areas and areas that could face increased risks under climate change as well as the rights of private property owners and the police power and trusteeship responsibilities of state and local governments to protect the community at large. These issues will likely be focused on private property adjacent to the beach and in low-lying areas subject to increased flooding. All these issues must be considered while planning for future growth, because between now and 2030, the state will need to develop residential, commercial, and retail areas to serve twice our current population.

Existing Actions

Governor Crist created the Florida Energy and Climate Change Action Team through executive order. That Action Team has appointed Technical Work Groups (TWGs) to address these issues. One TWG is reviewing the state's Transportation and Land Use (TLU) planning in particular, and the Government Policy (GP) TWG is addressing these issues as well.

The 2008 Florida Legislature passed HB 7135, which created the Florida Energy and Climate Commission (FECC). The FECC will continue the work of the Action Team and consider and coordinate certain recommended Action Team adaptations to the land-use planning process. The bill also amended Section 339.175, Florida Statutes, to encourage metropolitan planning organizations (MPOs) to consider GHG emissions in their planning processes.

ADP-2.1 Local Government Level

Goals and Strategies

Goal 1: Ensure that all relevant elements of local government comprehensive plans (e.g., future land use, coastal zone management, and capital facilities) are updated to reflect the best available data and strategies for adapting to future climate change impacts.

Strategy A: The Florida Department of Community Affairs (DCA) should work with the FECC to create a phase-in formula requiring future updating of local plans through the Evaluation and Appraisal Process (EAR).

Strategy B: The FECC and DCA will recommend to the Florida legislature new authority to provide necessary direction for local government comprehensive plans to address the range of adaptation actions, including built environment, anticipated from climate change impacts.

Goal 2: State and regional agencies should provide financial and technical assistance to local governments to ensure timely updates of local plans.

Strategy A: Update the climate change section of the DCA Planning Tools Web site with adaptation information from the Action Team and other sources.

Strategy B: Tie state and regional agencies into a broadly available state digital database focused on climate change and ensure that all pertinent state records are digitized to provide local government planners with instant access to the information they need to better consider the impacts of updates to local plans.

Goal 3: Counties and municipalities located within each county should collaborate to create working groups (e.g., Miami-Dade County Climate Change Advisory Task Force) to study their comprehensive plans and recommend changes that better address adaptation to local climate change.

Goal 4: Local governments should review elements of their coastal management plans to determine whether there are any amendments that could make their coastal areas (especially the coastal high-hazard areas) more resilient to the impacts of climate change, including SLR.

Strategy A: Amend Chapter 163.3178 (8), to provide for coastal counties to include SLR as a criterion when prioritizing lands for acquisition through state programs.

Strategy B: Create a best practices manual for local governments to use that incorporates risk from SLR when identifying coastal lands for state acquisition using new adaptation language incorporated into local, state, and regional government land acquisition processes.

Strategy C: Identify and revise statutory direction for local, state, and regional planning processes to identify potential within planning areas, particularly coastal areas, for SLR. Provide for an assessment of

- The potential movement of the coastal construction control line and related changes,
- The extent and potential for expansion of floodplains, and
- Habitat and wildlife migration potentials.

Strategy D: DEP, DCA, and the state's RPCs should jointly develop, assess, and recommend a suite of planning tools and climate change adaptation strategies for local governments so they can maximize opportunities to protect the beach/dune system, coastal wetlands, and other coastal resources in an era of rising seas. The tools should include strategies to encourage the landward siting and relocation of structures and public facilities in areas adjacent to receding shorelines through acquisition, rolling easements, transfer of development rights, stronger setbacks, and tax incentives.

ADP-2.2 Regional Government Level

Goals and Strategies

Goal 1: RPCs should update their Strategic Regional Policy Plans (SRPPs) to reflect important regional issues concerning adaptation to the impacts of climate change.

Strategy: DCA, RPCs, and the FECC should agree on guidance in the DCA-RPC annual contracts that directs how adaptation language is to be made part of the SRPPs.

Goal 2: WMDs should modify regional water supply plans and other regional water management activities to include adaptation measures that address impacts from climate change.

Strategy: DEP, the five WMDs, and the FECC should agree on future guidance for updating regional water supply plans and other water management activities to ensure that they address adaptation to climate change impacts such as SLR.

ADP-2.3 State Government Level

Goals and Strategies

Goal 1: The SCP and comprehensive plans of other relevant state agencies should be updated to reflect future actions that promote adaptation measures that address the impacts from climate change.

Strategy A: The Governor, acting as Chief Planning Officer of the state, should direct the Office of Planning and Budget to work with the FECC, state and regional agencies, local governments, special districts, and interested parties to propose changes to the SCP that address climate change adaptation for review by the Legislature.

Strategy B: The SCP, Chapter 187.201(8), Coastal and Marine Resources, goals and policies should be amended to address adaptation to the consequences of climate change.

Strategy C: The DCA should explore using the Areas of Critical State Concern Program as a way to provide special assistance in planning and redevelopment for areas of the state at high risk of change due to SLR.

Strategy D: The Florida Division of Emergency Management (DEM) should incorporate SLR and increasing storm surge impacts into its efforts to remap potential hazard areas in coastal zones. Revised hazard area designations should better reflect the risks to communities associated with climate change and allow reevaluation of suitability for development in these areas.

Goal 2: The FECC should encourage cooperation at all levels of government and recommend additional goals and strategies to ensure that adequate measures are taken to adapt to future impacts from climate change.

Goal 3: A balance should be achieved between protecting property rights and protecting communities and natural resources.

Strategy A: The Office of the Florida Attorney General should monitor state, regional, and local actions to address the impacts of climate change for potential conflicts between private property rights and the government's responsibilities to protect its communities, natural resources and public usage and access to government lands. Specific attention should be given to possible conflicts with the individual rights of private landowners who are affected by sea level rise, beach erosion, and other impacts of climate change. The Attorney General should issue a report with recommendations every five years.

ADP-3. Protection of Ecosystems and Biodiversity

Description of Issues

Florida's terrestrial, freshwater, and marine systems extend from temperate north Florida to subtropical south Florida. Many tropical species are at their northern range limits in Florida; many temperate species are at their southern limits. The result is a highly diverse, unique assemblage of species and, in terrestrial and freshwater systems, many species which occur only in Florida. Florida has 1,350 miles of coast that is home to a diverse array of marine and coastal natural communities and associated species, including the world's third largest fringing barrier reef and a barrier island system that provides a great amount of habitat diversity.

The State of Florida has the third highest number of species in the United States (more than 5,000), of which approximately 670 occur only in Florida. Its approximately 4,000 native and exotic plant species are distributed over 81 plant communities. According to the U.S. Fish and Wildlife Service (US FWS), 114 species are listed as endangered or threatened (2008), including the West Indian manatee, green sea turtle, and brown pelican.

Florida's upland ecosystems are characterized by temperate climate, dry soils, and gently sloping, forested hills. The dominant plant species in dry uplands include pines and oaks. Plant species in the wetter uplands include southern magnolia, beech, spruce pine, Shumard oak, Florida maple, and other hardwoods. Coastal uplands feature sandy soils, and their plant communities consist of sea oats and mixed salt-spray-tolerant grasses, shrubs, and herbs.

Florida's freshwater ecosystems include wetlands, streams, lakes, and ponds. Coastal wetlands and swamps are generally inundated with freshwater but are subject to tidal cycles and are saltwater-tolerant.

Wetlands cover approximately 30 percent of the State of Florida and play an important role in flood protection. Streams can vary from seasonal to permanent waterways, and plant species generally grow along stream edges.

Beaches, as Florida's primary tourism attraction, are one of the state's most important economic engines, generating tens of billions of dollars in annual revenues through jobs, tourism, recreation, and taxes. Beach-related tourism has a $41.6 billion annual impact on Florida's economy. In addition, over 25 percent of the value of Florida's coastal real estate can be attributed to beaches.[2]

[2] Stronge, W.B. 2002. "The Economic Benefits of Florida's Beaches: Local, State, and National Impacts." Boca Raton: Florida Atlantic University.

A healthy beach/dune system provides protection for upland property and infrastructure and increases a beach's resiliency (for example, its ability to recover from storm events). Florida's beach/dune system also provides important habitat for marine turtles, shorebirds, beach mice, invertebrates, and other species. Currently, more than half of Florida's 825 miles of sandy beaches are experiencing chronic erosion, and about 42 percent are designated as critically eroding (meaning they need long-term maintenance in order to ensure protection of vulnerable upland properties, recreational interests, wildlife habitat, or important cultural resources).

Reefs are affected by disease and bleaching. In addition, overfishing, polluted runoff, and reduced freshwater inflows also threaten the health of marine ecosystems. The state is making an effort to establish marine sanctuaries to protect its marine ecosystem from further damage. Species found here include seabirds, dolphins, whales, and manatees, as well as many types of invertebrates, crustaceans, and fishes (e.g., bony fishes, sharks, skates, rays, and eels). Alligators, crocodiles, and turtles can also be found in this area. Habitats include sea grass beds, sandy bottoms, reefs, and open ocean.

These natural resources provide many economic benefits to Florida. For example, 4.2 million people participated in some form of residential or nonresidential wildlife viewing in Florida in 2006, with related total retail sales estimated at $3.1 billion ($2.4 billion by residents and $653.3 million by nonresidents) for that period.

Objectives

The Florida Constitution calls for the "management, protection, and conservation of wild animal life and freshwater aquatic life." Florida law notes that the "State of Florida harbors a wide diversity of fish and wildlife and that it is the policy of this state to conserve and wisely manage these resources" and calls the state to "protect and acquire unique natural habitats and ecological systems…and restore degraded natural systems to a functional condition." With regard to coastal and marine resources, the "development and marine resource use and beach access improvements in coastal areas do not endanger public safety or important natural resources."

Managing ecosystems for resilience enhances their ability to naturally adapt to the stresses of climate change and other pervasive threats. Specifically, good management should:

- Maximize the resilience of species and habitats to climate change impacts by minimizing other human induced threats;
- Facilitate and maintain the persistence of coastal ecosystems and the ecological and human services they provide;
- Increase understanding of how Florida's marine and coastal ecosystems may migrate and change because of climate change;
- Identify areas, natural communities, and species of particular ecological vulnerability;

- Protect natural communities vulnerable to SLR from loss resulting from shoreline hardening and other actions that prevent or inhibit natural upslope migration;
- Identify and secure paths for other inland habitats to migrate with changes in temperature, rainfall patterns, and groundwater levels; and
- Protect inland natural communities from competing climate change adaptation pressures, such as the landward relocation of coastal development, human demands for ground and surface water, and engineered solutions for flood mitigation.

Specific objectives for beaches include ensuring the long-term protection of the beach/dune system and preserving its ecological functions as well as:

- Considering how climate change could be incorporated into all aspects of the beach management and coastal construction regulatory programs.
- Developing policies to discourage development adjacent to eroding shorelines and encouraging the placement of structures and infrastructure away from retreating shorelines; these measures may reduce future reliance on coastal bulkheading, which can accelerate beach loss.
- Purchasing private coastal lands that have been strategically targeted to provide buffers for retreating shorelines, to preserve and protect habitats and ecosystem function, and to increase the resiliency of the shoreline to recover from storm events.
- Enhancing communication on coastal resource protection between and within state regulatory agencies, such as DCA and DEP, can ensure more efficient use of resources and expertise in developing adaptation responses and strategies.

Assets at Risk

Temperature, rainfall, sea level, and ocean chemistry play critical roles in determining where individual species of plants and animals can live, grow, and reproduce. The effects of climate change on species and ecosystems can be direct and indirect. Climate change will change the structure and composition of ecosystems and communities; coastal and estuarine habitats; ocean chemistry (lower pH levels adversely affect growth of corals, shellfish, and some algae); geographic range of species; timing of species' life cycles, which may become out of sync with other species they depend on; plant growth, nutrient composition, plant-animal interactions, and ecosystem nutrient cycles; and the intensity and magnitude of existing stresses, such as invasive species and wildfire regimes, on biodiversity and ecosystem structures, functions, and processes. In addition, climate change is also projected to result in increased risk of extinction for some species (e.g., those with limited dispersal capabilities or those that live in specialized habitats) and opportunity for range expansion of invasive species.

SLR and other predicted impacts of climate change (e.g., increases in frequency and intensity of coastal storms and higher storm surges) increase beach erosion, shoreline recession, and barrier migration and have a profound impact on Florida's beaches, the beach-using public, and the tourism industry.

As beaches erode and recede, many of the values and benefits they provide are threatened. In addition, public access to lands held in trust for the public, including the wet sand beach and near shore-submerged lands, is greatly diminished. Conflicts over public usage and private property rights will likely increase as beaches recede and the area of dry sand beach decreases.

Existing Actions

DEP includes in its annual "*Florida Forever* Work Plan" a list of lands that sequester carbon, provide habitat, protect coastal lands or barrier islands, and otherwise mitigate and help adapt to the effects of SLR. DEP's Office of Coastal and Aquatic Managed Areas (CAMA) has 42 aquatic preserves around the state that are managed to protect natural values. CAMA also co-manages with the National Oceanic and Atmospheric Administration (NOAA) the Florida Keys National Marine Sanctuary, and three National Estuarine Research Reserves. The Florida Fish and Wildlife Conservation Commission (FWC) overseas the Florida Wildlife Legacy Initiative; which includes major terrestrial, freshwater, and marine systems and strives to keep common species common. In addition, DEP (state parks), (DOF), the Florida Fish and Wildlife Conservation Commission (FWC), and other state agencies have ongoing programs to maintain natural systems in a healthy state. On a parallel track, federal and local governments and private organizations, such as The Nature Conservancy and the Audubon Society, maintain parks, and natural areas.

ADP-3.1 Uplands, Freshwater and Marine Systems

Goals and Strategies

Goal 1: A representative portfolio of Florida's terrestrial, freshwater, and marine natural communities with redundant representation of habitats and species and connecting corridors (e.g., Florida's Biodiversity Blueprint) is protected and well managed in a manner that maximizes the health and resilience of these systems to climate change impacts.

Strategy A: Tie into existing and expanded databases such as CLIP to examine existing local, state, regional, and federal land holdings and categorize these holdings with regard to the representative portfolio.

Strategy B: Provide an accessible, expanded, and updated database to track changes to the natural communities and corridors.

Strategy C: The FECC should consider the recommendations for biodiversity and ecosystem adaptation to climate change developed through the Florida's Wildlife: On the Frontlines of Climate Change summit.

Goal 2: Acquire and appropriately manage lands needed to complete critical south-to-north migration corridors to accommodate range changes in species and natural communities driven by climate change.

Goal 3: Important natural communities vulnerable to SLR (e.g., intertidal and coastal habitats) are buffered or protected (from shoreline stabilization and hardening) to maximize the probability of their persistence into the future.

Strategy A: DEP and other relevant agencies should develop state wetlands conservation and restoration plans that clearly designate wetland migration corridors as the sea level rises.

Strategy B: The Legislature should place a priority on coastal land acquisition through the *Florida Forever* program, a separate dedicated funding source, or through other means. Greater incentives should be provided to local governments and private organizations to acquire and manage ecologically important coastal lands, including upland buffers. Acquisition efforts should be strategically targeted to protect coastal resources, reduce insured risk, and reduce the impacts of climate change on both ecosystems and communities.

Goal 4: Areas that may serve as refuges for at-risk species are identified, prioritized, protected, and managed in a manner that maximizes the persistence of at-risk species.

Goal 5: Enact legislation to define newly submerged lands contiguous to existing state aquatic preserves, parks, and others as part of the contiguous state-managed areas.

Goal 6: Establish an integrated network of early warning sites on protected lands to track long-term changes in biological communities and processes; establish a Center for Climate Archives for baseline and associated data.

ADP-3.2 Beaches and Beach Management

Goals and Strategies

Goal 1: Reduce and discourage future reliance on bulkheading/hardening to stabilize estuarine and beach shorelines. Shoreline hardening should be considered only after a full and cumulative assessment of short- and long-term impacts to coastal resources and coastal ecosystems.

Strategy A: Address local, state, and regional permitting programs and planning elements to fully assess and consider potential impacts and changes to coastal resources and ecosystems from proposed coastal protection measures in light of potential impacts of climate change.

Strategy B: Add an overview element to state and regional planning documents describing statewide strategies and circumstances for coastal and shoreline retreat and erosion.

Strategy C: The state should undertake a comprehensive reevaluation of the Coastal Construction Control Line Program to ensure that it is accomplishing its intended goal of protection of the beach and dune system. The reevaluation should consider, among other things, the adequacy of existing coastal setbacks, building siting and design requirements, and post-storm redevelopment policies in light of SLR scenarios.

Goal 2: Estimate the ecological value of beach resources around the state in order to give the highest priority to protecting beach resources with the highest ecological values.

Goal 3: Minimize conditions inhibiting natural long-shore sand movement to reduce coastal erosion, protect existing investment in and reduce the future need for beach re-nourishment, and increase beach system resiliency.

Strategy: DEP should be funded to support the design and implementation of inlet management plans for all of the state's modified inlets and should undertake all reasonable efforts to maximize inlet sand bypassing.

Goal 4: Require the state Acquisition and Restoration Council conduct a review of management plans for those lands under its authority every 10 years and include property-specific analyses of vulnerability to climate change in each management plan.

Strategy: Consider a Full Disclosure Law that alerts buyers of coastal property about erosion rates, storm history, SLR concerns, and other relevant information.

Goal 5: State and local governments establish policies and regulations that clearly define when, how, where, and under what circumstances emergency beach stabilization is allowed.

Goal 6: State and local governments establish policies and regulations that address coastal retreat and at what point vulnerable structures will have to be abandoned.

Goal 7: State and local governments establish policies and regulations to protect coastal resources from contamination resulting from inundation, structural failure, or abandonment of residential, industrial, and municipal assets resulting from SLR or storm events.

Goal 8: Ensure that the state's beach management program can accomplish its intended goals, including the long-term protection and resiliency of the beach/dune system, in an era of climate change and rising seas.

Strategy: DEP's Strategic Beach Management Plan should incorporate a range of sea level rise scenarios over at least a 50 year time horizon.

Goal 9: Provide incentives to encourage public and local governments to site structures and infrastructure away from areas at high risk from the impacts of climate change and SLR.

Strategy: See ADP 2.1, Goal 4, Strategy D

ADP-3.3 Species Protection

Goals and Strategies

Goal 1: The vulnerability of Florida's fish and wildlife to climate change impacts is assessed, the most vulnerable species are identified, and plans are prepared to enhance their chances of persistence where there is a reasonable likelihood that the species will persist over the next 50 years.

Strategy A: Utilize the CLIP and similar expanded and centralized digital databases to determine potential species and habitat vulnerability.

Strategy B: Incorporate species and habitat vulnerability from climate change into state and regional planning/zoning, government land acquisition, or determinations for conservation easements.

Goal 2: Put in place a system for monitoring how Florida's natural communities and associated species are responding to climate change impacts and widely distribute the results of this monitoring to all interested stakeholders.

Goal 3: Consider how climate change affects the nexus between species and habitat and act to protect habitat for vulnerable species in light of additional risks posed by climate change.

Goal 4: Evaluate likely persistence of Florida's rare species, natural communities, coastal ecosystem, and parks and protected areas under climate change.

Strategy: Conduct a review of required management plans for public parks, forests, and wildlife areas every 10 years and include analyses of vulnerability to climate change for each area.

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ADP-4. Water Resource Management

Description of Issues

The State of Florida is currently facing many water resource management challenges, including shortages due to drought, saltwater intrusion, and deterioration in quality and limits on the availability of its groundwater sources. The system is stressed even further by continued pressures from population growth, development styles, and potential new challenges resulting from climate change. Although there are uncertainties about climate change, water managers must nonetheless plan for potential increased variability in precipitation regimes, storm events, and rising sea levels. Significant changes in these phenomena are likely to result in changes to the amount of freshwater resources and land available to sustain life and maintain healthy water-dependent natural systems.

While Florida's extensive coastline provides a unique ability to tap saltwater as a future water source, primary water resource concerns revolve around changes to water-dependent ecosystems, impacts to and from human activity, and the quality of groundwater and surface water. There may be shifts in water demands for agricultural and municipal supply; increased energy consumption for advanced water treatment, transmission, and disposal; and changing environmental needs.

The rate of climate change and potential consequences over the next 100 years is uncertain, but the more rapid the rate of change, the more quickly Floridians will have to respond to manage Florida's water resources effectively. Planning and action now may significantly reduce the cost of deferring action.

Objectives

Local, state, and regional policies to protect groundwater and other water resources are designed to ensure adequate supplies to meet the needs of humans and the environment. Policies and measures to encourage conservation, protect existing supplies, identify and develop new supplies, and further invest in innovative technologies to treat water will be needed. Florida recognizes four areas of responsibility (AOR) critical to water resource management, as expressed in Chapter 373, Florida Statutes.

1. Water Supply—Managing water resources to ensure that there are adequate supplies for current and future Floridians.

2. Water Quality—Implementing measures to ensure that changes to existing landscapes will not cause degradation of existing groundwater and surface water quality.

3. Flood Protection—Identifying and protecting flood-prone areas to minimize the risk of floods to human activities through structural and non-structural means.

4. Natural Systems Protection—Managing water and related land resources to ensure that there are supplies of adequate quantity and quality to protect and maintain healthy natural systems.

In order for Floridians to have adequate freshwater supplies available to meet basic reasonable and beneficial needs and the requirements of natural systems, these principles should be followed:

- Intense conservation of all water uses and alternative water sources will need to play a larger role in meeting Florida's future water needs.
- Provide for stakeholder involvement in statewide and regional water supply planning processes.
- Incorporate methods to quantify and plan for uncertainties and risks related to population growth, climate change, and environmental regulations.

It is important that the five water management districts have consistent and coordinated water policies to address climate change.

Assets at Risk

The majority of Florida's population and the water infrastructure to serve them reside within 50 miles of the coast. The Florida population is projected to increase by an additional 50 percent by 2030. In addition to new infrastructure required to develop and distribute water supplies to meet the needs of that growing population, existing coastal and groundwater resources may be at risk due to saltwater intrusion and SLR. Additional consumptive use of freshwater will further diminish the head of pressure needed to stave off saltwater intrusion.

Florida could face rising seas, decreased precipitation, and more intense storms. These three currently predicted impacts alone could have serious implications for Florida's major areas of water resource responsibility.

Goals and Strategies

Goal 1: Identify and quantify the vulnerabilities and reliability of existing water supplies to potential effects of differing climate change scenarios with emphasis on source water availability and quality.

Strategy A: Develop an inventory of water supply facilities (source, storage, treatment, and distribution) and conduct a study to develop different climate change scenarios and potential impacts and adaptation strategies for high-risk utilities.

Strategy B: DEP, water management districts, and local and regional staff should evaluate and prepare for relocation and/or protection of drinking water well fields and groundwater recharge areas from saltwater intrusion.

Goal 2: Develop regional and statewide water demand projection scenarios that account for potential changes in (1) agricultural demand due to changes in the growing season or impacts on crop production; (2) municipal and industrial demand as temperatures increase and drought (seasonal or intra-annual) persists; and (3) water demand for energy generation due to possible changes in fuel sources over a 100-year planning horizon, with consideration for Florida's statutory obligation to provide water for the environment.

Strategy A: DEP, water management districts, and local and regional planners must evaluate and implement maximum wastewater treatment and reuse options to optimize drinking water and water for the environment and other beneficial uses.

Goal 3: Develop conservation programs that address and incentivize water and energy usage efficiencies.

Goal 4: Encourage water reuse.

Goal 5: Implement local, state, and regional water supply planning processes that quantify potential changes in existing water supplies and identify potential new water sources, including synergies between flood management structures and water supply. Promote coordination across jurisdictions within and across watersheds as appropriate. Incorporate methodologies that use not only historic hydrologic data, but also consider changes that may result from climate change and prioritize water for natural systems.

Goal 6: Integrate land-use considerations, flood management, and storm-water best management practices (BMPs) designed to protect water quality, water demand/supply management, and water reservations for the environment in watershed planning and design standards.

Goal 7: Incorporate methods that consider energy, environmental, and economic sustainability when evaluating potential water management strategies (e.g., in developing new surface water supplies or desalination projects).

Goal 8: Change monitoring compliance with minimum flows and levels and water/consumptive use permits, how structures are operated, and when alternative supplies sources are needed.

Goal 9: Change the basis for current Environmental Resource Permits (ERPs), watershed and water quality modeling, structural operations, and other flood management methodologies.

Goal 10: Address water quality changes and flooding of coastal and tidally influenced bodies of water that may occur due to more intense storms, higher surface water temperatures, and rising sea levels on coastal aquifers.

Goal 11: Increase freshwater pressure to offset SLR, retain as much freshwater in natural systems as is reasonable, and restore previously drained systems.

Goal 12: Redesign as necessary coastal recovery strategies, coastal restoration projects, coastal land acquisition, and other measures to allow for natural adaptations and movement inland.

Goal 13: Protect and maintain the natural mosaic of ecosystems, such as upland and lowland interfaces, to ensure the health of water and related natural resources.

Goal 14: Allow coastal estuaries, riverine, and other water dependent ecosystems to migrate or adapt to maintain healthy wildlife and fish populations consistent with new climate regimes.

Goal 15: Well fields, surface or subsurface storage facilities, and water treatment plants may be vulnerable. Siting and plans for new facilities should be closely examined to mitigate impacts or locate the facilities to reduce risks from increased winds and flooding.

ADP-5. Built Environment, Infrastructure, and Community Protection

Definition of Issues

The built environment can be defined as the aggregate of all buildings, facilities, and structures designed and built to provide shelter or to house the full breadth of human activity, as well as the infrastructure designed and built to supports or protect such human activity.

The conjugation of these factors has resulted in more than 70 percent of the population living in coastal counties, and perhaps close to 85 percent of the built environment (on the basis of total area of construction) is located in coastal counties with a high concentration in large urban areas such as the tri-county (Palm Beach, Broward, and Miami-Dade) corridor in Southeast Florida, the west-central region around Hillsborough and Pinellas counties, and the Jacksonville-St. Augustine region.

U.S. Census Bureau projections and other studies estimate that Florida's population will reach close to 29 million by 2030, which means an increase of some 10 million people more than the estimated 2007 state population and seven to eight million more residents in coastal counties. If these projected trends continue, the concentration of built environment will likely continue to increase along the same parameters as those currently in place.

Florida is vulnerable to a wide range of natural hazards, including hurricanes, coastal storms, floods, tornadoes, wildfire, drought, extreme heat, winter storms and freezes, erosion, sinkholes, and storm surge. The risk of some of these hazards will be exacerbated by climate change, while the risk of others will be lessened.

Design criteria are part of building codes used to design buildings that are expected to have a minimum service life of 75–100 years and that can withstand extreme events. The Florida Building Code became the single-state building code as of March 1, 2002. The expressed intent of the Florida Building Code is "…to establish the minimum requirements to safeguard the public health, safety and general welfare through structural strength, means of egress facilities, stability, sanitation, adequate light and ventilation, energy conservation, and safety to life and property from fire and other hazards attributed to the built environment…"

One of the most important issues with regard to adapting the built environment to climate change is that buildings and structures are designed on the basis of the minimum requirements established by the building code, which are primarily based on historical data on forces such as wind loads and hydrodynamic pressure from storm surge. As the risks from such natural hazards are exacerbated by climate change, existing buildings and those being designed today may be subjected to impacts that exceed the designed capabilities. This could lead to catastrophic damage. Adapting the built environment to the impact of climate change will require design criteria and building codes that consider potential future impacts in establishing minimum design requirements.

Objectives

1. Reduce the potential for damage to the built environment from the impact of natural hazards, especially from those hazards caused or exacerbated by climate change, make this a high priority for all levels of government and the private sector in Florida.

2. Make the practice of adapting the built environment to the impact of climate change an integral component of comprehensive planning, building codes, life-safety codes, emergency management, land development and zoning regulations, water management, flood control, coastal management, and community development.

3. Make the practice of adapting the built environment to the impact of climate change a preferred objective of building design, siting, and construction research funded by public monies in Florida.

4. Foster an environment of communicating and sharing knowledge about adaptation to climate change and the adaptation/protection of the built environment among the scientific community, lawmakers, various professional sectors (practitioners), and the general public.

5. Promote an environment to connect science with decision making regarding climate change and the need to adapt the built environment to its impacts.

6. Promote an environment for connecting scientific research with practical applications that will contribute to the adaptation of the built environment to the impact of climate change.

7. Encourage the search for practical and effective solutions to ensure that existing and future built environment in Florida will remain habitable, providing viable shelter for the full range of human activity and ensuring continuity of critical and essential functions in the aftermath of impact by climate change–exacerbated hazards.

8. Establish educational and professional licensing requirements to ensure that key professional sectors become practitioners of adaptation in support of planning, building design, and construction activities.

9. Require the state, county, and municipal governments throughout Florida to develop and maintain a local climate change adaptation plan, to provide a framework for assessing vulnerability, identifying risks, defining and quantifying the value of the built environment that is at risk (see attachment on Quantifying Value at Risk), and identifying and implementing effective adaptation measures at each jurisdictional level (i.e., state, county, municipality, and individual facility).

Exercise fiscal responsibility in recognizing not only the magnitude of the problem to be confronted by future generations but also the need to start implementing and paying for solutions now while also creating reserves to pay for future measures, especially those that may be community-wide or regional in scope.

Objectives for beaches in ADP-3 are relevant to this ADP Policy Option.

Assets at Risk

Climate change will modify or exacerbate most of the factors mentioned above, which were used to establish design criteria, during the remaining service life of existing buildings and new buildings just now being built. For example, certain aspects of climate change (specifically, increased global mean temperature and SLR) have the capacity to amplify hurricane strength and potential damage. SLR will have a direct impact on storm surge, perhaps the most destructive characteristic of hurricanes, as they impact the built environment in the coastal region. There will also likely be higher incidence of extreme rain events.

This means that a building created on the basis of current design criteria and the minimum requirements of the Florida Building Code may be subjected to higher loads from storm surge, wave impact, and precipitation during hurricanes than what it was originally designed for during its remaining service life. It is likely and perhaps highly probable that a building under such conditions will suffer severe damage and even structural failure. Those buildings constructed before the Florida Building Code came into effect are at much higher risk of suffering catastrophic damage under the impact of climate change–exacerbated hazards.

Existing Actions

HB 7135, passed by the 2008 Florida Legislature, provides certain "lead by example" improvements to local, state, and regional government building and renovation standards, including the use of specified green building standards and energy-efficient design. The Bill also creates the FECC to centralize policy development and program implementation for energy and climate change and to review and consider recommendations by the Action Team concerning building standards and adaptation. In addition, the Bill created the FESC as a "supercenter of excellence" within the SUS to better coordinate energy-related research that supports Florida's policy objectives for energy and climate change.

This ADP Policy Option covers the entire infrastructure and is divided into the following categories: building codes and regulations, flood protection, beaches as infrastructure, and transportation. Many of the issues regarding climate change, goals, and strategies can be applied to other infrastructure, such as communications; electric power production, transmission, and distribution; education; and government.

ADP-5.1 Building Codes and Regulations

Goals and Strategies

Goal 1: Require that the Florida Building Code incorporate design criteria for buildings to resist future loads that may result from the impact of climate change–exacerbated hazards during a minimum service life of 50 years.

Strategy A: Strengthen Florida Building Code requirements for new structures and appropriate renovations to encourage resistance to the impacts of climate change.

Strategy B: Conduct research on how building codes can be routinely updated to account for changes in climate and to develop options on how such codes could account for potential future changes in risks from climate change.

Strategy C: Determine whether existing construction siting and design requirements under the Coastal Construction Control Line (CCCL) Program intended to ensure avoidance of "significant adverse impacts" to the coastal system are adequate under a range of SLR scenarios.

Goal 2: Require the Florida Building Commission (FBC) to establish a technical committee that focuses on vulnerability to climate change and that will recommend updates to the building code as evidence of new trends of risk factors from climate change arise.

Goal 3: Encourage builders to construct new buildings that meet Leadership in Energy and Environmental Design™ (LEED) standards. Reducing energy demand is also an adaptation strategy, because less energy will be demanded during heat waves and the need for water to support energy production will be reduced.

Goal 4: Develop a required training program to educate professionals in relevant fields (e.g., architecture, engineering, and construction management) on the need to incorporate adaptation to climate change as a basis for establishing design criteria for new infrastructure. Completion of such required training should be a condition for relicensing.

Strategy A: Examine licensing and recertification requirements for building professionals and revise them to include design criteria that account for the impacts of climate change.

Strategy B: Add adaptation criteria to professional education curricula at state universities and trade schools for building and design degrees.

Goal 5: Empower the Department of Business and Professional Regulation (DBPR) and the various professional licensing boards to incorporate sections on climate change vulnerability and built environment adaptation methodologies in all licensing examinations.

Goal 6: Create and fund a built environment Climate Change Adaptation Program as a state research initiative. The program would be charged with engaging the scientific and research community, by way of competitive research projects and annual announcements of funds availability, in the assessment of vulnerability and risk of the built environment to the impact of climate change. It should focus on the development of adaptation methodologies based on new design criteria, methods and materials of construction, and similar initiatives.

Goal 7: Encourage public universities in Florida to develop educational programs for building design and construction professionals, planners, and those in other pertinent fields, focusing on vulnerability to climate change and adaptation methodologies.

ADP-5.2 Flood Protection

Goal 1: Reduce or eliminate the potential for damage from flooding by requiring all new or substantially renovated buildings to be elevated above potential threshold flood depth (considering climate change), which is to be determined on a site-specific basis for the projected service life of the building.

> **Strategy:** Implement zoning criteria and/or building code design criteria that will require all new buildings or buildings that are substantially renovated to have a zero-flood-depth elevation that is a minimum of one foot above a projected site-specific flood depth with an annual probability of flooding of 0.5 percent during the remaining service life of the building. For purposes of these requirements, a substantially renovated building is one where work to be done is equal to or above 25 percent of the current replacement value of the structure.

Goal 2: Substantially reduce or eliminate storm water runoff as a contributor to flooding.

> **Strategy:** Implement land use and zoning regulations and/or building code design criteria requiring all new or substantially renovated buildings to incorporate porous materials and other low-impact development techniques for site work, sidewalks, curbs, driveways, and other locations in order to promote water percolation into the ground to reduce runoff volume during rain events.

Goal 3: Set new parameters for water management with the objective of reducing the potential for flooding from extreme rain events.

> **Strategy:** Encourage the five water management districts in Florida to work with pertinent federal and state agencies and the research community to develop extreme-precipitation threshold models, which will be used to activate water management actions to reduce the potential for flash floods. These models and related water management actions are to be linked to monitoring systems using virtual rain gauges, satellite observations, and other

technology to forecast the risk of a given amount of precipitation occurring within a given time frame.

Goal 4: Substantially reduce or eliminate currently developed building sites subject to repetitive flood loss events.

Strategy: Charge counties and municipalities with cataloging currently developed building sites that have been flooded three or more times within the last 10 years. Target those sites for future use conversion to reduce the human risk or the potential for property damage.

Goal 5: Incorporate regional or community-wide flood protection, on the basis of projected SLR and other flood threats, into regional and/or comprehensive plans that focus on development and redevelopment over the next 50 to 100 years.

Strategy: Fund studies to identify community-wide or region-wide adaptation alternatives to reduce the potential for damage from coastal flooding exacerbated by projected SLR. Such studies will incorporate a comparative analysis, estimated costs, timelines, and associated economic, social, and environmental impacts of a range of adaptation measures, including engineering and structural works as well as land-use and zoning measures.

Goal 6: Develop scenarios for land-use conversion that accommodate future population growth and development and that incorporate flood prevention criteria on the basis of projected flood threats 50 to 100 years from now.

ADP-5.3 Beaches as Infrastructure

Goals and Strategies

Goal 1: Examine where, how, and to what extent coastal ecosystems confer protection to vulnerable human communities. Set priorities for protection and for the appropriate management of these systems.

Strategy A: Undertake comprehensive research and analysis to determine alternative solutions and establish the engineering and economic feasibility of whether or not selected sections of the coasts can or should be protected.

- Determine the engineering feasibility of protecting selected coastal areas, taking into consideration the porous nature of much of Florida's coastal geology.
- Compare the economic cost of armoring and other protection alternatives versus the cost of abandoning major coastal urbanized areas.
- Assess economic, political, social, and environmental impacts of alternative solutions or no action on Florida's beaches, coastal wetlands, other ecologically important areas, and near-shore coastal marine habitats.

- Begin the evaluation in the relatively near future since public works projects of this magnitude take many decades from concept to completion.

ADP-5.4. Transportation and Other Infrastructure

There are 121,525 miles public roads in the state: 12,062 on the state highway system (owned by FDOT), 107,421 city and county roads, and 2,042 owned by other federal entities.[3] There are 19 commercial airports, 14 of which are international. In addition, the state has 14 deepwater ports.[4]

Roads, airports, rail, pipelines, ports, beaches, and other infrastructure along and close to Florida's coastline are potentially vulnerable to climate change impacts. Unfortunately, a comprehensive listing of transportation infrastructure at risk in the United States has not been prepared. Improved information about projected climate change impacts and timing of such events will be needed to identify specific transportation and other infrastructure at risk.

In Florida, potential impacts of climate change include rising temperatures, increases in the intensity of heavy rainfalls and hurricanes, and rising sea levels. Because of this, transportation and other infrastructure along the coast and in low-lying areas are susceptible to damage from SLR, storm surge, erosion, flooding, and higher temperatures. However, adaptation, particularly related to transportation, has not yet received as much attention or research as climate change mitigation.

Goals and Strategies

Goal 1: Inventory the critical transportation infrastructure at risk; determine whether, when, and where projected impacts from climate change might be significant; and evaluate the costs and benefits of alternatives.

Goal 2: Ensure the coordination of adaptation efforts on transportation across jurisdictional boundaries and the exchange of information, resources, and best practices among government, the private sector, and other stakeholders.

Goal 3: Ensure that the long-range planning process on transportation addresses adaptation and the protection of critical infrastructure.

The following strategies support all three goals:

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[3] FDOT Website, Highway Mileage Reports at http://www.dot.state.fl.us/planning/statistics/mileage-rpts/shs2007.pdf

2007 SHS Annual Report at http://www2.dot.state.fl.us/planning/mileage/word/pdf/pdf_report_final_inet.asp

[4] State of Florida.com "Florida Quick Facts," available at: http://www.stateofflorida.com/Portal/DesktopDefault.aspx?tabid=95, accessed. July 23, 2008.

Strategy A: The FDOT should update the Florida Transportation Plan in cooperation with federal, state, regional and local governments and modal partners to develop long range goals, objectives, and strategies for addressing climate change and adapting to potential impacts from climate change.

Strategy B: State, regional, and local governments and modal partners in Florida should work cooperatively to identify and evaluate transportation infrastructure at risk and to coordinate adaptation efforts for infrastructure immediately landward of coastal high hazard areas or to provide emergency evacuation routes for coastal populations.

Strategy C: FDOT should continue its analysis of rainfall statistics and hurricane surge (including updating such statistics and analyzing the accompanying affects of wave forces and erosion on highways and bridges) and in other areas to identify infrastructure at risk.

ADP-6. Transportation and Other Infrastructure

This section has been moved to ADP-5.4.

ADP-7. Economic Development

Description of Issues

Florida's gross state product in 2007 was more than $734 billion. Of that, agriculture was $7 billion, mining was $1 billion, and construction was $45 billion. In 2007, Florida had more than 85 million visitors, generating more than $65 billion in revenues.

Objectives

- To adapt Florida to new economic trends and realities brought on by the powerful drivers of energy and climate change;
- To generate useful economic trend analysis and data to guide economic development decision making; and
- To create policies, programs, and implementation mechanisms that support the ability of Florida's economy to adapt to climate change.

Assets at Risk

Climate change is likely to have a significant effect on all sectors of Florida's economy. Some sectors will likely face acute challenges, while others will likely enjoy growth opportunities. There could be significant damage to some economic sectors, such as real estate, tourism, agriculture (e.g., productivity and export markets), and other resource-based industries.

The state would benefit by early identification of business opportunities (and risks) associated with climate change to increase its global competitive advantage and to increase the creation of new jobs within the state. An impact assessment is needed to forecast potential disruption to Florida's major economic sectors due to climate change impacts, such as more frequent tropical storms, SLR, drought, acute flooding events, saltwater intrusion, and possible habitat and species disruption.

Successful economic adaptation will require anticipating and responding to the challenges and opportunities, given such economic trends.

Goals and Strategies

Goal 1: The Office of Tourism, Trade, and Economic Development (OTTED) and Enterprise Florida—in conjunction with the FECC—should undertake an analysis to look at new opportunities and at economic sectors that may be negatively impacted.

Goal 2: Establish the economic value and importance of natural resources to the state economy overall and to tourism and other resource-based sectors.

Goal 3: Identify policy issues related to habitat and species management, human needs, hunting, fishing, boating, and outdoor recreation.

ADP-7.1 Tourism

Tourism in Florida constitutes more than 10 percent of the state's economy. The state's thriving tourism sector depends on the richness and diversity of Florida's natural resources. Its climate, forests, parks, waterways, beaches, marine systems, habitat, species, flora and fauna, and other attractions bring more than 70 million tourists to the state each year.

SLR, increased hurricane intensity, increased storm intensity, drought, wildfires, human health risks, and other outcomes of climate change could be threats to Florida's tourism industry. In addition, rising temperatures could make locations further north relatively more attractive to tourists.

Goals and Strategies

Goal 1: Assess the economic impact of climate change on the tourism sector.

Goal 2: Given the state's interest in ensuring a healthy tourism sector, assess the level of appropriate investment in the state's natural resources.

ADP-7.2 Other Resource-Based Industries

Other resource-based industries, besides tourism, include agriculture, forestry, marine resources (e.g., commercial fishing), aquaculture, and mining. While these constitute only about one percent of the state's economy, such industries are important to Florida's way of life and character. The state should contemplate its interest and role in mitigating the impact of a changing climate on these sectors.

ADP-7.2.1 Agriculture

The productivity of many crops may be impacted by warmer temperatures, altered precipitation patterns, more intense storms, changes in runoff patterns, invasive species, and new pests. Biofuels may present new growth opportunities; however, adequate care should be taken not to displace food crops. Planning for adequate water supplies may be important to sustaining this sector.

Goals and Strategies

Goal 1: Assess potential changes in the geographic range, climate tolerances, and economic viability of current and potential new annual and perennial crops and livestock.

Goal 2: Review land-use, tax, and subsidy policies to encourage appropriate adaptation in the agriculture sector.

Goal 3: Assess potential changes in the extent and distribution of irrigation demand and supply for agriculture that are due to climate change and incorporate long-term planning for agriculture.

ADP-7.2.2 Forests

Aside from the inherent value of Florida's forests as habitat for many native species, they have economic value as recreational areas for ecotourism activities and in traditional commercial applications as a resource for building products. In addition, Florida's many acres of longleaf pines and bottom hardwoods on public and private lands are excellent carbon sinks and could be a source of revenue for public and private landowners through a carbon-credit trading system.

Forest resources must be conserved and expanded. Work needs to be done to determine the level and areas of risk from climate change impacts (e.g., drought, pests, storms, saltwater intrusion, and invasive species) for this valuable resource.

Goals and Strategies

Goal 1: Continue existing land acquisition/management programs for forested lands.

Goal 2: Adopt land acquisition/management programs with a climate change component.

Goal 3: Explore adaptation of forest stocks through genetics to strengthen stocks against risks associated with climate change.

ADP-7.2.3 Marine

Florida's industries based on living marine resources include commercial and recreational fishing, marine ecotourism (including coastal parks and conservation areas), marine pharmaceuticals, and marine research and education. The direct 2006–2007 value of these industries to Florida's economy was $4.4 billion (National Ocean Economics Program [NOEP], 2008), and the indirect value of related infrastructure and support was many times larger. Adaptive responses to protect the core living resources these industries rely on are addressed in ADP-3, Protection of Ecosystems and Biodiversity. This section addresses threats to the availability and human uses of the resources, beyond considerations made in other adaptation response actions.

The adaptive management of Florida's marine resources and their sustainable use in a changing climate will be designed to protect the living resources and the social, economic, and cultural systems that form Florida's industries.

The geographic ranges and abundances of living marine resources are likely to change as climate, ocean temperatures and currents, water quality, and related controlling factors change. Likewise, the ranges, abundances, and impacts of marine diseases, invasive species, parasites, and harmful algal blooms could change.

Fisheries, principal fishing grounds, ecotourism destinations, and the land-based operations and facilities that support these industries may migrate to different areas in the state as a consequence of these changes. Such changes have the potential to impact the economic viability of industries dependent on living marine resources. The same changes can also have negative effects on the health and safety of industry workers and consumers of industry products and services. Public and private investments in land acquisition for future parks and conservation areas, future working waterfronts for fishing and ecotourism, and future marine research and education facilities will be influenced by climate change, and the effects could be significant. The same processes that may diminish Florida's existing marine industries may lead to new opportunities for fisheries, ecotourism, and allied economies. Adaptive management will require an ability to detect and exploit such possibilities.

Goals and Strategies

Goal 1: Provide an integrated tracking and reporting system for the ranges, abundances, and condition of species valued for their roles in fisheries, ecotourism, aquaculture, pharmaceuticals, and research.

Goal 2: Develop and implement an integrated screening and tracking program for species die-offs, marine diseases, invasive species, and parasites that is modeled after programs that monitor the state's harmful algal blooms.

> **Strategy:** Goals 1 and 2 will be met through the use and expansion of existing state and federal programs and platforms for monitoring, event responses, data management, and public reporting.

Goal 3: Implement educational programs to reduce vessel-based conveyances of unwanted species into Florida waters and to protect industry workers and consumers from novel health and safety challenges.

> **Strategy:** Collaborate with the Florida Sea Grant College Program (FSG) to implement the programs.

Goal 4: Develop conceptual plans for the co-location of new working waterfronts for activities such as fishing, ecotourism, and marine research that employ green infrastructure adapted to emerging challenges of climate change.

> **Strategy:** Engage university planning, engineering, and architectural schools in developing the conceptual plans.

ADP-7.2.4 Aquaculture

Aquaculture is a rapidly developing industry in Florida. As the state’s fisheries become depleted, either through over-harvest or climate change impacts, cultured seafood products will increase in importance. Florida producers sold $74.9 million of aquaculture products in 2005, ranking Florida seventh in the nation in terms of aquaculture sales. More than 900 Florida aquaculturists produce the largest variety of aquatic species of any state in the nation. Tropical fish dominate the Florida aquaculture industry as the number one commodity with $33million in sales in 2005, also making the state the number one producer nationwide. The state is also a leading U.S. producer of farm-raised aquatic plants and an important producer of hard clams.

The industry could be threatened by warmer water temperatures, which may make current breeding grounds unsuitable in the future by exceeding thermal tolerances of the species in question, reducing dissolved oxygen levels, and allowing for the introduction of pests and disease. SLR can threaten facilities with inundation, turn freshwaters brackish, and inundate coastal wetlands. Increased intensity of hurricanes and other storms can damage or destroy fisheries and facilities. Drought can reduce freshwater flows and degrade water quality.

Goals and Strategies

Goal 1: Develop plans for increasing seafood product aquaculture to supplement declining ocean stocks.

Goal 2: Encourage expanded and increased leases for aquaculture on submerged state lands.

Goal 3: Review existing out-of-state marketing programs with an eye to increasing those sales of Florida aquaculture products.

Goal 4: Identify and institute management practices to ensure healthy growth of this industry.

Goal 5: Identify innovative and federal funding sources for mitigation and adaptive strategies.

ADP-7.2.5 Mining

Nationally, Florida ranks fifth in the production of limestone, sand and gravel, clay, peat, heavy minerals, and phosphate. The state’s mines supply one-quarter of the world’s and three-quarters of the U.S. domestic needs. Nearly all of the phosphate mined is used for the national and international production of agricultural fertilizer. In 2000, approximately $1.13 billion worth of fertilizer was exported. Phosphate mines in northern and central Florida have been a valuable resource for the national and international production of agricultural fertilizers, although many of these lands are now considered degraded and disturbed.

After mining operations have ceased, these lands could be used for rotation bioenergy crops, as well as for carbon sequestration. Mining also has implications for aquifers and water supplies and storage that should be noted here.

Goals and Strategies

- Study soil carbon dynamics to estimate the long-term potential for carbon sequestration in new growth forest and through underground sequestration.
- Determine environmental and cost benefits of developing short-rotation woody crops on formerly mined lands.
- Review and select tree species appropriate for such sites.
- Identify management practices to ensure plant survival and maximize growth.

ADP-7.3 Construction

Construction is more than 6.0 percent of Florida's economic output. Construction employment represented approximately 8.5 percent of total non-agricultural jobs, and more than 210,000 annual building permits were issued as recently as the end of 2006. The industry has been affected by a change in supply and demand for key building materials (e.g., lumber, cement, reinforcing steel, and plywood), resulting in huge increases in prices that in some cases reached 200 percent, 300 percent, or higher in just one year. Climate change has the potential for exerting significant impact on the construction sector through such changes as extreme precipitation, drought, SLR, or the exacerbation of natural hazards such as storm surge and flooding.

Climate change–driven modifications in the construction industry have the potential to significantly impact the economy of the communities and regions affected. The consequences of climate change may include the following, all of which would likely result in increased costs:

- The need to adapt existing and future buildings so that they can withstand the impacts of climate change will require that design professionals carry out additional studies and calculations or engage other experts as consultants.
- Buildings may need to have deeper and stronger foundations, be elevated above a higher "zero flood elevation," have much higher insulation values than currently required, have much higher roof drainage capacity, or incorporate green building features.
- Higher temperatures during the work day or higher and more frequent extreme precipitation events have the potential for affecting working conditions, which will increase not only the cost of construction but also the income of construction workers.
- Should the need for adaptation become a requirement for new construction, the demand for adaptation-related practices would increase.
- Retrofitting, demolition, or conversion projects of existing buildings may be needed to adapt them to climate change, or to retreat from hazardous zones.

Retreat may have an adverse effect on the volume of construction in relatively vulnerable areas, leading to economic losses and labor reductions in the construction industry.

Goals and Strategies

Goal 1: Identify the sensitivity of the construction industry in Florida to a range of external, non-climate change–driven factors that have the potential for affecting the economic aspects of the construction industry.

Goal 2: Measure the economic impact resulting from climate change–driven consequences on the construction industry and related sectors and from non-climate change factors, with projected scenarios at five-year intervals.

Goal 3: Identify those communities, regions, or sectors along with related or interlinked sectors that may suffer adverse economic consequences as a result of the impact of climate change on the construction industry, and commission a study to identify effective measures to reduce the potential for such adverse consequences.

Goal 4: Measure how adaptation procedures applied through construction methods, materials, or design criteria may reduce the risk of damage to the built environment and link such risk-reduction to a reduction in insurance premiums.

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ADP-8. Insurance (Property and Casualty)

Description of Issues

With more than 1,350 miles of coastline, Florida is physically and financially vulnerable to the effects of climate change. Ninety percent of Floridians live within 50 miles of the coast, and the value of property in this area is approaching $2.0 trillion. Additionally, the state's largest insurance company—Citizens Property Insurance Corporation—has 1.3 million policyholders and is financially supported by Florida's insurance consumers.

Insurance from flooding falls under the National Flood Insurance Program (NFIP), which is administered by the federal government, and Floridians account for 40 percent of NFIP's policyholders. Insurance for wind damage is typically covered by private insurance policies, which are regulated by state governments. The Citizens Insurance Company is the insuring entity of last resort for hurricane wind coverage.

Assets at Risk

Insurance companies in Florida insure assets worth billions of dollars—homes, businesses, agriculture, infrastructure, parks, and beaches. All of these assets and more are at risk to the myriad effects of climate change. Florida's current pricing structure does not truly reflect the risk of loss, particularly for Florida's coastal regions.

Scientific studies have established that climate change increases the intensity of hurricanes. In addition, SLR will erode shorelines, threatening many properties, and will result in higher storm surge from hurricanes. Other climate outcomes, such as wildfire, intense rain events, and drought can also pose risks to lives and property. Given Florida's geography, coastal density, and a $65.0 billion dollar tourism economy, plus eight major storms in 2004 and 2005, property insurance and affordability issues are one of Florida's greatest challenges.

Existing Actions

In 2005, the Florida Legislature passed a law requiring all residential property insurance companies to file with the Office of Insurance Regulation (OIR) a range of premium discounts offered to customers who live in homes of certain construction types or who apply loss mitigation devices (like shutters) to their homes. Beginning on September 5, 2007, all property insurers were required to offer higher discounts in their insurance rates for policyholders who had recognized loss mitigation devices on their homes. Insurers are required to send a list of those discounts with exact dollar savings to all new and renewed policyholders.

The NFIP, managed by the federal government, provides insurance for damage from flooding (e.g., storm surge). Damage from wind and other causes is typically covered by private insurance. In 2007, Florida created the Florida Citizens Property Insurance Corporation (CPIC) to provide multi-cause and wind-only insurance coverage to homeowners and businesses in Florida.

Goals and Strategies

Goal 1: Encourage insurance companies to provide policyholders with greater disclosure about climate risk. Insurance companies need to adequately inform their customers and shareholders about the risks climate change poses to the insurance business and the ability of the industry to pay policyholders' claims. Insurance companies also need to take necessary steps to mitigate against these risks.

Goal 2: Understand the relationship between the threats of climate change, SLR, and providing affordable insurance premiums to Florida home and business owners. Address equitable and fair differences in insurance for coastal and inland properties.

Goal 3: Florida should develop policies that make coastal communities and infrastructure more resilient to natural disasters through programs such as the My Safe Florida Home program.

Goal 4: Fully define the issues surrounding risk-based pricing in the property and casualty insurance industry for Florida.

Goal 5: Insurance pricing and availability can encourage or discourage particular forms of coastal development. Subsidized coastal insurance polices such as the Florida CPIC, should be consistent with federal and state programs designed to reduce high-risk shoreline development, increase coastal system resiliency, and protect important coastal resources vulnerable to risks associated with climate change.

References

Bagstad K. J., et al, Ecological Economics, Vol. 63, Pages 285-298, 2007

ADP-9. Emergency Preparedness and Response (Extreme Events)

Definition of Issues

Throughout the history of settlement in Florida, extreme weather events—particularly in the form of hurricanes—have played a major role in shaping culture, commerce, and community development. As a result, Florida's state government has developed one of the more robust emergency preparedness and response infrastructures in the nation. This was particularly evident in the depth of aid provided by Florida to Mississippi during the 2006 hurricane season in the aftermath of Hurricane Katrina.

Global climate change is likely to increase Florida's risk of extreme weather events. Whether hurricane frequency will increase, given rising sea-surface temperatures, is uncertain at present. Current science supports increased intensity and duration for storms that form in the Atlantic and the Gulf of Mexico. When coupled with rising sea levels, future hurricane events may yield greater storm surge effects to put coastal communities at greater risk for damage than is the case today. In addition, there could be more intense rain events, droughts, wildfires, and heat emergencies.

Extreme weather across the state can:

- Overtax the emergency response systems and funding for flood response,
- Result in major storms and power outages,
- Affect buildings or transportation routes, and
- Cause drought-related fires.

Hurricanes, as Florida's typical extreme weather event, may no longer be the only major threat to Floridians. An analysis of predictable climate change impacts would include projections for other intense rain events, not to mention increased droughts, wildfires, heat, and public health emergencies.

Additionally, given the many fronts that climate change is expected to present to Florida's emergency infrastructure, there is the possibility that several of these impacts might occur simultaneously.

Delayed emergency response could become more common.

Objectives

Florida's current emergency preparedness and response functions are a coordinated effort between federal, state, and local governmental agencies, as well as nongovernmental organizations (NGOs). The objective of Florida's future emergency preparedness and response functions must be to build on the excellence gained through past experience to ensure sufficient capacity and efficacy in protecting public heath and welfare in more severe storm events with increased incidence of storm surge and the associated coastal damage. As the impact of SLR and higher storm surges becomes more evident, development patterns must be constrained to increase the resiliency of coastal communities and to protect those communities.

Floridians must be prepared for an increased incidence of heat-related illness in large sectors of the public, particularly given Florida's large population of senior citizens. As temperatures rise and the climate becomes more tropical, water- and vector-borne diseases now associated with more equatorial climes might become commonplace in Florida. This situation will be aggravated by increased flooding events and their associated impacts on certain portions of the public infrastructure such as sewage systems, hospitals, and nursing homes.

Moreover, Florida must be prepared to address the synergistic effects of multiple climate stressors on its emergency response infrastructure and, prior to such occurrences, must devise an approach to deal with this by building on our existing skills in emergency preparedness and environmental response. Policy makers in particular need information and data on changes in risks from climate change and need to know where to get such information.

Assets at Risk

While all of Florida's counties are subject to extreme weather events, coastal communities and ecosystems are at particular risk from increased storm surge and increased hurricane intensity. The vast majority (70 percent) of Florida's population lives in the coastal zone. Likewise, the vast majority of the state's existing building stock is situated near the coast. While many coastal ecosystems have adapted to periodic extreme weather, system resiliency in some cases may be undermined because of the loss of habitat, pressures from invasive exotic species, or other incidences that prevent post-hurricane recovery.

Aside from risk to the human population from hurricane events, increases in temperatures may cause certain water- and vector-borne diseases normally associated with more southern climates to migrate to Florida. Increased flooding and infrastructure damages resulting from increased heat and flooding could aggravate these risks.

Existing Actions

Many of the impacts that climate change is projected to bring are already familiar to Floridians. Consequently, programs to address impacts such as increased intensity of hurricanes and major storm events, storm surge and erosion, saltwater intrusion, and the availability of potable drinking water supplies have been implemented. Additionally, Florida's excellent emergency response infrastructure has proven itself under many scenarios, and the planning mechanisms that are part of that infrastructure are in place to deal with a large variety of catastrophic events. However, it is uncertain to what extent these programs and infrastructure will be affected by future impacts associate with climate change, or to what extent additional financial resources will be needed to meet these future conditions.

Goals and Strategies

Goal 1: Ensure sufficient response capability among regional, state, and local first responders to potential increases in extreme weather events.

Goal 2: Increase the resiliency of coastal communities to storm surge.

Strategy: See ADP 2.1, Goal 4, Strategy D

Goal 3: Assess the role of ecosystems such as coastal wetlands and beaches and dunes in reducing risks from extreme events.

Goal 4: Plan for other extreme events (e.g., flooding, wildfire, and heat waves).

Goal 5: Develop a process for early detection, evaluation, and handling of extreme events resulting from climate change. Effectively distribute such information to key emergency preparedness and response personnel.

Goal 6: Invest in emergency response and mitigation strategies for extreme environmental events likely to be exacerbated by climate change.

ADP-10. Human Health Concerns

Description of Issues

Florida's current population is over 18 million, and 17 percent are over 65 years of age (higher than the national average of 12 percent). By 2030, Florida is projected to be the nation's third most populous state with almost 29 million residents, with 27 percent of the population projected to be over age 65. That keeps Florida as the state with the highest population of senior citizens as a percentage of total population. Senior citizens have greater vulnerability to impacts of climate change than the population at large, although children under five, those living in poverty, and those living in coastal areas can also be vulnerable.

Objectives

The health and wellbeing of the citizens is of prime importance to the State of Florida. Incorporating considerations of climate change into the state's health plan to protect the citizens is as important as designing water treatment infrastructure to reduce harm to human health.

Successful research in this area would identify the increasing risks to human health, which segments of the population are most vulnerable, and how risks to their health can be reduced.

Assets at Risk

Climate change is expected to have a wide range of impacts on Florida's health systems. The historical range of mosquito- and vector-borne diseases may shift with a changing climate. More intense extreme weather events, such as hurricanes, heat waves, flooding, and wildfires, will directly impact human health in Florida. Equally important are alterations in the moisture content of the atmosphere and wind patterns that will likely affect the concentration of air pollution in a given location.

Climate change may increase the risk of some infectious diseases; particularly those diseases that appear in warm areas and are spread by mosquitoes and other insects. These vector-borne diseases include malaria, dengue fever, yellow fever, and encephalitis. Also, algal blooms could occur more frequently as temperatures warm—particularly in areas with polluted waters—in which case diseases (such as cholera) that tend to accompany algal blooms could become more frequent. These diseases can be transmitted to people and can also affect livestock and wildlife, which can indirectly affect people.

Goals and Strategies

ADP-10.1 Health Care

Goal 1: Ensure that health codes and policies are adequate to protect against known risks from observed (current) climate and appropriately incorporate potential changes in risk that are due to climate change.

Goal 2: Regularly revisit health codes and regulations as evidence of new or altered risks from climate change arises.

Goal 3: Strengthen vaccine campaigns.

ADP-10.2 Air Quality

Goal 1: Ensure that air quality policies provide an adequate level of safety to protect against known risks from the current climate.

Goal 2: Ensure that new air quality policies incorporate potential changes in risks from climate change to ensure appropriate design and adequate mitigation factors.

ADP-10.3 Water Supply and Wastewater Treatment

Goal 1: Ensure that wastewater infrastructure provides an adequate level of safety to protect against known risks from the current climate.

Goal 2: Ensure that new wastewater infrastructure incorporates potential changes in risks from climate change to ensure appropriate design and capacity over the lifetime of projects.

Goal 3: Ensure that water treatment facilities are able to safely capture, store, treat, and distribute potable water as the climate changes, creating possible subsequent changes in rainfall patterns, SLR, and flooding. Water treatment systems should anticipate changes in source water quality and availability and plan for corresponding changes needed to ensure effective water treatment.

Goal 4: For aboveground storage, such as reservoirs, management and operations protocol should account for changes in rainfall patterns and the impacts such changes may have on the adequacy of the storage volume as well as the structural safety of the impoundment.

ADP-10.4 Disaster Response

Goal 1: Establish communication mechanisms to coordinate efforts between disaster relief agencies and public health agencies.

Goal 2: Create communication systems and plans that address health issues associated with low-income and underserved populations and other vulnerable groups.

Goal 3: Provide adequate training for first responder and emergency responder personnel.

Goal 4: Limit growth in areas whose evacuation will be challenged by SLR and increased storm frequency or severity.

ADP-10.5 Medical Treatment and Biomedicine Development

Goal 1: Increase the focus of medical schools at state universities to include diseases that can be attributed to climate change.

Goal 2: Promote the research and development (R&D) of biopharmaceuticals for treating diseases that can be attributed to climate change.

ADP-11. Social Effects

Description of Issues

Currently Florida's population is over 18 million, and its projected growth is to 29 million by 2030. Additionally, Florida's coasts are home to at least 70 percent of the population. The coastal environment provides diverse habitats for countless marine and terrestrial species. For centuries, humans have lived, worked, and played along the coasts, and the ocean has long been an important component of the economy, from fishing to tourism.

Sea levels are expected to rise in the foreseeable future at an accelerated rate as the earth's climate warms, which makes Florida's coastlines particularly vulnerable. Climate change will likely affect not only the physical coastline, but also the millions of people who live and work in Florida. Understanding the impacts of climate change on Florida's coasts and inland areas therefore requires the perspectives of sociologists, economists, and scientists alike.

Society can deal with slow trends in climate, occurring over the many thousands of years that are characteristic of ice age cycles, but decade-to-century changes (i.e., those that occur on the timescale of a human lifetime) and the ability of societies to evolve quickly enough are potentially catastrophic.

Objectives

Climate change has the potential to play a critical role on human behavior over the next century. Even if all human activities that contribute to global change were stopped today, change would continue, as the present surplus of GHG in the atmosphere will remain for centuries. Therefore, Floridians need to decide today what changes they must make in their present behaviors in order to live in the changing climate.

Disaster management can provide some valuable lessons on encouraging changes in behavior. With Florida's experience in preparing for and responding to hurricanes, the tactics and strategies that people have learned to use to mitigate the effects of climate variability are now very basic. People will make decisions based on what they know and how they have operated in the past. It will be more difficult to adapt to climate change if it is dramatic and sudden and causes large disturbances. Thus, education and outreach (see ADP-15) will be an important component of adaptation, as will understanding how people respond to changes in risks and information on changes in risks.

Assets at Risk

Increased development to accommodate Florida's projected population growth will most likely increase climate exposure and risks to Florida's citizens and their current way of life. Florida must recognize that all regions of the state will encounter socioeconomic changes, including

- Increased housing and insurance costs, especially those related to storm events and SLR;
- Increased charges for energy consumption and transportation changes; and
- Increased cost of infrastructure improvements, including roads, sewer systems, wastewater treatment facilities, water control structures, and property protection.

An additional concern is the migration of people. Florida could attract people migrating from the Caribbean and elsewhere as a result of climate change impacts. In addition, it is possible that some Floridians will migrate inland from the coast.

ADP-11.1 Social Justice Issues

Goal 1: Promote social and economic equity, improve environmental management, reduce poverty, decrease the discharges of wastes, increase consumption efficiencies, and increase the quality of life for the vulnerable.

Goal 2: Assess potential social impacts of climate change on incomes, and other measures of well-being in vulnerable communities.

ADP-11.2 Food and Water Security

Goal 1: Ensure that access to safe food supply and water considers variations in risks from climate change such as SLR, increased hurricane intensity, inland flooding, wildfire, drought, changes in water quality, and other potential impacts

ADP-11.3 Housing Security

Goal 1: Consider potential impacts of climate change on housing. In particular, plan for SLR to threaten homes and apartment buildings located on the coast. Also consider other impacts of climate change and their risks to housing, such as more severe hurricanes, flooding, and wildfire.

ADP-11.4 Intersection of Climate Change and Human Behavior

Goal 1: Create incentives for the general public and businesses to use the latest technologies to adapt to climate change

Goal 2: Improve tracking of national and global trends on modifying human behavior and adopt the best management practices applicable to the State of Florida.

Goal 3: Convey information on the risks from changes in extreme events, including worst-case scenarios, to the public through education and outreach programs.

ADP-12. Organizing State Government for the Long Haul

Description of Issues

The range of adaptation planning issues outlined in this document is a testament to the number of issue areas and concerns that need to be adequately addressed to ensure that Florida successfully adapts to impacts caused by global climate change over the next century. In developing and implementing such a wide-ranging adaptation plan for the state, Florida will require a single point of focus within state government.

During the 2008 regular session of the Florida Legislature, HB 7135 (Ch. 2008-227, Laws of Florida) created the FECC and imbued the commission with a broad range of duties and powers, including responsibility for coordinating adaptation planning development and implementation within state government. The FECC is appropriately housed within the Executive Office of the Governor, thus elevating the climate change issue and enabling cross-agency coordination of efforts.

Objectives

The principal objective is to ensure the creation of a single point of focus within state government that can continue assessing the risks posed to Florida by global climate change, develop increasingly informed adaptation planning over many decades, and learn from prior implementation to adjust adaptation planning in Florida as events on the ground change.

Assets at Risk

Florida is a state with more than 1,350 miles of coastline and mostly low elevations. It is within the historic pathway of destructive weather events and particularly vulnerable to SLR, tidal surge, saltwater intrusion, and flooding. Coastal infrastructure (e.g., roads, bridges, and utilities) and towns and cities are also at risk. Florida has already felt the effects of mass human migrations for storm events alone. These conditions are expected to worsen in the future and be less temporary in nature. Freshwater resources are increasingly precious in the state and already pressured by Florida's growing population. Climate change poses risks to terrestrial and aquatic ecosystems, agriculture, forestry, and fisheries. All of these can add to existing stresses, such as population growth, land-use change, and pollution. The state of Florida will be affected by climate change through impacts on its physical assets, changes in revenues and expenditures, and changes in the activities it regulates.

Existing Actions

The Legislature created the FECC, which has the sufficient scope, powers, and resources to accomplish the intent of this element of adaptation planning.

Goals and Strategies

Goal 1: Determine effective planning and implementation mechanisms to integrate land, transportation, habitat, fish and wildlife protection, and water planning and management at all levels of government.

Goal 2: The FECC should create a State Climate Change Adaptation Plan Advisory Team to draft a State Climate Change Adaptation Plan. The plan should include identifying management, engineering, and technical solutions; developing design concepts for preferred solutions; and conducting initial feasibility studies relative to the scope, budgets, regulatory compliance, and timelines for the implementation of specific proposed adaptation solutions on regional scales.

Goal 3: Determine whether Florida should create a Coastal Commission to provide for more centralized authority and management of the state's coastal resources in view of future climate change impacts. The study should review existing Florida institutions, such as the Florida Ocean and Coastal Resources Council and similar institutions in other coastal states.

ADP-13. State Funding and Financing

Description of Issues

Adequate adaptation funding for Florida would include funds made available to address the impacts of climate change. Many programs are already in place and are intended to deal with some of these impacts. Some of these programs are already funded and may even have dedicated financing streams, but most existing programs are subject to political and economic cycles and disruption. Climate change impacts can be expected to intensify in the future and might also occur simultaneously, on all fronts, as opposed to the isolated incidences that are customary to Floridians and program resources. If and when this happens, it can be expected to greatly increase the pressure on funding and financing infrastructure.

Objectives

Florida should be prepared to fund the protection of human health and critical infrastructure, as well as address other impacts of climate change, where feasible, within a framework of protection, accommodation and, in some cases, retreat.

Assets at Risk

Florida is a state with more than 1,350 miles of coastline and mostly low elevations. It is within the historic pathway of destructive weather events and particularly vulnerable to SLR, tidal surge, saltwater intrusion, and flooding. Coastal infrastructure (e.g., roads, bridges, and utilities) and towns and cities are also at risk. Florida has already felt the effects of mass human migrations for storm events alone, and these conditions are expected to worsen in the future and be less temporary. Freshwater resources are increasingly scarce in the state and already pressured by Florida's growing population. Climate change poses risks to terrestrial and aquatic ecosystems, agriculture, forestry, and fisheries. All of these stresses can add to existing stresses, such as population growth, land-use change, and pollution, further straining any existing funding and financial resources intended to address these impacts.

Existing Actions

HB 7135, passed by the 2008 Florida Legislature, provided for the FECC, which is already preparing to explore funding and financing options with regard to adaptation issues in its deliberations.

Many of the expected impacts that climate change might bring are already familiar to Floridians. Consequently, programs to address such things as hurricanes and major storm events, storm surge and erosion, saltwater intrusion, and the availability of potable drinking water supplies have been implemented. Additionally, Florida's excellent emergency response infrastructure has proven itself under many scenarios and the planning mechanisms that are part of that infrastructure are in place to deal with a large variety of catastrophic events.

However, it is not known to what extent these programs and infrastructure will be pressured by future climate change–associated impacts or to what extent the funding will continue to be adequate under those future conditions.

Goals and Strategies

Many of the goals and strategies in other ADPs will require financial and staff resources. Florida will need to consider the financial implications of the adaptation goals and strategies.

Goal 1: Examine existing funding and financing infrastructure to determine adequacy for meeting increased demands of climate change impacts.

Goal 2: Examine alternative financing methods to meet climate change demands and consider protecting them from short-term economic or political cycles by dedicating funding.

Goal 3: Consider strategies for emergency funding or financing mechanisms for unforeseen and unplanned consequences of climate change.

Goal 4: Consider carbon credit revenues as an adaptation financing resource.

Goal 5: Examine opportunities for other sources of funding such as federal funds from emerging federal climate change legislation. In addition, opportunities to coordinate with private financing, including foundation resources, should be examined. Support allocation of cap and trade allocation funds to the states to support climate change adaptation.

ADP-14. Coordinating with Other Regulatory and Standards Entities

Description of Issues

The federal government is participating in a wide range of climate activities nationwide. They also fund state and regional entities that provide climate services. Activities include data collection and interpretation and product dissemination. Primary agencies involved include NOAA, U.S. Geological Survey (USGS), U.S. Environmental Protection Agency (EPA), Natural Resources Conservation Service (NRCS), and U.S. Department of Agriculture (USDA). Several products developed by federal agencies (e.g., drought severity categories and river flood forecasts) trigger a variety of Florida emergency and economic relief activities. Additional federal entities to be considered include the U.S. Energy Information Administration (EIA), U.S. Department of Energy (US DOE) (including the ENERGY STAR Program), National Science Foundation (NSF), and others.

In addition, a number of professional societies and other organizations are actively involved in activities to better understand the potential impacts of climate change on the members they serve. These societies often represent fundamental public service providers (e.g., water utilities [American Water Works Association] and coastal states [Coastal States Organization]) or are organizations such as the Intergovernmental Panel on Climate Change, the Pew Center on Global Climate Change and the Heinz Center that have examined climate change risks and adaptation. These organizations need early involvement in decision making and will require sufficient data to make informed decisions regarding risk and reliability, public health and safety, and financial management. Collectively, they represent a broad base of the population, possess unmatched knowledge of the industry they represent, and offer tremendous opportunities for technology transfer, public education, and widespread reach.

Objectives

Develop functional collaborative relationships between the State of Florida and selected federal government agencies, departments, and entities, as well as other states and, as appropriate, other countries and key professional societies to collaborate on climate change issues of mutual interest.

- Develop a research agenda to address shared interests and priorities.
- Identify and align with funding sources and allocation decisions essential to Florida's future as it relates to climate change.

Assets at Risk

The federal government has the lead and is central to most of the significant climate change and related programs, research, funding, and information dissemination. Failing to actively engage with the various agencies will result in missed opportunities to ensure that Florida's needs are expressed, understood, and addressed. Additionally, working in a vacuum will result in waste and inefficient use of the limited financial, intellectual, and physical resources and will not properly leverage the vast pool of people who have been working on climate change and related issues for years. Lastly, Florida must actively engage with the federal process and work as a cohesive unit (a state with numerous needs, challenges, and sometimes competing objectives) to ensure that the concerned parties are not competing with each other for limited dollars and research priorities.

Additionally, adaptation only "buys time." Rapid and significant GHG mitigation is the only long-term solution. Understanding that the two must go hand-in-hand is crucial.

Existing Actions

HB 7135, requires DEP and the Florida Department of Education (DOE), in coordination with the business, environmental, and energy communities, to develop an awards program to recognize efforts or achievements in conservation, energy and water use reduction, green cleaning solutions, green pest management, recycling efforts, and curriculum development that enhance the quality of education while preserving the environment. The Legislature encouraged the Florida DOE and DEP to form partnerships with the private sector to help fund the program. The provision would implement an environmental and educational award/recognition program that encourages district school boards, teachers, classes, and students to actively participate in strategies leading to environmental preservation.

14.1 Federal Government

Goals and Strategies

Goal 1: Develop a clear understanding of the functions and information available (needed) from key federal agencies.

Goal 2: Identify data gaps and prioritize research needs to establish an agreed-upon research agenda representing Florida's collective needs.

Goal 3: Prioritize funding needs and develop a strategy to secure federal and federal flow-down funding to meet strategic needs in Florida.

Goal 4: Request and engage the support of federal agencies, such as NOAA, USGS, Federal Emergency Management Agency (FEMA), and the U.S. Army Corps of Engineers (USACE), that can provide technological and logistical support and work with RPCs and other state, county, and local planning bodies to develop regional scenarios of climate change and analyze potential changes in vulnerability.

14.2 Professional Societies

Goals and Strategies

Goal 1: Engage professional societies and other organizations in establishing industry priorities for research and funding and work with state and federal officials to promote priorities.

Goal 2: Develop training and technology transfer tools and engage professional societies in reaching their members.

Goal 3: Establish a cross-functional task force of members of professional societies and other appropriate organizations that will be responsible for coordinating climate change issues within their respective industries.

Annex III of this Appendix includes the names of and summarizes the function of key professional societies involved with or who have a stake in climate change.

ADP-15. Public Education and Outreach

Description of Issues

Public education and outreach about climate change in Florida is needed to support necessary mitigation and adaptation actions. Florida is "ground zero" for climate change impacts in the United States with its low lying and densely populated coastal zones, susceptibility to hurricanes, and vulnerable natural resources. It seems that few people realize Florida's vulnerability, but these few are calling for detailed and accurate information and solutions. A focused and comprehensive stakeholder education and outreach program is a key component in building support for the mitigation and adaptation policy changes that will become critical issues in Florida.

Objectives

Florida can become a national and international leader in the distribution of climate change information in the process of educating a broad diversity of constituents with a cutting-edge and successful public education program. The success of any climate change adaptation demands full participation of the stakeholders (i.e., the citizens of Florida). The objectives of a successful public education outreach program would be fourfold:

1. To educate all of the stakeholders, including state leadership and state and regional government officials who implement adaptation actions, citizens of Florida (including retirees, families, the work force, and K-16 students), the broader business community, and faith-based and community organizations within and outside of Florida who are important stakeholders in Florida's adaptation actions. Create incentives to encourage involvement of the public and key stakeholders. Share not only current knowledge of the impacts already occurring and expected in Florida, but also short- and long-term solutions.

2. To design an overarching program that could be quickly and effectively disseminated to the stakeholders listed above, in clear, concise, and simple terms so all Floridians can embrace the knowledge. Use media such as the Internet that are widely and easily accessible.

3. Train, engage, and coordinate practitioners of climate change adaptation and needed technical support to help Florida plan for climate change. Climate change adaptation science and related policy improvements are developing fields requiring specific conceptual and technical skills, which exist independently in the expert community but require facilitation and training to bring together in a support group of adaptation experts.

4. Link outreach programs in public education to the best climate change science so that issues relating to adaptation and risk management create positive solutions to the environmental challenges of the future.

Assets at Risk

Principal risks include misunderstood and failed policy actions resulting in political stalemate and inaction. The best climate change adaptation programs will be at risk if not embraced by the stakeholders. The best policies might be approved in Tallahassee, but the full understanding and education of citizens will ensure their timely implementation and endorsement.

Existing Actions

HB 7135 addressed public outreach and education by requiring the DEP and the DOE, in coordination with the business, environmental, and energy communities, to develop an awards program to recognize efforts or achievements in conservation, energy and water use reduction, green cleaning solutions, green pest management, recycling efforts, and curriculum development that enhances the quality of education while preserving the environment. The Legislature encouraged DOE and DEP to form partnerships with the private sector to help fund the program. The provision would implement an environmental and educational award/recognition program that encourages district school boards, teachers, classes, and students to actively participate in strategies leading to environmental preservation.

Goals and Strategies

Goal 1: Provide immediate training on climate change adaptation.

Strategy A: Conduct short (2-day) executive seminars for Chief Executive Officers (CEOs) and state legislators that have been designed for policy makers and that are conducted by scientists trained in public education outreach.

Strategy B: Conduct a follow-up series of comprehensive workshops (4–6 days) that mixes business and civic leaders from public and private sectors. Local teachers should be included in all sessions.

Goal 2: Educate the public.

Strategy: Initiate a major public education campaign. Use high profile media and other appropriate outlets to raise general awareness on climate change in Florida. Make connections between mitigation and adaptation solutions and policy changes. Educate the public about the expected costs of inaction and delayed action compared with the costs of acting proactively. Focal topics could include heat waves and associated health risks, SLR and associated infrastructure and property risks, wildfire risks, species disturbances and habitat loss or change and associated ecosystem services losses (impacts to valuable and highly visible resources such as coral bleaching), and risks to water supplies. Focus groups could include the public; policy makers; media; business leaders; developers; and land owners, buyers, and sellers.

Goal 3: Create adaptation training and collaboration opportunities.

Strategy: Create opportunities for government agencies to work together and with experts in climate change adaptation to develop needed skills in applying adaptation concepts to their daily management and planning efforts. Adaptation focus areas would be natural resources and ecosystem services, infrastructure and development, financial markets, job markets, and human health and welfare. Technical expert focus groups would include Florida's policy makers, research institutions, NGOs, water boards, state agencies, and the media.

Goal 4: Develop education programs on climate change adaptation for primary and secondary schools.

Strategy: Revise the state Sunshine Standards for K-12 education so that vulnerability to climate change and the practice of adaptation become required subject matter in the curricula of public schools in Florida. In conjunction with the state standards, a team of professional educators and scientists should be funded to develop effective units of learning for all grade levels to ensure that all students are educated about climate change adaptation and, most importantly, on mechanisms for families to conserve energy and live more sustainably.

Goal 5: Encourage research and training on adaptation in Florida's public universities and research centers. Encourage public universities and research centers in Florida to develop educational programs in disciplines and professions affected by climate change to focus on developing adaptation methodologies.

Annex 1: Early Action Items Proposed by the ADP TWG

Aside from outlining a structure and plan for moving forward with a comprehensive effort to address adaptation in Florida, the Technical Work Group (TWG) was asked to identify up to approximately two dozen strategies or actions that merited early implementation. The TWG believes that the items listed below represent a selection of appropriate efforts that should be undertaken promptly. Please note that there are many additional strategies listed in the accompanying Adaptation TWG Policy Options Document (POD), and it is anticipated that the successor Florida Energy and Climate Commission will develop additional strategies to address the goals indicated in the POD in the course of its work.

ADP-1. Advancing Science Data and Analysis for Climate Change

Goal 2: Foster and support climate science research agenda for Florida with broad priorities. Institute a new scientific advisory council on climate change to advise state government on this research agenda. Identify and establish long-term funding to support research. Funding should be protected from short-term economic or political cycles.

- **a.** HB 7135 created the Florida Energy Systems Consortium as a "super center of excellence" within the State University System. The center should consider, as a priority order of business, the appointment of a scientific advisory council composed of members from disciplines relevant to adaptation to climate change and representative of each participating institution to better coordinate research in support of Florida's adaptation and climate change policy objectives.

- **b.** The Florida Energy and Climate Research Trust Fund should be created by the Legislature, and a dedicated revenue stream should be provided.

Goal 3: Conduct research needed to support incorporation of climate change into the protection of Florida's ecosystems and biodiversity.

- **a**. Define the likely new "states" of Florida ecological systems to determine state budget and policy requirements. Identify species and habitats that will likely be unable to migrate naturally and craft strategies to assist their relocation or recreate habitat elsewhere to facilitate this shift.

- **b.** Expand the newly developed Critical Lands & Waters Identification Project (CLIP) v1.0 database to incorporate impacts and adaptation to climate change.

Goal 4: Enhance support for mapping, monitoring, and modeling, all of which will be necessary to provide information to support policy making. For example, the state is supporting the use of light detection and ranging (LIDAR) to improve mapping of Florida's coastlines. Such mapping should be done for the entire coastline of the state. In addition, effective monitoring programs are needed to detect impacts of climate change; modeling is also needed to better project impacts.

a. Create a new center to coordinate and align data from proxy data sets to build a more precise picture of climate change in Florida over the last few thousand years and predict the effects of climate change in the future. This data center could also track associated responses in vegetation, sea level, and disturbances such as fire.

ADP-2.1. [Comprehensive Planning] Local Government Level

Goal 2: State and regional agencies should provide financial and technical assistance to local governments to ensure timely updates of local plans.

a. Update the Florida Department of Community Affairs (DCA) planning tools Web site section on climate change with adaptation information from the Action Team and other sources. Tie state and regional agencies into a central state digital database and ensure that all pertinent state records are digitized. This will provide local government planners with instant access to the information they need for considering the impacts of updates to local plans.

Goal 4: Local governments should review their coastal management elements to determine necessary amendments to make their coastal areas (especially the coastal high-hazard area) resilient to the future impacts of climate change, including sea level rise (SLR).

a. Create best practices manual, for local governments, that identifies coastal lands for state acquisition with new adaptation language incorporated into local, state, and regional government land acquisition processes.

b. Identify and revise statutory direction for local, state, and regional planning processes to determine the potential within planning areas for SLR, particularly in coastal areas. Provide for an assessment of:

- The potential movement of the coastal construction control line and related changes,
- The extent and potential for expansion of floodplains, and
- Potential habitat and wildlife migration.

c. The Florida Department of Environmental Protection (DEP), DCA, and the state's regional planning councils should jointly develop, assess, and recommend for local governments a suite of planning tools and climate change adaptation strategies to maximize opportunities to protect the beach/dune system, coastal wetlands, and other coastal resources in an era of rising seas. The tools should include strategies to encourage the landward siting and relocation of structures and public facilities in areas adjacent to receding shorelines through acquisition, rolling easements, transfer of development rights, stronger setbacks, and tax incentives.

ADP-2.3. [Comprehensive Planning] State Government Level

Goal 3: Balancing Property Rights and Protecting Communities and Natural Resources
Florida statutes, regulations, policies, and the Florida Administrative Code should be reviewed by the Florida Attorney General to determine potential conflicts between private property rights and the state and local governments' responsibility to protect communities.

a. The Florida Attorney General should examine Florida statutes, state policies, and agency administrative rules to identify, in advance, any potential conflicts between private property rights and the government's response to potential climate change impacts. State or local governments are responsible for protecting their communities, natural resources, and public usage and access to government-owned lands. That responsibility may come into conflict with the individual rights of private landowners who are affected by SLR, beach erosion, and other impacts of climate change. The Attorney General should issue a report of his findings that includes recommendations.

ADP-3.1. [Protection of Ecosystems and Biodiversity] Uplands, Freshwater and Marine Systems

Goal 1: Ensure that a representative portfolio of Florida's terrestrial, freshwater, and marine natural communities with redundant representation of habitats and species and connecting corridors (e.g., Florida's Biodiversity Blueprint) is protected and managed in a manner that maximizes the health and resilience of these communities when facing climate change impacts.

a. Tie into existing and expanded databases such as the CLIP in order to examine existing local, state, regional, and federal land holdings and categorize these holdings with regard to the representative portfolio.

b. Provide an accessible, expanded, and updated database to track changes to the natural communities and corridors.

c. Evaluate the adequacy of upland, freshwater, and marine systems protection status (for example through gap analysis) and, where necessary, increase protection area and/or status in each system to maximize their probability of adapting well to climate change impacts.

ADP-3.2. [Protection of Ecosystems and Biodiversity] Beaches and Beach Management

Goal 1: Reduce and discourage future reliance on bulkheading/hardening to stabilize estuarine and beach shorelines. Shoreline hardening should be considered only after a full and cumulative assessment of short- and long-term impacts to coastal resources and coastal ecosystems. Establish policies and regulations that clearly define when, how, where, and under what circumstances emergency beach stabilization is allowed.

a. Address local, state, and regional permitting programs and planning elements to fully assess potential impacts and changes to coastal resources and ecosystems from proposed coastal protection measures in light of potential impacts of climate change.

b. Add an overview element to state and regional planning documents describing statewide strategies and circumstances for coastal and shoreline retreat and erosion.

c. The state should undertake a comprehensive reevaluation of the Coastal Construction Control Line Program to ensure that it is accomplishing its intended goal of protecting the beach and dune system. The reevaluation should consider, among other things, the adequacy of existing coastal setbacks, building siting and design requirements, and post-storm redevelopment policies in light of SLR scenarios.

ADP-3.3. [Protection of Ecosystems and Biodiversity] Species Protection

Goal 1: The vulnerability of Florida's fish and wildlife to climate change impacts is assessed, the most vulnerable species are identified, and plans are prepared to enhance their chances of persistence where there is a reasonable likelihood that the species will persist over the next 50 years.

a. Utilize the CLIP and similar expanded and centralized digital databases to determine potential species and habitat vulnerability.

b. Incorporate species and habitat vulnerability to climate change into state and regional planning and zoning, government land acquisition, and determinations for conservation easements.

ADP-4. Water Resource Management

Goal 1: Identify and quantify the vulnerabilities and reliability of existing water supplies to potential effects of differing climate change scenarios with emphasis on source water availability and quality.

a. Develop inventory of water supply facilities (source, storage, treatment, and distribution) and conduct a study to develop different climate change scenarios and potential impacts and adaptation strategies for high-risk utilities.

ADP-5.1. [Built Environment, Infrastructure, and Community Protection] Building Codes and Regulation

Goal 1: Require that the Florida Building Code incorporate building design criteria for resisting future loads that may result from the impact of climate change–exacerbated hazards during a minimum service life of 50 years.

a. Strengthen Florida Building Code requirements for new structures and appropriate renovation to encourage climate change impact resistance.

b. Conduct research on how building codes can be routinely updated to account for changes in climate and develop options on how such codes could account for potential future changes in risks from climate change.

Goal 4: Develop a required training program to educate professionals in relevant fields (e.g., architecture, engineering, and construction management) on the need to incorporate adaptation to climate change as a basis for establishing design criteria for new infrastructure. Completion of such required training would be a condition for relicensing.

a. Examine licensing and recertification requirements for building professionals and revise them to include climate change impact design criteria.

b. Add adaptation criteria to professional education curricula at state universities and trade schools for building and design degrees.

ADP-15. Public Education and Outreach

Goal 1: Provide immediate training on climate change adaptation.

a. Conduct short (2-day) executive seminars for Chief Executive Officers (CEOs) and state legislators that have been designed for policy makers and that are conducted by scientists trained in public education outreach.

b. Conduct a follow-up series of comprehensive workshops (4–6 days) that mixes business and civic leaders from public and private sectors. Local teachers should be included in all sessions.

Goal 2: Educate the public.

a. Initiate a major public education campaign.

b. Use high-profile media and other appropriate outlets to raise general awareness on climate change in Florida. Make connections between mitigation and adaptation solutions and policy changes. Educate the public about the expected costs of inaction and delayed action compared with the costs of acting proactively. Focal topics may include heat waves and associated health risks; SLR and associated infrastructure and property risks; wildfire risks; species disturbances and habitat loss or change and associated ecosystem services losses (impacts to valuable and highly visible resources such as coral bleaching); and risks to water supplies. Focus groups may include the public; policy makers; media; business leaders; developers; and land owners, buyers, and sellers.

Annex 2: Priorities for Further Research and Analysis

ADP-1. Advancing Climate Change Science Data and Analysis

Priorities for Further Research and Analysis

Florida needs to *emphasize collaborations with international climate scientists, to refine climate predictions for Florida*. The state in partnership with federal agencies, international efforts, and Florida universities should (1) undertake review of current studies and models and (2) consider undertaking updating model development to more precisely forecast Florida's changes in weather patterns, (3) Undertake specific analysis of uncertainties and contingencies in climate scenarios for Florida.

Considering that Florida is so vulnerable to potential impacts of *sea level rise and hurricane activity, the state should place a special emphasis* on establishing or enhancing existing programs to follow developments in this field.

In addition to work on sea level rise and hurricane activity *the state needs to establish or enhance existing programs to monitor and determine trends in other climate related impacts* that could have consequences in Florida including: increased drought, wildfires, flooding and storm water runoff, heat waves, problems with invasive species and insect-borne disease resulting from changes in temperature and rainfall regimes, adverse effects on native terrestrial species, natural communities and marine life, salt water intrusion into aquifers, more frequent and intense storms, storm surges, tidal regimes, and coastal erosion. Build a decision support structure to guide and prioritize ongoing Florida-specific research agenda.

Deploy a "Florida Land and Sea Mesonet" (see e.g., the Oklahoma Mesonet for terrestrial counterpart) *to serve as a world class network of integrated environmental monitoring stations*, drawing from and contributing to existing terrestrial and marine networks, capitalizing and building upon deployed meteorological stations, ET stations, micro-meteorology towers , flow gauges and well/aquifer monitoring, and other critical monitoring networks, to meticulously track changes in Florida's climate and hydrology, filling missing gaps in statewide network coverage. The existing Florida Coastal Ocean Observing System should include climate impacts.

Support scientists working on *methods and availability of remote sensing data for continuous statewide coverage* (and associated surrounding oceanographic area of influence), with consistent spatial grids and measurements, for common inputs for climate and hydrologic models.

Long-term Climate Proxy data. Create a new Center, or virtual center, to coordinate and align data from available proxy datasets to build a more precise picture of climate change in Florida over last few thousand years with associated responses in e.g., vegetation, sea level, changes in fire regimes, etc. need for more proxy work and gaps in knowledge – spatial and temporal.

Evaluate likely persistence of Florida's rare species, natural communities, coastal ecosystem and parks and protected areas under climate change. Suggest during every 10-year review of state park, forest, and Wildlife Management Area Management Plans include a thoughtful analysis of vulnerability to climate change as part of their systematic management planning.

Linking climate scientists with ecologists, economists and social scientists. Issue a RFP from interdisciplinary teams of social scientists, economists and climate scientists, to build interactive models, including non-linearities and feedbacks, to better predict Floridian responses to anticipated changes. Agent based models are appropriate here because of the complexity of climate change models and responses.

Build socioeconomic models to evaluate the effectiveness of alternative incentives and policies. Select pilot areas and locations of the state to test policy programs. Evaluate effectiveness of adaptation strategies at regular intervals

Build better decision tools to incorporate total cost accounting for local and regional planning decisions, so that proposed land use change, agricultural policy shifts, water use policies, transportation decisions, siting of major new industries, etc. have a full assessment of all public costs including likely carbon/greenhouse gas footprint, and water use. Decision tools should also include assessments of proposals land use changes in the light of predicted climate changes.

ADP-3. Protection of Ecosystems and Biodiversity

Priorities for Further Research and Analysis

Florida's coral reef system should be evaluated, to ascertain changes from climate change or other stressors caused by people and actions taken to alleviate those that would provide greater resiliency and chances for coral recovery and expansion.

DEP should amend the Southeast Florida Coral Reef Initiative Local Action Strategy to consider the added stress on coral reefs due to global warming and develop an effective, coordinated management strategy to increase the protection of the region's coral reef ecosystem.

FWC and other relevant agencies should expand research and monitoring of coral reef ecosystems and assess of water quality and its effects on reefs over time.

Ecologically valuable coral reefs identified under Goal 1 above should be protected from shoreline development, overfishing and overuse, and other impacts to minimize their disappearance and to enhance their capacity to provide critical nursery habitat for fish and other organisms, storm surge protection and other public benefits.

The state should make monitoring of ocean pH and calcification rates a part of the coral monitoring plans in the Tortugas Ecological Reserve, the Florida Keys National Marine Sanctuary, Biscayne National Park, Florida Middle Grounds, Pulley Ridge and Oculina Bank Habitat Area of Particular Concern, and other locations around the state.

DEP, DACS and FWC should enhance state monitoring of biogenic reefs such as oyster reefs as well as valuable shellfish such as scallops and clams for calcification problems.

Priorities for Further Research and Analysis

Priorities for further research may include:[5]

- Estimate the absolute and relative vulnerability of species and habitats to climate change impacts.
- Determine the anticipated new states of natural communities in the face of climate change impacts.
- Assess the potential economic costs and benefits of climate change impacts on biodiversity, ecosystem processes, functions and services.
- Determine future costs (including environmental mitigation costs) of beach nourishment under different sea level rise scenarios. Will these costs be different in areas where adequate buffers have been established and where the shoreline is lined with high density development?
- Assess whether the state needs an Open Beaches Act. The research could address who owns the beach and what are the public's rights of access. On eroded shorelines with bulkheads, what happens to the public's common law right of access and customary use?
- Assess how the Burt Harris Act (takings law) affects the ability to adequately address coastal protection in an era of rising seas? Is it having a dampening effect on adequate regulatory policies? Will it increase the cost of implementing adaptation strategies?
- Asses how can the state legally authorize bulkheading or other armoring that will result in imperiled species take, violating state and federal endangered species law?
- Examine how beach access could be affected by climate change.
- Determine offshore sand availability for renourishment under differing scenarios and for different regions of the coast.

[5] Some of these priorities for research can be found in Florida's Comprehensive Wildlife Conservation Strategy (FWC, 2005) and Florida Ocean and Coastal Council's 2008-2009 Scientific Research Plan (FOCC, 2008).

- Model shoreline recession and erosion rates under different sea level rise scenarios.
- Model need for bulkheading under different scenarios.
- Inventory coastal public lands susceptible to impacts and assess those impacts. Determine need for buffers to allow habitat migration.

ADP-4. Water Resources Management

Priorities for Further Research and Analysis

The following is a partial list of research and analysis priorities.

Water Supply:

- Incorporate robust analytical methods to drive holistic planning and management of the built and natural water cycle. Such planning is essential to appropriately address an unknown future and should address energy requirements for water supply development, treatment and distribution and wastewater management.
- Apply "risk assessment" and "scenario planning" methodologies to assess risk under different climatic futures so that risks to existing assets can be understood, mitigation approaches evaluated and future assets can be developed within an anticipated risk framework.
- Continue innovation in the administration of District rules authorized under Chapter 373, F.S. (Applicable to water quality and flood protection.)
- Develop evolving technologies to improve the quality and reliability of data collection.
- Research to improve water use efficiency in various water use sectors.
- Identify new storage areas and technologies.
- Continue research on development of alternative water sources.
- Partner with other public and private sector entities to leverage resources to extend existing water supplies and develop prospective supplies.
- Research to identify and determine changes to the rainy season/rainfall patterns.
- Research to forecast quantities needed to fill and retain adequate water in reservoirs and other storage facilities.
- Assess and revise water conservation education activities
- Assess and revise appropriate quantities for water use and other permitting activities.
- Research to determine quantity effects of sea level rise on groundwater resources.

- Conduct regional downscaling on a watershed basis to quantify climate change on existing and potential water supplies.
- Research to determine the effects that predicted climate changes will have on the ground and surface water requirements of imperiled species.

Water Quality:

- Continue aggressive establishment of Minimum Flows and Levels and development of innovative and evolving methods to respond to future adaptations.
- Continue coordination with EPA, the Army Corps of Engineers, and other federal, state and local environmental agencies with shared jurisdiction to ensure that project activities will not degrade water resources.
- Work with the university community, Florida Yards & Neighborhoods, Adopt-A-Pond and other educational efforts to develop climate change and water resource materials to educate the public.
- Research innovative stormwater retention designs that maximize water quality benefits.
- Research necessary adjustments to the TMDL program.

Flood Protection:

- Continue assistance to update FEMA maps and maintain data as development occurs and flood prone areas change.
- Assist local governments with techniques to minimize development and infrastructure in potentially hazardous coastal areas.
- Research to determine effects of sea level rise on flood prone and historically non-flood prone areas.
- Develop stormwater retention designs and identify additional retention/storage areas to manage larger storm events.
- Create incentives to reverse the historic effects of drainage on landscapes to increase their capacity for natural water storage.
- Continue coordination with federal, state, and local emergency response agencies to develop adequate preparedness plans for potential flooding events as flood regimes change.
- Investigate and implement coastal and shoreline "rolling easements" to minimize potential structural damage and to maintain access and recreational benefits (tourism).

Natural Systems:

- Continue aggressive establishment of Minimum Flows and Levels and development of innovative and evolving methods to respond to future adaptations.

- Continue innovation in the administration of District rules authorized under Chapter 373, F.S.
- Develop processes to ensure environmental restoration work is done where long-term benefit is ensured under changing scenarios.
- Emphasize partnerships with other resource protection organizations to research and better facilitate acquisition and preservation of additional lands critical to preserving Florida's natural water resources.
- Develop a long-term and dense monitoring network for natural system health to ensure these resources are not endangered.
- Investigate strategies such as "rolling easements" (similar to strategies used in Texas, South Carolina and Maine) to allow long-term coastal migration, ecosystem adaptation and public access.
- Research to determine quality and quantity effects of sea level rise on ecosystems in transition.

ADP-5. Built Environment, Infrastructure and Community Protection

Priorities for Further Research and Analysis

Storm Surge:

Although ASCE-7 and the Florida Building Code prescribe methodology to quantify the main loads resulting from storm surge, there is very little region or site-specific information regarding the behavior of storm surge at specific locations and under the influence of local impact modifiers. Information such as: the angle of attack of storm surge at a given coastal location as a function of the direction of travel of a tropical cyclone, the velocity of flow of storm surge as it approaches a coastal location and the factors that influence such velocity of flow, and other related information are not readily available or not available at all for building design professionals to use in establishing design criteria for a specific building.

Research to identify such storm surge behavioral parameters on a basin-specific basis throughout the state could provide invaluable information to design professionals.

Research to develop protocols for the removal of abandoned residential, industrial and municipal structures will be essential to insure these structures do not release contaminants into coastal waters when inundated by sea level rise.

ADP-7. Economic Development

7.2.1 Forests

Priorities for Further Research and Analysis

- Determine carbon sequestration capacity of Florida's native tree species.
- Determine at-risk areas of forest resources due to climate change impacts.
- Research to determine the effects that predicted climate changes will have on the production and cultivation of agricultural commodities.

7.2.2 Marine

Priorities for Further Research and Analysis

- Couple IPCC outputs, regional climate and oceans data, and ocean circulation models to forecast areas and rates of coastal water temperature changes under several scenarios.
- Expand existing state programs and platforms for monitoring, event responses, data management, and public reporting to include range extensions, shifts in population centers of valued species, dispersion patterns of non-native marine and coastal species, marine diseases, and biological threats to industry workers and consumers.
- Couple future land use plans, sea level projections, hurricane risk models, energy-efficiency standards for marine ops, and land-based transportation systems to co-locate new parks, conservation areas, and working waterfronts for fishing, ecotourism, and marine research.

7.2.5 Mining

Priorities for Further Research and Analysis

Examination of soil characteristics for use of such properties as forested carbon sinks, bioenergy crop production and underground carbon sequestration.

ADP-8. Insurance (Property and Casualty)

Priorities for Further Research and Analysis

Conduct further research on incorporating climate change into hurricane models. Try to develop more of a scientific consensus on how hurricanes will change.

Conduct more research on hurricane mitigation techniques and effectiveness. For example, RenRe and Florida International University are researching how to build homes to withstand stronger hurricanes at the Wall of Wind, a cutting edge facility in Miami-Dade County. (www.renre.com/wow.html)

Currently, the Florida Office of Insurance Regulation has engaged in a residential wind loss mitigations study. The scope of this project is to evaluate windstorm loss relativities for construction features including but not limited to, those which enhance roof strength, opening protection, and window, door and skylight strength. The study includes single and multi-family homes. This report will be used, in part, to assist in developing accurate discounts for homeowners that employ specific mitigation methods.

ADP-9. Emergency Preparedness and Response (Extreme Events)

Priorities for Further Research and Analysis

Enhancing Florida's emergency preparedness and response functions to perform effectively in extreme events exacerbated by global climate change will require additional science and analysis. Current priorities include

- Additional research to better understand and predict the effects of global climate change on hurricane frequency and intensity in the Atlantic Basin;
- Local and regional analysis of shoreline elevation to better predict storm surge using statewide LIDAR survey data recently completed for the state's coastline;
- Additional research and analysis into the behavior of Floridians when facing extreme weather events and communications strategies that more effectively result in the evacuations of high-risk areas; and
- Analysis of strategies to ensure that special-risk populations can be effectively evacuated from high-risk areas.

ADP-10. Human Health Concerns

Priorities for Further Research and Analysis

- Improved projections of potential public health risk from the interaction of increasingly intense and long heat waves with existing air-quality problems in major urban areas.
- Projects on the potential in Florida for increases in the transmission of vector-borne infectious diseases (e.g., malaria, dengue, yellow fever, and some viral encephalitis) resulting from immigration from other climate change affected areas.
- Analysis of the relationship between heavy rainfall and biological contamination of water supplies, the influence of climate variability and extremes on notified illnesses, and quantification of the burden of water-related illnesses (including conditions such as gastroenteritis and skin infections).

ADP-12. Organizing State Government for the Long Haul

Priorities for Further Research and Analysis

Beyond the creation of the Florida Energy and Climate Commission, other entities and coordinating mechanisms may be required. Development and implementation of Florida's first generation adaptation plan should bring these additional organizational requirements to light. Further analysis of the following issues is encouraged:

- What coordinating mechanisms are required to assure that multiple state agencies with similar powers and duties are collaborating on adaptation planning and implementation?
- What coordinating mechanisms are required to assure that state government is working in concert with regional and local agencies to reduce risk and increase Florida's adaptability?

ADP-13. State Funding and Financing

Priorities for Further Research and Analysis

- Traditional funding mechanisms such as state, regional and local taxes, utility and land use fees.
- Develop new revenue streams resulting from federal legislation, cap and trade program revenues, potentials for carbon offsets/sequestration, resource use taxes, etc.

ADP-14. Coordinating with Other Regulatory and Standards Entities

14.1 Federal Government

14.2 Professional Societies

Priorities for Further Research and Analysis

Identify targeted Federal agencies based on Florida needs and issues addressed.

ADP-15. Public Education and Outreach

Priorities for Further Research and Analysis

Florida can learn from other successful outreach and education strategies for climate change in other states and countries which are farther along in these areas. Just as the state is learning about managing coral reefs in a changing climate from Australia, Florida can learn how to engage stakeholders from similar efforts.

Annex 3: Federal Agency Resources

The following list includes the name and summarizes the function of key Federal agencies (by category) involved with or who have a stake in climate change.

Drought Preparedness

- National Drought Mitigation Center (NDMC)

  This site hosts the Drought Monitor and The Drought Impact Reporter. NDMC helps people and institutions develop and implement measures to reduce societal vulnerability to drought. http://www.drought.unl.edu/dm/index.html, http://droughtreporter.unl.edu/

- National Integrated Drought Information System (NIDIS)

  This National Oceanic and Atmospheric Administration (NOAA) site hosts the federal drought monitoring system. NIDIS provides a complete summary of drought information at national, regional, state and local scales.

- Climate Prediction Center (CPC-NOAA)

  CPC provides a variety of climate analysis and prediction products, including the Drought Outlook, which projects drought category tendencies for a three-month period. http://www.cpc.ncep.noaa.gov/

Climate Information

- National Climatic Data Center (NCDC)

  NCDC is the national archive for climate data and products. http://www.ncdc.noaa.gov/oa/ncdc.html

- Applied Climate Information System (ACIS)

  ACIS is supported by the National Climatic Data Center (NCDC) under the National Virtual Data System and operated by the six Regional Climate Centers. ACIS provides both real-time and historical climate data from a variety of networks. ACIS also allows execution of user adjustable programs to support drought risk analysis. http://rcc-acis.org/

- Florida State Climatologist

  The Florida Climate Center is part of three-tiered system that serves to provide climate data, information, and services for the United States. http://www.coaps.fsu.edu/climate_center/nav.php

- Southeast Climate Consortium

The mission of the Southeast Climate Consortium is to use advances in climate sciences, including improved capabilities to forecast seasonal climate, to provide scientifically sound information and decision support tools for agriculture, forestry, and water resources management in the Southeastern USA. http://secc.coaps.fsu.edu/

Water Information

- National Water Information System (NWIS)

  NWIS is operated by the United States Geologic Survey (USGS) and provides both real-time and historical surface streamflow, reservoir and groundwater information. http://water.usgs.gov/waterwatch/

- U.S. Water Monitor

  This site provides a summary of water information at national, regional, state and basin scales. http://watermonitor.gov/

- National Weather Service–Hydrology

  The River Forecast Centers provide streamflow and flood forecasts for the U.S. http://www.nws.noaa.gov/oh/index.html

- U.S. Army Corps of Engineers

  In support of nation's interests, build broad-based relationships and alliances to collaboratively provide comprehensive, systems-based, sustainable and integrated solutions to water resources national and international challenges. http://www.usace.army.mil/

  The majority of Florida is served by the Jacksonville District Office (http://www.saj.usace.army.mil/) and the Panhandle is served by the Mobile, Alabama, office (http://www.sam.usace.army.mil/)

Agriculture

- Joint Agricultural Weather Facility (JAWF)

  This joint USDA/Department of Commerce operation provides production agriculture predictions for the United States and the world. http://www.usda.gov/oce/commodity/index.htm

- Natural Resources Conservation Service (NRCS)

  NRCS's natural resources conservation programs help people reduce soil erosion, enhance water supplies, improve water quality, increase wildlife habitat, and reduce damages caused by floods and other natural disasters. http://www.nrcs.usda.gov/programs/

Ecosystems

- The Mission of the U.S. Fish & Wildlife Service (USFWS) is working with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people.

  The challenge of climate change to the USFWS is two-fold. The scientific challenge is one of translating projections of climate change into transparent predictions of trust resource response that can guide management decisions. The resource conservation challenge is one of articulating and directing a conservation response that is strategic, adaptive, and collaborative.

The mission of the Environmental Protection Agency (US EPA) is to protect human health and the environment. Since 1970, US EPA has been working for a cleaner, healthier environment for the American people. http://www.epa.gov/

The following list includes the name and summarizes the function of key professional societies involved with or who have a stake in climate change.

- American Water Works Association (AWWA) and the Florida Section AWWA (FSAWWA)
- AWWA Research Foundation (AWWARF)
- Water Environment Foundation (WEF) and Florida Water Environment Association (FWEA)
- Water Environmental Research Foundation (WERF)
- American Water Resource Association (AWRA)
- WateReuse Foundation
- Southeast Desalting Association (SDA)
- Florida Stormwater Association (FSA)
- American Society of Highway Engineers (ASHE)
- Florida Engineering Society (FES)
- Association of Public Works Administrators (APWA)

Annex 4: Values at Risk

In order to assess the vulnerability of the built environment to hazards driven or exacerbated by climate change, it is essential to define and quantify the value at risk. In this specific case this refers to the value of the built environment and associated infrastructure.

The value at risk provides a baseline to assess the potential for damage from the impact of climate-driven or exacerbated hazards over a given time period, and to identify and evaluate the cost effectiveness of adaptation alternatives.

Defining the Value at Risk

Before quantifying the value of the built environment that is or may be at risk it is necessary to first define what is meant by value at risk. In defining the value at risk of the built environment the following criteria must be considered:

1. The value of the built environment is dynamic, meaning that it changes over time in response to a range of factors, such as total population, density of population, demographics, land use and zoning, the mix of occupancies in a given community or region, importance or criticality of the functions sheltered by given buildings or structures, total area of constructed space and others.
2. The value of the built environment is not limited to the cost of construction of the physical buildings, facilities and structures, but it is directly affected by the value of the human activity or function sheltered or supported by components of the built environment in a given community or region.
3. The value of the built environment is interlinked with the value of the land on which it is located. To the degree that buildings change the character of land from vacant to developed, they also change the value of the land. In this sense the value of the built environment and the value of property become synonymous.
4. The value of the built environment is a function of the vulnerability of the location on a regional and/or a site-specific basis.

Given the above criteria it is clear that there are several factors to be taken into account to define the value of the built environment that is at risk of being damaged by the impact of hazards caused or exacerbated by climate change. With respect to the built environment it is also clear that defining and quantifying the value at risk can at best be achieved through a series of snapshots that represent either current conditions or projected conditions based on future scenarios.

Given the variability of these factors from region to region, or from one community to the next, it should be noted that the value at risk must be defined by community or regional basis. The aggregate of all the regionally defined values at risk constitute the value at risk for the whole state of Florida.

In essence this means that the definition and quantification of the value at risk, of the built environment, must be a continuous exercise requiring the establishment of a baseline for a given region, community or site and periodic updates at specific time intervals.

Quantifying the Value at Risk

Once the value at risk has been defined on the basis of region or community-specific criteria and factors the value at risk can be quantified at the community or regional scale.

Quantifying the value at risk provides an essential foundation for the following:

1. The potential for damage to the built environment, from the impact of climate change caused or exacerbated hazards can be estimated as a percentage of the value at risk.
2. The effectiveness and benefits of adaptation measures can be quantified on the basis of their damage reduction capabilities.
3. The cost-effectiveness of adaptation measures can be assessed on the basis of their respective benefit-to-cost ratio.

Quantification of the value at risk [of the built environment] can be based, at a minimum, on the following parameters:

a) Replacement Value of Building[s]
b) Replacement Value of Contents
c) Criticality Factor: a multiplier reflecting the type of function housed in the building

Use of these parameters is represented by the equation below:

$$Vr = (C + N) \times Fc$$

Where:
- Vr = Value at Risk in current U.S. Dollars
- C = Replacement value of building in current \$
- N = Replacement value of contents in current \$
- Fc = Criticality factor

Quantification of the value at risk for the built environment can be simplified at the local level, by quantifying the value on the basis of the type of function sheltered by various buildings, facilities, and structures. For example, all residential use buildings can be grouped together, the same as all educational facilities, or health-care facilities, or government buildings etc. In the end the aggregate of all the values at risk by type of function will constitute the total value at risk at the municipal level for example.

Appendix G
Acronyms and Abbreviations

AAR	American Association of Railroads
AASHTO	American Association of State Highway and Transportation Officials
ABM	agent based model
ACEEE	American Council for an Energy Efficient Economy
ADP	Adaptation
AEO	Annual Energy Outlook
AFW	Agriculture, Forestry, and Waste Management
ANL	Argonne National Laboratory [United State Department of Energy]
AOR	areas of responsibility
ASAP	Appliance Standards Awareness Program
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ATA	American Trucking Associations, Inc.
BAU	business as usual
BC	black carbon
BMP	best management practice
BRT	bus rapid transit
C&T	cap-and-trade
CAFÉ	corporate average fuel economy [standards]
CAMA	[Florida Office of] Coastal and Aquatic Managed Areas
CARB	California Air Resources Board
CC&R	Conditions, Covenants and Restrictions
CCCL	Coastal Construction Control Line [Program]
CCS	Center for Climate Strategies
CCSR	carbon capture and storage or reuse
CDBG	Community Development Block Grant
CEO	Chief Executive Officer
CERP	Comprehensive Everglades Restoration Plan
CEU	continuing education unit
CGBP	Certified Green Building Professional
CH_4	methane
CHP	combined heat and power
CL&P	Connecticut Light and Power
CLIP	Critical Lands & Waters Identification Project [v1.0 database]
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CPIC	[Florida] Citizens Property Insurance Corporation

CRP	Conservation Reserve Program
CSE	cost of saved energy
CSI	Climate Status Investigations
CUTR	Center for Urban Transportation Research
DBPR	[Florida] Department of Business and Professional Regulation
DCA	[Florida] Department of Community Affairs
DEM	[Florida] Division of Emergency Management
DEP	[Florida] Department of Environmental Protection
DG	distributed generation
DOE	[Florida] Department of Education
DOF	[Florida] Division of Forestry
DOR	[Florida] Department of Revenue
DSM	demand-side management
EAR	Evaluation and Appraisal Process
EECBG	Energy Efficiency and Conservation Block Grant
EEPS	Energy Efficiency Portfolio Standard
EGU	electric generation unit
EIA	[U.S.] Energy Information Administration
EISA	Energy Independence and Security Act
EPA	[U.S.] Environmental Protection Agency
EPAct	Energy Policy Act of 2005
EPS	environmental portfolio standard
EQIP	Environmental Quality Incentives Program
ERP	Environmental Resource Permits
ESCO	Energy Service Company
ESD	Energy Supply and Demand
ET	evapotranspiration
ETDM	Efficient Transportation Decision Making
ETS	Excellence Through Stewardship
EU	European Union
FAC	Florida Association of Counties
FAR	floor area ratio
FBC	Florida Building Commission
FDACS	Florida Department of Agriculture and Consumer Services
FDOT	Florida Department of Transportation
FECC	Florida Energy and Climate Commission
FEECA	Florida Energy Efficiency and Conservation Act
FEMA	[U.S.] Federal Emergency Management Agency
FEO	Florida Energy Office
FESC	Florida Energy Systems Consortium

FFA	Florida Forestry Association
FGBC	Florida Green Building Coalition
FHWA	Federal Highway Administration
FIA	Forest Inventory and Analysis
FISE	Florida Institute for Sustainable Energy
FJD	First Jurisdiction Deliverer
FLC	Florida League of Cities
FLCOOS	Florida Coastal Ocean Observing System
FLM	Florida League of Mayors
FPL	Florida Power & Light [utility company]
FRCC	Florida Reliability Coordinating Council
FSG	Florida Sea Grant [College Program]
FTP	Florida Transportation Plan
FUSE	Faiths United for Sustainable Energy
FWC	[Florida] Fish and Wildlife Conservation Commission
GEF	Green Energy Fund
GEMS	Great Explorations in Math and Science
GHG	greenhouse gas
GIS	Geographic Information System
GLEE	[The Florida Keys] Green Living & Energy Education
GP	Government Policy
GPS	Global Positioning System
GREET	Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation
GRI	Gas Research Institute
GTR	General Technical Report
HB 7135	House Bill 7135
HB	House Bill
HERS	Home Energy Rating System
HFC	hydrofluorocarbon
HOA	Home Owners Association
HOT	high-occupancy toll
HOV	high-occupancy vehicle
HVAC	heating, ventilation, and air conditioning
I&F	Inventory and Forecast
ICLEI	International Council for Local Environmental Initiatives
IECC	International Energy Conservation Code
IFAS	Institute of Food and Agricultural Sciences
IOU	investor-owned utility
IPPC	Intergovernmental Panel on Climate Change
IRP	Integrated Resource Planning

ITS	intelligent transportation system
JEA	Jacksonville Electric Authority
LA	license application
LBNL	Lawrence Berkeley National Laboratory
LCFS	low-carbon fuel standard
LDV	light-duty vehicle
LED	light-emitting diode
LEED	Leadership in Energy and Environmental Design™
LEED-AP	Leadership in Energy and Environmental Design-Accredited Professional
LEED-H	LEED for Homes
LEED-ND	LEED-Neighborhood Development
LF	landfill
LFGTE	landfill gas-to-energy
LGCP	Local Government Comprehensive Plan
LIDAR	Light Detection and Ranging
LOS	level of service
LPG	liquefied petroleum gas
LRR	low-rolling resistance [tires]
LRTP	long-range transportation plan
MPO	metropolitan planning organization
MSW	municipal solid waste
N_2O	nitrous oxide
NAS	National Academy of Sciences
NETL	National Energy Technology Laboratory
NFIP	National Flood Insurance Program
NGO	nongovernmental organization
NOAA	National Oceanic and Atmospheric Administration
NOEP	National Ocean Economics Program
NO_x	nitrogen oxides
NRC	[U.S.] Nuclear Regulatory Commission
NRC	National Research Council
NRCS	Natural Resources Conservation Service
NRDC	Natural Resources Defense Council
NREL	National Renewable Energy Laboratory
NRI	Natural Resources Inventory
NS	Norfolk Southern [railroad]
NSF	National Science Foundation
NYSERDA	New York State Energy Research and Development Authority
O&M	operation and maintenance
OE	original equipment

OIR	[Florida] Office of Insurance Regulation
ORNL	Oak Ridge National Laboratory [U.S. DOE]
OTTED	[Florida] Office of Tourism, Trade, and Economic Development
OUC	Orlando Utilities Commission
PEF	Progress Energy Florida
PFC	perfluorocarbon
PIRG	public interest research group
PPSA	Power Plant Siting Act
PRC	[Florida] Public Regulatory Commission
PSA	public service announcement
PSC	[Florida] Public Service Commission
PUC	Public Utilities Commission
PV	photovoltaics
R&D	research and development
RAEL	Renewable and Appropriate Energy Laboratory
RD&D	research, development, and demonstration
REC	Renewable Energy Certificate
REIT	real estate investment trust
REPP	Renewable Energy Policy Project
RFP	Request for Proposal
RFS	Renewable Fuel Standard
RGGI	Regional Greenhouse Gas Initiative
RPC	regional planning council
RPS	renewable portfolio standard
RRC	rolling resistance coefficients
RTA	regional transportation authority
SBC	systems benefit charge
SCP	[Florida] State Comprehensive Plan
SEER 15	Seasonal Energy Efficiency Ratio 15
SF_6	sulfur hexafluoride
SIS	Strategic Intermodal System
SLR	sea level rise
SO_2	sulfur dioxide
SOV	single-occupancy vehicle
SRPP	Strategic Regional Policy Plans
STA	storage treatment area
SUS	State University System
TCR	The Climate Registry
TIMO	timber investment management organization
TLU	Transportation and Land Use

TMDL	total maximum daily load
TOS	time-of-sale
TOU	time-of-use
TRB	Transportation Research Board
TSM	Transportation System Management
TWG	Technical Work Group
TYSP	Ten-Year Site Plans
UCAR	University Corporation for Atmospheric Research
UF	University of Florida
UI	United Illuminating [power company]
ULI	Urban Land Institute
US DOE	U.S. Department of Energy
US DOT	U.S. Department of Transportation
US EPA	U.S. Environmental Protection Agency
US FWS	U.S. Fish and Wildlife Service
USACE	U.S. Army Corp of Engineers
USCM	U.S. Conference of Mayors
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USGBC	U.S. Green Building Council
USGS	U.S. Geological Survey
VEI	Vehicle Efficiency Incentive [program]
VHT	vehicle hours traveled
VMT	vehicle miles traveled
WCI	Western Climate Initiative
WGA	Western Governors' Association
WHIP	Wildlife Habitat Incentives Program
WMD	water management district
WW	wastewater
WWF	World Wildlife Fund

Units of Measure

$/tCO$_2$e	dollars per metric ton of carbon dioxide equivalent
Btu	British thermal unit
GWh	gigawatt-hour
kW	kilowatt
kWh	kilowatt-hours
MMtCO$_2$e	million metric tons of carbon dioxide equivalent
mpg	miles per gallon
MW	megawatt

MWh	megawatt-hours [one thousand kilowatt-hours]
sq ft	square feet