Executive Summary

Background

On December 12, 2006, Minnesota Governor Tim Pawlenty announced the state's "Next Generation Energy Initiative," including "development of a comprehensive plan to reduce Minnesota's emissions of greenhouse gases (GHGs)." In this announcement, the Governor requested assistance from the Center for Climate Strategies (CCS) in the development of a Minnesota Climate Mitigation Action Plan (Action Plan) and formation of the Minnesota Climate Change Advisory Group (MCCAG). This broad-based group of Minnesota citizens and leaders was charged with developing a comprehensive set of state-level policy recommendations to the Governor through a stakeholder-based consensus building process facilitated by CCS in coordination with the Minnesota Department of Commerce (DOC) and Minnesota Pollution Control Agency (PCA). Their work included:

- Development, prioritization, analysis, and approval of a final collection of existing and proposed actions that could contribute to GHG emissions reductions;
- Review and approval of an inventory of historical and forecasted GHG emissions in Minnesota as a basis against which to gauge priorities and progress; and
- Consideration of costs and benefits of recommended options.

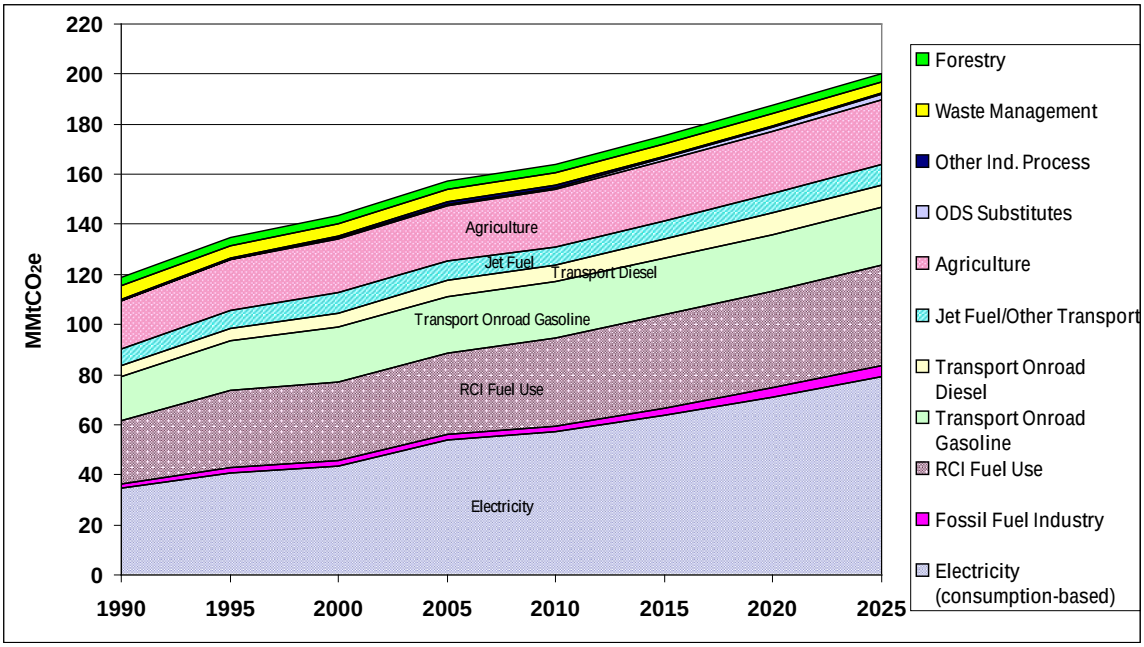
This report is the culmination of the work of more than 100 Minnesotans who were members of the MCCAG and the six Technical Work Groups (TWGs) that supported the MCCAG. In order to complete this monumental effort, the MCCAG and TWG members and CCS were required to make numerous estimates and assumptions. They did so with the best intentions, using the best information available in the time given, and using best professional judgment. Many will second guess parts of this report. That is appropriate and to be expected. Reducing GHG emissions will be a long-term effort. Most of the analyses completed for this report will be reexamined from time to time. As that occurs, assumptions should also be reexamined and changed as new information and understanding warrants.

Inventory of Minnesota's Greenhouse Gas Emissions

In July 2007, CCS, with assistance from the Minnesota PCA, prepared a preliminary draft GHG emissions inventory and reference case projection for the MCCAG and its TWGs to assist them in understanding past, current, and possible future GHG emissions in Minnesota and thereby inform the policy development process. The preliminary draft *Inventory and Projections* was improved by incorporating comments provided by the MCCAG and TWGs. As shown in Figure EX-1, the *Inventory and Projections* revealed substantial emissions growth rates and related mitigation challenges. Minnesota's gross emissions of GHGs grew by 32% between 1990 and 2005, twice the national average of 16%. Minnesota's emissions growth was driven largely by the growth of Minnesota's population and emissions associated with imported electricity; the state's emissions on a per capita basis increased by about 11% between 1990 and 2005, while U.S. per capita emissions declined slightly (2%) over this period. In the absence of recent developments that Minnesota has undertaken to control its emissions, Minnesota's gross GHG emissions are projected to rise fairly steeply to about 200 million metric tons of carbon dioxide

equivalent ($MMtCO_2e$) by 2025, or 68% over 1990 levels. Minnesota's forests and agricultural lands have been a net source rather than a sink of carbon emissions largely due to the loss of these lands to other uses. Consequently, in Minnesota "net emissions" (in which reductions due to sequestration are subtracted from gross emissions) are equal to gross emissions.

Figure EX-1. Gross GHG emissions by sector, 1990–2020: historical and projected (consumption-based approach) business as usual/base case



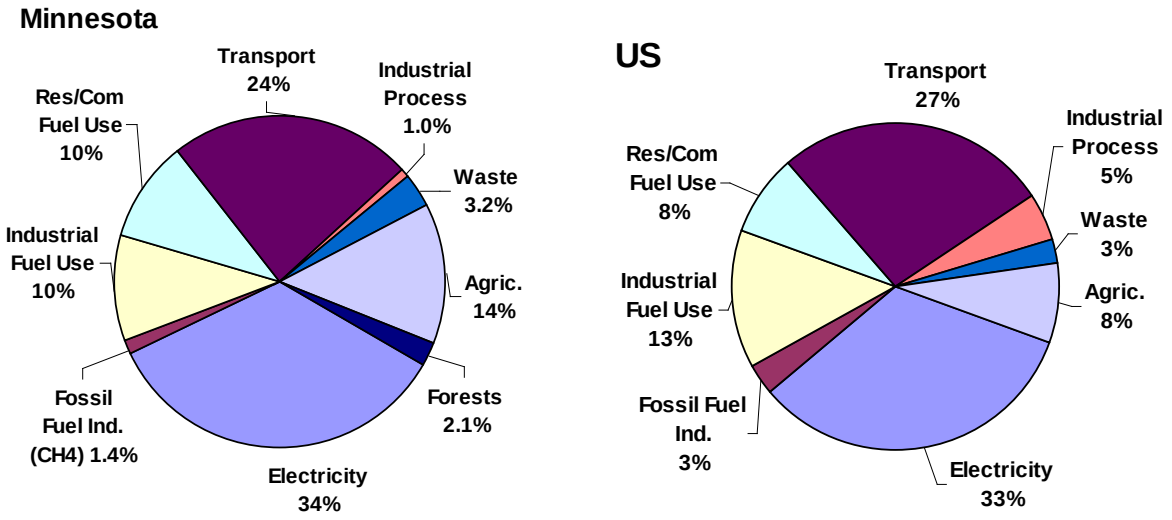
RCI = direct fuel use in residential, commercial, and industrial sectors; ODS = ozone depleting substance.

The principal sources of Minnesota's GHG emissions in 2005 are electricity use (including electricity imports) and transportation, accounting for 34% and 24% of Minnesota's gross GHG emissions, respectively, as shown in Figure EX-2. The use of fossil fuels—natural gas, oil products, coal, and wood—in the residential, commercial, and industrial (RCI) sectors accounted for another 20% of the state's emissions in 2005. Minnesota is slightly higher than the nation as a whole in emissions from electricity production and slightly lower in transportation. Agricultural activities, such as manure management, fertilizer use, livestock (enteric fermentation), and changes in soil carbon due to cultivation practices, result in methane (CH_4) and nitrous oxide (N_2O) emissions that account for another 14% of state GHG emissions. This is greater than the U.S. portion of emissions attributable to agriculture (8%). Landfills and wastewater management facilities produce CH_4 and N_2O emissions that accounted for 3% of total gross GHG emissions in Minnesota in 2005. Emissions associated with the transmission and distribution of natural gas accounted for 1% of the gross GHG emissions in 2005. Industrial process emissions accounted for about 1% of the state's GHG emissions in 2005, and these emissions are rising due to the increasing use of hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) as substitutes for ozone-depleting chlorofluorocarbons (CFCs).[1] Other industrial processes emissions result from

[1] CFCs are also potent GHGs; however, they are not included in GHG estimates because of concerns related to implementation of the Montreal Protocol. See Appendix I in the *Inventory and Projections* report for Minnesota.

taconite, lime, and peat manufacturing; PFC use in semiconductor manufacture; CO_2 released during limestone, dolomite, and peat use; sulfur hexafluoride (SF_6) released from transformers used in electricity transmission and distribution systems; and N_2O from medical uses.

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



Note: At a national level, forests act as a net sink of CO_2; therefore, they do not show up in the above graph of gross U.S. emissions sources.

Recent Developments

On May 25, 2007, Governor Tim Pawlenty signed the Next Generation Energy Act of 2007.[2] This state law, coupled with other state initiatives to control GHG emissions, positions Minnesota as a leader on the way toward our nation's energy future. The Next Generation Energy Act of 2007 includes requirements for Minnesotans to increase energy efficiency, expand community-based energy development, and establish a statewide goal to reduce GHG emissions. The state law also supplements the aggressive 25x'25 renewable energy standard proposed by the Governor and signed earlier this year.

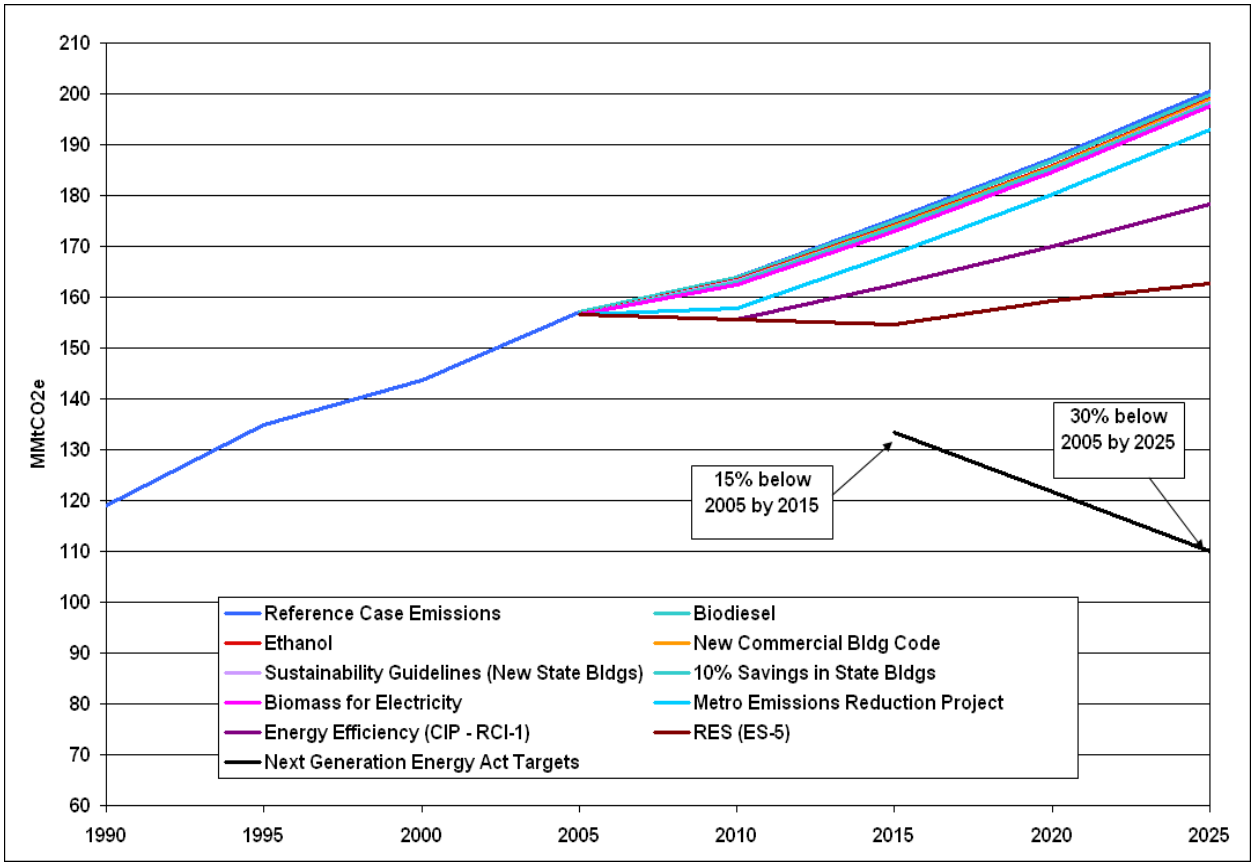
The act established aggressive goals for Minnesotans to reduce statewide GHG emissions across all sectors to a level at least 15% below 2005 levels by 2015, to a level at least 30% below 2005 levels by 2025, and to a level at least 80% below 2005 levels by 2050. This means that to meet the 2015 emissions goal, Minnesotans will have to reduce their emissions to about 131.8 $MMtCO_2e$ (or by about 41.3 $MMtCO_2e$ below 2015 levels). To meet the 2025 emissions goal, Minnesotans will have to reduce their emissions to about 108.5 $MMtCO_2e$ (or by about 89 $MMtCO_2e$ below 2025 levels).

At the beginning of the MCCAG process, DOC and PCA identified more than 40 different actions Minnesota has undertaken to control GHG emissions while at the same time conserving

[2] Next Generation Energy Act, Minnesota Senate File No. 145, at: https://www.revisor.leg.state.mn.us/bin/bldbill.php?bill=S0145.2.html&session=ls85

energy and promoting the development and use of renewable energy sources.[3] These actions also include assessments of both terrestrial and geologic carbon storage opportunities in Minnesota. The MCCAG recognized the importance of these recent actions as essential for setting Minnesota on the path toward meeting its aggressive statewide goals and used these actions to formulate the baseline from which it considered and developed its wide range of recommendations to ensure that Minnesota stays the course toward meeting its goals. A total of nine recent actions were identified for which data were available to estimate the emission reductions and costs/cost savings of the actions relative to the business-as-usual reference case projections. Implementation of the recent actions analyzed indicates that emissions reductions will be about 50% of the total emission reductions needed to meet the state's 2015 goal and about 42% of the total emission reductions needed to meet the state's 2025 goal (see Figure EX-3). These results underscore the importance of the contributions of the recent actions toward Minnesota's ability to meet its statewide reduction goals.[4]

Figure EX-3. Emission reductions associated with recent actions in Minnesota (consumption-basis, gross emissions)



$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; CIP = Conservation Improvement Program; RCI = Residential, Commercial, and Industrial [Sectors]; RES = Renewable Energy Standard; ES = Energy Supply.

[3] A summary of these actions can be found on the MCCAG's project Web site under "Background, What MN Is Already Doing" at: http://www.mnclimatechange.us/background-alreadydoing.cfm

[4] Note that actions recently adopted by the state of Minnesota have also been referred to as "existing" actions.

It is important to note that the top line in Figure EX-3 represents total emissions associated with all GHG-emitting activities across all sectors in Minnesota on a consumption basis prior to the implementation of any existing actions. For the electricity supply sector, this assumes the installation of the planned Big Stone 2 and Mesaba coal units and an assumed electricity demand growth rate of 2.04% per year. In making this assumption, the MCCAG is not recommending for or against the need for or merits of the addition of these units in Minnesota. The forecast also assumes a backing down of existing units if the Big Stone 2 and Mesaba units come on line in order to balance the supply of electricity with demand in Minnesota. It is possible that instead of backing down, the existing units that formerly supplied power in Minnesota could be used to supply power in other states, which, in turn, could lead to backing down less efficient units in other states. If built, these two units would have the potential to emit approximately 5.1 million tons of CO_2e per year. Future analyses should reexamine these assumptions.

Minnesota Climate Change Advisory Group Recommendations

The MCCAG recommended 46 policy actions. The MCCAG members present and voting approved 38 policy actions unanimously, approved 4 by a supermajority (four objections or fewer), and approved 4 by a majority (less than half objected). Explanations of both individual objections and qualifications are in the appendixes to this report containing the detailed accounts of the MCCAG's recommendations.

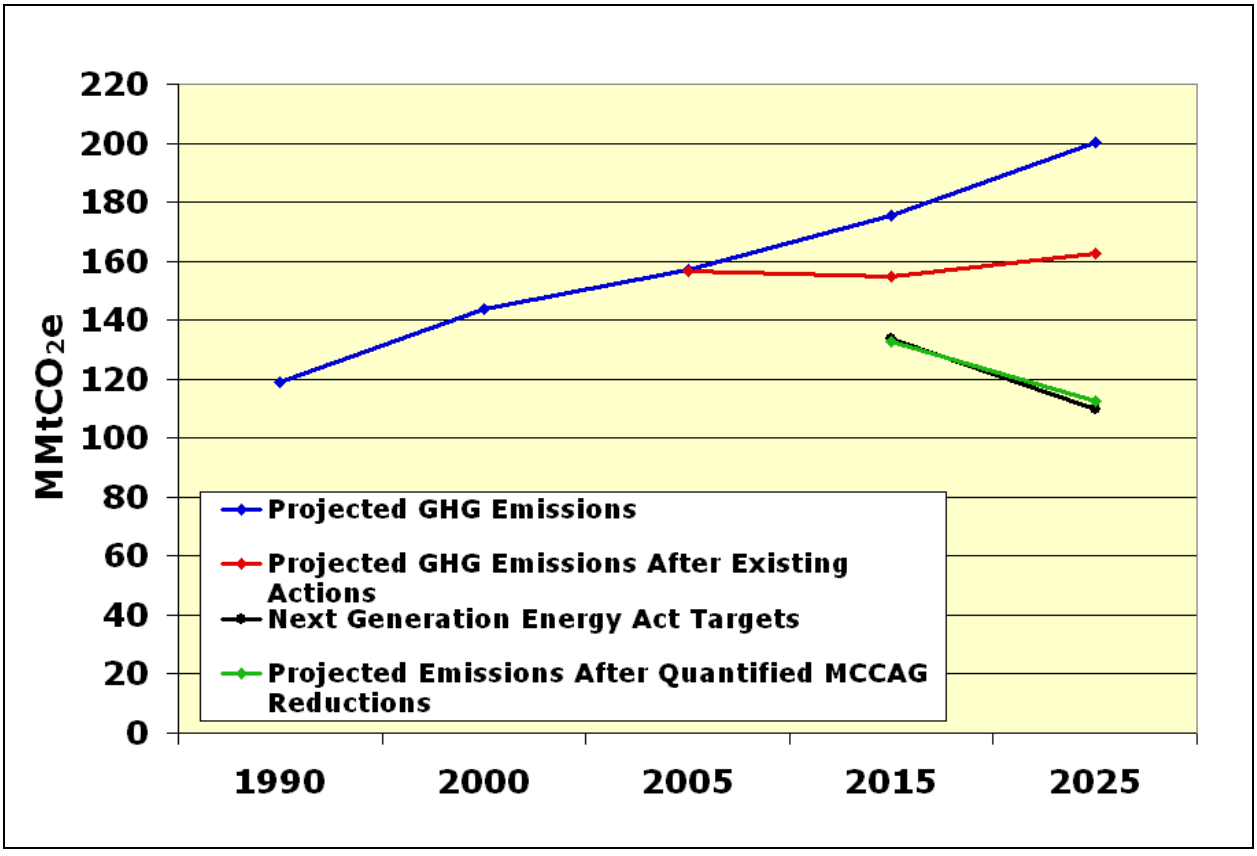
Figure EX-4 presents a summary of the policy recommendations for which emission reductions were quantified. Table EX-1 provides the numeric estimates underlying Figure EX-3. In Figure EX-3,

- Actual (for 1990, 2000, and 2005) and projected (for 2015 and 2025) levels of Minnesota's gross GHG emissions on a consumption basis are shown by the blue line. (The consumption-based approach accounts for emissions associated with the generation of electricity in-state and imported from out-of-state to meet Minnesota's demand for electricity.)
- Projected emissions associated with Minnesota's existing actions that were analyzed quantitatively are shown by the red line.
- Projected emissions if all of the MCCAG's 31 recommendations that were analyzed quantitatively with respect to their GHG reduction potential are completely implemented and the estimated reductions are fully achieved are shown by the green line. (Note that other MCCAG recommendations would have the effects of reducing emissions, but those reductions were not analyzed quantitatively, and they are not reflected in the green line.)
- Projected emissions associated with Minnesota's statewide GHG reduction targets are shown by the black line.
- To the extent that the calculations of emission reduction in a particular sector or that calculations for a particular recommendation are found to be overstated, then the reductions will be less, and in order to meet the goal, more aggressive action will be needed in other sectors.

The MCCAG approved 46 recommendations to reduce emissions, of which 31 were analyzed quantitatively to estimate their effects on emissions and 25 were analyzed quantitatively to

estimate their costs/cost savings. The analyzed measures were estimated to have a cumulative effect of reducing emissions by about 22 $MMtCO_2e$ in 2015 and 50 $MMtCO_2e$ in 2025. Together, the estimated emission reductions associated with the MCCAG's recommendations and recent actions would be enough to achieve Minnesota's GHG reduction goal for 2015 and be within 2.4 $MMtCO_2e$ of meeting Minnesota's goal for 2025. The 25 recommendations analyzed in terms of their cost-effectiveness were estimated to have a total net cost of about $726 million between now and 2025, representing the incremental cost to the recent actions. While the MCCAG's 15 other recommendations were not readily quantifiable, many of them would likely achieve additional reductions and net savings (e.g., recommendations for the Transportation and Land Use [TLU] sector). Should Minnesota implement the MCCAG's recommendations to participate in a cap-and-trade program, opportunities exist for reducing the costs associated with the MCCAG's policy recommendations for the electricity supply sector. In addition, emerging technologies may hold the potential to substantially reduce emissions even more.

Figure EX-4. Annual GHG emissions: reference case projections and MCCAG recommendations (consumption-basis, gross emissions)



$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; GHG = greenhouse gas; MCCAG = Minnesota Climate Change Advisory Group.

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

Annual Emissions ($MMtCO_2e$)	1990	2000	2005	2015	2025
Reference Case Projections	119.0	143.8	157.1	175.5	200.5
Reductions From Recent Actions	0.0	0.4	0.4	20.8	37.8
Projected GHG Emissions After Recent Actions			156.6	154.7	162.6
Next Generation Energy Act Targets				133.5	110.0
Total GHG Reductions From MCCAG Recommendations				22.2	50.3
Difference Between MCCAG Reductions and Next Generation Energy Act Targets				–1.0	2.4
Projected Annual Emissions After Quantified MCCAG Reductions				132.5	112.4

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; GHG = greenhouse gas; MCCAG = Minnesota Climate Change Advisory Group.

Table EX-2 provides a summary by sector of the estimated cumulative impacts of implementing all of the MCCAG's recommendations. Table EX-3 shows the estimated GHG reductions, costs, or savings from each policy recommendation and the cost-effectiveness (cost or savings per ton of reduction) upon which the cumulative impacts in Table EX-2 are based. 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.

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

Sector	GHG Reductions ($MMtCO_2e$)			Net Present Value 2008–2025 (Million $)	Cost-Effective-ness ($/tCO_2e$)
	2015	2025	Total 2008–2025		
Residential, Commercial and Industrial (RCI, non-electricity)	0.76	0.69	10.41	–$464	–$45
Integrated RCI and ES for electricity	1.56	7.34	51.06	–$1,098	–$22
Energy Supply (ES, including RCI options with impacts on electricity consumption, and adjusted for RCI and ES electricity options that overlap)	1.97	3.43	37.55	$462	$12
Transportation and Land Use	4.70	9.30	91.2	–$264	N/A
Agriculture, Forestry and Waste Management	13.2	29.5	279	$2,090	$7
Cross-Cutting Issues	*Non-quantified, enabling options*				
TOTAL (includes all adjustments for overlaps and recent actions)	**20.2**	**50.3**	**469.2**	**$725.8**	**N/A**

GHG = greenhouse gas; $MMtCO_2e$ = 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 net *cost savings* associated with the options. Within each sector, values have been adjusted to eliminate double counting for options or elements of options that overlap. In addition, values associated with options or elements of options within a sector that overlap with options or elements of options in another sector have been adjusted to eliminate double counting.

N/A = not available; for TLU policies, an overall cost-effectiveness value is not provided because costs or cost savings were not estimated for all of the policies (due to the lack of data) for which emission reductions were estimated. Similarly, an overall cost-effectiveness value for all sectors is not provided for the same reason.

Note that the row in Table EX-2 for the RCI sectors includes only that portion of RCI emissions reductions and net cost savings that are from RCI options (or elements of options) that affect fuels that are combusted for purposes other than to generate electricity. RCI emissions reductions and net cost savings that affect electricity use or generation are included in the "Integrated RCI and ES for electricity" row in Table EX-2, because the benefits and costs of electricity-sector options are dependent on the electrical load served, which is affected by RCI electricity savings.

The Agriculture, Forestry, and Waste Management (AFW) sector was found to have substantial opportunities for GHG reductions through 2025 (279 $MMtCO_2e$ through 2025). These reductions are tied to aggressive (and some would say optimistic) policy recommendations within each subsector, including biofuel production programs (both liquid and solid fuel from biomass); forestation, urban forestry and restocking programs; and municipal solid waste source reduction and recycling programs. Overall, the estimated cumulative costs were also estimated to be higher in the AFW sector than in the other sectors, although the reductions are delivered at a modest cost of $7 per metric ton of CO_2e ($/$tCO_2e$) reduced. This is largely driven by the methods for implementing these policy recommendations in the AFW sector, as compared with other sectors. Most of the AFW options incur net societal costs, because they are targeting changes in current practices which require incentives, capital investment, or other cost outlays during the policy period. A large contributor to the overall AFW sector costs is the forest restocking component of AFW-5, which has an estimated cost of $2.2 billion through 2025 (see Appendix I for more details). A number of options within the AFW sectors call for the use of biomass as an energy feedstock. The MCCAG recognized that the success of these options depends on Minnesota's ability to supply that biomass, noting that estimates of Minnesota's biomass resources vary (see Appendix I for more details).

In order for the policies recommended by the MCCAG to yield the levels of estimated emission reductions and cost savings shown in Table EX-2, the policies must be implemented in a timely, aggressive, and thorough manner. In some cases, the actions recommended by the MCCAG are precise, concrete steps. In other cases, the recommendations are more general, and work must be done to develop precise, concrete steps to achieve goals recommended by the MCCAG. In the latter case, the additional work to identify precise, concrete actions is needed before they can be implemented. While there are considerable benefits to both the environment and to consumers from implementation of the policy recommendations, careful, comprehensive, and detailed planning and implementation, as well as consistent support, of these policies will be required if these benefits are to be achieved.

Figure EX-5 presents the estimated tons of reductions for each policy recommendation for which estimates were prepared, expressed as a cumulative figure for the period 2008–2025. Figure EX-6 presents the estimated dollars per ton cost (or cost savings, depicted as a negative number) for each policy recommendation for which cost estimates were available. This measure is calculated by dividing the net present value of the cost of the policy recommendation by the cumulative GHG reductions, all for the period 2008–2025.

Table EX-3. Residential, Commercial, and Industrial Policy Recommendations

Policy No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support
		2015	2025	Total (2008–2025)			
RCI-1	Maximize Savings From the Utility Conservation Improvement Program (CIP) *	*Quantified as a "Recent Action"*					Enacted
RCI-2	Improved Uniform Statewide Building Codes	0.004	0.005	0.077	–$44	–$576	Unanimous
RCI-3	Green Building Guidelines and Standards Based on *Architecture 2030*	0.62	0.94	11.1	–$296	–$27	Unanimous
RCI-4	Incentives and Resources to Promote Combined Heat and Power (CHP)	0.96	4.95	33.1	$125	$3.8	Unanimous
RCI-5	Program to Reduce Emissions of Non-Fuel, High-Global-Warming-Potential GHGs	0.02	0.05	0.5	–$2	–$5	Unanimous
RCI-6	Non-Utility Strategies and Incentives to Encourage Energy Efficiency and Reduce GHG Emissions	0.25	1.30	8.3	–$307	–$37	Unanimous
RCI-7	Conservation Improvement-Type Program for Propane and Fuel Oil Efficiency	0.05	0.05	0.7	–$21	–$28	Unanimous
RCI-8	Energy Performance Disclosure	*Not quantified*					Unanimous
RCI-9	Promote Technology-Specific Applications to Reduce GHG Emissions	*Not quantified*					Unanimous
RCI-10	Support Strong Federal Appliance Standards and Require High State Standards in the Absence of Federal Standards	0.8	1.4	15.3	–$1,895	–$124	Unanimous
	Sector Total After Adjusting for Overlaps (RCI, Non-electricity)	**0.76**	**0.69**	**10.41**	**–$464**	**–$44.6**	
	Sector Total After Adjusting for Overlaps (Integrated RCI and ES for Electricity)	**1.56**	**7.34**	**51.06**	**–$1,098**	**–$21.5**	
	Reductions From Recent Actions	**6.50**	**15.50**	**143.4**	**–$8,454**	**–$59.0**	
	New Commercial Building Code	**0.18**	**0.21**	**3.16**	**–$1.8**	**–$0.6**	
	Sustainability Guidelines (New State Buildings)	**0.22**	**0.46**	**4.72**	**–$1.7**	**–$0.4**	
	10% Savings in State Buildings	**0.09**	**0.11**	**1.75**	**–$0.9**	**–$0.5**	
	RCI-1: New CIP *	**6.01**	**14.72**	**133.8**	**–$8,449**	**–$63.2**	
	Sector Total Plus Recent Actions	**8.82**	**23.5**	**204.9**	**–$10,016**	**–$48.9**	

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

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.

Only the results of recommendations included in the final tabulation of GHG reductions and costs are shown in this table. For discussion of any sensitivity analyses undertaken, please see the discussion in the RCI annex.

* The CIP considered here is based on the CIP requirements (i.e., 1.5% energy savings goal) included in the Next Generation Energy Act of 2007; therefore, the emission reductions and cost savings estimated are included under "recent actions."

Table EX-3 (continued). Energy Supply Policy Recommendations

Policy No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value 2008–2025 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support
		2015	2025	Total (2008–2025)			
ES-1	Generation Performance Standard	0.0	0.0	0.0	$0.0	$0.0	Majority (16 objections)
ES-3	Efficiency Improvements, Re-powering and other Upgrades to Existing Plants	1.8	3.0	33.3	$554.4	$16.7	Unanimous
ES-4	Transmission System Upgrading, Including Reducing Transmission Line and Distribution System Loss	0.2	0.4	3.9	–$92.2	–$26.1	Unanimous
ES-5	Renewable and/or Environmental Portfolio Standard*	*Quantified as a "Recent Action"*					Enacted
ES-6	Nuclear Power Support and Incentives	*Recommended for further study.*					Unanimous
ES-8	Advanced Fossil Fuel Technology Incentives, Support or Requirements, Including Carbon Capture and Storage	*Recommended for further study.*					Unanimous
ES-10	Voluntary GHG targets	*Not quantified*					Unanimous
ES-12	Distributed Renewable Energy Incentives and/or Barrier Removal	0.021	0.023	0.37	$29.1	$78.1	Unanimous
ES-13	Technology-Based Approaches, Including Research and Development, Fuel Cells, Energy Storage, Distributed Renewable Energy Technologies, etc.	*Not quantified*					Unanimous
	Sector Total After Adjusting for Overlaps	**2.0**	**3.4**	**37.5**	**$462.2**	**$12.3**	
	Reductions From Recent Actions	**12.8**	**20.8**	**225**	**$10,116**	**$45.0**	
	Biomass for Electricity	**0.60**	**0.60**	**11.4**	**$285.3**	**$25.0**	
	Metro Emissions Reduction Project	**4.52**	**4.52**	**80.4**	**$2,330**	**$29.0**	
	ES-5: Renewable Energy Standard *	**7.72**	**15.7**	**133.1**	**$7,502**	**$56.4**	
	Sector Total Plus Recent Actions	**14.8**	**24.2**	**262.5**	**$10,578**	**$40.3**	

GHG = greenhouse gas; $MMtCO_2e$ = 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 net cost savings associated with the recommendations. Totals in some columns may not add to the totals shown due to rounding.

All totals are relative to the underlying assumption that electricity expansion in Minnesota proceeds with the recently legislated Conservation Improvement Program (CIP), Renewable Energy Standard (RES), and all planned additions including the Mesaba and Big Stone 2 stations.

* The RES considered here is based on the RES requirements included in the Next Generation Energy Act of 2007; therefore, the emission reductions and costs estimated are included under "recent actions."

Note: A number of MCCAG members have raised concerns about the cost assumptions associated with wind power and believe the costs are too high. A lower wind cost assumption would lower the cost estimates for the Renewable Energy Standard (ES-5) and for the Cap-and-Trade analyses. Future analyses should reexamine the wind cost estimates.

Table EX-3 (continued). Transportation and Land Use Policy Recommendations

Policy No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value 2008–2025 (Million $)	Cost-Effectiveness ($/tCO2e)	Level of Support
		2015	2025	Total 2008–2025			
TLU Area 1: Reduce VMT (VMT goal to be established based on VMT implied by selected strategies)							
TLU-1	Improved Land-Use Planning and Development Strategies	0.7	1.9	14.9	*Net savings*	*Net savings*	Unanimous
TLU-2	Expand Transit, Bicycle, and Pedestrian Infrastructure	0.1	0.3	3.0	$0	$0	Unanimous
TLU-5	Climate-Friendly Transportation Pricing/Pay-as-You-Drive	1.1	2.1	20.9	–$1	–$1	Super-majority (3 objections)
TLU-7	"Fix-it-First" Transportation Investment Policy and Practice	*Not quantified*					Super-majority (2 objections)
TLU-9	Workplace Tools To Encourage Carpooling, Bicycling, and Transit Ridership	0.3	0.4	4.5	*Large net savings*	*Large net savings*	Unanimous
TLU-14	Freight Mode Shifts: Intermodal and Rail	*N/A*					Super-majority (1 objection)
TLU Area 2: Reduce Carbon per Unit of Fuel							
TLU-3	Low-GHG Fuel Standard	1.7	3.6	36.2	*Not quantified*		Unanimous
TLU Area 3: Reduce Carbon per Mile and/or per Hour							
TLU-4	Infrastructure Management	0.04	0.1	0.7	*Not quantified*		Unanimous
TLU-6	Adopt California Clean Car Standards	0.74	1.16	13.1	–$263	–$39	Majority (16 objections)
TLU-12	Voluntary Fleet Emission Reductions	0.4	0.4	6.1	*Not quantified*		Unanimous
TLU-13	Reduce Maximum Speed Limits	0.4	0.4	6.1	*N/A*	$50 at $2.40/gal –$19 at $3.40/gal	Majority (16 objections)
	Sector Total After Adjusting for Overlaps	**4.7**	**9.3**	**91.2**	**–$264**	***Not quantified***	
	Reductions From Recent Actions	**1.4**	**1.5**	**20.2**	***Not quantified***		
	Biodiesel	**0.64**	**0.75**	**8.1**			
	Ethanol	**0.78**	**0.79**	**12.1**			
	Sector Total Plus Recent Actions	**6.1**	**10.8**	**111.4**	**–$264**	***Not quantified***	

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent, VMT = vehicle miles traveled; N/A = not available.

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.

Table EX-3 (continued). Agriculture, Forestry, and Waste Management Policy Recommendations

Policy No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value 2008–2025 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support
		2015	2025	Total 2008–2025			
AFW-1	Agricultural Crop Management						Unanimous
	A. Soil Carbon Management	0.72	1.3	15	–$34	–$2	
	B. Nutrient Management	0.79	1.3	15	–$543	–$37	
AFW-2	Land Use Management Approaches for Protection and Enrichment of Soil Carbon						Unanimous
	A. Preserve Land	0.15	0.44	3.7	$120	$33	
	B. Reinvest in Minnesota–Clean Energy (RIM-CE)	0.09	0.19	1.8	$59	$34	
	C. Protection of Peatlands & Wetlands	*Not Quantified*					
AFW-3	In-State Liquid Biofuels Production						Super-majority (4 objections)
	A. Ethanol Carbon Content	1.8	2.2	27	–$242	–$9	
	B. Fossil Diesel Displacement	0.03	0.19	1.4	$74	$55	
	C. Gasoline 35% Displacement	2.8	9.1	73	$336	$5	
AFW-4	Expanded Use of Biomass Feedstocks for Electricity, Heat, or Steam Production	1.3	3.8	31	$102	$3	Unanimous
AFW-5	Forestry Management Programs to Enhance GHG Benefits						Unanimous
	A. Forestation	0.55	2.2	17	$218	$13	
	B. Urban Forestry	1.2	2.7	26	–$295	–$12	
	C. Wildfire Reduction	*Not Quantified*					
	D. Restocking	2.1	8.4	65	$2,187	$33	
	E. Forest Health and Enhanced Sequestration	*Not Quantified*					
AFW-6	Forest Protection—Reduced Clearing and Conversion to Non-Forest Cover	2.2	2.7	34	$101	$3	Unanimous
AFW-7	Front-End Waste Management Technologies						Unanimous
	A. Source Reduction	0	3.6	20	$59	$3	
	B. Recycling	3.1	3.4	45	–$207	–$5	
	C. Composting	0.29	0.41	4.9	$137	$28	
AFW-8	End-of-Life Waste Management Practices						Unanimous
	A. Landfill Methane Recovery	0.07	0.73	4.4	$5.7	$1	
	B. Residuals Management	0.52	0.63	8.1	$650	$80	
	C. WTE Preprocessing	0.37	0.84	7.9	$257	$32	
	Sector Total After Adjusting for Overlaps*	**13.2**	**29.5**	**279**	**$2,090**	**$7**	
	Reductions From Recent Actions	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	
	Sector Total Plus Recent Actions	**13.2**	**29.5**	**279**	**$2,090**	**$7**	

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

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.

*Overlaps include an assumed 100% overlap of AFW-3b&3c with TLU-3 (reductions excluded from AFW totals); an assumed 100% overlap of AFW-4 with ES-5 (reductions and costs excluded from AFW totals); overlap of AFW-7&8 (incremental benefits and costs of AFW-8 included in the AFW totals).

Table EX-3 (continued). Cross-Cutting Issues Policy Recommendations

Policy No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value 2008–2025 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support
		2015	2025	Total 2008-2025			
CC-1	GHG Inventories, Forecasting, Reporting, and Registry	*Not quantified*					Unanimous
CC-2	Statewide GHG Reduction Goals and Targets	*Not quantified*					Unanimous
CC-3	State and Local Government GHG Emissions (Lead-by-Example)	*Not quantified*					Unanimous
CC-4	Public Education and Outreach	*Not quantified*					Unanimous
CC-7	Participate in Regional and Multistate GHG Reduction Efforts	*Not quantified*					Unanimous
CC-8	Encourage the Creation of a Business-Oriented Organization to Share Information and Strategies, Recognize Successes, and Support Aggressive GHG Reduction Goals	*Not quantified*					Unanimous
CC-9	Dedicate Greater Public Investment to Climate Data and Analysis	*Not quantified*					Unanimous
	Sector Total After Adjusting for Overlaps	***Not quantified***					
	Reductions From Recent Actions	***Not quantified***					
	Sector Total Plus Recent Actions	***Not quantified***					

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

Table EX-3 (continued). Cap-and-Trade (C&T) Policy Recommendations

Policy No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value (Million $)	Cost-Effectiveness* ($/tCO$_2$e) 2025	Permit Price† ($/tCO$_2$e) 2025	Level of Support
		2015	2025	Total (2008–2025)				
C&T-1	Cap-and-Trade Program							Majority (9 objections)
	MGA Partners C&T *—no RES/CIP in the baseline*		79.82			–$12.17	$48.45	
	MGA Partners C&T *—with both RES/CIP in the baseline*		52.94			$2.65	$45.95	
	MGA Partners C&T *—with only RES in the baseline*		67.35			–$15.42	$46.64	
	MGA Partners+Observers C&T *—no RES/CIP in the baseline*		81.97			–$10.52	$52.44	
	MGA Partners+Observers C&T *—with both RES/CIP in the baseline*		55.45			$4.71	$50.72	
	MGA Partners+Observers C&T *—with only RES in the baseline*		69.45			–$13.48	$51.27	
	MGA plus WCI Partners C&T *—no RES/CIP in the baseline*		72.64			–$17.52	$35.69	
	MGA plus WCI Partners C&T *—with both RES/CIP in the baseline*		46.93			–$2.19	$34.95	
	MGA plus WCI Partners C&T *—with only RES in the baseline*		61.92			–$20.36	$35.07	
	MGA and WCI Partners+Observers C&T *—no RES/CIP in the baseline*		76.17			–$14.92	$41.87	
	MGA and WCI Partners+Observers C&T *—with both RES/CIP in the baseline*		50.41			$0.59	$41.25	
	MGA and WCI Partners+Observers C&T *—with only RES in the baseline*		64.92			–$17.65	$41.39	
C&T-2	MN-Only C&T *—no RES/CIP in the baseline*		89.18			–$2.39	$65.48	Merged into C&T-1
C&T-3	National C&T	*Not quantified*						Merged into C&T-1
C&T-5	Market Advisory Group (Formerly CC-11)	*Not quantified*						Unanimous
C&T-6	Regional and Multistate GHG Reduction Efforts (Formerly CC-7)	*Not quantified*						Unanimous

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; MGA = Midwestern Governors Association; C&T = cap-and-trade; RES = renewable electricity standard; CIP = Conservation Improvement Program; WCI = Western Climate Initiative; CC = Cost-Cutting Issues.

Negative numbers represent cost savings.

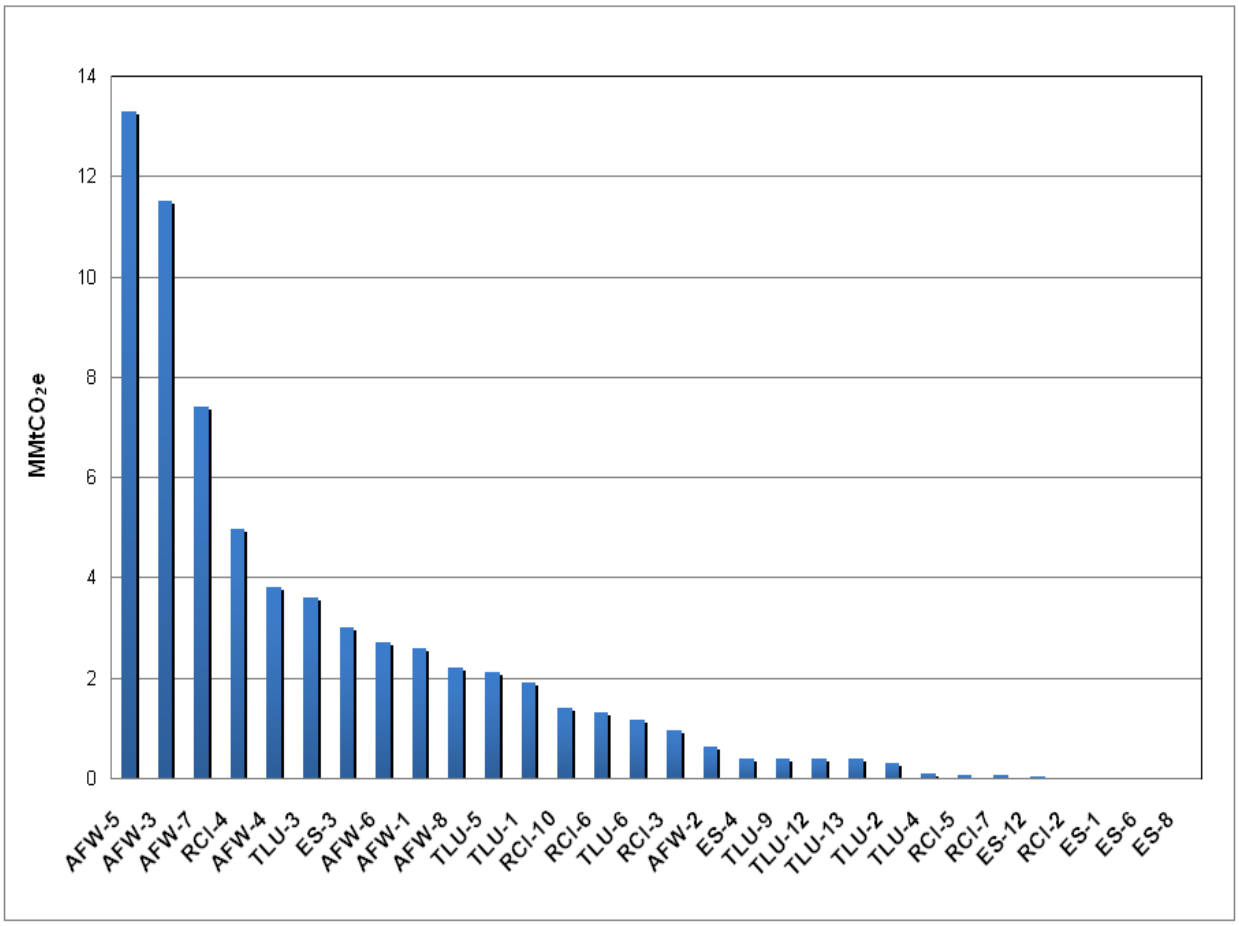
MGA C&T Partners include Illinois, Iowa, Kansas, Michigan, Minnesota, Wisconsin, and Manitoba; MGA C&T Observers include Indiana, Ohio, and South Dakota; WCI Partners include Arizona, California, New Mexico, Oregon, Utah, Washington, British Columbia, and Manitoba; WCI Observers include Colorado, Idaho, Montana, Nevada, and Wyoming. To run simulations including both MGA and WCI states in 2025, the C&T Technical Work Group (TWG) used 2020 marginal cost curves for WCI states for 2025. The emission cap for both MGA and WCI states (or provinces) is assumed to be 30% below the 2005 level in 2025.

* This represents the average $/tCO$_2$e mitigated/sequestered for Minnesota.

† This represents the marginal cost of the last tCO$_2$e mitigated/sequestered; it applies to all states involved in trading arrangements.

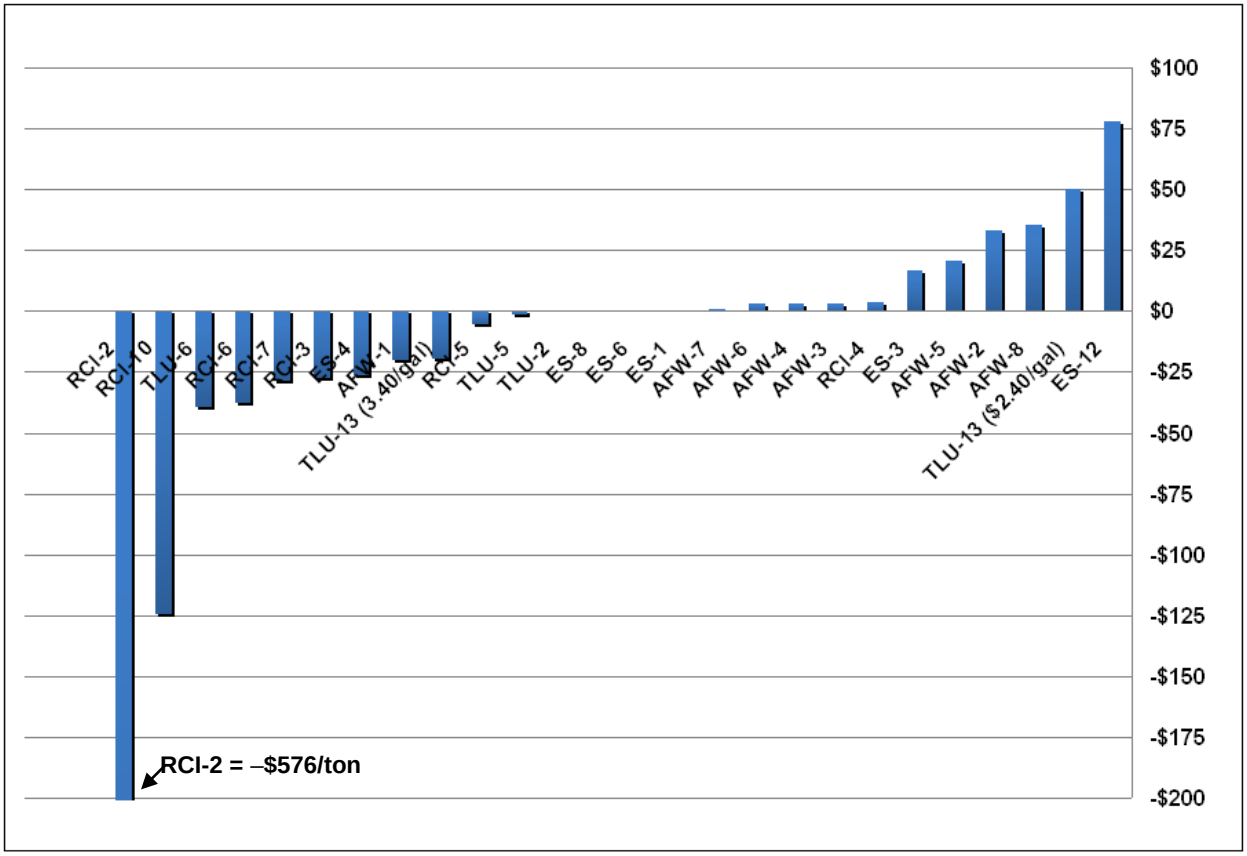
Note: Some MCCAG members have raised concerns about the cost assumptions associated with high cost estimates for wind power. A lower wind cost assumption would lower the cost estimates for the Renewable Energy Standard (ES-5) and for the Cap-and-Trade analyses. Future analyses should reexamine the wind cost estimates.

Figure EX-5. MCCAG policy recommendations ranked by 2025 annual GHG reduction potential



$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; AFW = Agriculture, Forestry, and Waste Management; RCI = Residential, Commercial, and Industrial; TLU = Transportation and Land Use; ES = Energy Supply.

Figure EX-6. MCCAG policy recommendations ranked by cost / cost savings per ton GHG removed



RCI = Residential, Commercial, and Industrial; TLU = Transportation and Land Use; ES = Energy Supply; AFW = Agriculture, Forestry, and Waste Management.

Note: Negative values represent net cost savings and positive values represent net costs associated with the policy recommendation.