THE CENTER FOR
CLIMATE STRATEGIES

Microeconomic and Macroeconomic Impact Analysis of Greenhouse Gas Mitigation Policy Options for the Southern California Climate and Economic Development Project (CEDP)

Final Report

Prepared for

The Southern California Association of Governments and the Project Stakeholder Committee (PSC) of the CEDP

By

The Center for Climate Strategies, Inc.

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ACRONYMS AND ABBREVIATIONS

Acronym	Definition
AB	Assembly Bill
AEO	(EIA) Annual Energy Outlook
AEPS	Alternative Energy Portfolio Standard
AF	Acre Foot
AFW	Agriculture, Forestry, and Waste Management
Ag	Agriculture
ARB	(California) Air Resources Board
AVO	Average Vehicle Occupancy
BAU	Business-as-Usual
BSC	Building Standards Commission
BTU	British Thermal Unit
C	Carbon
CalGREEN	California Green Building Standards Code
CAPCOA	California Air Pollution Control Officers Association
CARB	California Air Resources Board
CCS	Center for Climate Strategies
CCSR	Carbon Capture and Storage or Reuse
CE	Cost Effectiveness
CEC	California Energy Commission
CEDP	Climate and Economic Development Project
CGE	Computable Generated Equilibrium
CH_4	Methane
CHP	Combined Heat and Power
CMUA	California Municipal Utilities Association
CNG	Compressed Natural Gas
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide equivalent
CPUC	California Public Utilities Commission
DEP	Department of Environmental Protection
DG	Distributed Generation
DSM	Demand-Side Management
DWR	California Department of Water Resources
E3	Energy and Environmental Economics
ECR	Energy, Commerce and Resources
EE	Energy Efficiency
EIA	(United States Department of Energy) Energy Information Administration
EPA	(United States) Environmental Protection Agency
ES	Energy Supply
EX	Executive
GDP	Gross Domestic Product
GHG	Greenhouse Gas

Acronym	Definition
GSP	Gross State Product
GWh	Gigawatt-hour
HECA	Hydrogen Energy California project
HOT	High-Occupancy-Toll
HOV	High-Occupancy Vehicle
I-O	Input-Output
IRTC	Irrigation Training and Research Center
kg	Kilograms
km^2	Square Kilometers
kWh	Kilowatt-hour
LADWP	Los Angeles Department of Water and Power
LAEDC	Los Angeles County Economic Development Corporation
LPG	Liquefied Petroleum Gas
MCAC	Michigan Climate Action Council
ME	Macroeconometric
MM	Million
MMBtu	Million British Thermal Units
MMt	Million Metric tons
$MMtCO_2e$	Million Metric tons of Carbon Dioxide equivalents
MP	Mathematical Programming
Mt	Metric tons
MW	Megawatt
MWh	Megawatt-hour
N_2O	Nitrous Oxide
NAICS	Northern American Industry Classification System
NG	natural gas
NGCC	Natural Gas Combined-Cycle
NPV	net present value
PF	Plant Factor
PI+	Policy Insight Plus
POD	Policy Option Description
PSC	Project Stakeholders Committee
PV	Photovoltaic
RCI	Residential, Commercial, and Industrial
RE	Renewable Energy
REMI	Regional Economic Models, Inc.
RPC	Regional Purchase Coefficient
RPS	Renewable Portfolio Standard
RTP	Regional Transportation Plan
SB	Senate Bill
SCAG	Southern California Association of Governments
SCE	Southern California Edison
SCG	Southern California Gas

Acronym	Definition
SCPPA	Southern California Public Power Authority
SCS	Sustainable Communities Strategy
Sinks	Removals of carbon from the atmosphere, with the carbon stored in forests, soils, landfills, wood structures, or other biomass-related products.
SOV	single occupancy vehicle
SWRCB	California State Water Resources Control Board
t	Metric Tons
T&D	Transmission and Distribution
TAF	Thousand Acre-feet
TBtu	Trillion British Thermal Units
tCO_2e	Metric Tons Carbon Dioxide Equivalent
TCRP	Transit Cooperative Research Program
TJ	Trillion Joules (or Terajoule)
TLU	Transportation and Land Use
TOD	Transit-Oriented Development
TRC	Technical Review Committee
TS	TranSight
TSI	Transportation Systems and Investment
TWG	Technical Work Group
US	United States
USDA	United States Department of Agriculture
USDOE	United States Department of Energy
USDOT	United States Department of Transportation
USFS	United States Forest Service
USGS	United States Geological Survey
VMT	Vehicle-Miles Traveled
VRI	Variable Rate Irrigation

EXECUTIVE SUMMARY

The Southern California Association of Governments (SCAG) engaged a diverse and high-level group of stakeholders representing government entities, environmental interests, key industries, and other groups through its Climate and Economic Development Project (CEDP). The purpose of the CEDP was to identify regional and local strategies and policies to reduce greenhouse gas (GHG) emissions and yield positive economic impacts for Southern California. This Executive Summary summarizes the potential microeconomic and macroeconomic impacts associated with the policies identified as priorities for analysis by the Transportation System and Investments (TSI); Transportation and Land Use (TLU); and Energy, Commerce, and Resources (ECR) Technical Work Groups (TWGs) of the CEDP.

The stakeholders identified a total of 20 TSI and TLU policies for analysis. Data were available for 18 of the 20 policies to support a microeconomic and macroeconomic analysis of the potential impacts of the policies. The microeconomic results indicate that together the 18 policies have the potential over the 2013-2035 time period to:

- Reduce GHG emissions by nearly 40 million metric tons on a carbon dioxide equivalent basis (MMtCO_2e);
- Reduce vehicle miles traveled (VMT) by about 109 billion;
- Result in a fuel savings of about 3.6 billion gallons; and
- Provide a net savings to the businesses and households in the SCAG region of approximately $20 billion.

The macroeconomic results indicate that together the 18 TSI and TLU policies have the potential over the 2013-2035 time period to provide:

- A net gain of over 300,000 additional jobs;
- A net increase in the region's gross domestic product (GDP) of over $22 billion;
- A net increase of region-wide output of over $31 billion; and
- A net increase in disposable personal income of over $14 billion in net present value (NPV).

The stakeholders identified a total of 17 ECR policies for analysis. Among the 17 recommended options, 10 were analyzed quantitatively. The microeconomic results indicate that together the 10 ECR policies have the potential, over the 2013-2035 time period, to reduce GHG emissions by nearly 853 MMtCO_2e and provide a net savings to the businesses and households in the SCAG region of approximately $3 billion. The macroeconomic results indicate that together the 10 ECR policies have the potential over the 2013-2035 time period to provide:

- A net gain of over 61,100 jobs by 2035, or an increase of about 0.49% over the baseline level;
- An average gain of 20,781 additional jobs per year over the entire planning period;
- A net increase in disposable personal incomes of about $10.5 billion in NPV;
- A net decrease in GDP of $1.16 billion in 2035, or a decrease of about -0.06% over the baseline level; and
- A net decrease in GDP of $17.8 billion in NPV over the entire planning period.

Summary of Results for TSI and TLU Policies

Macroeconomic Analysis Results

The overall option-by-option analysis of 18 of the 20 TSI and TLU policy recommendations for which data were available is summarized in Table EX-1 (CCS, 2012a). The results indicate that the majority of the recommended GHG mitigation and carbon sequestration policies individually have positive impacts on the region's economy. The strategies related to public transportation investment and land use changes associated with more compact development patterns contributes the highest macroeconomic gains. The economic gains arise primarily from the ability of mitigation options to lower the overall cost of travel to individuals, households, businesses, and the regional economy.

Most strategies analyzed have the potential to improve energy efficiency and, as a result, decrease transportation energy costs and motor vehicle operating costs. These savings of money not spent on transportation costs results in higher consumer purchasing power, which stimulates increased spending within the SCAG region. The investment in transportation systems and infrastructure analyzed includes a net increase in capital investment from sources outside the SCAG region. This increase in capital spending from outside the region further results in increased economic activity and spending within the region. The overall impacts across the region from the combination of all TSI and TLU policies provide positive net impacts yielding on the order of an additional 1/10 of 1% of economic production activity, employment, and earnings.

In addition to the impacts from the investment in transportation infrastructure and technologies and the associated fuel and other vehicle operation savings of the proposed policies, the network and amenity benefits associated with improved transportation conditions in the region can result in nearly 90,000 job-years of employment.

These results are based on an integrated analysis of the TSI and TLU policies modeled together to capture the ways in which impacts of policies change in the presence of other policies, eliminate the potential for double-counting of macroeconomic impacts, and understand how the economy for the SCAG region is potentially affected if all of the policies were fully implemented in the region.

The analysis is based on data, methods, and assumptions from publicly available SCAG and other government sources within the State of California. In addition, the publicly available data and information was supplemented by specific additional information provided by SCAG staff to the analysis team. Note that the estimates of economic benefits to the SCAG region do not include the macroeconomic value of other benefits associated with the Regional Transportation Plan/Sustainable Communities Strategy (RTP/SCS), including the avoidance of negative environmental impacts from continued GHG emissions that have been mitigated; the savings from the associated decrease in ordinary pollutants that have important impacts upon human health; the reduction in the use of natural resources; and other factors.

Table EX-1. Macroeconomic Impact Analysis Results – Integrated Bundle of All TSI and TLU Policies

Integration of All TLU/TSI - Differences from Baseline Level*								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
Total Employment	Jobs	1,258	3,196	7,814	15,977	20,739	24,988	13,753**
Gross Domestic Product	Millions of Fixed 2010$	106.312	288.223	810.487	1,761.626	2,414.269	3,086.926	$22,611
Output	Millions of Fixed 2010$	181.106	422.908	1,146.819	2,499.713	3,384.904	4,279.254	$31,865
Disposable Personal Income	Millions of Fixed 2010$	92.734	195.269	502.953	1,089.387	1,551.115	2,052.940	$14,388
PCE-Price Index	2005=100 (Nation)	0.000	0.003	0.010	0.025	0.039	0.052	N/A
Population	Number of People	251	1,134	4,912	12,206	19,281	25,947	N/A
Integration of All TLU/TSI - Baseline Plus Addition of Policy*								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	10,232,121	10,543,308	11,140,635	11,601,829	12,127,987	12,780,483	
Gross Domestic Product	Millions of Fixed 2010$	1,017,249	1,095,655	1,303,023	1,439,833	1,601,953	1,804,504	
Output	Millions of Fixed 2010$	1,735,958	1,864,798	2,200,325	2,436,940	2,708,408	3,027,897	
Disposable Personal Income	Millions of Fixed 2010$	730,065	783,413	928,639	1,052,860	1,197,064	1,382,287	
PCE-Price Index	2005=100 (Nation)	111.3	117.2	134.2	154.0	177.7	206.0	
Population	Number of People	18,410,281	18,669,206	19,409,653	20,181,247	21,043,994	22,051,744	
Integration of All TLU/TSI - % Change*								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	0.01283%	0.03001%	0.06669%	0.13283%	0.16584%	0.19010%	
Gross Domestic Product	Millions of Fixed 2010$	0.01107%	0.02623%	0.05902%	0.11755%	0.14550%	0.16552%	
Output	Millions of Fixed 2010$	0.01109%	0.02294%	0.04992%	0.09879%	0.12080%	0.13682%	
Disposable Personal Income	Millions of Fixed 2010$	0.01330%	0.02453%	0.05149%	0.10025%	0.12660%	0.14583%	
PCE-Price Index	2005=100 (Nation)	0.00038%	0.00265%	0.00775%	0.01642%	0.02197%	0.02506%	
Population	Number of People	0.00147%	0.00609%	0.02386%	0.05685%	0.08660%	0.11176%	

* The “Differences from Baseline Level” represents the incremental impact of the policy or policies relative to the baseline. The “Baseline Plus Addition of Policy” represents the baseline plus the impact of the policy or policies. “% Change” is calculated as the ratio of the “Differences from Baseline Level” and “Baseline Plus Addition of Policy” times 100.
** The network and amenity benefits associated with the TLU/TSI options can yield an additional of 3,842 jobs per year.

The macroeconomic impact analysis was performed using the TranSight (TS) Model and Policy Insight Plus (PI+) Model, both produced by Regional Economic Models, Inc. (REMI). TranSight contains all of the same central components as the PI+ Model, but adds the capacity to model economic impacts of changes in travel demand and in transportation system characteristics.[1]

Prior to initiating the economic impact analysis of the TSI and TLU policies, SCAG released its Draft 2012 RTP/SCS for public review and comment. Because many of the TSI and TLU policies already proposed were included in the draft RTP/SCS, the CCS team worked with SCAG's staff to ensure, to the extent possible, that the policies had technical assumptions that mirrored the anticipated implementation of the RTP/SCS. This included the bundling of some of the TSI and TLU policies into groups to support the development of the policies consistent with the RTP.

These policies are not intended to represent the overall scope of the 2012 RTP/SCS. The policies were originally identified as largely planning-related opportunities to reduce GHG emissions from the transportation sector, and were then adjusted to conform to specific elements of the RTP/SCS. For example, they do not address the roadway construction or improvement envisioned in the RTP/SCS, since these elements of the RTP/SCS were not identified by stakeholders in the process for development of the priority 20 TSI and TLU options. In addition, some policies (particularly those addressing the adoption of new vehicle technologies and car-sharing) are not addressed directly by the RTP/SCS. Instead, the RTP/SCS envisions planning efforts to support state or federal initiatives related to these policies.

Microeconomic Analysis Results

The microeconomic analysis results are summarized in Table EX-2. The analysis estimates the potential direct costs and savings, GHG emission reductions, and cost-effectiveness (representing the dollars spent or saved per ton of emissions reduced) associated with each policy if fully implemented in the SCAG region. The direct cost estimates from the microeconomic analysis were used as inputs for the macroeconomic analysis. The CCS team worked with SCAG technical experts to develop the design criteria and identify the data sources for quantifying the potential microeconomic impacts associated with the policies.

The policies affecting transit-oriented development and mixed-use development by far have the largest impact, while many others had relatively small effects. This was due not to their ineffectiveness (most policies were assessed as highly cost-effective) but to their narrow definition or constrained level of investment.

To understand these results in some context, the marginal cost curve in Figure EX-1 displays the relative cost per ton of GHG emissions reduced associated with each policy (a negative number indicates a net savings per ton), as well as the GHG reduction potential associated with each

[1] The econometric modeling framework used in this study is the Regional Economic Models, Inc. (REMI) Model. It is peer-reviewed and is the most widely used state and regional level econometric modeling software package in the United States. Government agencies in practically every state have used a REMI Model for a variety of purposes, including evaluating the impacts of changes in tax rates, the exit or entry of major businesses in particular or economic programs in general, and, increasingly, the impacts of energy and/or environmental policy actions.

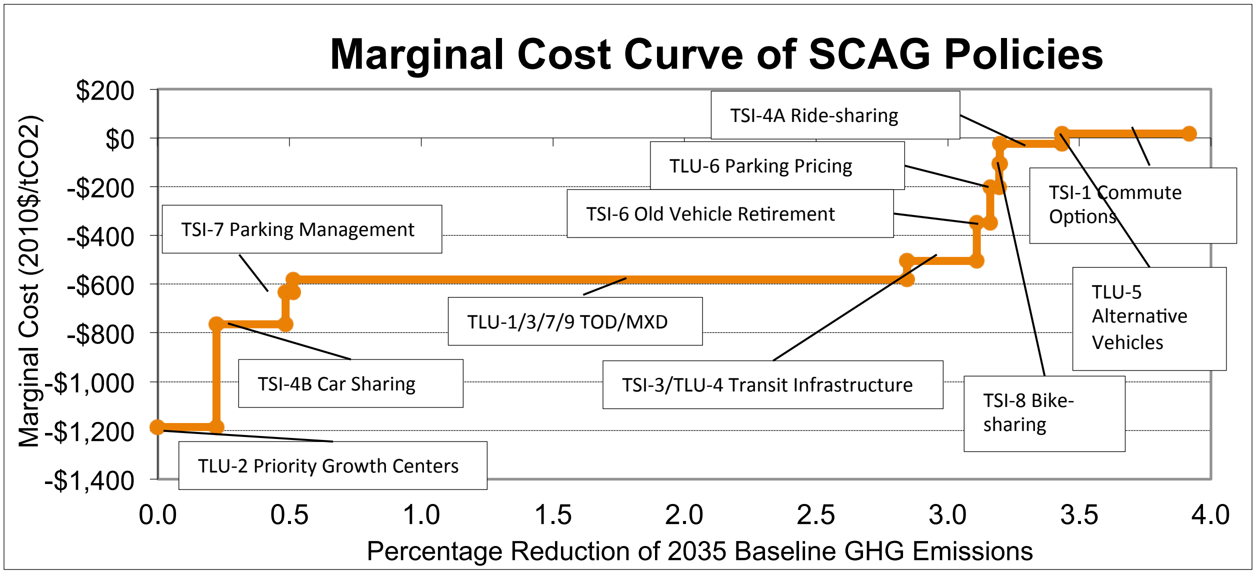
policy. The largest single effect comes from Transit-Oriented Development and Mixed-Use Development policies (analyzed together to avoid overlap and double-counting issues). Policies also vary significantly both in GHG reduction potential and in cost-effectiveness, though most policies are estimated to provide significant net savings, rather than net costs.

Table EX-2. Microeconomic Analysis Estimates for TSI and TLU Policies

Policy No.	Policy Option	GHG Reductions (MMtCO2)			Net Present Value (million 2010$)*	Cost-Effectiveness ($/tCO2)*	Fuel Savings (million gallons, 2013-2035)	VMT Reduction (billion, 2013-2035)
		2020	2035	Total (2013-2035)				
Employee Commuter Options								
TSI-1/ TSI-4A	Employer-Based Commute Option Programs	0.14	0.49	5.38	$14	$2.6	451	15.9
Public Transportation								
TSI-3/ TLU-4	Expand Transit Infrastructure and Transit Funding	0.23	0.26	5.40	-$2,272	-$420	449	7.4
Car Sharing								
TSI-4B	Car-sharing Programs	0.07	0.18	2.57	-$1,976	-$764	205	7.24
Bicycle and Pedestrian								
TSI-5/8/9 TLU-8/10	Increased Bike/Walk Trips, including Complete Streets and Bike share	0.01	0.01	0.03	$50	$1,695	2	0.1
Low Emission Vehicles								
TSI-6/ TLU-5	Promote Alt Vehicles/ Retirement and Replacement	0.11	0.03	2.25	-$233	-$103	330	N/A
Parking								
TSI-7/ TLU-6	Parking Management Strategies/ Parking Pricing	0.02	0.04	0.58	-$234	-$406	46	1.7
Transportation Financing and Pricing								
TSI-2/ TSI-10	Congestion Pricing and Transportation Financing Options	Not Quantified						
Land Use								
TLU-1/2/3/7/9	Cross – Cutting Land Use Scenario	0.57	2.29	26.99	-$16,643	-$617	2,171	76.9
Overall Impacts		**1.05**	**3.30**	**43.20**	**-$21,287**	**-$411**	**3,654**	**109.2**

* Negative values represent a net cost savings. $/t$CO_2$e stands for dollars per metric ton of carbon dioxide equivalent.

Figure EX-1. TSI and TLU Policy Cost Curve



Results by Major Category of RTP Spending

Strategies to reduce GHG emissions from the transportation sector generally fall into three distinct categories. The first approach relies on VMT reduction strategies, which seek to reduce overall vehicle travel. The second approach places an emphasis on vehicle-technology strategies, which seek to make vehicles more efficient in their ability to transport people and goods. The third approach contains fuel strategies, which seek to change the content of vehicle fuels so that emissions are reduced. Within the State of California, it is generally recognized that the legal authority for vehicle standards and fuel standards rests at the state government level. As a result, most of the SCAG region RTP/SCS strategies analyzed have the impact of reducing the amount of VMT, either through mode shift from single occupancy vehicle (SOV) automobile travel to more energy efficient modes, or through the combination of land use development patterns and mode shifts relative to a baseline situation.

The TSI and TLU policies were combined into three separate groups based on the policies' correlation to major areas of focus within the 2012 SCAG RTP/SCS.[2] These areas of focus include:

- Public transportation & land use
- Active transportation
- Transportation demand management

The remaining policies were combined into a fourth group called "Car-sharing and Vehicle Technology Policies," that combines the car-sharing and vehicle technology policies developed

[2] It is important to note that these TSI and TLU policies do not represent all of the economic impacts or GHG emissions impacts that might be expected as a result of all the initiatives envisioned by the RTP. These policies are largely, but not entirely, consistent with specific selected initiatives within the RTP, but represent only a small percentage of the overall investment and planning effort the RTP Report describes.

by the TWGs and SCAG staff. This group is not described as a major category of focus in the RTP, but is used to collect those policies not truly appropriate for inclusion in one of the other three areas. Figure EX-2 shows the projected change to employment for each of the four focus areas. Tables EX-3 and EX-4 show the results for the policies for each of the focus areas.

The network and amenity benefits associated with the TLU/TSI options can yield an additional 3,842 jobs per year. Figure EX-2 shows the employment changes expected from policies by the general category of policy, representing how they seek to reduce emissions from the transportation sector (such as through transit expansion, cleaner fuels or vehicles, or incentivizing behavior changes through a range of strategies).

Figure EX-2. Employment Impacts by Area of Focus (Changes to Employment (Jobs) from Policy Group and from Integration of All Policies)

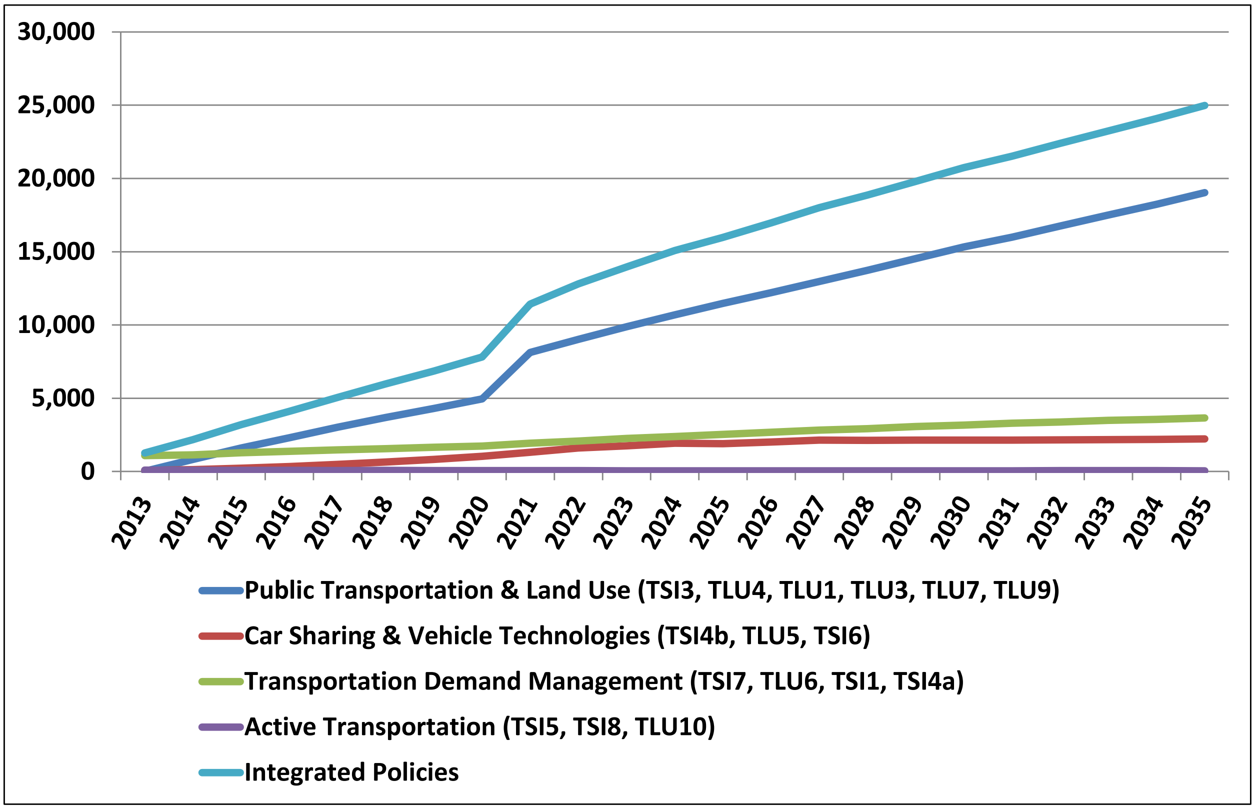


Table EX-3. Macroeconomic Impact Estimates for Public Transportation, Land-Use, and Transportation Demand Policies

Public Transportation / Land Use Policies								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
Total Employment	Jobs-Years	9.766	1,613	4,953	11,473	15,333	19,032	9,836
Gross Domestic Product	Millions of Fixed 2010$	$1	$148	$513	$1,258	$1,775	$2,339	$16.0 Billion
Output	Millions of Fixed 2010$	-$1	$203	$707	$1,753	$2,460	$3,225	$22.2 Billion
Disposable Personal Income	Millions of Fixed 2010$	$1	$73	$286	$750	$1,118	$1,540	$9.8 Billion
Transportation Demand Policies								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
Total Employment	Jobs-Years	1,077	1,280	1,754	2,539	3,188	3,654	2,486
Gross Domestic Product	Millions of Fixed 2010$	$91	$113	$176	$273	$362	$441	$3.9 Billion
Output	Millions of Fixed 2010$	$155	$180	$258	$387	$503	$599	$5.6 Billion
Disposable Personal Income	Millions of Fixed 2010$	$86	$105	$148	$211	$276	$340	$3.1 Billion

Table EX-4. Macroeconomic Impact Estimates for Active-Transportation and Car-Sharing & Vehicle Technology Policies

Active Transportation Policies								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
Total Employment	Jobs-Years	99	78	57	50	49	52	62
Gross Domestic Product	Millions of Fixed 2010$	$8	$6	$5	$5	$4	$5	$94 Million
Output	Millions of Fixed 2010$	$14	$11	$8	$8	$8	$9	$156 Million
Disposable Personal Income	Millions of Fixed 2010$	$4	$4	$4	$3	4	$5	$72 Million
Car Sharing & Vehicle Technology Policies								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
Total Employment	Jobs-Years	73	223	1,040	1,892	2,139	2,215	1,532
Gross Domestic Product	Millions of Fixed 2010$	6	20	113	224	268	295	$2.6 Billion
Output	Millions of Fixed 2010$	12	27	170	347	407	438	$3.9 Billion
Disposable Personal Income	Millions of Fixed 2010$	1	12	62	121	149	164	$1.4 Billion

Sectors of Economy Most Affected by TSI and TLU Policies

While changes to public spending, consumer spending and private investment can affect all sectors of the economy, certain sectors stand out as particularly affected. Those sectors are:

- Health Care and Social Assistance
- Accommodation and Food Service
- Construction
- Real Estate and Leasing
- Professional and Technical Services
- Finance and Insurance
- Administrative and Waste Services

The modeling effort found that for each of these sectors, employment was over 1,000 jobs higher than in the baseline scenario during the final years (2030-2035) of the scenario. Spending on wages was also higher in each of these sectors – typically tens of millions of dollars higher each year than in the baseline scenario. A few sectors showed losses. In such cases, however, the effects were very small in scale. For example, the mining sector, already small, showed no job losses but slight reductions in overall compensation. The manufacturing sector showed losses in output (which were expected), but, while those losses reduced productivity, the sector showed no losses in employment.

Sources of Policy Funding

In order to estimate macroeconomic impacts of these policies, some assumptions were required about the source of policy funding. The funding source for policies is instrumental in determining the macroeconomic effects on the SCAG region and beyond. The TWG selected policies were, with the exception of a few, refined to be consistent with initiatives described in the 2012 RTP. Those policies which could be made consistent with RTP initiatives were then assumed to be funded within the fiscally constrained RTP. Thus, all funding for policies included in the RTP were accounted for in the RTP financial plan and required no additional financing. The policies that were outside the RTP were associated with state and federal vehicle programs for which no RTP funding was identified. A car-sharing policy was also considered to be outside the RTP funding, as were the private-sector expenses identified in a variety of policies. These policies required new, non-RTP funding wherever public funding was envisioned.

The RTP funding is divided into existing (or "core") funding sources and additional sources. Additional sources represent revenues not currently collected but considered reasonable to anticipate. Both funding sources are required to fully fund the RTP programs. The RTP estimates that approximately 58% of the plan funding will come from existing sources with the remaining 42% attributed to the detailed additional sources. In general, specific RTP programs are not linked to specific funding sources. No attempt was made in this study to link individual policies with either existing or additional funding sources. All project costs for policies included in the RTP were deemed to come from the RTP finance pool. As some of this pool, the existing 58%, is included in the ongoing REMI model baseline, no offset for these funds was required. Offsets refer to the reduction in investment or government spending activity in the region required to provide policy funding. Offsets are only required for additional funding, so neither existing RTP funding nor funding provided by the state or federal government requires offset accounting in the macro models.

Thus, the decisions on the use of offset funding in the macro models required funding location determinations for each policy analyzed. If the policy was included and funded within the RTP, it was assumed that 42% of the funding will need to be raised and consequently will draw from or offset household, commercial, and government spending that would otherwise occur in the absence of the policies. This offset is assumed to be 50% at the regional level, 25% at the state level and 25% at the national level. There is no information on the actual distribution of these offsets, so the assumed ratios are consistent with previous REMI modeling assumptions for GHG impacts. For policies that are not included in the RTP, all funding must be offset at the assumed regional, state and federal rates.

Summary of Results for ECR Policies

Macroeconomic Analysis Results

The overall macroeconomic impacts of all ten ECR options over the 2013-35 planning period are summarized in Table EX-5. The results indicate that as a group the recommended ECR GHG mitigation policy options yield a net positive impact on the SCAG Region's economy in terms of employment and personal income, but slightly negative impact on GDP. The main reason that the results project overall moderate positive employment impacts, but slightly negative GDP impacts, is that the sectors benefiting directly and indirectly from the implementation of these options (such as professional and technical service sector and renewable energy sector) are relatively more labor-intensive than those adversely affected (such as conventional energy supply sectors).

Moreover more than half of the individual options themselves yield net positive impacts. The economic gains arise primarily from the ability of mitigation options to lower the overall costs of business and household economic activity and the stimulus to investment in green technologies.

Sensitivity analyses of the assumptions relating to potential variations in the location of manufacturing of green technologies, fuel prices, investment costs, and the extent of external investment were undertaken. They indicate that the results are generally robust. At the same time, the sensitivity tests indicate ways that the economic impacts can be made even more positive (or less negative for some of the options), by attracting more green manufacturing firms to locate within the SCAG Region, investing in R&D in green technologies to bring their costs down, and attracting more federal subsidies and investment from other regions. The results provide a basis for government and the private sector to cooperate in achieving the best possible outcome of climate policy.

Note that the estimates of economic benefits to the SCAG Region do not include the economic value of other benefits associated with implementing the ECR options, including the avoidance of negative environmental impacts from continued GHG emissions that have been mitigated, the savings from the associated decrease in ordinary pollutants that have important impacts upon human health, the reduction in the use of natural resources, and other factors.

Table EX-5. Integrated Macroeconomic Impacts of All Ten ECR Options

Category	Units	2013	2015	2020	2025	2030	2035	Jobs per Year / NPV
Differences from Baseline Level								
Total Employment	Jobs	-2,892	6	5,087	18,375	39,331	61,191	20,781
GDP	Millions of Fixed 2010$	-582	-763	-1,830	-2,155	-1,782	-1,162	-17,814
Output	Millions of Fixed 2010$	-645	-903	-2,809	-3,593	-3,238	-2,561	-27,066
Disposable Personal Income	Millions of Fixed 2010$	-323	-173	47	1,020	2,740	4,759	10,522
PCE-Price Index	2005=100	0.026	0.006	-0.033	-0.098	-0.176	-0.248	N/A
Population	Number of People	-3,336	-3,209	1,662	15,482	41,633	76,252	N/A
Baseline Plus Addition of Policy								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	10,218,278	10,535,888	11,062,814	11,476,396	11,965,508	12,581,877	
GDP	Millions of Fixed 2010$	1,000,261	1,078,595	1,273,803	1,401,026	1,553,441	1,745,214	
Output	Millions of Fixed 2010$	1,531,613	1,653,725	1,951,063	2,156,975	2,395,022	2,676,530	
Disposable Personal Income	Millions of Fixed 2010$	755,044	803,211	926,578	1,031,077	1,154,924	1,313,308	
PCE-Price Index	2005=100	110.9	116.8	133.6	153.2	176.6	204.6	
Population	Number of People	18,212,039	18,410,373	18,997,424	19,606,332	20,325,465	21,212,221	
Percent Change from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	-0.0283%	0.0001%	0.0460%	0.1604%	0.3298%	0.4887%	
GDP	Millions of Fixed 2010$	-0.0581%	-0.0707%	-0.1435%	-0.1535%	-0.1146%	-0.0665%	
Output	Millions of Fixed 2010$	-0.0421%	-0.0546%	-0.1438%	-0.1663%	-0.1350%	-0.0956%	
Disposable Personal Income	Millions of Fixed 2010$	-0.0427%	-0.0216%	0.0050%	0.0991%	0.2378%	0.3637%	
PCE-Price Index	2005=100	0.0238%	0.0051%	-0.0249%	-0.0638%	-0.0996%	-0.1210%	
Population	Number of People	-0.0183%	-0.0174%	0.0087%	0.0790%	0.2048%	0.3595%	

Microeconomic Analysis Results

The main data source for the macroeconomic modeling is the microeconomic impact quantification results of individual GHG mitigation policy options conducted by CCS team's sectoral analysts (CCS, 2012b).[3] Table EX-6 summarizes the estimated impacts (GHG mitigation potentials and costs/savings) of the policy options analyzed for the ECR sectors (ES—Energy Supply; RCI—Residential, Commercial, and Industrial; AFW—Agriculture, Forestry, and Waste Management). Among the 17 recommended options, 10 are analyzed quantitatively. In total, during the 2012-2035 period, the weighted average cost-effectiveness of the options (using GHG reduction potentials as weights) is about minus $4 per metric ton of carbon dioxide equivalent emissions removed. The minus sign means implementing these options on average would yield overall cost savings.

Figure EX-3 presents the marginal cost curve for the ECR sectors. 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 GHG reduction potential of the ECR options can avoid about 22% of 2035 baseline emissions in SCAG Region. Among the three sectors, RCI options in aggregate have the largest GHG reduction potential; and most of the RCI options are cost-effective (i.e., their implementation would result in cost savings).

Table EX-6. Microeconomic Analysis Results of ECR Options

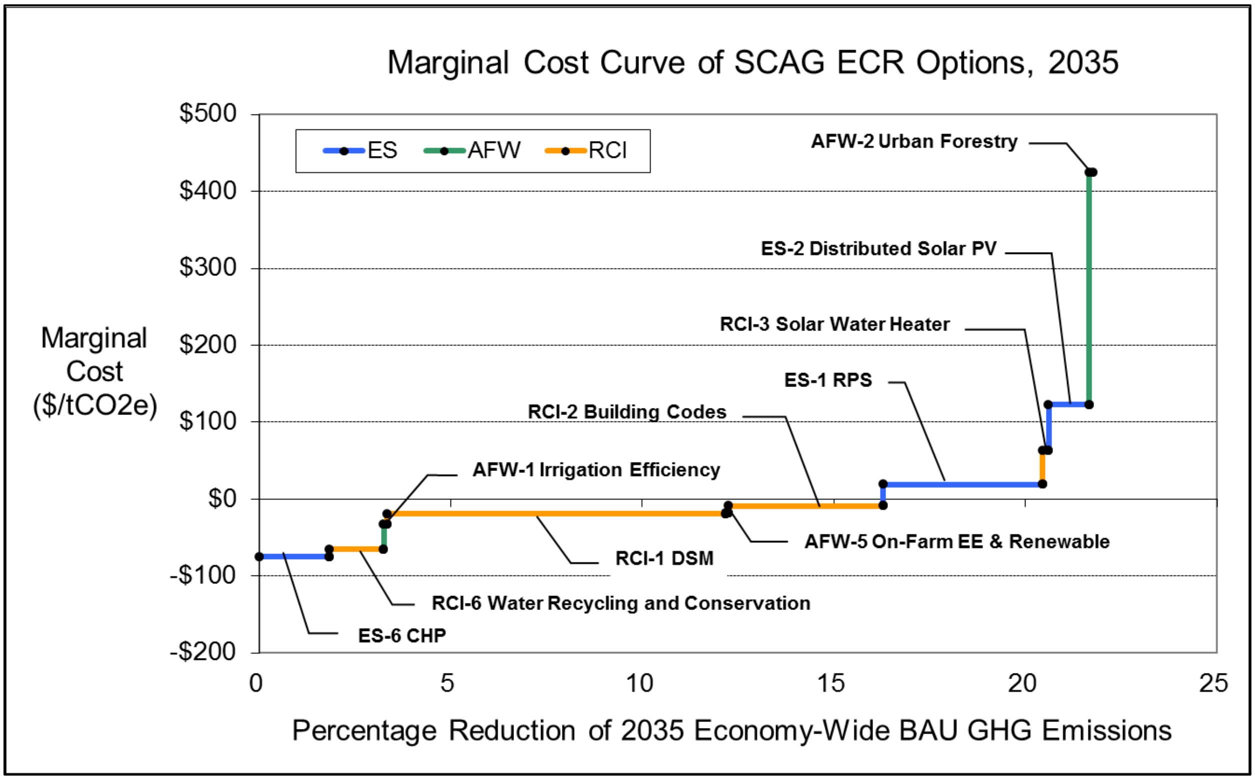
Policy Option Number	Policy Option Description	2020 (MMtCO2e)	2035 (MMtCO2e)	2012-2035 (MMtCO2e)	Net Present Value (million 2010$, 2012-2035 Cost / Cost Savings*	Cost-Effective-ness ($/tCO2e)*
RCI-1	Utility Demand Side Management (DSM) Programs for Electricity and Natural Gas (for Investor-owned, Government-owned, and Coop Utilities), and/or Energy Efficiency Funds (e.g. Public Benefit Funds) Administered by Local Agency, Utility, or Third Party	8.6	24.2	297	-5,652	-19
RCI-2	Improved Building Codes for Energy Efficiency	3.1	11	119	-1,025	-9
RCI-3	Incentives for Renewable Energy Systems at Residential, Commercial, and Industrial Sites	0.16	0.41	5.1	325	63
RCI-4	Consumer, Student, and Decision-maker Education Programs	Not Quantified				

[3] For each individual option, at the request of SCAG, CCS modeled the impact of existing California policies on the SCAG region, though some of those policies may have not been fully implemented yet. As a consequence, various assumptions have been made about how the policies might be implemented, such as the target and timing of the policy. Then the cost and emissions reduction performance of these policies are quantified, in a manner consistent with their goals and mandates as expressed in available documentations.

Policy Option Number	Policy Option Description	2020 (MMtCO2e)	2035 (MMtCO2e)	2012-2035 (MMtCO2e)	Net Present Value (million 2010$, 2012-2035 Cost / Cost Savings*	Cost-Effective-ness ($/tCO2e)*
RCI-5	GHG Emissions Reductions through Changes in Goods Production, Sourcing, and Delivery	Not Quantified				
RCI-6	Increase Water Recycling and Water End-use Efficiency and Conservation Goals and Programs	2.0	3.9	54	-3,528	-65
ES-1	Central Station Renewable Energy Incentives including Project Development Barrier Removal Issues	11.4	11.4	265	5,025	19
ES-2	Customer Sited Renewable Energy Incentives and/or Barrier Removal	1.2	2.9	37.5	4,624	123
ES-3	Transmission System Upgrading, Reduce Transmission and Distribution Line Loss	Not Quantified				
ES-4	CCSR Incentives and Infrastructure including R&D and Enabling Policies	Not Quantified				
ES-5	Public Benefits Charge Funds	Moved to RCI-1				
ES-6	Combined Heat and Power (CHP) Incentives and/or Barrier Removal, including Co-location or Integration of Energy-Producing Facilities	1.3	5.0	66.2	-4,971	-75
AFW-1	Improve Agricultural Irrigation Efficiency	0.22	0.22	4.4	-145	-33
AFW-2a	Improve Urban Forestry and Green Space Management through Expansion and Effective Management: Urban Forestry	0.05	0.28	2.7	1,359	424
AFW-2b	Improve Urban Forestry and Green Space Management through Expansion and Effective Management: Xeriscaping	Not Quantified				
AFW-3	Biomass to Energy Innovation through In-Situ Underground Decomposition	Not Quantified				
AFW-4	Preserve and Expand the Carbon Sequestration Capabilities of Open Space, Wildlands, Wetlands, and Agricultural Lands	Not Quantified				
AFW-5a	Increase On-Farm Energy Efficiency & Renewable Energy Production: Renewable Energy	0.02	0.04	0.65	-6	-9
AFW-5b	Increase On-Farm Energy Efficiency & Renewable Energy Production: Energy Efficiency	0.05	0.16	2.3	-47	-28
All	**Total Stand-Alone Results**	**28.0**	**59.7**	**854**	**-4,041**	**n/a**
	Total Estimated Policy Overlaps	**0.03**	**0.18**	**1.73**	**883**	**n/a**
	Total After Overlap Adjustments	**28.0**	**59.5**	**853**	**-3,157**	**-4**

* Negative values represent a net cost savings. $/t$CO_2$e stands for dollars per metric ton of carbon dioxide equivalent.

Figure EX-3. Marginal Cost Curve of ECR Options



CHAPTER 1. INTRODUCTION AND OVERVIEW

1.1. Overview

The Southern California Association of Governments (SCAG) established the Climate and Economic Development Project (CEDP) to assist in developing a comprehensive strategy and analysis for meeting the mandates of Senate Bill (SB) 375 and Assembly Bill (AB) 32. These two pieces of legislation adopted by the California General Assembly are designed to reduce greenhouse gas (GHG) emissions through economically desirable and socially equitable regional policies and strategies. SCAG engaged a diverse and high-level group of stakeholders representing government entities, environmental interests, key industries, and other groups to identify potential regional and local policies that reduce GHG emissions to comply with this legislation in the most economically desirable and equitable manner possible. SCAG contracted with the Center for Climate Strategies (CCS) to conduct effective, stakeholder-based climate planning and policy development processes, as well as related socioeconomic analysis and implementation support. This report summarizes the potential microeconomic and macroeconomic impacts associated with the policies identified as priorities for analysis by the stakeholders.

At the beginning of the CEDP, a memorandum (see Appendix A) was developed and approved by SCAG that established the Project Stakeholder Committee (PSC) as the decision making group for identifying and approving policies for further analysis. Given the extensive and in-depth work involved with this charge, three technical work groups (TWGs) were created to provide support to the PSC in identifying and recommending to the PSC policy actions for further analysis. The three TWGs focused on policy actions related to Transportation System and Investments (TSI); Transportation and Land Use (TLU); and Energy, Commerce, and Resources (ECR). In addition, a website (http://cedp.scag.ca.gov/) was established to support the CEDP process and encourage public involvement in the PSC and TWG meetings.

The PSC held three meetings from August 2010 through January 2011 and the TWGs met from August 2010 through March 2011. At its January 2011 meeting, the PSC identified a total of 37 policies that it recommended as priorities for analysis. The TWGs met once after the PSC's January 2011 meeting to begin work to flesh out the design details for each policy approved for further analysis by the PSC. However, due to budget constraints, work on developing the policy designs needed to support the quantification of the potential impacts of each policy was suspended at the end of March 2011. Work on policy design and quantification of their potential impacts was resumed in January 2012; however, at this point there was not sufficient budget to resume the PSC and TWG process. Consequently, SCAG requested that the CCS team analysts work with SCAG's technical staff and experts identified by SCAG to complete the design and quantification of the policies within the limitations of the available funding for the remainder of the project. In addition to the 37 policies identified by the PSC, the PSC also identified six cross-cutting policies related to education and outreach. However, due to budget constraints, work on completing the development of the six cross-cutting policies was discontinued.

Prior to initiating the economic impact analysis of the TSI and TLU policies, SCAG released its Draft 2012 RTP/SCS for public review and comment. Because many of the TSI and TLU policies already proposed were included in the draft RTP/SCS, the CCS team worked with SCAG's staff to ensure, to the extent possible, that the policies had technical assumptions that mirrored the anticipated implementation of the RTP/SCS. This included the bundling of some of the TSI and TLU policies into groups to support the development of the policies consistent with the RTP.

Independent review of this project was also conducted by SCAG's Technical Review Committee (TRC), which was comprised of economists with regional expertise, and the Center for Continuing Study of the California Economy. The TRC and the Center for Continuing Study of the California Economy provided valuable comments as a result of their review of the microeconomic and macroeconomic analysis of the policies. Each of their comments were carefully reviewed, addressed, and incorporated into this final report. The comments provided by the TRC and the Center for Continuing Study of the California Economy and responses to their comments are provided in Appendix B to this report.

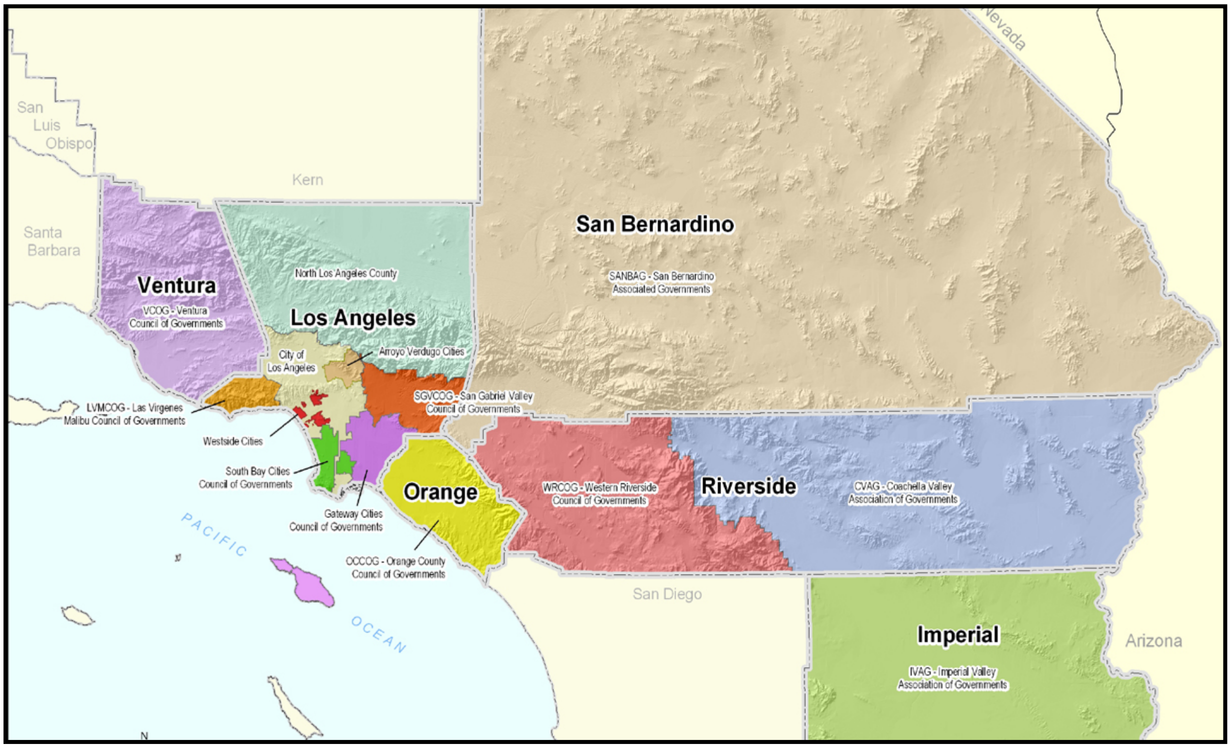
1.2. The SCAG Economy

SCAG is the largest Metropolitan Planning Organization in the United States. It encompasses six of the ten counties in Southern California (Imperial, Los Angeles, Orange, Riverside, San Bernardino and Ventura), 191 cities and over 18 million people (see Figure 1). Median household income in SCAG Region counties ranges from $38,000 (Imperial) to $75,000 (Ventura) (U.S. Census, 2010). Total civilian labor force totals almost 7.5 million, with a participation rate of 61%. Unemployment in the region is high, having reached more than 12.41% in 2010, and having dropped only slightly below the 12% threshold this past year (SCAG, 2012a).

The Service sector in aggregate represents a very large share of the Region's Economy. Manufacturing accounts for about 15% of regional total gross output, and Real Estate accounts for 13% of t output. The next nine largest sectors (in descending order) include Professional and Technical Services, Retail Trade, Wholesale Trade, Construction, Monetary Authorities, Motion Picture/Video/Sound Recording, Administrative and Support Services, Broadcasting and Telecommunication, and Health Care. Altogether these sectors account for about 50% of the total gross output in the region (REMI, 2012).

The largest sub-unit of the SCAG Region is the Los Angeles Metropolitan Area, which comprises about 60% of the Region' gross output. The area is the largest manufacturing center in the U.S., is widely known as the hub of the entertainment industry, and includes two of the nation's largest ports (Los Angeles and Long Beach). Other major sectors include Aerospace, Hi-Tech Manufacturing, Health Services, Petroleum Refining, Fashion, and Tourism.

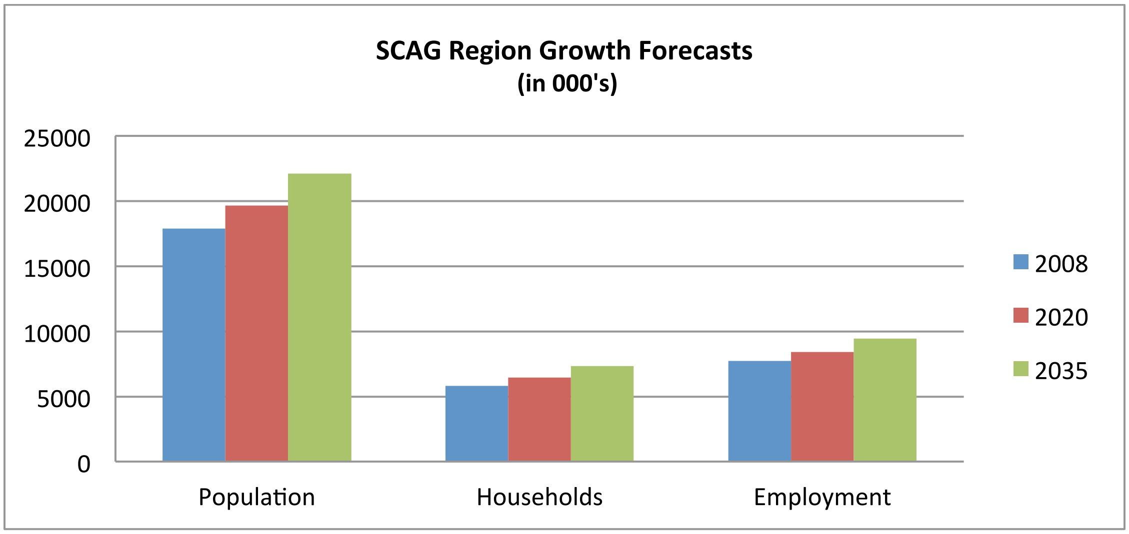
Figure 1. Map of the SCAG Region



Los Angeles County has recently witnessed strong growth in Business and Professional Management Services, Health, Freight Transportation, Fashion and Tourism (Los Angeles County Economic Development Corporation (LAEDC), 2012). The Financial Services sector posted some modest gains in 2011 after losing jobs over the previous 4 years. The Technology sector showed mixed results in 2010 and 2011. Technology Manufacturing was down 4.7% in 2011 over the previous year, but Technology Services increased in both employment and average wages (LAEDC, 2012).

SCAG (2012) has projected increases in population, number of households and employment in the Region (see Figure 2). Population is expected to increase by 23% by 2035 compared with the Year 2008 level. The number of households is expected to increase by 26%, and employment is expected to increase by 22% by 2035. Regional total gross output in 2008 was about $1.37 trillion (in 2005$), 2.5% below the 2007 level because of the recession. The historical average annual growth rate of gross output between 1990 and 2008 was about 1.65%. A baseline forecast indicates that regional gross output in 2035 will reach $2.6 trillion, with a projected average annual growth rate of 2.6% between 2009 and 2035 (REMI, 2012).

Figure 2. SCAG Region Growth Forecast



1.3. Greenhouse Gas Emissions Inventory and Forecast for the SCAG Region

At the beginning of the CEDP, the CCS team coordinated with SCAG and the California's Air Resources Board to prepare a draft assessment of the region's anthropogenic GHG emissions and sinks (carbon storage) from 1990 to 2035. This preliminary draft inventory and forecast served as a starting point to assist the PSC, as well as the TWGs of the PSC, with an initial comprehensive understanding of SCAG's current and possible future GHG emissions, and thereby informed the identification and analysis of policy options for mitigating GHG emissions. The PSC and TWGs reviewed, discussed, and evaluated the draft inventory and forecast methodologies as well as alternative data and approaches for improving the draft GHG inventory and forecast. Staff from California's Air Resources Board also provided significant review of and comments on the draft inventory and forecast. The inventory and forecast was revised to address the comments provided and approved by the PSC. The reader is referred to the final report entitled, *Regional Greenhouse Gas Emissions Inventory and Reference Case Projections, 1990-2035* for further details on the GHG emissions inventory and forecast prepared for the SCAG region (SCAG, 2012b).

1.4. Methods for Microeconomic Analysis of Policies

Appendix C to this report presents the principles, guidelines and general methods followed in developing the microeconomic impact analysis of the policy options. As a part of this effort, the CCS team worked with SCAG technical experts to develop the design criteria and identify the data sources for quantifying the potential microeconomic impacts associated with the policies. For each policy option, incremental emission reductions and incremental costs and savings were calculated relative to the characteristics of the baseline that would otherwise prevail in the SCAG region up through the end of the 2035 planning period, as well as the lifetime of the policy option. The net present value (NPV) of the cumulative net costs of each option, and the cumulative emission reductions of each option, were reported for the period starting with the initial year of the phase-in of the policy up through the target period for analysis (2035). For example, if a policy included a complete phase-in over time, the annual GHG reductions and the

NPV of the incremental costs and the cumulative emission reductions were reported for the entire period from the beginning of the phase-in up through 2035. Costs were discounted in constant 2010 dollars using a 5% annual real discount rate (7% nominal) based on standard rates used for regulatory impact analysis at the federal and state levels.

1.5. Methods for Macroeconomic Analysis of Policies

1.5.1. Model Selection

Several modeling approaches can be used to estimate the total regional economic impacts of environmental policy, including both direct (on-site) effects and various types of indirect (off-site) effects. These include: input-output (I-O), computable generated equilibrium (CGE), mathematical programming (MP), and macroeconometric (ME) models. Each has its own strengths and weaknesses (see, e.g., Rose and Miernyk, 1989; Partridge and Rickman, 2010).

The choice of which model to use depends on the purpose of the analysis and various considerations that can be considered as performance criteria, such as accuracy, transparency, manageability, and costs. After careful consideration of these criteria, we chose to use the Regional Economic Models, Inc. (REMI) Policy Insight Plus (PI^+) Model. The REMI PI^+ Model is superior to the others reviewed in terms of its forecasting ability and is comparable to CGE models in terms of analytical power and accuracy. With careful explanation of the model, its application, and its results, it can be made as transparent as any of the others.[4] Moreover, the research team has used the model successfully in similar analyses in the states of Florida, Pennsylvania, Michigan, Wisconsin and New York (Miller et al., 2010; Rose et al., 2011; Wei and Rose, 2011; Rose and Wei, 2012; Lawrence and Williamson, 2011).

The REMI Model has evolved over the course of 30 years of refinement (see, e.g., Treyz, 1993). It is a packaged program but is built with a combination of national and region-specific data. Government agencies in practically every state in the U.S. have used a REMI Model for a variety of purposes, including evaluating the impacts of the change in tax rates, the exit or entry of major businesses in particular or economic programs in general, and, more recently, the impacts of energy and/or environmental policy actions.

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[4] There is a debate about the size of the multipliers used in different regional policy analysis models. Rickman and Schwer (1995) compared the default multipliers in three of these models: IMPLAN, REMI and RIMS II. The comparison shows that the default multipliers have significant differences. Comparatively speaking, IMPLAN estimates the largest multipliers, while REMI estimates the smallest multipliers. The differences stem from three major causes. However, the REMI model has its special features that are important to our policy analysis. First, both IMPLAN and RIMS II are static input-output models, while the REMI model is dynamic. Thus, the REMI model has the capability to analyze the time path of impacts of the simulated policy change and is superior to the other two models in terms of its forecasting ability. In fact, the implicit multipliers of REMI vary from year to year. Second, the REMI model is non-linear. Therefore, in contrast to the other two models, the REMI simulation results are not dependent on fixed multipliers or linear relationship with the input data. In the REMI analysis, changes in the magnitude of the inputs will lead to an appropriate variation in the model's multipliers. Moreover, since the REMI multipliers are generally smaller than the multipliers of the other two models, this means that our impacts lean to the more conservative side, i.e., positive economic impacts are more likely to be understated than overstated.

A detailed discussion of the major features of the REMI Model is presented in Appendix D. We simply provide a summary for general readers here. A macroeconometric forecasting model covers the entire economy, typically in a "top-down" manner, based on macroeconomic aggregate relationships such as consumption and investment. REMI differs somewhat in that it includes some key relationships, such as exports, in a bottom-up approach. In fact, it makes use of the finely-grained sectoring detail of an I-O model, i.e., it divides the economy into 169 sectors, thereby allowing important differentials between them. This is especially important in a context of analyzing the impacts of GHG mitigation actions, where various options were fine-tuned to a given sector or where they directly affect several sectors somewhat differently.

The macroeconomic character of the model is able to analyze the interactions between sectors (ordinary multiplier effects) but with some refinement for price changes not found in I-O models. In other words, the REMI model incorporates the responses of the producers and consumers to price signals in the simulation. In contrast, in a basic input-output model, the change in prices is not readily taken into account. More specifically, a basic input-output model separates the determinants of quantity and prices, i.e., price changes will not generate any substitution effects in an I-O analysis, while the REMI model is capable to capture this and other price-quantity interactions.[5] The REMI Model also brings into play features of labor and capital markets, as well as trade with other states or countries, including changes in competitiveness.

The econometric feature of the model refers to two considerations. The first is that the model is based on inferential statistical estimation of key parameters based on pooled time series and regional (panel) data across all states of the U.S. (the other candidate models use "calibration," based on a single year's data).[6] This gives the REMI PI^{+} model an additional capability of being better able to extrapolate the future course of the economy, a capability the other models lack. The major limitation of the REMI PI^{+} model versus the others is that it is pre-packaged and not readily adjustable to any unique features of the case in point. The other models, because they are based on less data and a less formal estimation procedure, can more readily accommodate data changes in technology that might be inferred, for example from engineering data. However, our assessment of the REMI PI^{+} Model is that these adjustments were not needed for the purpose at hand.

1.5.2. Modeling of Policies

Regional Economic Models, Inc. (REMI) Models

The macroeconomic impact analysis was performed following the methods outlined the memorandum entitled "Draft Macroeconomic Impacts of Assembly Bill (AB) 32 & Senate Bill (SB) 375 on the SCAG Economy: Methodological Summary" (provided in Appendix D to this

[5] The production cost change of each sector in REMI will first affect the price of the goods produced by this sector. Then the price change will generate successive impacts to the down-stream customer sectors that use the product of sector *i* as an intermediate input.

[6] REMI is the only one of the models reviewed that really addresses the fact that many impacts take time to materialize and that the size of impacts changes over time as prices and wages adjust. In short, it better incorporates the actual dynamics of the economy.

report). For this project, all of the ECR and two of the TSI/TLU (i.e., TLU-5 and TSI-6) policies were modeled using the Regional Economic Models, Inc. (REMI) 169-sector Policy Insight Plus (PI+) Model. All of the TSI/TLU policies were modeled using REMI TranSight (TS) except for TLU-5 and TSI-6. The TS Model contains all of the same central components as the PI+ Model, but adds the capacity to model economic impacts of changes in travel demand and in transportation system characteristics.

The microeconomic analysis results were used as inputs to the macroeconomic models. The inputs to the macroeconomic models including mapping of the costs and savings of the policies to the sectors affected by the policies; for example, to account for program costs and capital costs for construction of new infrastructure incurred by local government, changes in travel costs (primarily fuel and vehicle spending) by the public, changes in transit fare costs faced by the public, and costs of compliance faced by private-sector businesses. These costs and savings were identified separately and made compatible with the REMI models' requirements. The macroeconomic analysis also accounted for the effect of changes in consumer and business spending resulting from those costs and savings, estimates for displacement of other government spending and ordinary business investment by the new spending and investment anticipated to implement the policies, as well as the extent to which spending was funded by resources from outside the SCAG region.

All of the cost estimates of mitigation options in the analysis apply to the site of their application, or what are termed local economic impacts. In this case, the SCAG region is analyzed. The estimation of the macroeconomic impacts of mitigation options include the ripple effects of decreased or increased spending on mitigation, and the interaction of demand and supply in various markets. For example, reduction in consumer demand for gasoline fuel reduces the demand for petroleum products on a marginal basis. It therefore reduces the demand for transportation fuel inputs such as crude oil and other inputs. At the same time, businesses and households whose transportation energy demands have decreased have more money to spend on other goods and services. If the households purchase more food or clothing, this stimulates the production of these goods, at least in part, within the region. Food processing and clothing manufactures in turn purchase more raw materials and hire more employees. Then more raw material suppliers in turn purchase more of the inputs they need, and the additional employees of all these firms in the supply chain purchase more goods and service from their wages and salaries. The sum total of these "indirect" impacts is some multiple of the original direct on site impact; hence this is often referred to as the multiplier effect, a key aspect of macroeconomic impacts. It applies to both increases and decreases in economic activity. It can be further stimulated by price decreases and muted by price increases.

The many types of linkages in the economy and macroeconomic impacts are extensive and cannot be traced by a simple set of calculations. It requires the use of a sophisticated model that reflects the major structural features of an economy, the workings of its markets, and all of the interactions between them. In this study, we used the Regional Economic Models, Inc. (REMI) Modeling software. This is the most widely used state and regional level econometric modeling software package in the U.S. and heavily peer reviewed. The REMI Model is used extensively to measure proposed legislative and other program and policy economic impacts across the private and public sectors by government agencies in nearly every state of the U.S. In addition, it is the preferred tool to measure these impacts by a number of university researchers and private research groups that evaluate economic impacts across a state and nation.

REMI Model Input Development

Before undertaking any economic simulations, the key quantification results for each policy option conducted by the TWGs are translated to model inputs that can be utilized in the REMI Model. This step involved the selection of appropriate policy levers in the REMI Model to simulate the policy's changes. Appendix E of this report provides details on how the microeconomic analysis results are mapped as inputs into the REMI model for the TSI, TLU, and ECR policies.

Simulation Set-Up in REMI

Figure 3 shows how a policy simulation process is undertaken in the REMI Model. First, a policy question is formulated. Second, external policy variables that embody the effects of the policy are identified (e.g., in RPS, relevant policy variables would include incremental costs and investment in renewable electricity generation; avoided generation of conventional electricity; and government subsidies). Third, baseline values for all the policy variables are used to generate the baseline, or "control", forecast. In REMI, the baseline forecast uses the most recent data available (i.e., 2008 data for SCAG Region) and the external policy variables are set equal to their baseline values. Fourth, an alternative forecast is generated by changing the values of the external policy variables. Usually, the changing values of these variables represent the direct effects of the simulated policy scenario. For example, in our analysis of the RPS option, the investments to the renewable electricity generation, and the avoided investment to the conventional electricity generation were based on the technical assessment associated with implementing this ECR mitigation option.[7] Fifth, the effects of the policy scenario are measured by comparing the baseline forecast and the alternative forecast. Sensitivity analysis is undertaken by running a series of alternative policy forecasts with different assumptions on the values of the policy variables.

In this study, we first run the REMI model for each of the TLU/TSI and ECR options *individually* in a comparative static manner, i.e., one at a time, holding everything else constant. Next, we run *simultaneous* simulations in which we assume that all TLU/TSI policy options or ECR options are implemented together. Then the simple summation of the effects of individual options is compared to the simultaneous simulation results to determine whether the "whole" is different from the "sum" of the parts. Differences can arise from non-linearities and/or synergies. The latter would stem from complex functional relationships in the REMI Model.

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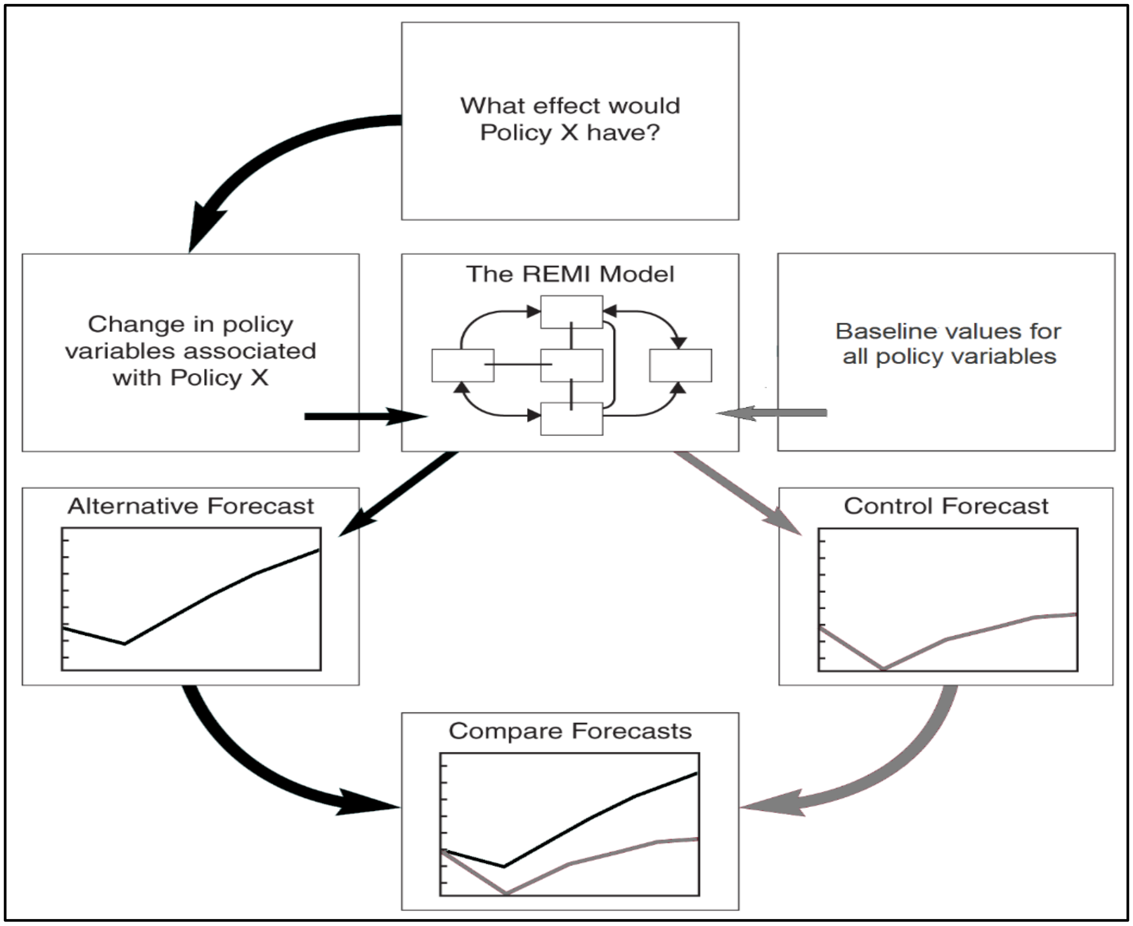
[7] The REMI Model was constructed in a manner to be consistent with the SCAG economic and population forecasts. There may be a concern that if the REMI baseline forecast is not entirely consistent with the SCAG forecasts, especially in cases of a long planning horizon, that this might undercut the accuracy of the policy simulations. However, our simulations focus on differential impacts, i.e., the difference in economic activity that compliance with AB 32 would bring about. Thus, if there is a divergence of a couple of percentage points between the SCAG baseline forecast and the actual path of the economy, this will have a negligible effect on the differential impacts with regard to either the forecast or actual baseline trajectory. In sum, we are not providing a projection of exactly what the total employment will be in the SCAG Region in 2035 as a result of AB 32, but simply the difference in the number of jobs (either positive or negative) between the implementation scenario and a business as usual scenario.

Before performing the simulations in REMI, intra-sector and inter-sector overlaps between policy options are eliminated as much as possible to avoid double counting. This process is conducted by applying "overlap factors" to both the costs and savings of the relevant policy options.

Figure 3. Process of Policy Simulation in REMI



Source: REMI, 2012

1.6. Estimating Future Macroeconomic Impacts

The scenario analysis conducted in this project is not a forecasting effort. Forecasting economic conditions in a particular year is a challenging prospect. Projections of future economic conditions depend on the expected growth in population and in economic activities, but are subject to the effects of natural, economic and political conditions during the forecast period that are impossible to predict with precision. Natural disasters, recessions or booms, international political tensions, and many other unpredictable events will determine the future level of economic activity. The best that can be done is to develop an economic forecast that is consistent with the national forecast and recognizes any unique characteristics of the regional economy. This forecast is the "Business As Usual" or "BAU" scenario.

Impact analyses are always framed within the context of “with” and “without” (benchmark) perspectives. The impact of an exogenous event is defined and measured in terms of the differences between the condition, or "state,” of the economy associated with the change and its state without. Thus, impact analysis requires the ability to forecast a baseline condition.
All impact analyses require an explicit or implicit model that explains how the economy is affected by a variety of factors determined outside the control of private decision makers. Many issues must be considered in the baseline, including the underlying growth in SCAG region population and economic activity. These expectations are in the baseline scenario (referred to as BAU scenario). Note that there are both microeconomic and macroeconomic baseline considerations.

1.7. Regulatory Uncertainty / Recommendations for Future Research

The policies analyzed have not yet been implemented by any regulatory authority. Consequently, for this analysis, it is necessary to make assumptions on how businesses that may be affected by the policy analyzed may respond. If and when a policy is implemented, the design of the policy as well as how it is implemented and enforced may be quite different from the policy analyzed. This raises uncertainties about the final costs to businesses that may be affected by the policies and how the cost of uncertainty may affect business decisions, for example, on whether businesses will decide to: 1) purchase goods and services in-region or out-of-region (or state); 2) locate manufacturing facilities within the region (or state); or 3) move existing facilities outside of the region (or state). Members of the Technical Review Committee (TRC) for this analysis have indicated that the uncertainties associated with policies and regulations developed to comply with AB32 and SB375 may be significant for the SCAG region. Therefore, it is recommended that a separate study be conducted in an effort to identify the types of uncertainties and how these uncertainties translate into real costs to businesses in the region.

CHAPTER 2. MICROECONOMIC AND MACROECONOMIC ANALYSIS OF TRANSPORTATION SYSTEMS AND INVESTMENT (TSI) AND TRANSPORTATION AND LAND USE (TLU) GREENHOUSE GAS MITIGATION POLICY OPTIONS

2.1. Introduction and Overview

This chapter summarizes results of the microeconomic and macroeconomic impact analysis the TSI and TLU policies identified as priorities for analysis by the TWGs through CEDP (CCS, 2012a).

Prior to initiating the microeconomic impact analysis of the TSI and TLU policies, SCAG released its Draft 2012 Regional Transportation Plan (RTP) for public review and comment. Because some of the TSI and TLU policies already proposed were included in the draft RTP, CCS team members worked with SCAG's technical experts to ensure that the policies were designed to be consistent with how the policies are designed to support the RTP. This included the bundling of some of the TSI and TLU policies into groups to support the development of the policies to be consistent with the RTP. This approach also supported the development of the policy designs to eliminate potential overlaps and double counting of emission reductions and costs or savings associated with the policies

The TSI and TLU TWGs identified a total of 20 policies for analysis in terms of their potential to reduce GHG emissions and potential economic impacts on the transportation sector in the SCAG region. Some of these policies were similar between the two TWGs, and thus were combined into policy bundles for microeconomic and macroeconomic analysis. Each policy or policy bundle was evaluated for investment requirements, transportation sector impacts and GHG emissions reductions. For each policy bundle, the cost-effectiveness of that policy in reducing GHG emissions was estimated. Policy bundle impacts were further aggregated to match major categories of focus within the 2012 SCAG RTP/Sustainable Community Strategies (SCSs).

The results indicate that the net macroeconomic impacts on the SCAG regional economy will be significantly positive. While many mitigation activities incur some costs, these costs are more than offset by cost savings in other areas and also by shifts in spending out of energy savings and by the investment stimulus of business in the state that produce the necessary equipment.

The analysis is based on the best estimation of the cost of various mitigation options. However, these costs and some conditions relating to the implementation of these options are not known with full certainty. Examples include the net cost or cost savings of the options themselves and the extent to which investment in new equipment will simply displace investment in other equipment in the state or will attract new capital from elsewhere. Accordingly, we performed sensitivity analyses to investigate these alternative conditions.

2.2. Organization of Chapter

The results of the microeconomic and macroeconomic impact analysis for the TSI and TLU policies are presented in the following sections of this chapter:

- Section 2.3: Relationship of Policies to Initiatives with SCAG's 2012 RTP/SCS
- Section 2.4: Potential Microeconomic Impacts Associated with Individual TSI and TLU Policies
- Section 2.5: Integrated Analysis of Macroeconomic Impacts of All TSI and TLU Policies
- Section 2.6: Sectors of Economy Most Affected by TSI & TLU Policies
- Section 2.7: Analysis of Macroeconomic Impacts by Major Category
- Section 2.8: Macroeconomic Impacts of Individual Policies
- Section 2.9: Discussion of Network and Amenity Benefits
- Section 2.10: Summary of Sensitivity Analyses and the Macroeconomic Impacts on the California and US Economies

2.3. Relationship of Policies to Initiatives with SCAG's 2012 RTP/SCS

Some policies are limited in the magnitude of their expected impacts, and the microeconomic analyses identified a few which produced costs and/or savings in only small amounts every year. Because the direct costs and savings associated with some policies were small, these policies were expected to have miniscule effects on the wider regional economy. This expectation was confirmed through the TranSight and PI+ analyses.

The process of policy design originally began with the organization of three TWGs, which were tasked with coming to consensus on recommended policies for inclusion in the CEDP report. As the process evolved, SCAG staff sought to refine the general policy areas by developing more detailed definitions. This process, undertaken by the CCS team with SCAG staff input, sought to refine the general policies identified by the TWGs into specific policies that are thematically and logically consistent with the language of related initiatives described in SCAG's draft 2012 RTP/SCS. To the extent the RTP/SCS described specific goals or targets related to a topic addressed by one of the TWG's chosen policies, the CCS team and SCAG staff developed goals for the CEDP policies that are consistent with those targets. This process required making a range of assumptions about the nature, timing and effectiveness of each policy's design and implementation. The RTP/SCS often did not establish hard goals or clarify the method by which policies would be implemented. In response, CCS team analysts worked with SCAG's technical staff to identify appropriate policy mechanisms and methods of analysis to estimate the potential impacts those mechanisms would produce. Policy design specifics were drawn from existing state and local policies, as well as from climate action planning documentation for similar policies produced as part of existing state climate action plans. While these policies were thus designed to be consistent with the initiatives described, they do not necessarily reflect the exact method, timing, level of intensity, or effectiveness of what will eventually be carried out when and if the RTP/SCS initiatives are fully implemented.

These policies are not, however, intended to represent the overall scope of the 2012 RTP/SCS. The policies were originally identified as largely planning-related opportunities to reduce GHG emissions from the transportation sector, and were then adjusted to conform to specific elements of the RTP/SCS. They do not address any of the roadway construction or improvement envisioned in the RTP/SCS, nor do they address the vast majority of transit-related spending. When taken together, these two areas of investment are expected to represent a majority of the spending in the RTP/SCS. In addition, some policies (particularly those addressing the adoption of new vehicle technologies and car-sharing) are not addressed directly by the RTP/SCS. Instead, the RTP/SCS envisions planning efforts to support state or federal initiatives related to these policies. As a consequence, not all policies could be made entirely consistent with the RTP/SCS.

2.4. Potential Microeconomic Impacts Associated with Individual TSI and TLU Policies

The microeconomic analysis estimates the potential direct costs and savings, GHG emission reductions, and cost-effectiveness (representing the dollars spent or saved per ton of emissions reduced) associated with each policy if fully implemented in the SCAG region. The CCS team worked with SCAG technical experts to develop the design criteria and identify the data sources for quantifying the potential microeconomic impacts associated with the policies following the methods outlined the memorandum entitled “Draft Principles and Guidelines for Quantification of Policy Options and Scenarios,” which was developed for this work (see Appendix C).

The results (summarized in Table 1) indicate that if all of the policies are fully implemented over the 2013-2035 period, the policies can achieve the following:

- Reduce GHG emissions by nearly 40 million metric tons on a carbon dioxide equivalent basis (MMtCO_2e);
- Reduce vehicle miles traveled (VMT) by about 109 billion:
- Result in a fuel savings of about 3.6 billion gallons; and
- Provide a net savings to the businesses and households in the SCAG region of approximately $20 billion.

The policies affecting transit-oriented development and mixed-use development were by far the largest in impact, while many others had relatively small effects. This was due not to their ineffectiveness (most policies were assessed as highly cost-effective) but to their narrow definition or constrained level of investment.

To understand these results in some context, the marginal cost curve in Figure 4 displays the relative cost per ton of GHG emissions reduced associated with each policy (a negative number indicates a net savings per ton), as well as the GHG reduction potential associated with each policy. The largest single effect comes from Transit-Oriented Development and Mixed-Use Development policies (analyzed together to avoid overlap and double-counting issues). Policies also vary significantly both in GHG reduction potential and in cost-effectiveness, though most policies are estimated to provide significant net savings, rather than net costs.

2.5. Integrated Analysis of Macroeconomic Impacts of All TSI and TLU Policies

The results of the macroeconomic modeling analysis are summarized in Table 2. The results indicate that if all of the policies are fully implemented over the 2013-2035 period, the policies can achieve the following:

- A net gain of over 13,000 jobs per year (or 300,000 additional job-years of employment) over the entire planning period;
- A net increase in the region's gross domestic product (GDP) of over $22 billion in net present value (NPV);
- A net increase of region-wide output of over $31 billion in NPV; and
- A net increase in disposable personal incomes of over $14 billion in NPV.

These results are based on an integrated analysis of the TSI and TLU policies modeled together to capture the ways in which impacts of policies change in the presence of other policies, eliminate the potential for double-counting of macroeconomic impacts, and understand how the economy for the SCAG region potentially affected if all of the policies were fully implemented in the region.

Table 1. Microeconomic Analysis Results Summary

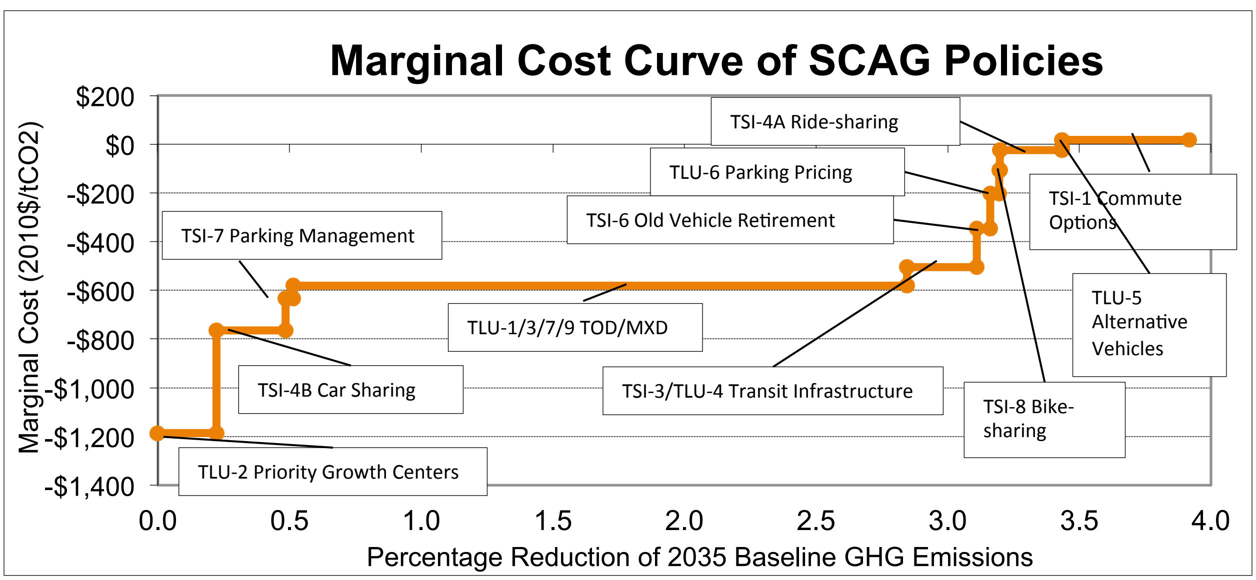
Policy No.	Policy Option	GHG Reductions (MMtCO2) 2020	2035	Total (2013-2035)	Net Present Value (million 2010$)*	Cost-Effectiveness ($/tCO2)*	Fuel Savings (million gallons, 2013-2035)	VMT Reduction (billion, 2013-2035)
Employee Commuter Options								
TSI-1/ TSI-4A	Employer-Based Commute Option Programs	0.14	0.49	5.38	$14	$2.6	451	15.9
Public Transportation								
TSI-3/ TLU-4	Expand Transit Infrastructure and Transit Funding	0.23	0.26	5.40	-$2,272	-$420	449	7.4
Car Sharing								
TSI-4B	Car-sharing Programs	0.07	0.18	2.57	-$1,976	-$764	205	7.24
Bicycle and Pedestrian								
TSI-5/8/9 TLU-8/10	Increased Bike/Walk Trips, including Complete Streets and Bike share	0.01	0.01	0.03	$50	$1,695	2	0.1
Low Emission Vehicles								
TSI-6/ TLU-5	Promote Alt Vehicles/ Retirement and Replacement	0.11	0.03	2.25	-$233	-$103	330	N/A
Parking								
TSI-7/ TLU-6	Parking Management Strategies/ Parking Pricing	0.02	0.04	0.58	-$234	-$406	46	1.7
Transportation Financing and Pricing								
TSI-2/ TSI-10	Congestion Pricing and Transportation	Not Quantified						

Policy No.	Policy Option	GHG Reductions (MMtCO2) 2020	2035	Total (2013-2035)	Net Present Value (million 2010$)*	Cost-Effectiveness ($/tCO2)*	Fuel Savings (million gallons, 2013-2035)	VMT Reduction (billion, 2013-2035)
	Financing Options							
Land Use								
TLU-1/2/3/7/9	Cross – Cutting Land Use Scenario	0.57	2.29	26.99	-$16,643	-$617	2,171	76.9
Overall Impacts		1.05	3.30	43.20	-$21,287	-$411	3,654	109.2

* Negative values represent a net cost savings. $/tCO$_2$e stands for dollars per metric ton of carbon dioxide equivalent.

In addition to the job impacts associated with increased spending on transportation infrastructure and advanced vehicle and transportation fuel technologies, as well as the ensuing savings of conventional transportation fuels and vehicle operation costs, improved transportation infrastructure and enhanced travel conditions will also bring economic benefits associated with productivity improvement and competitiveness gains in the SCAG Region. In Section 2.9 of this report, job impacts are estimated for the network and amenity benefits of the TLU/TSI options. The method applied the productivity gain / investment ratios extracted from the RTP Report (SCAG, 2012c) to the total investment in the TLU and TSI options analyzed in this study. The result indicates that the gains associated with the network and amenity benefits are 3,842 jobs per year (or 88,374 job-years over the entire planning period), which represents a nearly 30% increase over the base estimate we obtained from the REMI Model analysis. Finally, the benefits estimated also produce an increase in population as the opportunities for employment rise and the personal disposable income available to employees rises. Both make the region more attractive to the labor force.

Figure 4. TLU and TSI Policy Cost Curve



2.6. Sectors of Economy Most Affected by TSI & TLU Policies

While changes to public spending, consumer spending and private investment can affect all sectors of the economy, certain sectors stand out as particularly affected in results of the modeling effort. Those sectors are as follows:

- Health Care and Social Assistance
- Accommodation and Food Service
- Construction
- Real Estate and Leasing
- Professional and Technical Services
- Finance and Insurance
- Administrative and Waste Services

The modeling effort found that for each of these sectors, employment was over 1,000 jobs higher than in the baseline scenario during the final years (2030-2035) of the scenario. Spending on wages was also higher in each of these sectors – typically tens of millions of dollars higher each year than in the baseline scenario.

A few sectors showed losses. In such cases, however, the effects were very small in scale. For example, the mining sector, already small, showed no job losses but slight reductions in overall compensation. The manufacturing sector showed losses in demand (which were expected) but while that reduced productivity, the sector showed no losses in employment.

Table 2. Macroeconomic Impact Analysis Results – Integrated Bundle of All TSI and TLU Policies

Integration of All TLU/TSI - Differences from Baseline Level*								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per - Year / NPV**
Total Employment	Jobs	1,258	3,196	7,814	15,977	20,739	24,988	13,753**
Gross Domestic Product	Millions of Fixed 2010$	106.312	288.223	810.487	1,761.626	2,414.269	3,086.926	$22,611
Output	Millions of Fixed 2010$	181.106	422.908	1,146.819	2,499.713	3,384.904	4,279.254	$31,865
Disposable Personal Income	Millions of Fixed 2010$	92.734	195.269	502.953	1,089.387	1,551.115	2,052.940	$14,388
PCE-Price Index	2005=100 (Nation)	0.000	0.003	0.010	0.025	0.039	0.052	N/A
Population	Number of People	251	1,134	4,912	12,206	19,281	25,947	N/A
Integration of All TLU/TSI - Baseline Plus Addition of Policy*								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	10,232,121	10,543,308	11,140,635	11,601,829	12,127,987	12,780,483	
Gross Domestic Product	Millions of Fixed 2010$	1,017,249	1,095,655	1,303,023	1,439,833	1,601,953	1,804,504	
Output	Millions of Fixed 2010$	1,735,958	1,864,798	2,200,325	2,436,940	2,708,408	3,027,897	
Disposable Personal Income	Millions of Fixed 2010$	730,065	783,413	928,639	1,052,860	1,197,064	1,382,287	
PCE-Price Index	2005=100 (Nation)	111.3	117.2	134.2	154.0	177.7	206.0	
Population	Number of	18,410,281	18,669,206	19,409,653	20,181,247	21,043,994	22,051,744	

	People							
Integration of All TLU/TSI - % Change*								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	0.01283%	0.03001%	0.06669%	0.13283%	0.16584%	0.19010%	
Gross Domestic Product	Millions of Fixed 2010$	0.01107%	0.02623%	0.05902%	0.11755%	0.14550%	0.16552%	
Output	Millions of Fixed 2010$	0.01109%	0.02294%	0.04992%	0.09879%	0.12080%	0.13682%	
Disposable Personal Income	Millions of Fixed 2010$	0.01330%	0.02453%	0.05149%	0.10025%	0.12660%	0.14583%	
PCE-Price Index	2005=100 (Nation)	0.00038%	0.00265%	0.00775%	0.01642%	0.02197%	0.02506%	
Population	Number of People	0.00147%	0.00609%	0.02386%	0.05685%	0.08660%	0.11176%	

* The "Differences from Baseline Level" represents the incremental impact of the policy or policies relative to the baseline. The "Baseline Plus Addition of Policy" represents the baseline plus the impact of the policy or policies. "% Change" is calculated as the ratio of the "Differences from Baseline Level" and "Baseline Plus Addition of Policy" times 100.
** The network and amenity benefits associated with the TLU/TSI options can yield an additional of 3,842 jobs per year.

2.7. Analysis of Macroeconomic Impacts by Major Category

The estimation of total economic impacts of public policy often focuses on three types of impacts. In addition to an integrated analysis of all TSI and TLU policies, the TSI and TLU policies were combined into three separate groups based on the policies' correlation to major areas of focus within the 2012 SCAG RTP/SCS.[8] These areas of focus include: a) public transportation & land use, b) active transportation, and c) transportation demand management. The remaining car-sharing and vehicle technology policies were combined into a fourth distinct group. This fourth group is not described as an area of focus in the RTP, but is used to collect those policies not truly appropriate for inclusion in one of the other three areas. The policies were allocated to groups as follows:

Public Transportation & Land Use
- TSI 3: Expand Transit Infrastructure (Rail, Bus, Bus Rapid Transit)
- TLU 1: Transit-Oriented and Mixed-Use Planning and Development
- TLU 2: Urban Growth Bundle
- TLU 3: Land Use, Building Code and Zoning Reform and Location-Efficient Funding Strategies
- TLU 4: Transit Funding
- TLU 7: Infill and Brownfield Redevelopment
- TLU 9: Mixed Income and Affordable Housing Funding

Transportation Demand Management
- TSI 7: Parking Pricing

[8] It is important to note that these TSI and TLU policies do not represent all of the economic impacts or GHG emissions impacts that might be expected as a result of all the initiatives envisioned by the RTP. These policies are largely, but not entirely, consistent with specific selected initiatives within the RTP, but represent only a small percentage of the overall investment and planning effort that document describes.

- TLU 6: Parking Strategies
- TSI 1: Employer Based Commute Option Programs
- TSI 4A: Ride Sharing Programs

Active Transportation

- TSI 5: Increase Bike/Walk Trips with Improved Complete Streets
- TSI 8: Promote Bike Share Opportunities and Programs
- TSI 9: Sustainable Road Design Standards
- TLU 8: Site Planning and Design Strategies to Promote Walking, Bicycling, Ridesharing and Transit Use
- TLU 10: First Mile/Last Mile Bike, Pedestrian and Circulator Connections

Car Sharing & Vehicle Technologies

- TSI 4B: Car Sharing Programs
- TSI 6: Encourage Old Vehicle Retirement and Expand Alternative Fuels Use/Zero Emissions Vehicles and Infrastructure and Promote Goods Movement
- TLU 5: Zoning Ordinances and Policies to Promote Alternative Vehicles and Accelerated Fleet Mix

For each group, an integrated macroeconomic impact analysis was performed modeling all of the policies in each group together. The following graphs (Figures 5, 6, and 7) show for each group the relative impacts on three major economic indicators: GDP, Personal Disposable Income, and Jobs. Tables 3 through 6 present the integrated macroeconomic impacts projected for each group of policies. The data in the tables represents the results for key years throughout the 2013-2035 period.

Two policies, TSI 2 and TSI 10, address congestion pricing and increased gas/VMT taxes respectively. These two policies were not analyzed as part of this effort because SCAG is carrying on a separate analytical effort to better understand the likely effects of congestion pricing and mileage-based user fees.

Figure 5. Changes to Employment (Jobs) by Policy Group, and Overall

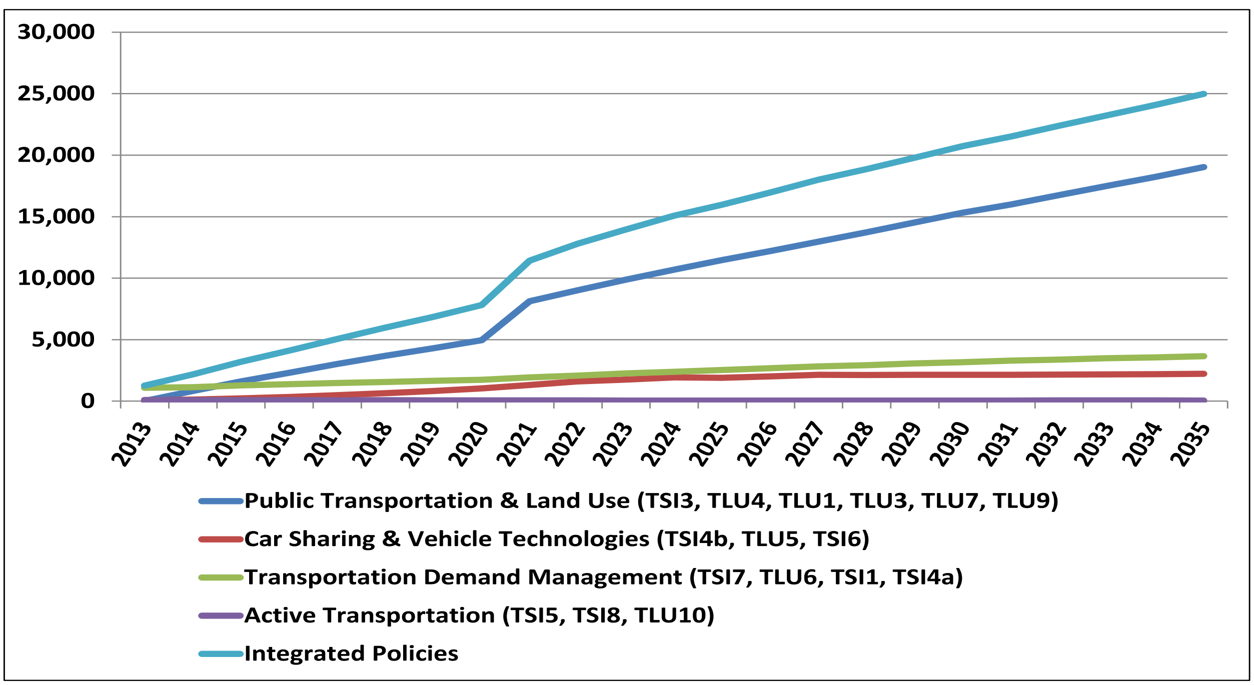


Figure 6. Changes to GDP (Millions of Fixed 2010$) by Policy Group, and Overall

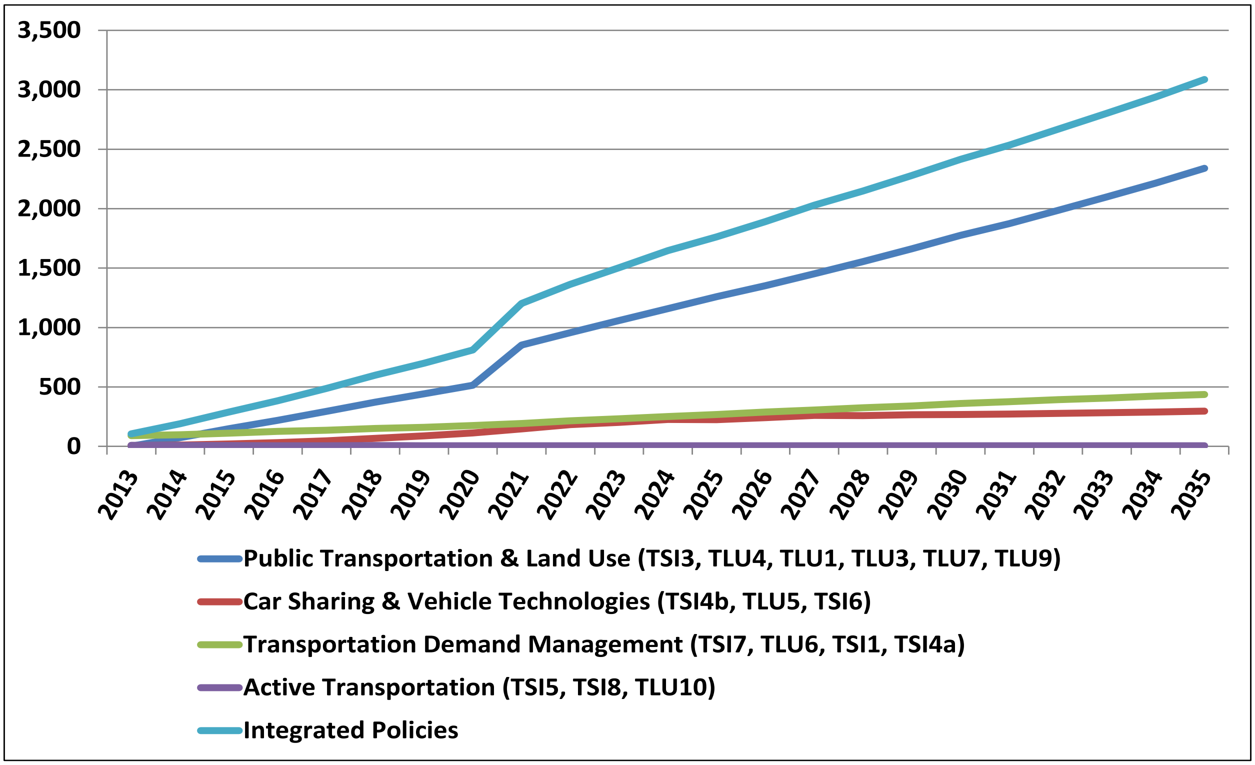


Figure 7. Changes to Personal Disposable Income (Millions of Fixed 2010$) by Policy Group, and Overall

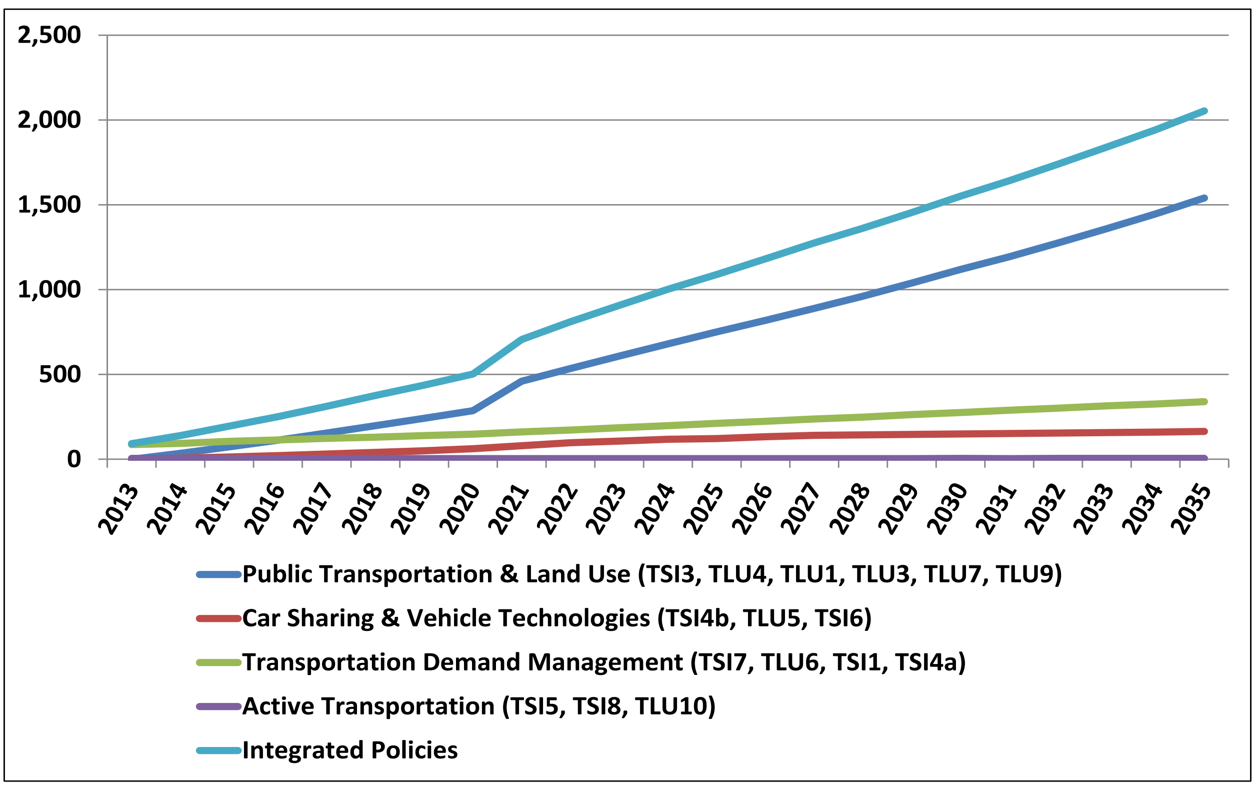


Table 3. Public Transportation & Land Use Group Macroeconomic Impact Analysis Results

Public Transportation / Land Use Group - Differences from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
Total Employment	Jobs	9.766	1,613.281	4,953.125	11,473.633	15,333.984	19,032.227	9,836
Gross Domestic Product	Millions of Fixed 2010$	0.609	148.304	513.210	1,258.590	1,775.456	2,339.838	$16,009
Output	Millions of Fixed 2010$	-0.406	203.470	707.204	1,753.390	2,460.323	3,225.468	$22,170
Disposable Personal Income	Millions of Fixed 2010$	0.352	73.422	286.720	750.479	1,118.608	1,540.132	$9,751
PCE-Price Index	2005=100 (Nation)	0.000	0.001	0.006	0.018	0.030	0.041	N/A
Population	Number of People	1.953	443.359	2,845.703	8,214.844	13,533.203	18,802.734	N/A
Public Transportation / Land Use Group - Baseline Plus Addition of Policy								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	10,230,873	10,541,725	11,137,774	11,597,326	12,122,582	12,774,527	
Gross Domestic Product	Millions of Fixed 2010$	1,017,143	1,095,515	1,302,726	1,439,330	1,601,314	1,803,757	
Output	Millions of Fixed 2010$	1,735,776	1,864,579	2,199,885	2,436,194	2,707,483	3,026,843	
Disposable Personal Income	Millions of Fixed 2010$	729,973	783,291	928,423	1,052,521	1,196,631	1,381,774	
PCE-Price Index	2005=100 (Nation)	111.3	117.2	134.2	154.0	177.7	206.0	
Population	Number of People	18,410,031	18,668,516	19,407,586	20,177,256	21,038,246	22,044,600	
Public Transportation / Land Use Group - % Change								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	0.00010%	0.01531%	0.04449%	0.09903%	0.12665%	0.14921%	
Gross Domestic Product	Millions of Fixed 2010$	0.00006%	0.01354%	0.03941%	0.08752%	0.11100%	0.12989%	
Output	Millions of Fixed 2010$	-0.00002%	0.01091%	0.03216%	0.07202%	0.09095%	0.10668%	
Disposable Personal Income	Millions of Fixed 2010$	0.00005%	0.00937%	0.03089%	0.07135%	0.09357%	0.11158%	
PCE-Price Index	2005=100 (Nation)	0.00001%	0.00087%	0.00480%	0.01174%	0.01661%	0.01980%	
Population	Number of People	0.00001%	0.00237%	0.01466%	0.04073%	0.06437%	0.08537%	

Table 4. Transportation Demand Management Group Macroeconomic Impact Analysis Results

Transportation Demand Management Bundle - Differences from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
Total Employment	Jobs	1,077.148	1,280.273	1,754.883	2,539.063	3,188.477	3,654.297	2,378
Gross Domestic Product	Millions of Fixed 2010$	91.650	113.919	176.530	273.053	362.401	441.055	$3,884
Output	Millions of Fixed 2010$	155.276	180.998	258.027	387.717	503.869	599.445	$5,572
Disposable Personal Income	Millions of Fixed 2010$	86.533	105.074	148.733	211.553	276.685	340.386	$3,114
PCE-Price Index	2005=100 (Nation)	0.000	0.002	0.003	0.005	0.007	0.009	N/A
Population	Number of People	224.609	576.172	1,343.750	2,187.500	3,072.266	3,871.094	N/A
Transportation Demand Management Bundle - Baseline Plus Addition of Policy								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	10,231,940	10,541,392	11,134,576	11,588,392	12,110,437	12,759,149	
Gross Domestic Product	Millions of Fixed 2010$	1,017,234	1,095,481	1,302,390	1,438,344	1,599,901	1,801,859	
Output	Millions of Fixed 2010$	1,735,932	1,864,556	2,199,435	2,434,828	2,705,527	3,024,217	
Disposable Personal Income	Millions of Fixed 2010$	730,059	783,323	928,285	1,051,982	1,195,789	1,380,574	
PCE-Price Index	2005=100 (Nation)	111.3	117.2	134.2	154.0	177.6	206.0	
Population	Number of People	18,410,254	18,668,648	19,406,084	20,171,229	21,027,785	22,029,668	
Transportation Demand Management Bundle - % Change								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	0.01053%	0.01215%	0.01576%	0.02192%	0.02634%	0.02865%	
Gross Domestic Product	Millions of Fixed 2010$	0.00901%	0.01040%	0.01356%	0.01899%	0.02266%	0.02448%	
Output	Millions of Fixed 2010$	0.00895%	0.00971%	0.01173%	0.01593%	0.01863%	0.01983%	
Disposable Personal Income	Millions of Fixed 2010$	0.01185%	0.01342%	0.01602%	0.02011%	0.02314%	0.02466%	
PCE-Price Index	2005=100 (Nation)	0.00027%	0.00144%	0.00249%	0.00325%	0.00396%	0.00428%	
Population	Number of People	0.00122%	0.00309%	0.00692%	0.01085%	0.01461%	0.01758%	

Table 5. Active Transportation Group Macroeconomic Impact Analysis Results

Active Transportation Bundle - Differences from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
Total Employment	Jobs	99.609	78.125	57.617	50.781	49.805	52.734	60
Gross Domestic Product	Millions of Fixed 2010$	8.190	6.836	5.144	5.009	4.874	5.821	$94
Output	Millions of Fixed 2010$	14.079	11.642	8.529	8.123	8.123	9.206	$156
Disposable Personal Income	Millions of Fixed 2010$	4.696	4.498	4.118	3.733	4.528	5.052	$72
PCE-Price Index	2005=100 (Nation)	0.000	0.000	0.000	0.000	0.001	0.001	N/A
Population	Number of People	21.484	46.875	68.359	78.125	78.125	64.453	N/A

Active Transportation Bundle - Baseline Plus Addition of Policy								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	10,230,963	10,540,189	11,132,879	11,585,903	12,107,298	12,755,548	
Gross Domestic Product	Millions of Fixed 2010$	1,017,151	1,095,374	1,302,218	1,438,076	1,599,543	1,801,423	
Output	Millions of Fixed 2010$	1,735,790	1,864,387	2,199,186	2,434,448	2,705,031	3,023,627	
Disposable Personal Income	Millions of Fixed 2010$	729,978	783,222	928,140	1,051,774	1,195,517	1,380,239	
PCE-Price Index	2005=100 (Nation)	111.3	117.2	134.2	154.0	177.6	206.0	
Population	Number of People	18,410,051	18,668,119	19,404,809	20,169,119	21,024,791	22,025,861	

Active Transportation Bundle - % Change								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	0.00097%	0.00074%	0.00052%	0.00044%	0.00041%	0.00041%	
Gross Domestic Product	Millions of Fixed 2010$	0.00081%	0.00062%	0.00040%	0.00035%	0.00030%	0.00032%	
Output	Millions of Fixed 2010$	0.00081%	0.00062%	0.00039%	0.00033%	0.00030%	0.00030%	
Disposable Personal Income	Millions of Fixed 2010$	0.00064%	0.00057%	0.00044%	0.00035%	0.00038%	0.00037%	
PCE-Price Index	2005=100 (Nation)	0.00002%	0.00005%	0.00030%	0.00024%	0.00031%	0.00024%	
Population	Number of People	0.00012%	0.00025%	0.00035%	0.00039%	0.00037%	0.00029%	

Table 6. Car-Sharing & Vehicle Technologies Group Macroeconomic Impact Analysis Results

Car Sharing & Vehicle Technologies Bundle - Differences from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
Total Employment	Jobs	73.230	223.630	1,040.008	1,892.628	2,139.680	2,215.773	1,465
Gross Domestic Product	Millions of Fixed 2010$	6.336	20.111	113.978	224.703	268.560	295.879	$2,598
Output	Millions of Fixed 2010$	12.022	27.746	170.758	347.506	407.715	438.908	$3,928
Disposable Personal Income	Millions of Fixed 2010$	1.094	12.894	62.580	121.667	149.342	164.503	$1,433
PCE-Price Index	2005=100 (Nation)	0.000	0.000	0.001	0.002	0.004	0.004	N/A
Population	Number of People	5.891	78.078	621.138	1,671.828	2,529.313	3,078.122	N/A
Car Sharing & Vehicle Technologies Bundle - Baseline Plus Addition of Policy								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	10,230,936	10,540,335	11,133,861	11,587,745	12,109,388	12,757,711	
Gross Domestic Product	Millions of Fixed 2010$	1,017,149	1,095,387	1,302,327	1,438,296	1,599,807	1,801,713	
Output	Millions of Fixed 2010$	1,735,789	1,864,403	2,199,348	2,434,788	2,705,430	3,024,057	
Disposable Personal Income	Millions of Fixed 2010$	729,974	783,230	928,199	1,051,892	1,195,662	1,380,398	
PCE-Price Index	2005=100 (Nation)	111.3	117.2	134.2	154.0	177.6	206.0	
Population	Number of People	18,410,035	18,668,150	19,405,362	20,170,713	21,027,242	22,028,875	
Car Sharing & Vehicle Technologies Bundle - % Change								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	0.00125%	0.00181%	0.00583%	0.01126%	0.01221%	0.01157%	
Gross Domestic Product	Millions of Fixed 2010$	0.00124%	0.00176%	0.00553%	0.01068%	0.01135%	0.01058%	
Output	Millions of Fixed 2010$	0.00135%	0.00175%	0.00554%	0.01039%	0.01074%	0.00981%	
Disposable Personal Income	Millions of Fixed 2010$	0.00075%	0.00124%	0.00404%	0.00824%	0.00935%	0.00901%	
PCE-Price Index	2005=100 (Nation)	0.00001%	0.00009%	0.00069%	0.00154%	0.00211%	0.00202%	
Population	Number of People	0.00014%	0.00043%	0.00175%	0.00462%	0.00693%	0.00793%	

2.8. Macroeconomic Impacts of Individual Policies

2.8.1. Introduction

This subsection of the macroeconomic analysis report presents the individual results from the analysis of each policy's effect on the SCAG region's economy. For each policy, this subsection provides an introduction and brief discussion of the types of costs and savings. The discussion for each policy is followed by a table summarizing the macroeconomic results for each policy.

As with the microeconomic analysis effort, some policies were analyzed jointly with others at this step. Because the microeconomic analysis provides the estimates for direct costs and savings associated with each policy, from which macroeconomic analyses can then be done, the level of detail for the macroeconomic analysis is constrained by the detail provided in the microeconomic efforts. The macroeconomic modeling effort was completed for all policies for which microeconomic results were available.

This subsection begins with summary graphs showing the general scale of impacts. After the summary results, this part presents discussions of each policy followed by results tables describing the impacts on major economic indicators at five-year intervals across the 2013-2035 period.

2.8.2. Summary of Results

Figures 8, 9, and 10 show the potential net impacts of each policy on employment, GDP, and income, respectively. In most cases, the impacts are positive, with only TSI 7 (which applies parking pricing to control travel demand) producing a set of small, but negative, impacts on the economy. In this case, the higher parking-meter fees overwhelmed the projected fuel- and vehicle-cost savings expected from the policy.

The policies covering Transit-Oriented Development and Mixed-Use Planning (specifically TLU 1, TLU 3, TLU 7 and TLU 9) produced the largest positive economic impacts, generating over two thirds of the total job growth, GDP growth and improvement in other major indicators. This policy group includes a far-reaching collection of policies causing significant reductions in VMT associated with commuting and other trips (reaching 4% of total light-duty VMT by 2035).

Figure 8. Changes to Employment (Jobs) by Policy

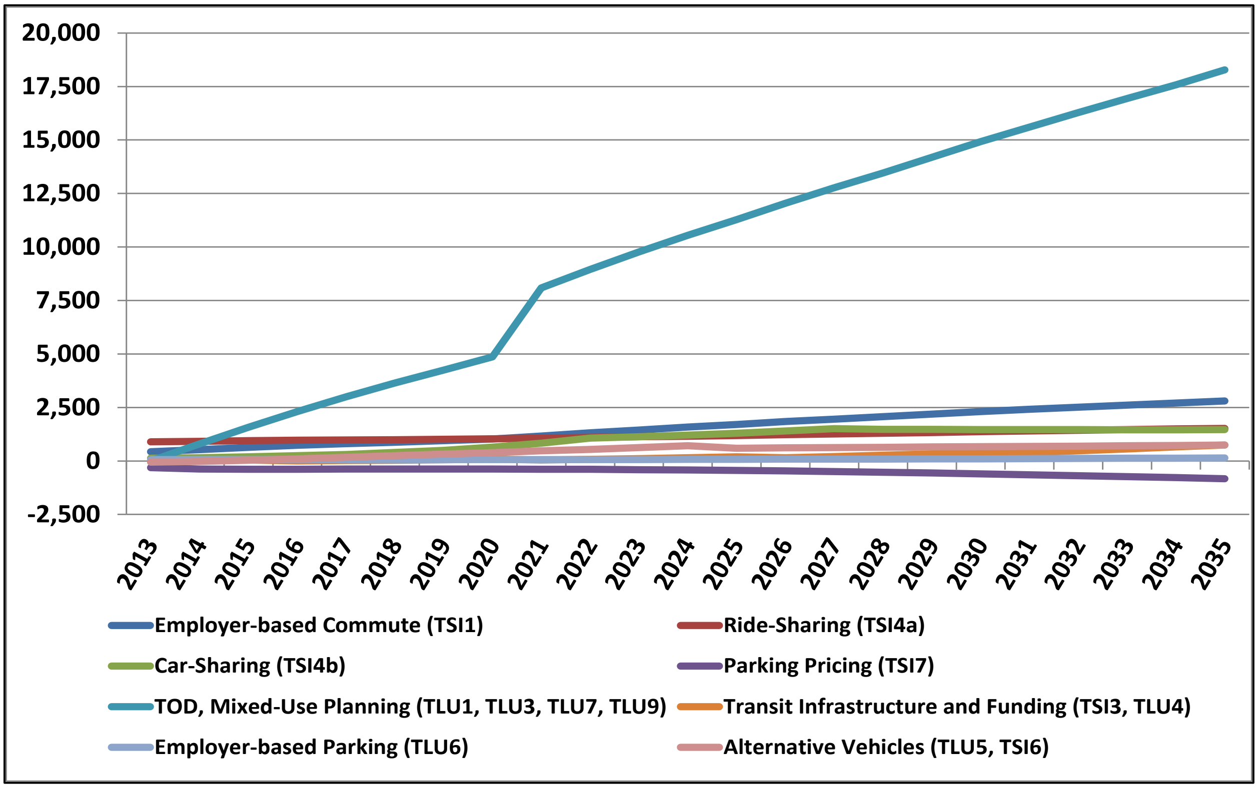


Figure 9. Changes to GDP (Millions of Fixed 2010$) by Policy

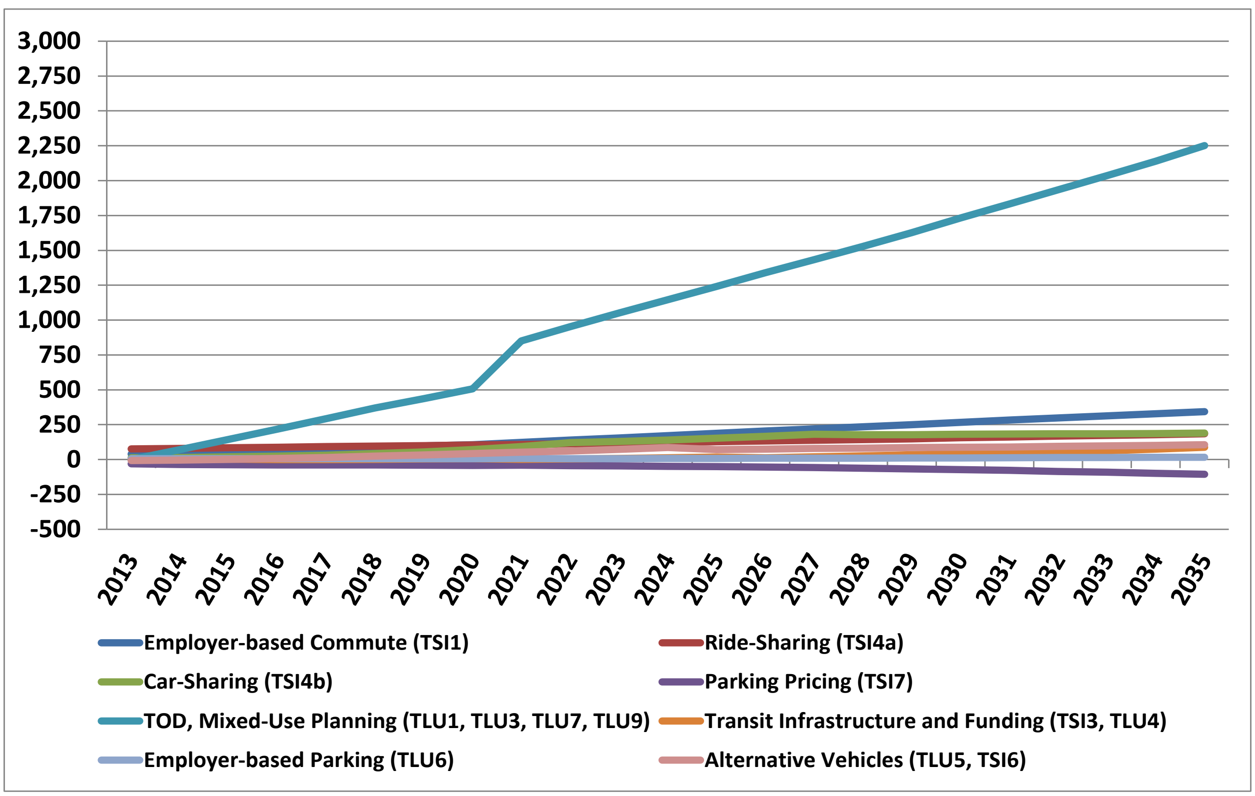
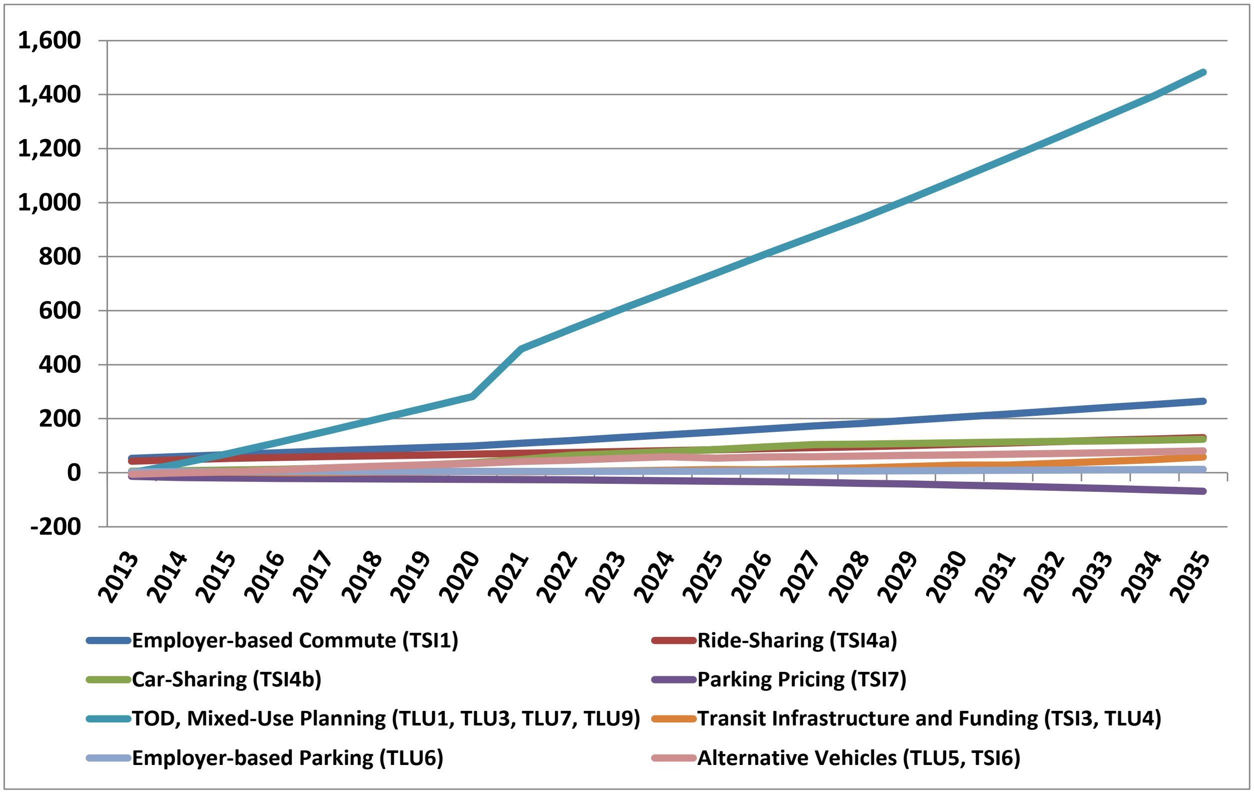


Figure 10. Changes to Personal Disposable Income (Millions of Fixed 2010$) by Policy



TSI 1: Employer-based Commute Option Programs (Telecommuting & Alternative Work Schedules)

As stated in the RTP, SCAG will reduce peak-hour congestion in the region by promoting telecommuting and flexible work schedules. The region will increase telecommuting from 2.6% to 5% in 2020 and to 10% in 2035, and increase flexible work schedule employees from 2% to 3% in 2020 and to 5% in 2035.

The policy achieves positive economic change in the SCAG region by reducing the amount of fuel that commuters are compelled to use in order to make their commutes to work. This savings is achieved in two ways: (1) through a reduction in trips as over 2% of the region's workforce shifts to telecommuting, and (2) through a reduction in idling and low-efficiency driving as workers take advantage of flexible schedules to avoid the most congested travel periods.

The policy also produces savings to commuters in the form of reduced wear and tear on vehicles. Even without accounting for fuel costs, the obligations of car ownership (including routine maintenance, repairs, insurance and mileage-based depreciation) are estimated to cost, on average, $0.27 for each mile driven. The significance of these savings to the wider economy comes from the increased freedom of affected commuters to spend the saved money throughout the economy.

The policy does require costs, however. The microeconomic analysis assumed program implementation costs of approximately $10,000 per year which would be borne by over ten thousand businesses and other local employers. This expenditure represents a mix of administrative costs and incentives to commuters to adopt alternatives to typical rush-hour commuting. However, the savings achieved from fuel and vehicle cost reductions overwhelms the cost to implement the program. In total, the analysis projects that this policy will produce 2,800 new jobs by 2035 and a total of over 36,600 worker-years of additional employment between now and 2035. This commuting shift policy is also projected to generate nearly $2.6 billion in additional GDP for the region.

Table 7. TSI 1 Macroeconomic Impact Analysis Results

TSI1 - Differences from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
Total Employment	Jobs	429.688	636.719	1,026.367	1,708.008	2,305.664	2,800.781	1,593
Gross Domestic Product	Millions of Fixed 2010$	39.191	59.430	106.270	187.631	266.826	343.855	$2,633
Output	Millions of Fixed 2010$	63.491	91.650	155.276	268.315	378.240	481.938	$3,787
Disposable Personal Income	Millions of Fixed 2010$	53.305	67.294	99.222	150.576	206.187	264.335	$2,216
PCE-Price Index	2005=100 (Nation)	0.000	0.001	0.002	0.003	0.005	0.007	N/A
Population	Number of People	80.078	238.281	679.688	1,267.578	1,964.844	2,679.688	N/A
TSI1 - Baseline Plus Addition of Policy								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	10,231,293	10,540,748	11,133,848	11,587,561	12,109,554	12,758,296	
Gross Domestic Product	Millions of Fixed 2010$	1,017,182	1,095,426	1,302,319	1,438,259	1,599,805	1,801,762	
Output	Millions of Fixed 2010$	1,735,840	1,864,467	2,199,333	2,434,709	2,705,401	3,024,100	
Disposable Personal Income	Millions of Fixed 2010$	730,026	783,285	928,236	1,051,921	1,195,718	1,380,498	
PCE-Price Index	2005=100 (Nation)	111.3	117.2	134.2	154.0	177.6	206.0	
Population	Number of People	18,410,109	18,668,311	19,405,420	20,170,309	21,026,678	22,028,477	
TSI1 - % Change								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	0.00420%	0.00604%	0.00922%	0.01474%	0.01904%	0.02196%	
Gross Domestic Product	Millions of Fixed 2010$	0.00385%	0.00543%	0.00816%	0.01305%	0.01668%	0.01909%	
Output	Millions of Fixed 2010$	0.00366%	0.00492%	0.00706%	0.01102%	0.01398%	0.01594%	
Disposable Personal Income	Millions of Fixed 2010$	0.00730%	0.00859%	0.01069%	0.01432%	0.01725%	0.01915%	
PCE-Price Index	2005=100 (Nation)	0.00008%	0.00065%	0.00147%	0.00219%	0.00304%	0.00341%	
Population	Number of People	0.00043%	0.00128%	0.00350%	0.00628%	0.00935%	0.01217%	

TSI 3 and TLU 4: Expanding Transit Infrastructure and Transit Funding

The energy and GHG emission impacts of expanding transit infrastructure (TSI-3) and transit funding (TLU-4) were estimated based on goals stated in SCAG's 2012 RTP. According to the RTP, SCAG will observe a 73% increase in rail ridership (defined as "per capita transit trips") and 30% increase in bus ridership (also defined as "per capita transit trips") between 2008 and 2035.

As with other policies, transit ridership produces economic benefits through reductions in spending on fuel and vehicle costs associated with commuting. These savings represent total $1.9 billion. Much of this savings is offset, however, by increased spending on transit ridership of approximately $1.2 billion. These offsetting costs and savings result in a net $700 million in savings, which is redirected to the rest of the economy in the form of other consumer spending.

There is also additional government spending (approximately $50 million on system expansion and $66 million on additional operations). Following the general assumptions outlined above, the majority of this money is assumed to be either contained within the existing RTP funding or to come from state and federal sources. This spending produces additional economic activity in the region.

In total, the analysis projects that this policy will produce 750 new jobs by 2035 and a total of over 5,000 worker-years of additional employment between now and 2035. This transit expansion is also projected to generate nearly $300 million in additional GDP for the region.

Table 8. TSI 3 and TLU 4 Macroeconomic Impact Analysis Results

Category	Units	2013	2015	2020	2025	2030	2035	Jobs per Year / NPV
TSI3 & TLU 4 - Differences from Baseline Level								
Total Employment	Jobs	9.766	42.969	87.891	194.336	408.203	750.000	220
Gross Domestic Product	Millions of Fixed 2010$	0.609	3.249	6.904	18.276	42.779	87.994	$296
Output	Millions of Fixed 2010$	-0.406	1.218	0.542	12.455	44.945	109.113	$248
Disposable Personal Income	Millions of Fixed 2010$	0.352	1.911	4.620	12.089	28.418	58.028	$208
PCE-Price Index	2005=100 (Nation)	0.000	0.000	0.000	0.000	0.001	0.002	N/A
Population	Number of People	1.953	13.672	50.781	140.625	281.250	542.969	N/A
TSI3 & TLU 4 - Baseline Plus Addition of Policy								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	10,230,873	10,540,154	11,132,909	11,586,047	12,107,656	12,756,245	
Gross Domestic Product	Millions of Fixed 2010$	1,017,143	1,095,370	1,302,220	1,438,089	1,599,581	1,801,506	
Output	Millions of Fixed 2010$	1,735,776	1,864,376	2,199,178	2,434,453	2,705,068	3,023,727	
Disposable Personal Income	Millions of Fixed 2010$	729,973	783,220	928,141	1,051,782	1,195,541	1,380,292	
PCE-Price Index	2005=100 (Nation)	111.3	117.2	134.2	154.0	177.6	206.0	
Population	Number of People	18,410,031	18,668,086	19,404,791	20,169,182	21,024,994	22,026,340	
TSI3 & TLU 4 - % Change								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	0.00010%	0.00041%	0.00079%	0.00168%	0.00337%	0.00588%	
Gross Domestic Product	Millions of Fixed 2010$	0.00006%	0.00030%	0.00053%	0.00127%	0.00267%	0.00488%	
Output	Millions of Fixed 2010$	-0.00002%	0.00007%	0.00002%	0.00051%	0.00166%	0.00361%	
Disposable Personal Income	Millions of Fixed 2010$	0.00005%	0.00024%	0.00050%	0.00115%	0.00238%	0.00420%	
PCE-Price Index	2005=100 (Nation)	0.00001%	0.00002%	0.00013%	0.00021%	0.00062%	0.00087%	
Population	Number of People	0.00001%	0.00007%	0.00026%	0.00070%	0.00134%	0.00247%	

TSI 4A: Implementing Ride-Sharing Programs

According to SCAG's 2012 RTP, the region's carpooling rate for commute trips has dropped to under 12% from 15% in 2000, while the national average carpooling rate dropped from 20% in 1980 to 10% in 2010. By encouraging ride-sharing (including carpooling and vanpooling), the SCAG region will increase the average vehicle occupancy (AVO) rate for commute trips from 1.085 to 1.091 in 2035. In total, the analysis projects that this policy will produce over 1,500 new jobs by 2035 and a total of over 27,000 worker-years of additional employment between now and 2035. This ride-sharing policy is also projected to generate nearly $2.0 billion in additional GDP for the region.

Table 9. TSI 4A Macroeconomic Impact Analysis Results

TSI4A - Differences from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
Total Employment	Jobs	896.484	954.102	1,040.039	1,189.453	1,365.234	1,524.414	1,183
Gross Domestic Product	Millions of Fixed 2010$	75.946	85.016	104.510	127.930	155.818	184.788	$1,967
Output	Millions of Fixed 2010$	132.804	141.739	160.691	190.068	226.890	265.066	$2,996
Disposable Personal Income	Millions of Fixed 2010$	42.973	52.846	68.793	84.977	105.709	129.983	$1,304
PCE-Price Index	2005=100 (Nation)	0.000	0.001	0.002	0.003	0.004	0.004	N/A
Population	Number of People	191.406	480.469	966.797	1,294.922	1,574.219	1,800.781	N/A
TSI4A - Baseline Plus Addition of Policy								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	10,231,760	10,541,065	11,133,861	11,587,042	12,108,613	12,757,020	
Gross Domestic Product	Millions of Fixed 2010$	1,017,218	1,095,452	1,302,318	1,438,199	1,599,694	1,801,602	
Output	Millions of Fixed 2010$	1,735,909	1,864,517	2,199,338	2,434,630	2,705,250	3,023,883	
Disposable Personal Income	Millions of Fixed 2010$	730,016	783,270	928,205	1,051,855	1,195,618	1,380,364	
PCE-Price Index	2005=100 (Nation)	111.3	117.2	134.2	154.0	177.6	206.0	
Population	Number of People	18,410,221	18,668,553	19,405,707	20,170,336	21,026,287	22,027,598	
TSI4A - % Change								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	0.00876%	0.00905%	0.00934%	0.01027%	0.01128%	0.01195%	
Gross Domestic Product	Millions of Fixed 2010$	0.00747%	0.00776%	0.00803%	0.00890%	0.00974%	0.01026%	
Output	Millions of Fixed 2010$	0.00765%	0.00760%	0.00731%	0.00781%	0.00839%	0.00877%	
Disposable Personal Income	Millions of Fixed 2010$	0.00589%	0.00675%	0.00741%	0.00808%	0.00884%	0.00942%	
PCE-Price Index	2005=100 (Nation)	0.00022%	0.00096%	0.00148%	0.00172%	0.00206%	0.00216%	
Population	Number of People	0.00104%	0.00257%	0.00498%	0.00642%	0.00749%	0.00818%	

TSI 4B: Car-Sharing Programs

As the car-sharing market expands to embrace private companies, not-for-profits, established car-rental companies and peer-to-peer car-sharing, we can expect growth in the number of shared cars and corresponding reductions in VMT and CO_2 emissions. This expectation is supported by current growth rates and projections from car-sharing firms like Zipcar Inc. The SCAG region will have 50,000 car-sharing members by 2020 and 150,000 car-sharing members in 2035. In total, the analysis projects that this policy will produce nearly 1,500 new jobs by 2035 and a total of nearly 23,000 worker-years of additional employment between now and 2035. This car-sharing policy is also projected to generate nearly $1.7 billion in additional GDP for the region.

Table 10. TSI 4B Macroeconomic Impact Analysis Results

TSI4b - Differences from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
Total Employment	Jobs	127.930	190.430	645.508	1,298.828	1,471.680	1,467.773	991
Gross Domestic Product	Millions of Fixed 2010$	12.658	19.223	71.614	152.839	180.727	189.526	$1,738
Output	Millions of Fixed 2010$	23.555	32.626	121.297	251.799	289.163	294.849	$2,840
Disposable Personal Income	Millions of Fixed 2010$	5.518	9.670	37.158	86.132	111.096	123.566	$1,011
PCE-Price Index	2005=100 (Nation)	0.000	0.000	0.001	0.002	0.004	0.004	N/A
Population	Number of People	25.391	80.078	335.938	923.828	1,445.313	1,732.422	N/A
TSI4b - Baseline Plus Addition of Policy								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	10,230,991	10,540,302	11,133,467	11,587,151	12,108,720	12,756,963	
Gross Domestic Product	Millions of Fixed 2010$	1,017,155	1,095,386	1,302,285	1,438,224	1,599,719	1,801,607	
Output	Millions of Fixed 2010$	1,735,800	1,864,408	2,199,299	2,434,692	2,705,312	3,023,912	
Disposable Personal Income	Millions of Fixed 2010$	729,978	783,227	928,173	1,051,856	1,195,623	1,380,357	
PCE-Price Index	2005=100 (Nation)	111.3	117.2	134.2	154.0	177.6	206.0	
Population	Number of People	18,410,055	18,668,152	19,405,076	20,169,965	21,026,158	22,027,529	
TSI4b - % Change								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	0.00125%	0.00181%	0.00580%	0.01121%	0.01216%	0.01151%	
Gross Domestic Product	Millions of Fixed 2010$	0.00124%	0.00175%	0.00550%	0.01063%	0.01130%	0.01052%	
Output	Millions of Fixed 2010$	0.00136%	0.00175%	0.00552%	0.01034%	0.01069%	0.00975%	
Disposable Personal Income	Millions of Fixed 2010$	0.00076%	0.00123%	0.00400%	0.00819%	0.00929%	0.00895%	
PCE-Price Index	2005=100 (Nation)	0.00001%	0.00009%	0.00069%	0.00154%	0.00211%	0.00202%	
Population	Number of People	0.00014%	0.00043%	0.00173%	0.00458%	0.00687%	0.00787%	

TSI 5, 8 & 9 and TLU 8 & 10: Increased Walking and Bicycle Trips, Improved Complete Streets, First Mile/Last Mile Connections, and Bicycle Sharing

According to SCAG's 2012 RTP, the region will extend existing bikeway network by 5,807 miles to promote bicycle ridership. This extension includes 1,236 miles in LA County and 4,571 miles in all other SCAG Counties. As stated in the POD, these additional bicycle facilities will increase the mode share of bicycle commuting in LA County from 0.63% to 1.50% in 2020 and to 2.20% in 2035, and increase the mode share of bicycle commuting in the rest of the SCAG region from 0.63% to 1.00% in 2020 and to 1.50% in 2035.

The RTP/SCS extends the reach of transit by focusing on "first mile/last mile" solutions. One of the biggest challenges in attracting new riders to transit is providing a reasonable and practical means of accessing transit at the origin and destination. "First mile/last mile" strategies are TDM strategies that offer reasonable and practical solutions to this problem, resulting in higher ridership for our transit services. Specific first mile/last mile strategies include development of mobility hubs around major transit stations to provide easier access to destinations. Other strategies include integrating bicycling and transit through folding bikes on buses programs, triple racks on buses, and dedicated racks on light and heavy rail vehicles.

The bike share program will involve 1,850 bicycles in the start year, including 1,000 bicycles in LA County and 850 bicycles in all the other Counties. Growth rates for the number of bicycles in the entire program are 1% over the first 10 years, 3% over the next five years, and 5% over the rest of the years.

These policies were bundled together into a single analysis because their areas of focus were very similar and because their individual impacts were quite limited in scope and overall scale of impacts. The entire bundle is estimated to reduce gasoline consumption by only approximately 100,000 gallons per year across a region which consumes approximately one million gallons per day. Individual analyses of small changes in the number of commuting or single-occupancy vehicle trips would produce insignificant results. They would also potentially challenge the precision of the TranSight model, which is structured to measure large impacts in especially nuanced ways but not necessarily to measure tiny impacts with high accuracy.

In total, the analysis projects that this bundle of policies, because of its small size, will produce only around 50 new jobs by 2035 and a total of nearly 1,300 worker-years of additional employment between now and 2035. This collection of active-transportation policies is also projected to generate nearly $94 million in additional GDP for the region.

Table 11. TSI 5/8/9 and TLU 8/10 Macroeconomic Impact Analysis Results

Active Transportation Bundle - Differences from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
Total Employment	Jobs	99.609	78.125	57.617	50.781	49.805	52.734	60
Gross Domestic Product	Millions of Fixed 2010$	8.190	6.836	5.144	5.009	4.874	5.821	$94
Output	Millions of Fixed 2010$	14.079	11.642	8.529	8.123	8.123	9.206	$156
Disposable Personal Income	Millions of Fixed 2010$	4.696	4.498	4.118	3.733	4.528	5.052	$72
PCE-Price Index	2005=100 (Nation)	0.000	0.000	0.000	0.000	0.001	0.001	N/A
Population	Number of People	21.484	46.875	68.359	78.125	78.125	64.453	N/A
Active Transportation Bundle - Baseline Plus Addition of Policy								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	10,230,963	10,540,189	11,132,879	11,585,903	12,107,298	12,755,548	
Gross Domestic Product	Millions of Fixed 2010$	1,017,151	1,095,374	1,302,218	1,438,076	1,599,543	1,801,423	
Output	Millions of Fixed 2010$	1,735,790	1,864,387	2,199,186	2,434,448	2,705,031	3,023,627	
Disposable Personal Income	Millions of Fixed 2010$	729,978	783,222	928,140	1,051,774	1,195,517	1,380,239	
PCE-Price Index	2005=100 (Nation)	111.3	117.2	134.2	154.0	177.6	206.0	
Population	Number of People	18,410,051	18,668,119	19,404,809	20,169,119	21,024,791	22,025,861	
Active Transportation Bundle - % Change								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	0.00097%	0.00074%	0.00052%	0.00044%	0.00041%	0.00041%	
Gross Domestic Product	Millions of Fixed 2010$	0.00081%	0.00062%	0.00040%	0.00035%	0.00030%	0.00032%	
Output	Millions of Fixed 2010$	0.00081%	0.00062%	0.00039%	0.00033%	0.00030%	0.00030%	
Disposable Personal Income	Millions of Fixed 2010$	0.00064%	0.00057%	0.00044%	0.00035%	0.00038%	0.00037%	
PCE-Price Index	2005=100 (Nation)	0.00002%	0.00005%	0.00030%	0.00024%	0.00031%	0.00024%	
Population	Number of People	0.00012%	0.00025%	0.00035%	0.00039%	0.00037%	0.00029%	

TSI 7: Parking Pricing

The energy and GHG impacts of parking pricing and parking management were estimated based on the expected reductions in trips as a result of changes in incentives currently encountered by travelers who would normally take SOV trips. These travelers encounter incentives through higher prices to park, particularly at times of peak demand, that change the choice to utilize SOV travel. According to existing literature, parking pricing may reduce VMT by 0.83% to 1.9% in affected areas.

In total, the analysis projects that this parking-pricing policy will produce economic losses, which is distinct from the results achieved from all other policies. The major reason for this is the utilization of a parking-meter price increase to create an incentive for change. The microeconomic analysis projected that this additional meter revenue would charge drivers much more in additional fees to park than they would end up saving in fuel and vehicle costs from reduced trips.

Because the fees charged are so much larger than the savings attained, the analysis projects that the policy would actually reduce jobs by around 830 in the year 2035 and would reduce demand for employees by a total of approximately 11,300 worker-years between now and 2035. This parking-pricing policy is also projected to reduce GDP in the region by approximately nearly $870 million.

Table 12. TSI 7 Macroeconomic Impact Analysis Results

TSI7 - Differences from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
Total Employment	Jobs	-316.406	-381.836	-375.977	-446.289	-604.492	-829.102	493
Gross Domestic Product	Millions of Fixed 2010$	-29.850	-37.093	-41.425	-50.631	-72.832	-106.406	-$868
Output	Millions of Fixed 2010$	-49.141	-61.190	-67.146	-83.121	-119.131	-171.386	-$1,419
Disposable Personal Income	Millions of Fixed 2010$	-13.444	-19.508	-24.404	-31.466	-45.672	-68.268	-$522.115
PCE-Price Index	2005=100 (Nation)	0.000	0.000	0.000	0.000	0.000	-0.001	N/A
Population	Number of People	-60.547	-171.875	-361.328	-513.672	-687.500	-900.391	N/A
TSI7 - Baseline Plus Addition of Policy								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	10,230,547	10,539,729	11,132,445	11,585,406	12,106,644	12,754,666	
Gross Domestic Product	Millions of Fixed 2010$	1,017,113	1,095,330	1,302,172	1,438,020	1,599,465	1,801,311	
Output	Millions of Fixed 2010$	1,735,727	1,864,314	2,199,110	2,434,357	2,704,904	3,023,446	
Disposable Personal Income	Millions of Fixed 2010$	729,959	783,198	928,112	1,051,739	1,195,467	1,380,166	
PCE-Price Index	2005=100 (Nation)	111.3	117.2	134.2	154.0	177.6	206.0	
Population	Number of People	18,409,969	18,667,900	19,404,379	20,168,527	21,024,025	22,024,896	
TSI7 - % Change								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	-0.00309%	-0.00362%	-0.00338%	-0.00385%	-0.00499%	-0.00650%	
Gross Domestic Product	Millions of Fixed 2010$	-0.00293%	-0.00339%	-0.00318%	-0.00352%	-0.00455%	-0.00591%	
Output	Millions of Fixed 2010$	-0.00283%	-0.00328%	-0.00305%	-0.00341%	-0.00440%	-0.00567%	
Disposable Personal Income	Millions of Fixed 2010$	-0.00184%	-0.00249%	-0.00263%	-0.00299%	-0.00382%	-0.00495%	
PCE-Price Index	2005=100 (Nation)	-0.00009%	-0.00029%	-0.00015%	-0.00022%	-0.00015%	-0.00051%	
Population	Number of People	-0.00033%	-0.00092%	-0.00186%	-0.00255%	-0.00327%	-0.00409%	

TLU 1, 3, 7 and 9: Transit-Oriented Development, Mixed-Use Planning, Infill & Brownfield Redevelopment

Transit-oriented development (TOD) is the creation of compact, mixed-use commercial or residential communities, designed to maximize access to public transit and create a community attractive to pedestrians and bicyclists. Economic incentives, reformed zoning, land-use restrictions, and permit streamlining encourages dense mixed-use development of properties in proximity to transit stations or facilities.

The creation of mixed-use, TOD communities requires a combined increase in housing units and jobs. SCAG's goal in encouraging the growth of these communities is to focus a large proportion of new housing units in Transit Priority Project areas, within a ½ mile of high quality transit. By 2020, 35% of new housing will be within a 1/2 mile catchment of high-quality transit and 34% of development will be refill in urban and compact settings. By 2035, 52% of new housing will have access to high quality transit while maintaining the portion of new affordable housing and refill development form 2020.

These policies are very large in their scope and effect. Together, they seek to gradually reduce the entire region's VMT over time, reaching nearly 4% below the baseline projection of travel volume in the year 2035. This represents a reduction of over 1.2 million miles traveled (on the order of 100,000 vehicle trips) per day, and a reduction of over 7 billion miles traveled in 2035 alone. This produces projections of fuel and vehicle savings nearing $8 billion *per day* by 2035. These large savings distribute large amounts of money away from the auto and petroleum sectors to other forms of consumer spending. It is this reallocation of spending that produces positive results.

This analysis considered the second, more aggressive of two scenarios developed for microeconomic analysis. In total, the analysis projects that this bundle of policies, because of its large size, will produce over 18,000 new jobs by 2035 and a total of over 221,000 worker-years of additional employment between now and 2035. This collection of land-use policies is also projected to generate nearly $15.8 billion in additional GDP for the region.

Table 13. TLU 1/3/7/9 Macroeconomic Impact Analysis Results

BUNDLE OF TLU1, TLU3, TLU7, TLU9 - Differences from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
Total Employment	Jobs	0.000	1,572.266	4,866.211	11,277.344	14,918.945	18,278.320	9,615
Gross Domestic Product	Millions of Fixed 2010$	0.000	144.988	506.442	1,240.856	1,731.865	2,251.302	$15,709
Output	Millions of Fixed 2010$	0.000	201.981	706.663	1,740.664	2,414.295	3,116.084	$21,916
Disposable Personal Income	Millions of Fixed 2010$	0.000	71.455	282.000	738.301	1,090.034	1,482.514	$9,543
PCE-Price Index	2005=100 (Nation)	0.000	0.001	0.006	0.018	0.029	0.039	N/A
Population	Number of People	0.000	429.688	2,794.922	8,074.219	13,232.422	18,234.375	N/A
BUNDLE OF TLU1, TLU3, TLU7, TLU9 - Baseline Plus Addition of Policy								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	10,230,863	10,541,684	11,137,688	11,597,130	12,122,167	12,773,773	
Gross Domestic Product	Millions of Fixed 2010$	1,017,143	1,095,512	1,302,720	1,439,312	1,601,270	1,803,669	
Output	Millions of Fixed 2010$	1,735,776	1,864,577	2,199,884	2,436,181	2,707,437	3,026,734	
Disposable Personal Income	Millions of Fixed 2010$	729,973	783,289	928,418	1,052,509	1,196,602	1,381,716	
PCE-Price Index	2005=100 (Nation)	111.3	117.2	134.2	154.0	177.7	206.0	
Population	Number of People	18,410,029	18,668,502	19,407,535	20,177,115	21,037,945	22,044,031	
BUNDLE OF TLU1, TLU3, TLU7, TLU9 - % Change								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	0.00000%	0.01492%	0.04371%	0.09734%	0.12322%	0.14330%	
Gross Domestic Product	Millions of Fixed 2010$	0.00000%	0.01324%	0.03889%	0.08629%	0.10827%	0.12497%	
Output	Millions of Fixed 2010$	0.00000%	0.01083%	0.03213%	0.07150%	0.08925%	0.10306%	
Disposable Personal Income	Millions of Fixed 2010$	0.00000%	0.00912%	0.03038%	0.07020%	0.09118%	0.10741%	
PCE-Price Index	2005=100 (Nation)	0.00000%	0.00085%	0.00471%	0.01182%	0.01633%	0.01915%	
Population	Number of People	0.00000%	0.00230%	0.01440%	0.04003%	0.06294%	0.08279%	

TLU 6: Employee Parking Strategies

The energy and GHG impacts of parking pricing and parking management were estimated based on the expected reductions in trips as a result of changes in incentives currently encountered by travelers who would normally take SOV trips. These travelers encounter incentives, either through higher prices to park or through the opportunity to receive cash incentives to avoid utilizing provided parking, that change the choice to utilize SOV travel. High-Occupancy Vehicle (HOV) discounts in workplace parking lots may decrease vehicle commute trips by 9% to 17%, according to recent Transit Cooperative Research Program (TCRP) literature. In total, the analysis projects that this policy will produce approximately 140 new jobs by 2035 and a total of nearly 2,000 worker-years of additional employment between now and 2035. This employer-based parking policy is also projected to generate nearly $140 million in additional GDP for the region.

Table 14. TLU 6 Macroeconomic Impact Analysis Results

TLU6 - Differences from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
Total Employment	Jobs	65.430	66.406	63.477	75.195	99.609	140.625	84
Gross Domestic Product	Millions of Fixed 2010$	5.821	6.295	6.363	8.529	11.507	16.787	$140
Output	Millions of Fixed 2010$	7.716	8.393	8.529	10.830	15.162	22.743	$185
Disposable Personal Income	Millions of Fixed 2010$	3.522	4.216	4.821	6.044	8.588	12.834	$102
PCE-Price Index	2005=100 (Nation)	0.000	0.000	0.000	0.000	0.001	0.001	N/A
Population	Number of People	11.719	33.203	58.594	91.797	115.234	138.672	N/A
TLU6 - Baseline Plus Addition of Policy								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	10,230,929	10,540,178	11,132,885	11,585,928	12,107,348	12,755,636	
Gross Domestic Product	Millions of Fixed 2010$	1,017,148	1,095,373	1,302,220	1,438,080	1,599,550	1,801,434	
Output	Millions of Fixed 2010$	1,735,784	1,864,383	2,199,186	2,434,451	2,705,038	3,023,640	
Disposable Personal Income	Millions of Fixed 2010$	729,976	783,222	928,141	1,051,776	1,195,521	1,380,247	
PCE-Price Index	2005=100 (Nation)	111.3	117.2	134.2	154.0	177.6	206.0	
Population	Number of People	18,410,041	18,668,105	19,404,799	20,169,133	21,024,828	22,025,936	
TLU6 - % Change								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	0.00064%	0.00063%	0.00057%	0.00065%	0.00082%	0.00110%	
Gross Domestic Product	Millions of Fixed 2010$	0.00057%	0.00057%	0.00049%	0.00059%	0.00072%	0.00093%	
Output	Millions of Fixed 2010$	0.00044%	0.00045%	0.00039%	0.00044%	0.00056%	0.00075%	
Disposable Personal Income	Millions of Fixed 2010$	0.00048%	0.00054%	0.00052%	0.00057%	0.00072%	0.00093%	
PCE-Price Index	2005=100 (Nation)	0.00001%	0.00002%	0.00026%	0.00032%	0.00044%	0.00041%	
Population	Number of People	0.00006%	0.00018%	0.00030%	0.00046%	0.00055%	0.00063%	

TLU-5: Ordinances and Policies to Promote Alternative-Fuel Light-Duty Vehicles

This policy seeks to improve, through local planning efforts, the effectiveness of California's already-existing advanced clean car standards. These standards are set to take effect in 2017, and are expected to require the adoption of a significant number of plug-in hybrid electric vehicles and plug-in electric vehicles to enter the on-road fleet of light-duty vehicles. California seeks to achieve a fleet of 1.4 million such vehicles on the road by 2025. This policy seeks to facilitate the adoption of those vehicles in Southern California, allowing the SCAG region to adopt those vehicles earlier than they would otherwise enter the fleet.

The economic impacts of this policy are driven largely by the earlier access drivers are expected to have to the relatively low cost of transportation using electricity. Electricity, while not significantly cheaper per unit of energy, does produce more distance traveled on that energy. Thus, the cost per mile to fuel a vehicle falls, producing fuel savings even without changes in total travel volume. Also, shorter-range vehicles can constrain trip length, though that effect was not assumed to be present in this analysis. The savings on fuel exceeds $44 million over the duration of the effort, leaving that money to be spent in other areas of the economy. This is despite a significant cost premium, and the resulting lost spending, from the purchase of more-expensive new-technology vehicles.

The policy's scale is fairly small. The microeconomic analysis estimated that the policy would make the region's fleet larger by a few thousand vehicles each year between 2017 and 2025. In total, the analysis projects that this policy will produce a small number (below 50) of new jobs by 2020. This policy is also projected to generate a small increase (around $20 million) in additional GDP for the region.

Table 15. TLU 5 Macroeconomic Impact Analysis Results

TLU5 - Differences from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
Total Employment	Jobs	0.000	0.000	21.480	0.000	0.000	0.000	17
Gross Domestic Product	Millions of Fixed 2010$	0.000	0.000	2.307	0.000	0.000	0.000	$26.3
Output	Millions of Fixed 2010$	0.000	0.000	2.029	0.000	0.000	0.000	$22.0
Disposable Personal Income	Millions of Fixed 2010$	0.000	0.000	1.153	0.000	0.000	0.000	$12.0
PCE-Price Index	2005=100 (Nation)	0.000	0.000	0.000	0.000	0.000	0.000	N/A
Population	Number of People	0.000	0.000	11.720	0.000	0.000	0.000	N/A
TLU5 - Baseline Plus Addition of Policy								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	10,221,170	10,535,882	11,057,749	11,458,021	11,926,177	12,520,685	
Gross Domestic Product	Millions of Fixed 2010$	1,000,843	1,079,358	1,275,635	1,403,180	1,555,223	1,746,376	
Output	Millions of Fixed 2010$	1,532,259	1,654,629	1,953,874	2,160,568	2,398,260	2,679,091	
Disposable Personal Income	Millions of Fixed 2010$	755,367	803,384	926,533	1,030,056	1,152,184	1,308,548	
PCE-Price Index	2005=100 (Nation)	110.9	116.8	133.6	153.3	176.7	204.9	
Population	Number of People	18,215,375	18,413,582	18,995,773	19,606,332	20,325,465	21,212,221	
TLU5 - % Change								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	0.00000%	0.00000%	0.00019%	0.00000%	0.00000%	0.00000%	
Gross Domestic Product	Millions of Fixed 2010$	0.00000%	0.00000%	0.00018%	0.00000%	0.00000%	0.00000%	
Output	Millions of Fixed 2010$	0.00000%	0.00000%	0.00010%	0.00000%	0.00000%	0.00000%	
Disposable Personal Income	Millions of Fixed 2010$	0.00000%	0.00000%	0.00012%	0.00000%	0.00000%	0.00000%	
PCE-Price Index	2005=100 (Nation)	0.00000%	0.00000%	0.00000%	0.00000%	0.00000%	0.00000%	
Population	Number of People	0.00000%	0.00000%	0.00006%	0.00000%	0.00000%	0.00000%	

TSI-6: HDV Shift to Natural Gas with Supporting Infrastructure

This policy seeks to provide incentives and infrastructure sufficient to support the adoption of 25,000 new heavy-duty trucks fueled by natural gas rather than diesel. These trucks would be supported by 25 new natural-gas fueling stations.

This policy produces new vehicle costs, as these vehicles typically require a purchase-price premium of approximately 20% above the price of a conventional diesel truck. These additional purchase costs total over $172 million between 2013 and 2035 (net present value $125 million). Infrastructure in the form of fueling stations requires an investment of over $50 million. It also produces significant fuel savings, as natural gas is projected to remain significantly cheaper (approximately half the price) of diesel over the 2013-2025 on a per-unit energy basis. These savings, which reach $550 million (net present value $366 million), approach three times the magnitude of the additional costs, producing a net savings over time to the private sector.

As with the other vehicle-technology policy (TLU 5), this policy's scale is fairly small. In total, the analysis projects that this policy will produce around 750 new jobs by 2035. This policy is also projected to generate around $500 million in additional GDP for the region.

TSI-2/TSI-10: Congestion Pricing and Transportation Financing Options

These policies focus on implementing and expanding upon congestion pricing strategies and policies for the existing high-occupancy-toll (HOT) lane and toll road systems to address congested commuter corridors. Congestion pricing is a system of surcharging users of a transport network in periods of peak demand to reduce traffic congestion. Revenues collected through the charge could be used to fund expansions and improvements to regional transit systems and other alternative transportation services. The congestion pricing programs would be patterned after similar programs currently in operation in London, Stockholm, and Singapore that have shown a range of 13% to 22% reduction in regional VMT.

TSI-10 would increase the fuels sales tax to decrease congestion and increase transportation system funding. The policy would also link VMT and emissions rates in an effort to reduce the number of high-emitting vehicles and to promote vehicle maintenance. Implementing VMT tax would reduce congestions and charge people for how much they actually drive.

Table 16. TSI 6 Macroeconomic Impact Analysis Results

TSI6 - Differences from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
Total Employment	Jobs	-55.000	33.000	376.000	586.000	665.000	743.000	456
Gross Domestic Product	Millions of Fixed 2010$	-6.654	1.109	39.924	70.976	87.611	105.355	$585.1
Output	Millions of Fixed 2010$	-11.090	-4.436	47.687	94.265	118.663	143.061	$745.4
Disposable Personal Income	Millions of Fixed 2010$	-5.545	4.436	33.270	53.232	64.322	78.739	$462.4
PCE-Price Index	2005=100 (Nation)	0.000	0.000	-0.002	-0.002	-0.002	-0.003	N/A
Population	Number of People	-20.000	-2.000	277.000	695.000	1,033.000	1,279.000	N/A
TSI6 - Baseline Plus Addition of Policy								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	10,221,115	10,535,915	11,058,104	11,458,607	11,926,842	12,521,429	
Gross Domestic Product	Millions of Fixed 2010$	1,000,837	1,079,359	1,275,673	1,403,251	1,555,310	1,746,482	
Output	Millions of Fixed 2010$	1,532,247	1,654,624	1,953,919	2,160,662	2,398,379	2,679,235	
Disposable Personal Income	Millions of Fixed 2010$	755,361	803,387	926,565	1,030,109	1,152,249	1,308,627	
PCE-Price Index	2005=100 (Nation)	110.9	116.8	133.6	153.3	176.7	204.9	
Population	Number of People	18,215,355	18,413,580	18,996,039	19,607,027	20,326,498	21,213,500	
TSI6 - % Change								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	-0.0005%	0.0003%	0.0034%	0.0051%	0.0056%	0.0059%	
Gross Domestic Product	Millions of Fixed 2010$	-0.0006%	0.0001%	0.0031%	0.0050%	0.0056%	0.0060%	
Output	Millions of Fixed 2010$	-0.0008%	-0.0003%	0.0024%	0.0044%	0.0049%	0.0054%	
Disposable Personal Income	Millions of Fixed 2010$	-0.0007%	0.0005%	0.0036%	0.0051%	0.0056%	0.0060%	
PCE-Price Index	2005=100 (Nation)	0.0003%	-0.0004%	-0.0012%	-0.0013%	-0.0013%	-0.0014%	
Population	Number of People	-0.0001%	0.0000%	0.0015%	0.0035%	0.0051%	0.0060%	

2.9. Discussion of Network and Amenity Benefits

The REMI macroeconomic impact analysis summarized in the previous sections covers the job creation and economic growth benefits associated with the following considerations: 1) increased activities of highway and public transportation system construction; 2) increased activities associated with the operation and maintenance of these systems; 3) increased demand for goods and services from the manufacturing sectors that produce advanced vehicles; and 4) benefits from the transportation fuel savings and reduced vehicle operation costs.

In addition to the above benefits, improved transportation infrastructure and enhanced travel conditions will also yield economic benefits associated with productivity improvement and competitiveness gains in the SCAG region. In the Economic Analysis Chapter of the SCAG RTP (SCAG, 2012c), "Network Benefits" includes not only the benefits from reduced commuting costs, but also quantifies the benefits of improved accessibility and lowered effective transportation costs by using a combination of SCAG's travel model and the REMI TranSight model. The modeling results indicate that the employment impact from the network benefits is an annual average of 512,000 jobs. However, after a comparison with the other studies in the literature, including Boarnet (1997) and Hymel (2009), the final estimate of job gains associated with network benefits reported in the SCAG RTP Economic Analysis Chapter is adjusted to an annual average of 354,000 jobs.

The ratio of the annual average job gains from network benefits with respect to the RTP spending of about $500 billion is an annual average of 708 jobs per $1 billion investment. Applying this ratio to the total investment of $4.8 billion we evaluated for the TLU/TSI GHG mitigation options, we estimate the employment gains associated with network benefits of 3,400 jobs per year.

The SCAG RTP Economic Analysis Chapter also considered the potential amenity benefits associated with improved air quality, reduced travel time, and safe driving conditions in the region (SCAG, 2012c). However, the SCAG RTP report presents the amenity benefits together with the benefits stemming from the operating cost reduction (i.e., reduced expenditures on fuel and vehicle repair) under the category of "Amenity & Operations". The employment impact stemming from "Amenity & Operations" is estimated to be 64,000 jobs per year in the SCAG RTP report (SCAG, 2012c). In our REMI modeling of the TLU/TSI GHG mitigation options, we have already analyzed the impacts associated with operating cost reduction. The amenity benefits account for 72% of the employment benefits estimated under the "Amenity & Operations" category in the RTP report, which corresponds to an average annual employment gain of about 46,000 jobs. The ratio of the annual average job gains from amenity benefits with respect to the total RTP spending is an annual average of about 92 jobs per $1 billion investment. Applying this ratio to the total investment of $4.8 billion we evaluated for the TLU/TSI GHG mitigation options, we estimate an employment gain associated with amenity benefits of 442 jobs per year.

Combining the estimated job gains associated with both network and amenity benefits, we obtain an employment impact of 3,842 jobs per year (and 88,374 job-years over the entire planning period) in addition to the job gains we estimated for the TLU and TSI options in the REMI models. This represents a nearly 30% increase over the base estimation from the REMI simulations.

2.10. Summary of Sensitivity Analyses and the Macroeconomic Impacts on the California and US Economies

2.10.1. Assumptions Regarding the Sources of Public and Private Funds

Analyses of the economic impacts of public spending must consider that such spending is usually funded from a variety of government sources, sometimes in a coordinated fashion. This is particularly true for transportation infrastructure spending, which is funded by a mix of federal, state and local funding. This mix differs based on the type of facility, the mode of transportation addressed, and a collection of other characteristics.

The sources of funding are important when determining the likely macroeconomic impacts expected from a public-sector initiative. Programs or projects relying largely on federal funding represent a net inflow of capital into the region, adding to the capital already present. By contrast, programs or projects relying largely on local funding are usually expected to displace existing spending or investment, and the economic effect represents more of a shift in spending from one sector to another than an increase in the total amount spent. Macroeconomic analyses of local policies are often more positive when funding for infrastructure is largely from external (state and federal) sources.

The same is true of private-sector spending driven by government actions. Increased or decreased private investment as a result of a government policy is also affected by investment attracted from outside the region, as well as the type of investors within the region.

2.10.2. Analytical Approach

A careful, detailed analysis leading to a projection of exactly how much funding would come from state, federal and local sources for each type of investment envisioned in the TLU and TSI policies for the 2013-2035 period was beyond the scope of this effort. However, the CCS team did utilize an assumption regarding spending sources, and completed alternative analyses for scenarios with higher and lower percentages of spending coming from local government. The purpose of this additional effort is to assess the importance of funding sources on the overall economic impact described above.

The base case assumption for local, state and federal contributions to public spending in these policies, as well as the two alternative scenarios, were as follows:

Table 17. Assumptions for Sensitivity Analysis of Public & Private Investment Sources

	High Local-Government Spending Scenario	Base Case Scenario	Low Local-Government Spending Scenario
Local Government Share	75%	50%	25%
State (CA) Government Share	12.5%	25%	37.5%
Federal Government Share	12.5%	25%	37.5%

These percentages were applied to all the spending considered to be dependent on "additional" revenue sources as described in the 2012 RTP/SCS.[9] These percentages were also applied to private-sector investment impacts for those options not related to vehicle technology estimated by the microeconomic analysis process. Because the policies were focused in their impacts on only the SCAG region, they were not applied to costs and savings encountered by the general public as different policies changed expected travel demand and increased access to transit.

For the two options that promote the use of alternative light duty vehicles and compressed natural gas (CNG) trucks (TLU-5 and TSI-6), since they are not covered by either the "core" or "additional" revenue sources of the RTP, we adopt some different assumptions regarding the source of investment funding. For these two options, we assume that 80% of the cost would be borne by the businesses in the SCAG region, and 20% would be covered by out-of-region private investment. Furthermore, in the Base Case Scenario, we assume that 50% of the in-region business capital investment will come from the displacement of ordinary business investment on plant and equipment. Hence, 40% (50% of 80%) of the total investment will displace ordinary investment. In the sensitivity analysis, we assume ordinary investment displacement would be 50% higher and 50% lower than in the Base Case Scenario (i.e., 75% and 25%, respectively, of the in-region business capital investment will displace ordinary investment).

2.10.3. Relationship to Estimates of Impacts outside the SCAG Region

Just as scenarios involving inflows of state and federal money tend to result in positive economic impacts for a city or region, the rest of the state and the rest of the country must also be expected to be affected by the flight of capital out of their respective economies. The losses of investment there might tend to produce projections of lower economic activity. That said, because the local, state and federal economies are deeply interrelated, the positive gains within the SCAG region can reverberate outside the region, providing an offsetting counterweight to the losses expected.

Table 18 shows the cumulative (2013-2035) impacts generated by the macroeconomic modeling effort. These results are expanded from those presented earlier in this report in that they project economic changes for not only the SCAG region but also for the rest of California, and the rest of the U.S. In addition, the results cover all three alternative assumptions for the share of public and private investment that comes from within the region.

[9] As discussed above, public spending from revenue sources already in existence was considered to be captured in the Base Case assumptions for the economy before these impacts were modeled.

Table 18. Results of Sensitivity Analysis

Geographic Area	Units	25% local funding, 75% from outside SCAG	Base Case: 50% local funding, 50% from outside SCAG	75% local funding, 25% from outside SCAG
SCAG				
Disposable Personal Income	Millions of Fixed 2010$	$14,847	$14,388	$13,873
Employment	Jobs per Year	13,930	13,753	13,548
GDP	Millions of Fixed 2010$	$22,916	$22,611	$22,173
Output	Millions of Fixed 2010$	$32,361	$31,866	$31,160
CA (outside of SCAG)				
Disposable Personal Income	Millions of Fixed 2010$	$571	$792	$1,021
Employment	Jobs per Year	769	835	896
GDP	Millions of Fixed 2010$	$1,722	$1,840	$1,949
Output	Millions of Fixed 2010$	$1,998	$2,185	$2,358
US (outside of CA				
Disposable Personal Income	Millions of Fixed 2010$	$1,561	$1,811	$2,037
Employment	Jobs per Year	2,688	2,798	2,881
GDP	Millions of Fixed 2010$	$2,633	$2,848	$2,991
Output	Millions of Fixed 2010$	$724	$1,070	$1,299

The macroeconomic analysis shows that just as the impacts for the SCAG region are very positive, the state of California and the overall U.S. economy also generally benefit. This shows that such investment does not produce a zero-sum scenario, where gains in the SCAG region are necessarily offset by losses outside of the region. Instead, even though investment is transferred into the SCAG region from outside, the rest of the state and country still benefit from the resulting gains in employment and economic activity, though only to a very small degree. Only population is traded in a zero-sum fashion; the improved SCAG economy attracts people from the rest of the state and country. This analysis did not, however, estimate the impacts on international immigration that might result from these policies.

As mentioned above, the sensitivity analysis modeled the same investments as the standard scenario, but assumed that as little as 25% and as much as 75% of the investment would come from within the SCAG region. The standard scenario assumed that 50% would come from within the region, and the other 50% would come from outside the region. The results indicate that even a dramatic change in the source of funding for the investments contemplated here would have only a minor effect on the broader economic impacts of these policies. The benefits to the SCAG region when it must fund three-quarters of the program costs are only 3-7% smaller than the benefits when the region receives three-quarters of the funding from outside the region. In all funding-source scenarios, the benefits are consistent in direction and close in scale. This modeling result suggests that the economic impacts projected from the implementation of these policies are only mildly dependent upon the actual source of the funds that would be used to implement them.

CHAPTER 3. MACROECONOMIC ANALYSIS OF ENERGY, COMMERCE, AND RESOURCES GREENHOUSE GAS MITIGATION POLICY OPTIONS

3.1. Introduction / Overview

This chapter summarizes results of the microeconomic and macroeconomic impact analysis of the ECR policies identified as priorities for analysis by the Energy, Commerce, and Resources (ECR) TWGs through the CEDP. Appendix F provides the following information for each policy that served as the basis for the design and quantification of the potential emission reductions and costs/savings for each policy:

- Policy Description;
- Policy Design (Goals or Level of Effort, Timing (Start, Phase In, End), Parties Involved);
- Type(s) of GHG Reductions;
- Estimated Net GHG Reductions and Net Financial Costs or Savings (Data Sources, Quantification Methods, Key Assumptions);
- Key Uncertainties; and
- Additional Benefits and Costs.

3.2. Organization of Chapter

The results of the microeconomic and macroeconomic impact analysis for the ECR policies are presented in the following sections of this chapter:

- Section 3.3: Microeconomic Analysis
- Section 3.4: Macroeconomic Analysis
  - 3.4.1. Major Modeling Assumptions
  - 3.4.2. Basic Aggregate Results
  - 3.4.3. Sectoral Impacts
  - 3.4.4. Sensitivity Tests
  - 3.4.5. Economic Impacts Outside of the SCAG Region
  - 3.4.6. Discussion of Results
  - 3.4.7. Conclusion

3.3. Microeconomic Analysis

Table 19 summarizes the estimated microeconomic impacts (GHG mitigation potentials and costs/savings) of the ECR options analyzed. In total, the 10 policy options can generate over $3 billion net present value (NPV) cost savings and reduce 853 million tons of carbon dioxide-equivalent ($MMtCO_2e$) GHG emissions during the 2012-2035 period. The weighted average cost-effectiveness of the options (using GHG reduction potentials as weights) is about minus $4 per $MMtCO_2e$ emissions removed. The minus sign means implementing these options on average would yield overall cost savings.

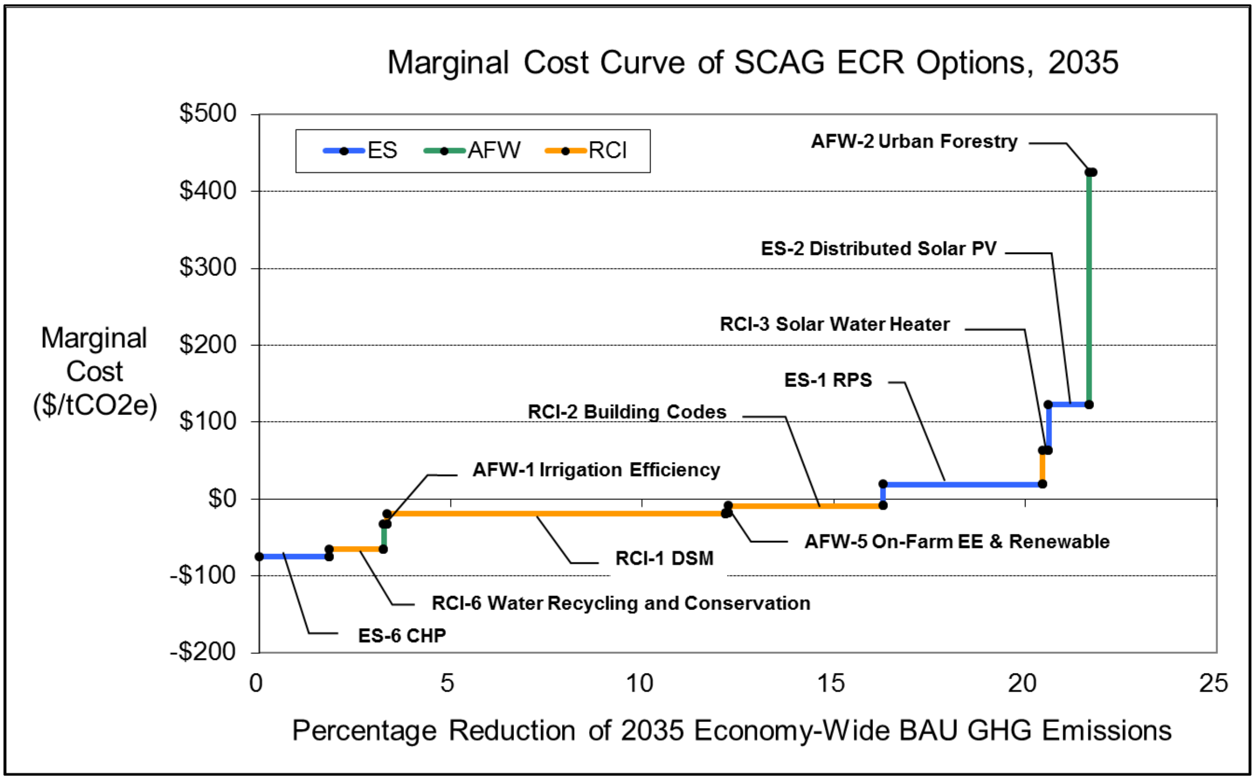
Table 19. Microeconomic Analysis Results of ECR Options

Policy Option Number	Policy Option Description	2020 (MMtCO2e)	2035 (MMtCO2e)	2012-2035 (MMtCO2e)	Net Present Value (million 2010$), 2012-2035 Cost / Cost Savings*	Cost-Effective-ness ($/tCO2e)*
RCI-1	Utility Demand Side Management (DSM) Programs for Electricity and Natural Gas (for Investor-owned, Government-owned, and Coop Utilities), and/or Energy Efficiency Funds (e.g. Public Benefit Funds) Administered by Local Agency, Utility, or Third Party	8.6	24.2	297	-5,652	-19
RCI-2	Improved Building Codes for Energy Efficiency	3.1	11	119	-1,025	-9
RCI-3	Incentives for Renewable Energy Systems at Residential, Commercial, and Industrial Sites	0.16	0.41	5.1	325	63
RCI-4	Consumer, Student, and Decision-maker Education Programs	Not Quantified				
RCI-5	GHG Emissions Reductions through Changes in Goods Production, Sourcing, and Delivery	Not Quantified				
RCI-6	Increase Water Recycling and Water End-use Efficiency and Conservation Goals and Programs	2.0	3.9	54	-3,528	-65
ES-1	Central Station Renewable Energy Incentives including Project Development Barrier Removal Issues	11.4	11.4	265	5,025	19
ES-2	Customer Sited Renewable Energy Incentives and/or Barrier Removal	1.2	2.9	37.5	4,624	123
ES-3	Transmission System Upgrading, Reduce Transmission and Distribution Line Loss	Not Quantified				
ES-4	CCSR Incentives and Infrastructure including R&D and Enabling Policies	Not Quantified				
ES-5	Public Benefits Charge Funds	Moved to RCI-1				
ES-6	Combined Heat and Power (CHP) Incentives and/or Barrier Removal, including Co-location or Integration of Energy-Producing Facilities	1.3	5.0	66.2	-4,971	-75
AFW-1	Improve Agricultural Irrigation Efficiency	0.22	0.22	4.4	-145	-33
AFW-2a	Improve Urban Forestry and Green Space Management through Expansion and Effective Management: Urban Forestry	0.05	0.28	2.7	1,359	424
AFW-2b	Improve Urban Forestry and Green Space Management through Expansion and Effective Management: Xeriscaping	Not Quantified				
AFW-3	Biomass to Energy Innovation through In-Situ Underground Decomposition	Not Quantified				
AFW-4	Preserve and Expand the Carbon Sequestration Capabilities of Open Space, Wildlands, Wetlands, and Agricultural Lands	Not Quantified				
AFW-5a	Increase On-Farm Energy Efficiency & Renewable Energy Production: Renewable Energy	0.02	0.04	0.65	-6	-9
AFW-5b	Increase On-Farm Energy Efficiency & Renewable Energy Production: Energy Efficiency	0.05	0.16	2.3	-47	-28
All	**Total Stand-Alone Results**	**28.0**	**59.7**	**854**	**-4,041**	**n/a**
	Total Estimated Policy Overlaps	**0.03**	**0.18**	**1.73**	**883**	**n/a**
	Total After Overlap Adjustments	**28.0**	**59.5**	**853**	**-3,157**	**-4**

* Negative values represent a net cost savings. $/t$CO_2$e stands for dollars per metric ton of carbon dioxide equivalent.

Figure 11 presents the marginal cost curve for the ECR sectors (ES—Energy Supply; RCI—Residential, Commercial, and Industrial; AFW—Agriculture, Forestry, and Waste Management). 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 GHG reduction potential of the ECR options can avoid about 22% of 2035 baseline emissions in SCAG Region. Among the three sectors, RCI options in aggregate have the largest GHG reduction potential; and most of the RCI options are cost-effective (i.e., their implementation would result in cost savings).

Figure 11. Marginal Cost Curve of ECR Options



3.4. Macroeconomic Analysis

3.4.1. Major Modeling Assumptions

The major data sources for the macroeconomic impact analysis are the microeconomic quantification results on the direct costs and savings of the ECR options. However, we supplement these with additional data and assumptions in the REMI analysis in cases where these costs/savings and some conditions relating to the implementation of the options are not specified in the micro analysis or are not known with certainty. Below is the list of major assumptions we adopted in the analysis. Most of these assumptions are general ones we have used in other studies of this type (e.g., Miller et al., 2010; Rose et al., 2011; Rose and Wei, 2012). Those assumptions that are tailored to the SCAG Region are indicated as such below.

1. In the Base Case analysis, we assume that 50% of the in-region private capital investment will displace ordinary private investment in plant and equipment.[10] This means that 50% of the incremental capital investment by the businesses will simply displace other investment in the region, and thus only 50% of the investment is additive to the regional economy.
2. In the Base Case, capital investment expenditures for power generation are split 60:40 between sectors that produce generating equipment and the construction sector for large power plants (such as NG-fired power plants), and 80:20 for smaller installations (mainly renewables).
3. In the Base Case, the percentages of renewable electricity generation equipment and energy-efficient appliances and equipment that are purchased from producers within the SCAG region are assumed to be same as the average in-region production rate of such equipment, i.e., the REMI default Regional Purchase Coefficients for the relevant equipment manufacturing sectors for the SCAG region are used in the Base Case analysis.
4. For RCI-1, it is assumed that 10% of the utility program cost is administrative, and 90% is attributable to annualized capital and operating cost of this option; it is further assumed that 100% of the utility cost change will eventually be passed onto the ratepayers.
5. For the RCI options, both the option costs and energy savings are computed for the residential, commercial, and/or industrial sectors in the microanalysis. For the commercial and industrial sectors, the microanalyses only provide the aggregated costs and savings for the entire commercial sector and the entire industrial sectors. Since in the REMI model, capital cost and production cost variables can only be simulated for individual commercial sectors or industrial sectors, we distributed these costs and savings among the 169 REMI sectors using baseline sectoral energy consumptions as weights.
6. The interest payment is separated from the levelized capital cost using the following assumptions:
    a. For RCI-1 (DSM) and RCI-6 (Water Recycling and Efficiency), it is assumed that 50% of the capital cost will be covered by debt financing and 50% will be covered by equity financing. For RCI-2 (Building Codes) and RCI-3 (Solar Water Heater Program), it is assumed that debt financing will cover 75% of the capital cost.
    b. For ES options, except for the federal subsidies and transfers, the remaining costs are assumed to be covered by private investment. In addition, the private investment is assumed to be covered 50% by debt financing and 50% through equity.
    c. For AFW options, it is assumed that 100% of the capital cost will be covered through debt financing.
7. For the Combined Heat and Power option (ES-3), the total costs and savings of installing the CHP systems are only available for the commercial and industrial sectors as a whole from the microanalysis. These costs and savings are then distributed among the REMI commercial and

[10] The assumption of 50% ordinary private investment displacement is made due to lack of data. Note that sensitivity tests were performed on this key assumption in Section 3.4.4 of Chapter 3.

industrial sectors based on the CHP technical potential by Northern American Industry Classification System (NAICS) sector presented in Hedman et al. (2012).

8. For the Urban Forestry option (AFW-2), it is assumed that the planting and maintenance costs are split 20:30:50 among local government, commercial sectors, and the residential sector. The electricity and gas savings are split 30:70 between the commercial and residential sectors.
9. For ES-1 (RPS), in order to meet the 33% RPS goal by Year 2020, the renewables that will be deployed in the SCAG Region, rest of California, and outside of California are based on ISO interconnection queue location and renewable type as shown in Table 20. In addition, in all the cases, the displaced power generation is assumed to be natural gas combined-cycle (NGCC).

Table 20. Renewables Deployment by Region for ES-1 RPS

Resource	Percent in SCAG Region	Percent in Rest of California	Percent Outside of California	Total
Geothermal	100%	0%	0%	100%
Solar PV	50%	40%	10%	100%
Solar Thermal	60%	30%	10%	100%
Biomass-dedicated	40%	50%	10%	100%
Onshore Wind I	22%	68%	10%	100%

The assumptions for regional deployment come from two primary sources. Solar PV and solar thermal estimates for projects in the SCAG region come from the CA ISO active interconnection queue. The estimates for wind come from E3 RPS calculator v1.4 "v-all selected resources" tab for 33% RPS (no RECs) for wind projects in Imperial, Palm Springs, San Bernardino-Lucerne renewable energy zones, with the balance coming from Tehachapi area, which is out of the SCAG region. Finally, solar, wind and biomass all assume that 10% of projects are deployed in the Western Interconnect outside California.

3.4.2. Basic Aggregate Results

Macroeconomic Impacts of Individual ECR Options

Table 21 to Table 30 present the macroeconomic impacts of each of the 10 quantified ECR policy options. In terms of employment impacts, 7 out of the 10 options yield positive impacts. In terms of GDP impacts, 4 out of the 10 options yield positive impacts. RCI-2 Building Codes results in the highest positive impacts on the economy—an NPV of $10.6 billion gains in GDP and an average annual increase of more than 10 thousand jobs. ES-1 RPS yields the highest negative impacts to the economy—an NPV of $24 billion decrease in GDP and a loss of nearly 16 thousand jobs per year.

Some of the results might appear counter-intuitive in their own right, or in comparison with findings in other states. A major example is mitigation option ES-1, Renewable Portfolio Standard (RPS). This simulation analyzes the impact of moving from the current 20% renewable electricity generation target to a 33% target by the year 2020 and 40% by the year 2035. Our results project a loss of nearly 16 thousand jobs per year, for example. Our analysis in

Pennsylvania on the Alternative Energy Portfolio Standard (AEPS)[11] and the analysis in Florida and Michigan on their state RPS indicated positive impacts. We summarize two of the major factors that affect these results.

First is the differential between renewable energy prices and the fossil energy electricity generation that is being displaced in the various states. Comparing the weighted average renewable electricity generation cost in PA and MI with the SCAG Region, the latter has the highest weighted average generation cost of the renewables among the three. If we compare the differential between the electricity generation costs of renewables and fossil-fuel technologies, the differentials in the SCAG Region are higher than the ones for PA after Year 2015 (MCAC, 2009; PA DEP, 2009; CCS, 2012b).

The second is revealed by a formal decomposition of the results of our RPS analysis for the SCAG Region. This refers to simulating each of the various drivers of the impacts individually and holding all other factors constant. This enables us to identify the factors that contribute most positively or negatively to the outcome. These findings indicate that the relatively high capital cost of renewable electricity generation is the dominant negative factor in the SCAG Region in terms of both employment and GDP impacts.

In addition, the price of the fuel used in the displaced electricity generation technology, in this case the price of natural gas, is also a key factor affecting the cost-effectiveness, and thus the macroeconomic performance, of the RPS option. Lower future natural gas prices would lead to lower avoided costs of natural gas combined-cycle (NGCC) generation in the SCAG Region, and thus reduced cost-effectiveness of renewable electricity alternatives. In other words, with a declining natural gas price, renewable generation will become relatively more expensive and less competitive. However, this variable has far less influence on the relative competiveness of renewables than does the capital cost.

[11] The Pennsylvania AEPS includes coal waste products, but our analysis was focused on the Tier 1 energy resources, which are all renewable energy.

Table 21. Macroeconomic Impact Analysis Results of RCI-1 Utility Demand Side Management Programs for Electricity and Natural Gas

Differences from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
Total Employment	Jobs	-2,410	-732	3,873	10,673	19,247	29,015	10,237
GDP	Millions of Fixed 2010$	-329	-326	-316	-169	116	475	-3,056
Output	Millions of Fixed 2010$	-471	-498	-587	-495	-200	184	-6,733
Disposable Personal Income	Millions of Fixed 2010$	-62	40	369	945	1,763	2,841	8,880
PCE-Price Index	2005=100	-0.018	-0.026	-0.048	-0.082	-0.128	-0.188	N/A
Population	Number of People	-1,701	-1,119	3,350	11,988	24,848	41,309	N/A
Baseline Plus Addition of Policy								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	10,218,760	10,535,149	11,061,601	11,468,694	11,945,424	12,549,700	
GDP	Millions of Fixed 2010$	1,000,514	1,079,031	1,275,317	1,403,011	1,555,338	1,746,851	
Output	Millions of Fixed 2010$	1,531,787	1,654,131	1,953,286	2,160,074	2,398,061	2,679,276	
Disposable Personal Income	Millions of Fixed 2010$	755,304	803,424	926,901	1,031,002	1,153,947	1,311,389	
PCE-Price Index	2005=100	110.8	116.7	133.6	153.2	176.6	204.7	
Population	Number of People	18,213,674	18,412,463	18,999,111	19,606,332	20,325,465	21,212,220	
Percent Change from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	-0.0236%	-0.0070%	0.0350%	0.0931%	0.1614%	0.2317%	
GDP	Millions of Fixed 2010$	-0.0329%	-0.0302%	-0.0248%	-0.0120%	0.0075%	0.0272%	
Output	Millions of Fixed 2010$	-0.0308%	-0.0301%	-0.0300%	-0.0229%	-0.0083%	0.0069%	
Disposable Personal Income	Millions of Fixed 2010$	-0.0082%	0.0050%	0.0398%	0.0917%	0.1530%	0.2171%	
PCE-Price Index	2005=100	-0.0164%	-0.0226%	-0.0356%	-0.0538%	-0.0726%	-0.0919%	
Population	Number of People	-0.0093%	-0.0061%	0.0176%	0.0611%	0.1222%	0.1947%	

Table 22. Macroeconomic Impact Analysis Results of RCI-2 Improved Building Codes

Differences from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
Total Employment	Jobs	3,530	6,786	12,523	16,044	22,751	29,170	16,158
GDP	Millions of Fixed 2010$	261	499	868	965	1,303	1,565	10,667
Output	Millions of Fixed 2010$	430	807	1,327	1,410	1,860	2,159	15,877
Disposable Personal Income	Millions of Fixed 2010$	177	360	763	1,099	1,711	2,429	11,679
PCE-Price Index	2005=100	0.001	0.002	0.002	-0.011	-0.028	-0.052	N/A
Population	Number of People	1,277	3,301	10,639	17,727	27,510	38,867	N/A
Baseline Plus Addition of Policy								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	10,224,700	10,542,668	11,070,251	11,474,065	11,948,928	12,549,855	
GDP	Millions of Fixed 2010$	1,001,103	1,079,857	1,276,501	1,404,145	1,556,525	1,747,941	
Output	Millions of Fixed 2010$	1,532,689	1,655,436	1,955,199	2,161,979	2,400,120	2,681,251	
Disposable Personal Income	Millions of Fixed 2010$	755,543	803,744	927,295	1,031,156	1,153,895	1,310,977	
PCE-Price Index	2005=100	110.9	116.8	133.6	153.3	176.7	204.8	
Population	Number of People	18,216,652	18,416,883	19,006,400	19,606,332	20,325,465	21,212,221	
Percent Change from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	0.0345%	0.0644%	0.1133%	0.1400%	0.1908%	0.2330%	
GDP	Millions of Fixed 2010$	0.0261%	0.0462%	0.0681%	0.0687%	0.0838%	0.0896%	
Output	Millions of Fixed 2010$	0.0281%	0.0488%	0.0679%	0.0653%	0.0775%	0.0806%	
Disposable Personal Income	Millions of Fixed 2010$	0.0234%	0.0449%	0.0823%	0.1067%	0.1485%	0.1856%	
PCE-Price Index	2005=100	0.0009%	0.0016%	0.0018%	-0.0070%	-0.0157%	-0.0256%	
Population	Number of People	0.0070%	0.0179%	0.0560%	0.0904%	0.1353%	0.1832%	

Table 23. Macroeconomic Impact Analysis Results of RCI-3 Incentives for Renewable Energy Systems at Residential, Commercial, and Industrial Sites

Differences from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
Total Employment	Jobs	346	289	-356	-416	-444	-472	-267
GDP	Millions of Fixed 2010$	42	34	-47	-77	-109	-147	-516
Output	Millions of Fixed 2010$	80	64	-69	-119	-176	-243	-757
Disposable Personal Income	Millions of Fixed 2010$	43	39	-26	-37	-43	-53	-130
PCE-Price Index	2005=100	0.000	0.000	0.001	0.001	0.000	0.001	N/A
Population	Number of People	152	242	-68	-371	-588	-746	N/A
Baseline Plus Addition of Policy								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	10,221,516	10,536,171	11,057,371	11,457,605	11,925,732	12,520,214	
GDP	Millions of Fixed 2010$	1,000,885	1,079,392	1,275,586	1,403,103	1,555,114	1,746,229	
Output	Millions of Fixed 2010$	1,532,337	1,654,692	1,953,804	2,160,450	2,398,084	2,678,849	
Disposable Personal Income	Millions of Fixed 2010$	755,410	803,423	926,506	1,030,019	1,152,140	1,308,495	
PCE-Price Index	2005=100	110.9	116.8	133.6	153.3	176.7	204.9	
Population	Number of People	18,215,527	18,413,824	18,995,693	19,606,332	20,325,465	21,212,221	
Percent Change from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	0.0034%	0.0027%	-0.0032%	-0.0036%	-0.0037%	-0.0038%	
GDP	Millions of Fixed 2010$	0.0042%	0.0031%	-0.0037%	-0.0055%	-0.0070%	-0.0084%	
Output	Millions of Fixed 2010$	0.0052%	0.0039%	-0.0035%	-0.0055%	-0.0074%	-0.0090%	
Disposable Personal Income	Millions of Fixed 2010$	0.0058%	0.0048%	-0.0028%	-0.0036%	-0.0038%	-0.0041%	
PCE-Price Index	2005=100	-0.0003%	-0.0001%	0.0004%	0.0004%	0.0002%	0.0002%	
Population	Number of People	0.0008%	0.0013%	-0.0004%	-0.0019%	-0.0029%	-0.0035%	

Table 24. Macroeconomic Impact Analysis Results of RCI-6 Increase Water Recycling and Water End-use Efficiency and Conservation Goals and Programs

Differences from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
Total Employment	Jobs	2,455	3,446	6,181	10,374	15,237	19,986	10,127
GDP	Millions of Fixed 2010$	134	155	271	696	1,259	1,889	7,086
Output	Millions of Fixed 2010$	237	269	427	1,044	1,868	2,766	10,760
Disposable Personal Income	Millions of Fixed 2010$	157	257	552	875	1,305	1,814	8,836
PCE-Price Index	2005=100	-0.009	-0.020	-0.049	-0.055	-0.062	-0.070	N/A
Population	Number of People	1,043	2,490	7,191	13,398	20,686	28,605	N/A
Baseline Plus Addition of Policy								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	10,223,625	10,539,328	11,063,908	11,468,396	11,941,414	12,540,672	
GDP	Millions of Fixed 2010$	1,000,977	1,079,513	1,275,903	1,403,878	1,556,482	1,748,265	
Output	Millions of Fixed 2010$	1,532,496	1,654,899	1,954,299	2,161,613	2,400,128	2,681,858	
Disposable Personal Income	Millions of Fixed 2010$	755,523	803,641	927,084	1,030,932	1,153,489	1,310,362	
PCE-Price Index	2005=100	110.9	116.7	133.6	153.2	176.7	204.8	
Population	Number of People	18,216,418	18,416,072	19,002,953	19,606,332	20,325,464	21,212,221	
Percent Change from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	0.0240%	0.0327%	0.0559%	0.0905%	0.1278%	0.1596%	
GDP	Millions of Fixed 2010$	0.0134%	0.0144%	0.0212%	0.0497%	0.0810%	0.1082%	
Output	Millions of Fixed 2010$	0.0155%	0.0163%	0.0218%	0.0483%	0.0779%	0.1033%	
Disposable Personal Income	Millions of Fixed 2010$	0.0208%	0.0320%	0.0596%	0.0850%	0.1133%	0.1387%	
PCE-Price Index	2005=100	-0.0082%	-0.0168%	-0.0363%	-0.0359%	-0.0349%	-0.0340%	
Population	Number of People	0.0057%	0.0135%	0.0379%	0.0683%	0.1018%	0.1349%	

Table 25. Macroeconomic Impact Analysis Results of ES-1 Renewable Electricity Supply

Differences from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
Total Employment	Jobs	-9,643	-11,856	-15,762	-16,773	-17,813	-18,701	-15,962
GDP	Millions of Fixed 2010$	-1,026	-1,280	-2,010	-2,381	-2,690	-3,001	-23,908
Output	Millions of Fixed 2010$	-1,688	-2,024	-3,155	-3,771	-4,235	-4,676	-36,643
Disposable Personal Income	Millions of Fixed 2010$	-774	-948	-1,392	-1,610	-1,856	-2,157	-17,792
PCE-Price Index	2005=100	0.046	0.043	0.052	0.059	0.069	0.083	N/A
Population	Number of People	-5,549	-9,764	-19,459	-26,537	-31,412	-34,752	N/A
Baseline Plus Addition of Policy								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	10,211,527	10,524,025	11,041,966	11,441,248	11,908,363	12,501,984	
GDP	Millions of Fixed 2010$	999,817	1,078,078	1,273,623	1,400,800	1,552,532	1,743,376	
Output	Millions of Fixed 2010$	1,530,570	1,652,604	1,950,718	2,156,798	2,394,025	2,674,417	
Disposable Personal Income	Millions of Fixed 2010$	754,592	802,436	925,140	1,028,447	1,150,327	1,306,391	
PCE-Price Index	2005=100	110.9	116.8	133.7	153.3	176.8	205.0	
Population	Number of People	18,209,826	18,403,818	18,976,303	19,606,332	20,325,465	21,212,221	
Percent Change from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	-0.0943%	-0.1125%	-0.1425%	-0.1464%	-0.1494%	-0.1494%	
GDP	Millions of Fixed 2010$	-0.1025%	-0.1186%	-0.1575%	-0.1697%	-0.1730%	-0.1718%	
Output	Millions of Fixed 2010$	-0.1102%	-0.1223%	-0.1615%	-0.1745%	-0.1766%	-0.1745%	
Disposable Personal Income	Millions of Fixed 2010$	-0.1024%	-0.1180%	-0.1502%	-0.1563%	-0.1611%	-0.1649%	
PCE-Price Index	2005=100	0.0414%	0.0371%	0.0393%	0.0384%	0.0393%	0.0403%	
Population	Number of People	-0.0305%	-0.0530%	-0.1024%	-0.1353%	-0.1545%	-0.1638%	

Table 26. Macroeconomic Impact Analysis Results of ES-2 Customer Sited Renewable Energy

Differences from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
Total Employment	Jobs	3,088	1,853	-2,719	-4,525	-5,798	-5,764	-2,871
GDP	Millions of Fixed 2010$	391	226	-532	-1,064	-1,615	-2,084	-7,336
Output	Millions of Fixed 2010$	844	572	-679	-1,516	-2,383	-3,114	-8,978
Disposable Personal Income	Millions of Fixed 2010$	138	52	-304	-543	-762	-895	-3,903
PCE-Price Index	2005=100	0.011	0.014	0.019	0.027	0.036	0.043	N/A
Population	Number of People	1,395	1,408	-1,400	-4,852	-8,385	-10,941	N/A
Baseline Plus Addition of Policy								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	10,224,258	10,537,734	11,055,009	11,453,496	11,920,379	12,514,922	
GDP	Millions of Fixed 2010$	1,001,235	1,079,584	1,275,100	1,402,116	1,553,608	1,744,293	
Output	Millions of Fixed 2010$	1,533,102	1,655,201	1,953,193	2,159,053	2,395,877	2,675,977	
Disposable Personal Income	Millions of Fixed 2010$	755,504	803,436	926,228	1,029,512	1,151,421	1,307,653	
PCE-Price Index	2005=100	110.9	116.8	133.6	153.3	176.8	204.9	
Population	Number of People	18,216,770	18,414,990	18,994,361	19,606,332	20,325,465	21,212,220	
Percent Change from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	0.0302%	0.0176%	-0.0246%	-0.0395%	-0.0486%	-0.0460%	
GDP	Millions of Fixed 2010$	0.0392%	0.0209%	-0.0417%	-0.0758%	-0.1038%	-0.1193%	
Output	Millions of Fixed 2010$	0.0551%	0.0346%	-0.0347%	-0.0702%	-0.0994%	-0.1163%	
Disposable Personal Income	Millions of Fixed 2010$	0.0182%	0.0065%	-0.0328%	-0.0528%	-0.0661%	-0.0684%	
PCE-Price Index	2005=100	0.0095%	0.0119%	0.0142%	0.0179%	0.0204%	0.0212%	
Population	Number of People	0.0077%	0.0076%	-0.0074%	-0.0247%	-0.0413%	-0.0516%	

Table 27. Macroeconomic Impact Analysis Results of ES-6 Combined Heat and Power

Differences from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
Total Employment	Jobs	106	336	1,254	3,705	7,442	9,859	4,087
GDP	Millions of Fixed 2010$	-21	-49	-64	-62	67	314	-73
Output	Millions of Fixed 2010$	-29	-68	-83	-49	205	629	396
Disposable Personal Income	Millions of Fixed 2010$	26	64	139	427	846	1,075	4,321
PCE-Price Index	2005=100	-0.004	-0.009	-0.014	-0.039	-0.068	-0.066	N/A
Population	Number of People	145	480	1,859	5,191	10,941	16,621	N/A
Baseline Plus Addition of Policy								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	10,221,276	10,536,218	11,058,981	11,461,727	11,933,619	12,530,545	
GDP	Millions of Fixed 2010$	1,000,821	1,079,309	1,275,568	1,403,119	1,555,289	1,746,691	
Output	Millions of Fixed 2010$	1,532,230	1,654,561	1,953,790	2,160,519	2,398,465	2,679,721	
Disposable Personal Income	Millions of Fixed 2010$	755,391	803,447	926,670	1,030,483	1,153,030	1,309,624	
PCE-Price Index	2005=100	110.9	116.7	133.6	153.2	176.7	204.8	
Population	Number of People	18,215,520	18,414,063	18,997,621	19,606,332	20,325,465	21,212,221	
Percent Change from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	0.0010%	0.0032%	0.0113%	0.0323%	0.0624%	0.0787%	
GDP	Millions of Fixed 2010$	-0.0021%	-0.0045%	-0.0051%	-0.0044%	0.0043%	0.0180%	
Output	Millions of Fixed 2010$	-0.0019%	-0.0041%	-0.0042%	-0.0023%	0.0086%	0.0235%	
Disposable Personal Income	Millions of Fixed 2010$	0.0033%	0.0080%	0.0150%	0.0414%	0.0734%	0.0822%	
PCE-Price Index	2005=100	-0.0035%	-0.0078%	-0.0105%	-0.0255%	-0.0384%	-0.0323%	
Population	Number of People	0.0008%	0.0026%	0.0098%	0.0265%	0.0538%	0.0784%	

Table 28. Macroeconomic Impact Analysis Results of AFW-1 Improve Agricultural Irrigation Efficiency

Differences from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
Total Employment	Jobs	16	14	21	19	19	20	16
GDP	Millions of Fixed 2010$	1	1	2	2	2	3	20
Output	Millions of Fixed 2010$	3	2	4	4	4	4	42
Disposable Personal Income	Millions of Fixed 2010$	1	1	1	1	1	2	13
PCE-Price Index	2005=100	0.000	0.000	0.000	0.000	0.000	0.000	N/A
Population	Number of People	0	4	20	23	39	45	N/A
Baseline Plus Addition of Policy								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	10,221,186	10,535,896	11,057,748	11,458,040	11,926,195	12,520,705	
GDP	Millions of Fixed 2010$	1,000,845	1,079,359	1,275,635	1,403,182	1,555,225	1,746,380	
Output	Millions of Fixed 2010$	1,532,262	1,654,631	1,953,877	2,160,574	2,398,265	2,679,097	
Disposable Personal Income	Millions of Fixed 2010$	755,367	803,384	926,533	1,030,057	1,152,184	1,308,551	
PCE-Price Index	2005=100	110.9	116.8	133.6	153.3	176.7	204.9	
Population	Number of People	18,215,375	18,413,586	18,995,781	19,606,332	20,325,465	21,212,221	
Percent Change from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	0.0002%	0.0001%	0.0002%	0.0002%	0.0002%	0.0002%	
GDP	Millions of Fixed 2010$	0.0002%	0.0001%	0.0002%	0.0002%	0.0001%	0.0002%	
Output	Millions of Fixed 2010$	0.0002%	0.0002%	0.0002%	0.0002%	0.0002%	0.0002%	
Disposable Personal Income	Millions of Fixed 2010$	0.0001%	0.0001%	0.0001%	0.0001%	0.0001%	0.0002%	
PCE-Price Index	2005=100	0.0000%	0.0000%	0.0001%	0.0001%	0.0000%	-0.0001%	
Population	Number of People	0.0000%	0.0000%	0.0001%	0.0001%	0.0002%	0.0002%	

Table 29. Macroeconomic Impact Analysis Results of AFW-2 Urban Forestry

Differences from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
Total Employment	Jobs	-356	16	899	1,091	1,440	1,282	871
GDP	Millions of Fixed 2010$	-45	-31	17	11	29	-2	-54
Output	Millions of Fixed 2010$	-65	-43	28	17	39	-13	-74
Disposable Personal Income	Millions of Fixed 2010$	-23	-18	0	4	18	16	-40
PCE-Price Index	2005=100	0.000	0.001	0.005	0.007	0.009	0.009	N/A
Population	Number of People	-94	-152	78	498	852	1,115	N/A
Baseline Plus Addition of Policy								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	10,220,813	10,535,897	11,058,627	11,459,112	11,927,617	12,521,968	
GDP	Millions of Fixed 2010$	1,000,798	1,079,326	1,275,649	1,403,191	1,555,252	1,746,374	
Output	Millions of Fixed 2010$	1,532,193	1,654,586	1,953,901	2,160,585	2,398,299	2,679,079	
Disposable Personal Income	Millions of Fixed 2010$	755,343	803,366	926,532	1,030,060	1,152,201	1,308,563	
PCE-Price Index	2005=100	110.9	116.8	133.6	153.3	176.8	204.9	
Population	Number of People	18,215,281	18,413,430	18,995,840	19,606,332	20,325,464	21,212,221	
Percent Change from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	-0.0035%	0.0001%	0.0081%	0.0095%	0.0121%	0.0102%	
GDP	Millions of Fixed 2010$	-0.0045%	-0.0029%	0.0013%	0.0008%	0.0018%	-0.0001%	
Output	Millions of Fixed 2010$	-0.0043%	-0.0026%	0.0014%	0.0008%	0.0016%	-0.0005%	
Disposable Personal Income	Millions of Fixed 2010$	-0.0030%	-0.0022%	0.0001%	0.0004%	0.0016%	0.0012%	
PCE-Price Index	2005=100	0.0003%	0.0010%	0.0035%	0.0044%	0.0049%	0.0043%	
Population	Number of People	-0.0005%	-0.0008%	0.0004%	0.0025%	0.0042%	0.0053%	

Table 30. Macroeconomic Impact Analysis Results of AFW-5 Increase On-Farm Energy Efficiency & Renewable Energy Production

Differences from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
Total Employment	Jobs	68	59	44	44	28	43	48
GDP	Millions of Fixed 2010$	9	8	4	2	-4	-4	46
Output	Millions of Fixed 2010$	17	14	10	6	-8	-7	93
Disposable Personal Income	Millions of Fixed 2010$	3	3	4	8	12	20	89
PCE-Price Index	2005=100	0.000	0.000	0.000	0.000	0.000	0.000	N/A
Population	Number of People	12	29	55	76	94	86	N/A
Baseline Plus Addition of Policy								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	10,221,238	10,535,940	11,057,771	11,458,065	11,926,205	12,520,729	
GDP	Millions of Fixed 2010$	1,000,851	1,079,365	1,275,637	1,403,182	1,555,217	1,746,372	
Output	Millions of Fixed 2010$	1,532,274	1,654,644	1,953,882	2,160,575	2,398,252	2,679,084	
Disposable Personal Income	Millions of Fixed 2010$	755,370	803,386	926,536	1,030,065	1,152,197	1,308,568	
PCE-Price Index	2005=100	110.9	116.8	133.6	153.3	176.7	204.9	
Population	Number of People	18,215,387	18,413,611	18,995,816	19,606,332	20,325,465	21,212,221	
Percent Change from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	0.0007%	0.0006%	0.0004%	0.0004%	0.0002%	0.0003%	
GDP	Millions of Fixed 2010$	0.0008%	0.0007%	0.0004%	0.0002%	-0.0003%	-0.0002%	
Output	Millions of Fixed 2010$	0.0011%	0.0009%	0.0005%	0.0003%	-0.0003%	-0.0003%	
Disposable Personal Income	Millions of Fixed 2010$	0.0005%	0.0004%	0.0005%	0.0008%	0.0011%	0.0015%	
PCE-Price Index	2005=100	0.0000%	0.0001%	0.0002%	0.0001%	0.0000%	-0.0001%	
Population	Number of People	0.0001%	0.0002%	0.0003%	0.0004%	0.0005%	0.0004%	

Integrated Analysis of All ECR Options

Table 31 presents the integrated macroeconomic impacts of the ten ECR options. This simulation is based on an integrated analysis of all the quantifiable ECR options modeled in one simultaneous run in the REMI Model. The simultaneous run provides the macro impacts for the case that all of the options are implemented together, eliminating the potential double-counting of the impacts among the options. The results highlight the following impacts of the ECR options on the SCAG economy:

- An employment increase of 61,191 jobs by 2035, or an increase of about 0.49% over the baseline level;
- An average gain of 20,781 additional jobs per year over the entire planning period;
- A net increase in disposable personal incomes of about $10.5 billion in NPV;
- A decrease in GDP of $1.16 billion in 2035, or a decrease of about -0.06% over the baseline level; and
- A net decrease in GDP of about $17.8 billion in NPV over the entire planning period.

The main reason that the results project an overall moderate positive employment impact, but slightly negative GDP impact, is that the sectors benefiting directly and indirectly from the implementation of these options (such as professional and technical service sector and renewable energy sector) are relatively more labor-intensive than those adversely affected (such as conventional energy supply sectors).

Table 32 presents the summary results of employment and GDP impacts of the ECR options. This table first presents the impacts of each individual option and then presents the summation total of the impacts of individual options, as well as the simultaneous simulation results of the 10 options. The simulation results indicate that options in the Residential, Commercial, and Industrial sector are expected to result in the highest positive impacts to the SCAG economy. Options in Energy Supply sector are expected to result in overall negative employment and GDP impacts on the SCAG economy. The overall negative GDP impacts from the integrated analysis of the 10 ECR options are primarily due to the impacts of the ES options, especially ES-1 and ES-2. From the microeconomic analysis result table (Table 19), these two options result in the highest direct net cost ($5.0 billion and $4.6 billion, respectively) among all the options. The negative impacts from these two options mainly stem from the high capital cost of the renewable electricity generation compared with the avoided fossil fuel electricity generation.

A comparison between the summation of simulations of individual option and the simultaneous simulation shows that the former yields higher positive employment impacts and lower negative GDP impacts to the economy. However, the differences are within 8%. The overlaps between the options have been accounted for in the microeconomic analysis and have been eliminated before performing the macroeconomic analysis. The difference between the simultaneous simulation and the ordinary sum can be explained by the non-linearity in the REMI model and synergies in economic actions it captures. Given that the impacts are not calculated through fixed multipliers in the REMI Model and the simulation results are magnitude-dependent, it is not surprising that when we model all the mitigation options together, we obtain different results than when we compute the sum of the results of each option modeled separately.

Table 31. Integrated Macroeconomic Impacts of All Ten ECR Options

Differences from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
Total Employment	Jobs	-2,892	6	5,087	18,375	39,331	61,191	20,781
GDP	Millions of Fixed 2010$	-582	-763	-1,830	-2,155	-1,782	-1,162	-17,814
Output	Millions of Fixed 2010$	-645	-903	-2,809	-3,593	-3,238	-2,561	-27,066
Disposable Personal Income	Millions of Fixed 2010$	-323	-173	47	1,020	2,740	4,759	10,522
PCE-Price Index	2005=100	0.026	0.006	-0.033	-0.098	-0.176	-0.248	N/A
Population	Number of People	-3,336	-3,209	1,662	15,482	41,633	76,252	N/A
Baseline Plus Addition of Policy								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	10,218,278	10,535,888	11,062,814	11,476,396	11,965,508	12,581,877	
GDP	Millions of Fixed 2010$	1,000,261	1,078,595	1,273,803	1,401,026	1,553,441	1,745,214	
Output	Millions of Fixed 2010$	1,531,613	1,653,725	1,951,063	2,156,975	2,395,022	2,676,530	
Disposable Personal Income	Millions of Fixed 2010$	755,044	803,211	926,578	1,031,077	1,154,924	1,313,308	
PCE-Price Index	2005=100	110.9	116.8	133.6	153.2	176.6	204.6	
Population	Number of People	18,212,039	18,410,373	18,997,424	19,606,332	20,325,465	21,212,221	
Percent Change from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	-0.0283%	0.0001%	0.0460%	0.1604%	0.3298%	0.4887%	
GDP	Millions of Fixed 2010$	-0.0581%	-0.0707%	-0.1435%	-0.1535%	-0.1146%	-0.0665%	
Output	Millions of Fixed 2010$	-0.0421%	-0.0546%	-0.1438%	-0.1663%	-0.1350%	-0.0956%	
Disposable Personal Income	Millions of Fixed 2010$	-0.0427%	-0.0216%	0.0050%	0.0991%	0.2378%	0.3637%	
PCE-Price Index	2005=100	0.0238%	0.0051%	-0.0249%	-0.0638%	-0.0996%	-0.1210%	
Population	Number of People	-0.0183%	-0.0174%	0.0087%	0.0790%	0.2048%	0.3595%	

Table 32. Summary of ECR Options Macro Impacts

Gross Domestic Product (Millions of Fixed 2010$)								
Scenario	**Policy Option**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**NPV**
	ES1	-$1,026	-$1,280	-$2,010	-$2,381	-$2,690	-$3,001	-$23,908
	ES2	$391	$226	-$532	-$1,064	-$1,615	-$2,084	-$7,336
	ES6	-$21	-$49	-$64	-$62	$67	$314	-$73
Subtotal - ES		-$655	-$1,102	-$2,606	-$3,507	-$4,239	-$4,771	-$31,317
	RCI1	-$329	-$326	-$316	-$169	$116	$475	-$3,056
	RCI2	$261	$499	$868	$965	$1,303	$1,565	$10,667
	RCI3	$42	$34	-$47	-$77	-$109	-$147	-$516
	RCI6	$134	$155	$271	$696	$1,259	$1,889	$7,086
Subtotal - RCI		$108	$363	$776	$1,416	$2,570	$3,781	$14,180
	AFW1	$1	$1	$2	$2	$2	$3	$20
	AFW2	-$45	-$31	$17	$11	$29	-$2	-$54
	AFW5	$9	$8	$4	$2	-$4	-$4	$46
Subtotal - AFW		-$35	-$22	$23	$16	$27	-$3	$11
Summation Total		**-$583**	**-$762**	**-$1,807**	**-$2,075**	**-$1,642**	**-$994**	**-$17,126**
Simultaneous Total		**-$582**	**-$763**	**-$1,830**	**-$2,155**	**-$1,782**	**-$1,162**	**-$17,814**

Employment (number of jobs)								
Scenario	**Policy Option**	**2,013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Years**
	ES1	-9,643	-11,856	-15,762	-16,773	-17,813	-18,701	-15,962
	ES2	3,088	1,853	-2,719	-4,525	-5,798	-5,764	-2,871
	ES6	106	336	1,254	3,705	7,442	9,859	4,087
Subtotal - ES		-6,449	-9,667	-17,227	-17,593	-16,169	-14,606	-14,746
	RCI1	-2,410	-732	3,873	10,673	19,247	29,015	10,237
	RCI2	3,530	6,786	12,523	16,044	22,751	29,170	16,158
	RCI3	346	289	-356	-416	-444	-472	-267
	RCI6	2,455	3,446	6,181	10,374	15,237	19,986	10,127
Subtotal - RCI		3,921	9,789	22,221	36,675	56,791	77,699	36,255
	AFW1	16	14	21	19	19	20	16
	AFW2	-356	16	899	1,091	1,440	1,282	871
	AFW5	68	59	44	44	28	43	48
Subtotal - AFW		-272	89.0	964.0	1,154.0	1,487.0	1,345.0	934.3
Summation Total		**-2,800**	**211**	**5,958**	**20,236**	**42,109**	**64,438**	**22,443**
Simultaneous Total		**-2,892**	**6**	**5,087**	**18,375**	**39,331**	**61,191**	**20,781**

3.4.3. Sectoral Impacts

Table 33 presents the results in relation to major sectors that are positively and negatively affected by the ECR policy options. The results are presented in terms of both employment and GDP impacts, and in absolute and percentage terms, respectively.

In terms of employment impacts, from the absolute impact perspective, most of the top positively stimulated sectors are those related to household spending (e.g., Retail Trade, Restaurant and Accommodation, Health Services, Real Estate, Financial Services, etc.) and the implementation of renewable energy (e.g., Semiconductor and Other Electric Components). The major negatively affected sectors include electric power generation and fossil fuel production sectors. There are three reasons that the Construction sector is projected to be the top negatively affected sector in terms of absolute employment impact. First, the reduced demand for electricity from energy efficiency improvement in the RCI sectors would reduce the need to build new power plants, which will in turn reduce the demand for the Construction. Second, compared with conventional electricity generation, renewable electricity generation has a relatively lower percentage investment demand for the Construction. Third, the Construction sector is among the top five sectors with respect to total employment in the SCAG region. Therefore, even a small percentage change of employment in this sector would result in relatively high changes in absolute terms. From the percentage change perspective, Ag and Forestry related sectors and some Manufacturing sectors, especially those related to energy-efficiency equipment production, are expected to experience large percentage employment increases by 2035. The major negatively affected sectors in relation to percentage employment change are electric power generation, and fossil fuel production and delivery sectors.

The second section of Table 33 shows the sectoral GDP impacts in both absolute and percentage terms, respectively. The top impacted sectors are very similar to those in the sectoral employment impact analysis. In general, sectors related to household spending and renewable and energy-efficient appliances and equipment manufacturing are expected to contribute most to GDP increases, while electricity generation and fossil fuel production and distribution sectors are expected to be most negatively impacted by the ECR options.

In the LA Metropolitan area, four industry groups -- Transportation and Utilities, Educational Services, Health Care and Social Services, and Public Administration -- combined account for over two-thirds of the total union labor (Appelbaum and Zipperer, 2011). Our simulation indicates that implementing all of the 10 ECR options together would result in an average annual increase of nearly 6 thousand new jobs in these four industry groups in aggregate during the planning period. Sectors with a high percentage of union membership are expected to experience overall positive gains in employment, except the Utilities sector and Public Administration sector. The negative employment impacts for these two sectors are mainly caused by policy option ES-1 RPS.

Table 33. Major Sectoral Impacts of ECR Options

Top 10 Positive and Negative Impacted Sectors in terms of Absolute Per Year Employment Impact (Jobs)	
Top 10 Positive Impact	***Top 10 Negative Impact***
Retail Trade	Construction
Food Services and Drinking Places	Computer Systems Design and Related Services
Offices of Health Practitioners	Water, Sewage, and Other Systems
Elementary and Secondary Schools; Junior Colleges, Colleges, Universities, and Professional Schools; Other Educational Services	Electric Power Generation, Transmission, and Distribution
Monetary Authorities, Credit Intermediation, and Related Activities	Architectural, Engineering, and Related Services
Real Estate	Natural Gas Distribution
Semiconductor and Other Electronic Component Manufacturing	Oil and Gas Extraction
Accommodation	Software Publishers
Personal Care Services	Employment Services
Hospitals	Legal Services
Top 10 Positive and Negative Impacted Sectors in terms of Percentage Employment impacts in 2035	
Top 10 Positive Impact	***Top 10 Negative Impact***
Alumina and Aluminum Production and Processing	Water, Sewage, and Other Systems
Basic Chemical Manufacturing	Electric Power Generation, Transmission, and Distribution
Fiber, Yarn, and Thread Mills	Natural Gas Distribution
Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	Oil and Gas Extraction
Forestry; Fishing, Hunting, Trapping	Support Activities for Mining
Ventilation, Heating, Air-Conditioning, and Commercial Refrigeration Equipment Manufacturing	Computer Systems Design and Related Services
Electric Lighting Equipment Manufacturing	Software Publishers
Veneer, Plywood, and Engineered Wood Product Manufacturing	Pipeline Transportation
Sawmills and Wood Preservation	Railroad Rolling Stock Manufacturing
Pulp, Paper, and Paperboard Mills	Metalworking Machinery Manufacturing
Top 10 Positive and Negative Impacted Sectors in terms of Absolute GSP impacts in NPV (million 2010$)	
Top 10 Positive Impact	***Top 10 Negative Impact***
Monetary Authorities, Credit Intermediation, and Related Activities	Electric Power Generation, Transmission, and Distribution
Semiconductor and Other Electronic Component Manufacturing	Construction
Real Estate	Water, Sewage, and Other Systems
Offices of Health Practitioners	Computer Systems Design and Related Services
Retail Trade	Software Publishers
Securities, Commodity Contracts, and Other Financial Investments and Related Activities	Natural Gas Distribution
Hospitals	Architectural, Engineering, and Related Services
Accommodation	Wholesale Trade
Management of Companies and Enterprises	Oil and Gas Extraction
Food Services and Drinking Places	Computer and Peripheral Equipment Manufacturing
Top 10 Positive and Negative Impacted Sectors in terms of Percentage GDP impacts in 2035	
Top 10 Positive Impact	***Top 10 Negative Impact***
Forestry; Fishing, Hunting, Trapping	Electric Power Generation, Transmission, and Distribution
Ventilation, Heating, Air-Conditioning, and Commercial	Water, Sewage, and Other Systems

Top 10 Positive and Negative Impacted Sectors in terms of Absolute Per Year Employment Impact (Jobs)	
Top 10 Positive Impact	***Top 10 Negative Impact***
Refrigeration Equipment Manufacturing	
Electric Lighting Equipment Manufacturing	Natural Gas Distribution
Alumina and Aluminum Production and Processing	Oil and Gas Extraction
Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	Support Activities for Mining
Household Appliance Manufacturing	Computer Systems Design and Related Services
Support Activities for Agriculture And Forestry	Pipeline Transportation
Veneer, Plywood, and Engineered Wood Product Manufacturing	Software Publishers
Air Transportation	Metalworking Machinery Manufacturing
Basic Chemical Manufacturing	Railroad Rolling Stock Manufacturing

3.4.4. Sensitivity Tests

Several sensitivity tests were run to analyze how the changes in some key assumptions would affect the macroeconomic impact analysis results for the ECR options.

Percentage of renewable electricity generation equipment and energy-efficient appliances and equipment produced within the SCAG region

Regional Purchase Coefficients (RPCs) in the REMI model determine what percent of the demand for each good or service is produced within the SCAG Region. Sensitivity analyses on this variable enable us to examine the impacts related to business decisions under new regulations, such as whether to purchase goods and services from in-region or out-of-region sources, or whether to locate manufacturing facilities within the region or move existing facilities outside of the region. For example, decreasing a baseline RPC can represent a situation in which businesses leave the region, due to increased uncertainties about the regulations, for instance. Conversely, increasing a baseline RPC can represent the attraction of new business into the region, due to aggressive industrial targeting efforts, for example.

In this section, we perform sensitivity analyses on the RPCs for key sectors that produce major renewable electricity generation equipment or energy-efficient appliances and equipment. In the Base Case, the REMI Model utilizes projected RPCs, estimated using historical data, for the manufacturing sectors of energy-efficient and renewable equipment. Increasing the values of RPCs for these manufacturing sectors will increase the percentage of demand for mitigation equipment supplied by regional companies. This can also represent the case where more companies that produce these goods will be attracted to the SCAG region due to the incentive policies the regional governments may adopt to promote green technologies and thus achieve the climate mitigation goal. On the other hand, decreasing the values of RPCs of the related manufacturing sectors is consistent with the assumption that some of the existing companies will move out of the SCAG Region, and thus a lower percentage of the demand for mitigation equipment will be supplied by local companies.[12]

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[12] In the REMI model, RPC is a pre-determined exogenous variable. In order to change the RPC of a particular sector, a combination of the "Industry Sales" and "Exogenous Final Demand" variables should be used. The former variable is used when we assume 100% of the increased demand is supplied by the in-state producers. The second variable applies the default RPC of a sector. A proper split of the final demand increase between these two variables will yield the desired

The impacts of changes in the default RPCs on the macro simulation results are performed for two policy options: RCI-1 (DSM) and ES-1 (RPS). The default RPCs for the directly affected sectors in these two options differ, ranging from 6% (Household Appliance Manufacturing sector) to 40% (Semiconductor and Other Electronic Component Manufacturing sector). For RCI-1, the weighted average of the default RPCs of energy-efficient appliances and equipment manufacturing sectors in the SCAG Region REMI model is about 20%, meaning that on average 20% of the demand for goods and services from these sectors can be supplied by the companies located within the SCAG Region. For ES-1, the weighted average of the default RPCs of the renewable electricity generation equipment manufacturing sectors in the REMI model is about 30%, meaning that on average 30% of this equipment can be supplied by the companies located within the SCAG Region. In the sensitivity tests, we assume that the RPCs of these key sectors are 50% higher or lower than the default values used in the Base Case simulations. In other words, for RCI-1, the 50% lower and higher weighted average RPCs in the two sensitivity tests are 10% and 30%, respectively. For ES-1, the weighted average RPCs are 15% and 45%, respectively, in the 50% lower and 50% higher RPCs cases.

Tables 34 and 35 show the sensitivity test results for RCI-1 (DSM) and ES-1(RPS), respectively. Please note, for ES-1 RPS, the renewable deployment will take place in three regions (SCAG Region, Rest of CA, and Rest of U.S.), but in the sensitivity test, we only change the percentage of in-region supply of renewable generation equipment for the SCAG Region. The sensitivity test results for both of the two ECR options indicate that a 50% increase in the in-region supply of energy-efficient equipment or renewable generation equipment would improve the macroeconomic performance of the options: the positive employment impact of RCI-1 can be increased by 13%, and the negative employment impact of ES-1 can be improved by 7%. With 50% lower RPCs of the key related equipment manufacturing sectors, the macro impacts of both options would worsen: the positive employment impact of RCI-1 would be reduced by 14%, and the negative employment impact of ES-1 would be increased by 8%.

Projected Price of Natural Gas

In this sensitivity test, we assume that the price of natural gas for the displaced NGCC generation in ES-1 is 50% higher than the price used in the Base Case analysis. The results indicate that a 50% higher projection on natural gas price would improve the macroeconomic performance of ES-1 by about 30% in terms of both employment and GDP impacts (see Table 36). The higher price of natural gas makes renewables more competitive. The results indicate that 50% higher price of natural will not result in positive economic impacts for the RPS. However, negative impacts on employment could be decreased from an annual average of 15,962 to 11,934 jobs and negative impacts in GDP could be decreased from an NPV of $23.9 billion to an NPV of $15.6 billion. The technical methodology for this sensitivity analysis as well as a sensitivity analysis on lower natural gas prices is documented in a November 7, 2012 memorandum from CCS to SCAG and provided in Appendix E to this report.

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level of demand that is satisfied by in-state production. Unfortunately, one cannot change the default RPC of a sector directly in REMI, and, since this approach only adjusts the direct effect, the successive rounds of indirect effects would still be computed using the default RPC of the sectors.   However, the indirect rounds of demand for these goods are likely to be very small.

Table 34. Sensitivity Test on the Percentage of In-Region Supply of Energy-Efficient Equipment/Appliances for RCI-1 (DSM)

Category	Units	50% Lower RPC Case	Base Case	50% Higher RPC Case
Differences from Baseline Level (2013-2035)				
Average Annual Employment	Jobs per year	8,741	10,237	11,557
Gross Domestic Product (NPV)	Millions of Fixed 2010$	-5,597	-3,056	-802
Output (NPV)	Millions of Fixed 2010$	-11,434	-6,733	-2,506
Disposable Personal Income (NPV)	Millions of Fixed 2010$	7,785	8,880	9,985
Percent Change from Baseline Level (2035)				
Total Employment	Jobs	0.2224%	0.2317%	0.2402%
Gross Domestic Product	Millions of Fixed 2010$	0.0159%	0.0272%	0.0375%
Output	Millions of Fixed 2010$	-0.0068%	0.0069%	0.0194%
Disposable Personal Income	Millions of Fixed 2010$	0.2105%	0.2171%	0.2242%

Table 35. Sensitivity Test on the Percentage of In-Region Supply of Renewable Electricity Generation Equipment for ES-1 (RPS)

Category	Units	50% Lower RPC Case	Base Case	50% Higher RPC Case
Differences from Baseline Level (2013-2035)				
Average Annual Employment	Jobs per year	-17,341	-15,962	-14,811
Gross Domestic Product (NPV)	Millions of Fixed 2010$	-27,282	-23,908	-21,043
Output (NPV)	Millions of Fixed 2010$	-42,842	-36,643	-31,255
Disposable Personal Income (NPV)	Millions of Fixed 2010$	-19,402	-17,792	-16,316
Percent Change from Baseline Level (2035)				
Total Employment	Jobs	-0.1505%	-0.1494%	-0.1484%
Gross Domestic Product	Millions of Fixed 2010$	-0.1727%	-0.1718%	-0.1712%
Output	Millions of Fixed 2010$	-0.1754%	-0.1745%	-0.1739%
Disposable Personal Income	Millions of Fixed 2010$	-0.1664%	-0.1649%	-0.1630%

Table 36. Sensitivity Test on the Projected Price of Natural Gas (NG) used in the Displaced NGCC Generation for ES-1 (RPS)

Category	Units	Base Case	Higher NG Price
Differences from Baseline Level (2013-2035)			
Average Annual Employment	Jobs per year	-15,962	-11,394
Gross Domestic Product (NPV)	Millions of Fixed 2010$	-23,908	-15,621
Output (NPV)	Millions of Fixed 2010$	-36,643	-24,216
Disposable Personal Income (NPV)	Millions of Fixed 2010$	-17,792	-9,109
Percent Change from Baseline Level (2035)			
Total Employment	Jobs	-0.1494%	-0.1053%
Gross Domestic Product	Millions of Fixed 2010$	-0.1718%	-0.1166%
Output	Millions of Fixed 2010$	-0.1745%	-0.1205%
Disposable Personal Income	Millions of Fixed 2010$	-0.1649%	-0.0935%

Capital Cost of Renewable Electricity Generation

In this sensitivity test, we analyze the impacts of variations in the capital cost of renewable electricity generation in ES-1 RPS on the macro impact of this option. Specifically, we assume that the capital cost of renewable generation is 50% lower or higher than the capital cost used in the Base Case analysis. The results are presented in Tables 37. The results indicate that, if the capital cost of renewable electricity generation can be decreased by 50%, the macroeconomic impacts of ES-1 can be greatly improved to about $2 billion in positive GDP impacts and only slightly over 300 average annual job losses over the entire planning period. However, if the capital cost of renewable generation is higher than in the Base Case by 50%, the negative impacts on employment and GDP of ES-1 would be more than doubled. Comparing the sensitivity test results in Tables 34-37, we find that capital cost of the renewable electricity generation is the most influential factor that affects the macroeconomic impact outcome of ES-1.

Table 37. Sensitivity Test on the Capital Cost of ES-1 for Renewable Electricity Generation (RPS)

Category	Units	Higher Capital Cost of Renewable Generation	Base Case	Lower Capital Cost of Renewable Generation
Differences from Baseline Level (2013-2035)				
Average Annual Employment	Jobs per year	-31,490	-15,962	-311
Gross Domestic Product (NPV)	Millions of Fixed 2010$	-49,322	-23,908	1,966
Output (NPV)	Millions of Fixed 2010$	-75,241	-36,643	2,653
Disposable Personal Income (NPV)	Millions of Fixed 2010$	-39,918	-17,792	4,667
Percent Change from Baseline Level (2035)				
Total Employment	Jobs	-0.2989%	-0.1494%	0.0000%
Gross Domestic Product	Millions of Fixed 2010$	-0.3501%	-0.1718%	0.0078%
Output	Millions of Fixed 2010$	-0.3530%	-0.1745%	0.0052%
Disposable Personal Income	Millions of Fixed 2010$	-0.3610%	-0.1649%	0.0318%

Percentage of ordinary private investment displacement

In the Base Case, it is assumed that 50% of the in-Region private capital investment will come from the displacement of ordinary investment in plant and equipment, meaning that 50% of the incremental capital investment by businesses will simply displace other investment in the SCAG Region, and thus only 50% of the investment will be directly additive to the Region's economy. In the sensitivity tests, we simulate two alternatives: 25% and 75% displacement of ordinary private investment in the simultaneous run of all the 10 ECR options together. A comparison of the macroeconomic impacts of the Base Case and the two sensitivity tests on the percentage of ordinary investment displacement is shown in Table 38. The simulation results indicate that when a higher percentage of the mitigation investment is additive (less displacement of ordinary investment), more favorable employment, GDP, output, and personal income impacts will ensue.

Table 38. Sensitivity Tests on the Percentage of Ordinary Investment Displacement (Simultaneous Runs for All ECR Options)

Category	Units	25% Displacement	Base Case (50% Displacement)	75% Displacement
Differences from Baseline Level (2013-2035)				
Average Annual Employment	Jobs per year	22,654	20,781	19,017
Gross Domestic Product (NPV)	Millions of Fixed 2010$	-9,091	-20,268	-26,414
Output (NPV)	Millions of Fixed 2010$	-13,754	-32,404	-40,189
Disposable Personal Income (NPV)	Millions of Fixed 2010$	16,511	11,005	4,437
Percent Change from Baseline Level (2035)				
Total Employment	Jobs	0.4634%	0.4887%	0.5151%
Gross Domestic Product	Millions of Fixed 2010$	-0.0401%	-0.0665%	-0.0922%
Output	Millions of Fixed 2010$	-0.0716%	-0.0956%	-0.1187%
Disposable Personal Income	Millions of Fixed 2010$	0.3991%	0.3637%	0.3270%

Discount Rate

When we evaluate the impacts on gross domestic product, it is important to consider the time value of money. People place a higher value on cash flows today than if they are delayed into the future. In the Base Case, we discount the cash flows between 2011 and 2035 to present values at a rate of 5%. Table 39 compares GDP impacts using alternative discount rates. The middle numerical column of Table 39 replicates the net present values shown in Table 32, while the first numerical column shows the net present value calculation based on a 2% discount rate, and the third numerical column shows the calculation using an 8% discount rate. In general, the absolute value of the total net present value decreases when the discount rate increases and vice versa. This sensitivity test shows that the net present value of GDP impacts ranges between around -$27 billion to -$12 billion in the simultaneous simulation when the discount rate varies between 2% and 8%.

3.4.5. Economic Impacts Outside of the SCAG Region

Table 40 and Table 41 present the impacts of the ECR options on the Rest of California and Rest of U.S. economies. In general, the regions outside of the SCAG Region would experience slightly negative impacts due to the implementation of the ECR options. There are several reasons for this result. First, the flows of capital investment from rest of CA and rest of U.S. to the SCAG region tend to lower the investment activities in regions elsewhere. Second, in ES-1 RPS, certain portions of the renewable electricity generation will take place outside of the SCAG region. The overall high capital cost of renewable electricity generation compared with the displaced NGCC generation would result in similar net negative impacts on these regions as in the SCAG region. Finally, we find that for the RCI options, although the stimulus effects stemming from energy savings in the SCAG region would generate positive spillover effects to the other two regions, this stimulus effect cannot offset the spillover of the negative effects on the utility sectors resulting from the reduced demand for electricity and various fossil fuels in the SCAG region. In other words, while more of the positive re-spending effects of the energy savings to businesses and households tend to remain in the SCAG region, the dampening effect on the utility and energy supply sectors are greater in the other regions.

Table 39. GDP NPV Impacts with Alternative Discount Rates (million 2010$)

Discount Rate		**2%**	**5%**	**8%**
Scenario		**NPV**	**NPV**	**NPV**
	ES1	-$36,632	-$26,717	-$16,245
	ES2	-$13,418	-$8,235	-$3,952
	ES6	$166	-$77	-$159
Subtotal - ES		-$49,884	-$35,029	-$20,356
	RCI1	-$3,324	-$2,538	-$2,737
	RCI2	$16,357	$11,112	$7,290
	RCI3	-$944	-$542	-$279
	RCI6	$11,879	$7,440	$4,416
Subtotal - RCI		$23,969	$15,472	$8,690
	AFW1	$30	$21	$14
	AFW2	-$22	-$57	-$68
	AFW5	$52	$48	$39
Subtotal - AFW		$60	$12	-$15
Summation Total		**-$25,855**	**-$19,544**	**-$11,681**
Simultaneous Total		**-$27,038**	**-$20,268**	**-$12,095**

Table 40. Impacts of ECR Options on the Rest of CA Economy

Differences from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
Total Employment	Jobs	-247	-3,230	-10,787	-16,190	-22,492	-29,416	-14,495
GDP	Millions of Fixed 2010$	-305	-676	-2,084	-3,311	-4,686	-6,299	-28,873
Output	Millions of Fixed 2010$	-403	-903	-3,150	-5,137	-7,269	-9,714	-42,329
Disposable Personal Income	Millions of Fixed 2010$	-340	-543	-1,235	-1,721	-2,312	-3,097	-16,765
PCE-Price Index	2005=100	0.061	0.061	0.072	0.067	0.062	0.056	N/A
Population	Number of People	109	-2,490	-11,588	-21,844	-32,604	-43,986	N/A
Baseline Plus Addition of Policy								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	11,335,853	11,825,795	12,734,234	13,289,589	13,861,139	14,475,791	
GDP	Millions of Fixed 2010$	1,179,595	1,300,377	1,608,105	1,795,183	2,007,530	2,253,754	
Output	Millions of Fixed 2010$	1,796,365	1,990,503	2,476,959	2,788,190	3,131,583	3,505,305	
Disposable Personal Income	Millions of Fixed 2010$	845,795	910,663	1,077,288	1,204,724	1,346,194	1,516,555	
PCE-Price Index	2005=100	119.0	125.4	143.8	165.0	190.1	220.0	
Population	Number of People	19,606,703	20,041,039	21,325,215	22,571,852	23,766,956	24,929,506	
Percent Change from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	-0.0022%	-0.0273%	-0.0846%	-0.1217%	-0.1620%	-0.2028%	
GDP	Millions of Fixed 2010$	-0.0259%	-0.0520%	-0.1294%	-0.1841%	-0.2328%	-0.2787%	
Output	Millions of Fixed 2010$	-0.0224%	-0.0453%	-0.1270%	-0.1839%	-0.2316%	-0.2763%	
Disposable Personal Income	Millions of Fixed 2010$	-0.0403%	-0.0596%	-0.1145%	-0.1426%	-0.1715%	-0.2038%	
PCE-Price Index	2005=100	0.0514%	0.0486%	0.0502%	0.0409%	0.0324%	0.0255%	
Population	Number of People	0.0006%	-0.0124%	-0.0543%	-0.0968%	-0.1372%	-0.1764%	

Table 41. Impacts of ECR Options on the Rest of U.S. Economy

Differences from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
Total Employment	Jobs	5,484	1,766	-12,609	-24,438	-42,328	-62,484	-22,702
GDP	Millions of Fixed 2010$	-244	-654	-2,621	-4,434	-7,279	-10,845	-41,213
Output	Millions of Fixed 2010$	-390	-1,102	-4,475	-7,399	-11,945	-17,501	-78,148
Disposable Personal Income	Millions of Fixed 2010$	-708	-851	-1,685	-2,150	-3,093	-4,511	-25,396
PCE-Price Index	2005=100	0.012	0.011	0.011	0.006	0.002	-0.003	N/A
Population	Number of People	3,219	5,688	9,906	6,156	-9,469	-32,875	N/A
Baseline Plus Addition of Policy								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	161,625,563	166,369,828	173,977,422	180,662,656	187,545,406	195,289,938	
GDP	Millions of Fixed 2010$	13,933,073	15,008,009	17,672,470	19,502,763	21,590,194	24,069,806	
Output	Millions of Fixed 2010$	21,732,571	23,419,587	27,523,105	30,535,463	33,873,398	37,588,706	
Disposable Personal Income	Millions of Fixed 2010$	10,982,364	11,668,460	13,414,155	14,847,930	16,468,654	18,452,433	
PCE-Price Index	2005=100	111.2	117.1	133.7	153.4	176.7	204.3	
Population	Number of People	280,749,031	286,230,813	300,108,281	313,719,782	327,383,969	341,090,219	
Percent Change from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	
Total Employment	Jobs	0.0034%	0.0011%	-0.0072%	-0.0135%	-0.0226%	-0.0320%	
GDP	Millions of Fixed 2010$	-0.0017%	-0.0044%	-0.0148%	-0.0227%	-0.0337%	-0.0450%	
Output	Millions of Fixed 2010$	-0.0018%	-0.0047%	-0.0163%	-0.0242%	-0.0353%	-0.0465%	
Disposable Personal Income	Millions of Fixed 2010$	-0.0064%	-0.0073%	-0.0126%	-0.0145%	-0.0188%	-0.0244%	
PCE-Price Index	2005=100	0.0105%	0.0094%	0.0080%	0.0041%	0.0009%	-0.0014%	
Population	Number of People	0.0011%	0.0020%	0.0033%	0.0020%	-0.0029%	-0.0096%	

3.4.6. Discussion of Results

The results presented in this study are consistent with those of most studies for other regions of the U.S. These studies have generally projected very slight positive improvements in economic activity as a result of the implementation of climate action plans, with the employment impacts generally being greater than GDP and personal income impacts owing to the relatively high labor-intensity of green technology manufacturing and construction (Miller et al., 2010; Pollin et al., 2009; Rose and Dormady, 2011; Rose et al., 2011; Roland-Holst, 2010). Many of the studies have indicated negative macro impacts from some individual options, especially RPS. Studies that include cap-and-trade features generally find more positive impacts than those that do not, owing to the ability of this policy instrument to induce the least-cost combination of responses (see, e.g., Rose et al., 2010; Rose et al., 2012). At the same time, many studies overestimate the ability of various mitigation options to respond to price signals.

As noted above, the macro impacts of the SCAG ECR options can become less negative or more positive if conditions depart from Base Case assumptions. Some of the assumptions, as for example, natural gas prices, are based on projections, including changing market conditions. However, others are based on historical experience (in-region production of green technologies) or on equal likelihood in the absence of better information (geographic origin of investment funds). The in-region production of green technologies is likely to increase as a result of market forces in general and as a result of the fact that California has been a leader in this area, including production for export markets. Also, California may have an edge in attracting investment from outside the State given the fact that it is out front in implementing a climate action plan. Still, the results provide a basis for government and the private sector cooperation in achieving the best possible outcome of climate policy.

3.4.7. Conclusion

This section summarizes the analysis of the macroeconomic impacts on the SCAG Region economy of ten major ECR mitigation options to comply with AB 32. We used a state of the art macroeconometric model to perform this analysis. The data used in this study are based on the microeconomic impact analysis of the cost and saving estimates associated with the ECR options, and are supplemented by a set of standard macroeconomic modeling assumptions. The modeling framework applied in this study is the REMI PI+ Model, the most widely used macroeconometric-modeling tool in the United States.

The macroeconomic analysis results indicate that, as a group, the recommended ECR GHG mitigation policy options yield a net positive impact on the SCAG Region's economy in terms of employment and personal income but a slightly negative impact on GDP. On net, the combination of the 10 options are expected to result in positive employment impacts of about 61.2 thousand new jobs and a slightly negative GDP impact of about -$1.1 billion by the Year 2035.

More than half of the individual options themselves yield net positive impacts in terms of employment impact. The Building Codes option is estimated to contribute the highest economic gains. This stems primarily from their ability to improve energy efficiency and thus reduce production costs and raise consumer purchasing power. The results also stem from the stimulus of increased investment in plant and equipment.

The overall negative GDP impacts from the integrated analysis of the 10 ECR options are primarily due to the impacts of the ES options, especially ES-1 and ES-2. From the microeconomic analysis result table (Table 19), these two options result in the highest direct net cost ($5.0 billion and $4.6 billion, respectively) among all the options. The negative impacts from these two options mainly stem from the high capital cost of renewable electricity generation compared with the avoided fossil fuel electricity generation.

Several analyses were performed to determine the sensitivity of the results to major changes in key variables such as investment capital costs, location of manufacturing of green technologies, avoided fuel costs, and the extent of external investment. They indicate that the results are generally robust. At the same time, the sensitivity tests indicate ways that the economic impacts can be made even more positive (or less negative for some of the options), by attracting more green manufacturing firms to locate within the SCAG Region, investing in R&D in green technologies to bring their costs down, and attracting more federal subsidies and investment from other regions.

Note that the estimates of economic benefits to the SCAG Region do not include the economic value of other benefits associated with implementing the ECR options, including the avoidance of negative environmental impacts from continued GHG emissions that have been mitigated, the savings from the associated decrease in ordinary pollutants that have important impacts upon human health, the reduction in the use of natural resources, and other factors.

Overall, the findings from this study suggest that implementing the various ECR mitigation policy options recommended would generate net positive employment impacts to the SCAG Region’s economy and only very slight negative impact on GDP. Also, the macroeconomic performance of these options can be improved by various ways that help lower the costs of new green technologies and attract investment from other regions. The results provide a basis for government and the private sector to cooperate in achieving the best possible outcome of climate policy.

CHAPTER 4. REFERENCES

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APPENDIX A. CLIMATE AND ECONOMIC DEVELOPMENT PROJECT (CEDP) PROCESS DESCRIPTION

APPENDIX B. TECHNICAL REVIEW COMMITTEE COMMENTS & RESPONSES

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