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.

December 2012

Disclaimer: The preparation of this report was financed in part through grants from the United States Department of Transportation (DOT), the California Strategic Growth Council (SGC), and the Sea Change Foundation (SCF). The contents of this report reflect the views of the authors who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of SCAG, USDOT, SGC, or SCF. This report does not constitute a standard, specification or regulation.

ACKNOWLEDGEMENTS

The Center for Climate Strategies, Inc. (CCS) gratefully acknowledges the following individuals and organizations who contributed significantly to the successful completion of this project: Great appreciation is due to the Southern California Association of Governments (SCAG) for providing CCS the opportunity to support this effort and the following organizations that provided funding for the project: SCAG, United States Department of Transportation (USDOT), California Strategic Growth Council, and the Sea Change Foundation.

Our thanks to the SCAG management and staff for their dedication and support of the project. In particular we would like to thank Hasan Ikhrata, Sharon Neely, Huasha Liu, Darin Chidsey, Dr. Frank Wen, Jacob Lieb, Kimberly Clark, Grieg Asher, Ranjini Zucker, and Joann Africa for working with us throughout this process. We also would like to thank the members of the SCAG Regional Council for their interest and support.

Great thanks to the volunteer members of the Project Stakeholder Committee and the Technical Work Groups whose participation and commitment was instrumental to the success of the project. We honor the memory of Lee Harrington who was a driving force behind the Southern California CEDP, and whose vision continues to be an inspiration to everyone connected to this project.

Independent review of this project was also conducted by SCAG's Technical Review Committee, which was comprised of economists with regional expertise. Thanks go to Dr. Christine Cooper, Dr. John Husing, and Dr. Wallace Walrod, for their in-depth examination of the methodology and results of the CEDP. Steve Levy and the Center for Continuing Study of the California Economy also provided their technical expertise in reviewing the methodology and results of this effort.

Thomas D. Peterson and CCS, with its dedicated team of professionals, contributed extraordinary amounts of time, energy, and expertise in developing the technical data and preparing the analyses for the project. Special appreciation to CCS's Project Managers Randy Strait and Paul Aldretti, Senior Technical Program Manager Stephen Roe, and analyst Loretta Bauer for their work on the project, as well as to all of CCS' team members. Dr. Hal Nelson of Policy Consultants, Inc. and David von Hippel of DVH Analysis & Planning provided facilitation and analytical support for the Energy Supply and Residential, Commercial, and Industrial polities, respectively. Bradley Strode provided analytical support to Steve Roe for the Agriculture, Forestry, and Waste Sectors. Members of Jack Faucett Associates, Lewison Lem, Michael Lawrence, Scott Williamson, Shanshan Zhang and Rami Chami, provided support for developing the micro- and macroeconomic analysis of Transportation Systems and Investment (TSI) and Transportation and Land Use (TLU) Policies. Finally, Drs. Adam Rose and Dan Wei from the University of Southern California Price School of Public Policy conducted the macroeconomic modeling analysis of the Energy, Commerce and Resources (ECR) policies and two of the transportation policies. They were assisted by Noah Dormady and Jake Grandy. In addition, Drs. Genevieve Giuliano and Lisa Schweitzer of USC's Price School served on an internal review board for this analysis. Dr. Adam Rose, Dr. Hal Nelson, and Dr. David von Hippel serve as members of the CCS Advisory Council and were paid consultants to CCS for this project or previous projects.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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.

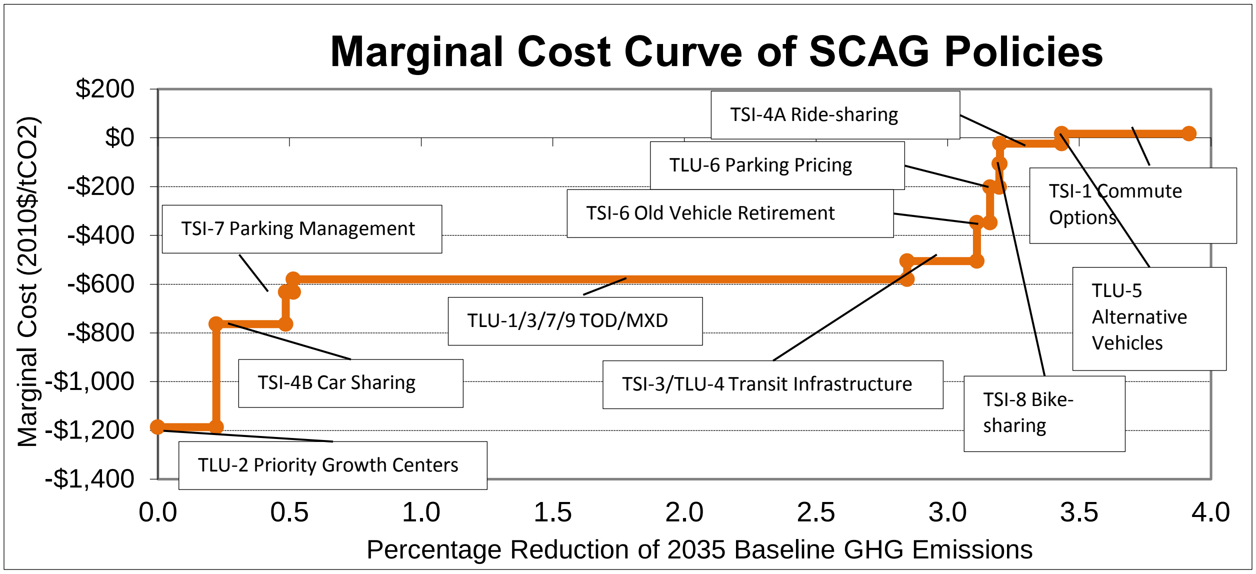
policy. The largest single effect comes from Transit-Oriented Development and Mixed-Use Development policies (analyzed together to avoid overlap and double-counting issues). Policies also vary significantly both in GHG reduction potential and in cost-effectiveness, though most policies are estimated 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) 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 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. $/tCO$_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)

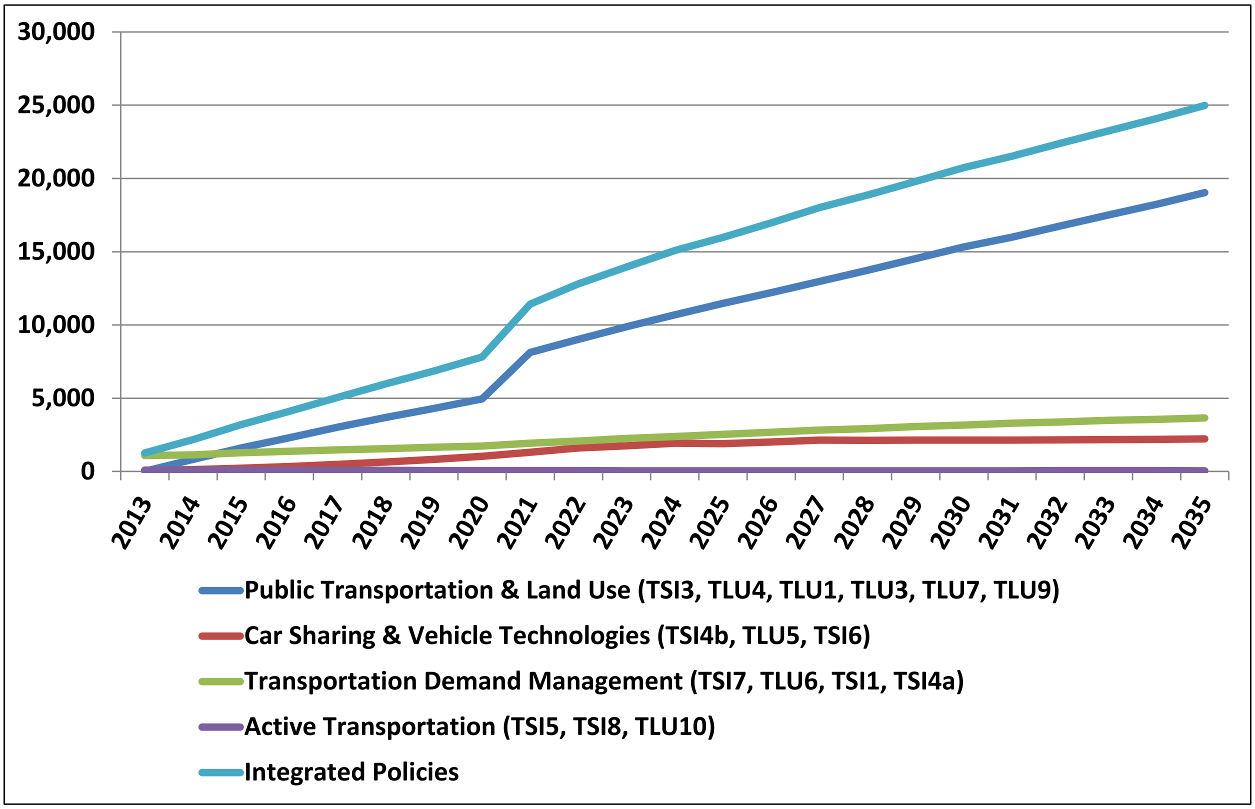


Table EX-3. Macroeconomic Impact Estimates for Public Transportation, Land-Use, and Transportation Demand Policies

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

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%	

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

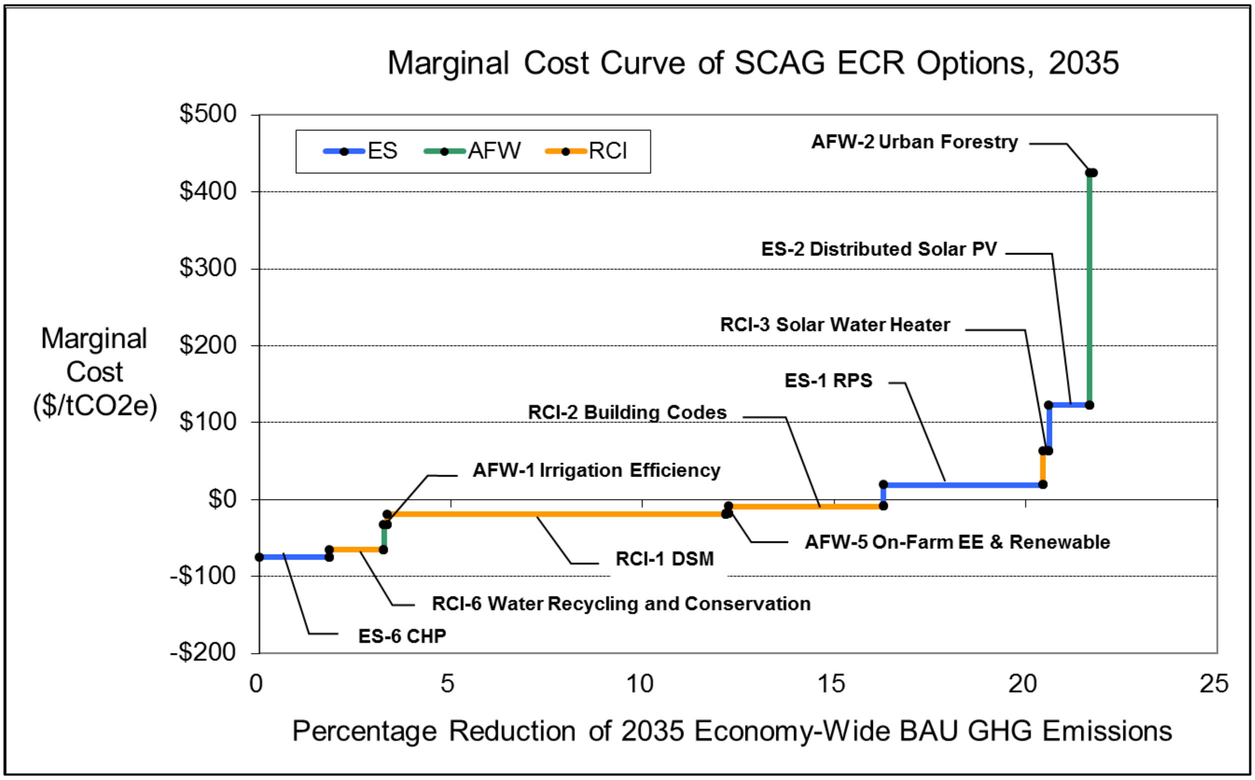
Policy Option Number	Policy Option Description	2020 (MMtCO2e)	2035 (MMtCO2e)	2012-2035 (MMtCO2e)	Net Present Value (million 2010$, 2012-2035 Cost / Cost Savings*	Cost-Effective-ness ($/tCO2e)*
RCI-1	Utility Demand Side Management (DSM) Programs for Electricity and Natural Gas (for Investor-owned, Government-owned, 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. $/tCO$_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).

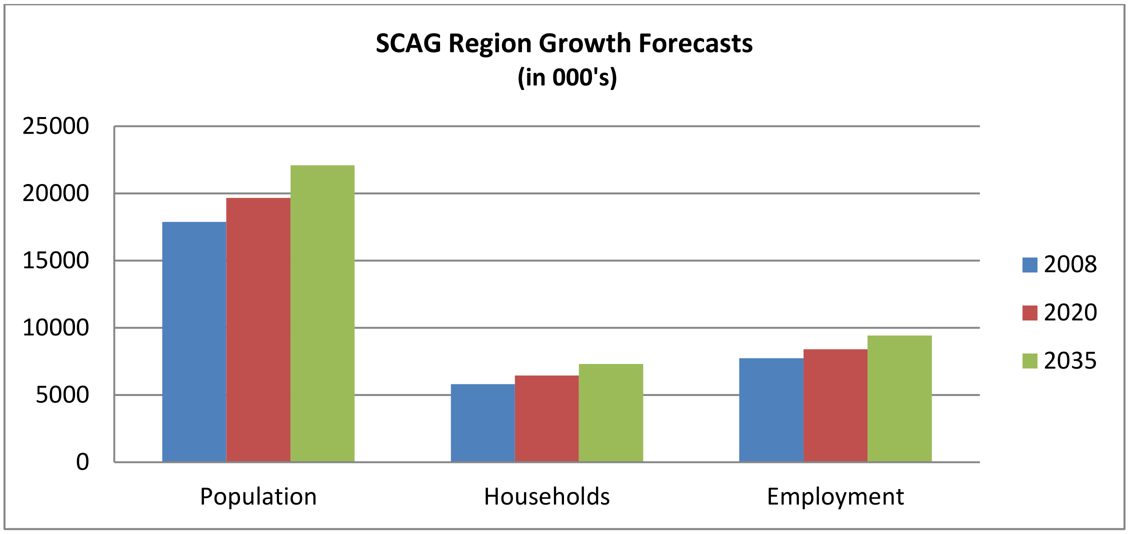
The largest sub-unit of the SCAG Region is the Los Angeles Metropolitan Area, which comprises about 60% of the Region' gross output. The area is the largest manufacturing center in the U.S., is widely known as the hub of the entertainment industry, and includes two of the nation's largest ports (Los 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.

---

[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.

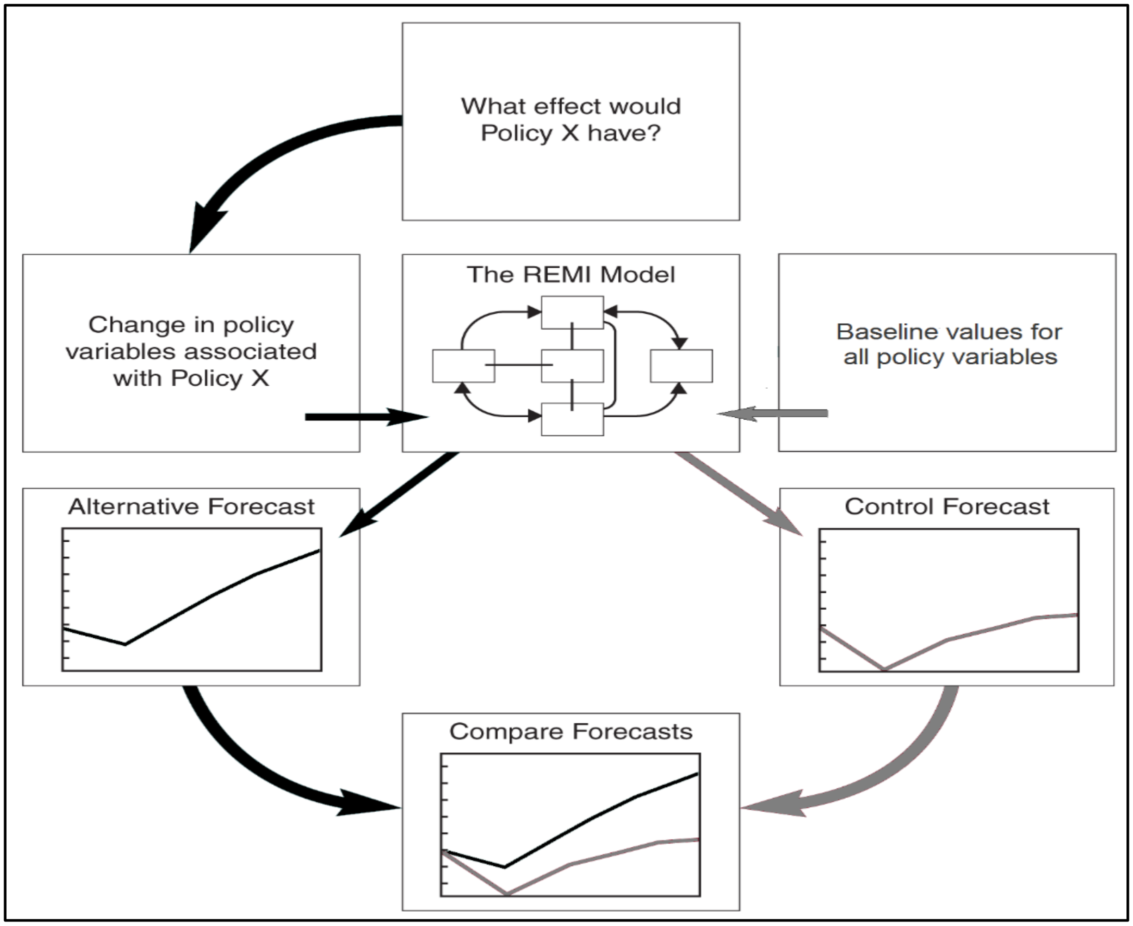
In this study, we first run the REMI model for each of the TLU/TSI and ECR options *individually* in a comparative static manner, i.e., one at a time, holding everything else constant. Next, we run *simultaneous* simulations in which we assume that all TLU/TSI policy options or ECR options are implemented 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.

---

[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 <u>differential</u> 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

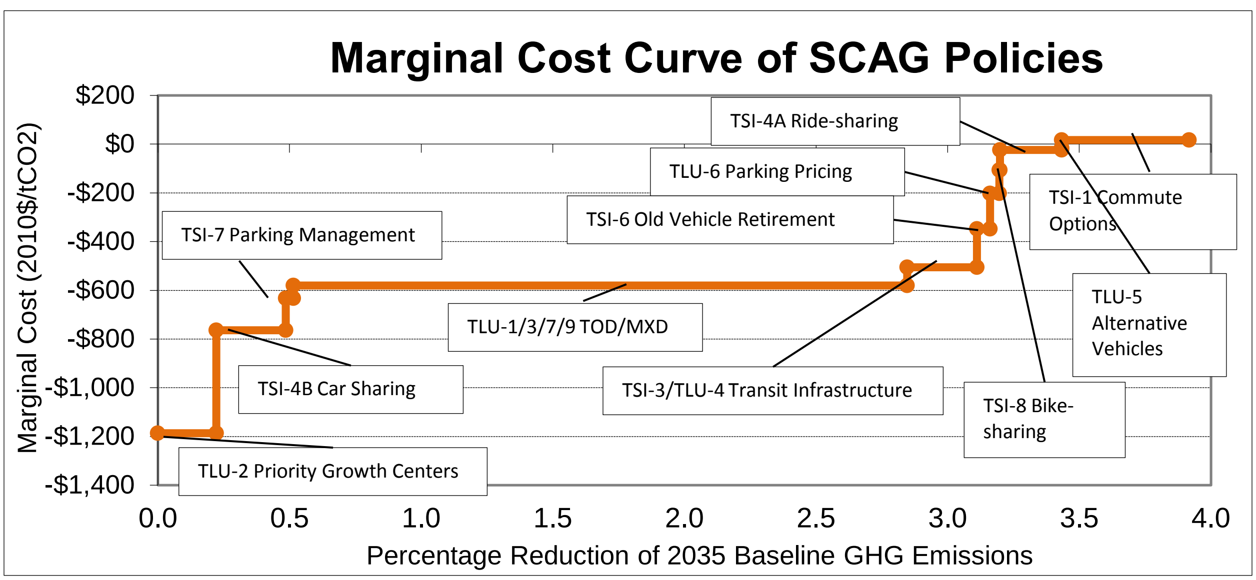
Policy No.	Policy Option	GHG Reductions (MMtCO2)			Net Present Value (million 2010$)*	Cost-Effectiveness ($/tCO2)*	Fuel Savings (million gallons, 2013-2035)	VMT Reduction (billion, 2013-2035)
		2020	2035	Total (2013-2035)				
Employee Commuter Options								
TSI-1/ TSI-4A	Employer-Based Commute Option 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	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

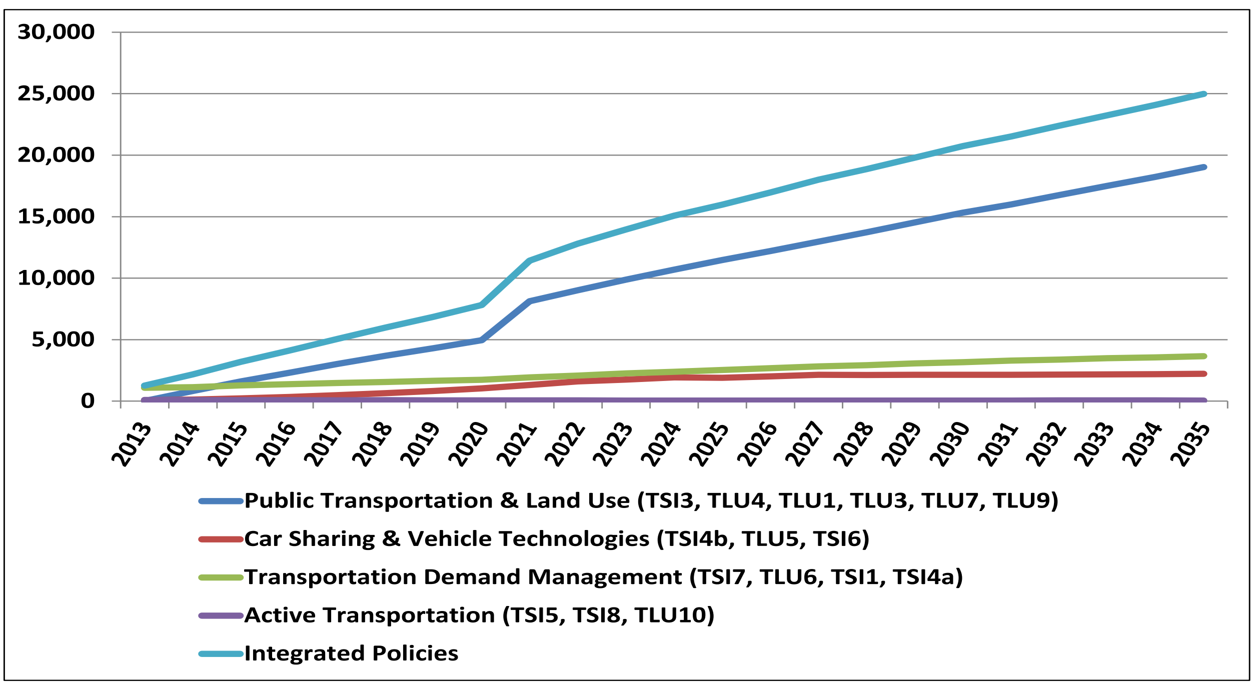


Figure 6. Changes to GDP (Millions of Fixed 2010$) by Policy Group, and Overall

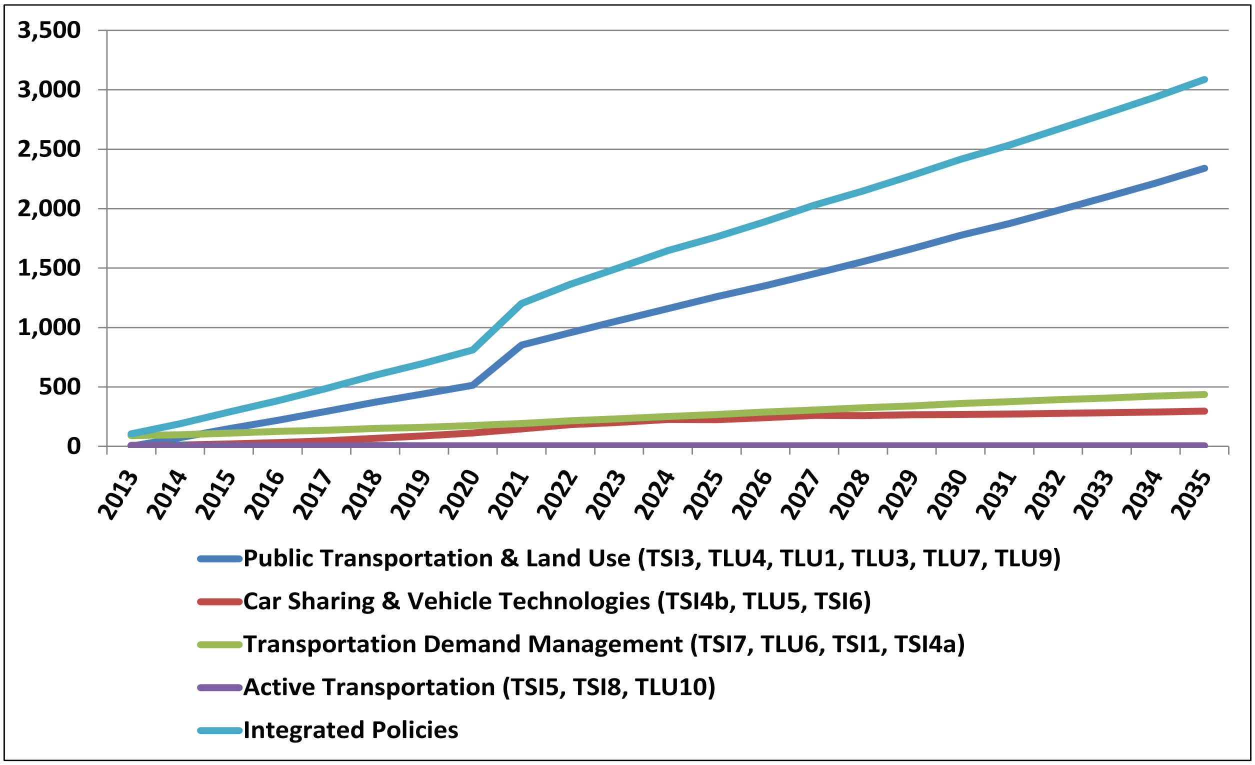


Figure 7. Changes to Personal Disposable Income (Millions of Fixed 2010$) by Policy Group, and Overall

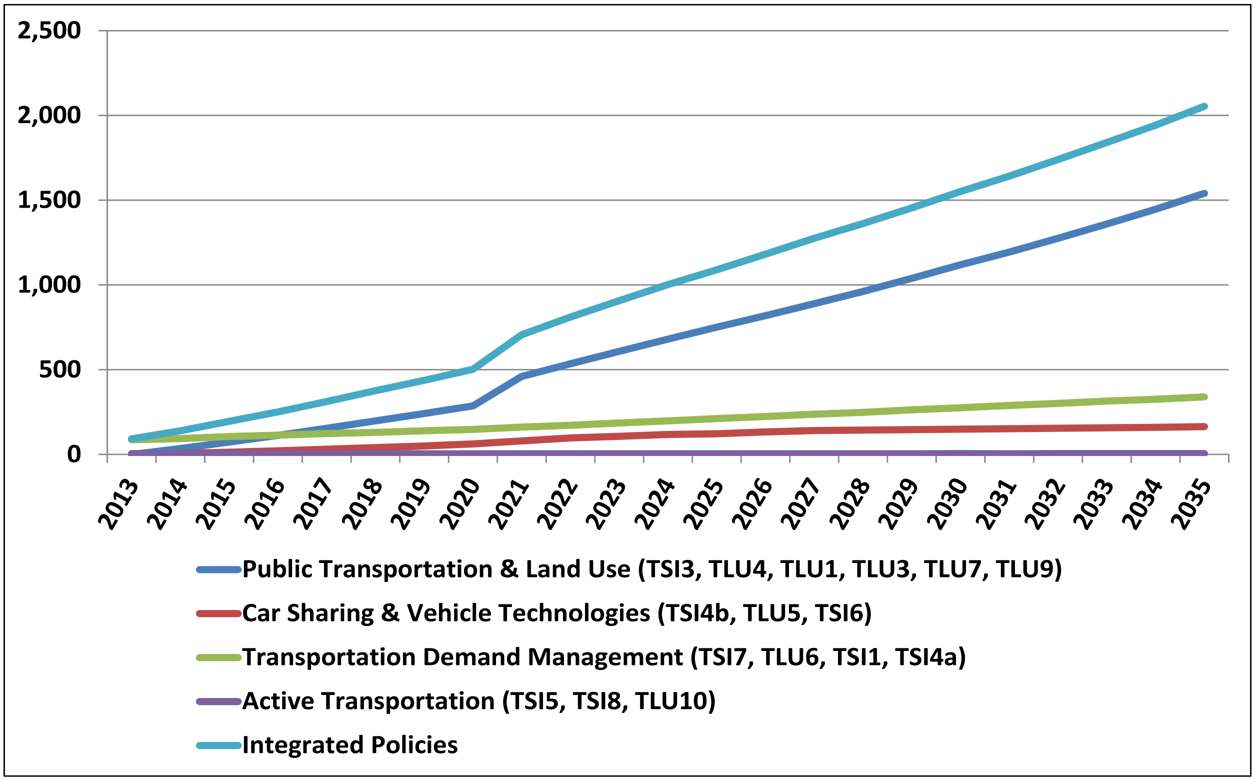


Table 3. Public Transportation & Land Use Group Macroeconomic Impact Analysis Results

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

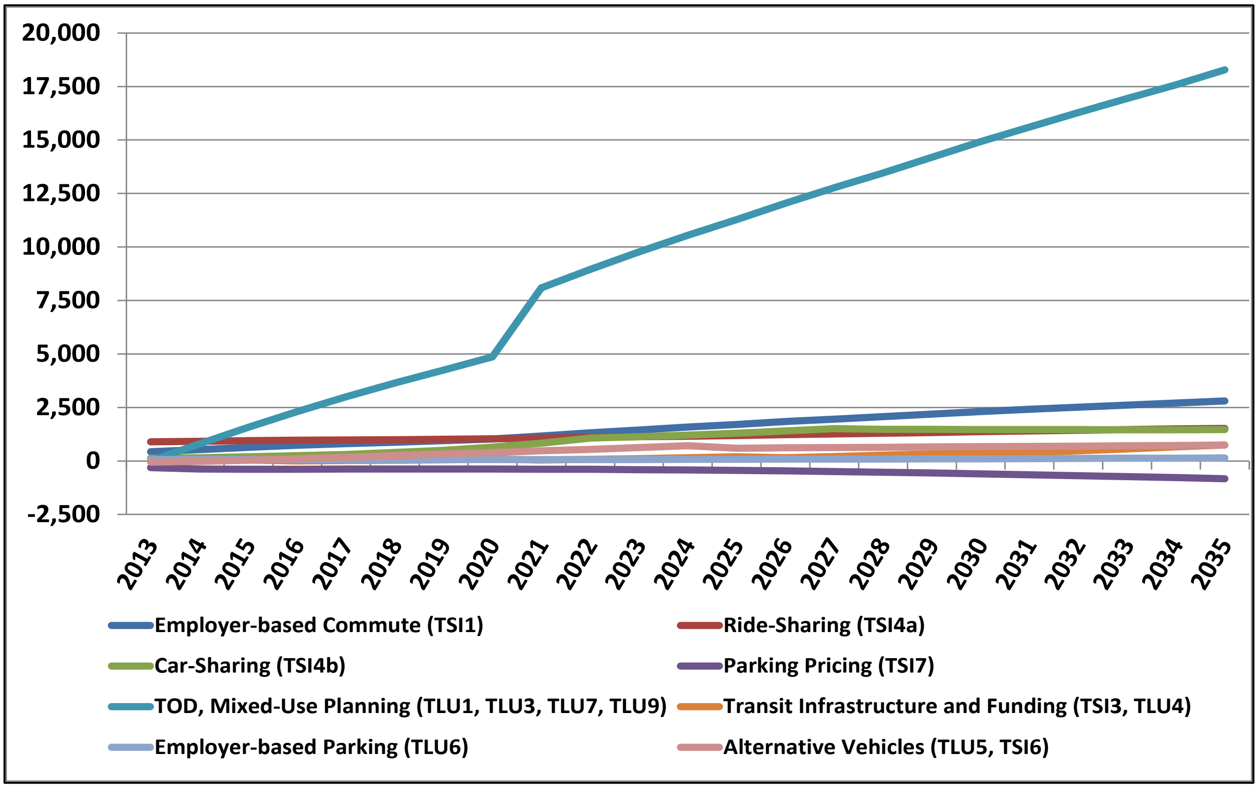


Figure 9. Changes to GDP (Millions of Fixed 2010$) by Policy

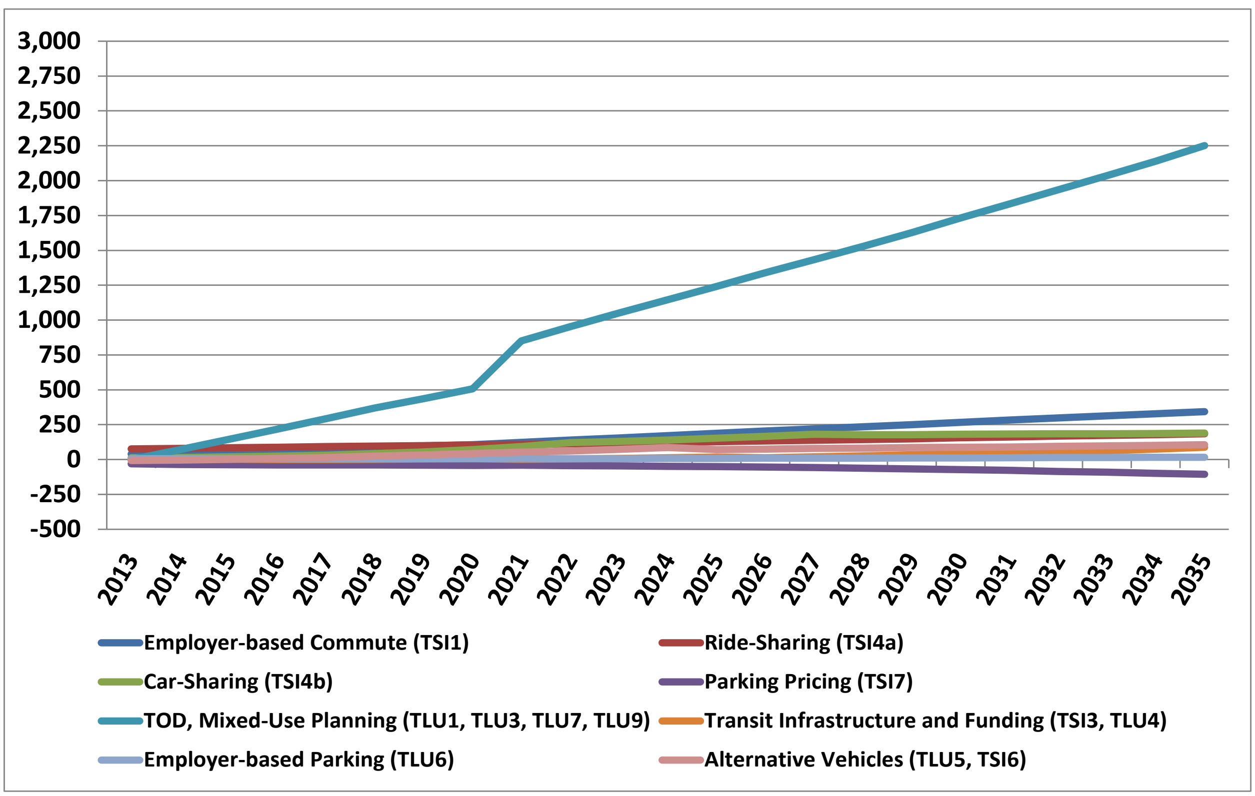
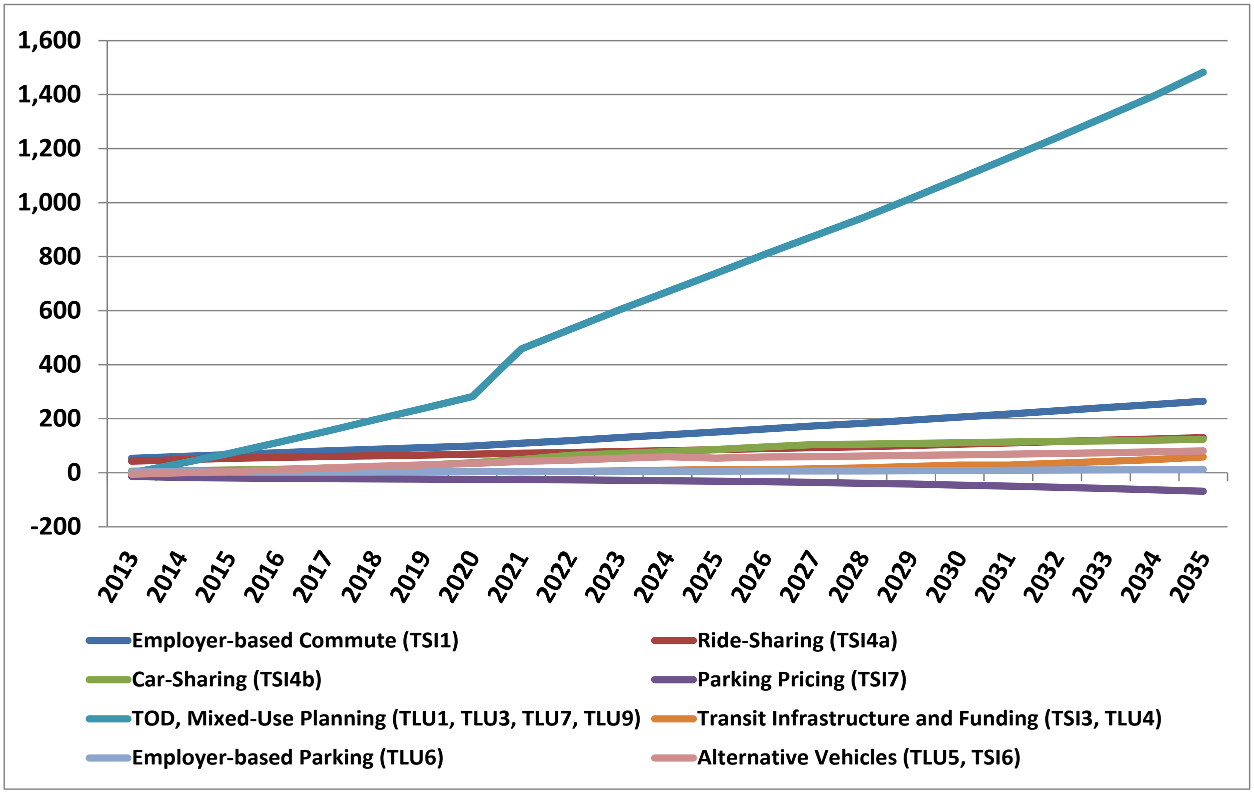


Figure 10. Changes to Personal Disposable Income (Millions of Fixed 2010$) by Policy



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

TSI3 & TLU 4 - Differences from Baseline Level								
Category	**Units**	**2013**	**2015**	**2020**	**2025**	**2030**	**2035**	**Jobs per Year / NPV**
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 $4 per MMt$CO_2$e emissions removed. The minus sign means implementing these options on average would yield overall cost savings.

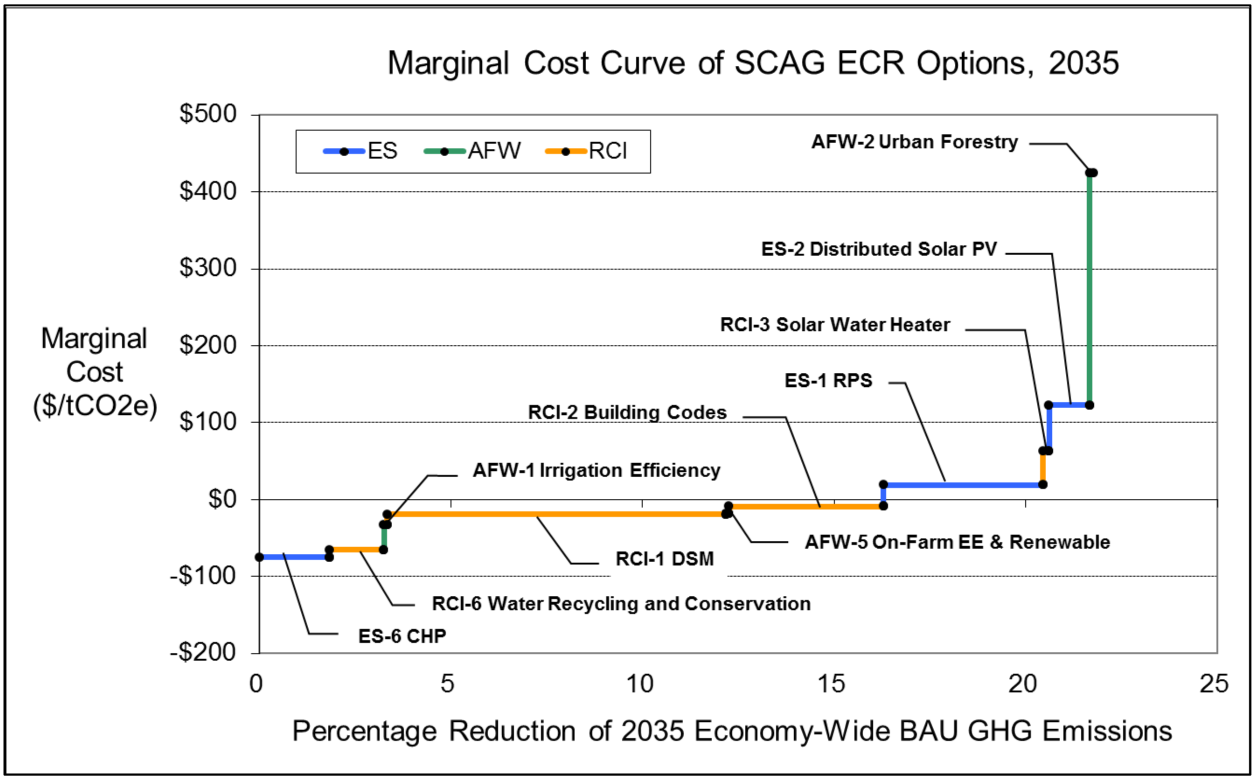
Table 19. Microeconomic Analysis Results of ECR Options

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]

[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.

---

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

Appelbaum, L and B. Zipperer, 2011. *State of the Unions 2011*. Los Angeles, CA, UCLA Institute for Research on Labor and Employment.

Boarnet, M. G. 1997. "Infrastructure Services and the Productivity of Public Capital: The Case of Streets and Highways," *National Tax Journal* 50(1): 39-57.

Center for Climate Strategies (CCS). 2012a. *Microeconomic Analysis of Transportation Strategy Options*.

Center for Climate Strategies (CCS). 2012b. *Microeconomic Analysis of ECR Options*.

Hedman, B., Wong, E., Darrow, K., and Hampson, A. 2012. *Combined Heat and Power: Policy Analysis and 2011-2030 Market Assessment*. Report prepared for California Energy Commission.

Hymel, K. 2009. "Does traffic congestion reduce employment growth?" *Journal of Urban Economics* 65: 127-135.

Lawrence, M. F. and Williamson, S, *Oregon Low Carbon Fuel Standards: Appendix D - Economic Analysis*, January 25, 2011, Oregon Department of Environmental Quality. http://www.deq.state.or.us/aq/committees/docs/lcfs/appendixDeconimpact.pdf.

Los Angeles Economic Development Corporation (LAEDC), 2012. 2012-2013 Economic Forecast and Industry Outlook. Retrieved May 31, 2012 from http://laedc.org/reports/.

Michigan Climate Action Council (MCAC). 2009. Chapter 3 and associated Appendix F in *Michigan Climate Action Plan MCAC Final Report*. http://www.miclimatechange.us/stakeholder.cfm.

Miller, S., Wei, D., and Rose, A. 2010. *The Macroeconomic Impact of the Michigan Climate Action Council Climate Action Plan on the State's Economy*. Report to Michigan Department of Environmental Quality. http://www.climatestrategies.us/ewebeditpro/items/O25F22416.pdf.

Partridge, M.D. and D.S. Rickman. 2010. "CGE Modelling for Regional Economic Development Analysis," *Regional Studies* 44(10): 1311-28.

Pennsylvania Department of Environmental Protection (PA DEP). 2009. Chapter 4 and associated Appendix E in *Pennsylvania Final Climate Change Action Plan*. http://www.elibrary.dep.state.pa.us/dsweb/View/Collection-10677.

Pollin, R., Heintz, J., and Garrett-Peltier, H. 2009. *The Economic Benefits of Investing in Clean Energy*. Department of Economics and Political Economy Research Institute, University of Massachusetts, Amherst.

REMI. 2012. REMI Model Online Documents. http://www.remi.com/.

Rickman, D.S. and R.K. Schwer. 1995. "A Comparison of the Multipliers of IMPLAN, REMI, and RIMS II: Benchmarking Ready-made Models for Comparison," *The Annals of Regional Science* 29: 363-374.

Roland-Holst, D. 2010. "Real Incomes, Employment, and California Climate Policy," Report to Next 10, Available at: http://next10.org/next10/publications/trading.html.

Rose, A. and Miernyk, W. 1989. "Input-Output Analysis: The First Fifty Years," *Economic Systems Research* 1(2): 229-71.

Rose, A. and Dormady, N. 2011. "A Meta-Analysis of the Economic Impacts of Climate Change Policy in the United States," *The Energy Journal* 32(2): 143-166.

Rose, A. and Wei, D. 2012. "Macroeconomic Impacts of the Florida Energy and Climate Change Action Plan," *Climate Policy* 12(1): 50-69.

Rose, A., Wei, D., and Dormady, N. 2011. "Regional Macroeconomic Assessment of the Pennsylvania Climate Action Plan," *Regional Science Policy and Practice* 3(4): 357-79.

Rose, A., Wei, D., and Miller, S. 2010. *Macroeconomic Impacts of the New Mexico Cap-and Trade Program on the State's Economy: A REMI Analysis*. Report to New Mexico Environment Department.

Rose, A., Wei, D., and Prager, F. 2012. "Distributional Impacts of Greenhouse Gas Emissions Trading: Alternative Allocation and Recycling Strategies in California", *Contemporary Economic Policy* 30(4): 603-617.

SCAG, 2012a. SCAG Region Socioeconomic Data. Retrieved May 31, 2012 from http://www.scag.ca.gov/economy/socioecondata.htm.

SCAG, 2012b. "*Regional Greenhouse Gas Emissions Inventory and Reference Case Projections, 1990-2035,"* prepared by the Center for Climate Strategies, Inc., May 30, 2012.

SCAG, 2012c. "*Regional Transportation Plan 2012-2035 Sustainable Communities Strategy Towards a Sustainable Future,"* http://rtpscs.scag.ca.gov/Documents/2012/final/f2012RTPSCS.pdf.

Treyz, G. 1993. *Regional Economic Modeling: A Systematic Approach to Economic Forecasting and Policy Analysis*. Boston: Kluwer.

U.S. Census, 2010. State and County Quick Facts. Retrieved May 31, 2012 from http://quickfacts.census.gov/qfd/index.html.

Wei, D. and Rose, A. 2011. *The Macroeconomic Impact of the New York Climate Action Plan: A Screening Analysis*. Report to New York State Energy Research and Development Authority, forthcoming.

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

http://cedp.scag.ca.gov

PROCESS DESCRIPTION

This document outlines the work plan that the Climate & Economic Development Project – Southern California (CEDP) – will use 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. The process described in this work plan will produce a final report that identifies a comprehensive and integrated set of policy options to meet these goals. This report will be presented to the Southern California Association of Governments (SCAG) Regional Council for consideration and further action. The work described in this document is performed under the auspices of SCAG utilizing the facilitation and technical expertise of the Center for Climate Strategies (CCS) in conducting effective, stakeholder-based climate planning and policy development processes, as well as related socioeconomic analysis and implementation support.

Purpose and Goals of the Process

In 2006, the California General Assembly adopted AB 32, which mandated that the California Air Resources Board (ARB) take responsibility for monitoring and reducing GHG emissions in the state through comprehensive multiple-sector approaches to meet statewide emissions reduction targets starting in 2010. As part of the enactment of this legislation, the Assembly passed SB 375 in 2008. SB 375:

> "Requires metropolitan planning organizations (MPOs) to include sustainable communities strategies (SCS), as defined, in their regional transportation plans (RTPs) for the purpose of reducing greenhouse gas emissions, aligns planning for transportation and housing, and creates specified incentives for the implementation of the strategies."

SCAG is seeking to determine the socio-economic impacts and opportunities of potential regional and local policies and to adopt actions that reduce GHG emissions to comply with this legislation in the most economically desirable and equitable manner possible. SCAG believes it is possible to reduce GHG emissions while creating new economic opportunities and jobs, improving the quality of life for residents, and protecting the integrity of natural resources upon which the region depends. The report will contain comprehensive recommendations designed to meet the mandates of SB 375 and AB 32, and will inform the draft RTP due in May 2011.

To achieve these goals, SCAG has engaged CCS to design and facilitate a stakeholder and community consensus building process and conduct a range of related technical and economic analyses. This collaborative policy development process is designed to identify, design, and analyze potential new actions through the direct participation of key stakeholders and technical experts in the region. The fact-finding and joint policy development process will use and expand the best available research and analysis and associated tools. It will identify the potential socio-economic impacts and benefits of all strategies, including distributional impacts. By using this deliberative consensus building process, CEDP also will ensure that the resulting draft RTP and compliance strategy for AB 32 and SB 375 optimally reflects the best opportunities, concerns, and interests of regional households, workers, and businesses in jointly meeting environmental, economic, energy, and transportation goals.

A diverse and high level group of stakeholders representing government entities, environmental interests, key industries, and other groups will be formed and comprise the Project Stakeholder Committee (PSC). In addition, Technical Work Groups (TWGs) will support the PSC and provide technical and advisory support to specific issue areas related to AB 32, SB 375, and the development of the RTP. The PSC and TWG will receive guidance from subject matter experts serving on the Technical Assistance Committee (TAC) and Technical Review Committee (TRC) [is this the new name?]. More detailed descriptions of these groups and their function can be found below.

Final Report and End Product

CCS will deliver a final report to SCAG with the recommendations and supporting analysis of the PSC. This final report will be presented to the SCAG Regional Council for consideration and action.

The outline of the final report and supporting materials is as follows:

1. Executive Summary
2. Chapter 1: Introduction and Background of the Process
3. Chapter 2: SCAG Region Inventory and Forecast of GHG Emissions
4. Chapter 3: Existing and Planned SCAG Actions Related to AB 32, SB 375 and the Regional Transportation Plan
5. Chapter 4: Integrated Transportation and Land Use Land Use (TLU) Policy Recommendations
6. Chapter 5: Transportation Infrastructure Investments (TII) Recommendations
7. Chapter 6: Transportation Demand Management (TDM) Policy Recommendations
8. Chapter 7: Transportation System Management (TSM) Policy Recommendations
9. Chapter 8: Energy, Commerce and Resources Sector Institutional and Integrative Issues Recommendations
10. Appendices:
    a. Meeting Schedule, Members, and Attendance
    b. Quantification Methods Guidance Memos for Cost Effectiveness, Macroeconomic and Distributional Impacts, and Co-benefits Assessments
    c. Regional GHG Inventory and Forecast Details

d. Policy Options Templates, Analyses, and References for PSC Recommendations by TWG including:
   i. Integrated Transportation and Land Use (TLU) Policy Recommendations
   ii. Transportation Infrastructure Investments (TII) Recommendations
   iii. Transportation Demand Management (TDM) Policy Recommendations
   iv. Transportation System Management (TSM) Policy Recommendations
   v. Energy, Commerce and Resources Sector Institutional and Integrative Issues Recommendations

e. Other Technical Materials As Needed

Timing and Milestones

The first in-person meeting of the PSC will be held on August 24, 2010. A series of five or more additional meetings will be held during the following 10 months. Based on the agreements and work of the PSC, CCS will issue the final report of the PSC to SCAG following its final meeting. For each of the TWGs, two or more conference calls or meetings will be held between each of the PSC meetings.

The following draft schedule is suggested for planning purposes:

Date	Meeting
August 24, 2010	1st PSC Meeting
October 2010	2nd PSC Meeting
December 2010	3rd PSC Meeting
February 2011	4th PSC Meeting
March 2011	5th PSC Meeting
May 2011	6th PSC Meeting
June 2011	Final Report

Design of the Process

The planning process will rely on intensive use of information and interaction, and require substantial organization and integrated communications among facilitators, participants, and technical analysts. The project will follow a proven process that CCS has successfully employed in a number of states to develop climate change mitigation plans. The structured and professionally facilitated process brings together a broadly representative group of stakeholders and technical experts in a transparent, stepwise and fact-based effort. The process will use formal consensus building to meet the goals and deliverables of the initiative.

CCS will oversee and manage this information exchange and decisional process in partnership with SCAG. CCS will provide central coordination of PSC and TWG activities though a project director team and a group of CCS technical facilitators and consultants. The CCS team will provide close coordination of PSC, TWG, TAC and TRC facilitation and technical support activities.

The process includes the following key *principles and guidelines*:

- The process is fully transparent – All materials considered by the PSC and TWGs, in addition to the TAC and TRC, are posted to the project website, and all meetings are open to the public. The transparency of technical analyses, the design of response actions, and participant viewpoints is critical to the identification and resolution of potential conflicts.
- The process is inclusive – A diverse group of PSC and TWG members are chosen to represent a broad spectrum of interests and expertise in the SCAG region. A ground rule for participation is to be supportive of the process, but members are free to disagree on specific decisions within the process. The public also is invited to provide meaningful review of and input to decisions.
- The process will seek but not mandate consensus – Votes will be taken at key milestones in the process in order to advance to next steps as indicated in meeting agendas. Alternatives that address barriers to consensus will be developed by the PSC and TWGs with the assistance of CCS, as needed. Voting is conducted by simple request for objection at the point of decision (by hand), followed by resolution of conflicts with the development of alternatives, as needed, to proceed. Final votes by the PSC, and the TWGs where appropriate, include support at three levels, including: unanimous consent (no objection), super majority (less than 25% of members object), and majority (less than half object). The final report by CCS will document PSC recommendations and views on each response action, including alternative views as needed.
- The process is implementation-oriented – The goal of the process is ultimate adoption of specific policies based on the recommendations of the PSC and any subsequent, more-detailed analyses as needed.
- The process is stepwise – Each step of the process builds incrementally on the former step toward a final solution. Sufficient time, information, and interaction are provided between steps to ensure comfort with decisions and quality of results.

Roles and Responsibilities

The structure of the advisory process, including the roles and responsibilities of the convener, committees, panels and public participants are as follows:

1. SCAG: SCAG will serve as the convener of the process and in that role provide: oversight, agency coordination and funding; appoint PSC, TWG, TAC and TRC members; provide a project website; and be responsible for policy implementation. Glen Becerra, SCAG 2nd Vice President and Mayor Pro Tem of the City of Simi Valley will serve as Chair and, in this role, will work in partnership with CCS to support orderly,

timely and orderly completion of tasks, good-faith participation, resolution of issues by PSC members, enforce ground rules, and open and close PSC meetings.

2. CCS: CCS will report to SCAG and provide facilitation, technical, and communications support to the PSC and TWGs, as well as project management, communications, cost share development, and coordination support to SCAG. CCS will coordinate with SCAG on TAC and TRC review and advice activities. CCS will deliver a final report to SCAG with PSC recommendations. CCS is a neutral party and will not take positions on issues before the PSC or TWGs. SCAG retained CCS following a public RFP and selection process. CCS will produce a comprehensive final report that describes the process, findings, and results of the regional project.

3. Project Stakeholder Committee (PSC): The PSC will make non-binding recommendations to SCAG through technical and facilitative assistance by CCS and with advice and assistance of the TWGs. The PSC will be composed of local and regional representatives with expertise and interest in the project. The PSC will provide local and regional perspectives important to addressing project objectives. SCAG will appoint the members of the PSC.

   a. The PSC will be comprised of members who represent key interests and competencies in the region. PSC members must be able to provide continuity, competence, decision-making, and effective participation. The members should be locally based and reside in the region. Organizations that can directly represent themselves are preferred.

   b. Due to the focused and time-sensitive nature of this process, all PSC members should endeavor to attend every meeting. PSC members should commit at least one full day for each meeting. PSC meetings will be approximately 6 hours in duration. No proxies will be allowed. In the case that any PSC member must miss a meeting, a personal representative of that member may attend to gather information.

   c. The PSC must be supportive of the process and ground rules, including:

      i. Objective criticisms accompanied by constructive alternatives

      ii. No backsliding or returning to issues on which decisions have previously been made through the process identified above

      iii. No representation of SCAG or the CEDP process to the media

      iv. Supportive of the CEDP process as described in this document

      v. Must represent themselves in process, as opposed to their organization, and be able to make decisions without delayed conferrals with their organization

2. Technical Work Groups (TWGs): The TWGs will make non-binding recommendations to the PSC with technical and facilitative assistance by CCS. The TWGs will be composed of PSC members, their key advisors, and other subject matter experts who will support and augment the PSC's activities and deliberations. The TWGs will focus on specific topics related to the project objectives. TWGs will meet primarily by teleconference between PSC meetings. TWG teleconferences will be approximately 90 minutes in duration. SCAG will appoint the members of the TWGs.

a. Scope of the TWGs:

   i. Integrated Transportation and Land Use (TLU) – development patterns and distribution of population, business/commercial and employment, housing

   ii. Transportation Infrastructure Investments (TII), particularly transit investment and other infrastructure that may impact upon GHG emissions

   iii. Transportation planning and programs that fall under the category of Transportation Demand Management (TDM)

   iv. Transportation System Management (TSM) and operational policies and practices

   v. Energy, Commerce and Resources Sector Issues (ECR), incorporating energy; agriculture, forestry and waste management; commercial and industrial building sectors; industrial fuel use; and, cross cutting issues, including multi-sector institutional and integrative issues.

b. Composition: Each of the TWGs will include active members from the PSC, plus additional active members representing key local interests and competencies that match the scope of each TWG. Members must provide continuity, competence, and effective participation. If they are a proxy for the PSC representative, both the PSC and TWG representatives must be fully coordinated and able at all times to represent their work jointly (proxies are not preferred). The TWG members will be locally based and reside in the region. TWG members must be supportive of process and other ground rules.

3. Technical Advisory Committee (TAC): SCAG will appoint the members of the TAC. The TAC will provide review and advice to CEDP regarding methodology issues, including:

   i. Direct economic impacts

   ii. Indirect macroeconomic impacts

   iii. Co-benefits assessments

   iv. Emissions impacts

   v. Distributional impacts

   Composition: TAC members who provide competency and impartiality, including familiarity with public policy analysis and development, as well as regional issues

4. Technical Review Committee (TRC): The TRC will provide review and advice to SCAG, CCS and the TAC regarding methodology issues. SCAG will appoint the members of the TRC.

   a. The TRC will provide periodic review of analytical findings of the PSC and TWGs, including recommendations of the TAC

   b. The TRC will include 3-5 members who provide competency and impartiality, and are familiar with public policy analysis and development, as well as regional issues

5. The public will be able to fully monitor the proceedings of the initiative and provide input at regular, scheduled points during PSC and TWG meetings, at special public events, as well as other means. All materials for the PSC and TWG meetings will be posted to a public website. CEDP also will work to develop and provide appropriate communications strategies for target audiences and the general public including workshops, a website and webinars, briefings, and publications.

Meetings and Milestones

The objectives and agendas for each of the PSC and interim TWG teleconference meetings are listed below, with notes regarding each of the sequential decisions of the PSC.

PSC Meeting One

1. Objectives:
    a. Introduction to the process.
    b. Presentation of preliminary fact-finding
    c. Formation of TWGs – PSC members should be prepared to select one or more TWGs in which to participate
2. Agenda:
    a. Introductions
    b. Purpose and goals
    c. Review of the process
    d. Review of AB32 and SB375 implications for regional planning
    e. Review of the regional inventory and forecast of GHG emissions
    f. Review compendium of general categories of potential response actions
    g. Formation of TWG's, next meeting agenda, time, location, date
    h. Public input
3. Interim TWG calls will: (1) review and suggest additions to the draft compilation of potential policies and action; and (2) review the GHG inventory and forecast and identify potential modifications that are needed.
4. Public meetings if/as needed.
5. TAC and TRC reviews.

PSC Meeting Two

1. Objectives:
    a. Approve the addition of identified policies and strategies

   b. Prepare for the next step of ranking policies and actions based on evaluative criteria

2. Agenda:
   a. Review and approve suggested additions to the compendium of policies and actions, with a focus on those related to SB375 and AB32
   b. Discussion of the process for identifying initial priorities for analysis
   c. Public input
3. Interim TWG calls will cover review and balloting of policies and actions for further analysis.
4. Public meetings if/as needed.
5. TAC reviews.

PSC Meeting Three

1. Objectives:
   a. Approve priority policies and actions for further analysis
   b. Report on updates to the regional GHG inventory and forecast
2. Agenda:
   a. Review and approve initial priorities for policies and actions
   b. Review and approve suggested updates to the regional GHG inventory and forecast
   c. Public input
3. Interim TWG calls will cover development of straw policy design proposals.
4. Public meetings if/as needed.
5. TAC reviews.

PSC Meeting Four

1. Objectives:
   a. Approve straw policy design proposals
   b. Approve recommendations for Interim Report to SCAG
2. Agenda:
   a. Review and approve straw proposals for policies and actions
   b. Review and approve recommended changes to the regional GHG inventory and forecast
   c. Review proposed approaches for macroeconomic and distributional impact analysis
   d. Public input
3. Interim TWG calls will cover proposed approaches for analysis of priority policy options and scenarios, and review and assistance with preliminary analysis of options.

4. Public meetings if/as needed.
5. TAC and TRC reviews.

PSC Meeting Five

1. Objectives:
   a. Review and approve initial analysis of policy options and scenarios, with modifications and iterations to further TWG action as needed
   b. Review of macroeconomic and distributional impact analysis
2. Agenda:
   a. Review and approve initial analysis of policy options and scenarios, with modifications as needed
   b. Review draft macroeconomic and distributional impact analysis
   c. Identify early consensus policies for PSC approval
   d. Identify barriers and alternatives for remaining options, with guidance for additional work on options to TWGs
   e. Review final report progress and plans
   f. Public input
3. Interim TWG calls will cover final analysis of options and alternative approaches.
4. Public meetings if/as needed.
5. TAC and TRC reviews.

PSC Meeting Six

1. Objectives:
   a. Final approval of policy recommendations and analysis
   b. Approval of final report process
2. Agenda:
   a. Review final macroeconomic and distributional impact analysis
   b. Review and approval final policy recommendations, including final votes
   c. Summarize the process, review of next steps, and transmittal of the final report.
   d. Public input
3. Public meetings

Final Report

1. Draft report language by CCS to the PSC and public
2. Final TAC and TRC reviews
3. First round of review and inputs to CCS
4. Updated draft report language to the PSC and public
5. Final PSC call to discuss suggested changes to the final report
6. Public review and input
7. Final report transmitted to SCAG by CCS

APPENDIX B. TECHNICAL REVIEW COMMITTEE COMMENTS & RESPONSES

To: Wallace Walrod
From: Christine Cooper
Date: June 27, 2012

RE: TRC Initial Comments on Review of Draft Impact Analyses

In order to adequately review the methodology and results presented in the two memos (Draft Macroeconomic Impact Analysis Results for the ECR and for the TSI/TLU), there needs to be a more detailed description of the assumptions used in each policy scenario and how these assumptions and policy designs were addressed in the REMI model. For example, in the TSI/TLU memo, pages 26 through 44 provide descriptions, but do not show which blocks in REMI were affected. This is quite standard and would allow us to more accurately gauge whether the policies were adequately simulated. The ECR memo offers no similar description for individual policies.

> >>For ECR options, detailed descriptions of policy designs and assumptions used in the calculation of direct costs/savings and GHG mitigation potentials are included in the Microeconomic Impact Analysis Report of the ECR Options.
>
> >>In the ECR memo, CCS provided a detailed mapping table (Table 3) for one example policy option (RCI-1), which provides detailed descriptions on the choices of REMI policy levers, as well as in which one of the five major blocks in REMI the policy levers can be found. Mapping of micro analysis results and policy lever selections in REMI for RCI-2 and ES-1 are provided in Appendix A below. Appendix B provides the mapping for all of the TSI and TLU policies used in the REMI TranSight model.

Both memos failed to address differential geographic impacts. The REMI model is a six-county SCAG region model so this may not be possible.

> >> It was agreed with Frank Wen that we would not provide county level results because of the time consuming nature of such calculations and because it might spawn jealousies among counties concerning the results. Given these considerations, we have used a 6-county aggregated SCAG Region REMI Model in the analysis. However, in terms of differential geographic impacts, we did analyze the economic impacts to the Rest of CA Region and Rest of US Region.

A specific question about the REMI modeling exercise: Consumer spending is reallocated away from transportation (due to reductions VMT etc) to other sectors. The sectors that experience the largest gains are listed on page 15 of the TSI/TLU memo. Is there any accounting for declining marginal propensity to consume in the model? i.e. isn't there a bliss point in health care or accommodation and food services, or are consumers capable of consuming unlimited amounts? We should be concerned about the likelihood that these consumer choices are adequately modeled since the savings to consumers from saved transportation costs are significant.

>>In the REMI Model, when the user increases the value of the Consumption Reallocation policy variable, increased spending is allocated among various commodity categories based on whether the commodity is categorized as a necessity or luxury, which is in turn determined based on the income elasticities of the commodities. REMI analysts provided us a table that shows the consumption response of a 10% increase in the value of the Consumption Reallocation policy variable (please see Appendix C below). However, the relationship between the % change in the Consumption Reallocation variable and % change in consumption by category in the REMI Model do not change when the dollar amount of spending reallocation increases. In other words, there is no declining marginal propensity to consume embedded in the model. Such considerations need separate evaluations and manual input into the REMI Model. Since the total transportation fuel savings for the TLU/TSI GHG mitigation options we analyzed account for less than 0.1% of the baseline total personal consumption expenditures in the SCAG Region (average annual fuel cost savings are about $635 million, while according to the SCAG REMI Model, 2012 total personal consumption expenditures in the Region are $707 billion), it seems acceptable not making further adjustment on MPC.

Also, I continue to be confused by the connection between the RTP and the CEDP and what is funded and what portions are accounted for in the baseline. Some clarity here is needed, not only in the overlap but in the assumptions of the funding streams.

The relationship between the RTP and the CEDP policies is that all CEDP policies evaluated are directly or indirectly included in the RTP. Not all components of the RTP are included in the CEDP policies. The CEDP policies were selected by the TWGs based on their understanding of the kind of policy that would be regionally desirable and technically feasible. The final set of CEDP policies were combined and structured for quantification in a way that was consistent with the RTP programs and policies. Each CEDP policy option was reviewed by appropriate SCAG staff for consistency with the RTP. Some CEDP policies were related to the known RTP funding and others were related to anticipated RTP funding (see the RTP finance chapter). Depending on the source of funds, internal or external to the SCAG region, the anticipated macroeconomic impacts differ and thus not all policies offer the same economic benefits per dollar of microeconomics cost to the region, institutions, households and industry.

Specifically regarding the TSI/TLU policies on page 38 (TLU 1, 3, 7 and 9): Perhaps beyond our scope but do the policies consider the saturation of areas within ½ mile of transit stations? Are we building transit stations every 2 miles or are we building 50-story buildings? Are business locations also modeled? The TOD portion of the analysis is such a major contributor to the benefits that for this policy we should understand all the assumptions.

For additional information on the RTP/SCS assumptions, please see the RTP documents and in particular the Environmental Impact Review (EIR) documents for the RTP. These documents and information within them were the basis around which the analysis was conducted. Some specific information responding to this question can be found in the discussion of the "Rapid Fire" modeling assumptions that were used in the analysis of potential land use changes. The overall set of analysis uses assumptions about types of households and types of housing units. As far as the information that was the basis for the analysis, the RTP EIR documents do not appear to have specific assumptions about changes in business locations. Instead, the overall focus is on housing and population changes and associated changes in travel patterns. There is no geographically based analysis in the Rapid Fire model or in the REMI modeling framework. For this kind of geographical analysis, another set of modeling tools would be used.

Appendix A. Mapping Tables for Additional Example Policy Options

Table A1. Mapping RCI-2 Building Codes into REMI Inputs

Linkage	Microeconomic Quantification Results		Policy Variable Selection in REMI	Positive or Negative Stimulus to the Economy
1	Upfront Mitigation Capital Investment on Building Codes for Energy Efficiency		Output and Demand Block →Exogenous Final Demand (amount) for Construction sector → Increase	Positive
2	Interest Payment of Financing Capital Investment		Output and Demand Block →Exogenous Final Demand (amount) for Monetary Authorities, Credit Intermediation sector→Increase	Positive
3	Annual Levelized Capital Cost of Building Codes Improvement	Businesses (Commercial and Industrial Sectors)	Compensation, Prices, and Costs Block →Capital Cost (amount) of Individual Commercial and Industrial Sectors→Increase	Negative
		Households (Residential Sector)	Output and Demand Block →Consumption Reallocation (amount)→All Consumption Sectors →Decrease	
4	Energy Savings (Electricity, NG, and Oil Savings)	Businesses (Commercial and Industrial Sectors)	Compensation, Prices, and Costs Block→ Production Cost of Individual Industrial and Commercial Sectors→Decrease	Positive
		Households (Residential Sector)	Output and Demand Block →Consumption Reallocation (amount)→All Consumption Sectors →Increase	
5	Energy Demand Decrease from the Energy Supply Sectors		Output and Demand Block →Exogenous Final Demand (amount) for Electric Power Generation, Transmission, and Distribution, Natural Gas Distribution, and Petroleum Product Mfg sectors→Decrease	Negative
6	Avoided Annual Capital Cost or Debt Repayment of Ordinary Investment	Businesses (Commercial and Industrial Sectors)	Compensation, Prices, and Costs Block →Capital Cost (amount) of individual commercial and industrial sectors→Decrease	Positive
		Households (Residential Sector)	Output and Demand Block →Consumption Reallocation (amount)→All Consumption Sectors →Increase	
7	Foregone Stimulus Effect of the Upfront Business Ordinary Investment		Output and Demand Block →Investment Spending on Producer's Durable Equipment and Demand of Goods and Services from Construction sector →Decrease	Negative
8	Reduced Upfront Household Expenditures on Regular Goods and Services		Output and Demand Block →Consumption Reallocation (amount)→All Consumption Sectors →Decrease	Negative
9	Foregone Productivity Improvement from Displaced Business Ordinary Investment		Labor and Capital Demand Block →Factor Productivity (Share)→All Private Non-Farm Sector →Decrease	Negative

Table A2. Mapping ES-1 RPS into REMI Inputs

Linkage	Microeconomic Quantification Results	Policy Variable Selection in REMI	Positive or Negative Stimulus to the Economy
1	Incremental Capital Cost of Electricity Generation (Renewable minus Avoided Conventional Generation)	Compensation, Prices, and Costs Block → Capital Cost (amount) of Electric Power Generation, Transmission, and Distribution sector → Increase	Negative
2	Incremental O&M Cost of Electricity Generation (Renewable minus Avoided Conventional Generation)	Compensation, Prices, and Costs Block →Production Cost (amount) of Electric Power Generation, Transmission, and Distribution sector→Increase	Negative
3	Reduced Fuel Cost of Electricity Generation	Compensation, Prices, and Costs Block →Production Cost (amount) of Electric Power Generation, Transmission, and Distribution sector→Decrease	Positive
4	Federal Subsidies	Compensation, Prices, and Costs Block →Production Cost (amount) of Electric Power Generation, Transmission, and Distribution sector→Decrease	Positive
5	Incremental Investment in Renewable Electricity Generation	Output and Demand Block →Exogenous Final Demand (amount) for Construction sector→Increase Output and Demand Block →Exogenous Final Demand (amount) for Engine, Turbine, and Power Transmission Equipment Manufacturing, Semiconductor and Other Electronic Component Mfg, Other Electrical Equipment and Component Mfg, Other General Purpose Machinery Mfg, Electrical Equipment Mfg, and Agriculture, Construction, and Mining Machinery Mfg sectors →Increase	Positive
6	Decreased Investment in Avoided Conventional Electricity Generation	Output and Demand Block →Exogenous Final Demand (amount) for Construction sector→Decrease Output and Demand Block →Exogenous Final Demand (amount) for Boiler and Tank Mfg sector and Engine, Turbine, and Power Transmission Equipment Mfg sector→Decrease	Negative
7	Increased Interest Payment of Financing Capital Investment	Output and Demand Block →Exogenous Final Demand (amount) for Monetary Authorities, Credit Intermediation sector→Increase	Positive
8	Renewable (Biomass) Fuel Inputs	Output and Demand Block →Exogenous Final Demand (amount) for Forestry sector→Increase Output and Demand Block →Proprietors' Income for Farm sector→Increase	Positive
9	Reduced Fossil Fuel Demand from Decreased NGCC Generation	Output and Demand Block →Exogenous Final Demand (amount) for Oil and Gas Extraction sector→Decrease	Negative
10	Avoided Annual Capital Cost or Debt Repayment of Utility Sector Ordinary Investment	Compensation, Prices, and Costs Block →Capital Cost (amount) of Electric Power Generation, Transmission, and Distribution sector →Decrease	Positive

Linkage	Microeconomic Quantification Results	Policy Variable Selection in REMI	Positive or Negative Stimulus to the Economy
11	Foregone Stimulus Effect of the Upfront Utility Sector Ordinary Investment	Output and Demand Block →Investment Spending on Producer's Durable Equipment and Demand of Goods and Services from Construction sector →Decrease	Negative
12	Foregone Productivity Improvement from Displaced Utility Sector Ordinary Investment	Labor and Capital Demand Block →Factor Productivity (Share)→ Electric Power Generation, Transmission, and Distribution sector →Decrease	Negative

Appendix B. TLU and TSI Policy Input Data Mapping to the REMI TranSight Model

The following table summarizes the mapping for ten of the policies or policy bundles analyzed as part of the CEDP Macroeconomic Analysis process. It shows the types of spending or saving modeled in the REMI TranSight tool for each of these ten policies. The table articulates the sector to which each type of spending was allocated. In many cases, the decisions regarding which sector to use to reflect investments or spending flows were made with the help of REMI staff to ensure the correct use of the TranSight tool.

Because directing money to any particular activity creates some level of displacement (meaning that the money is no longer free to be spent or invested as it was before), each policy-driven change is paired with an offsetting change that reflects this expected displacement. In the case of public-sector spending, the presence of some level of external funding (federal or state) meant that only the local portion of the investment was subject to offsetting, while the state and federal portion of the investment represented new money coming into the region. Therefore many offsets were smaller in scale than their associated investments.

The table also shows productivity adjustments, which apply only to policies that drive private-sector investment. When private-sector capital spending was driven by a policy, the economic analysis effort assumed that, like public-sector investment, this would displace investment elsewhere. However, the analysts assumed that the investment to be displaced would be lower than average in its productivity (i.e. the least valuable and most favored for cutting by private enterprises), while the new investment was assumed to equal to the economy-wide average for productivity returns.

Policy Number - Micro Data Output Category	Policy-Driven Capital or Spending Change Modeled in TranSight	TranSight Sector	Negative Offsets and Productivity Adjustments	TranSight Sector
TLU6 - Employer Spending	Increased compensation to workers	Professional and technical services	Additional Expenditures by Employers	Professional and technical services
TLU6 - Fuel Spending	Reduced Spending on Fuel, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Petroleum and coal product manufacturing
TLU6 - Productivity Offset	-	-	Increased productivity vs. Displaced Low-Productivity Investment (Private Sector)	All Private Non-Farm Sectors
TLU6 - Vehicle Spending	Reduced Spending on Vehicles, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Motor vehicles, bodies & trailers, and parts manufacturing
TLU7 - Fuel Spending	Reduced Spending on Fuel, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Petroleum and coal product manufacturing
TLU7 - Parking Meter Revenue	Toll Revenue from Consumers	Tolls	Reduced Consumer Spending in other areas	All Consumption Categories
TLU7 - Vehicle Spending	Reduced Spending on Vehicles, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Motor vehicles, bodies & trailers, and parts manufacturing
TSI1 - Employer Spending	Increased compensation to workers	Professional and technical services	Additional Expenditures by Employers	Professional and technical services
TSI1 - Fuel Spending	Reduced Spending on Fuel, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Petroleum and coal product manufacturing

Policy Number - Micro Data Output Category	Policy-Driven Capital or Spending Change Modeled in TranSight	TranSight Sector	Negative Offsets and Productivity Adjustments	TranSight Sector
TSI1 - Productivity Offset	-	-	Increased productivity vs. Displaced Low-Productivity Investment (Private Sector)	All Private Non-Farm Sectors
TSI1 - Vehicle Spending	Reduced Spending on Vehicles, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Motor vehicles, bodies & trailers, and parts manufacturing
TSI10 - Construction	Construction Investment	Construction	Government Spending	Government Spending
TSI10 - Fuel Spending	Reduced Spending on Fuel, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Petroleum and coal product manufacturing
TSI10 - Vehicle Spending	Reduced Spending on Vehicles, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Motor vehicles, bodies & trailers, and parts manufacturing
TSI3 - Construction	Construction Investment	Construction	Government Spending	Government Spending
TSI3 - Fairbox Revenues	Toll Revenue from Consumers	Tolls	Reduced Consumer Spending in other areas	All Consumption Categories
TSI3 - Fuel Spending	Reduced Spending on Fuel, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Petroleum and coal product manufacturing
TSI3 - Transit Operations	Local Government Spending on Operations	Local Government Spending	Portions of Local Government Spending in Other Areas	Local Government Spending
TSI3 - Vehicle Spending	Reduced Spending on Vehicles, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Motor vehicles, bodies & trailers, and parts manufacturing
TSI4a - Construction	Construction Investment	Construction	Government Spending	Government Spending
TSI4a - Fuel Spending	Reduced Spending on Fuel, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Petroleum and coal product manufacturing
TSI4a - Vehicle Spending	Reduced Spending on Vehicles, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Motor vehicles, bodies & trailers, and parts manufacturing
TSI4b - Fuel Spending	Reduced Spending on Fuel, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Petroleum and coal product manufacturing
TSI4b - Productivity Offset	-	-	Increased productivity vs. Displaced Low-Productivity Investment (Private Sector)	All Private Non-Farm Sectors
TSI4b - Purchases and Equipment Spending	Increased sales and production of vehicles	Motor vehicles, bodies & trailers, and parts manufacturing	Reduced Spending on Other Equipment	Producer's Durable Equipment
TSI4b - Vehicle Spending	Reduced Spending on Vehicles, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Motor vehicles, bodies & trailers, and parts manufacturing
TSI5 - Construction	Construction Investment	Construction	Government Spending	Government Spending
TSI5 - Fuel Spending	Reduced Spending on Fuel, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Petroleum and coal product manufacturing
TSI5 - Vehicle	Reduced Spending on	All Consumption	Exogenous Demand	Motor vehicles, bodies &

Policy Number - Micro Data Output Category	Policy-Driven Capital or Spending Change Modeled in TranSight	TranSight Sector	Negative Offsets and Productivity Adjustments	TranSight Sector
Spending	Vehicles, Leading to Increased Consumption	Categories		trailers, and parts manufacturing
TSI7 - Construction	Construction Investment	Construction	Government Spending	Government Spending
TSI7 - Fuel Spending	Reduced Spending on Fuel, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Petroleum and coal product manufacturing
TSI7 - Parking Meter Revenue	Toll Revenue from Consumers	Tolls	Reduced Consumer Spending in other areas	All Consumption Categories
TSI7 - Vehicle Spending	Reduced Spending on Vehicles, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Motor vehicles, bodies & trailers, and parts manufacturing
TSI8 - Construction	Construction Investment	Construction	Government Spending	Government Spending
TSI8 - Fuel Spending	Reduced Spending on Fuel, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Petroleum and coal product manufacturing
TSI8 - Productivity Offset	-	-	Increased productivity vs. Displaced Low-Productivity Investment (Private Sector)	All Private Non-Farm Sectors
TSI8 - Vehicle Spending	Reduced Spending on Vehicles, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Motor vehicles, bodies & trailers, and parts manufacturing

Appendix C. Consumption Response in REMI

Table C1. Consumption Response of a 10% Increase in Consumption Reallocation (REMI PI+ v1.2)

Category	2009	2010	2020	2030	2040
New autos	5.18%	5.51%	4.55%	4.79%	4.99%
Net purchases of used autos	1.21%	1.35%	1.69%	1.90%	2.02%
Other motor vehicles	5.18%	5.49%	4.58%	4.82%	4.95%
Motor vehicle parts	1.22%	1.37%	1.72%	1.92%	2.04%
Furniture (incl. mattresses and bedsprings)	5.16%	5.46%	4.51%	4.75%	4.93%
Kitchen & other household appliances	1.20%	1.35%	1.67%	1.90%	2.05%
China, glassware, tableware & utensils	5.15%	5.43%	4.46%	4.71%	4.90%
Video & audio goods, incl. musical instruments	5.15%	5.44%	4.46%	4.72%	4.91%
Computers, peripherals & software	1.20%	1.33%	1.66%	1.89%	2.04%
Other durable house furnishings	5.15%	5.42%	4.45%	4.70%	4.90%
Ophthalmic & orthopedic products	5.15%	5.42%	4.42%	4.68%	4.87%
Sports & photographic equip., bicycles & motorcycles, boats & pleasure aircraft	5.15%	5.42%	4.44%	4.70%	4.89%
Jewelry and watches	5.14%	5.41%	4.43%	4.68%	4.88%
Books & maps	5.15%	5.41%	4.42%	4.68%	4.87%
Food & alcoholic beverages purchased for off-premise consumption	1.20%	1.35%	1.67%	1.89%	2.02%
Purchased meals and beverages	1.20%	1.33%	1.66%	1.88%	2.01%
Food furnished to employees	1.21%	1.37%	1.70%	1.92%	2.06%
Food produced and consumed on farms	1.22%	1.38%	1.72%	1.93%	2.07%
Shoes	1.21%	1.36%	1.71%	1.93%	2.04%
Women's and children's clothing and accessories except shoes	1.21%	1.35%	1.68%	1.91%	2.05%
Men's and boys' clothing and accessories except shoes	1.21%	1.36%	1.72%	1.94%	2.06%
Military issue clothing	1.21%	1.36%	1.69%	1.91%	2.04%
Gasoline and oil	1.20%	1.33%	1.66%	1.88%	2.02%
Fuel oil & coal	1.17%	1.27%	1.52%	1.77%	1.90%
Tobacco products	1.21%	1.35%	1.67%	1.91%	2.07%
Toilet articles & preparations	1.19%	1.32%	1.62%	1.85%	1.99%
Semidurable house furnishings	1.20%	1.34%	1.65%	1.88%	2.04%
Cleaning and misc. household supplies and paper products	1.20%	1.35%	1.67%	1.88%	2.01%
Stationary and writing supplies	1.18%	1.31%	1.58%	1.83%	1.99%
Drug preparations and sundries	5.12%	5.36%	4.24%	4.50%	4.72%
Magazines, newspapers & sheet music	1.18%	1.30%	1.56%	1.79%	1.95%
Nondurable toys and sporting goods	1.20%	1.34%	1.67%	1.90%	2.04%
Flowers, seeds and potted plants	1.19%	1.33%	1.60%	1.85%	2.00%
Expenditures abroad by U.S. residents	5.17%	5.50%	4.52%	4.79%	4.99%
Personal remittances to nonresidents	1.19%	1.33%	1.57%	1.80%	1.95%
Owner-occupied nonfarm dwellings	1.19%	1.24%	1.55%	1.78%	1.87%
Tenant-occupied non-farm dwellings	1.24%	1.32%	1.63%	1.74%	1.85%
Rental value of farm dwellings	1.24%	1.32%	1.62%	1.74%	1.84%
Other housing (hotels and other lodging places)	1.18%	1.30%	1.57%	1.85%	2.03%
Electricity	1.20%	1.29%	1.58%	1.80%	1.94%

Category	2009	2010	2020	2030	2040
Gas	1.19%	1.28%	1.55%	1.78%	1.91%
Water & sanitary services	1.20%	1.35%	1.65%	1.87%	2.01%
Telephone & telegraph	1.21%	1.34%	1.65%	1.87%	2.00%
Domestic services	5.10%	5.38%	4.54%	4.74%	4.78%
Other household operation	5.13%	5.38%	4.36%	4.62%	4.81%
Motor vehicle repair, rental, leasing	1.20%	1.31%	1.63%	1.86%	1.99%
Tolls	1.21%	1.38%	1.70%	1.93%	2.08%
Auto insurance less claims paid	5.17%	5.47%	4.51%	4.76%	4.94%
Airline	1.19%	1.34%	1.65%	1.88%	2.03%
Railway	1.21%	1.36%	1.68%	1.91%	2.06%
Intercity bus	5.17%	5.48%	4.51%	4.76%	4.95%
Intracity mass transit	1.20%	1.35%	1.67%	1.90%	2.04%
Taxicabs	1.20%	1.35%	1.67%	1.90%	2.04%
Other intercity transportation	1.18%	1.31%	1.61%	1.85%	1.99%
Physicians	5.08%	5.30%	4.25%	4.52%	4.71%
Dentists	5.08%	5.29%	4.24%	4.52%	4.71%
Other professional medical services	1.17%	1.28%	1.54%	1.79%	1.95%
Nonprofit hospitals	1.17%	1.30%	1.56%	1.81%	1.97%
Proprietary hospitals	1.17%	1.30%	1.56%	1.81%	1.97%
Government hospitals	1.17%	1.30%	1.56%	1.81%	1.97%
Nursing homes	1.17%	1.29%	1.55%	1.80%	1.96%
Health insurance, income loss, workers comp	1.17%	1.30%	1.51%	1.72%	1.89%
Motion picture admissions	1.21%	1.36%	1.70%	1.95%	2.06%
Legitimate theater admissions	1.19%	1.32%	1.65%	1.90%	2.01%
Spectator sports admissions	1.19%	1.33%	1.66%	1.91%	2.02%
Clubs and fraternal organizations	1.20%	1.33%	1.67%	1.92%	2.03%
Commercial participant amusements	1.20%	1.33%	1.66%	1.91%	2.02%
Radio and television repair	5.14%	5.37%	4.39%	4.62%	4.79%
Other recreation services	5.15%	5.41%	4.44%	4.72%	4.89%
Barbershops, beauty parlors and health clubs	5.13%	5.31%	4.28%	4.51%	4.67%
Other personal care	5.12%	5.29%	4.26%	4.49%	4.64%
Brokerage charges and investment counseling	5.17%	5.48%	4.53%	4.77%	4.94%
Bank service charges, trust services, and safe deposit box rental	5.16%	5.39%	4.40%	4.64%	4.80%
Financial services furnished without payment	5.16%	5.39%	4.41%	4.64%	4.80%
Other personal business	1.20%	1.34%	1.66%	1.88%	2.01%
Education and research	1.22%	1.38%	1.72%	2.00%	2.16%
Religious and welfare activities	1.19%	1.33%	1.62%	1.87%	2.02%
Foreign travel by U.S. residents	5.16%	5.48%	4.51%	4.77%	4.96%
Foreign travel in the U.S. and other expenditures in U.S. by nonresidents	5.17%	5.50%	4.54%	4.80%	4.99%

Economics & Politics, Inc.

961 Creek View Lane
Redlands, CA 92373
(909) 307-9444 Phone
(909) 748-0620 FAX
john@johnhusing.com
www.johnhusing.com

To: Wallace Walrod

From: John Husing

Subject: Climate Strategy Concerns

Date: June 27, 2012

In reviewing the various memos on the development of the economic impact of the SCAG climate strategies, the following broad issues of concern present themselves:

1. In the REMI modeling, a key consideration is how the strategies would affect the relative cost of businesses operating in the SCAG region versus elsewhere. This block is relied upon to determine the extent to which raising the dollar and cents cost of operations would cause firms to:
   a. Move their operations out of the market.
   b. Bring new operations into the market.
   c. Reduce their existing operations in the market.
   d. Expand their existing operations in the market.

   It would be useful to know from REMI how this section functions since an issue private sector representatives continually raise is the impact of increasing California's costs through environmental policies on the viability of their sectors. In particular:

      i. What are the variables triggering migration of firms in or out of the market or causing existing operations to grow or shrink?

   What are the thresholds of these variables that cause this changes to occur?

   >>Our understanding is that changes in production costs would affect the delivered price of the commodities produced by the businesses, which will in turn affect the competitiveness and market shares of the businesses. The market shares in REMI represent the ability of the industries in the study region to sell output within the region, to other regions in the nation, and to other nations. Market shares increase when production cost decreases or output increases in the Model.

   >>The REMI Model is not constructed at the firm level. We don't believe it predicts migration of individual firms. However, the model provides aggregate results on the total output, imports/exports from/to the rest of nation, and imports/exports from/to rest of

world of each industry. All of these variables are continuous-changing variables, not discrete-changing variables. For example, any change in production cost would result in changes in market shares of any given industry. Our understanding is that there are no thresholds of these variables beyond which the changes start to occur.

2. A related issue is the fact that SCAG's climate strategies would represent the latest iteration in the constantly changing regulatory environment faced by firms in Southern California. That situation creates costs of a different type that also impact the willingness of firms to leave, enter, reduce or expand operations.

    a. There are the staffing costs to dealing with the changing regulatory environment.

        i. Are these staffing costs accounted for in this portion of the REMI model.

        No, but they are likely to be minor.

    b. More importantly, there is the cost of uncertainty given that companies cannot have confidence in the rules they will face within their planning horizons.

        i. Are the costs of uncertainty accounted for in any way in this portion of the REMI model?

        No, but this is especially difficult to evaluate. CCS can briefly summarize the results of some studies, but I anticipate that these studies will suggest the costs range from minor to moderately significant.

3. Major policy changes of the type anticipated by SCAG's climate policies will create geographic winners and losers. There does not appear to be any discussion of these impacts on, at a minimum, the six counties of the SCAG region.

    a. Given the stakes involved in these policies for the large numbers of people and firms in the various sub-region's, a report that does not provide this information for the various policies is inadequate. Alone in population, Los Angeles County would rank as the 9th largest state, the Inland Empire would rank 26th, Orange County would rank 31st.

        i. Can the breakdown by at least these areas plus Ventura and Imperial counties be provided?

        It was agreed with Frank Wen that we would not provide county level results because of the time consuming nature of such calculations and because it might spawn jealousies among counties concerning the results.

4. Major policy changes of the type anticipated by SCAG's climate policies will create sector winners and losers. There does not appear to be any discussion of these impacts which are of enormous concern:

    a. Industry leaders to see how their sectors would be helped or hurt.

i. Can a breakdown by sector of the gains and losses from the policies be provided?

The discussions on the sectoral impacts have been provided in the draft report. For example, Section VB in the ECR macro report (starting from p. 22) presents both the top positively and negatively affected sectors by the ECR policy options.

b. Labor leaders to see how their members would be helped or hurt.

i. Can a breakdown of the sectors in which organized labor is a major factor be provided?

Additional information will be provided in the final report.

c. Ethnic leaders to see evaluate the social justice implications of the creation of work that their populations can perform.

i. Can a breakdown of the sectors providing upward job mobility to Hispanics and African Americans be provided?

This is beyond the scope of the study.

5. It may be beyond the scope of this work, but the ability to impact some of the policies is heavily dependent upon redevelopment.

a. Without that tool, the cost of implementation of policies like Transit Oriented Development will be greatly increased.

i. Has allowance in the cost factors been made for the extra expenses of assembling parcels, financing infrastructure, and paying for demolition before older areas suited for Transit Oriented Development can be made competitive with other areas without those issues?

This is beyond the scope of the study.

PCENTER FOR CONTINUING STUDY OF THE CALIFORNIA ECONOMY

132 HAMILTON AVENUE • PALO ALTO • CALIFORNIA • 94301

TELEPHONE: (650) 321-8550
FAX: (650) 321-5451
www.ccsce.com

DATE: June 14, 2012

TO: SCAG Economic Impact Analysis Team

FROM: Stephen Levy

SUBJECT: CCS Economic Impact Analysis of the CEDP Project

This memo focuses on the interpretation of the results and methodology in the CCS memo of June 11, 2012 for ECR Policies and early CCS report on March 30 on impact analysis results for the Transportation Systems and Investment (TSI) and Transportation and Land Use (TLU) policies selected as part of the Climate and Economic Development Project (CEDP). The memo also includes comments on the earlier RTP and CCS economic impact analyses and on methodological and interpretation issues that are important to discuss for the next rounds of economic impact analyses.

My Understanding

The CCS ECR, TSI and TLU analyses serve two purposes—1) to help SCAG and other parties prioritize policies for effectiveness in reducing GHG emissions and 2) to identify selected economic impacts associated with the individual policies and with the overall packages of policies.

The Principal Findings—ECR Report

As I read the ECR analysis report, all of the differences in jobs, income and gross regional product are less than 1% and often much less than that compared to baseline values in 2035.

However, as I look at the analysis report and the baseline inventory report, it appears to me that the policies have a much more significant impact on reducing GHG emissions relative to the baseline projected inventory.

And, in particular, two policies—RC1 and ES1—relating to energy efficiency and central station incentives—produce most of the GHG emission reductions.

So the analysis appears to be successful in identifying priorities for reducing GHG emissions all of which have minor changes in jobs and income.

The Principal Findings for TSI and TLU Policies

The bottom line is that, like the ECR analysis, the CCS analysis is helpful in identifying priorities in terms of impact for reducing GHG emissions and finds some policies that have a substantial potential to reduce emissions.

The main benefits of the CCS land use and transportation work are 1) showing that the policies CCS looked at are relatively modest in terms of economic impact compared to the growth forecast job growth or the RTP analysis and 2) that the most important policies they examined are the land use policies in support of less driving and more transit or walking for both work and non work trips. Their results show a significant impact on GHG emission reduction.

CCS prepared detailed descriptions of the key polices they analyzed. They took cost information from the RTP but they included only a small portion of the public transit RTP costs, taking into account only the costs and investments directly associated with GHG reduction. This is why their results show much smaller job and GDP impacts compared to the RTP analyses as discussed below.

The CCS analysis had as its primary purpose to produce estimates of GHG, VMT and fuel savings impacts. I asked CCS about how their reductions compare to overall GHG levels and they provided the table shown on page 12 of this memo. It appears as if the measures they analyzed account for a 6% reduction in the baseline inventory in 2035. This is a total reduction and not per capita. I did not ask for similar comparisons for VMT and fuel savings but probably CCS could provide this data as well.

They expect approximately 14,000 jobs per year as the impact of the policies they model. It is on this basis that I have characterized their reported impacts as "small". As shown on page 14 of the CCS report the job impacts are estimated as .2% of average regional jobs and between .1% and .2% of regional GDP and income, most of which are attributable to the land use policies confirming that their scope covered only a **very small** part of the regional economy.

There are some methodological issues to discuss for future work but they do not affect the bottom line findings of the CCS land use and transportation policy analyses.

Interpreting the Results

CCS correctly identifies that the job, income and gross regional product impacts are only part of a full economic evaluation. This is particularly important to acknowledge when the economic impacts themselves are very small as they are in this case.

When the focus is on GHG emission reduction, it is likely that the broader economic impacts including health and environmental factors will outweigh the job, income and gross regional product impacts in decision making. These impacts, which regularly are the focus of AQMD analysis, will be the more important in deciding on policy approaches. I understand that CCS's scope was restricted to the topics covered in their reports.

It is up to SCAG to decide how to interpret and present economic impact results that are less than 1% of the region's jobs, income and gross product 25 years in the future. In the EEAC work on AB 32, we decided to minimize the importance of similarly small results and offer the interpretation that meeting the AB 32 goals would have a minimum impact one way or the other on the economy.

Questions

1) Now that CCS has completed and published an inventory of emissions, can they prepare a simple table that shows the reduction and % reduction from the baseline for each individual policy in this and the prior memo and for all policies together? My impression is that they are indicating substantial progress in GHG emission reduction from these policies but want them to confirm.

   >>Figure 2 (marginal cost curve) in the ECR report presents some of the information (such as % emission reduction with respect to the economy-wide baseline level) for the ECR options. We can provide additional information if necessary.

2) I am unclear as to whether any and all of the GHG emission reduction estimates are assumptions or based on analysis.

   >>The GHG emission reduction estimates are generally based upon spreadsheet quantitative analysis. For the TLU and TSI options, the goal of the analysis was to be consistent with the documentation in the SCAG draft RTP/SCS and EIR/S which were available at the time of the analysis. In addition, the CCS team made some specific information and data requests to SCAG staff, and the information received was incorporated into the spreadsheet analysis for the GHG emission reduction estimates.

For example, the following section from the CCS ECR policy option memo of May 29, 2012 has the following beginning section. This reads to me as if the RC1 emission reductions are simply assumed. If so, I am not sure how to interpret the results since I do not know how likely this assumption is to actually be successful.

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 (e.g. Energy Trust)

Policy Description

Demand-side management (DSM) programs are designed to assist energy users in reducing or changing the timing of their energy use. This policy option focuses on increasing investment in effective electricity and gas DSM programs, which might be run by utilities (including investor-owned utilities, municipal utilities, and cooperatives) or non-utility third parties (either governmental or non-governmental). Expanded investment is supported by collection of energy efficiency funds and/or energy efficiency goals. DSM programs may be designed to work in tandem with other strategies that can also encourage efficiency gains.

Policy Design

Goals or Level of Effort:

The public and investor-owned utilities of the SCAG region are assumed to fulfill the goals of California Assembly Bill 2021 (AB2021), which mandates that utilities achieve 10% consumption reduction (which we assume to be net of any decay in efficiency savings over time) relative to forecast demand within the period 2011 through 2020. It is assumed that this rate of savings continues throughout the modeling period (through 2035).

I don't know what options were or are open to CCS and SCAG in terms of these analyses, but to me there is a big difference between saying "If you do this, the following will occur" and saying "If you assume this will happen, here are the impacts on jobs and income".

> At the request of SCAG, CCS modeled the RCI-1 option for the SCAG region consistent with the SB2021 mandate that utilities achieve 10 percent consumption reduction relative to forecast demand within the period 2011 through 2020. As such, what the modeling of RCI-1 is in effect saying is that if the utilities of the SCAG region mount aggressive energy efficiency programs consistent in terms of level of effort with the SB2021 mandate—which is itself also consistent with the results of some of the historically best-performing energy efficiency programs in California and in other U.S. states—then the micro- and macroeconomic impacts of those programs will be as indicated by the analytical results.

Another way to say this is that I am unclear as to whether CCS was measuring the impact of actual policies or of ideas that could be turned into specific policies but have not been done so yet.

> In general, and again at the direction of SCAG, CCS modeled the impact of existing California policies on the SCAG region, though not all of those policies have been fully implemented. As a consequence, CCS was obliged to make various assumptions about how the policies might be implemented, and their cost and emissions reduction performance, consistent with the goals and mandates of the policies as expressed in available documentation.

3) I am unclear as to what the actual costs associated with each policy option are or where they came from. In the RTP analysis, CCS said they were

using the RTP cost estimates, which I could trace. Personally, I find the NVP and cost-effectiveness presentations confusing although I have no reason to question the conclusions.

>>Direct costs and savings associated with each policy option are calculated and detailed explained in the Microeconomic Impact Analysis Reports of the ECR and TLU/TSI options. CCS can confirm that the TLU/TSI cost estimates were done in a manner to be consistent with the cost information included in the RTP, as has been discussed and reviewed with CCSCE previously.

Other Issues

I recommend deleting the use of "job years" in any SCAG document. Also it would be helpful to see averages for 2010-2035 instead of focusing on the 2035 results exclusively.

>>Good idea.
Both job years and a focus on 2035 tend to exaggerate both the average size and timing of impacts.

It remains true that the SCAG economy will be at or near full employment for most years and that policies here and in the RTP analysis are unlikely to produce many jobs in the near term that are not already in the baseline projections.

>>We disagree. Given the small number of jobs, it is reasonable to assume that they would be additive.

The major contribution of the CCS work is to show that it is possible to clean the air with minimum impact on the economy. The small pluses and minuses are not worth much attention in my view as opposed to the fact **that all estimated impacts on jobs and income are small** or to use CCS's words "very slight".

The CCS modeling uses the REMI version of SCAG jobs, total and by industry, which does not match the NAICS based SCAG jobs database. I do not think this makes a big difference in the results but it is an issue that SCAG and AQMD have worked on in the past to conform the REMI projections baseline to the SCAG growth forecast.

CCS assumes that 50% of the private capital investment displaces other investment and 50% does not. I don't know how they determined this but all of these assumption issues for this memo are tempered by the fact that economic results are less than 1% for differences.

>>CCS made this assumption for lack of data. Note that we did perform sensitivity tests on this.

Background

CCSCE provided SCAG with comments on the earlier RTP economic impact analysis and the earlier CCS analysis of land use and transportation policies related to GHG emission reduction. CCSCE also made suggestions to SCAG regarding interpretation of economic impact analyses and developing common agreements about assumptions and methodology for future work.

The following is a summary of the earlier comments.

Positive Contributions

The positive contribution of the RTP economic impact analysis is that it shows the importance and rationale for the RTP plans and investments. I will argue below that the way to interpret these results is that the RTP supports the growth forecast and without the full RTP that job growth would be lower and, as a result, that the RTP makes a **critical difference** to regional competitiveness.

The main benefits of the CCS land use and transportation work are 1) showing that the policies CCS looked at are relatively modest in terms of economic impact compared to the growth forecast job growth or the RTP analysis and 2) that the most important policies they examined are the land use policies in support of less driving and more transit or walking for both work and non work trips. Their results show a significant impact on GHG emission reduction.

Relating the Economic Impact Findings to the Growth Forecast

SCAG prepared a regional growth forecast and the RTP and CCS studies analyzed the impact of components of the policies that support the growth forecast and RTP/SCS.

Growth Forecast

SCAG and CCSCE projected a share of national and state job growth for the SCAG region by analyzing growth trends in many individual industries. Our overall projected job growth was reviewed by expert panels. I think we agreed that the adopted growth forecast took a conservative view of the region's growth potential.

The SCAG growth forecasts are based on (assume) the continuance and expansion of the existing RTP and land use policies. Many if not most of the 2012 RTP and SCS policies and funding is already in place. We also assume that the new RTP and SCS will plan what is needed to support continued job growth and competitiveness.

RTP Economic Impact Analyses

The RTP economic impact analysis keyed off of the expected $525 billion in physical infrastructure investment and operational/maintenance funding incorporated in the RTP. They calculated three sets of impacts from this spending—1) from the direct construction, 2) from the efficiency/competitiveness improvements (higher shares of national job growth) and from 3) amenity changes (people and businesses more likely to move for amenity reasons).

The $525B represents an average of $21B per year in spending, some of which is already ongoing and funded and some of which depends on future new revenues.

So these are the main differences in approach and scope for our discussion below—SCAG produced a growth forecast for **all** of the region's economy, the RTP analysis covers **some** of the region's economy related to the RTP and the CCS analysis covers a **smaller part** of the regional economy focused on GHG emission reduction.

How Should the Growth Forecast and RTP/SCS Economic Impact Analyses be Related

Here are the current findings and related interpretation issues. At the end I make some suggestions for the future.

Growth Forecast

The SCAG growth forecast shows

2008-- 7.7 million jobs

2010 – 7.2 million jobs

2035 – 9.4 million jobs

The growth forecast has a gain of either 1.7M jobs or 2.2M depending on whether you start in 2008 or 2010

RTP Economic Impact Analysis

They expect approximately 600,000 jobs per year will be "created or sustained" by the RTP investments. I argue that the correct interpretation is "sustained" and that these jobs are probably not in addition to the growth forecast but it is one of the issues for further discussion. Since the SCAG growth forecast analyses were done in different time periods, it is theoretically possible that some of the RTP investments would have caused SCAG to slightly raise the growth forecast.

In the RTP analysis the $21 billion per year in RTP investments ($525B/25years) accounts for roughly 2% of the regional GDP and the direct and multiplier impacts of the spending are 175,000 jobs on average or also approximately 2% of the regional job total. As I discuss below most of the $21B, particularly in the early years, already exists and should be in any baseline alternative.

The RTP analysis then considers that these investments will support approximately 400,000 jobs per year as a result of competitiveness and amenity impacts. Assuming that the estimates are accurate, the big question discussed below is how to interpret these results.

Do any of the RTP or CCS Economic Impacts Change the Growth Forecast?

This is a **conceptual** not a **measurement** issue and it raises the interesting point of "compared to what" or "what is in the baseline".

I will argue that the answer is mostly **no** for two reasons:

- It is reasonable to argue that the growth forecast did assume all or most of the investments or policies in the RTP/SCS that it was developed for. If this case, The RTP and CCS analyses are measuring the contribution/importance of the RTP/SCS in supporting the conditions that provide the competitiveness assumed in the growth forecast.

  >> CCS TLU/TSI analysis measures those aspects of the RTP related to GHG mitigation.

- One fact that may have been overlooked in the RTP analysis is that **the RTP investments are neither all new nor all incremental.** In fact most of the funding is simply a continuation of what is already happening, for example, there are existing local sales tax funding, existing state gas tax funding, and existing federal funding supported by existing gas taxes.

  The region already sees money spent on building new facilities and on operating existing and growing levels of public systems. **So not only is all or most of the funding already in the old RTP and in the growth forecast, much of it is in the existing job levels for the base year 2010.** This can be seen from the RTP finance section tables.

  It might be interesting in future work to identify what is new or added in each RTP/SCS compared to the last one. But much of the 2012 RTP (the $21B in annual spending) is a continuation of existing annual funding and when/if new funding is available, it will be long into the forecast period and **have nothing to do with recovering from the recent recession.**

I believe that the **jobs** and income associated with maintaining the current level of spending are **in the baseline growth forecast and should not be counted in any way as "additional" in the economic impact analysis.** Furthermore, much of the RTP spending supports jobs that are exist **now** so not only are they in the baseline growth forecast, they are in the no growth baseline. For economic impact analyses related to the RTP I think there is an issue of separating out funds that are a continuation of existing spending from funds that support **additional spending.**

I think the fairest statement to make about the RTP and SCS is that if these policies are not fully implemented, regional economic competitiveness and job growth would be lower than if they are implemented. So the RTP/SCS do not raise the growth forecast but do prevent it from being lower, which **is important.**

>>In the CCS TLU/TSI analysis, distinctions between options that utilize existing funding sources and those that will depend on new funding sources are made. For the former, their impacts should be considered to be within the baseline forecast. For the latter, when CCS undertook the analysis, investment displacement effects were considered based on the assumption that any new funding that will be invested in TLU/TSI options will displace either public or private investment in other areas.

Methodological and Interpretation Issues

I recommend that the SCAG and consultant staff that will engage in ongoing economic impact analyses meet to discuss issues of common methodology and interpretation of results. The following comments provide background on the issues I think should be discussed.

Relating Economic Impact Findings to the Growth Forecast

Here are some thoughts to get our discussion going.

One, we need a closer connection and better understanding of the policy implications that underlie the growth forecast. The expert panel and staff and management should be involved in developing and understanding how the growth forecast and regional policies are related.

Two, since the growth forecast comes earlier in the process than the final RTP/SCS we should try and understand how much of the existing RTP/SCS will continue, how much progress has been made in implementing/funding the existing plans and at least some idea of what new additions will be coming.

Three, we need to develop a clear understanding of how the growth forecast and ongoing economic impact analyses are and should be related, especially if they are managed by different divisions within SCAG.

Correctly Identifying the Baseline

In the case of the RTP investments there is no doubt that the regional economy will be more prosperous (jobs and income) if the investments are made compared to if they are not made. But the question remains “better in comparison to what”.

How, for example, should the RTP economic impact analyses be interpreted in relation to the growth forecast? Is it accurate, as Frank and I argued, that primarily the RTP supports the job growth projections in the growth forecast and that, in the absence of the RTP investments, job growth would be lower? Or is it possible that the RTP pushes job growth higher than the growth forecast?

This is a central question of analysis coordination and common assumptions for the next rounds of analysis. How should the growth forecast and ongoing economic impact analyses be coordinated and interpreted in comparison to current economic conditions?

It is reflected in the language of “create jobs” versus “support projected job growth”.

There is a second related issue. The productivity benefits are based on the assumption that some factor (driving time, amenities) improves as a result of the RTP spending. I am comfortable that this is true. But the implicit assumption seems to be that this is **all** net gain versus other regions and I am not comfortable assuming that other regions will not make similar improvements.

> >>Many of these gains are not at the expense of other regions. Lowering costs of goods due to transportation cost reductions can lead to lower prices and thus greater consumer purchasing power in the SCAG Region without any adverse effect on other regions.

Not Fully Accounting for Offsetting Reductions in Spending

One of my concerns in general and in the recent analyses conducted for SCAG is the way they analyze whether project funds are required to be offset by reductions in spending elsewhere in the economy. I am concerned that project funds are modeled as “free” from the point of view of regional residents and businesses when it is not accurate. This is both a theoretical and practical issue.

Most infrastructure funding is raised in the region (sales taxes, gas taxes, and tolls) and is a direct transfer of funds from one use to another, not a net addition to regional spending. But this is also true of state and federal funding. Residents in the SCAG region pay their fair share (or more) of state and federal budgets. We are having an intense national debate about balancing these budgets and offsetting any additional spending with revenues or spending cuts. So, in practice, state and federal funds are certainly not “free”.

I argue that virtually all the infrastructure spending in the RTP should be offset by reductions in other spending. **This does not negate that spending money on infrastructure may be better than other spending uses or that RTP spending can create productivity benefits** but is does require that we treat these investments as **not** free and as **requiring offsets** in the analysis.

Increasing the proportion of spending that is required to be offset will reduce the direct and multiplier impacts but should not change the impacts created by productivity and amenity improvements.

> >>CCS has included spending offsets adequately in the macroeconomic impact analysis of the TLU/TSI and ECR GHG mitigation options.

Economic Impact versus Cost Benefit Analyses

Cost-benefit analysis is the approach for a complete evaluation of projects. Economic impact analyses are partial evaluations that stress the outcomes for job and income growth in the aggregate and on particular industries and groups of people.

It is well understood that an economic impact analysis can give a different answer from a full cost-benefit analysis. One major example of this is in air quality policies where a slight loss in jobs and measured income can be more than offset by gains in health benefits, climate protection and amenity values connected with clean air.

The differences between cost-benefit and economic impact analyses are well understood and accepted by practitioners. My concern is that the partial nature of the results of a focus on jobs and income be well clarified in reporting results to decision makers. This is also important to understand in cases where proponents are using economic impact modeling to argue that a policy should not be enacted because it will “hurt business”.

> >>CCS has briefly discussed these points in the second to last paragraph in the Conclusion section of the ECR macro report:
>
> “Note that the estimates of economic benefits reported in this study represent a “lower bound” from a broader perspective. These estimates do not include the economic value of other benefits associated with AB 32, 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."

When is Spending Additional and When are Multipliers Justified

The theory is that the direct spending on infrastructure sets off a chain of additional spending as the recipients of the initial spending inject these funds back into the economy. There are two standard uses of multipliers.

The first use refers to federal stimulus policies. It is widely accepted that when there are underutilized resources such as high unemployment, that additional spending or tax cuts will put money into the economy directly and that there will be a multiplier. In the recent recession, there was considerable analysis of the different multipliers associated with different kinds of spending and tax policies.

In the fiscal stimulus cases the extent of the multiplier depends on the extent of unemployment. It is also widely accepted that additional stimulus in a full employment economy will increase prices more than expand output and employment.

>>All of this is true in a closed economy. But employment can increase due to in-migration as well.

The second major use is connected with changes in an area's economic base. For example, recently ADM closed an ethanol plant in a small North Dakota town. The closing takes money out of the local economy as the plant exported its products and the initial loss of income will be multiplied as former employees cut back on their local purchases. In a similar and much larger way, the cutbacks in defense spending in the early 1990s had both direct and multiplier losses to the SCAG region economy.

The reason that local area use of multipliers is tied to economic base theory in the literature is that the usual examples are when an export industry plant or sector expands or contracts the money is added to or taken away from the local economy.

In some cases for the RTP and CCS analysis, there is new money being added to the local economy. The problem is, as described above, that this is not the traditional economic base case where someone from outside invests in the region. In most cases it is a reallocation of local resources (through taxes and fees) to other uses. **So it may be new money spent on RTP or GHG reduction activities but it is not additional money; it is a reallocation of resources.**

>>We have taken care to make the appropriate distinctions and offsets.

Issues with the History of Economic Impact Analyses

These comments are **not** related to the RTP or CCS economic impact analyses but to the general history and level of skepticism usually greet these analyses.

You can see why in a job-starved economy and with the public focus on jobs, jobs, jobs that decision makers want to use economic impact analyses to talk about job growth and sometimes push the envelope of what is justified. And even in times of full employment, the prospect of job growth is enticing to policy makers.

Economic impact analyses are usually conducted for two purposes: 1) to show the benefit in terms of jobs and output of a proposed project or set of projects or 2) to show that a proposed policy or project will cause great harm to businesses.

Think of the current set of studies designed to show the great harm to communities from planned federal defense spending cuts. Unfortunately they are usually done with an outcome in mind and are greeted either with skepticism or intense pushback.

In California think about the controversy with the high speed rail economic analyses or the AB 32 analyses.

I think both the contentious history around commissioning and interpreting economic impact analyses and the fact that they are usually used to influence decision making should make it important for SCAG to develop and use clear, transparent and consistent methodologies for these analyses and a clear statement on how they relate to the growth forecasts and other agency policies.

- Total CEDP TLU and TSI GHG Reduction Potential Estimates:
  - 2020 – **0.97 MMtCO2e potential reductio**n
  - 2035 – **3.22 MMtCO2e potential Reduction**

- Revised Draft CEDP Inventory and Forecast (I&F):
  - Onroad Gasoline: **2020 – 56.4 MMtCO2e**
  - **2035 – 54.0 MMtCO2e**

Memo

DATE: August 20, 2012

TO: Paul Aldretti and Randy Strait; Center for Climate Strategies (CCS)

FROM: Project Management Team for CEDP; SCAG

SUBJECT: CEDP Peer Review

SCAG's technical review of its recent Climate and Economic Development Project (CEDP) included an evaluation of the project's methodology and results by three independent economists specializing in the Southern California regional economy. This Technical Review Committee (TRC) included Dr. Christine Cooper from the los Angeles County Economic Development Corporation, Dr. John Husing from Economics & Politics, Inc., and Dr. Wallace Walrod from the Orange County Business Council.

Included with this memo are the findings from this work (Attachment 1). To summarize, the TRC has some reservations that prevented them from fully supporting the CEDP report and findings. Some of these issues deal with the technical methodology of the analysis, and some are related to items that are not within the scope of the project. It is the goal of the Project Management Team that CCS works to resolve, as possible, the issues that have been identified that touch on the technical aspects of the analysis. For items that are out of the scope of the project, SCAG staff recognize that CCS cannot address these items fully due to the limited resources remaining on the contract. Here is a listing of the specific items identified by the TRC, taken directly from the prior referenced memo:

<u>Technical Issues</u>

- In the third paragraph of Appendix B of the CCS response to memo dated June 27, 2012, it is stated that "the analysts assumed that the (*private-sector*) investment to be displaced would be lower than average in its productivity…" While analysts might reasonably assume that when businesses have a choice, they would displace lower productivity investment with higher productivity investment, this might not be true when the business is mandated to replace current equipment, and when the specific equipment may be dictated by regulatory authorities.

  Response: In the cases of the policies in question, it is not a single business that would displace one investment with another, but the entire region's capital market that would invest more heavily in one type of new business (such as a car-sharing operation) rather than another. The displaced investment represents capital from banks directed to specified industries that can no longer be accessed by the rest of the SCAG region's borrowers. The assumption that the displaced investment would be lower in productivity represents the understanding that lenders would be free to choose their investments, and that the displaced investments would likely be those with the least attractive profiles of risk and return.

More generally, the policies analyzed have not yet been implemented by any regulatory authority. 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. Consequently, for this analysis, it is necessary to make assumptions on how businesses that may be affected by the policy analyzed may respond. To address this point, we will add text to Appendix B to note that there is uncertainty associated with the assumptions because at this time we do not know how policies ultimately will be implanted and enforced by a regulatory authority. If reviewers have actual specific examples they would like to provide we will include these in Appendix B as well.

- Appendix C of the CCS response to memo dated June 27, 2012 provides an array of consumption responses by commodity if household discretionary income rises as a result of policy implementation. The highest modeled consumption responses are for variables related to automobiles, with several auto-related responses on the list. Since most polices are designed to reduce automobile ownership and use, the question arises as to whether these responses were modified to reflect that new behavior.

  Response: We propose to add text to Appendix C to clarify the implications associated with timing for reductions in VMT and potential impact on consumer spending on vehicles. While many policies did target reduced travel demand, policies were not explicitly targeted toward reducing vehicle ownership, and so the analysis did not assume significant changes in actual ownership levels. Also, while the policies targeted reductions in travel behavior, the projected impacts were fairly conservative, reducing VMT by less than 5% even in 2035, and by less in earlier years. Because of these two circumstances, and the limited resources available, the analysis did not include adjustments to the factors allocating additional consumer incomes to automobile-related expenditures.

- There appears to be a lack of clarity about how some key assumptions were specified into the REMI model. Among others:

  - Regional Purchase Coefficients related to local demand and manufacture of energy efficient and renewable equipment are apparently modeled under the assumption that the current levels of these coefficients, as set in REMI, will remain unchanged over time. The only future question reviewed by the sensitivity analysis was what would happen if these Regional Purchase Coefficients went up dramatically. Implicitly, the assumption appears to be that because demand for this equipment will rise due to Southern California's policies that the products will made here. Our experience and discussions with companies already buying equipment indicate that there is a better chance that the Regional Purchase Coefficients will go down, not up. In any case, this is an issue requiring more than an assumption or a cursory examination as these coefficients are critical to understanding the macroeconomic impacts of long term policies. Without such an effort, the modeling is incomplete.

    Response: We are willing to do another sensitivity test that reduces the RPC for energy efficient and renewable equipment if we can get a renewed REMI PI+

license key. However, we would appreciate some further explanation from TRC reviewers as to why they think it is likely that a higher percentage of these equipment and appliances will be imported to SCAG Region.

- In judging the cost effectiveness of alternative energy solutions, natural gas prices are used as a key comparable measure. From the materials supplied to the peer review team, it was not possible to determine the assumed levels of those prices or how they would change over time. Here, the sensitivity analysis considered the case of natural gas prices rising dramatically. Again, the analysis is incomplete in not looking at the impact of prices dropping dramatically, a likely scenario since average annual well head prices have fallen from $7.98 per 1,000 BTUs in 2005 to $2.29 in 2012, and lower natural gas prices reduce the relative cost effectiveness of alternate energy solutions.

  Response: The natural gas price forecast provided in the following table comes from the most recent CPUC Market Price Referent model (http://www.cpuc.ca.gov/PUC/energy/Renewables/mpr). These prices were used in the base case macro analysis as well. Note that sensitivity tests were performed already for natural gas prices 50% higher than the base case. We can also perform the sensitivity analysis for natural gas prices 50% lower than the base case.

	2012	**2015**	**2020**	**2025**	**2030**	**2035**	**Source**
Natural Gas Price $/MMBTU	$5.26	$6.12	$7.54	$9.39	$10.84	$12.57	2011 California Market Price Referent

- In its draft memo, the CCS states that, "the estimates of economic benefits reported in this study represent a 'lower bound' from a broader perspective. These estimates do not include the economic value of other benefits associated with AB 32, 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."

  It follows from our concerns outlined above that the peer review team finds that the current documentation is not sufficient to allow to us to come to the same conclusion. We worry that in many cases CCS has chosen to specify and make assumptions regarding policies (such as energy efficiency programs and land use) that would require "optimal" implementation or "best performing" cases rather than more realistic, tempered policy assumptions and forecasts. Hence, it would perhaps be better to say that the CCS/CEDP results are "upper bound" or "aspirational," rather than "lower bound."

  Response: We will replace the language in the original draft macroeconomic memo dated June 11, 2012 with the following to remove reference to "lower bound":

  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.

Other Items

- Measuring the potential for differential (*negative*) impacts of policies upon different geographies within the SCAG region.

  Response: As previously discussed with SCAG, this sub-SCAG region level of analysis is beyond the budget and scope of the project. As previously discussed with SCAG, the results could also potentially raise issues that would generate tensions between the MPOs depending on the results.

  The REMI model used by the CCS research team was for the entire SCAG Region and did not allow for the computation of impacts from individual counties. However, some inferences can be drawn by applying separate county baseline economic data with our region-wide sectorial results. Tables 1a, 1b and 2 referenced in the following text are provided in a separate Excel workbook file named “08-17-12_SCAG_Sub-Reg_Manufacturing.xlsx”.

  Tables 1a and 1b provides sectoral gross output, value-added, and employment impacts for the SCAG Region from implementing all ECR options combined and all TLU/TSI options combined in Year 2035, respectively. Please note ECR options were run in REMI PI+ Model, which uses a sectoring scheme of 169 sectors. TLU/TSI options were run in REMI TranSight Model, which applies the 70-sector scheme. In the tables, we highlighted the impacts for individual manufacturing sectors in blue and highlighted the impacts to the Petroleum Refining sector (which is “Petroleum and coal products manufacturing” in REMI) in yellow. Row 171 in the “Table 1a” sheet and Row 73 in the “Table 1b” sheet also present the total impacts on all manufacturing sectors combined. Table 2 lists the REMI baseline projected gross output levels prior to the GHG mitigation options implementation (i.e., baseline levels) in each county for each REMI sector (in the 169-sectoring scheme) in Year 2035. Again, we have highlighted the manufacturing sectors in blue and the petroleum refining sector in yellow. Row 172 in the “Table 2” sheet shows the aggregated numbers for the entire manufacturing sector.

  It is immediately evident that the majority of manufacturing in the Region is located in Los Angeles County (51%) and Orange County (30%), so it is likely that the majority of manufacturing sectoral impacts will affect these two counties.

  As for the Petroleum Refining, over 83% of this sector’s production within the SCAG Region is in LA County, so nearly all of the impacts on this sector will be confined to this county.

- Measuring the potential for differential economic and employment impacts of policies upon key groups within Southern California's population defined by demographics, income and/or educational attainment.

  Response: This work is defined under Task 7 that was not funded.

- Cost effectiveness of key policies in light of recent changes in funding mechanisms such as redevelopment.

  Response: Transportation financing is experiencing a major transition. What was traditionally controlled by the state and federal transportation authorities is now controlled by regional and local authorities. This has occurred as funding has become more locally and regionally based. The RTP recognizes this and relies very heavily on the continued growth in local funding sources. The design of the macroeconomic analysis explicitly takes the RTP funding categories and funding sources into account when estimating regional impacts. Funding that is sourced locally is recognized as a reduction in the positive impacts that many of the policies considered, because it is anticipated to displace other investments that would be supported by locally-sourced funds.

- The impact of uncertainty on business decision making.

  Response: While we acknowledge that a change in regulations and other policies related to GHG emissions can have at least short-term impacts on business costs and competitiveness, and on business decision-making, an exploration of the impacts of regulatory uncertainty is clearly beyond the scope of the report. In addition, we would expect that the regulatory uncertainty impacts would largely occur in the few years following a change in policy, and thus not particularly amenable to the type of longer-term analysis presented here. The key to reducing uncertainty is to set out clear and consistent policies and to stick with them, giving firms certainty about a rule, incentive program, or other implementation mechanism in their planning efforts. This does not mean that some adjustment in policies cannot happen over time, as policymakers evaluate and revise policies to make them more effective. With policies consistently applied, businesses will be able to make decisions that will allow them to adapt and compete in the medium- to long-term.

- The stated concerns about the necessary land density to implement the TOD/MX policies have not been satisfactorily addressed. If the only way to reach the policy options' implicit land use density targets is building residential towers and mixed use facilities at transit nodes, but there is no funding mechanism in place to do so, or funding mechanisms which might reasonably have been used such as Redevelopment *(RDA)* funding, have been eliminated, then the analysis is incomplete since it does not discuss the impact of these difficulties on the costs and feasibility of the policies.

  Alternatively, if towers are not the answer, then the policies appear to require significant amounts of available or converted land to accommodate residential uses near transit nodes. In this case, the analysis is again incomplete since it does not review policy costs and feasibility based upon the known locations of existing or future transit nodes as well as the known current levels of land availability and, where necessary, the likely costs of conversion.

Response: This question seems to address the microeconomic analysis of the TOD/MXD policy's potential to effectively reduce travel demand and relocate land uses. In designing and completing this analysis (which was preliminary to the macroeconomic impact analysis), we relied on the outcome of the TWG process, our communications with SCAG staff, and the RTP/SCS documentation as the foundation the analysis of the policy. An analysis of residential density as a threshold for effective VMT reduction as a result of TOD and MXD was not feasible given the resource constraints involved with the microeconomic analysis. TOD and MXD policies are inherently complex, and a full analysis could go beyond estimating the policy's effectiveness to estimating a range of economic impacts from land value change, land-use change due to zoning, as well as changes in the competitive strengths of different locations for different uses. In defining the policy and measuring its impacts, we attempted to be consistent with the RTP/SCS, the policy concepts approved by the TWGs, and the input of SCAG staff.

	Table 1a. Non-Farm Private Sectoral Impacts for the ECR Options Combined, for Year 2035			
	(the blue highlighted rows are the manufacturing sectors and the yellow-highlighted is the petroleum refining sector in			
	REMI Sector	Gross Output (in millions 2005$)	Value-Added (in millions 2005$)	Employment (jobs)
1	Forestry; Fishing, hunting, trapping	11.8	5.0	45.7
2	Logging	0.2	0.1	0.9
3	Support activities for agriculture and forestry	31.3	16.9	1,204.8
4	Oil and gas extraction	-159.0	-65.6	-186.2
5	Coal mining	0.0	0.0	0.0
6	Metal ore mining	0.2	0.1	7.0
7	Nonmetallic mineral mining and quarrying	-0.7	-0.3	24.9
8	Support activities for mining	-37.2	-16.3	-117.7
9	Electric power generation, transmission, and distribution	-7,305.2	-4,714.7	-3,285.0
10	Natural gas distribution	-1,514.2	-372.6	-1,335.0
11	Water, sewage, and other systems	-422.8	-301.4	-1,868.8
12	Construction	-1,031.6	-594.3	-4,178.7
13	Sawmills and wood preservation	3.1	0.7	7.5
14	Veneer, plywood, and engineered wood product manufacturing	17.9	6.7	74.0
15	Other wood product manufacturing	14.7	5.1	98.5
16	Clay product and refractory manufacturing	2.0	1.2	20.5
17	Glass and glass product manufacturing	12.3	6.1	36.9
18	Cement and concrete product manufacturing	-10.5	-4.6	44.7
19	Lime, gypsum product manufacturing; Other nonmetallic mineral product manufacturing	3.5	1.6	48.6
20	Iron and steel mills and ferroalloy manufacturing	5.4	1.5	60.0
21	Steel product manufacturing from purchased steel	5.5	1.1	36.3
22	Alumina and aluminum production and processing	66.7	16.9	142.0
23	Nonferrous metal (except aluminum) production and processing	9.6	1.3	119.4
24	Foundries	6.6	2.9	36.1
25	Forging and stamping	-0.7	-0.4	14.3
26	Cutlery and handtool manufacturing	3.2	1.7	13.4
27	Architectural and structural metals manufacturing	-24.6	-8.1	-23.1
28	Boiler, tank, and shipping container manufacturing	-5.1	-1.7	2.3
29	Hardware manufacturing	0.8	0.5	3.1
30	Spring and wire product manufacturing	1.2	0.4	10.0
31	Machine shops; turned product; and screw, nut, and bolt manufacturing	4.5	2.2	105.6
32	Coating, engraving, heat treating, and allied activities	0.1	0.0	76.9
33	Other fabricated metal product manufacturing	19.8	10.8	96.7
34	Agriculture, construction, and mining machinery manufacturing	-9.6	-3.9	-15.6
35	Industrial machinery manufacturing	0.9	0.4	7.7
36	Commercial and service industry machinery manufacturing	26.6	12.0	106.4
37	Ventilation, heating, air-conditioning, and commercial refrigeration equipment manufacturing	97.0	34.5	126.0
38	Metalworking machinery manufacturing	-35.8	-16.4	-100.7
39	Engine, turbine, power transmission equipment manufacturing	-12.1	-5.4	-5.8
40	Other general purpose machinery manufacturing	-23.6	-10.4	-23.6
41	Computer and peripheral equipment manufacturing	-405.9	-168.2	-47.7
42	Communications equipment manufacturing	-122.2	-51.1	-68.3

	REMI Sector	Gross Output (in millions 2005$)	Value-Added (in millions 2005$)	Employment (jobs)
43	Audio and video equipment manufacturing	22.0	8.0	27.3
44	Semiconductor and other electronic component manufacturing	486.9	216.3	454.8
45	Navigational, measuring, electromedical, and control instruments manufacturing	-46.2	-20.7	-5.5
46	Manufacturing and reproducing magnetic and optical media	6.3	3.2	11.5
47	Electric lighting equipment manufacturing	61.5	26.9	274.1
48	Household appliance manufacturing	20.0	10.0	16.6
49	Electrical equipment manufacturing	14.3	8.8	48.1
50	Other electrical equipment and component manufacturing	39.3	17.2	149.4
51	Motor vehicle manufacturing	-7.6	-1.9	-0.4
52	Motor vehicle body and trailer manufacturing	-0.7	-0.2	10.5
53	Motor vehicle parts manufacturing	18.6	5.4	52.7
54	Aerospace product and parts manufacturing	14.3	7.7	155.5
55	Railroad rolling stock manufacturing	-0.4	-0.2	-0.8
56	Ship and boat building	1.1	0.5	7.2
57	Other transportation equipment manufacturing	14.6	6.5	34.2
58	Household and institutional furniture and kitchen cabinet manufacturing	53.0	25.2	108.3
59	Office furniture (including fixtures) manufacturing	-23.3	-12.4	-41.9
60	Other furniture related product manufacturing	7.8	3.0	40.2
61	Medical equipment and supplies manufacturing	-83.5	-49.3	-46.8
62	Other miscellaneous manufacturing	22.2	11.3	126.1
63	Animal food manufacturing	9.6	2.3	17.3
64	Grain and oilseed milling	11.3	2.0	32.9
65	Sugar and confectionery product manufacturing	16.4	5.1	38.9
66	Fruit and vegetable preserving and specialty food manufacturing	36.6	10.8	121.7
67	Dairy product manufacturing	24.4	5.1	78.6
68	Animal slaughtering and processing	26.1	4.0	170.7
69	Seafood product preparation and packaging	8.8	2.1	45.4
70	Bakeries and tortilla manufacturing	42.6	15.4	365.5
71	Other food manufacturing	41.3	15.7	146.6
72	Beverage manufacturing	38.5	14.3	104.7
73	Tobacco manufacturing	0.1	0.0	0.0
74	Fiber, yarn, and thread mills	1.2	0.1	7.4
75	Fabric mills	8.9	3.1	35.2
76	Textile and fabric finishing and fabric coating mills	15.5	5.5	120.5
77	Textile furnishings mills	9.5	3.9	60.7
78	Other textile product mills	4.5	1.6	58.6
79	Apparel knitting mills	3.3	1.5	21.0
80	Cut and sew apparel manufacturing	32.7	16.3	339.2
81	Apparel accessories and other apparel manufacturing	2.7	1.6	17.1
82	Leather, hide tanning, finishing; Other leather, allied product manufacturing	2.3	0.8	11.3
83	Footwear manufacturing	-0.4	-0.4	0.2
84	Pulp, paper, and paperboard mills	18.3	8.8	27.0
85	Converted paper product manufacturing	17.5	7.0	120.9
86	Printing and related support activities	6.1	3.2	101.8
87	Petroleum and coal products manufacturing	-75.8	-7.9	3.6

	REMI Sector	Gross Output (in millions 2005$)	Value-Added (in millions 2005$)	Employment (jobs)
88	Basic chemical manufacturing	68.9	18.8	59.0
89	Resin, synthetic rubber, and artificial synthetic fibers and filaments manufacturing	57.4	13.0	72.5
90	Pesticide, fertilizer, and other agricultural chemical manufacturing	28.9	9.9	32.5
91	Pharmaceutical and medicine manufacturing	227.4	127.3	338.5
92	Paint, coating, and adhesive manufacturing	7.1	2.2	19.6
93	Soap, cleaning compound, and toilet preparation manufacturing	46.7	21.3	51.8
94	Other chemical product and preparation manufacturing	19.6	6.9	45.3
95	Plastics product manufacturing	83.8	29.7	369.1
96	Rubber product manufacturing	10.3	4.6	42.6
97	Wholesale trade	-16.2	-11.7	738.4
98	Retail trade	1,067.4	765.0	9,681.6
99	Air transportation	345.3	170.2	844.4
100	Rail transportation	-31.9	-16.8	-49.2
101	Water transportation	1.3	0.4	7.3
102	Truck transportation	-2.1	-1.1	306.7
103	Couriers and messengers	39.5	22.0	521.4
104	Transit and ground passenger transportation	30.1	17.8	488.7
105	Pipeline transportation	-12.1	-5.4	-6.7
106	Scenic and sightseeing transportation and support activities for transportation	49.0	27.9	633.1
107	Warehousing and storage	47.2	29.6	843.8
108	Newspaper, periodical, book, and directory publishers	52.7	26.6	218.6
109	Software publishers	-596.1	-367.7	-271.7
110	Motion picture, video, and sound recording industries	69.0	42.2	552.0
111	Data processing, hosting, related services, and other information services	-0.6	-0.3	53.0
112	Broadcasting (except internet)	58.4	34.3	176.7
113	Telecommunications	231.1	136.0	199.5
114	Monetary authorities, credit intermediation, and related activities	1,661.0	1,064.4	2,942.3
115	Funds, trusts, and other financial vehicles	68.4	14.3	75.0
116	Securities, commodity contracts, and other financial investments and related activities	312.9	170.6	1,258.2
117	Insurance carriers	80.9	43.1	282.5
118	Agencies, brokerages, and other insurance related activities	32.7	20.0	299.9
119	Real estate	1,263.6	965.2	4,424.0
120	Automotive equipment rental and leasing	24.6	11.3	118.9
121	Consumer goods rental and general rental centers	68.2	29.8	310.7
122	Commercial and industrial machinery and equipment rental and leasing	9.7	4.0	49.3
123	Lessors of nonfinancial intangible assets (except copyrighted works)	103.3	74.0	19.8
124	Legal services	-49.8	-38.5	-157.6
125	Accounting, tax preparation, bookkeeping, and payroll services	-35.9	-26.7	-62.6
126	Architectural, engineering, and related services	-226.1	-143.5	-1,030.0
127	Specialized design services	3.9	2.5	140.9

	REMI Sector	Gross Output (in millions 2005$)	Value-Added (in millions 2005$)	Employment (jobs)
128	Computer systems design and related services	-571.8	-412.8	-4,667.0
129	Management, scientific, and technical consulting services	10.7	7.5	530.7
130	Scientific research and development services	-7.2	-4.2	95.9
131	Advertising and related services	-16.7	-9.4	42.9
132	Other professional, scientific, and technical services	43.2	35.6	463.5
133	Management of companies and enterprises	195.6	105.6	595.1
134	Office administrative services; Facilities support services	2.0	1.2	141.1
135	Employment services	-13.2	-10.3	179.3
136	Business support services; Investigation and security services; Other support services	2.2	1.3	596.6
137	Travel arrangement and reservation services	20.4	11.6	164.2
138	Services to buildings and dwellings	80.8	49.5	1,594.8
139	Waste management and remediation services	-15.0	-8.7	295.1
140	Elementary and secondary schools; Junior colleges, colleges, universities, and professional schools; Other educational services	159.4	96.8	5,942.5
141	Offices of health practitioners	755.4	549.5	6,470.1
142	Outpatient, laboratory, and other ambulatory care services	118.3	79.1	1,095.7
143	Home health care services	24.3	18.9	479.0
144	Hospitals	373.2	223.6	2,273.8
145	Nursing and residential care facilities	87.6	59.9	2,360.7
146	Individual, family, community, and vocational rehabilitation services	21.6	13.3	1,207.8
147	Child day care services	11.2	6.6	608.0
148	Performing arts companies; Promoters of events, and agents and managers	13.3	6.0	241.1
149	Spectator sports	6.8	4.3	116.5
150	Independent artists, writers, and performers	0.0	0.0	190.2
151	Museums, historical sites, and similar institutions	5.1	3.2	98.0
152	Amusement, gambling, and recreation industries	72.2	49.7	1,531.9
153	Accommodation	255.1	163.0	2,832.2
154	Food services and drinking places	294.6	158.3	7,362.4
155	Automotive repair and maintenance	54.0	28.5	1,175.5
156	Electronic and precision equipment repair and maintenance	53.6	40.0	124.6
157	Commercial and industrial equipment (except automotive and electronic) repair and maintenance	9.9	7.2	82.0
158	Personal and household goods repair and maintenance	16.7	8.0	268.1
159	Personal care services	77.0	50.0	2,380.1
160	Death care services	3.3	1.6	68.4
161	Drycleaning and laundry services	26.7	20.4	486.7
162	Other personal services	88.1	52.3	521.3
163	Religious organizations; Grantmaking and giving services, and social advocacy organizations	31.4	11.4	969.7
164	Civic, social, professional, and similar organizations	32.8	12.5	483.3
165	Private households	22.6	22.6	2,038.4
	Manufacturing Sectors Total	**1,123.6**	**458.3**	**5,500.9**
	All-Sector Total	**-2,309.2**	**-1,071.6**	**60,861.6**

Table 1b. Non-Farm Private Sectoral Impacts for the TLU/TSI Options Combined, for Year 2035			
(the blue highlighted rows are the manufacturing sectors and the yellow-highlighted is the petroleum refining			
Category	Output (in millions 2005$)	Value-Added (in millions 2005$)	Employment (Jobs)
Forestry and logging; Fishing, hunting, and trapping	0	0	0
Agriculture and forestry support activities; Other	0	0	11
Oil and gas extraction	-13	-5	-16
Mining (except oil and gas)	0	0	1
Support activities for mining	1	0	3
Utilities	35	21	30
Construction	243	140	1372
Wood product manufacturing	4	1	10
Nonmetallic mineral product manufacturing	4	2	11
Primary metal manufacturing	-3	-1	-6
Fabricated metal product manufacturing	9	4	28
Machinery manufacturing	6	2	11
Computer and electronic product manufacturing	11	5	4
Electrical equipment and appliance manufacturing	1	1	2
Motor vehicles, bodies & trailers, and parts manufacturing	-288	-77	-228
Other transportation equipment manufacturing	9	4	12
Furniture and related product manufacturing	24	12	47
Miscellaneous manufacturing	17	10	24
Food manufacturing	20	5	38
Beverage and tobacco product manufacturing	12	5	17
Textile mills	0	0	-1
Textile product mills	0	0	0
Apparel manufacturing	2	1	6
Leather and allied product manufacturing	1	0	1
Paper manufacturing	3	1	7
Printing and related support activities	5	3	25
Petroleum and coal product manufacturing	-326	-34	-37
Chemical manufacturing	76	30	61
Plastics and rubber product manufacturing	11	4	22
Wholesale trade	358	258	847
Retail trade	569	408	3697
Air transportation	17	8	35
Rail transportation	0	0	1
Water transportation	0	0	0
Truck transportation; Couriers and messengers	29	15	145
Transit and ground passenger transportation	5	3	57
Pipeline transportation	0	0	-1
Scenic and sightseeing transportation; support activities	3	2	21
Warehousing and storage	1	1	10
Publishing industries, except Internet	42	25	33

Category	Output (in millions 2005$)	Value-Added (in millions 2005$)	Employment (Jobs)
Motion picture, video, and sound recording industries	34	21	90
Internet publishing and broadcasting; ISPs, search portals, and data processing; Other information services	64	38	60
Broadcasting, except Internet; Telecommunications	185	109	137
Monetary authorities - central bank; Credit intermediation and related activities; Funds, trusts, & other financial vehicles	323	198	510
Securities, commodity contracts, investments	139	76	420
Insurance carriers and related activities	69	39	219
Real estate	428	327	999
Rental and leasing services; Lessors of nonfinancial intangible assets	47	29	48
Professional and technical services	195	133	1396
Management of companies and enterprises	13	7	16
Administrative and support services	114	75	1274
Waste management and remediation services	13	7	33
Educational services	28	17	644
Ambulatory health care services	469	338	3706
Hospitals	88	53	387
Nursing and residential care facilities	20	14	393
Social assistance	13	8	488
Performing arts and spectator sports	21	12	189
Museums, historical sites, zoos, and parks	2	1	22
Amusement, gambling, and recreation	23	16	344
Accommodation	24	15	207
Food services and drinking places	100	54	1554
Repair and maintenance	54	33	487
Personal and laundry services	81	51	1128
Membership associations and organizations	21	8	352
Private households	12	12	904
Manufacturing Sectors Total	**-402.0**	**-22.0**	**54.0**
All-Sector Total	**3,468.0**	**2,545.0**	**22,307.0**

Table 2. REMI Baseline Sectoral Gross Output of SCAG Counties in Year 2035

(the blue highlighted rows are the manufacturing sectors and the yellow-highlighted is the petroleum refining sector in REMI)

		County Gross Output (millions 2005$)							County Gross Output (percentage of regional total)						
	REMI Sector	LA County	Orange County	Riverside County	San Bernardino County	Imperial County	Ventura County	SCAG Total	LA County	Orange County	Riverside County	San Bernardino County	Imperial County	Ventura County	SCAG Total
1	Forestry; Fishing, hunting, trapping	53.6	4.2	83.1	15.4	9.8	28.7	194.8	27.5%	2.2%	42.7%	7.9%	5.1%	14.7%	100.0%
2	Logging	12.4	2.7	5.6	7.2	2.9	0.0	30.8	40.4%	8.7%	18.0%	23.3%	9.5%	0.0%	100.0%
3	Support activities for agriculture and forestry	59.7	57.8	242.3	29.2	262.0	326.7	977.8	6.1%	5.9%	24.8%	3.0%	26.8%	33.4%	100.0%
4	Oil and gas extraction	2,194.5	61.0	13.7	3.4	0.0	215.8	2,488.3	88.2%	2.5%	0.5%	0.1%	0.0%	8.7%	100.0%
5	Coal mining	0.0	0.0	0.0	0.0	0.0	0.0	0.0							
6	Metal ore mining	0.7	0.0	0.0	16.0	13.0	0.0	29.7	2.5%	0.0%	0.0%	53.8%	43.7%	0.0%	100.0%
7	Nonmetallic mineral mining and quarrying	263.3	81.1	206.0	244.7	3.2	85.2	883.6	29.8%	9.2%	23.3%	27.7%	0.4%	9.6%	100.0%
8	Support activities for mining	707.7	97.7	0.9	0.3	19.8	223.2	1,049.6	67.4%	9.3%	0.1%	0.0%	1.9%	21.3%	100.0%
9	Electric power generation, transmission, and distribution	5,703.2	2,925.4	633.8	2,024.6	288.1	486.5	12,061.6	47.3%	24.3%	5.3%	16.8%	2.4%	4.0%	100.0%
10	Natural gas distribution	7,572.4	1,276.7	863.3	1,314.3	80.1	371.4	11,478.2	66.0%	11.1%	7.5%	11.5%	0.7%	3.2%	100.0%
11	Water, sewage, and other systems	549.5	35.8	35.2	104.5	3.6	31.5	760.1	72.3%	4.7%	4.6%	13.7%	0.5%	4.1%	100.0%
12	Construction	50,306.6	36,669.5	20,617.7	12,400.8	392.0	5,268.9	125,655.5	40.0%	29.2%	16.4%	9.9%	0.3%	4.2%	100.0%
13	Sawmills and wood preservation	58.6	11.9	6.3	44.3	0.0	0.0	121.1	48.4%	9.8%	5.2%	36.6%	0.0%	0.0%	100.0%
14	Veneer, plywood, and engineered wood product manufacturing	107.0	28.8	155.5	247.3	39.0	9.6	587.3	18.2%	4.9%	26.5%	42.1%	6.6%	1.6%	100.0%
15	Other wood product manufacturing	887.2	245.7	728.4	342.8	17.3	37.7	2,259.2	39.3%	10.9%	32.2%	15.2%	0.8%	1.7%	100.0%
16	Clay product and refractory manufacturing	126.9	12.6	61.9	13.6	0.0	5.1	220.0	57.7%	5.7%	28.1%	6.2%	0.0%	2.3%	100.0%
17	Glass and glass product manufacturing	1,002.0	154.2	70.6	138.7	0.0	88.7	1,454.3	68.9%	10.6%	4.9%	9.5%	0.0%	6.1%	100.0%
18	Cement and concrete product manufacturing	622.9	436.6	470.9	1,381.1	34.0	151.1	3,096.5	20.1%	14.1%	15.2%	44.6%	1.1%	4.9%	100.0%
19	Lime, gypsum product manufacturing; Other nonmetallic mineral product manufacturing	444.1	222.3	183.6	100.8	133.9	214.6	1,299.3	34.2%	17.1%	14.1%	7.8%	10.3%	16.5%	100.0%
20	Iron and steel mills and ferroalloy manufacturing	77.9	16.6	56.6	743.5	0.0	63.6	958.2	8.1%	1.7%	5.9%	77.6%	0.0%	6.6%	100.0%
21	Steel product manufacturing from purchased steel	533.1	12.6	37.3	158.6	0.0	5.3	746.9	71.4%	1.7%	5.0%	21.2%	0.0%	0.7%	100.0%
22	Alumina and aluminum production and processing	677.4	205.7	263.9	385.6	0.0	1.0	1,533.6	44.2%	13.4%	17.2%	25.1%	0.0%	0.1%	100.0%
23	Nonferrous metal (except aluminum) production and processing	638.9	101.0	27.2	3.9	0.0	0.0	771.0	82.9%	13.1%	3.5%	0.5%	0.0%	0.0%	100.0%
24	Foundries	545.6	70.2	28.7	65.7	0.0	42.1	752.4	72.5%	9.3%	3.8%	8.7%	0.0%	5.6%	100.0%
25	Forging and stamping	1,095.3	585.1	27.5	235.4	0.0	55.9	1,999.2	54.8%	29.3%	1.4%	11.8%	0.0%	2.8%	100.0%
26	Cutlery and handtool manufacturing	208.7	157.9	71.8	48.4	0.0	55.3	542.2	38.5%	29.1%	13.2%	8.9%	0.0%	10.2%	100.0%

		County Gross Output (millions 2005$)							County Gross Output (percentage of regional total)						
	REMI Sector	LA County	Orange County	Riverside County	San Bernardino County	Imperial County	Ventura County	SCAG Total	LA County	Orange County	Riverside County	San Bernardino County	Imperial County	Ventura County	SCAG Total
27	Architectural and structural metals manufacturing	3,258.7	1,467.0	568.9	793.5	0.0	219.9	6,307.9	51.7%	23.3%	9.0%	12.6%	0.0%	3.5%	100.0%
28	Boiler, tank, and shipping container manufacturing	694.5	173.9	252.4	72.4	0.0	64.4	1,257.6	55.2%	13.8%	20.1%	5.8%	0.0%	5.1%	100.0%
29	Hardware manufacturing	337.8	49.0	31.8	16.1	0.0	32.9	467.6	72.2%	10.5%	6.8%	3.4%	0.0%	7.0%	100.0%
30	Spring and wire product manufacturing	261.6	111.4	65.2	59.5	0.0	15.4	513.1	51.0%	21.7%	12.7%	11.6%	0.0%	3.0%	100.0%
31	Machine shops; turned product; and screw, nut, and bolt manufacturing	3,209.1	2,400.6	153.9	443.2	5.6	276.7	6,489.2	49.5%	37.0%	2.4%	6.8%	0.1%	4.3%	100.0%
32	Coating, engraving, heat treating, and allied activities	1,789.0	1,141.7	65.6	164.5	0.0	56.6	3,217.4	55.6%	35.5%	2.0%	5.1%	0.0%	1.8%	100.0%
33	Other fabricated metal product manufacturing	2,176.9	1,354.6	419.2	372.2	16.6	93.0	4,432.5	49.1%	30.6%	9.5%	8.4%	0.4%	2.1%	100.0%
34	Agriculture, construction, and mining machinery manufacturing	510.0	325.9	136.2	158.0	22.6	7.5	1,160.1	44.0%	28.1%	11.7%	13.6%	1.9%	0.6%	100.0%
35	Industrial machinery manufacturing	523.3	164.2	91.5	67.7	0.0	61.8	908.4	57.6%	18.1%	10.1%	7.5%	0.0%	6.8%	100.0%
36	Commercial and service industry machinery manufacturing	1,228.8	1,304.4	232.5	68.2	0.0	213.5	3,047.5	40.3%	42.8%	7.6%	2.2%	0.0%	7.0%	100.0%
37	Ventilation, heating, air-conditioning, and commercial refrigeration equipment manufacturing	560.9	591.8	36.3	381.4	0.0	245.7	1,816.1	30.9%	32.6%	2.0%	21.0%	0.0%	13.5%	100.0%
38	Metalworking machinery manufacturing	1,358.7	748.9	118.2	254.7	0.0	534.2	3,014.6	45.1%	24.8%	3.9%	8.4%	0.0%	17.7%	100.0%
39	Engine, turbine, power transmission equipment manufacturing	1,183.2	295.6	0.0	11.6	0.0	227.7	1,718.1	68.9%	17.2%	0.0%	0.7%	0.0%	13.3%	100.0%
40	Other general purpose machinery manufacturing	2,738.1	1,543.2	290.0	330.9	0.0	218.0	5,120.1	53.5%	30.1%	5.7%	6.5%	0.0%	4.3%	100.0%
41	Computer and peripheral equipment manufacturing	15,296.6	42,640.5	2,395.4	886.7	15.5	6,637.1	67,871.8	22.5%	62.8%	3.5%	1.3%	0.0%	9.8%	100.0%
42	Communications equipment manufacturing	14,008.3	5,141.4	381.9	236.0	0.0	397.5	20,165.1	69.5%	25.5%	1.9%	1.2%	0.0%	2.0%	100.0%
43	Audio and video equipment manufacturing	625.7	355.0	99.7	29.4	0.0	76.4	1,186.2	52.8%	29.9%	8.4%	2.5%	0.0%	6.4%	100.0%
44	Semiconductor and other electronic component manufacturing	9,786.7	14,472.6	1,458.2	316.2	14.1	4,280.9	30,328.8	32.3%	47.7%	4.8%	1.0%	0.0%	14.1%	100.0%
45	Navigational, measuring, electromedical, and control instruments manufacturing	11,510.8	4,355.0	177.5	172.5	0.0	527.9	16,743.7	68.7%	26.0%	1.1%	1.0%	0.0%	3.2%	100.0%
46	Manufacturing and reproducing magnetic and optical media	432.8	175.2	6.8	44.5	0.0	276.1	935.3	46.3%	18.7%	0.7%	4.8%	0.0%	29.5%	100.0%

		County Gross Output (millions 2005$)							County Gross Output (percentage of regional total)						
	REMI Sector	LA County	Orange County	Riverside County	San Bernardino County	Imperial County	Ventura County	SCAG Total	LA County	Orange County	Riverside County	San Bernardino County	Imperial County	Ventura County	SCAG Total
47	Electric lighting equipment manufacturing	740.3	219.8	30.2	202.2	0.0	35.6	1,228.1	60.3%	17.9%	2.5%	16.5%	0.0%	2.9%	100.0%
48	Household appliance manufacturing	222.7	231.9	10.0	44.0	0.0	1.3	509.8	43.7%	45.5%	2.0%	8.6%	0.0%	0.3%	100.0%
49	Electrical equipment manufacturing	616.9	552.6	61.9	9.7	0.0	241.3	1,482.5	41.6%	37.3%	4.2%	0.7%	0.0%	16.3%	100.0%
50	Other electrical equipment and component manufacturing	1,224.4	488.2	118.9	75.6	0.0	59.3	1,966.3	62.3%	24.8%	6.0%	3.8%	0.0%	3.0%	100.0%
51	Motor vehicle manufacturing	287.1	823.3	200.3	1,148.1	0.2	10.9	2,469.8	11.6%	33.3%	8.1%	46.5%	0.0%	0.4%	100.0%
52	Motor vehicle body and trailer manufacturing	1,395.2	116.3	361.6	284.9	0.0	5.0	2,163.1	64.5%	5.4%	16.7%	13.2%	0.0%	0.2%	100.0%
53	Motor vehicle parts manufacturing	3,003.7	752.9	103.5	191.2	0.0	222.3	4,273.7	70.3%	17.6%	2.4%	4.5%	0.0%	5.2%	100.0%
54	Aerospace product and parts manufacturing	29,669.2	6,427.3	746.9	415.2	0.5	601.9	37,861.0	78.4%	17.0%	2.0%	1.1%	0.0%	1.6%	100.0%
55	Railroad rolling stock manufacturing	12.1	20.2	0.8	1.5	0.0	0.0	34.6	34.9%	58.5%	2.3%	4.3%	0.0%	0.0%	100.0%
56	Ship and boat building	84.5	194.5	54.4	110.6	0.0	29.4	473.4	17.9%	41.1%	11.5%	23.4%	0.0%	6.2%	100.0%
57	Other transportation equipment manufacturing	351.0	1,790.6	204.1	108.8	0.0	149.0	2,603.5	13.5%	68.8%	7.8%	4.2%	0.0%	5.7%	100.0%
58	Household and institutional furniture and kitchen cabinet manufacturing	3,975.9	1,100.8	384.7	1,264.2	0.9	148.6	6,875.1	57.8%	16.0%	5.6%	18.4%	0.0%	2.2%	100.0%
59	Office furniture (including fixtures) manufacturing	1,615.6	683.5	159.8	285.3	0.0	14.5	2,758.8	58.6%	24.8%	5.8%	10.3%	0.0%	0.5%	100.0%
60	Other furniture related product manufacturing	595.0	186.9	136.7	56.0	0.0	1.5	976.2	61.0%	19.1%	14.0%	5.7%	0.0%	0.2%	100.0%
61	Medical equipment and supplies manufacturing	9,034.2	13,424.6	3,957.8	938.1	13.3	519.5	27,887.5	32.4%	48.1%	14.2%	3.4%	0.0%	1.9%	100.0%
62	Other miscellaneous manufacturing	10,657.4	4,075.9	1,747.0	899.9	11.9	573.8	17,965.8	59.3%	22.7%	9.7%	5.0%	0.1%	3.2%	100.0%
63	Animal food manufacturing	1,960.1	16.4	176.2	129.6	14.8	0.0	2,297.1	85.3%	0.7%	7.7%	5.6%	0.6%	0.0%	100.0%
64	Grain and oilseed milling	1,288.4	59.6	78.1	75.2	35.0	0.0	1,536.3	83.9%	3.9%	5.1%	4.9%	2.3%	0.0%	100.0%
65	Sugar and confectionery product manufacturing	1,357.6	39.8	7.7	112.6	71.8	9.1	1,598.6	84.9%	2.5%	0.5%	7.0%	4.5%	0.6%	100.0%
66	Fruit and vegetable preserving and specialty food manufacturing	2,075.8	524.9	395.2	497.5	3.8	148.6	3,645.7	56.9%	14.4%	10.8%	13.6%	0.1%	4.1%	100.0%
67	Dairy product manufacturing	2,701.8	498.4	340.8	156.2	20.7	73.1	3,791.0	71.3%	13.1%	9.0%	4.1%	0.5%	1.9%	100.0%
68	Animal slaughtering and processing	3,311.4	81.1	22.7	141.3	530.0	1.0	4,087.6	81.0%	2.0%	0.6%	3.5%	13.0%	0.0%	100.0%
69	Seafood product preparation and packaging	595.1	0.0	0.0	93.6	0.0	25.4	714.1	83.3%	0.0%	0.0%	13.1%	0.0%	3.6%	100.0%
70	Bakeries and tortilla manufacturing	3,311.7	724.6	96.7	480.0	6.3	65.7	4,685.0	70.7%	15.5%	2.1%	10.2%	0.1%	1.4%	100.0%
71	Other food manufacturing	4,612.6	833.1	238.3	572.4	0.0	149.4	6,405.8	72.0%	13.0%	3.7%	8.9%	0.0%	2.3%	100.0%

		County Gross Output (millions 2005$)							County Gross Output (percentage of regional total)						
	REMI Sector	LA County	Orange County	Riverside County	San Bernardino County	Imperial County	Ventura County	SCAG Total	LA County	Orange County	Riverside County	San Bernardino County	Imperial County	Ventura County	SCAG Total
72	Beverage manufacturing	3,981.4	988.1	818.9	646.4	42.8	119.1	6,596.7	60.4%	15.0%	12.4%	9.8%	0.6%	1.8%	100.0%
73	Tobacco manufacturing	11.5	6.5	0.0	0.0	0.0	0.0	18.0	63.8%	36.2%	0.0%	0.0%	0.0%	0.0%	100.0%
74	Fiber, yarn, and thread mills	55.8	6.5	1.0	4.7	0.0	0.0	68.0	82.0%	9.6%	1.5%	6.8%	0.0%	0.0%	100.0%
75	Fabric mills	422.8	15.3	8.5	16.4	0.0	0.1	463.2	91.3%	3.3%	1.8%	3.5%	0.0%	0.0%	100.0%
76	Textile and fabric finishing and fabric coating mills	643.9	80.2	14.9	2.7	0.0	0.3	741.9	86.8%	10.8%	2.0%	0.4%	0.0%	0.0%	100.0%
77	Textile furnishings mills	475.6	183.5	8.3	48.4	0.0	0.6	716.4	66.4%	25.6%	1.2%	6.8%	0.0%	0.1%	100.0%
78	Other textile product mills	196.1	80.0	26.7	17.2	0.0	2.7	322.8	60.7%	24.8%	8.3%	5.3%	0.0%	0.8%	100.0%
79	Apparel knitting mills	184.0	44.6	0.6	10.3	0.0	0.0	239.6	76.8%	18.6%	0.3%	4.3%	0.0%	0.0%	100.0%
80	Cut and sew apparel manufacturing	9,037.4	1,608.7	9.3	34.7	0.3	62.9	10,753.3	84.0%	15.0%	0.1%	0.3%	0.0%	0.6%	100.0%
81	Apparel accessories and other apparel manufacturing	273.6	10.8	5.1	1.3	0.0	3.6	294.4	92.9%	3.7%	1.7%	0.4%	0.0%	1.2%	100.0%
82	Leather, hide tanning, finishing; Other leather, allied product manufacturing	527.2	68.6	4.2	1.2	0.0	0.5	601.6	87.6%	11.4%	0.7%	0.2%	0.0%	0.1%	100.0%
83	Footwear manufacturing	386.3	127.4	0.0	2.5	0.0	1.3	517.5	74.7%	24.6%	0.0%	0.5%	0.0%	0.2%	100.0%
84	Pulp, paper, and paperboard mills	256.0	180.4	0.0	103.1	0.0	290.0	829.6	30.9%	21.8%	0.0%	12.4%	0.0%	35.0%	100.0%
85	Converted paper product manufacturing	1,598.9	752.5	133.1	254.0	0.5	111.5	2,850.5	56.1%	26.4%	4.7%	8.9%	0.0%	3.9%	100.0%
86	Printing and related support activities	2,665.9	1,222.4	185.5	198.1	4.3	131.2	4,407.4	60.5%	27.7%	4.2%	4.5%	0.1%	3.0%	100.0%
87	Petroleum and coal products manufacturing	20,422.5	3,281.6	394.4	347.8	0.0	136.7	24,583.0	83.1%	13.3%	1.6%	1.4%	0.0%	0.6%	100.0%
88	Basic chemical manufacturing	1,213.2	108.4	8.6	721.9	0.0	437.7	2,489.7	48.7%	4.4%	0.3%	29.0%	0.0%	17.6%	100.0%
89	Resin, synthetic rubber, and artificial synthetic fibers and filaments manufacturing	1,349.7	439.5	94.5	255.1	0.0	1,097.6	3,236.4	41.7%	13.6%	2.9%	7.9%	0.0%	33.9%	100.0%
90	Pesticide, fertilizer, and other agricultural chemical manufacturing	337.5	15.2	13.5	109.4	0.0	222.8	698.3	48.3%	2.2%	1.9%	15.7%	0.0%	31.9%	100.0%
91	Pharmaceutical and medicine manufacturing	7,711.7	6,549.9	2,044.4	776.6	0.0	11,413.8	28,496.4	27.1%	23.0%	7.2%	2.7%	0.0%	40.1%	100.0%
92	Paint, coating, and adhesive manufacturing	1,301.0	537.4	14.0	187.3	0.0	57.1	2,096.8	62.0%	25.6%	0.7%	8.9%	0.0%	2.7%	100.0%
93	Soap, cleaning compound, and toilet preparation manufacturing	6,654.9	570.3	129.9	154.1	27.7	1,879.1	9,416.1	70.7%	6.1%	1.4%	1.6%	0.3%	20.0%	100.0%
94	Other chemical product and preparation manufacturing	1,497.8	368.6	173.3	152.1	0.0	676.7	2,868.5	52.2%	12.9%	6.0%	5.3%	0.0%	23.6%	100.0%
95	Plastics product manufacturing	6,521.7	4,540.9	1,702.2	2,574.0	3.9	402.5	15,745.1	41.4%	28.8%	10.8%	16.3%	0.0%	2.6%	100.0%
96	Rubber product manufacturing	677.7	346.4	63.9	218.1	0.4	4.9	1,311.4	51.7%	26.4%	4.9%	16.6%	0.0%	0.4%	100.0%
97	Wholesale trade	94,886.5	55,846.5	8,995.3	13,188.1	555.7	6,991.1	180,463.2	52.6%	30.9%	5.0%	7.3%	0.3%	3.9%	100.0%
98	Retail trade	80,037.3	33,272.2	17,815.1	15,775.1	1,012.3	6,684.7	154,596.7	51.8%	21.5%	11.5%	10.2%	0.7%	4.3%	100.0%
99	Air transportation	10,562.6	333.0	525.7	573.5	6.0	57.0	12,057.7	87.6%	2.8%	4.4%	4.8%	0.0%	0.5%	100.0%
100	Rail transportation	1,577.5	138.8	436.7	1,146.2	26.1	20.1	3,345.4	47.2%	4.1%	13.1%	34.3%	0.8%	0.6%	100.0%

		County Gross Output (millions 2005$)							County Gross Output (percentage of regional total)						
	REMI Sector	LA County	Orange County	Riverside County	San Bernardino County	Imperial County	Ventura County	SCAG Total	LA County	Orange County	Riverside County	San Bernardino County	Imperial County	Ventura County	SCAG Total
101	Water transportation	1,303.6	195.8	0.0	268.4	0.0	17.7	1,785.4	73.0%	11.0%	0.0%	15.0%	0.0%	1.0%	100.0%
102	Truck transportation	11,783.3	2,360.7	2,152.1	7,978.3	218.0	612.2	25,104.6	46.9%	9.4%	8.6%	31.8%	0.9%	2.4%	100.0%
103	Couriers and messengers	6,185.0	1,774.3	385.2	2,339.5	39.7	217.7	10,941.3	56.5%	16.2%	3.5%	21.4%	0.4%	2.0%	100.0%
104	Transit and ground passenger transportation	2,272.9	402.4	236.3	256.0	9.9	98.0	3,275.5	69.4%	12.3%	7.2%	7.8%	0.3%	3.0%	100.0%
105	Pipeline transportation	306.5	127.0	30.0	69.3	5.0	0.0	537.6	57.0%	23.6%	5.6%	12.9%	0.9%	0.0%	100.0%
106	Scenic and sightseeing transportation and support activities for transportation	10,725.1	861.6	277.4	664.8	32.5	226.6	12,787.9	83.9%	6.7%	2.2%	5.2%	0.3%	1.8%	100.0%
107	Warehousing and storage	2,217.7	1,004.6	882.3	981.7	21.1	146.1	5,253.5	42.2%	19.1%	16.8%	18.7%	0.4%	2.8%	100.0%
108	Newspaper, periodical, book, and directory publishers	3,328.7	1,651.4	237.9	59.3	9.2	326.8	5,613.3	59.3%	29.4%	4.2%	1.1%	0.2%	5.8%	100.0%
109	Software publishers	15,584.1	15,376.6	132.2	1,431.8	0.0	808.5	33,333.3	46.8%	46.1%	0.4%	4.3%	0.0%	2.4%	100.0%
110	Motion picture, video, and sound recording industries	72,603.3	495.6	154.0	127.9	5.4	163.5	73,549.7	98.7%	0.7%	0.2%	0.2%	0.0%	0.2%	100.0%
111	Data processing, hosting, related services, and other information services	23,188.7	4,945.4	430.2	148.6	0.0	1,064.3	29,777.0	77.9%	16.6%	1.4%	0.5%	0.0%	3.6%	100.0%
112	Broadcasting (except internet)	15,498.5	572.0	249.8	166.7	30.3	129.6	16,646.9	93.1%	3.4%	1.5%	1.0%	0.2%	0.8%	100.0%
113	Telecommunications	41,262.1	19,262.5	4,902.1	4,878.4	180.9	3,695.9	74,182.0	55.6%	26.0%	6.6%	6.6%	0.2%	5.0%	100.0%
114	Monetary authorities, credit intermediation, and related activities	61,460.2	29,683.1	4,775.2	5,108.1	312.0	6,435.2	107,773.8	57.0%	27.5%	4.4%	4.7%	0.3%	6.0%	100.0%
115	Funds, trusts, and other financial vehicles	5,089.1	1,980.9	64.8	140.0	12.7	227.2	7,514.7	67.7%	26.4%	0.9%	1.9%	0.2%	3.0%	100.0%
116	Securities, commodity contracts, and other financial investments and related activities	46,906.2	14,810.8	830.2	473.8	8.9	785.7	63,815.6	73.5%	23.2%	1.3%	0.7%	0.0%	1.2%	100.0%
117	Insurance carriers	16,774.3	10,543.6	555.3	1,052.4	15.2	2,570.1	31,511.1	53.2%	33.5%	1.8%	3.3%	0.0%	8.2%	100.0%
118	Agencies, brokerages, and other insurance related activities	7,333.3	4,399.8	628.3	859.5	27.7	588.4	13,837.0	53.0%	31.8%	4.5%	6.2%	0.2%	4.3%	100.0%
119	Real estate	157,605.6	97,709.2	15,168.2	11,942.2	340.0	6,147.2	288,912.5	54.6%	33.8%	5.3%	4.1%	0.1%	2.1%	100.0%
120	Automotive equipment rental and leasing	4,013.2	437.0	260.7	466.2	9.5	53.2	5,239.8	76.6%	8.3%	5.0%	8.9%	0.2%	1.0%	100.0%
121	Consumer goods rental and general rental centers	3,143.9	997.2	486.9	412.9	35.0	355.5	5,431.4	57.9%	18.4%	9.0%	7.6%	0.6%	6.5%	100.0%
122	Commercial and industrial machinery and equipment rental and leasing	4,084.6	908.7	462.8	388.5	16.7	232.3	6,093.6	67.0%	14.9%	7.6%	6.4%	0.3%	3.8%	100.0%
123	Lessors of nonfinancial intangible assets (except copyrighted works)	18,606.3	8,297.4	616.7	258.3	0.0	273.1	28,051.8	66.3%	29.6%	2.2%	0.9%	0.0%	1.0%	100.0%
124	Legal services	13,982.8	4,320.5	658.9	576.7	33.0	229.3	19,801.3	70.6%	21.8%	3.3%	2.9%	0.2%	1.2%	100.0%
125	Accounting, tax preparation, bookkeeping, and payroll services	17,814.3	2,245.8	246.6	268.2	14.7	103.9	20,693.4	86.1%	10.9%	1.2%	1.3%	0.1%	0.5%	100.0%

	REMI Sector	County Gross Output (millions 2005$)								County Gross Output (percentage of regional total)						
		LA County	Orange County	Riverside County	San Bernardino County	Imperial County	Ventura County	SCAG Total		LA County	Orange County	Riverside County	San Bernardino County	Imperial County	Ventura County	SCAG Total
126	Architectural, engineering, and related services	11,421.9	11,267.9	1,637.7	1,623.6	62.9	765.8	26,779.8		42.7%	42.1%	6.1%	6.1%	0.2%	2.9%	100.0%
127	Specialized design services	3,582.2	1,255.9	120.1	73.9	2.3	100.7	5,135.2		69.8%	24.5%	2.3%	1.4%	0.0%	2.0%	100.0%
128	Computer systems design and related services	13,660.9	9,047.4	776.9	380.7	2.7	398.2	24,266.8		56.3%	37.3%	3.2%	1.6%	0.0%	1.6%	100.0%
129	Management, scientific, and technical consulting services	14,366.6	7,562.6	1,222.9	1,034.0	32.8	700.4	24,919.3		57.7%	30.3%	4.9%	4.1%	0.1%	2.8%	100.0%
130	Scientific research and development services	12,573.2	4,283.6	168.5	149.8	3.0	4,524.1	21,702.2		57.9%	19.7%	0.8%	0.7%	0.0%	20.8%	100.0%
131	Advertising and related services	10,942.5	3,457.0	305.8	280.1	7.2	97.1	15,089.7		72.5%	22.9%	2.0%	1.9%	0.0%	0.6%	100.0%
132	Other professional, scientific, and technical services	5,148.6	2,812.1	583.7	550.0	15.9	289.1	9,399.5		54.8%	29.9%	6.2%	5.9%	0.2%	3.1%	100.0%
133	Management of companies and enterprises	43,224.9	21,826.1	1,469.0	3,351.4	113.5	2,453.4	72,438.3		59.7%	30.1%	2.0%	4.6%	0.2%	3.4%	100.0%
134	Office administrative services; Facilities support services	6,395.9	2,066.6	387.3	622.6	4.0	207.8	9,684.1		66.0%	21.3%	4.0%	6.4%	0.0%	2.1%	100.0%
135	Employment services	11,058.4	6,475.6	1,274.7	3,488.3	69.0	992.8	23,358.9		47.3%	27.7%	5.5%	14.9%	0.3%	4.3%	100.0%
136	Business support services; Investigation and security services; Other support services	10,679.2	5,082.5	778.2	1,195.2	57.8	491.6	18,284.6		58.4%	27.8%	4.3%	6.5%	0.3%	2.7%	100.0%
137	Travel arrangement and reservation services	2,617.2	1,722.2	392.4	89.1	5.0	154.6	4,980.5		52.5%	34.6%	7.9%	1.8%	0.1%	3.1%	100.0%
138	Services to buildings and dwellings	8,516.9	6,345.0	2,059.9	1,690.0	71.1	1,039.2	19,722.1		43.2%	32.2%	10.4%	8.6%	0.4%	5.3%	100.0%
139	Waste management and remediation services	4,679.2	2,185.1	751.6	786.8	65.3	452.1	8,920.1		52.5%	24.5%	8.4%	8.8%	0.7%	5.1%	100.0%
140	Elementary and secondary schools; Junior colleges, colleges, universities, and professional schools; Other educational services	8,382.0	1,747.0	467.8	689.2	14.2	282.9	11,583.0		72.4%	15.1%	4.0%	6.0%	0.1%	2.4%	100.0%
141	Offices of health practitioners	40,635.3	16,271.7	6,026.9	6,567.0	239.1	2,988.3	72,728.3		55.9%	22.4%	8.3%	9.0%	0.3%	4.1%	100.0%
142	Outpatient, laboratory, and other ambulatory care services	9,308.3	4,811.2	1,289.8	1,579.4	73.0	674.6	17,736.3		52.5%	27.1%	7.3%	8.9%	0.4%	3.8%	100.0%
143	Home health care services	3,279.7	1,016.4	716.0	487.4	27.2	236.0	5,762.7		56.9%	17.6%	12.4%	8.5%	0.5%	4.1%	100.0%
144	Hospitals	26,516.5	6,853.3	3,637.7	5,291.6	0.0	1,456.9	43,756.0		60.6%	15.7%	8.3%	12.1%	0.0%	3.3%	100.0%
145	Nursing and residential care facilities	5,423.4	1,891.0	1,070.4	945.0	18.0	282.4	9,630.2		56.3%	19.6%	11.1%	9.8%	0.2%	2.9%	100.0%
146	Individual, family, community, and vocational rehabilitation services	3,728.4	780.6	312.3	394.9	54.1	223.2	5,493.5		67.9%	14.2%	5.7%	7.2%	1.0%	4.1%	100.0%
147	Child day care services	1,222.9	353.9	125.6	146.7	7.4	112.7	1,969.3		62.1%	18.0%	6.4%	7.5%	0.4%	5.7%	100.0%
148	Performing arts companies; Promoters of events, and agents and managers	2,446.2	448.7	71.0	40.4	0.0	25.0	3,031.3		80.7%	14.8%	2.3%	1.3%	0.0%	0.8%	100.0%
149	Spectator sports	523.4	621.4	12.2	13.3	0.0	3.0	1,173.3		44.6%	53.0%	1.0%	1.1%	0.0%	0.3%	100.0%

		County Gross Output (millions 2005$)								County Gross Output (percentage of regional total)						
	REMI Sector	**LA County**	**Orange County**	**Riverside County**	**San Bernardino County**	**Imperial County**	**Ventura County**	**SCAG Total**		**LA County**	**Orange County**	**Riverside County**	**San Bernardino County**	**Imperial County**	**Ventura County**	**SCAG Total**
150	Independent artists, writers, and performers	12,754.5	338.5	67.0	53.1	0.2	82.1	13,295.3		95.9%	2.5%	0.5%	0.4%	0.0%	0.6%	100.0%
151	Museums, historical sites, and similar institutions	415.5	35.5	35.3	6.8	0.0	4.5	497.7		83.5%	7.1%	7.1%	1.4%	0.0%	0.9%	100.0%
152	Amusement, gambling, and recreation industries	3,296.2	2,660.9	856.5	338.5	9.7	302.8	7,464.5		44.2%	35.6%	11.5%	4.5%	0.1%	4.1%	100.0%
153	Accommodation	6,090.3	3,443.4	1,771.3	425.1	29.5	354.1	12,113.6		50.3%	28.4%	14.6%	3.5%	0.2%	2.9%	100.0%
154	Food services and drinking places	23,352.4	9,835.7	4,788.2	3,448.8	189.6	1,719.9	43,334.6		53.9%	22.7%	11.0%	8.0%	0.4%	4.0%	100.0%
155	Automotive repair and maintenance	3,896.0	1,680.9	923.0	898.4	32.8	393.1	7,824.3		49.8%	21.5%	11.8%	11.5%	0.4%	5.0%	100.0%
156	Electronic and precision equipment repair and maintenance	3,159.5	1,838.3	247.7	749.5	25.3	457.5	6,477.8		48.8%	28.4%	3.8%	11.6%	0.4%	7.1%	100.0%
157	Commercial and industrial equipment (except automotive and electronic) repair and maintenance	1,960.1	873.9	204.6	424.7	40.0	95.0	3,598.4		54.5%	24.3%	5.7%	11.8%	1.1%	2.6%	100.0%
158	Personal and household goods repair and maintenance	747.6	302.0	98.3	130.1	3.4	54.6	1,336.0		56.0%	22.6%	7.4%	9.7%	0.3%	4.1%	100.0%
159	Personal care services	2,536.4	882.5	438.7	266.8	9.0	166.9	4,300.3		59.0%	20.5%	10.2%	6.2%	0.2%	3.9%	100.0%
160	Death care services	319.2	60.1	43.0	30.9	1.9	8.8	463.8		68.8%	13.0%	9.3%	6.7%	0.4%	1.9%	100.0%
161	Drycleaning and laundry services	1,614.0	331.7	143.0	199.0	11.8	48.8	2,348.3		68.7%	14.1%	6.1%	8.5%	0.5%	2.1%	100.0%
162	Other personal services	8,767.6	1,441.3	577.9	411.6	10.0	162.1	11,370.5		77.1%	12.7%	5.1%	3.6%	0.1%	1.4%	100.0%
163	Religious organizations; Grantmaking and giving services, and social advocacy organizations	2,990.9	986.1	576.8	486.1	54.0	230.8	5,324.8		56.2%	18.5%	10.8%	9.1%	1.0%	4.3%	100.0%
164	Civic, social, professional, and similar organizations	3,133.5	712.6	523.9	495.9	37.9	152.0	5,055.8		62.0%	14.1%	10.4%	9.8%	0.7%	3.0%	100.0%
165	Private households	2,343.0	477.1	226.0	175.0	9.3	112.3	3,342.7		70.1%	14.3%	6.8%	5.2%	0.3%	3.4%	100.0%
	Manufacturing Sectors Total	**231,620.9**	**137,074.1**	**24,660.3**	**23,920.3**	**1,087.8**	**35,332.2**	**453,695.5**		**51.1%**	**30.2%**	**5.4%**	**5.3%**	**0.2%**	**7.8%**	**100.0%**
	All-Sector Total	**1,386,892.3**	**639,326.1**	**147,138.0**	**152,091.8**	**6,549.5**	**104,928.1**	**2,436,925.9**		**56.9%**	**26.2%**	**6.0%**	**6.2%**	**0.3%**	**4.3%**	**100.0%**

ATTACHMENT 1

To: Darin Chidsey, SCAG

From: Dr. John Husing, Dr. Christine Cooper, Dr. Wallace Walrod

Subject: Memo on CEDP Peer Review

Date: August 7, 2012

SCAG's Southern California Climate and Economic Development Project (*CEDP*) was initiated to estimate the cost-effectiveness of various AB 32 and SB 375 related policies and approaches, focusing on the socio-economic impacts on Southern California's economy. The Center for Climate Strategies (*CCS*) was engaged to:

- Facilitate and provide technical assistance to the CEDP process and CEDP stakeholder meetings.

- Develop technical reports that quantify the greenhouse gas (*GHG*) reduction potential of proposed CEDP options, including providing economic and cost benefit analysis of options and macroeconomic modeling of CEDP PSC recommendations.

As an added measure to ensure the study accurately reflects the complexities of Southern California's economy, SCAG sought assistance from its team of Economic Advisors with expert knowledge of Southern California's economy. Our role has been to provide an independent peer review of the draft reports and related CCS deliverables and materials. This has meant reviewing the technical methodology and analytical findings of the project's economic components including CCS's analysis of the cost effectiveness, macroeconomic impacts, and regional competitiveness of CEDP's selected GHG emissions reduction measures on the SCAG region's economy.

SCAG's team of Economic Advisors is comprised of Dr. Christine Cooper from the Los Angeles County Economic Development Corporation, Dr. John Husing from Economics & Politics, Inc, and Dr. Wallace Walrod from the Orange County Business Council.

At SCAG's request, from April 2012 through July 2012, the Economic Advisors reviewed various draft reports, presentations, appendices, and back-up materials provided by SCAG staff and the CCS team. Additionally, we had subsequent conference calls, produced interim memos, formulated inquiries and requested additional materials, analyses and clarifications. In accordance with our scope, some of our review was at a high-level, while some required drilling down into detailed analysis. For example, to adequately review the methodology and results presented in two key memos (*Draft Macroeconomic Impact Analysis Results for the ECR and TSI/TLU*), the Economic Advisors needed much more detailed descriptions of the assumptions used in each policy scenario than were contained in the draft reports, as well as explanations of how these assumptions and policy designs were addressed in the REMI model. Only some of the requested materials were provided by CCS.

The purpose of these requests was to allow the Economic Advisors to more accurately gauge whether the policies were adequately simulated and modeled. Despite the team's review, and several iterations of queries by the team and responses by CCS, the CEDP methods, assumptions and results still have a bit of a "black box" feel to us and we are unable to fully sign off on the CCS CEDP report at this time.

In particular, the Economic Advisers still have questions on technical issues that require further attention, explanation, clarification and potential analysis, including:

- In the third paragraph of Appendix B of the CCS response to memo dated June 27, 2012, it is stated that "the analysts assumed that the (*private-sector*) investment to be displaced would be lower than average in its productivity…" While analysts might reasonably assume that when businesses have a choice, they would displace lower productivity investment with higher productivity investment, this might not be true when the business is mandated to replace current equipment, and when the specific equipment may be dictated by regulatory authorities.

- Appendix C of the CCS response to memo dated June 27, 2012 provides an array of consumption responses by commodity if household discretionary income rises as a result of policy implementation. The highest modeled consumption responses are for variables related to automobiles, with several auto-related responses on the list. Since most polices are designed to reduce automobile ownership and use, the question arises as to whether these responses were modified to reflect that new behavior.

- There appears to be a lack of clarity about how some key assumptions were specified into the REMI model. Among others:

    - Regional Purchase Coefficients related to local demand and manufacture of energy efficient and renewable equipment are apparently modeled under the assumption that the current levels of these coefficients, as set in REMI, will remain unchanged over time. The only future question reviewed by the sensitivity analysis was what would happen if these Regional Purchase Coefficients went up dramatically. Implicitly, the assumption appears to be that because demand for this equipment will rise due to Southern California's policies that the products will made here. Our experience and discussions with companies already buying equipment indicate that there is a better chance that the Regional Purchase Coefficients will go down, not up. In any case, this is an issue requiring more than an assumption or a cursory examination as these coefficients are critical to understanding the macroeconomic impacts of long term policies. Without such an effort, the modeling is incomplete.

    - In judging the cost effectiveness of alternative energy solutions, natural gas prices are used as a key comparable measure. From the materials supplied to the peer review team, it was not possible to determine the assumed levels of those prices or how they would change over time. Here, the sensitivity analysis considered the case of natural gas prices rising dramatically. Again, the analysis is incomplete in not looking at the impact of prices dropping dramatically, a likely scenario since average annual well head prices have fallen from $7.98 per 1,000 BTUs in 2005 to $2.29 in 2012, and lower natural gas prices reduce the relative cost effectiveness of alternate energy solutions.

In addition to the technical issues outlined above, several very important questions and concerns raised by the Economic Advisors that seem especially important to understanding the economic impacts of these policies to the SCAG' region were deemed "outside of the CEDP scope of work". We realize the CEDP scope has changed at key points in the CEDP process. Nevertheless, the Economic Advisors cannot at this time fully support the CEDP report or findings because we feel that the essence of this analysis should include consideration of these additional concerns:

- Measuring the potential for differential (*negative*) impacts of policies upon different geographies within the SCAG region.

  It appears that CCS and SCAG staff agreed to not look at county level results because of the "time consuming nature of such calculations and because it might spawn jealousies among counties concerning the results." Given the peer review team's awareness that regional policies can disadvantage some area economies vis-a-vis others, such an analysis would seem to be crucial to understanding the fairness of policy options.

- Measuring the potential for differential economic and employment impacts of policies upon key groups within Southern California's population defined by demographics, income and/or educational attainment.

  The analyses of different policy options shows that some sectors of the regional economy benefit while others are harmed, with the sectors favored often inordinately composed of lower paying retail and consumer service jobs. The Economic Advisors are aware that different groups within Southern California's population benefit or are harmed by the success or failure of the sectors upon which they rely for their standards of living. Again, understanding the fairness of the impact of policy options would appear to require analyzing the extent to which the incomes and employability of different groups are helped or hurt by them. This is especially true if a policy option exacerbates regional poverty as that implies that the cost benefit analysis should have included the costs this outcome imposes on impacted groups and the region, and on regional social services. This type of understanding is also of critical importance in communicating the overall costs and benefits to stakeholders, some of whom may be negatively impacted but whose support will nevertheless be needed.

- Cost effectiveness of key policies in light of recent changes in funding mechanisms such as redevelopment.

  The demise of funding mechanisms such as redevelopment agencies (RDAs) needed to execute some policies means that the historic stream of funding to implement them has been cutoff. This would appear very likely to either raise the cost of these options as more expensive funding streams are required or to make them infeasible. It would seem to be unreasonable to omit such crucial concerns from the analysis.

- The impact of uncertainty on business decision making.

  As regional economists who interface with a variety of economic agents, including entrepreneurs and executives, the Economic Advisors believe that regulatory uncertainty has become a major issue for Southern California's employers with the potential to impact variables such as Regional Purchase Coefficients and the general growth of key sectors that are relied upon as economic drivers over time. While costs and impacts of regulatory uncertainty or additional regulatory burden may be difficult to specify or quantify, they are real. Our team knows from both and practical experience that these costs and burdens can be significant to Southern California's businesses and impact their competitiveness over and above their typical operating cost structures. Additional analysis is needed to account for the impact of a major change in the region's regulatory regime.

Overriding these issues, however, the team has concerns regarding the high-level assumptions about how policies will be implemented, with important TOD/MX and TSI/TLU policies appearing either unrealistic or counter to our experience with Southern California's economy and business community.

- Our stated concerns about the necessary land density to implement the TOD/MX policies have not been satisfactorily addressed. If the only way to reach the policy options' implicit land use density targets is building residential towers and mixed use facilities at transit nodes, but there is no funding mechanism in place to do so, or funding mechanisms which might reasonably have been used such as Redevelopment *(RDA*) funding, have been eliminated, then the analysis is incomplete since it does not discuss the impact of these difficulties on the costs and feasibility of the policies.

  Alternatively, if towers are not the answer, then the policies appear to require significant amounts of available or converted land to accommodate residential uses near transit nodes. In this case, the analysis is again incomplete since it does not review policy costs and feasibility based upon the known locations of existing or future transit nodes as well as the known current levels of land availability and, where necessary, the likely costs of conversion.

- In its draft memo, the CCS states that, "the estimates of economic benefits reported in this study represent a 'lower bound' from a broader perspective. These estimates do not include the economic value of other benefits associated with AB 32, 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."

  It follows from our concerns outlined above that the peer review team finds that the current documentation is not sufficient to allow to us to come to the same conclusion. We worry that in many cases CCS has chosen to specify and make assumptions regarding policies (such as energy efficiency programs and land use) that would require "optimal" implementation or "best performing" cases rather than more realistic, tempered policy assumptions and forecasts. Hence, it would perhaps be better to say that the CCS/CEDP results are "upper bound" or "aspirational," rather than "lower bound."

In the opinion of the Economic Advisors, there are critical technical issues as outlined above that need further clarification and/or additional analysis for the representations made by CCS to be relied upon. Beyond that, the overriding issue that weighs on the ability of the peer review team to accept the CEDP analysis is that of the "feasibility" of several key policy options. As economists, we note that it is not sufficient to state that the modeling technique, the inputs used and the underlying assumptions are all reasonable if the motivating policy is not as specified.

It is thus the collective opinion of the peer review team that more analysis, and more documentation, is necessary for the CEDP results and the underlying policy choices and approaches to be credible, defensible, and feasible for SCAG and its stakeholders.

We hope you find this memo, and our team's concerns and comments, to be constructive. Our team's primary concern is to understand the potentially significant impact of many of these policies on Southern California's economy, residents and businesses.

APPENDIX C. PRINCIPLES AND GUIDELINES FOR QUANTIFICATION OF POLICY OPTIONS AND SCENARIOS

Center for Climate Strategies
Helping States and Nations Tackle Climate Change

www.climatestrategies.us

Memo

To: Frank Wen and Kimberly Martin, Southern California Association of Governments (SCAG)

From: Tom Peterson, Randy Strait, Paul Aldretti, and Stephen Roe, Center for Climate Strategies (CCS)

CC: Management Group, SCAG; Technical Team, CCS

Re: Principles and Guidelines for Quantification of Policy Options and Scenarios

Date: December 3, 2012

The purpose of this Quantification Memo is to propose and explain the principles, guidelines and general methods needed for quantifying socio economic impacts for recommended SB 375 and AB 32 policies and scenarios for the SCAG Region.

I. General Guidelines

Selection of Policy Options and Scenarios

The policies and scenarios that will be analyzed will be developed through the SCAG Climate Planning Process as described in the contract and work plan between SCAG and CCS, including project timelines for tasks and sub tasks. In this process, five Technical Work Group (TWGs) that will cover key issue areas related to SB 375 and AB 32 in support of the Project Stakeholder Committee (PSC).

Through facilitative and technical support of CCS, and with advice and feedback from the Technical Advisory Panel (TAP) and Technical Advisory Committee (TAC), the PSC and TWGs will identify, design and guide analysis of the socioeconomic impacts analysis of specific policy options and aggregate scenarios (combined set or sets of policy options). Co-benefits will be described and or analyzed where possible and applicable.

The five issue based TWG areas include:

1. *Transportation Issues TWGs (coverage of pricing and non motorized transportation, as well as other issues, will be included in each of the four TWGs as needed, depending on policy options selected for analysis)*

a. *Land Use TWG*, including development patterns and distribution of population, business/commercial and employment, housing

b. *Transportation Investments TWG*, particularly transit investment and other infrastructure that may impact greenhouse gas (GHG) emissions

c. *Transportation Demand Management (TDM) TWG* planning and programs

d. *Transportation System Management (TSM) TWG* and operational policies and practices, and

2. *Multi-Sector Issues TWG*, including sector specific issues outside of the four transportation work groups, and multi-sector institutional and integrative issues that involve more than one sector at the same time

Specification of Policy Option Design Parameters

For each policy option and related scenario that is selected for design by the PSC and TWGs, a series of policy design parameters must be defined to support detailed quantification of impacts. These include:

- *Timing* (start and stop dates for the proposed)
- *Level of effort* (or goals for the proposed action)
- *Coverage of implementing or affected parties* (including geographic boundaries)
- *Other definitional issues* or eligibility provisions (such as renewable fuel definitions)

Specification of Policy Option Implementation Mechanisms

In addition, the instruments or mechanisms used to implement each policy option must be defined, at least in general terms, to capture potential variations in effectiveness. A variety of instruments or mechanisms exist, including:

- *Voluntary agreements*
- *Technical assistance*
- *Targeted financial assistance*
- *Taxes or fees*
- *Cap and trade*
- *Codes and standards*
- *Disclosure and reporting*
- *Information and education*
- *Others*

The impacts of each are policy specific and will vary by circumstance. For instance, price instruments, such as taxes and cap and trade, may perform better for policy options that are price responsive in comparison to those that are relatively unresponsive to price. Similarly, non-price instruments, such as codes and standards, may perform better where significant market barriers exist and require barrier removal.

Coverage and Metrics of Policy Impacts

Quantitative estimates will be developed for the following types of impacts where applicable based on priorities set by SCAG and the PSC, and within the analytical capacity of the contract and process:

- *Net GHG reduction potential*, expressed as Million Metric Tons Carbon Dioxide Equivalent ($MMtCO_2e$) removed, including net effects of carbon sequestration or sinks, measured as an incremental change against a forecasted baseline; where very small denominations of GHGs are involved use of Metric Tons (tCO_2e) may be used with notation.
- *Non GHG physical impacts* (such as on air quality or energy use), as appropriate and possible based on the availability of data, applied on a case-by-case basis
- *Individual or "stand alone" impacts* of policies, as well as *aggregate or interactive effects* of policy sets and scenarios ("system-wide" impacts); these will be measured as an incremental change against a forecasted baseline
- *Direct economic impacts*, also known as *net costs/savings, microeconomic analysis, or cost effectiveness* (expressed as $/$tCO_2e$ removed); this will include avoided costs of policy options, such as avoided cost of investment in infrastructure or services from efficiency measures
- *Indirect or secondary economic impacts* on jobs, income, economic growth, and prices, also known as *macroeconomic impacts*, that arise from or in association with direct costs and savings
- *Distributional impacts,* including differential impacts related to size, location, and socio-economic character of affected households, entities, and communities; often framed as *fairness and equity*
- *Full energy-cycle impacts*, including net energy effects that include all inputs and outputs of projects, as possible based on the availability of data and relevance
- *Discounting* or time value of assets, typically using standard rates of 5 percent/yr real and 7 percent/yr nominal, applied to net flows of costs or savings over an appropriate time period corresponding to AB 32 and SB 375 targets and policy implementation horizons
- *Annualized impacts*, typically using levelization of net present value (NPV) impacts, that provide both cumulative and year-specific snapshots
- *Impacts beyond the end of the project period*; where additional GHG reductions or costs occur beyond the project period as a direct result of actions taken during the project period, these will be shown for illustration

Direct vs. Indirect Effects and Linkages

Socio-economic impacts of policy options and scenarios will include direct, indirect, and distributional effects. Direct effects are those borne or created by the specific entities, households or populations subject to the policy or implementing the new policies. Indirect effects are other than those specifically involved in implementing the policy recommendation. For instance, new vehicle standards may directly affect manufacturers and consumers of cars. Indirectly, their sales may increase or decrease local taxes and spending on goods and services that benefit from or are hurt by increased disposable income of the manufacturing workforce and consumers. These direct and indirect economic analyses are sequentially linked, with overlap. Direct effects must be calculated first in order for indirect effects and distributional impacts to be calculated.

Direct physical effects of GHG impacts will be estimated to support cost-effectiveness and GHG target evaluations. Indirect GHG effects will be conducted only as needed to address life cycle and boundary issues, based on availability of data, acceptability of methods, and priority. Examples of direct and indirect net costs and benefits metrics are included at the end of this memo for purposes of illustration.

Transparency of Analysis

All key elements of policy development and analysis will be explicitly provided for review and consideration by the PSC and TWGs, and all general methodological proposals will be available for TAP and TAC review. All proceedings and decisions of the process will be available for public review. This includes policy design and implementation mechanism choices (above) as well as the technical specification of analysis for options and scenarios. These technical specifications for analysis include:

- *Data sources*, based on best available data and PSC and TWG determinations
- *Methods and models*, following review and advice from the TAP and TAC, as well as PSC and TWGs
- *Key assumptions*, based on PSC and TWG determinations
- *Key uncertainties*, to be identified and discussed either qualitatively, or addressed through sensitivity analysis or other analytical approaches, as appropriate and possible.

Decisions on each of these variables will be made through open facilitated decisions of the PSC and TWGs, and CCS analysis will follow these guidelines and specifications as they are approved.

Documentation of Results

Documentation of the work completed for each policy option will be provided in a standard Policy Option Template format that addresses the following topics (among others) to ensure consistency for comparison of information and also assist with identifying data gaps that will be addressed.

- TWG Area (Sector)
- Name of policy option
- Plain English Policy Description
- Technical Policy Design Specifications
- Policy Implementation Mechanisms
- Related Policies and Programs in place or anticipated, for baseline definition
- Quantification Results, including:
    - Estimated Net GHG Savings in target years,
    - Cumulative GHG reduction potential and net costs/savings,
    - Net Cost/savings per cumulative MMtCO_2e saved
    - Macroeconomic impacts,

- Distributional impacts,
- Specified data sources, quantification methods, and key assumptions

- Key Uncertainties and Sensitivity analyses
- Co-Benefits assessments or characterization, as appropriate
- Specific barriers to consensus, if any
- Final levels of PSC support

The completed Policy Option Templates will be assembled into a separate appendix of the final report. Additional printouts of worksheets and reference materials may be provided where needed.

II. Additional Background

Use of Pollutant Coverage and Global Warming Potentials

The analysis will cover the following six GHGs: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). Emissions of these gases will be presented using a common metric, CO_2e, which indicates the relative contribution of each gas to global average radiative forcing on a Global Warming Potential- (GWP-) weighted basis. Table 1 shows the 100-year GWPs published by the Intergovernmental Panel on Climate Change (IPCC) in its Second, Third, and Fourth Assessment Report. To be consistent with the draft GHG emissions inventory and forecast for the state of California, the 100-year GWP's published in the IPCC's Second Assessment Report will be used to convert mass emissions to a 100-year GWP basis. Use of the 100-year GWP's published in the IPCC's Second Assessment Report is also consistent with U.S. Environmental Protection Agency (EPA) and IPCC guidance for consistency with how U.S. national, state, and country-specific GHG emissions inventories have been developed in the past.

Table 1. 100-Year Global Warming Potentials from the 2nd, 3rd, and 4th IPCC Assessment Reports

Gas	100-year GWP (2nd Assessment)[1]	100-year GWP (3rd Assessment)[2]	100-year GWP (4th Assessment)[3]
CO_2	1	1	1
CH_4	21	23	25
N_2O	310	296	298
HFC-23	11,700	12,000	14,800
HFC-125	2,800	3,400	3,500
HFC-134a	1,300	1,300	1,430
HFC-143a	3,800	4,300	4,470
HFC-152a	140	120	124
HFC-227ea	2,900	3,500	3,220
HFC-236fa	6,300	9,400	794
HFC-4310mee	1,300	1,500	1,640

[1] Second Assessment: http://www.epa.gov/climatechange/emissions/downloads/ghg_gwp.pdf 1995. Because only a summary of the Second Assessment Report if available online, an EPA document is cited which has the table from the IPCC report.
[2] Third Assessment: http://www.ipcc.ch/ipccreports/tar/wg1/248.htm, 2001.
[3] Fourth Assessment: http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-chapter2.pdf, 2007.

Gas	100-year GWP (2nd Assessment)[1]	100-year GWP (3rd Assessment)[2]	100-year GWP (4th Assessment)[3]
CF_4	6,500	5,700	7,390
C_2F_6	9,200	11,900	12,200
C_4F_{10}	7,000	8,600	8,860
C_6F_{14}	7,400	9,000	9,300
SF_6	23,900	22,200	22,800

* The methane GWP includes the direct effects and those indirect effects due to the production of tropospheric ozone and stratospheric water vapor.

Emission Reductions

Emission reductions for individual policies will be estimated incremental to baseline emissions based on the change (reduction) in emissions activity (e.g., physical energy or activity units), or as a percentage reduction in emissions activity (e.g., physical energy or activity units or emissions) depending on the availability of data. This information will be needed to support the cost-effectiveness calculation for each policy option.

Fuel- and pollutant-specific emission factors will be used to convert physical units of emissions activity to emissions. Activity based emissions factors may also be used where applicable. The emission factors will be based, initially, on those used by SCAG or ARB, or on other established and accepted protocols (such as those of the EPA or IPCC). For fuel combustion sources, fuel-specific oxidation factors will be used with emission factors to estimate emissions. Fuel combustion oxidation factors refer to the percentage of fuel that is fully oxidized during the combustion process. Table 2 provides the oxidation factors to be used for this analysis; these factors are based on those used in the EPA's most recent GHG inventory for the U.S.[4]

Table 2. Fuel Combustion Oxidation Factors

Fuel	Oxidation Factor
Coal	0.990
Natural Gas and LPG	0.995
Distillate and Residual Oil	0.990
Municipal Solid Waste	0.980

Net Costs and Savings

Net capital outlays and receipts, operation and maintenance (O&M) costs or savings, energy/fuel costs or savings, or other direct financial costs and savings will be estimated for each of the policies that are determined quantifiable. Costs and savings will be discounted as a multi-year stream of net costs/savings to arrive at the NPV cost associated with implementing new technologies and best practices. It is proposed that costs be discounted in constant 2010 dollars using a 5 percent annual real discount rate (7 percent nominal) based on standard rates used for regulatory impact analysis at the federal and state levels.

Capital investments will be represented in terms of annualized or amortized costs over the project period. Capital costs or savings represent the material, equipment, labor, and other costs

[4] U.S. EPA, April 2008. Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2006. Available at: http://www.epa.gov/climatechange/emissions/usinventoryreport.html.

or savings associated with the implementation of a policy option relative to the baseline or reference technology or practice. For policy options that require a capital investment, these costs will be annualized using a fixed charge rate (FCR), a factor that reflects the sum of the cost of capital (equals the cost of debt plus the cost of equity), taxes, and depreciation, as well as the lifetime of the investment.

O&M costs or savings refer to labor, equipment, and fuel costs related to annual operation and maintenance of policy measures, and are differentiated into annual expenditures (i.e., variable O&M) and fixed expenditures (i.e., fixed O&M). Variable O&M estimates are provided in activity units over the full period of operation of the technology. O&M costs are described and included in the life-cycle costs when there is a differential between the baseline technology and the GHG-reducing alternative.

Savings calculations include avoided costs of fixed and variable policy implementation investments, as applicable. For instance, location efficiency measures may reduce the required infrastructure or services associated with new communities, depending on design and other circumstances. Similarly, electricity end use efficiency may reduce the need for new power generation facilities, and fuel efficiency measures may reduce the need for new fuel generation facilities.

Cost Effectiveness

Because the monetized dollar value of the impacts of GHG emissions reduction is not available, physical avoided emissions benefits are used instead as an input to cost effectiveness calculations, measured as dollars per tCO_2e (cost or savings per ton), and referred to as "cost effectiveness". Both positive costs and cost savings (negative costs) are estimated as a part of the calculation of emissions mitigation costs. When combined with GHG impact assessments, the results of these cost estimates will be aggregated into a stepwise marginal cost curve that can be broken down by sector or subsector, as needed.

The net cost of saved carbon, or cost effectiveness, of a proposed policy is calculated by dividing the cumulative future streams of incremental costs or savings over the appropriate policy option time period, discounted back to the present time, by the cumulative undiscounted net CO_2e reductions achieved by the technology or best practice. Mathematically, the equation to be used is as follows:

$$\text{CSC} = \frac{\sum_{t=0}^{n}\left\{\frac{((LC_m - LC_r) * A_t)}{(1+D_r)^t}\right\}}{\sum_{t=0}^{n}(CO_2e_r - CO_2e_m)}$$

Where:

CSC	=	Cost of saved carbon (or cost-effectiveness) of a technology or best practice, $/tCO_2e$ avoided
LCm	=	Levelized cost of a technology or best practice, $/activity unit
LCr	=	Levelized cost of the baseline or reference technology or best practice, $/activity unit
A	=	Amount of activity affected by the technology or best practice in year t, activity unit
Dr	=	Real discount rate, dimensionless

CO_2er	=	CO_2e emissions associated with the baseline or reference technology in year t, tons CO_2e
CO_2em	=	CO_2e emissions associated with a technology or best practice in year t, tons CO_2e
t	=	year in the evaluation period ($0 \leq t \leq 40$)

Activity units refer to a unit indicator of GHG emissions activity for a policy option. The activity units will vary depending on the Area (sector) and within each sector by the individual option. The activity units are used to normalize data for comparison of the policy option to the baseline. For example, for the Power Supply sector, megawatt-hours (MWh) of gross electricity generation could be used as the activity unit such that dollars per megawatt-hour ($/MWh) would be used as the activity unit for the "LCm" and "LCr" terms and MWh would be used as the activity unit for the cost terms in the equation.

The results of the analyses will be used to develop a GHG abatement cost curve, which will rank each technology or best practice in the order of its cost effectiveness for reducing a $MtCO_2e$ of emissions. This ranking will be represented in the form of a curve. Each point on this curve represents the cost-effectiveness of a given policy option relative to its contribution to reductions from the baseline, expressed as a percentage of baseline emissions. The points on the curve appear sequentially, from most cost-effective in the lower left area of the curve, to the least cost-effective options located higher in the cost curve in the upper right area.

Levelized Costs

The costs of each policy option that will be evaluated will be levelized and converted into dollars per activity unit. The cost components to be considered include capital, fixed O&M, variable O&M, and fuel costs and savings. Other sector-specific direct costs and savings (e.g., savings from avoided losses in transmission of electricity) will be included as applicable to each sector or policy option (see CCS example provided for power generation).

The levelization calculation is similar to amortization and its purpose is to develop a level stream of equal dollar payments that lasts for a fixed period of time. This allows snapshot evaluations of policy impact at any given point in time in a manner that incorporates the fixed and variable expenses and savings over the full time period applicable to implementation of the policy. The levelization formula to be used in the analysis is as follows:

$$LC = \frac{[PV * D_r * (1 + D_r)^t]}{((1 + D_r)^t) - 1}$$

Where:

LC	=	Levelized cost of the a technology or best practice, $/activity unit
PV	=	Present value of discounted cost stream
D_r	=	Real discount rate, dimensionless
t	=	Levelization period, or number of years over which payments are to be made

There are several parameters that will be used in the levelization process for different policy costs. Some are technology-specific (e.g., plant lifetime, capacity factor), others are region-specific (e.g., state or local income tax rate), others are market-driven (cost of capital or energy), while others are driven by policy (e.g., real discount rate). Attachment 1 to this memo provides an example of how levelized costs are calculated.

Time Period of Analysis

For each policy option, incremental emission reductions and incremental costs and savings will be 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 in question. The NPV of the cumulative net costs of each option, and the cumulative emission reductions of each option, will be reported for the AB 32 and SB 375 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 includes a complete phase-in over time, the annual GHG reductions and the NPV of the incremental costs and the cumulative emission reductions will be reported for the entire period from the beginning of the phase-in up through 2035. Annual GHG reductions will also be reported for an interim year of 2020.

Geographic Inclusion

GHG impacts of activities that occur within the SCAG region will be estimated, regardless of the actual location of emissions reductions. For instance, a major benefit of recycling is the reduction in material extraction and processing (e.g., bauxite mining and aluminum production) and in energy use for same. While a policy option may increase recycling in the region, the reduction in emissions may occur where the recycled materials are produced. Where significant emissions impacts are likely to occur outside the SCAG region, this will be clearly indicated. These emissions reductions are counted towards the achievement of the region's emission goal, since they result from actions taken by the region.

Energy-Cycle Coverage

GHG reductions for each policy option will be based on an energy-cycle and net energy impact analysis wherever possible, based on best available data and priority need. Tracking the full range of fuel use inputs is preferred, and in some cases essential, for accurately tracking full cycle carbon emissions for technology options and best practices displaying very different performance characteristics from the standard practices they are replacing. The approach involves identifying all the possible stages of the fuel cycle, for instance, and quantifying the fuel input per unit of energy produced (electricity or fossil fuel). The focus, however, will be on those fuel cycle elements where there are significant differences in greenhouse gas emissions between the business or reference case (standard practice) and the policy option.

Energy-cycle impacts will be reported for each source for which information is available to support an energy-cycle analysis. Where net energy-cycle emission reductions are captured, there can often be two sets of emission reductions estimated: the total energy-cycle reductions and those estimated on just a direct basis (e.g., tailpipe emissions). In some cases, these will be difficult to separate based on available information. Therefore, by default, the in-region reductions will often be those associated with estimated differences in fuel combustion between standard practice and policy cases for in-region processes.

Emission reductions from in-region processes associated with non-combustion reduction sources include only those processes that are known to occur within the SCAG region (e.g., landfill emission reductions, but not the upstream GHG emissions embedded in the waste component) and exclude processes where the geographic origin of the mitigated emissions is uncertain (e.g., emissions from extraction/processing/packaging of virgin materials into usable products).

Macroeconomic Impacts

The principles and guidelines and key decisions on methods, data sources and assumptions for macroeconomic analysis will be provided in a separate and linked advisory memo.

Distributional Impacts

The principles and guidelines and key decisions on methods, data sources and assumptions for distributional impact analysis, including environmental justice and small business impacts, will be provided in a separate and linked advisory memo.

Co-benefits Assessments

To the extent needed, the principles and guidelines and key decisions on methods, data sources and assumptions for co-benefits analysis will be provided in a separate and linked advisory memo by CCS.

* For additional reference see the economic analysis guidelines developed by the Science Advisory Board of the US EPA available at: http://yosemite.epa.gov/ee/epa/eed.nsf/webpages/Guidelines.html.

Examples of Direct/Indirect Net Cost and Benefit Metrics

Note: These examples are meant to be illustrative and are not necessarily comprehensive or the focus of the SCAG Climate Planning Process.

1. **Transportation and Land Use (TLU) Sector**
    a. Direct Costs and/or Savings
        i. Incremental capital and operating cost of more efficient vehicles, net of fuel savings.
        ii. Incremental costs of implementing Smart Growth programs, net of saved infrastructure and service costs.
        iii. Incremental cost of mass transit investment and operating expenses, net of any saved infrastructure and service costs (e.g., roads, road maintenance, vehicles)
        iv. Incremental cost of alternative fuel, net of any change in maintenance costs
        v. Net effects of carbon sequestration from land use measures
    b. Indirect Costs and/or Savings
        i. Net value of employment and income impacts, including differential impacts by socio economic category
        ii. Re-spending effects on the economy from financial savings
        iii. Net changes in the prices of goods and services in the region
        iv. Health benefits of reduced air and water pollution
        v. Ecosystem benefits of reduced air and water pollution
        vi. Value of quality-of-life improvements
        vii. Value of improved road and community safety
        viii. Energy security
2. **Residential, Commercial, and Industrial (RCI) Sectors**
    a. Direct Costs and/or Savings
        i. Net capital costs or savings (or incremental costs or savings relative to standard practice) of improved buildings, appliances, equipment (for example, cost of higher-efficiency refrigerator versus refrigerator of similar size and with similar features that meets standards)
        ii. Net operation and maintenance (O&M) costs or savings (relative to standard practice) of improved buildings, appliances, equipment, including avoided/extra labor costs for maintenance (for example, maintenance cost savings from less changing of longer-lived compact fluorescent light

(CFL) or light-emitting diode (LED) bulbs in lamps relative to incandescent bulbs)

iii. Net fuel (gas, electricity, biomass, etc.) costs (typically expressed as avoided costs from a societal perspective, that is, based on the net cost to society of producing an additional unit of fuel, as opposed to the retail cost of fuel)

iv. Cost/value of net water use/savings

v. Cost/value of net materials use/savings (for example, raw materials savings via recycling, or lower/higher cost of low-global warming potential (GWP) refrigerants)

vi. Direct improved productivity as a result of industrial measures (measured as change in cost per unit output, for example, for an energy/GHG-saving improvement that also speeds up a production line or results in higher product yield)

b. Indirect Costs and/or Savings

i. Net value of employment and income impacts, including differential impacts by socio economic category

ii. Re-spending effect on economy

iii. Net value of health benefits/impacts

iv. Value of net environmental benefits/impacts (value of damage by air pollutants on structures, crops, etc.)

v. Net embodied energy of materials used in buildings, appliances, equipment, relative to standard practice

vi. Improved productivity as a result of an improved working environment, such as improved office productivity through improved lighting (though the inclusion of this as indirect might be argued in some cases)

3. Energy Supply (ES) Sector

a. Direct Costs and/or Savings

i. Net capital costs or savings (or incremental costs or savings relative to reference case technologies) of renewables or other advanced technologies implemented as a result of policies

ii. Net O&M costs or savings (relative to reference case technologies) of renewables or other advanced technologies implemented as a result of policies

iii. Avoided or net fuel savings (gas, coal, biomass, etc.) of renewables or other advanced technologies implemented as a result of policies relative to reference case technologies

iv. Total system costs (net capital + net O&M + avoided/net fuel savings + net imports/exports + net transmission and distribution (T&D) costs) relative to reference case total system costs

b. Indirect Costs and/or Savings

i. Net value of employment and income impacts, including differential impacts by socio economic category

ii. Re-spending effect on economy

iii. Higher cost of electricity in the region

iv. Energy security

v. Net value of health benefits/impacts

vi. Value of net environmental benefits/impacts (value of damage by air pollutants on structures, crops, etc.)

4. Agriculture, Forestry, and Waste Management (AFW) Sectors

a. Direct Costs and/or Savings

i. Net capital costs or savings (or incremental costs relative to standard practice) of facilities or equipment (e.g., manure digesters, biogas-fired generators, and associated infrastructure; ethanol production facilities)

ii. Net O&M costs or savings (relative to standard practice) of equipment or facilities

iii. Net fuel (gas, electricity, biomass, etc.) costs or avoided costs

iv. Cost/value of net water use/savings

v. Cost/value of carbon sequestration from land use measures

vi. Reduced vehicle miles traveled (VMT) and fuel consumption associated with land use conversions (e.g., as a result of forest/rangeland/cropland protection policies)

b. Indirect Costs and/or Savings

i. Net value of employment and income impacts, including differential impacts by socio economic category

ii. Net value of human health benefits/impacts

iii. Net value of ecosystem health benefits/impacts (wildlife habitat; reduction in wildfire potential; etc.)

iv. Value of net environmental benefits/impacts (value of damage by air or water pollutants on structures, crops, etc.)

v. Net embodied energy of water use in equipment or facilities relative to standard practice

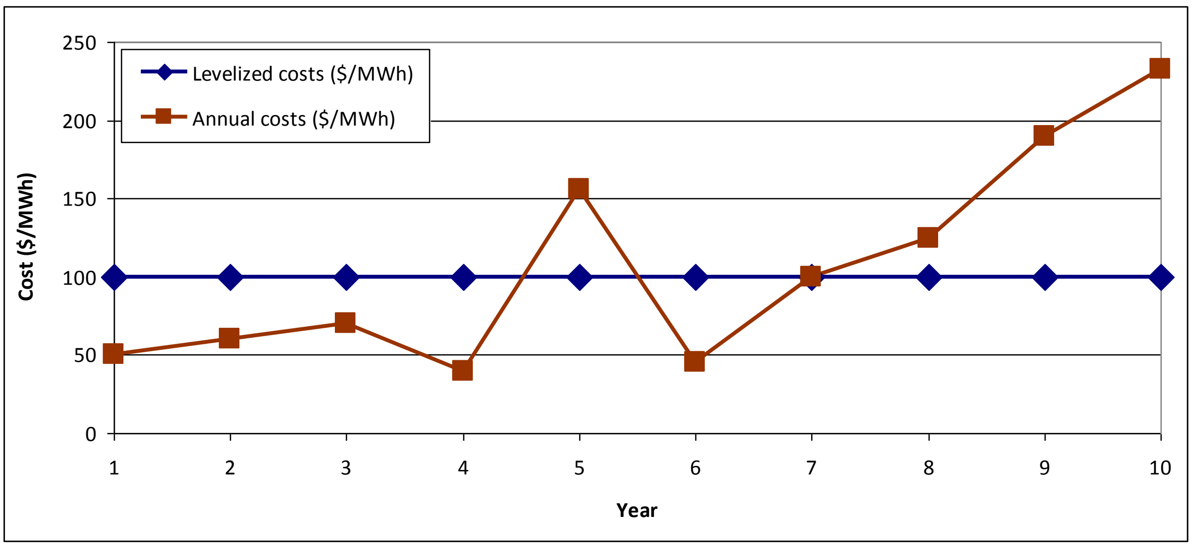
Attachment I
Example Calculation of Levelized Costs

This memo provides a brief conceptual overview as well as an annotated example regarding the calculation of levelized costs associated with power generation technology. Levelized costs are useful in evaluating financial feasibility and for directly comparing the cost of one technology against another.

Conceptual Overview of Levelized Costs

Levelized cost can be defined as a constant annual cost that is equivalent on a present value basis to the actual annual costs. That is, if one calculates the present value of levelized costs over a certain period, its value would be equal to the present value of the actual costs of the same period. Using levelized costs, often reported in $/MWh, allows for a ready comparison of technologies in any year, something that would be more difficult to do with differing annual costs. This can be illustrated in the Figure below. The present value of the levelized cost as shown is exactly equal to the present value of the annual costs.

Figure 1: Illustrative comparison of levelized and actual annual costs



Components of Levelized Costs

For power generation technologies, there are several components that typically make up the levelized cost, as briefly described in the bullets below.

- *Capital costs:* Typically reported in units of $/kW, these costs include the total costs of construction, including land purchase, land development, permitting, interconnections, equipment, materials and all other components. Construction financing costs are also included.
- *Fixed operations & maintenance (O&M):* Typically reported in units of $/kW-yr, these costs are for those that occur on an annual basis regardless of how much the plant operates. They typically include staffing, overhead, regulatory filings, and miscellaneous direct costs.

- *Variable O&M:* Typically reported in units of $/MWh, these costs are for those that occur on an annual basis based on how much the plant operates. They typically include costs associated with maintenance and overhauls, including repairs for forced outages, consumables such as chemicals for pollution control equipment or boiler maintenance, water use, and other environmental compliance costs.
- *Fuel:* Typically reported in units of dollars per million British Thermal Units of fuel heat content ($/mmbtu), these costs are for startup fuel use as well as online fuel use.

Information needed to Calculate Levelized Costs

There are several other bits of information that is needed in order to calculate levelized costs, as briefly described in the bullets below.

- *Plant size:* This refers to the size of the plant, expressed in units of MW.
- *Capacity factor:* This refers to the share of the year that the plant is in operation, expressed as a percentage.
- *Fixed charge factor:* This factor is calculated based on assumptions regarding the plant lifetime, the effective interest rate or discount rate used to amortize capital costs, and various other factors specific to the power industry. Expressed as a decimal, typical fixed charge factors are typically between 0.10 and 0.20, meaning that the annual cost of ownership of a power generation technology is typically between 10 and 20 percent of the capital cost. Fixed charge factors decrease with longer plant lifetimes, and increase with higher discount or interest rates.
- *Fuel price projection:* This refers to the projected price of the fuel used to produce electricity over the lifetime of the plant, expressed in units of $/mmbtu in each year of the fuel price forecast. Price projections from the U.S. Department of Energy's Energy Information Administration are often used. In some cases, fuel price projections are expressed as levelized values for use in calculating the overall levelized costs of generation.
- *Heat rate:* This refers to the efficiency by which fuel is consumed for the production of electricity, expressed in units of btu/kWh.

Formulas used to Calculate Levelized Costs

There are several formulas needed to convert the various units into the $/MWh units used to express levelized costs. These are briefly described below.

- *Capital costs (CC):* These costs are converted to $/MWh units as per the formula below:

  *Levelized capital cost = CC * FCF * conversion factor / (HPY * CF)*

  Where: CC = capital cost ($/kW)
  CF = capacity factor (%)
  HPY = hours per year = 8,760
  FCF = fixed charge factor
  conversion factor = 1,000 (convert from $/kW to $/MW)

- *Fixed O&M (FOM):* These costs are converted to $/MWh units as per the formula below:

  *Levelized fixed O&M cost = FOM * conversion factor / (HPY * CF)*

  Where: FOM = fixed O&M ($/kW-yr)

CF = capacity factor (%)
HPY = hours per year = 8,760
conversion factor = 1,000 (convert from \$/kW to \$/MW)

- *Variable O&M (VOM):* These costs are already provided in units of \$/MWh so no conversion is needed.
- *Fuel costs (FC):* Each year's fuel price is converted to units of \$/MWh as follows:

$$Fuel\ price = FP_t * HR / conversion\ factor$$

Where: FP_t = fuel price in year t (\$/mmbtu)
HR = heat rate (btu/kWh)
Conversion factor = 1,000 (convert from kWh to MWh)
t = year in the plant lifetime

These annual fuel costs are then levelized as follows:

$$Levelized\ fuel\ cost = [\ PV * DR * (1+DR)^t\ ] / [\ (1 + DR)^t - 1\ ]$$

Where: PV = present value of discounted fuel cost stream
DR = discount rate

Example Calculation of Levelized Costs

The above information can be combined to develop the levelized cost for any technology. As an example, the case of a conventional natural gas-fired combined cycle plant is considered. Table 1 summarizes the starting assumptions. Levelized cost calculations are offered in the bullets that follow the table. Note that cost parameters are specified on a per-unit basis, the calculation is independent of the size of the generator.

Table 1: Cost and Performance Assumptions

Parameter	Value	Annual Fuel Price (constant \$/mmbtu)					
Size (MW)	540	Year	Price	Year	Price	Year	Price
Online year	2012	1	7.57	11	6.09	21	6.57
Fuel type	Natural gas	2	7.12	12	6.14	22	6.61
Heat rate (btu/kWh)	7,064	3	7.54	13	6.20	23	6.83
Capacity factor (%)	65%	4	7.77	14	6.25	24	6.96
Discount rate (%)	5.0%	5	7.30	15	6.16	25	7.09
Operating life (years)	30	6	7.01	16	6.06	26	7.20
Fixed charge factor (%)	12%	7	6.77	17	6.18	27	7.25
Capital cost (\$/kW)	703	8	6.47	18	6.25	28	7.30
Fixed O&M cost (\$/kW-yr)	12.14	9	6.26	19	6.36	29	7.35
Variable O&M cost (\$/MWh)	2.01	10	6.14	20	6.46	30	7.4

- *Capital costs:* The levelized capital cost is equal to:

$$Levelized\ capital\ cost = 703 * 0.12 * 1{,}000 / (8{,}760 * 0.65) = \$14.82/MWh$$

- *Fixed O&M:* The levelized fixed O&M cost is equal to:

$$Levelized\ fixed\ O\&M\ cost = 12.14 * 1{,}000 / (8{,}760 * 0.65) = \$2.13/MWh$$

- *Variable O&M:* The levelized variable O&M cost is equal to \$2.01/MWh

- *Fuel costs:* The present value of the discounted fuel cost stream is equal to \$104.35/mmbtu. The levelized fuel cost is equal to:

$$[\ 104.35 * 0.05 * (1+0.05)^{30}\ ] / [\ (1 + 0.05)^{30} - 1\ ] = \$6.79/mmbtu$$

  This levelized value is then converted to units of \$/MWh as follows:

$$Levelized\ fuel\ cost = 6.79 * 7{,}064 / 1{,}000 = \$47.97/MWh$$

- *Total levelized cost:* The total levelized cost is equal to the sum of the above components, as follows:

$$Total\ levelized\ cost = levelized\ CC + levelized\ FOM + VOM + levelized\ FC$$
$$= 14.82 + 2.13 + 2.01 + 47.97$$
$$\underline{\mathbf{= \$66.93/MWh}}$$

List of Common Factors for Policy Quantification (needed across sectors)

1. Energy price forecasts: covering electricity, as well as each fuel type; sources could include United States Department of Energy (USDOE) EIA forecasts or possibly CEC;
2. Forecasts for electricity and gas sales in the SCAG region over the modeling period;
3. Information on current (most recent year) utility sales of gas and electricity in the SCAG region, preferably by utility, especially if different goals are to apply to different utilities. To the extent that utilities serving the SCAG region also serve areas outside the region, information would be needed on the fraction of sales of each relevant utility inside the SCAG region;
4. Carbon intensity of grid electricity: should be taken from the region's GHG I&F. This value may change over the modeling period, and will be needed for many ES and RCI options. If SCAG already has calculated a future stream of such values, they can be used directly in the analysis of the option. If SCAG has not attempted to calculate an avoided emissions value, statewide model results may be helpful, or SCAG and CCS staff may need to collaborate on a rough estimate (for example, based on proxy generating plants—perhaps gas combined cycle);
5. Estimates of the average current and projected gas and electricity avoided costs (in $/MMBtu and $/MWh) in the SCAG region. If these data are not readily available, they can probably be estimated from PUC filings or CEC documents, or from the results of other regional or statewide cost modeling exercises;
6. Energy-cycle emission factors: for electricity, as well as each fuel type; sources could be ANL GREET model or a specific set developed for CA (e.g., potentially available through the California Air Resources Board);
7. Regional population forecast (e.g., county-level): source SCAG;
8. Forecasts for the number of new residential buildings to be constructed over the planning period (by year), and of the commercial floor space to be constructed annually (or, for example, forecasts for these parameters in five-year increments);
9. Estimates of current total water use, preferably by sector, for the most current year available (and, preferably, for recent years) in the SCAG area. If water use data are unavailable, water production (volume of water treated of water for domestic, commercial, and industrial uses) in the SCAG area would be a good proxy; embedded energy/carbon content of water deliveries in the SCAG region.
10. Estimates of future water use in the SCAG area. These may be available from water treatment/distribution authorities, or may need to be created by extrapolating trends in use per person and applying them to demographic projections;
11. Estimates of current and future volumes of wastewater treated;
12. Regional economic forecast (employment, GDP): source SCAG; and
13. Biomass supply and demand assessment: a common need for energy and GHG planning where strategies target in-region fuel supplies; it's not clear based on the current selection and design of SCAG policies, whether in-region biofuel supplies are being targeted (e.g., ES-2/RCI-3; TSI-6).

APPENDIX D. MACROECONOMIC IMPACTS OF AB 32 & SB 375 ON THE SCAG ECONOMY: METHODOLOGICAL SUMMARY

Center for Climate Strategies
Helping States and Nations Tackle Climate Change

www.climatestrategies.us

Memo

To: Frank Wen and Kimberly Martin, Southern California Association of Governments (SCAG)

From: Tom Peterson, Randy Strait and Paul Aldretti, Center for Climate Strategies (CCS)

Adam Rose and Dan Wei, University of Southern California (USC), Michael Lawrence, Lewison Lem and Scott Williamson, Jack Faucett Associates

CC: Management Group, SCAG; Technical Team, CCS

Re: Draft Macroeconomic Impacts of AB 32 & SB 375 on the SCAG Economy: Methodological Summary

Date: December 3, 2012

I. Introduction and Overview

Assembly Bill (AB) 32 has established greenhouse gas (GHG) emissions reduction goals and limits and has identified a series of policy actions and mechanisms that can achieve them at the sector-based and economy-wide levels. In addition, Senate Bill (SB) 375 directs the Air Resources Board to set regional targets for the reduction of GHGs in the transportation sector through regional and local actions that reduce transportation demand. These actions are intended to help California achieve GHG reduction goals for cars and light-duty trucks under AB 32.

The major focus of economic analysis of environmental legislation until recently has been on the direct, or on-site, impacts of individual mitigation policies or collective scenarios. Some of these policy options and scenarios can result in cost-savings directly to those who implement them, but they also provide gains to their customers if the savings are passed on in the form of lower prices. It is also likely that some other options will incur additional costs to businesses, households, non-profit institutions, and government operations, and the likely cutback in economic activity will also affect their suppliers.

Complicating the situation are various types of indirect effects stemming from the interdependence of the economy. Increases in demand ripple through the economy generating a set of successive rounds of positive supplier multiplier effects. Cost savings are passed along to several rounds of customers to add further to the stimulus. Decreases in demand will have their own ripple effects on different sets of suppliers and customers in an analogous negative way (see, e.g., Rose and Oladosu, 2002; Rose and Wei, 2009a and 2009b; Miller et al., 2009).

The purpose of this summary is to describe the methods we will use to estimate the economy-wide impacts on the SCAG Region of specific AB32 policies and measures, and cap & trade, as well as specific SB 375 transportation and land use planning policy options. It is divided into 5 sections. Section 2 summarizes the choice of the Regional Economic Models, Inc. (REMI) Policy Insight Plus (PI^+) Model and the TranSight (TS) Model that we will use to estimate the macroeconomic impacts. Section 3 presents an overview of how we translate the results of the microeconomic analysis into REMI simulation policy variables, as well as how the data are further refined and linked to key structural and policy variables in the Model. Section 4 summarizes the set-up process of policy simulations in the REMI PI^+ model. Section 5 lists the output variables of the model, and briefly describes sensitivity analyses that will be performed to ensure the results will be robust. The Appendices provide more detail on the REMI model and modeling alternatives.

II. REMI Model Analysis

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, 1998).

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 REMI PI^+ Model and the TS 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 (see Appendix B). With careful explanation of the model, its application, and its results, it can be made as transparent as any of the others. Moreover, the research team has used the model successfully in similar analyses in the states of Florida, Pennsylvania, Michigan and Wisconsin (Rose and Wei, 2009a; Rose and Wei, 2009b; Miller et al., 2009). The REMI TS Model is similar to $PI^{+,}$ but adds an economic geography dimension that allows consideration of policies that alter the transportation network, transportation choices and land use patterns.

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.

A detailed discussion of the major features of the REMI Model is presented in appendix A. 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 that allows evaluation of specific sector-based policy options. 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 less expensive 70-sector REMI Model would not be satisfactory because it does not provide sufficient detail with respect to utilities and manufacturing. In the 70-sector model, electricity, gas, and water are combined into one sector, as opposed to being in separate categories in the 169-sector model. The 70-sector model divides the economy into only 22 manufacturing sectors, while the 169-sector model has 84 manufacturing sectors.

The TS Model currently includes the 70-sector REMI I-O model industry detail. The TS Model adds a great deal of new information to the PI^+ Model with the inclusion of gravity models to account for the regional economic geography. This allows the model to translate highway and transit investments and traveler behavioral changes into inputs to the macro model. As REMI does not offer a version of the TS Model at the 169-sector level at this time, the study team will evaluate the energy impacts with PI^+ and will evaluate transportation infrastructure impacts with TS.

Moreover, rather than using just a model for the 6-county SCAG Region, it would be best to use a 3-region REMI Model (at modest additional cost). This would include the SCAG Region, Rest of CA and REST of the U.S. This would be useful in gauging industrial leakage from the SCAG region due to the implementation of AB32 or SB 375 policies.

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. 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).[1] This gives the REMI PI^+ and REMI TS models an additional capability of being better able to extrapolate[2] the future course of the economy, a capability the other models lack. The major limitation of the REMI PI^+ and REMI TS models 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

[1] 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.

[2] The model can be used alone for forecasting with some caveats, or used in conjunction with other forecast "drivers".

from engineering data. However, our assessment of the REMI PI^+ and REMI TS models is that these adjustments were not needed for the purpose at hand.

The use of the REMI PI^+ and REMI TS models will involve the generation of a baseline forecast of the economy through 2035, consistent with the SCAG baseline forecast. Then simulations are run of the changes brought about through the implementation of the various GHG mitigation policy options. This includes the direct effects in the sectors in which the options are implemented, and then the combination of multiplier (purely quantitative interactions), general equilibrium (price-quantity interactions), and macroeconomic (aggregate interactions) impacts. The differences between the baseline and the "counter-factual" simulation represent the total state economic impacts of these policy options. The TS model also adds the benefits of improved access or the costs of restricted access on transactions in the SCAG economy.

III. Input Data

The quantification analysis of the costs/savings of policy options in the microeconomic analysis of this project is limited to the direct effects of their implementation. For example, the direct costs of an energy efficiency option include the energy customers' expenditure on energy efficiency equipments and devices. The direct benefits of this option include the savings on energy bills of the customers.

Before undertaking any economic simulations, the costs and savings for the policy options are translated to model inputs that can be utilized in the model. This step involves the selection of appropriate policy levers in the REMI PI^+ and REMI TS models to simulate the policy's changes. The input data include sectoral spending and savings over the full time horizon (2010-2020) of the analysis.

Major outputs from the micro analysis that we will use include the following, among others:

- Change in Upfront Capital Investment by sector and policy option
- Change in Annualized Capital Cost by sector and policy option
- Change in O&M Cost by sector and policy option
- Change in Fuel expenditures by sector and policy option
- Program implementation and administrative costs
- Proportion of public funding and private debt financing
- Federal or state subsidies/tax credits

In this study we will perform analysis on two sets of GHG mitigation policy options: non-transportation policies and measures (e.g. Energy Efficiency, RPS, CHP) and transportation policy options (TLU/TSI options).

In addition, the transportation policy options that affect the SCAG region transportation network will be evaluated with the TS Model. This would benefit from the exercise of the SCAG Travel Demand Model to capture the travel impacts of groups of policy options.

In Table 1, we choose Energy Efficiency to illustrate how we will translate, or map, the potential micro results into REMI PI^+ economic variable inputs. The first set of inputs in Table 1 is the increased cost to the commercial, industrial, and residential sectors due to the purchases of energy efficient equipment and appliances. For the commercial and industrial sectors, this is simulated in REMI by increasing the value of the “Capital Cost” variable of individual commercial sectors and individual industrial sectors under the “Compensation, Prices, and Costs Block.” For the residential sector, the program costs (which represent total incremental costs of new equipment over conventional equipment) are simulated by increasing the “Consumer Spending” on “Kitchen & Other Household Appliances” (and decreasing all the other consumptions correspondingly). The “Consumer Spending (amount)” and “Consumption Reallocation (amount)” variables can be found in the “Output and Demand Block” in the REMI Model.

The second set of inputs is the corresponding stimulus effect to the economy of the spending on efficient equipment and appliances, i.e., the increase in the final demand for goods and services from the industries that supply energy efficient equipment and appliances. This is simulated in REMI by increasing the “Exogenous Final Demand” (in the “Output and Demand Block”) of the following sectors: Ventilation, Heating, Air-conditioning, and Commercial Refrigeration Equipment Manufacturing sector; Electric Lighting Equipment Manufacturing sector; Electrical Equipment Manufacturing sector; and Other Electrical Equipment and Component Manufacturing sector. The interest payment due to the financing of the capital investment is simulated as the “Exogenous Final Demand” increase of the Monetary Authorities, Credit Intermediation sector.[3] Any administrative cost of the Energy Efficiency program is simulated as the “Exogenous Final Demand” increase of the Management, Scientific, and Technical Consulting Services sector.

The third set of inputs to REMI is the energy savings of the commercial, industrial, and residential sectors resulted from the Energy Efficiency program. For the commercial and industrial sectors, the energy savings are simulated in REMI by decreasing the value of the “Electricity/Natural Gas/Residual Fuel Cost of All Commercial/Industrial Sectors” variables. These variables can be found in the “Compensation, Prices, and Costs Block.” For the residential sector, the energy savings are simulated by decreasing the “Consumer Spending” on “Electricity”, “Gas” and “Fuel Oil” (and increasing all the other consumption categories correspondingly). Again, the “Consumer Spending (amount)” and “Consumption Reallocation (amount)” variables can be found in the “Output and Demand Block” in the REMI model.

[3] The opportunity cost of the interest payment is included in the increase of the “Capital Cost” variable for the commercial and industrial sectors (row 1 in Table 2). As for the residential sector, it is reflected in the reduction in consumption of all other commodities (i.e., this is reflected in a decrease in the “Consumption Reallocation” variable shown in row 2 in Table 2).

Table 1. Mapping Micro Analysis Outputs on Energy Efficiency into REMI Inputs

Quantification Results (ENERGY 2020 outputs plus additional necessary data from other sources)		Policy Variable Selection in REMI
Customer Outlay on Energy Efficiency (EE)	Businesses (Commercial and Industrial Sectors)	Compensation, Prices, and Costs Block →Capital Cost (amount) of individual commercial sectors→Increase
	Households (Residential Sector)	Output and Demand Block→Consumer Spending (amount)→Kitchen & other household appliances→Increase
		Output and Demand Block→Consumer Spending (amount)→ Bank service charges, trust services, and safe deposit box rental→Increase
		Output and Demand Block →Consumption Reallocation (amount)→All Consumption Sectors →Decrease
Investment on EE Technologies		Output and Demand Block →Exogenous Final Demand (amount) for Ventilation, Heating, Air-conditioning, and Commercial Refrigeration Equipment Manufacturing sector; Electric Lighting Equipment Manufacturing sector; Electrical Equipment Manufacturing sector; and Other Electrical Equipment and Component Manufacturing sector→Increase
Interest Payment of Financing Capital Investment		Output and Demand Block →Exogenous Final Demand (amount) for Monetary Authorities, Credit Intermediation sector→Increase
Administrative Outlays		Output and Demand Block →Exogenous Final Demand (amount) for Management, Scientific, and Technical Consulting Services sector→Increase
Energy Savings of the Customers	Businesses (Commercial and Industrial Sectors)	Compensation, Prices, and Costs Block→ Electricity, Natural Gas, and Residual (Commercial Sectors) Fuel Cost (share) of All Commercial Sectors→Decrease
		Compensation, Prices, and Costs Block→ Electricity, Natural Gas, and Residual (Industrial Sectors) Fuel Cost (share) of All Industrial Sectors→Decrease
	Households (Residential Sector)	Output and Demand Block→Consumer Spending (amount)→Electricity, Gas, and Fuel Oil→Decrease
		Output and Demand Block →Consumption Reallocation (amount)→All Consumption Sectors →Increase
Energy Demand Decrease from the Energy Supply Sectors[a]		Output and Demand Block →Exogenous Final Demand (amount) for Electric Power Generation, Transmission, and Distribution sector; Natural Gas Distribution sector; and Petroleum and Coal Products Manufacturing sector→Decrease

[a] The final demand change here only reflects the energy consumption reductions from the commercial and industrial sectors. The residential sector energy consumption reductions will be entered into the model through the "Consumer Spending" variable.

The last set of inputs is the corresponding damping effects to the energy supply sector due to the decrease in the demand from the customer sectors. These effects are simulated by reducing the "Exogenous Final Demand" of the Electric Power Generation, Transmission, and Distribution sector, Natural Gas Distribution sector, and Petroleum and Coal Products Manufacturing sector in REMI. In this step, the final demand change is only modeled for the non-residential sectors, i.e., only the decreased demand from the commercial and industrial sectors need to be manually entered into the model as final demand change for the energy supply sectors. For the Residential sector, the model will internally convert the change in the Consumer Spending (amount) policy variable into changes in final demand for the corresponding sectors.

IV. Simulation Set-up in REMI

Figure 1 shows how a policy simulation process is undertaken in the REMI PI^+ model. First, a policy question is formulated (such as what would be the economic impacts of implementing the Energy Efficiency Programs). Second, external policy variables that would embody the effects of the policy are identified (take Energy Efficiency as an example, relevant policy variables would include incremental costs and investment in energy efficient appliances; final demand increase in the sectors that produce the equipments and appliances; and the avoided consumption of electricity, natural gas, etc.). Third, baseline values for all the policy variables are used to generate the control forecast (baseline forecast). In REMI PI^+, the baseline forecast uses the most recent data available (i.e., 2007 data) for the study 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. Fifth, the effects of the policy scenario are measured by comparing the baseline forecast and the alternative forecast. Sensitivity analysis can be undertaken by running a series of alternative forecasts with different assumptions on the values of the policy variables.

In this study, we first run the REMI PI^+ model for each of the SCAG policy 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 options under same categories are bundled together. Finally, we run a simulation that includes all the policies 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 PI^+ Model.

Similar procedures will be followed for the transportation policy options. Simulations of these options will be run independently in REMI TS. These simulations will produce estimates of the macroeconomic effects of the transportation policy options. These macro impacts (e.g. output, income, employment, etc.) can be added to the energy impacts produced in the combined PI^+ Model simulations. As these two models undertake the simulation at different levels of detail, 70 verses 169 sectors, some benefits and costs of the interaction of these energy and infrastructure policies may not be accounted for. The REMI staff believes these lost impacts will be minor compared to the aggregate level of the impacts. The study team will evaluate these potential impacts during the study.

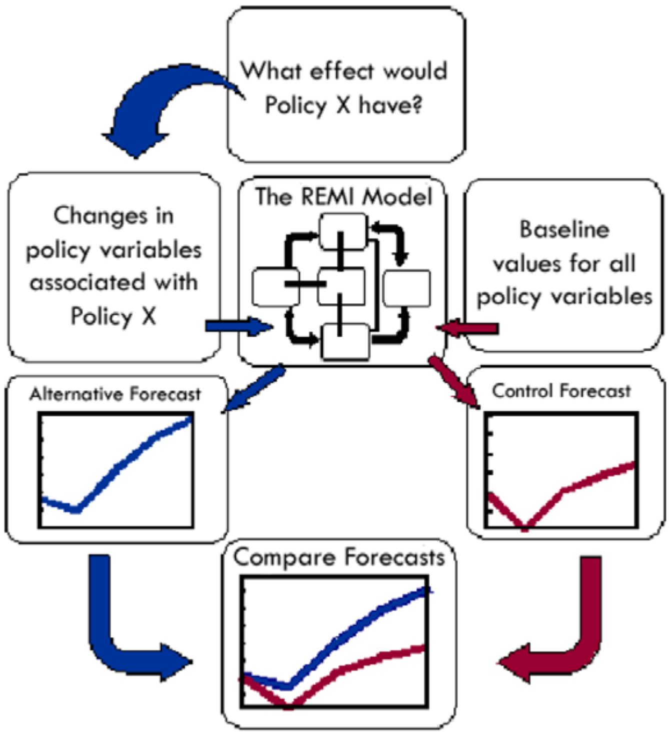


Figure 1. Process of Policy Simulation in REMI

V. Model Outputs

Simulations will be performed of the impacts of 2 sets of AB32 mitigation policies:

- Cap and trade
- Complementary policies, other than those related to Transportation and Land Use (Energy Efficiency, RPS, and CHP)

The policies will be simulated individually and combined. We will ascertain the extent to which the simple sum of the parts differs from the whole. Differences will be ascribable to a combination of non-linearities and synergies in the SCAG economy.

The REMI Model analysis will yield the following aggregate output variable impacts:

- Economic growth, or change in Gross State Product (GSP) by year
- Employment (job creation or losses)
- Personal Income
- Output
- Price Index
- Population

In addition, sectoral impacts of each of the 169 sectors (70 for TS), or key affected sectors, of the SCAG economy can be provided.

Finally, we will also run sensitivity tests on the following key variables:

- Energy prices
- Investment addition/displacement
- Discount rates

APPENDIX A. Description of the REMI PI$^+$ Model

REMI PI$^+$ (REMI, 2009) is a structural economic forecasting and policy analysis model. It integrates input-output, computable general equilibrium, econometric and economic geography methodologies. The model is dynamic, with forecasts and simulations generated on an annual basis and behavioral responses to wage, price, and other economic factors.

The REMI model consists of thousands of simultaneous equations with a structure that is relatively straightforward. The exact number of equations used varies depending on the extent of industry, demographic, demand, and other detail in the model. The overall structure of the model can be summarized in five major blocks: (1) Output and Demand, (2) Labor and Capital Demand, (3) Population and Labor Supply, (4) Compensation, Prices, and Costs, and (5) Market Shares. The blocks and their key interactions are shown in Figures A1 and A2.

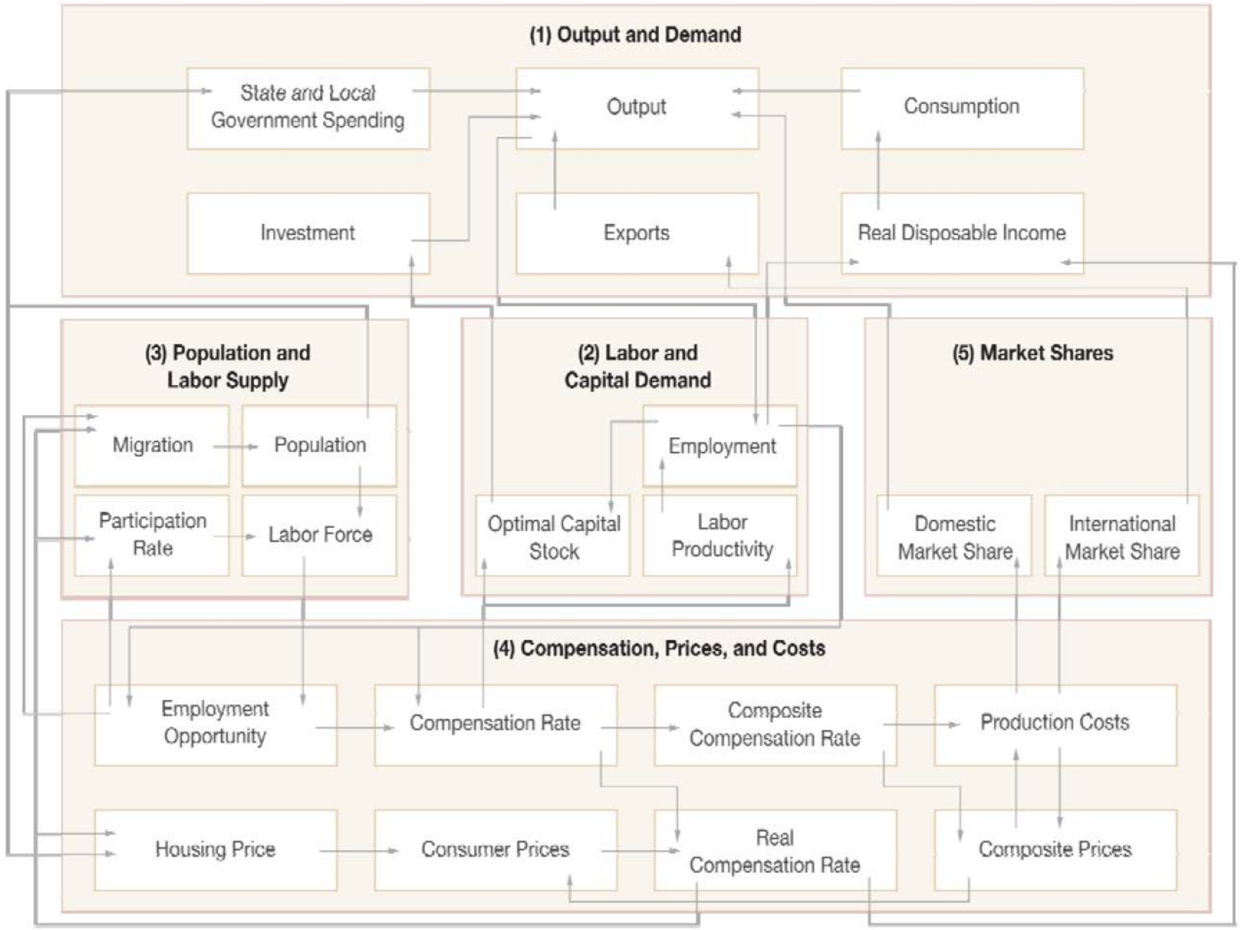
The Output and Demand block includes output, demand, consumption, investment, government spending, import, product access, and export concepts. Output for each industry is determined by industry demand in a given region and its trade with the US market, and international imports and exports. For each industry, demand is determined by the amount of output, consumption, investment, and capital demand on that industry. Consumption depends on real disposable income per capita, relative prices, differential income elasticities and population. Input productivity depends on access to inputs because the larger the choice set of inputs, the more likely that the input with the specific characteristics required for the job will be formed. In the capital stock adjustment process, investment occurs to fill the difference between optimal and actual capital stock for residential, non-residential, and equipment investment. Government spending changes are determined by changes in the population.

The Labor and Capital Demand block includes the determination of labor productivity, labor intensity and the optimal capital stocks. Industry-specific labor productivity depends on the availability of workers with differentiated skills for the occupations used in each industry. The occupational labor supply and commuting costs determine firms' access to a specialized labor force.

Labor intensity is determined by the cost of labor relative to the other factor inputs, capital and fuel. Demand for capital is driven by the optimal capital stock equation for both non-residential capital and equipment. Optimal capital stock for each industry depends on the relative cost of labor and capital, and the employment weighted by capital use for each industry. Employment in private industries is determined by the value added and employment per unit of value added in each industry.

The Population and Labor Supply block includes detailed demographic information about the region. Population data is given for age and gender, with birth and survival rates for each group. The size and labor force participation rate of each group determines the labor supply. These participation rates respond to changes in employment relative to the potential labor force and to changes in the real after tax compensation rate. Migration includes retirement, military, international and economic migration. Economic migration is determined by the relative real after tax compensation rate, relative employment opportunity and consumer access to variety.

Figure A1. REMI Model Linkages (Excluding Economic Geography Linkages)

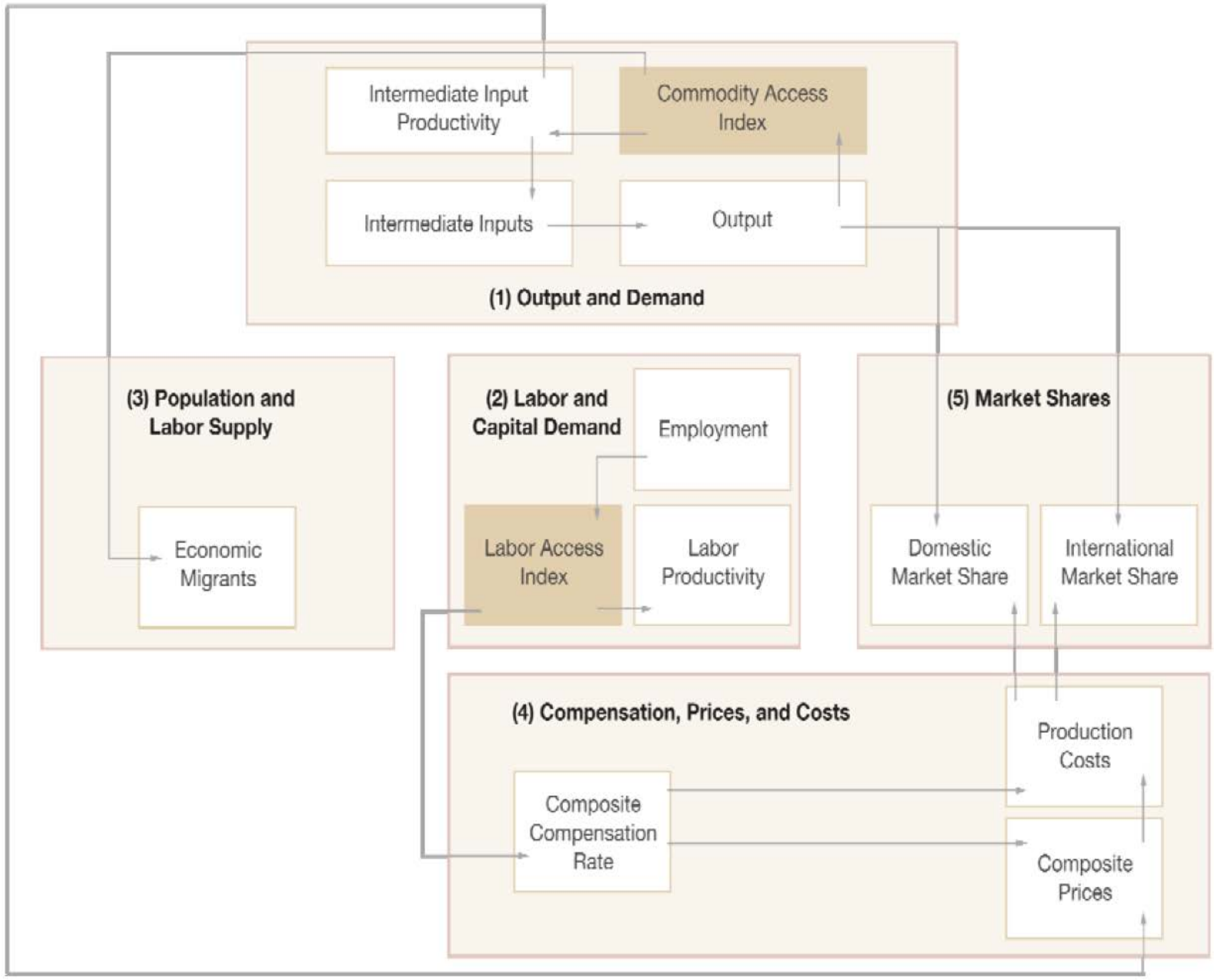


The Compensation, Prices, and Costs block includes delivered prices, production costs, equipment cost, the consumption deflator, consumer prices, the price of housing, and the wage equation. Economic geography concepts account for the productivity and price effects of access to specialized labor, goods and services.

These prices measure the value of the industry output, taking into account the access to production locations. This access is important due to the specialization of production that takes place within each industry, and because transportation and transaction costs associated with distance are significant. Composite prices for each industry are then calculated based on the production costs of supplying regions, the effective distance to these regions, and the index of access to the variety of output in the industry relative to the access by other uses of the product.

The cost of production for each industry is determined by cost of labor, capital, fuel and intermediate inputs. Labor costs reflect a productivity adjustment to account for access to specialized labor, as well as underlying compensation rates. Capital costs include costs of non-residential structures and equipment, while fuel costs incorporate electricity, natural gas and residual fuels.

Figure A2. Economic Geography Linkages



The consumption deflator converts industry prices to prices for consumption commodities. For potential migrants, the consumer price is additionally calculated to include housing prices. Housing price changes from their initial level depend on changes in income and population density. Regional employee compensation changes are due to changes in labor demand and supply conditions, and changes in the national compensation rate. Changes in employment opportunities relative to the labor force and occupational demand change determine compensation rates by industry.

The Market Shares equations measure the proportion of local and export markets that are captured by each industry. These depend on relative production costs, the estimated price elasticity of demand, and effective distance between the home region and each of the other regions. The change in share of a specific area in any region depends on changes in its delivered price and the quantity it produces compared with the same factors for competitors in that market. The share of local and external markets then drives the exports from and imports to the home economy.

As shown in Figure A2, the Labor and Capital Demand block includes labor intensity and productivity, as well as demand for labor and capital. Labor force participation rate and migration equations are in the Population and Labor Supply block. The Compensation, Prices, and Costs block includes composite prices, determinants of production costs, the consumption price deflator, housing prices, and the wage equations. The proportion of local, interregional and international markets captured by each region is included in the Market Shares block.

APPENDIX B. Evaluation of Alternative Models

I. OVERALL CRITERIA AND MODEL SPECIFICATIONS

In evaluating economic models, it is first prudent to identify a set of criteria on which to base the decision.

A. Model Performance Criteria:

1. Accuracy. This pertains to the extent the model will yield predictions of macroeconomic impacts that are likely to be close to actual occurrences. Of course, it cannot be absolutely ascertained in advance. Therefore, we depend on standard model features that are likely to enhance accuracy. These include the level of sophistication of the model and its consistency with economic theory, the data that it utilizes, and "goodness of fit" measures where applicable.

2. Scope. This relates to the breadth of coverage of the model. It would include such features as whether it consists only of selected sectors or the entire economy. It also pertains to the number of mitigation and sequestration options that can be included.

3. Detail. This pertains to the degree of resolution of the model. This is indicated by the extent to which the model is divided into a number of sectors and to the number of macroeconomic indicators that can be analyzed with it.

4. Transparency. This pertains to whether the workings of the model can be made clear to those who would utilize its results, as well as whether the model can offer a clear picture of how the results were obtained.

5. Manageability. This relates to the ability of the modeler to develop simulations with the model in a reasonable amount of time. It also pertains to the potential for the eventual transfer of the model to SCAG staff.

6. Cost. This pertains primarily to the expense of building and operating the model itself. It also pertains to the expense of updating and refining the model at a later date.

7. Other. No other criteria were specified during the conference call. However, forecasting ability should be considered.

B. Model Specifications

1. Geographic area of coverage. This pertains to whether the analysis is to be performed only for the SCAG Region, or whether there is a need to include any of the sub-regions. It would be best to use a model that could include the REST of CA and the Rest of the U.S. as well, to better gauge economic and emissions leakage

2. Time of analysis. This refers to the time horizon for the policy simulation.

3. Macroeconomic Indicators. There is a large list, but the conclusion of the conference call was an emphasis on gross state product (GSP) and employment.

4. Sectoral Resolution. It would be preferable to have as much resolution as possible, especially with respect to manufacturing sector detail.

5. Income distribution. The model chosen needs to be able to analyze the income distribution impacts of AB32.

C. Parameter Values

1. Flexibility. This refers to the extent that models can address considerations such as substitution of one fuel or energy technology for another.

2. Productivity and Competitiveness. This refers to the extent that the model can incorporate cost changes and improvements stemming from technological change and the extent to which these considerations affect the region's cost of production relative to that of other regions.

3. Economic Growth. This refers to the extent to which the model can factor economic growth into the baseline forecast.

4. Population Growth. Same as above but with respect to population.

5. Trend Factors. This refers to other secular changes that affect the baseline or the analysis, such as a steady increase in energy efficiency or a steady change in electricity prices.

6. Discount Rate. A 5% real discount rate has been specified. However, sensitivity runs using 2% and 7% percent would be valuable. N7

D. Follow up

1. Presentations. No extensive presentation of the model or its results will be needed for groups outside SCAG.

2. Technology Transfer. This refers to providing the model and the know-how on how to utilize it for other applications to SCAG staff.

II. MODEL EVALUATION

In this section we evaluate the REMI Model and a generic CGE Model (see, e.g., Rose and Oladosu, 2002) in terms of the criteria and other considerations listed in the previous section.

A. Model Performance Criteria

1. Accuracy. Both models are capable of a high level of accuracy. This relates in part to their inherent capabilities, but also depends somewhat on how the models are structured and applied. Both modeling approaches are widely used, indirectly testifying to their abilities on this score. Unfortunately, there are no formal comparisons in the literature between the two (including any type of CGE model). Moreover, analysts rarely go back and assess past projections or impact study results. While there are goodness of fit measures for macroencometric models, they are not available for individual equations or the entirety of REMI. CGE models are "calibrated", i.e., based on a single year's data. This approach is considered less sound than the inferential statistical approach to parameter estimation using time series data inherent in macroeconometric modeling. SCAG and others have experience in assessing the SCAG REMI Model's accuracy. In contrast, a CGE model would have to be built for the SCAG Region for the first time, and thus there is no experience with it in this regard.

Increasing the sectoral resolution will improve the accuracy of both models. Care in factoring in special features of mitigation options, and future technological and structural changes in the SCAG economy would improve accuracy, as would care in modeling mitigation options and linking them to the appropriate variables. Of course, there is a tradeoff between cost and accuracy (see below)

2. Scope. Both models are equally capable of analyzing the entire state economy and the major macroeconomic indicators of interest to this study.

3. Detail. Both models can be disaggregated to as fine a level of detail as desired in terms of economic sectors. However, the 169-sector REMI Model contains more sectors than the standard CGE model.

4. Transparency. Neither approach is a black box. The workings can be readily explained by using simple economic principles. Individual functional relationships (e.g., production functions or consumption functions) can be extracted for further examination, though it is much more difficult to do this in REMI (it would require help from REMI staff).

5. Manageability. Both models are relatively straightforward to use. However, REMI has a major advantage in that it comes with a user's guide.

6. Cost. REMI has a clear advantage here, because SCAG already has the model in hand. It would cost another $35-50K to build the CGE Model from scratch. The costs of preparing the model for application (linking mitigation options to relevant variables) and the actual application are about equivalent to the REMI Model.

7. Forecasting ability. REMI is able to generate forecasts for future baselines. The CGE model cannot do so, and must depend on external forecasts. If only differences in GSP and employment are crucial, rather than their absolute levels, this is not so important.

B. Model Specifications

1. Geographic area of coverage. The REMI Model in the possession of SCAG is essentially a 2-region model—SCAG and the Rest of the U.S., and a third region—Rest of CA—could be added at a modest cost. A three-region CGE model could be built as well, though this would increase the cost of model building by about 50%, and the cost of applying it by about 10%.

2. Time period of analysis. Both models are capable of analyzing the entire time period of 2009-20.

3. Macroeconomic Indicators. Both models are adept at evaluating impacts on both GSP and employment.

4. Sectoral Resolution. The REMI model of 169 sectors is adequate to the task. A comparable sectoring scheme can be developed for the CGE Model. It has the advantage here, if a tailored sectoring scheme is deemed important.

C. Parameter Values

1. Flexibility. The production functions of the CGE model are more sophisticated, and thus it is able to perform better in terms of modeling substitution between fossil fuels and between thee fuels and renewables. This has implications for accuracy as well.

2. Productivity and Competitiveness. Both models can address this somewhat. However, REMI has a more formal and comprehensive approach.

3. Economic Growth. REMI can do this in its forecasts. The CGE model cannot.

4. Population Growth. REMI can do this in its forecasts. The CGE model cannot.

5. Trend Factors. Both models can do this through the inclusion of exogenous variables.

6. Discount Rate.   Both models can do this equally well.

III. OVERALL ASSESSMENT

Based on the analysis of above, the REMI Model has a strong overall edge over a CGE Model to analyze the macroeconomic impacts of AB32. It is not the superior alternative according to all indicators, but it is for most.

A good deal of the edge stems from the fact that SCAG has the model in house and has experience using it. Other major advantages stem from its econometric foundation, including its forecasting ability.

III. REFERENCES

Center for Climate Strategies (CCS). 2009. Updated Analysis of the New Mexico Climate Change Action Plan, Washington, DC

Miller, S., Wei, D., and Rose, A. 2009. *The Economic Impact of the Michigan Climate Change Action Plan on the State's Economy*. Report to the Michigan Department of Environmental Quality, The Center for Climate Strategies, Washington DC. http://www.climatestrategies.us/ewebeditpro/items/O25F22416.pdf.

Partridge, M.D. and Rickman, D.S. 1998. "Regional Computable General Equilibrium Modeling: A Survey and Critical Appraisal," *International Regional Science Review* 21(3), 205-248.

Regional Economic Models, Inc. 2009. *REMI PI$^+$ Model Document*. www.remi.com.

Rose, A. and Miernyk, W. 1989. "Input-Output Analysis: The First Fifty Years," *Economic Systems Research* 1(2): 229-271.

Rose, A. and G. Oladosu. 2002. "Greenhouse Gas Reduction in the U.S.: Identifying Winners and Losers in an Expanded Permit Trading System," *Energy Journal* 23(1): 1-18.

Rose, A. and Wei, D. 2009a. *The Economic Impact of the Florida Energy and Climate Change Action Plan on the State's Economy*. Report to the Office of the Governor of the State of Florida, The Center for Climate Strategies, Washington DC.

Rose, A. and Wei, D. 2009b. "Macroeconomic Assessment," Chapter 11 in Pennsylvania Climate Action Plan. http://www.depweb.state.pa.us/energy/cwp/view.asp?q=539829.

Rose, A., Wei, D., Wennberg, J., and Peterson, T. 2009. "Climate Change Policy Formation in Michigan: The Case for Integrated Regional Policies," *International Regional Science Review* 32(4): 445-465.

Treyz, G. 1993. *Regional Economic Modeling: A Systematic Approach to Economic Forecasting and Policy Analysis*. Boston: Kluwer.

APPENDIX E. MAPPING OF MICROECONOMIC COST RESULTS AS INPUTS TO THE REMI MODEL

Appendix C

Mapping of Microeconomic Cost Results as Inputs to the REMI Model

Mapping of TLU and TSI Policy Microeconomic Cost Results to REMI Model Policy Variables

Table C-1 summarizes the mapping for ten of the policies or policy bundles analyzed as part of the CEDP Macroeconomic Analysis process. It shows the types of spending or saving modeled in the REMI TranSight tool for each of these ten policies. The table articulates the sector to which each type of spending was allocated. In many cases, the decisions regarding which sector to use to reflect investments or spending flows were made with the help of REMI staff to ensure the correct use of the TranSight tool.

Because directing money to any particular activity creates some level of displacement (meaning that the money is no longer free to be spent or invested as it was before), each policy-driven change is paired with an offsetting change that reflects this expected displacement. In the case of public-sector spending, the presence of some level of external funding (federal or state) meant that only the local portion of the investment was subject to offsetting, while the state and federal portion of the investment represented new money coming into the region. Therefore many offsets were smaller in scale than their associated investments.

The table also shows productivity adjustments, which apply only to policies that drive private-sector investment. When private-sector capital spending was driven by a policy, the economic analysis effort assumed that, like public-sector investment, this would displace investment elsewhere. However, the analysts assumed that the investment to be displaced would be lower than average in its productivity (i.e. the least valuable and most favored for cutting by private enterprises), while the new investment was assumed to equal to the economy-wide average for productivity returns.

Table C-1. Mapping TSI and TLU Policies into REMI Inputs

Policy Number - Micro Data Output Category	Policy-Driven Capital or Spending Change Modeled in TranSight	TranSight Sector	Negative Offsets and Productivity Adjustments	TranSight Sector
TLU6 - Employer Spending	Increased compensation to workers	Professional and technical services	Additional Expenditures by Employers	Professional and technical services
TLU6 - Fuel Spending	Reduced Spending on Fuel, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Petroleum and coal product manufacturing
TLU6 - Productivity Offset	-	-	Increased productivity vs. Displaced Low-Productivity Investment (Private Sector)	All Private Non-Farm Sectors
TLU6 - Vehicle Spending	Reduced Spending on Vehicles, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Motor vehicles, bodies & trailers, and parts manufacturing
TLU7 - Fuel Spending	Reduced Spending on Fuel, Leading to Increased	All Consumption Categories	Exogenous Demand	Petroleum and coal product manufacturing

Policy Number - Micro Data Output Category	Policy-Driven Capital or Spending Change Modeled in TranSight	TranSight Sector	Negative Offsets and Productivity Adjustments	TranSight Sector
	Consumption			
TLU7 - Parking Meter Revenue	Toll Revenue from Consumers	Tolls	Reduced Consumer Spending in other areas	All Consumption Categories
TLU7 - Vehicle Spending	Reduced Spending on Vehicles, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Motor vehicles, bodies & trailers, and parts manufacturing
TSI1 - Employer Spending	Increased compensation to workers	Professional and technical services	Additional Expenditures by Employers	Professional and technical services
TSI1 - Fuel Spending	Reduced Spending on Fuel, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Petroleum and coal product manufacturing
TSI1 - Productivity Offset	-	-	Increased productivity vs. Displaced Low-Productivity Investment (Private Sector)	All Private Non-Farm Sectors
TSI1 - Vehicle Spending	Reduced Spending on Vehicles, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Motor vehicles, bodies & trailers, and parts manufacturing
TSI10 - Construction	Construction Investment	Construction	Government Spending	Government Spending
TSI10 - Fuel Spending	Reduced Spending on Fuel, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Petroleum and coal product manufacturing
TSI10 - Vehicle Spending	Reduced Spending on Vehicles, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Motor vehicles, bodies & trailers, and parts manufacturing
TSI3 - Construction	Construction Investment	Construction	Government Spending	Government Spending
TSI3 - Fairbox Revenues	Toll Revenue from Consumers	Tolls	Reduced Consumer Spending in other areas	All Consumption Categories
TSI3 - Fuel Spending	Reduced Spending on Fuel, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Petroleum and coal product manufacturing
TSI3 - Transit Operations	Local Government Spending on Operations	Local Government Spending	Portions of Local Government Spending in Other Areas	Local Government Spending
TSI3 - Vehicle Spending	Reduced Spending on Vehicles, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Motor vehicles, bodies & trailers, and parts manufacturing
TSI4a - Construction	Construction Investment	Construction	Government Spending	Government Spending
TSI4a - Fuel Spending	Reduced Spending on Fuel, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Petroleum and coal product manufacturing
TSI4a - Vehicle Spending	Reduced Spending on Vehicles, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Motor vehicles, bodies & trailers, and parts manufacturing
TSI4b - Fuel Spending	Reduced Spending on Fuel, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Petroleum and coal product manufacturing
TSI4b -	-	-	Increased	All Private Non-Farm

Policy Number - Micro Data Output Category	Policy-Driven Capital or Spending Change Modeled in TranSight	TranSight Sector	Negative Offsets and Productivity Adjustments	TranSight Sector
Productivity Offset			productivity vs. Displaced Low-Productivity Investment (Private Sector)	Sectors
TSI4b - Purchases and Equipment Spending	Increased sales and production of vehicles	Motor vehicles, bodies & trailers, and parts manufacturing	Reduced Spending on Other Equipment	Producer's Durable Equipment
TSI4b - Vehicle Spending	Reduced Spending on Vehicles, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Motor vehicles, bodies & trailers, and parts manufacturing
TSI5 - Construction	Construction Investment	Construction	Government Spending	Government Spending
TSI5 - Fuel Spending	Reduced Spending on Fuel, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Petroleum and coal product manufacturing
TSI5 - Vehicle Spending	Reduced Spending on Vehicles, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Motor vehicles, bodies & trailers, and parts manufacturing
TSI7 - Construction	Construction Investment	Construction	Government Spending	Government Spending
TSI7 - Fuel Spending	Reduced Spending on Fuel, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Petroleum and coal product manufacturing
TSI7 - Parking Meter Revenue	Toll Revenue from Consumers	Tolls	Reduced Consumer Spending in other areas	All Consumption Categories
TSI7 - Vehicle Spending	Reduced Spending on Vehicles, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Motor vehicles, bodies & trailers, and parts manufacturing
TSI8 - Construction	Construction Investment	Construction	Government Spending	Government Spending
TSI8 - Fuel Spending	Reduced Spending on Fuel, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Petroleum and coal product manufacturing
TSI8 - Productivity Offset	-	-	Increased productivity vs. Displaced Low-Productivity Investment (Private Sector)	All Private Non-Farm Sectors
TSI8 - Vehicle Spending	Reduced Spending on Vehicles, Leading to Increased Consumption	All Consumption Categories	Exogenous Demand	Motor vehicles, bodies & trailers, and parts manufacturing

Mapping of ECR Policy Microeconomic Cost Results to REMI Model Policy Variables

Before undertaking any economic simulations, the key quantification results for each policy option are translated to model inputs. This step involves the selection of appropriate policy levers in the REMI PI+ Model to simulate the policy's changes. The input data include sectoral costs and savings over the full time horizon (2011-2035) of the analysis. In Tables C-2 through C-4, we choose three example options, RCI-1 Demand-Side Management (DSM), RCI-2 Building Codes, and ES-1 Renewable Portfolio Standards, to illustrate how we translate, or map, the microeconomic results into REMI economic variable inputs.

In Table C-2, the first two columns show the quantification analysis results of this mitigation option according to their applicability to business (commercial and industrial) sectors and the household (residential) sector. The last column of Table C-2 presents the corresponding economic variables in the REMI PI+ Model and their position within the Model (i.e., in which one of the five major blocks, as introduced in Appendix A, the policy variables can be found). Rows 1 through 6 present the linkages for the costs and savings stemming from the mitigation expenditures. Rows 7 through 10 present the simulations for the impacts of the displacement of private ordinary investment. Tables C-3 and C-4 have the same structure as Table C-2.

Table C-2. Mapping RCI-1 Demand-Side Management into REMI Inputs

<table>
<tr><th>Linkage</th><th colspan="2">Microeconomic Quantification Results</th><th>Policy Variable Selection in REMI</th><th>Positive or Negative Stimulus to the Economy</th></tr>
<tr><td>1</td><td colspan="2">Upfront Mitigation Capital Investment on Energy Efficiency Equipment</td><td>Output and Demand Block →Exogenous Final Demand (amount) for Ventilation, Heating, Air-conditioning, and Commercial Refrigeration Equipment Manufacturing (Mfg), Electric Lighting Equipment Mfg, Household Appliance Mfg, Audio and Video Equipment Mfg, Commercial and Service Industry Machinery Mfg, Computer and Peripheral Equipment Mfg, Electrical Equipment Mfg, Other Electrical Equipment and Component Mfg, Industrial Machinery Mfg, and Other general purpose machinery Mfg sectors→ Increase</td><td>Positive</td></tr>
<tr><td>2</td><td colspan="2">Increased DSM Administrative Spending</td><td>Output and Demand Block →Exogenous Final Demand (amount) for Electric Power Generation Sector →Increase</td><td>Positive</td></tr>
<tr><td>3</td><td colspan="2">Interest Payment of Financing Capital Investment</td><td>Output and Demand Block →Exogenous Final Demand (amount) for Monetary Authorities, Credit Intermediation sector→Increase</td><td>Positive</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">Annual Levelized Capital Cost of the Ratepayers</td><td>Businesses (Commercial and Industrial Sectors)</td><td>Compensation, Prices, and Costs Block →Capital Cost (amount) of Individual Commercial and Industrial Sectors→Increase</td><td rowspan="2">Negative</td></tr>
<tr><td>Households (Residential Sector)</td><td>Output and Demand Block →Consumption Reallocation (amount)→All Consumption Sectors →Decrease</td></tr>
<tr><td>5</td><td>Energy Savings (Electricity and</td><td>Businesses (Commercial</td><td>Compensation, Prices, and Costs Block→ Production Cost of Individual Industrial and Commercial</td><td>Positive</td></tr>
</table>

Linkage	Microeconomic Quantification Results		Policy Variable Selection in REMI	Positive or Negative Stimulus to the Economy
	NG)	and Industrial Sectors)	Sectors→Decrease	
		Households (Residential Sector)	Output and Demand Block →Consumption Reallocation (amount)→All Consumption Sectors →Increase	
6	Energy Demand Decrease from the Energy Supply Sectors		Output and Demand Block →Exogenous Final Demand (amount) for Electric Power Generation, Transmission, and Distribution sector and Natural Gas Distribution sector→Decrease	Negative
7	Avoided Annual Capital Cost or Debt Repayment of Ordinary Investment	Businesses (Commercial and Industrial Sectors)	Compensation, Prices, and Costs Block →Capital Cost (amount) of individual commercial and industrial sectors→Decrease	Positive
		Households (Residential Sector)	Output and Demand Block →Consumption Reallocation (amount)→All Consumption Sectors →Increase	
8	Foregone Stimulus Effect of the Upfront Business Ordinary Investment		Output and Demand Block →Investment Spending on Producer's Durable Equipment and Demand of Goods and Services from Construction sector →Decrease	Negative
9	Reduced Upfront Household Expenditures on Regular Goods and Services		Output and Demand Block →Consumption Reallocation (amount)→All Consumption Sectors →Decrease	Negative
10	Foregone Productivity Improvement from Displaced Business Ordinary Investment		Labor and Capital Demand Block →Factor Productivity (Share)→All Private Non-Farm Sector →Decrease	Negative

Table C-3. Mapping RCI-2 Building Codes into REMI Inputs

Linkage	Microeconomic Quantification Results		Policy Variable Selection in REMI	Positive or Negative Stimulus to the Economy
1	Upfront Mitigation Capital Investment on Building Codes for Energy Efficiency		Output and Demand Block →Exogenous Final Demand (amount) for Construction sector → Increase	Positive
2	Interest Payment of Financing Capital Investment		Output and Demand Block →Exogenous Final Demand (amount) for Monetary Authorities, Credit Intermediation sector→Increase	Positive
3	Annual Levelized Capital Cost of Building Codes Improvement	Businesses (Commercial and Industrial Sectors)	Compensation, Prices, and Costs Block →Capital Cost (amount) of Individual Commercial and Industrial Sectors→Increase	Negative
		Households (Residential Sector)	Output and Demand Block →Consumption Reallocation (amount)→All Consumption Sectors →Decrease	
4	Energy Savings (Electricity, NG, and Oil Savings)	Businesses (Commercial and Industrial Sectors)	Compensation, Prices, and Costs Block→ Production Cost of Individual Industrial and Commercial Sectors→Decrease	Positive
		Households	Output and Demand Block →Consumption	

Linkage	Microeconomic Quantification Results		Policy Variable Selection in REMI	Positive or Negative Stimulus to the Economy
		(Residential Sector)	Reallocation (amount)→All Consumption Sectors →Increase	
5	Energy Demand Decrease from the Energy Supply Sectors		Output and Demand Block →Exogenous Final Demand (amount) for Electric Power Generation, Transmission, and Distribution, Natural Gas Distribution, and Petroleum Product Mfg sectors→Decrease	Negative
6	Avoided Annual Capital Cost or Debt Repayment of Ordinary Investment	Businesses (Commercial and Industrial Sectors)	Compensation, Prices, and Costs Block →Capital Cost (amount) of individual commercial and industrial sectors→Decrease	Positive
		Households (Residential Sector)	Output and Demand Block →Consumption Reallocation (amount)→All Consumption Sectors →Increase	
7	Foregone Stimulus Effect of the Upfront Business Ordinary Investment		Output and Demand Block →Investment Spending on Producer's Durable Equipment and Demand of Goods and Services from Construction sector →Decrease	Negative
8	Reduced Upfront Household Expenditures on Regular Goods and Services		Output and Demand Block →Consumption Reallocation (amount)→All Consumption Sectors →Decrease	Negative
9	Foregone Productivity Improvement from Displaced Business Ordinary Investment		Labor and Capital Demand Block →Factor Productivity (Share)→All Private Non-Farm Sector →Decrease	Negative

Table C-4. Mapping ES-1 RPS into REMI Inputs

Linkage	Microeconomic Quantification Results	Policy Variable Selection in REMI	Positive or Negative Stimulus to the Economy
1	Incremental Capital Cost of Electricity Generation (Renewable minus Avoided Conventional Generation)	Compensation, Prices, and Costs Block → Capital Cost (amount) of Electric Power Generation, Transmission, and Distribution sector → Increase	Negative
2	Incremental O&M Cost of Electricity Generation (Renewable minus Avoided Conventional Generation)	Compensation, Prices, and Costs Block →Production Cost (amount) of Electric Power Generation, Transmission, and Distribution sector→Increase	Negative
3	Reduced Fuel Cost of Electricity Generation	Compensation, Prices, and Costs Block →Production Cost (amount) of Electric Power Generation, Transmission, and Distribution sector→Decrease	Positive
4	Federal Subsidies	Compensation, Prices, and Costs Block →Production Cost (amount) of Electric Power Generation, Transmission, and Distribution sector→Decrease	Positive
5	Incremental Investment in Renewable Electricity Generation	Output and Demand Block →Exogenous Final Demand (amount) for Construction sector→Increase Output and Demand Block →Exogenous Final Demand (amount) for Engine, Turbine, and Power Transmission Equipment Manufacturing, Semiconductor and Other	Positive

Linkage	Microeconomic Quantification Results	Policy Variable Selection in REMI	Positive or Negative Stimulus to the Economy
		Electronic Component Mfg, Other Electrical Equipment and Component Mfg, Other General Purpose Machinery Mfg, Electrical Equipment Mfg, and Agriculture, Construction, and Mining Machinery Mfg sectors →Increase	
6	Decreased Investment in Avoided Conventional Electricity Generation	Output and Demand Block →Exogenous Final Demand (amount) for Construction sector→Decrease Output and Demand Block →Exogenous Final Demand (amount) for Boiler and Tank Mfg sector and Engine, Turbine, and Power Transmission Equipment Mfg sector→Decrease	Negative
7	Increased Interest Payment of Financing Capital Investment	Output and Demand Block →Exogenous Final Demand (amount) for Monetary Authorities, Credit Intermediation sector→Increase	Positive
8	Renewable (Biomass) Fuel Inputs	Output and Demand Block →Exogenous Final Demand (amount) for Forestry sector→Increase Output and Demand Block →Proprietors' Income for Farm sector→Increase	Positive
9	Reduced Fossil Fuel Demand from Decreased NGCC Generation	Output and Demand Block →Exogenous Final Demand (amount) for Oil and Gas Extraction sector→Decrease	Negative
10	Avoided Annual Capital Cost or Debt Repayment of Utility Sector Ordinary Investment	Compensation, Prices, and Costs Block →Capital Cost (amount) of Electric Power Generation, Transmission, and Distribution sector →Decrease	Positive
11	Foregone Stimulus Effect of the Upfront Utility Sector Ordinary Investment	Output and Demand Block →Investment Spending on Producer's Durable Equipment and Demand of Goods and Services from Construction sector →Decrease	Negative
12	Foregone Productivity Improvement from Displaced Utility Sector Ordinary Investment	Labor and Capital Demand Block →Factor Productivity (Share)→ Electric Power Generation, Transmission, and Distribution sector →Decrease	Negative

APPENDIX F. ECR POLICY OPTION DESCRIPTIONS

Climate and Economic Development Project (CEDP)

Energy, Commerce and Resources (ECR) Options: Microeconomic Analysis

1. **Summary Table of Stand-Alone Policy Results and Integrated Cumulative Results**
2. **Identification of Policy Overlaps and Integration Issues**
3. **Example Completed Policy Option Documents**

Prepared by

Center for Climate Strategies (CCS)

For the

Southern California Association of Governments (SCAG)

INDEX

TABLES AND FIGURES

Section I. Introduction and Summary of Energy, Commerce and Resources (ECR) Policies and Results

Table I-1 provides a summary of the micro-economic analysis completed by CCS for the Clean and Economic Development Project (CEDP) ECR options that could be quantified based on available information. For the non-quantified options, it is possible that some, if not all, of these could be quantified once additional data and methods are identified. The results in Table I-1 are referred to as "stand-alone" results, since they represent the GHG reductions and costs that would occur if each was fully implemented separately without consideration of any overlaps with other policies.

The values presented in each column of Table I-1 are defined as follows:

- *2020 MMtCO$_2$e*: annual greenhouse gas (GHG) reductions for each policy in 2020 in million metric tons (MMt) of carbon dioxide equivalent (CO_2e) emissions;
- *2035 MMtCO$_2$e*: annual GHG reductions for each policy in 2035;
- *2012-2035 MMtCO$_2$e*: cumulative annual GHG reductions from 2012 to 2035;
- *$Million NPV 2012-2035 Cost/Cost Savings*: the net present value (NPV) of all costs and cost savings for each option from 2012-2035 in $2010. Negative values indicate a net savings to society due to implementation of the policy; and
- *$/tCO$_2$e:* this is the cost effectiveness (CE) calculated for each policy option in $2010 per metric ton of CO_2e reduced. It is derived by dividing the NPV cost/cost savings by the cumulative GHG reductions. Negative values indicate a net savings to society due to implementation of the policy.

At the bottom of Table I-1, the cumulative "stand-alone" results of all ECR policies are presented for all of the policies before adjusting for overlaps between policies. The totals for the "stand-alone" results are the sums of all values in the table columns. A cost-effectiveness value is not produced here because overlaps between the policies have not yet been addressed. Table I-2 identifies ECR policy options that have potential overlaps. The notes in Table I-2 provide an indication of what the overlap/interaction is and the estimated extent (GHG reductions and cost/cost savings that need to be removed from the "stand-alone" policy option results). After addressing all overlaps and interactions, the last row of Table I-1 provides the cumulative results after overlap adjustments. As shown, the total reductions expected annually by 2035 are 59.5 MMtCO$_2$e. The net present value of these policies represents an overall savings to society of about $3.2 billion. Cumulative GHG reductions for all policies are estimated to be 853 MMtCO$_2$e through the 2035 planning period. These cumulative costs and reductions from 2012 through 2035 yield a cost effectiveness of -$4/tCO$_2$e representing an overall savings to society.

Table I-3 provides a summary of the total overlap associated with each policy. As shown in this table, the ECR policies were not found to have a great deal of overlap. Policy overlaps can exist both within and between sectors. For example, utility demand-side management programs (DSM) covered in RCI-1 has overlap with the improved building codes for energy efficiency under RCI-2. An example of an intra-sector overlap is AFW-2a covering urban forest expansion and RCI-2. Since the main GHG benefit of urban forest expansion is gained through electricity savings due to lower residential and commercial cooling needs, these lower future energy demands need to be taken into consideration when estimating of their impact on the total RCI-2 GHG reductions.

In addition to policy overlaps, there are additional policy interactions that affect the total GHG reduction potential of some options. For example, there are several options that produce reductions in future electricity demand (RCI-1, -2, -6, AFW-1, -2a, -5b). The lower future demand as a result of implementing these options needs to be accounted for when quantifying the benefits of ES options. The electricity savings/generation of these options was all integrated into the electricity supply load and generation forecasts. Hence, the results shown for the stand-alone ES analysis already capture the interaction with these RCI and AFW options.

Table I-1. Stand-Alone Results of ECR Micro-Economic Analysis

Policy Option Number	Policy Option Description	2020 ($MMtCO_2e$)	2035 ($MMtCO_2e$)	2012-2035 ($MMtCO_2e$)	Net Present Value (million 2010$, 2012-2035 Cost / Cost Savings*	Cost-Effective-ness ($\$/tCO_2e$)*
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				

Policy Option Number	Policy Option Description	2020 ($MMtCO_2e$)	2035 ($MMtCO_2e$)	2012-2035 ($MMtCO_2e$)	Net Present Value (million 2010$, 2012-2035 Cost / Cost Savings*	Cost-Effective-ness ($\$/tCO_2e$)*
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. $\$/tCO_2e$ stands for dollars per metric ton of carbon dioxide equivalent.

Table I-2. Identified ECR Policy Overlaps and Integration Issues

Policy Number	Policy Option Title	Overlaps with Policy Number	Policy Option Title	Notes
AFW-2a	Improve Urban Forestry and Green Space Management through Expansion and Effective Management: Urban Forestry	RCI-2	Improved Building Codes for Energy Efficiency	65% of AFW-2a GHG reductions (mostly from urban tree shading) are removed from RCI-2 to eliminate potential double counting that would result from implementation of AFW-2a which results in lower heat gain in residential and low-rise commercial buildings.
ES-1	Central Station Renewable Energy Incentives including Project Development Barrier Removal Issues	Multiple RCI and AFW Options	All RCI and AFW Options covering energy efficiency and renewable energy	The RCI and AFW estimated energy efficiency and renewable energy generation MWh are included in the ES-1 future load forecast; so, these interactions are addressed in the ES-1 stand-alone analysis.

Table I-3. Estimates of GHG Reduction Overlap Among ECR Policies

Policy Option Number	Policy Option Description	2020 ($MMtCO_2e$)	2035 ($MMtCO_2e$)	2012-2035 ($MMtCO_2e$)	Net Present Value (million 2010$, 2012-2035 Cost / Cost Savings	Description
		Total Overlap for Removal				
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	0.00	0.00	0.00	0.00	No additional interaction/overlap identified.
RCI-2	Improved Building Codes for Energy Efficiency	0.03	0.18	1.73	883.4	65% of AFW-2a GHG reductions (mostly from urban tree shading) are removed from RCI-2 to eliminate potential double counting that would result from implementation of AFW-2a which results in lower heat gain in residential and low-rise commercial buildings.
RCI-3	Incentives for Renewable Energy Systems at Residential, Commercial, and Industrial Sites	0.00	0.00	0.00	0.00	This option doesn't address the renewable energy projects targeted for the agriculture sector as addressed in option AFW-5a.
RCI-4	Consumer, Student, and Decision-maker Education Programs	0.00	0.00	0.00	0.00	No additional interaction/overlap identified.
RCI-5	GHG Emissions Reductions through Changes in Goods Production, Sourcing, and Delivery	0.00	0.00	0.00	0.00	No additional interaction/overlap identified.
RCI-6	Increase Water Recycling and Water End-use Efficiency and Conservation Goals and Programs	0.00	0.00	0.00	0.00	This option covers water end use only in the residential and commercial sectors; so no overlap with AFW-1.
ES-1	Central Station Renewable Energy Incentives including Project Development Barrier Removal Issues	0.00	0.00	0.00	0.00	Energy efficiency savings from RCI and AFW are subtracted from forecasted loads in the ES-1 Stand-Alone analysis; hence, the interaction is already addressed in the stand-alone estimates for ES-1.
ES-2	Customer Sited Renewable Energy Incentives and/or Barrier Removal	0.00	0.00	0.00	0.00	Renewable energy projects under AFW-5 are small enough that any overlap is considered to be negligible.
ES-3	Transmission System Upgrading, Reduce Transmission and Distribution Line Loss	0.00	0.00	0.00	0.00	No additional interaction/overlap identified.

Policy Option Number	Policy Option Description	2020 ($MMtCO_2e$)	2035 ($MMtCO_2e$)	2012-2035 ($MMtCO_2e$)	Net Present Value (million 2010$, 2012-2035 Cost / Cost Savings	Description
		Total Overlap for Removal				
ES-4	CCSR Incentives and Infrastructure including R&D and Enabling Policies	0.00	0.00	0.00	0.00	No additional interaction/overlap identified.
ES-5	Public Benefits Charge Funds	0.00	0.00	0.00	0.00	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	0.00	0.00	0.00	0.00	No additional interaction/overlap identified.
AFW-1	Improve Agricultural Irrigation Efficiency	0.00	0.00	0.00	0.00	No additional interaction/overlap identified.
AFW-2a	Improve Urban Forestry and Green Space Management through Expansion and Effective Management: Urban Forestry	0.00	0.00	0.00	0.00	No additional interaction/overlap identified beyond the adjustment documented under RCI-2
AFW-5a	Increase On-Farm Energy Efficiency & Renewable Energy Production: Renewable Energy	0.00	0.0	0.00	0.00	No additional interaction/overlap identified.
AFW-5b	Increase On-Farm Energy Efficiency & Renewable Energy Production: Energy Efficiency	0.00	0.0	0.00	0.00	No additional interaction/overlap identified.
Total Estimated Adjustment for Policy Overlaps		**0.03**	**0.2**	**1.7**	**883.4**	These values are subtracted from the stand-alone results in Table I-1.

Section II. Residential, Commercial and Industrial (RCI) Policy Options

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 (e.g. Energy Trust)

Policy Description

Demand-side management (DSM) programs are designed to assist energy users in reducing or changing the timing of their energy use. This policy option focuses on increasing investment in effective electricity and gas DSM programs, which might be run by utilities (including investor-owned utilities, municipal utilities, and cooperatives) or non-utility third parties (either governmental or non-governmental). Expanded investment is supported by collection of energy efficiency funds and/or energy efficiency goals. DSM programs may be designed to work in tandem with other strategies that can also encourage efficiency gains.

Policy Design

Goals or Level of Effort:

The public and investor-owned utilities of the SCAG region are assumed to fulfill the goals of California Assembly Bill 2021 (AB2021), which mandates that utilities achieve 10% consumption reduction (which we assume to be net of any decay in efficiency savings over time) relative to forecast demand within the period 2011 through 2020. It is assumed that this rate of savings continues throughout the modeling period (through 2035). This level of savings is assumed to apply to both electric and gas utilities in the SCAG region, but is not applied to the (relatively modest) use of petroleum products and other fuels in the RCI sectors. The AB2021 target is referenced, for example, in the California Energy Commission (CEC) DRAFT STAFF REPORT: ACHIEVING COST-EFFECTIVE ENERGY EFFICIENCY FOR CALIFORNIA 2011–2020 (CEC-200-2011-007-SD), dated July, 2011, and available as http://www.energy.ca.gov/2011publications/CEC-200-2011-007/CEC-200-2011-007-SD.pdf.

Timing (Start, Phase In, End):

Given that substantial energy efficiency programs are already underway in most of the utilities of the SCAG region, no "ramp-in" for the goals above is assumed. Savings at a level of 1% of forecast demand per year is assumed to start in 2011, and to continue such that cumulative energy savings relative to forecast electricity and gas demand in target years equals 10% after 10 years (by 2020), and 25% by 2035. It is further assumed that the impacts of energy efficiency programs in the SCAG region carried out prior to 2011 are included in the base CEC forecasts that underlie the CCS forecast of electricity demand in the SCAG region, and these impacts are thus not accounted for in quantifying this option.

Parties Involved:

- Public and investor-owned utilities in the SCAG region
- Residential, Commercial, and Industrial utility customers (defined as all non-residential or commercial consumers of electricity, not including the portion of utility demand forecast for use in charging electric vehicles)
- Authorities regulating, overseeing, and evaluating utility energy efficiency programs.
- Vendors, engineers, third-party efficiency providers, and others likely to be involved in helping to deliver utility- or public benefits charge-driven energy efficiency programs.

Other: Not Applicable

Type(s) of GHG Reductions

GHG emissions associated with electricity generation, and those associated with natural gas transmission/distribution and end-use.

Estimated Net GHG Reductions and Net Financial Costs or Savings

Quantification results for RCI-1 are summarized in the table below.

GHG Reductions ($MMtCO_2$)			Net Present Value (million 2010$)*	Cost-Effectiveness ($/$tCO_2$)*	Grid Electricity Reduction (GWh, 2010-2035)	Natural Gas Use Reduction (TBtu, 2010-2035)	Oil Products Use Reduction (TBtu, 2010-2035)
2020	2035	Total (2010-2035)					
8.6	24.2	297.0	-$5,652	-$19	476,717	1,448	0

* Negative values represent a net cost savings. $/$tCO_2e$ stands for dollars per metric ton of carbon dioxide equivalent.

Data Sources: Information sources identified and used, in addition to those noted above, included:

- Reports on energy efficiency programs to the CPUC by SCAG-area utilities, for example, file SCE.MN.201112.1.xls and file SCG.MN.201112.1.xls, downloaded from http://eega.cpuc.ca.gov/Documents.aspx.
- California Municipal Utilities Association (CMUA, 2011), Energy Efficiency in California's Public Power Sector: A Status Report, dated March 2011, available as http://www.ncpa.com/images/stories/LegReg/2011%20SB1037%20Report_Final_%2803162011%29.pdf.
- PRELIMINARY CALIFORNIA ENERGY DEMAND FORECAST 2012-2022, California Energy Commission, August, 2011. http://www.energy.ca.gov/2011publications/CEC-200-2011-011/CEC-200-2011-011-SD.pdf.
- California Energy Commission forecasts of energy demand by utility area, workbooks dated August, 2011, and downloaded from http://www.energy.ca.gov/2011_energypolicy/documents/2011-08-30_workshop/mid-case/.

Quantification Methods:

The overall approach used for quantification of this option was as follows:

1. Adopt the AB2021 target as interpreted in the CEC document referenced in the 2011 CEC document referenced above under "Policy Design" (CEC-200-2011-007-SD), making the assumption that the target refers to net cumulative savings to be achieved in future years.
2. Calculate the required net GWh and TBtu savings in each year by applying the percentage targets to forecast RCI electricity and natural gas demand (not including power use for charging electric vehicles).
3. Apply a factor to compensate for the limited lifetime of energy efficiency measures included in programs to estimate the average contribution of each year's energy efficiency investments to cumulative energy efficiency savings.
4. Estimate the cost to utilities by applying estimates of first-year energy savings per unit program investment as experienced by the large SCAG utilities (Southern California Edison—SCE, the Los Angeles Department of Water and Power—LADWP, and Southern California Gas—SCG)

during approximately 2010, as derived from California Public Utilities Commission and California Municipal Utilities Association documents.

5. Estimate the fraction of utility revenues required for energy efficiency investments by first calculating estimated revenues (as forecast energy demand multiplied by CEC estimates of future electricity and gas prices for the major utilities of the SCAG region), then dividing the annual utility costs of energy efficiency programs by the estimates of total annual revenue.
6. Apply estimates of average levelized costs per kilowatt-hour (kWh) and MMBtu of energy saved, derived from energy efficiency potential studies for utilities operating in the SCAG region where available, to net savings estimates to estimate a Total Resource Cost-based average costs of saved electricity and gas.
7. Estimate the MW savings implied by the electrical energy savings by applying a factor derived from the reports of approximately 2010 energy efficiency program effectiveness in the source documents used for Step 4.
8. Estimate the total electricity and gas supply costs avoided by the savings produced by the energy efficiency programs.
9. Estimate the total GHG savings by applying emission factors to electricity and gas savings estimates. The emission factors are derived from the CCS inventory and forecasts for GHGs emissions from electricity supply and from fuels combustion, respectively.
10. Summarize the total net costs (avoided energy supply costs less costs of saved energy) and emissions benefits, and report net costs per unit of GHG saved.

Key Assumptions: As noted above.

Key Uncertainties

Though energy efficiency improvements catalyzed by DSM programs offered by utilities in the SCAG region have shown the potential to reach the level of savings assumed for this option, it remains to be seen if new annual savings at the level include here can be sustained through 2035.

Additional Benefits and Costs

The programs included in this option can be expected to play significant roles in developing and sustaining markets for energy-efficiency devices and services (and thus job creation in these areas), in contributing toward reduction of criteria air pollutant emissions from buildings and power plants, and to reducing water use in the SCAG region, among other benefits.

RCI-2 Improved Building Codes for Energy Efficiency

Policy Description

Building energy codes specify minimum energy efficiency requirements for new buildings or for existing buildings undergoing a major renovation. Given the long lifetime of most buildings, amending state and/or local building codes to include minimum energy efficiency requirements and periodically updating energy efficiency codes can provide long-term GHG savings. Implementation of building energy codes can require additional resources, particularly for effective energy code enforcement.

Policy Design

The following measures identified in the AB 32 Scoping Plan to reduce GHG emissions from building energy use will be implemented in the SCAG region under this option consistent with projections for statewide implementation:

1. Green Building Standards Code: On January 12, 2010, the Building Standards Commission (BSC) unanimously adopted the 2010 California Green Building Standards Code (CalGREEN) with amendments. CalGREEN 2010 includes mandatory measures that support the goals of the State's greenhouse gas reduction and building energy efficiency programs, as well as promote healthful indoor and outdoor air quality. CalGREEN 2010 includes voluntary "reach" standards, which offer model building code language for local governments to adopt more advanced measures beyond the mandatory measures. The 2010 Green Building Standards Code will be published by July 1, 2010 and will go into effect on January 1, 2011. (http://www.documents.dgs.ca.gov/bsc/CALGreen/2010_CA_Green_Bldg.pdf)

2. Beyond Code: Encourage voluntary efforts to go beyond mandatory code requirements (SCAG Cities such as West Hollywood, Riverside, and Anaheim have adopted local green building programs that go beyond CalGREEN): Cities and counties are essential partners contributing significantly to California's efforts to reduce greenhouse gas (GHG) emissions. Several local municipalities are already taking action to be part of the solution to address climate change. Many of these municipalities have enacted policies, ordinances, and guidelines that mandate or encourage green building in commercial and residential developments to increase energy efficiency and reduce GHG emissions. They have the authority to establish more restrictive standards that exceed the mandatory measures in the CALGreen because of local climatic, geological, or topographical conditions. (more information at http://www.arb.ca.gov/cc/localgovernment/localgovernment.htm)

3. Existing Building Retrofits/Retrofit existing State, school, residential and commercial buildings: Since 1978, new buildings in California have been required to implement increasingly stringent energy efficiency measures, saving home and business owners over $56 billion in energy costs. However, there has been no requirement to improve the energy efficiency of three quarters of California's 13 million residential buildings and five billion square feet of non-residential structures that were built before 1978. These older buildings offer a large and cost effective opportunity to reduce energy use, cost, pollution and greenhouse gas emissions. Based on the California Energy Commission's analysis, 15% to 18% of 2005 statewide electricity and natural gas energy consumption could be saved by making improvements to existing structures. The Scoping Plan aims to achieve 20 $MMtCO_2e$ of ANNUAL greenhouse gas emission reductions by 2020 statewide from making existing structures more energy efficient.

Goals or Level of Effort: This option will is designed to achieve SCAG-region greenhouse gas emissions savings from buildings energy use roughly consistent with the statewide AB32 Scoping Plan goals The measures identified in the AB 32 Scoping Plan (as presented in http://www.arb.ca.gov/cc/greenbuildings/greenbuildings.htm) are anticipated to reduce GHG emissions from buildings at the following levels statewide as of 2020:

Green Building Codes = 2.9 $MMtCO_2e$

Beyond Code = 3.6 $MMtCO_2e$

Existing Building Retrofits = 20 $MMtCO_2e$

After 2020, it is assumed that actions in each of these areas continue so as to yield additional savings of approximately the same magnitude by 2035. That is, activities in the SCAG region will yield total savings during 2021-2035 consistent with statewide savings from the three areas of 26.5 $MMtCO_2e$. This represents a decline in annual savings from those implied for 2012-2020, but reflects the probably increased difficulty of achieving savings over time.

Timing (Start, Phase In, End):

The 2010 Green Building Standards Code will be published by July 1, 2010 and will go into effect on January 1, 2011. The next update of Title 24 will be effective January 1, 2014. Implementation of the Code in SCAG will be consistent with implementation statewide. Similarly, implementation of other elements of this option is assumed to be timed in a manner consistent with the statewide AB32 Scoping Plan measures described above.

Parties Involved:

Affected: local governments, state agencies constructing new buildings

Implementation: California Department of General Services, California Building Standards Commission, California Department of Housing and Community Development, California Energy Commission, Public Utilities Commission, State Architect

Other: Not Applicable

Type(s) of GHG Reductions

GHG emissions associated with electricity generation, those associated with natural gas transmission/distribution and end-use, and, to a lesser extent, emissions associated with oil products use in buildings.

Estimated Net GHG Reductions and Net Financial Costs or Savings

Quantification results for RCI-2 are summarized in the table below[1].

GHG Reductions ($MMtCO_2$)			Net Present Value (million 2010$)*	Cost-Effectiveness ($/$tCO_2$)*	Grid Electricity Reduction (GWh, 2010-2035)	Natural Gas Use Reduction (TBtu, 2010-2035)	Oil Products Use Reduction (TBtu, 2010-2035)
2020	2035	Total (2010-2035)					
6.6	25.3	263.8	-$1,438	-$5	414,315	1,224	103

* Negative values represent a net cost savings. $/$tCO_2e$ stands for dollars per metric ton of carbon dioxide equivalent.

[1] Please note that though this option overlaps somewhat in scope with other RCI options, the results shown here are not adjusted to reflect those overlaps. Totals adjusted for overlaps are presented in the summary all-sector ECR table provided in this Report.

Data Sources: Information sources noted above were used, along with a number of other Southern California, statewide, and national references on relevant topics.

Quantification Methods:

The overall approach used for quantification of this option was as follows:

1. Some, albeit incomplete, background information was obtained on the statewide "Green Buildings" estimates referenced above, and how they were prepared, probably from the California Air Resources Board (ARB).
2. Using consideration of the portion of the estimated statewide reductions above that would be likely to occur in the SCAG region as a rough guide, progressively stringent savings goals per-unit (per residence or floor area) were assumed for the years both before and beyond 2020 (see above) in three option areas—building codes, "beyond code" measures for new buildings, and improvements in existing buildings—for electricity, gas, and oil products end-uses related to building energy use in the residential, commercial, and (for non-process energy) industrial sectors. Estimates of energy use reductions and GHG reductions for the years 2021 through 2035 for the SCAG region were prepared for each element of the option.
3. Estimates of the net costs of building energy improvements were adapted for the three categories of reductions described above from regional studies, for electricity and for gas and oil products use. These cost estimates were expressed as levelized costs of saved energy for electricity and for gas (and oil).
4. Reporting as needed for input to SCAG-area REMI model was prepared.

Key Assumptions:

- Implementation of building energy measures consistent with statewide goals.
- Future growth in households/housing consistent with of Southern California Association of Governments (SCAG) GROWTH FORECAST APPENDIX, Regional Transportation Plan, 2012-2035, adopted April, 2012, and available as http://rtpscs.scag.ca.gov/Documents/2012/final/SR/2012fRTP_GrowthForecast.pdf.
- Growth in commercial building floor area as projected by the California Energy Commission through 2022, with growth in years through 2035 assumed to be at the same rate as growth in years 2017-2022.
- Energy efficiency improvement through improved building codes of 20% for electricity and 8% for natural gas relative to current practice.
- Energy efficiency through retrofitting of existing buildings equal to 50% of current per-unit energy use by 2035, and covering 50% of existing buildings.
- "Beyond code" improvements in 75% of new buildings such that the efficiency of 75% of new buildings exceed existing practice/codes by over 50% by 2020, and by over 90% of purchased power, gas, and oil (factoring in contributions from on-site renewable energy and "green power" purchases) by 2035.

Key Uncertainties

The major uncertainties in the analysis are related to the rates of participation in each element of the option, and the rate of energy savings/purchased energy displacement actually achievable.

Additional Benefits and Costs

The types of activities needed to improve building energy efficiency are especially good for the local economy. Such activities, referred to as “retrofitting” when applied to existing buildings, generate local construction employment, support retailers who provide needed services and materials, and keep more dollars circulating in the local economy. This option also has strong synergies with efforts to reduce water use, and to produce compact dwelling units that offer advantages related to transport energy use.

RCI-3 Incentives for Renewable Energy Systems at Residential, Commercial, and Industrial Sites

Policy Description

Distributed electricity generation sited at residences and commercial and industrial facilities, and powered by renewable energy sources (typically solar, but also wind, small hydroelectric power sources, or biomass or biomass-derived fuels), displaces fossil-fueled generation and avoids electricity transmission and distribution losses, thus reducing GHG emissions. This policy can also encourage consumers to switch from using fossil fuels to renewable fuels in such applications as water, process, and space heating, as well as to supply new energy services using fuels that produce low or no GHG emissions. Increasing the use of renewable energy applications in homes, businesses, and institutions in the SCAG region can be achieved through a combination of new and augmented regulatory changes and financial incentives.

Policy Design

The goal of increasing the use of renewable energy in homes, businesses, and institutions in the SCAG region includes both increasing the use of customer-sited renewable energy systems for electric power generation, and increasing the use of customer-sited non-electric renewable energy systems, for example, to provide space, process, or water heat.

With respect to customer-sited renewable energy systems for power generation, the goals and design of this policy are identical to those in option ES-2 "Customer Sited Renewable Energy Incentives and/or Barrier Removal". Please see the summary of ES-2 for further information on this element of the RCI-3 option.

With respect to customer-sited renewable energy systems for heating (or absorption cooling) end-uses, the goals of this are designed to be consistent with the California Solar Initiative (see for example, CALIFORNIA SOLAR INITIATIVE-THERMAL Program Handbook, by the California Public Utilities Commission (CPUC), dated February, 2012, and available as http://www.gosolarcalifornia.ca.gov/documents/CSI-Thermal_Handbook.pdf).

Goals or Level of Effort: Note that goals listed here focus on the non-electric renewable energy measures not covered in ES-2. The goals of this option are to implement in the SCAG region non-electric customer-sited renewable energy systems consistent with statewide plans and legislation. An example is AB 1470, the Solar Thermal Heating Act of 2007, which calls for "installation of 200,000 solar water heating systems in homes and businesses throughout the state by 2017". For this and other statewide non-electric renewable energy goals, this option assumes implementation in the SCAG region at a rate sufficient to be consistent with statewide goals in the years for which goals are specified. The implied rates of renewable energy systems implementation are assumed to be continued past the goal year (2017) specified in statewide plans (listed as the equivalent of 200,000 residential solar water heaters statewide displacing gas-fired water heat, and 100,800 solar water heaters displacing electric units) and through 2035.

Timing (Start, Phase In, End): See above.

Parties Involved:

- Residential, commercial, institutional and industrial consumers of water heat, process heat, and space heating and cooling (and for rental properties, building owners).
- Property developers, builders, and designers.
- Local, state and federal agencies associated with renewable energy deployment.
- Gas and electric utilities serving the SCAG area.
- Vendors, suppliers, designers, manufacturers, and installers of renewable energy systems.

- Financial institutions/financing agencies (private and public).

Other: Not applicable.

Type(s) of GHG Reductions

GHG emissions associated with electricity generation, and those associated with the transmission/distribution and end-use of natural gas and other fuels whose use is displaced by renewable energy systems, net of any GHG emissions from the renewable energy systems themselves (for biomass-fired systems).

Estimated Net GHG Reductions and Net Financial Costs or Savings

Quantification results for RCI-3 are summarized in the table below[2].

GHG Reductions ($MMtCO_2$)			Net Present Value (million 2010$)	Cost-Effectiveness ($/tCO_2$)	Grid Electricity Reduction (GWh, 2010-2035)	Natural Gas Use Reduction (TBtu, 2010-2035)	LPG Use Reduction (TBtu, 2010-2035)
2020	2035	Total (2010-2035)					
0.2	0.4	5.1	$325	$63	6,112	45	1.9

Data Sources: Information sources noted above and below were used to inform the analysis, along with other documentation.

- California Solar Energy Industries Association (2009), The Value Proposition of Solar Water Heating In California, available as http://www.seia.org/galleries/pdf/CALSEIA_Report_SWH_Value_Proposition.pdf.
- California Public Utilities Commission (CPUC, 2010), DECISION ESTABLISHING THE CALIFORNIA SOLAR INITIATIVE THERMAL PROGRAM TO PROVIDE SOLAR WATER HEATING INCENTIVES, available as http://docs.cpuc.ca.gov/PUBLISHED/FINAL_DECISION/112748.htm#P80_1949.
- Center for Sustainable Energy Solar Water Heating Pilot Program Final Evaluation Report, Itron, Inc., dated March 30, 2011, and available as http://energycenter.org/index.php/incentive-programs/solar-water-heating/swhpp-documents/doc_download/727-swh-pilot-program-itron-final-evaluation-report

Quantification Methods:

The overall approach to evaluating the impacts of this option was as follows:

1. Adopt statewide estimate of the number of units deployed for a program of renewable energy system deployment of solar water heating technologies in the residential and commercial sectors.
2. Extend the statewide estimates by extrapolation or assumption through the end of the analysis period (2035).
3. Adapt the estimate of solar water heater deployment to the SCAG region using the relative forecasts of electricity and natural gas consumption in the SCAG region and in California as a whole by sector (residential and commercial) and by fuel (electricity, natural gas, and liquefied petroleum gas—LPG).

[2] Please note that though this option overlaps somewhat in scope with other RCI options, the results shown here are not adjusted to reflect those overlaps. Totals adjusted for overlaps are presented in the summary all-sector ECR table provided in this Report.

4. Use the resulting estimate for policy results in the SCAG region to estimate the energy saved by fuel by year and by sector for solar water heat.
5. Estimate the costs of providing heat using solar water, with levelized costs derived based on estimates of incremental capital costs for renewable versus conventional technologies.
6. Apply emission factors for avoided electricity, natural gas, and LPG use to estimate the net GHG emissions impacts by year and by sector for the technologies included in the analysis, totaling emissions by sector.
7. Apply avoided electricity, gas, and LPG costs (as developed for general use on all RCI options) to estimate the avoided fuel costs estimates for the technologies included in the analysis, reporting fuel cost savings by year and by sector.
8. Calculate total GHG emissions savings and net costs for the non-electric elements of RCI-3.

Key Assumptions: As noted above, and:

- The deployment of solar water heater by sector is estimated based roughly on participation rules for the California Solar Initiative (55% in the residential sector, of which 25% is in multi-family dwellings, and 45% in the commercial sector).
- Federal solar tax credits are applied through 2016, when they are scheduled to "sunset".
- Average solar water heater capital costs decline by 2.67% annually through 2017, as targeted by the California Solar Initiative, and are then assumed to decline at 1% per year (in real terms) through 2035.
- Solar water heater capital costs are assumed to be amortized over 25-year unit lifetimes, at an interest rate of 5% per year.

Key Uncertainties

Key uncertainties include the trajectory of future costs for solar water heaters, and the rate of deployment of the program. Note, however, that the penetration rates assumed by the California Solar Initiative are actually not particularly aggressive relative to the potential for this technology in the SCAG region.

Additional Benefits and Costs

Additional benefits of this option can be expected to include stimulation of the local economy through employment of installers and manufacturers, and keeping more dollars circulating in the local economy. This option also has strong synergies with efforts to reduce water and building energy use, and helps to build additional value in the buildings sector.

RCI-4 Consumer, Student, and Decision-maker Education Programs

Policy Description

The ultimate effectiveness of emission reduction activities in many cases depends on providing information and education to both present and future consumers regarding the energy and GHG emissions implications of consumer choices. Public education and outreach is vital to fostering a broad awareness of climate change issues and effects (including co-benefits, such as clean air and public health) among the region's citizens, young and old alike. Such awareness is necessary to engage citizens in actions to reduce GHG emissions in their personal and professional lives. Likewise, education of primary and secondary school students regarding the energy and GHG emission implications of consumer and societal choices helps to engage the younger generation in mitigating climate change.

Policy Design

Elements of this Option may include:

- Energy efficiency and related education courses introduced at community colleges and trade schools to help build a workforce to staff climate change mitigation-related efforts.
- Mount consumer education programs related to greenhouse gas emissions reduction and climate.
- Provide funding to meet the expanding role of local and state agencies in providing consumers with information on greenhouse gas reduction.
- Emphasize provision of resources directing consumers to information and technologies for energy-efficiency and climate impacts reduction.
- Introduce climate-related topics in school curricula, including providing resources for curriculum development.
- Assure the availability of sufficient training for required professional trades, including training of building code and other officials in energy code enforcement, energy management training/training of building operators, training and education for builders and contractors (such as in HVAC sizing, duct sealing building energy analysis, waste recycling, renewable energy system installation, and enhancement of water distribution systems) to support other greenhouse gas emissions reduction efforts.

Goals or Level of Effort: Implement training and education as described above in support of other ECR, TLU, and TSI options. When implemented, more quantitative goals may be defined for the activities included in this option, such as number of persons trained in a given topic area. For example, goals can be quantified by identifying the number of trade professionals who go through a training program each year, the number of credits/courses offered, the number of students reached, or the fractions of applicants receiving specific types of training, or investment outlays for specific types of training.

Timing (Start, Phase In, End): Education programs should be deployed with timing consistent with the needs to support other ECR, TLU, and TSI activities.

Parties Involved: Parties likely to play roles in this option include (but are not limited to):

- Energy and water utilities serving the SCAG area (as providers/funders of information campaigns)
- Retailers and service providers
- Climate and energy efficiency advocacy groups
- Local and State government agencies
- Educators at the K-12, community/junior college, and university levels

- Students and consumers/homeowners
- Building trade and related professionals

Other: Not applicable.

Type(s) of GHG Reductions

This option can be expected to support the attainment of emissions reductions targeted by other ECR, TLU, and TSI options.

Estimated Net GHG Reductions and Net Financial Costs or Savings

As this option is primarily designed to be in support of other emissions reduction efforts, its impacts and costs have not been quantitatively evaluated.

Key Uncertainties

Not directly applicable.

Additional Benefits and Costs

Education programs related to emissions reduction provide jobs in the local community and enhance the effectiveness of other environmental sustainability efforts.

RCI-5 GHG Emissions Reductions through Changes in Goods Production, Sourcing, and Delivery

Policy Description

A region's choices in how goods consumed in the region are produced, sourced, and transported can affect the greenhouse gases emitted per unit of product consumed. Likewise, the ways that goods exported from a region are produced and transported also have greenhouse gas implications. The region can engage in outreach activities and voluntary partnerships with industry and consumer groups to promote the reduction of greenhouse gas emissions throughout the supply chain, applying innovation and concepts such as systems-based analysis to reduce GHG emissions from production. Other possible elements that could be promoted or strengthened through this option include by-product synergy, in which waste streams from one industry or process are used as a resource for another, certification (formal or informal) of products as coming from local sources (farms or factories, for example), labeling of products to indicate reduced GHGs emissions throughout the product supply chain, and the preference of local bids for products purchased by government agencies or others so as to reduce GHGs from goods transportation.

Policy Design

Elements of this policy may include[3]:

- Development of a "product stewardship" framework that provides, for example, requirements that producers or others finance and provide product stewardship programs that provide environmentally-sound collection, transportation, reuse, and either recycling or disposal (as appropriate) of selected products, and an effective approach for decreasing GHG generation, with language to encourage the design of products that are less toxic, more recyclable, more energy efficient, and have lower GHG emissions during the product's lifecycle, a process for building markets for the recyclable materials.
- Development and deployment of processes for the evaluation of product performance.
- Packaging reduction and food waste reduction.
- Support revisions to public sector purchasing laws to ensure that products and services used by government have the lowest possible environmental and carbon footprint.
- Expand, recruit or develop in-state businesses that use recyclable materials in their manufacturing processes.
- Determine actions to expand byproduct synergy, zero waste business practices, design for the environment and other emerging commercial activities and encourage consumer demand for these activities.

Goals or Level of Effort: Goals and level of effort in support of the actions suggested above have yet to be determined.

Timing (Start, Phase In, End): To be determined.

Parties Involved: The parties involved in this option could include a large range of different organizations, from product manufacturers to consumer/consumer advocacy groups, small business

[3] Adapted from Actions 1B, 2A, 2B, and 4, starting on pages 7, 25, 27, and 30 of Appendix 5, "Beyond Waste IWG Report", a part of the document Leading the Way: Implementing Practical Solutions to the Climate Change Challenge, by the State of Washington Climate Action Team, dated November, 2008 (available as http://www.ecy.wa.gov/climatechange/2008CATdocs/ltw_app_v2.pdf).

organizations, local farming movements, government agencies, transport organizations, solid waste management firms and organizations, and industrial firms.

Other: Not applicable.

Type(s) of GHG Reductions

This option is likely to reduce emissions of range of greenhouse gases, including those related to energy consumption and solid waste management, as well as non-energy GHGs emitted during production of goods and services.

Estimated Net GHG Reductions and Net Financial Costs or Savings

The impacts and costs of this option have not been quantitatively evaluated.

Key Uncertainties

Not directly applicable.

Additional Benefits and Costs

This option is likely to provide additional benefits related to enhance local production and employment, reduced volumes of traffic, solid wastes, and other pollutants, and development of innovative business models.

RCI-6 Increase Water Recycling and Water End-use Efficiency and Conservation Goals and Programs

Policy Description

Apart from issues associated with the shortage of fresh water itself, provision of fresh water in the SCAG region, and treatment of wastewater, requires significant inputs of energy and is thus responsible for significant greenhouse gas emissions. Increasing water recycling and improving the end-use efficiency and conservation of water can help to reduce GHG emissions associated with water delivery and treatment. Encouraging and providing incentives for increased water conservation and efficiency of use, both to reduce water imports and protect groundwater reserves, are also included in this option, again with implications for GHG emissions associated with water transport, treatment, and wastewater treatment.

Policy Design

For this option, water conservation, efficiency, recycling, and related measures will be implemented in the SCAG region consistent with the following statewide initiatives:

- The California Department of Water Resources (DWR) has developed a "20x2020" Water Conservation Program, which establishes a Baseline and Target for reducing statewide per capita urban water use by 20% by 2020. This program was later augmented by SB X7-7 Water Conservation Act of 2009, which includes water conservation and water use efficiency for BOTH urban and agricultural water uses.
- In 2010, DWR's Urban Water Management Plan guidelines were revised to include a Climate Change Element addressing the water-energy nexus.
- Also, in 2011 the State Water & Energy Team (CPUC, CEC, DWR, State Water Resources Control Board (SWRCB)) was implementing the Governor's Water & Energy Policy Initiative, of 6 Measures including 5 mitigation measures and one financing measure: Recycled water, water use efficiency, water system efficiency, storm water capture & reuse & low-impact development, renewable energy generation in the water sector, and the development of a public goods charge for water.
- The CPUC in 2011 opened a rulemaking process to develop a comprehensive policy framework for recycled water for investor-owned water companies
- The California Energy Commission (CEC) has a current investigation underway into the energy intensity of the water system, including water conservation and subsequent energy conservation, with an expected GHG reduction of 2 $MMtCO_2e$ in 2020.

Goals or Level of Effort: Meet DWR's Urban water use goal of 20% per capita reduction in Urban water use by 2020, with extrapolation of this goal at a reduced rate of 1% of water saved per year through 2035.

Timing (Start, Phase In, End): As described above.

Parties Involved:

- Investor-owned water companies
- State agencies; local agencies tasked with regulating water use and wastewater treatment, and/or with developing, managing, and/or funding water efficiency and related programs
- Wastewater treatment authorities
- Residential, commercial, institutional and industrial users of water
- Vendors, installers, and manufacturers of water end-use technologies (including appliances)

- Conservation organizations

Other: Not applicable

Type(s) of GHG Reductions

Avoided emissions will include emissions related to electricity use for water and wastewater pumping or treatment, and/or for fossil-fueled water pumping, as well as for heating water in homes and businesses. Some non-energy-related (such as methane) emissions may also be reduced, to the extent that wastewater quantities to be treated are reduced.

Estimated Net GHG Reductions and Net Financial Costs or Savings

Quantification results are summarized in the table below for RCI-6[4].

GHG Reductions ($MMtCO_2$)			Net Present Value (million 2010$)	Cost-Effectiveness ($/$tCO_2$)	Grid Electricity Reduction (GWh, 2010-2035)	Natural Gas Use Reduction (TBtu, 2010-2035)	Oil Products Use Reduction (TBtu, 2010-2035)
2020	2035	Total (2010-2035)					
3.4	6.6	92.3	-$5,982	-$65	162,292	425	0

* Negative values represent a net cost savings. $/$tCO_2e$ stands for dollars per metric ton of carbon dioxide equivalent.

Data Sources: Information sources noted as above and below were used, along with other documentation as available and needed.

- California Energy Commission Public Interest Energy Research Program (2006), REFINING ESTIMATES OF WATER RELATED ENERGY USE IN CALIFORNIA, dated December 2006, available as http://www.energy.ca.gov/2006publications/CEC-500-2006-118/CEC-500-2006-118.PDF.
- California Air Pollution Control Officers Association (CAPCOA, 2010), Quantifying Greenhouse Gas Mitigation Measures, dated August, 2010, and available as http://www.capcoa.org/wp-content/uploads/2010/11/CAPCOA-Quantification-Report-9-14-Final.pdf. The report includes the following Table II-1 (which comes from the CEC document listed above):

Table II-1. Water Intensity

	Indoor Water Uses		Outdoor Water Uses	
	Northern California	Southern California	Northern California	Southern California
	kWh/MG			
Water Supply and Conveyance	2,117	9,727	2,117	9,727
Water Treatment	111	111	111	111
Water Distribution	1,272	1,272	1,272	1,272
Wastewater Treatment	1,911	1,911	0	0
Regional Total	5,411	13,022	3,500	11,111

Note: Based on Table ES-1 from CEC. 2006. Refining Estimates of Water-Related Energy Use in California, CEC-500-2006-118.

[4] Please note that though this option overlaps somewhat in scope with other RCI options, the results shown here are not adjusted to reflect those overlaps. Totals adjusted for overlaps are presented in the summary all-sector ECR table provided in this Report.

- The document California's Next Million Acre-Feet: Saving Water, Energy, and Money, by Heather Cooley, Juliet Christian-Smith, Peter H. Gleick, Michael J. Cohen, and Matthew Heberger of Pacific Institute (Oakland, CA), dated September 2010, and available as http://www.pacinst.org/reports/next_million_acre_feet/next_million_acre_feet.pdf.

- The document20x2020 Water Conservation Plan, dated February 2010, prepared by the California Department of Water Resources, State Water Resources Control Board, California Bay-Delta Authority, California Energy Commission, California Department of Public Health, California Public Utilities Commission, and the California Air Resources Board, with assistance from the California Urban Water Conservation Council and U. S. Bureau of Reclamation, and available as www.water.ca.gov/wateruseefficiency/sb7/docs/20x2020plan.pdf.

Quantification Methods:

Based on the policy goals expressed as above, the overall approach to analysis of this option was as follows:

1. Apply the statewide estimate for urban water use savings described above to projected urban water use in the SCAG region. Projections of urban water use in the SCAG region were prepared using per-capita estimates of current water consumption for Southern California and estimates of population and population growth in the SCAG counties.
2. Extend the statewide estimate by extrapolation and/or assumption through the end of the analysis period (2035).
3. Obtain estimates of the energy used per unit urban water delivered to consumers by fuel (electricity and natural gas).
4. Apply fuel use estimates above to water savings to estimate amount of fuel use avoided by RCI-6 measures.
5. Adapt overall statewide estimate of water savings (and the net costs of same) to the SCAG region, assuming roughly similar applications of the same "bundle" of water savings measures in the SCAG region.
6. Estimate the fraction of net costs accounted for by avoided costs for electricity and gas, and partition those from other costs to yield an estimate of the non-energy, non-water net costs of water saving measures.
7. Obtain estimates of the average non-energy costs of providing water to urban consumers, and apply those estimates to estimated water savings as an input to the calculation of net costs of water-saving measures.
8. Apply emission factors for avoided electricity and natural gas use to estimate the net GHG emissions impacts by year and by sector for the technologies included in the analysis, totaling emissions by sector.
9. Apply avoided electricity and gas costs (as developed for general use on all RCI options) to estimate the avoided fuel costs estimates for the technologies included in the analysis, reporting fuel cost savings by year and by sector.
10. Calculate total GHG emissions savings and net costs for reports.

Key Assumptions: As noted above and below:

- Baseline per capita water use in the SCAG region of 185 gallons per day.

- Fraction of above as outdoor water uses (assumed mostly residential) set at 30%.

Key Uncertainties

Key uncertainties in this analysis include the ultimate level of deployment of water-saving technologies and methods, the net costs of those options (which could in fact be much lower, since only a limited suite of measures was used for the weighted average value included in the estimate), and the avoided capital costs of future water supply infrastructure, for which a relatively conservative value was assumed for this analysis.

Additional Benefits and Costs

The types of activities needed to improve water use efficiency are, like energy efficiency measures, especially good for the local economy, as they stimulate demand in the construction and related trades, and support retailers who provide needed services and materials. This option also has strong synergies with efforts to reduce energy use, and to produce compact dwelling units that offer advantages related to transport energy use. In addition, reduced requirements of energy for water supply, treatment, water heating, and wastewater treatment offer local criteria air pollution reduction benefits.

Section III. Energy-Supply Policy Options

ES-1 Central Station Renewable Energy Incentives including Project Development Barrier Removal Issues

Policy Description

This policy option reflects financial incentives to encourage investment in renewable energy resources, such as wind, bioenergy, and solar resources. Examples include: (1) tax credits or exemptions for purchasing renewable technologies; (2) feed-in tariffs, which provide direct payments to renewable generators for each kilowatt-hour (kWh) of electricity generated from a qualifying renewable facility; (3) tax credits for each kWh generated from a qualifying renewable facility. Policy measures in support of this option could provide incentives to utilities to upgrade transmission systems. Siting new transmission lines can be a difficult process, given their cost and their local impacts on the environment and on the use, enjoyment, and value of property. This policy includes measures to reduce barriers to siting new transmission lines.

Policy Design

The California Renewable Portfolio Standard (RPS) Program was established by SB 1078, and then modified by SB 107, SB 1036, and SB 2 (1x) to increase total procurement of eligible renewable energy resources that 33% of retail sales are served by renewable energy resources no later than 12/31/20.

Goals or Level of Effort:

Renewable electricity generation as a percent of sales in the SCAG region reaches 33% by 2020 consistent with SBX1-2 (2011). Intermediate procurement quantity requirements for interim years are 21.7% (2014); 23.3% (2015); 27% (2017); 29% (2018); and 31% (2019).

The policy targets SCAG renewable electricity generation as a percent of sales reaching 40% by 2035. The central station generation targets are net of the relevant distributed electricity generation under ES-2, that comply with SBX1-2 requirements.

The quantification of the costs and benefits of ES-1 assume that the reference case for the region includes only a 20% RPS by 2020 which is based on the SCAG region Inventory and Forecast.

Timing (Start, Phase In, End):

The policy is implemented in 2011 and ends in 2035.

Parties Involved:

- Local, state and federal agencies associated with renewable energy deployment.
- California Independent System Operator
- Electric utilities serving the SCAG area.
- Vendors, suppliers, designers, manufacturers, and installers of renewable energy systems.
- Financial institutions/financing agencies (private and public).

Other: None at present.

Type(s) of GHG Reductions

GHG emissions associated with electricity generation net of any GHG emissions from the renewable energy systems themselves (for biomass-fired systems).

Estimated Net GHG Reductions and Net Financial Costs or Savings

Policy Option Number	Policy Recommendation	GHG Reductions ($MMtCO_2e$) 2020	2035	Total 2010–2035	Net Present Value 2010–2035 (Million 2010$)	Cost-Effectiveness ($/t$CO_2$e)
ES-1	Renewable Electricity Supply	11	11	265	$5,025	$19

The above table shows the GHG reductions from ES-1 are 11 $MMtCO_2e$ in both 2020 and 2035. The GHG reductions under ES-1 peak in 2020 because in the following years, DSM electricity programs from the RCI sector are estimated to eliminate growth in electricity loads.

Data Sources: Information sources noted above as well as:

- Klein, Joel. 2009. *Comparative Costs of California Central Station Electricity Generation Technologies*, California Energy Commission, CEC-200-2009-017-SD http://www.energy.ca.gov/2009publications/CEC-200-2009-017/CEC-200-2009-017-SF.PDF
- EIA. (2011). Electricity Market Module. http://www.eia.gov/forecasts/aeo/assumptions/pdf/electricity.pdf p. 97.
- CPUC. (2011a). MPR Model. Available at: http://www.cpuc.ca.gov/PUC/energy/Renewables/mpr
- CPUC. (2011b). Renewables Portfolio Standard Quarterly Report. 1st Quarter 2011. http://www.cpuc.ca.gov/NR/rdonlyres/62B4B596-1CE1-47C9-AB53-2DEF1BF52770/0/Q12011RPSReporttotheLegislatureFINAL.pdf
- E3. (2011). 33% RPS Calculator v1.4. Downloaded Feb 13, 2012 from https://www.ethree.com/public_projects/cpuc6.php
- Hoste, et al. (ND). Matching Hourly and Peak Demand by Combining Different Renewable Energy Sources: A case study for California in 2020. http://www.stanford.edu/group/efmh/jacobson/Articles/I/CombiningRenew/HosteFinalDraft Accessed April 18, 2012.

Quantification Methods: The overall approach to evaluating the impacts of this policy option was as follows:

1. Renewable electricity sales targets are estimated from the above policy goals and timing section. ES-1 adds new renewable generation, in addition to renewables generation under the reference case forecast, to meet the policy targets in each year.
2. Estimates of the fraction of MW renewable electricity deployment goals provided by each technology, including solar PV, wind power, geothermal, as well as large scale biomass combustion are estimated from the 33% Trajectory scenario in the 1st quarter 2011 RPS status report to the CA legislature (CPUC, 2011b, p. 11).

Renewables Supplies (for all years)		Supply Share
ES-1	Geothermal	12%
ES-2	Solar PV	17%
ES-3	Solar Thermal	18%
ES-4	Biomass-dedicated	6%

Renewables Supplies (for all years)		Supply Share
ES-5	Biomass gasification	0%
ES-6	Biomass co-firing	0%
ES-7	Landfill gas	0%
ES-8	Municipal solid waste	0%
ES-9	Small hydro	0%
ES-10	Hydro repowering	0%
ES-11	Onshore Wind I	48%

These supply share assumptions are largely consistent with the CA ISO interconnection queue which shows a larger share of PV and wind in the short term (thru 2013) with more solar thermal included in the 2014+ years.[5]

3. For electricity generating technologies, capital costs, fixed costs, and operating and maintenance costs come from Klein (2010) Tables 11 and 14 on pages 49 and 54, was well as EIA (2011).

4. Estimates of the average current and projected electricity avoided costs (in $/MMBtu and $/MWh) in the SCAG region were developed using the 2011 CPUC Referent Price model (CPUC, 2011a). For each non-baseload renewable technology (wind, solar thermal, solar PV, small hydro) an annual was Time of Use allocation factor was developed using SCE energy allocation factors. Quarterly load curves for each of the above technologies was derived from Hoste et al, (ND).

    a. The annual time of use allocation factors are estimated for wind (0.98), solar thermal (1.33), solar PV (1.29), small hydro (0.84). These are multiplied times the MPR in each year for the avoided cost from electricity generated from each of these non-baseload resources.

    b. Carbon dioxide (CO_2) values were removed from the 2011 MPR. These are the average of NP 15 and SP 15 over the period and rise from $7/MWh in 2011 to $41/MWh in 2035.

    c. 2010 and 2011 avoided costs are developed outside the Market Price Referent model. They are estimated at $42.94 and $39.94 for 2010 and 2011 respectively from historical Short Run Avoided Costs for SCE.[6]

5. An estimate of the GHG emissions avoided by reducing a kWh of electricity demand in the SCAG region is estimated using the 2011 MPR heat rates with degradation factor for age and dry cooling: avoided CO_2 value is approximately .367 tons CO_2 / MWh for all years.

Key Assumptions: As noted above and as follows:

- The RPS generation requirements are net of DSM electricity reductions from the RCI and AFW (pending) sectors as well as any distributed renewable electricity generation from those sectors. These demand side activities represent a considerable reduction in the amount of renewable electricity required under ES-1 targets which are on a percent of sales basis.
- Calculations assume that new generation under ES-1 begins in 2011.
- California state tax rebates and incentives are not included in levelized costs, nor are renewable energy credit values, only Federal incentives.

[5] http://www.caiso.com/planning/Pages/GeneratorInterconnection/Default.aspx. Accessed April 27, 2012.
[6] http://www.sce.com/nrc/aboutsCE/regulatory/qualifyingfacilities/srac_hist.pdf Simple average of monthly time weighted average.

- Property taxes are assumed to be 1.2% of plant cost from the 2011 MRP
- Biomass fuel costs come from the E3 RPS calculator (2011) and are estimated at $2.99/ MMBTU for all years.
- Consistent with the Annual Energy Outlook (EIA, 2011) we assume a 20% reduction in capital costs for solar technologies through 2025, 10% for geothermal, and 10% for dedicated biomass and biomass gasification.[7] We extend the same annual reduction in capital costs for the years 2026-2035.
- Wind capacity factor of 32% is low (conservative) and consistent with modeling assumptions for the Tehachapi region (typically 37-42%).[8]

Table III-1 shows the primary assumptions used to estimate the economic costs associated with electricity generation under ES-1.

Table III-1. Generation Modeling Assumptions (Primary Source: Klein, 2011. Also EIA, 2011)

		For the Year 2025 in 2010 Dollars					
Technology	Supply MW	Fuel Cost ($/MMBTU)	Capital Cost ($/kW)	Capacity Factor	Tax Credits	Integration Cost ($)	Net Generation Cost ($/MWh)
Geothermal-Binary	547	-	3,888	83%	(20.83)	-	32.80
Solar PV	2,389	-	5,093	27%	(20.83)	-	188.95
Solar Thermal	2,566	-	5,189	27%	(20.83)	-	192.74
Biomass-Fluidized Bed	259	2.99	3,156	83%	(20.83)	-	64.20
Biomass gasification	-	2.99	3,082	73%	(20.83)	-	55.23
Biomass co-firing	-	2.99	243	85%	(10.41)	-	26.22
Landfill gas	-	1.00	7,990	80%	(10.41)	-	144.46
Municipal solid waste	-	1.00	5,772	80%	(10.41)	-	111.38
Small hydro	-	-	1,741	30%	(10.41)	-	71.66
Hydro repowering	-	-	741	30%	(10.41)	-	22.06
Onshore Wind I	5,823	-	1,823	32%	(20.83)	7.50	62.96
Onshore Wind II	-	-	1,823	32%	(20.83)	7.50	62.96

Key Uncertainties

None Identified.

Additional Benefits and Costs

None Identified.

[7] http://www.eia.gov/forecasts/aeo/assumptions/pdf/electricity.pdf p. 97.
[8] http://www.energy.ca.gov/2009_energypolicy/documents/2009-06-29_workshop/presentations/03a_Pacific_Gas_and_Electric_Renewable_Integration_Calculator.pdf uses 37% for Tehachapi while Klein (2010) estimates 37% for class 3 and 4 and 42% for class 5 resources.

ES-2 Customer Sited Renewable Energy Incentives and/or Barrier Removal

Policy Description

This option focuses on providing incentives for, and removing barriers to, customer sited renewable energy production throughout the region. Incentives under this option could include corporate tax incentives, sustainable building tax credits, wind and solar energy tax deductions, renewable energy bond programs, personal tax incentives, sales tax incentives, lease purchase programs, grant programs, and loan programs. Policies to reduce barriers to customer sited energy production include net metering, interconnection standards, and pricing strategies, among others. This policy can also address overcoming zoning and other barriers to customers developing new small wind, PV, bioenergy, or other renewable projects.

California has a host of existing programs designed to increase renewable energy generation. These include California's Renewable Portfolio Standard (RPS), Self-Generation Incentive Program, California Solar Initiative, California Feed-In Tariff, Property Tax Exclusion for Solar Energy Systems, as well as others.[9]

Policy Design

The goal of increasing the use of renewable energy in homes, businesses, and institutions in the SCAG region includes both increasing the use of customer-sited renewable energy systems for electric power generation, and increasing the use of customer-sited non-electric renewable energy systems, for example, to provide space, process, or water heat.

With respect to customer-sited renewable energy systems for power generation, the goals and design of this policy are identical to those in option RCI-3 "RCI-3 Incentives for Renewable Energy Systems at Residential, Commercial, and Industrial Sites".

Goals or Level of Effort:

ES-2 targets distributed renewables installations through 2035 at the expected rate of 2006-2016. Statewide, the Go Solar program targets 3000 MW of solar electric by 2016, or an average of 300 MW per year.[10]

- Extended through 2035 and applied to the SCAG region, new solar electric generation capacity of 135 MW per year from 2011-2035, assuming 44% SCAG share of statewide electricity sales.
- Tthe SCAG Reference Case GHG forecast assumes only 20% renewables target by 2020 and the targets for ES-2 counts PV installations from 2011 on as part of the its targets.

Note that goals listed here focus on the electric renewable energy measures not covered in RCI-3.

Timing (Start, Phase In, End): See above.

Parties Involved:

- Residential, commercial, institutional and industrial consumers of electricity
- Property developers, builders, and designers.
- Local, state and federal agencies associated with renewable energy deployment.

[9] http://www.cpuc.ca.gov/PUC/energy/Renewables/overview.htm
http://www.cpuc.ca.gov/PUC/energy/DistGen/sgip/aboutsgip.htm http://www.gridalternatives.org/sash
http://www.cpuc.ca.gov/PUC/energy/Renewables/feedintariffssum.htm
http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CA25F&re=1&ee=1
[10] http://www.gosolarcalifornia.ca.gov/about/index.php

- Electric utilities serving the SCAG area.
- California Independent System Operator
- Vendors, suppliers, designers, manufacturers, and installers of renewable energy systems.
- Financial institutions/financing agencies (private and public).

Other: None at present.

Type(s) of GHG Reductions

GHG emissions associated with electricity generation, and those associated with the transmission/distribution and end-use of natural gas and other fuels whose use is displaced by renewable energy systems, net of any GHG emissions from the renewable energy systems themselves (for biomass-fired systems).

Estimated Net GHG Reductions and Net Financial Costs or Savings

Policy No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value 2010–2035 (Million 2010$)	Cost-Effectiveness ($\$/tCO_2e$)
		2020	2035	Total 2010–2035		
ES-2	Customer Sited Renewable Energy	1	3	38	4,624	123

Please see the GHG reductions and cost effectiveness of non-electricity distributed renewables in RCI-3: Incentives for Renewable Energy Systems at Residential, Commercial, and Industrial Sites.

Data Sources: Information sources noted above as well as the following:

- CPUC. (2011). RPS Program Update. http://www.cpuc.ca.gov/PUC/energy/Renewables/hot/RPS+Program+Update.htm
- Kavalec, Chris, Tom Gorin, Mark Ciminelli, Nicholas Fugate, Asish Gautam, and Glen Sharp. 2011. Preliminary California Energy Demand Forecast 2012-2022. CEC-200-2011-011-SD. http://www.energy.ca.gov/2011publications/CEC-200-2011-011/CEC-200-2011-011-SD.pdf
- E3. (2012). Technical Potential for Local Distributed Photovoltaics in California. March. http://www.cpuc.ca.gov/NR/rdonlyres/8A822C08-A56C-4674-A5D2-099E48B41160/0/LDPVPotentialReportMarch2012.pdf
- E3. (2011). California Solar Initiative Cost-Effectiveness Evaluation. April. Appendix B. http://ethree.com/documents/CSI/CSI%20Report_Complete_E3_Final.pdf

Quantification Methods: The overall approach to evaluating the impacts of this option was as follows:

9. The 300 MW annual goal for new distributed solar installations under the California Solar Initiative and other related programs through 2016 were estimated and SCAG region's share was estimated at 44% of statewide electricity sales (~135 MW / year of incremental PV capacity).

a. The following table indicates the assumed technology deployment for each year:

PV End Use Technology	Supply Share
Residential Rooftop	30%
Commercial Rooftop	30%
Ground Mount <1 MW	10%
Ground Mount 1-3 MW	10%
Ground Mount 3-5 MW	20%

10. The MW target was assumed to begin in 2011 and extended through 2035. MW capacity was converted to GWh using a weighted average capacity factor for the 5 types of solar PV assumed to be deployed.

11. The levelized costs based on estimates of incremental capital, operating, and other costs for PV were calculated based on the E3 PV assessment document (2012) pages 47-49.

    - We applied emission factors for avoided electricity to estimate the net GHG emissions impacts by year for the technologies included in the analysis.
        - Avoided CO_2 emission rates for PV for all years are based on California Energy Commission assumption of a new 100MW single cycle gas turbine with a heat rate of 9,300 = 0.493693 tons/MWh with a natural gas emissions factor of 0.053085299 tonnes CO_2/MMBTU. This CO_2 intensity is consistent with the 2010 CSI evaluation that showed 985 GWh reducing 485000 tons of CO_2 (0.49 tons CO_2 /MWh)[11]

12. Avoided electricity costs were developed to estimate the avoided fuel, capacity, and T&D costs estimates for the technologies included in the analysis.

    a. Avoided costs come from E3's evaluation of the California Solar Initiative (2011) and are updated to reflect lower electricity prices from the 2011. Market Price Referent (MPR). First, the energy portion of total avoided costs was estimated at 55% from the workbook tool "Distributed Resource Avoided Cost Calculator" prepared by Energy and Environmental Economics (E3) of San Francisco. Filename DERAvoidedCostModel_v3.9_2011 v4b CA Avg.xlsm which was used in calculating avoided costs for the RCI measures. Next, the change in energy costs between the 2009 MPR, which was used for the CSI cost effectiveness calculations, and the 2011 MPR used in this analysis was estimated for years 2011-2020.

    b. Next, CO_2 values were subtracted from the 2009 avoided cost estimates from E3 (2011). Finally, the avoided cost in the terminal years post 2020 of the CSI analysis was estimated using the low gas case scenario which forecasted a 3.2% annual increase in gas prices through 2040.

13. Calculated total GHG emissions savings and net costs for the electric elements of ES-2.

14. Combined GHG emissions savings and costs results for electric options with results for RCI-3 to present overall ES-2 results.

[11] http://www.cpuc.ca.gov/NR/rdonlyres/6C1CF950-93C7-485C-8CC6-2633CB49218D/0/CompleteCSIwebinarpresentations.pdf p. 17.

Key Assumptions:

- The costs associated with electricity generation under ES-2 are presented in Table III-2. Consistent with the Annual Energy Outlook (2011) and E3 (2012), we assume a 20% reduction in capital costs for all PV technologies through 2025.[12] We extend the same annual reduction in capital costs for the years 2026-2035.
- Calculations assume that new distributed generation under ES-2 begins in 2011.
- California state tax rebates and incentives are not included in levelized costs, nor are renewable energy credit values, only Federal incentives.
- The federal investment tax credit of 30% of installed costs is included through 2016. The federal production tax credit is assumed to be extended for the years 2017-2035.

Table III-2. Modeling Assumptions. Sources: Capital costs from E3. (2012)

Solar PV Generation Modeling Assumptions		For the Year 2025 in in 2010 Dollars					
	Supply (MW)	Fuel Cost ($/MMBTU)	Capital Cost ($/kW)	Capacity Factor	Tax Credits ($/MWh)	Integration Cost ($/MWh)	Generation Cost ($/MWh)
Residential Rooftop	635	-	6,660	18%	(20.83)	-	394.50
Commercial Rooftop	635	-	5,854	18%	(20.83)	-	344.45
Ground Mount <1 MW	212	-	6,002	18%	(20.83)	-	353.64
Ground Mount 1-3 MW	183	-	5,710	20%	(20.83)	-	286.79
Ground Mount >10 MW	365	-	4,975	20%	(20.83)	-	247.28

Key Uncertainties

None Identified.

Additional Benefits and Costs

None Identified.

[12] http://www.eia.gov/forecasts/aeo/assumptions/pdf/electricity.pdf p. 97.

ES-3 Transmission System Upgrading, Reduce Transmission and Distribution Line Loss

Policy Description

GHGs can be reduced through measures to improve transmission systems that reduce bottlenecks and enhance throughput. Opportunities may exist to substantially increase transmission line carrying capacity through the implementation of new construction and retrofit activities on the transmission grid, including incorporating advanced composite conductor technologies, capacitance technologies, and grid management software. Several energy efficiency measures can be implemented to reduce transmission and distribution (T&D) line losses of electricity, including replacing old equipment and dead end lags. Increasing the efficiency of baseline components can further reduce losses and associated GHG emissions.

Policy Design

Goals or Level of Effort: Starting in 2014, assume SCAG utilities achieve industry best practices electricity T&D loss rate for forecasted line losses. The policy is implemented linearly over a 10 year period.

Timing (Start, Phase In, End):

See above

Parties Involved:

- Local, state and federal agencies associated with electricity generation.
- California Independent System Operator
- Electric utilities serving the SCAG area.
- Vendors, suppliers, designers, manufacturers, and installers of transmission and distribution equipment.
- Financial institutions/financing agencies (private and public).

Other: None at present.

Type(s) of GHG Reductions

GHG emissions associated with electricity generation including SF6 and other industrial chemicals associated with electricity transmission and distribution.

Estimated Net GHG Reductions and Net Financial Costs or Savings

This policy was not quantified as the GHG reductions associated with the T&D improvements are not significant to the region's total GHG emissions.

Key Uncertainties

None at present.

Additional Benefits and Costs

None at present.

ES-4 CCSR Incentives and Infrastructure including R&D and Enabling Policies

Policy Description

Carbon capture and storage or reuse (CCSR) is a process that includes separation of CO_2 from industrial and energy-related sources, transport to a storage location, and permanent or long-term storage. Captured carbon can also be used for enhanced recovery of oil and gas. Policies to encourage development of CCSR technology could include a local agency or department within an existing agency tasked with promoting CCSR, financial incentives to capture and store or capture and reuse carbon, and/or mandates – coupled with technical feasibility, and cost and investment recovery mechanisms, if appropriate – to capture and store or reuse CO_2 from power plants. Incentives to build and operate the rather complex infrastructure for CCSR can also be a part of the incentive system. Technological as well as financial barriers exist to implementation of CCSR. Further R&D funding to improve CCSR technologies and evaluation studies to identify geologically sound reservoirs will be needed for this technology to play a significant role in reducing GHG emissions.

Policy Design

Goals or Level of Effort:

Target includes development of two 500 MW carbon capture facilities with reuse for Enhanced Oil Recovery applications. One facility comes online in 2020 and the second in 2025 and they operate through 2035. One facility will likely use the Wilmington Graben reservoir and the other project is likely to be the Hydrogen Energy California Project (HECA).

Timing (Start, Phase In, End): See above

Parties Involved:

- Oil producing firms in California
- Industrial consumers of electricity and fossil fuels
- State and federal resource agencies
- California Independent System Operator
- Vendors, suppliers, designers, manufacturers, and installers of CCSR systems.
- Financial institutions/financing agencies (private and public).

Other: None at present.

Type(s) of GHG Reductions

GHG emissions associated with oil production, fuel combustion and electricity generation, and those associated with the transmission/distribution and end-use of electricity, natural gas and other fuels whose use is displaced by CCSR systems, net of any GHG emissions from the CCSR system (leakage).

Estimated Net GHG Reductions and Net Financial Costs or Savings

This policy was quantified as the GHG reductions associated with the pilot projects are not significant to the region's total GHG emissions. Also, the costs of GHG reductions from CCSR are significantly higher than other GHG reduction sources available to California and the SCAG region.

Data Sources:

- Terralog Technologies. (2011). Wilmington Graben Project Update and SoCal Carbon Atlas. http://www.netl.doe.gov/publications/proceedings/11/carbon_storage/thursday/DOE%202011_Young.pdf
- Hydrogen Energy California. (2012). The Project . http://hydrogenenergycalifornia.com/how-heca-works Accessed 4 April, 2012.
- California Carbon Capture and Storage Review Panel (2010). *Findings and Recommendations by the California Carbon Capture and Storage Review Panel: Incentives to Accelerate CCS Deployment in California.* December. http://climatechange.ca.gov/carbon_capture_review_panel/documents/2011-01-14_CSS_Panel_Recommendations.pdf

Key Uncertainties

None at present.

Additional Benefits and Costs

None at present.

ES-5 Public Benefits Charge Funds

This policy option was moved to 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).

ES-6 Combined Heat and Power (CHP) Incentives and/or Barrier Removal, including Co-location or Integration of Energy-Producing Facilities

Policy Description

Combined heat and power (CHP) can reduce GHG emissions by increasing the overall efficiency of fuel use. Policies to remove barriers can include improved interconnection policies, improved rates and fees policies, streamlined permitting, recognition of the emission reduction value provided by CHP and clean distributed generation (DG), financing packages and bonding programs, power procurement policies, education and outreach, etc. Financial incentives for CHP could include: (1) direct subsidies for purchasing/selling CHP systems given to the buyer/seller; (2) tax credits for each kWh or BTU generated from a qualifying CHP system; (3) tax credits or exemptions for operating CHP systems; and (4) a feed-in tariff, which is a direct payment to CHP owners for each kWh of electricity or British thermal unit (BTU of heat generated from a qualifying CHP system. The policy can also encourage the co-location of integrated energy-producing facilities to enable the more efficient utilization of heat and energy. Examples of this co-location include co-firing of biomass or the integration of ethanol and biodiesel facilities. Waste heat from industrial parks can be used to provide space conditioning and domestic hot water for residential and commercial buildings.

Policy Design

The theory of CHP is to maximize the energy use from fuel consumed and to avoid additional GHG's by the use of reclaimed thermal energy. The reclaimed thermal energy can be used by other nearby entities (e.g., within an industrial park or district steam loop) for productive purposes. Generating stations in urban areas may have existing opportunities or may require the co-location of new industry. For California, the largest source of new, cost-effective CHP potential is in the commercial and institutional sectors that have continuous thermal loads for domestic hot water and process heating, such as hotels, hospitals, schools, laundromats, and laboratories. Commercial CHP units are typically sized to the minimum thermal load for the facility and have high capacity utilization factors.

The CHP Qualifying Facilities Settlement Agreement replaces the PURPA program for CHP facilities greater than 20 MW.

Goals or Level of Effort:

The SCAG region 2020 goal is 832 MW of new CHP systems, which consistent with the CPUC's 2010 LTPP proceeding calling for the development of 1,871 MW (statewide) of new CHP by 2020.[13] By 2030, SCAG's region share is 2890 MW of new CHP based on Governor Brown's statewide target of 6500 MW. SCAG region 2030-2035 targets remain constant at 2030 levels.

These targets are consistent with the technical potential identified in Hedman et al (2012, p. 59) which shows technical potential of over 6500 MW in LADWP and SCE service territory by 2030.

Timing (Start, Phase In, End):

The CHP policy targets are assumed to be implemented linearly beginning in 2012 through the 2020 and 2030 targets.

[13] In 2011 demand forecast (Kavelec et al, 2011) existing onsite use at CHP facilities is held constant through 2022 as older systems are assumed to be replaced. (p. B-6). http://www.energy.ca.gov/2011publications/CEC-200-2011-011/CEC-200-2011-011-SD.pdf.

Parties Involved:

- Commercial, institutional and industrial consumers of electricity and fuels
- Property developers, builders, and designers.
- Independent power providers
- State and federal resource agencies
- California Independent System Operator
- Local, state and federal agencies associated with combined heat and power deployment.
- Electric and gas utilities serving the SCAG area.
- Vendors, suppliers, designers, manufacturers, and installers of CHP systems.
- Financial institutions/financing agencies (private and public).

Type(s) of GHG Reductions

GHG emissions associated with fuel combustion and electricity generation, and those associated with the transmission/distribution and end-use of electricity, natural gas and other fuels whose use is displaced by CHP systems, net of any GHG emissions from the CHP systems themselves.

Estimated Net GHG Reductions and Net Financial Costs or Savings

The following table shows the quantification results for the CHP option. The results show that the policy can result in significant cost savings to the SCAG region.

Policy No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value 2010–2035 (Million 2010$)*	Cost-Effectiveness ($/t$CO_2$e)*
		2020	2035	Total 2010–2035		
ES-6	Combined Heat and Power	1.3	5.0	66	-4,971	-75

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

As noted by Hedman (2012) the GHG savings estimated here are smaller than those in the California Air Resources Board (CARB) scoping plan because the, "in the Scoping Plan, all the CHP market penetration was assumed to be high load factor systems with full thermal utilization. In this analysis, thermal utilization rates for the small markets were assumed to be only 80%. Larger markets were assumed to have 90-100% thermal utilization." (Hedman et al 2012 p. 11).

Part of the reason for the large cost savings is due to the difference in natural gas tariffs for dedicated CHP systems and gas tariffs for boilers. The cost breakdown between commercial and industrial applications is exhibited in Table III-3 shows commercial cost savings are slightly higher, partly due to the larger differential in commercial CHP and boiler gas tariffs.

Table III-3. Estimated Sectoral CHP Results

CHP TYPE	Cumulative GHG Reductions 2010-2035 ($MMtCO_2e$)	Net Present Value 2010–2035 (Million 2010$)*	Cost Effectiveness ($/tCO_2e$)*
Commercial CHP	25	-1,975	-78
Industrial CHP	41	-2,996	-73
Total	66	-4,971	-75

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

Data Sources: Information sources noted above as well as:

- Kavalec, Chris, Tom Gorin, Mark Ciminelli, Nicholas Fugate, Asish Gautam, and Glen Sharp. 2011. *Preliminary California Energy Demand Forecast 2012-2022*. CEC-200-2011-011-SD. http://www.energy.ca.gov/2011publications/CEC-200-2011-011/CEC-200-2011-011-SD.pdf
- Hedman, Bruce, Ken Darrow, Eric Wong, Anne Hampson. ICF International, Inc.2012. *Combined Heat and Power: 2011-2030 Market Assessment.* California Energy Commission. CEC-200-2012-002. http://www.energy.ca.gov/2012publications/CEC-200-2012-002/CEC-200-2012-002.pdf
- Southern California Edison. (2011). Regulatory Information - SCE Tariff Books. http://www.sce.com/AboutSCE/Regulatory/tariffbooks/ratespricing/businessrates.htm
- California Air Resources Board. (2008). Climate Change Proposed Scoping Plan Appendices. VOLUME II: Analysis and Documentation. http://www.arb.ca.gov/cc/scopingplan/document/appendix2.pdf p. I-28.

Quantification Methods:

6. The fraction of MW CHP deployment goals provided by reciprocating engines and turbines as specified below.
7. The installed capital ($/kW) and operating ($/kWhr for variable operating costs, and $/kW-yr for fixed operating costs) of those technologies are from is Hedman, et al. (2011).
8. Estimates of the average current and projected natural gas, fuel oil and electricity avoided costs (in $/MMBtu and $/MWh) in the SCAG region are developed from the source below.
9. The estimate of the GHG emissions avoided by reducing a kWh of electricity demand from CHP in the SCAG region is estimated at .437 tonnes/MWh from the CARB Scoping Plan (2008) page I-28 to I-29.

Key Assumptions:

- State SGIP Incentives are not included in the quantification of costs, only the Federal tax credit which is assumed to expire at the end of 2016.
- SCAG's region share is 44.5% of statewide CHP based on 2020 electricity consumption forecasts (mid-case 2011 IEPR).

- Table III-4 shows the key assumptions for ES-6. Because capital costs and heat rates vary over time, the assumptions listed in Table III-4 are for the year 2025 for both commercial and industrial CHP applications.

Table III-4. CHP Technology Assumptions for 2025

	2025	2025	
Avoided T&D Charges ($2010)	**Commercial**	**Industrial**	**Source**
Demand Charge $/kW/month	**12.18**	**4.95**	Comm: SCE GS-2 demand tariff Non-TOU. Ind: SCE TOU-8 above 50kv
Transmission Charge Customer/ kW / Month	**-**	**-**	
T&D Losses	**7.5%**	**7.5%**	Electricity Inventory and Forecast.
CHP Characteristics			
CHP Technology	**Recip Engine**	**Gas Turbine**	
CHP Unit Size MW	**0.80**	**40.00**	
Heat Rate BTU/kWh	**9,225**	**8,759**	Hedman et al. (2012) Tables 38-40.
Capacity Factor	**80%**	**80%**	Hedman et al. (2012) Table A-2.
Heat Recovered from CHP (Power to heat ratio)	**80%**	**100%**	Hedman et al. (2012) Table A-2.
Installed Capital Costs $/kW	**1,615**	**1,181**	Hedman et al. (2012) Tables 38-40.
O&M Costs $/MWh	**13.50**	**5.00**	Hedman et al. (2012) Tables 38-40.
Economic Life/years	**15**	**20**	Hedman et al. (2012) Tables 38-40.
Natural Gas Fuel Percent	**100%**	**100%**	Assumption
Levelized Cost of Electricity $/MWh	**102.74**	**78.02**	Calc
Avoided Thermal Charges $/MWh	**34.40**	**51.33**	Calc
Avoided Capacity Charges $/MWh	**24.29**	**9.87**	Calc
Net Generation Cost $/MWh	**44.04**	**16.81**	Calc
Avoided Price of Power $/MWh	**89.10**	**70.87**	Assumption
MW Capacity	**906**	**955**	ES-2 Policy Targets
Avoided Boiler Characteristics			
Displaced boiler efficiency	**80%**	**80%**	CARB Scoping Plan Assumption
Fixed O&M $/MMBTU	**0.07**	**0.07**	Assumption
Variable O&M $/MMBTU	**0.07**	**0.07**	Assumption

- Avoided boiler fuel shares shown in Table III-5 are the simple average of coal, gas, and petroleum fossil fuel consumption over the 2011-2035 period for the commercial and industrial sectors in California. The implication is that CHP units are installed in facilities using each fossil fuel according to statewide fossil fuel shares. Data from the workbook "SCAG_CO2FFC Module" "Commercial", and "Industrial" worksheets.

Table III-5. Displaced Boiler Fuel Assumptions

	Displaced Boiler Fuel			
CHP Types (Sector/Fuel)	Natural Gas	Coal	Petroleum	Biomass
Commercial CHP	88%	0%	12%	0%
Industrial CHP	52%	8%	39%	0%

- Commercial boiler and CHP natural gas prices come from Hedman et al, (2012, p. 66) for SoCal Gas. That report notes that California law gives favorable tariffs to CHP customers versus traditional commercial and industrial consumers.
- Industrial coal prices are for the Annual Energy Outlook 2012 Early Release: Energy Prices by Sector and Source, Pacific, Reference case. http://www.eia.gov/oiaf/aeo/tablebrowser/#release=EARLY2012&subject=0-EARLY2012&table=3-EARLY2012&region=1-0&cases=full2011-d020911a,early2012-d121011b
- Distillate prices are from the United States Department of Energy (USDOE) EIA data (http://www.eia.gov/dnav/pet/pet_pri_refoth_dcu_SCA_a.htm) which gives California average wholesale prices for distillate oil (#2) for 2000 through 2010. This cost does not include fuel taxes. Prices expressed in $/MMBtu using conversion of 0.1387 MMBtu/gallon. Future growth in prices based on USDOE Annual Energy Outlook 2011 reference case projections for the US as a whole; see data in "AEO_2011" Worksheet in this workbook.

Phase-in Year:	**2012**
Terminal Year:	**2035**
From ES-6 Goals and Timing	
CHP Target in 2020 (MW)	**832**
CHP Target in 2030 (MW)	**2890**
CHP Target in 2035 (MW)	**2890**
From ES-6 Goals and Timing	
Commercial Share of CHP MW (all years)	**48.7%**
Industrial Share of CHP MW (all years)	**51.3%**
Biofuels Share of CHP MW (all years)	**0.0%**
Table ES-3 in Hedman et al (2012) Med Case shows 1766 MW for <20 MW systems and 1863 MW for > 20MW systems	
Number of Unscheduled Outages per year	**3**
# of months CHP unit must pay demand charges. In Hedman, et al (2012, p.71)	
Real Discount Rate (yr)	**5%**
Cross policy assumption	
CHP Financing Rate	**8.3%**
Cross policy assumption	
Share of Industrial MWh for Export	**50.0%**

This is consistent with the Med Case in Hedman et al (2012) table ES-3 p. 11. Higher export share results in lower avoided costs.		
Federal Tax Credit		**10.0%**
Sunset date (December of)		**2016**
Consistent with existing Federal Business tax credit		

- The quantification assumes that the displaced boiler is fully depreciated at the time of the CHP installation (no avoided capital charges).
- Avoided electricity prices are taken from Table 27: CHP Average Avoidable Rate Forecast High Load Factor Customers from Hedman et al (2012). Average avoidable rates based on the retail rates, standby, and departing load charges and are considerably lower than retail rates. For the SCAG region, DWP avoidable rates in Table 27 are weighted at 35% and SCE at 65% based on the estimated ratio of public to investor owned electricity sales in the SCAG region.
    - Avoided electricity prices for the assumed share of exported electricity under the California feed in tariff under AB1613 are taken from Table 30 in Hedman et al (2012) for 5-20 MW units.

Key Uncertainties

None Identified.

Additional Benefits and Costs

None Identified.

Section IV. Agriculture, Forestry and Waste Management Policy Options

AFW-1 Improve Agricultural Irrigation Efficiency

Policy Description

This policy aims to reduce agricultural water use through efficient irrigation techniques and better management. This reduced water use will lower GHG emissions by reducing energy consumption needed for water pumping and distribution. The policy would also promote efficient planning of new water delivery systems and support improvements and upgrading of existing water delivery systems and delivery equipment. This policy is consistent with the recommendations of the California Water Plan Update (including the Agricultural Water Use Efficiency measure) and the 2005 Integrated Energy Policy Report.

From the Agricultural Water Use Efficiency Chapter of the State Water Plan, improving agricultural water use efficiency can occur from three activities:

- *Hardware*: Improving on-farm irrigation systems and water supplier delivery systems;
- *Water management*: Improving management[14] of on-farm irrigation and water supplier delivery systems; and
- *Crop water consumption*: Reducing non-beneficial evapotranspiration.

This policy focuses on the first of these activities by promoting higher levels of use of precision irrigation technology, including the use of drip or micro-spray irrigation. SCAG agricultural subregions that are dependent on groundwater or pumped surface water with high embedded energy and GHGs should be targeted (e.g., State Water Project via the CA Aqueduct); however any reduction in water use should have a GHG benefit.

Policy Design

Goals or Level of Effort:

By 2020, reduce the amount of energy used by agricultural water systems in the region by 20% from 2006 levels.

Timing (Start, Phase In, End): Implementation of this policy would begin in 2013 and would ramp up linearly each year to reach the intended policy goal by 2020.

Parties Involved: SCAG, CA DWR, county agricultural extension offices, farmers.

Other: The CA AB32 Scoping plan calls for a reduction in water consumption of 20% by 2020 (reduction in per capita urban water use); however, the write-up for that measure (W-1) also mentions agricultural water use.[15] This option, combined with the xeriscaping element of AFW-2, is designed to

[14] It's important to recognize that growers manage their use of water for multiple objectives. For example, flooding of fields might be done to reduce weed production and subsequent use of herbicides. So "management" as used in this policy option is specific to water delivery to cover the water requirements of crops (same meaning as "irrigation" as used in this policy.

[15] CARB, *Climate Change Scoping Plan Appendices, Vol. 1: Supporting Documents and Measure Detail*, December 2008. Appendix C, Measure W-1: Water Use Efficiency.

assist SCAG in meeting that goal, although additional actions might be needed to further reduce urban water use.

Type(s) of GHG Reductions

CO_2, CH_4, N_2O from energy used to create the electricity for irrigation water pumping or from fuel (e.g., diesel) combustion used to run irrigation pumps. GHG reductions are also possible through increased crop yields which reduce emissions on net production basis.

Estimated Net GHG Reductions and Net Financial Costs or Savings

Summary of Analysis Results

Policy	Description	GHG Reductions ($MMtCO_2$)			Net Present Value (million 2010$)*	Cost-Effective-ness ($\$/tCO_2$)*	Water Savings (TAF, 2013-2035)	Electricity Reduction (MWh, 2013-2035)
		2020	2035	Total (2013-2035)				
AFW-1	Ag Irrigation Efficiency	0.22	0.22	4.4	-145	-33	481	10.1MM

* Negative values represent a net cost savings. $\$/tCO_2e$ stands for dollars per metric ton of carbon dioxide equivalent.

Note that the results above do not include additional non-energy monetary savings associated with reduced water deliveries (covering infrastructure, operations and maintenance, and administration). By reducing 481 thousand acre-feet (TAF) of agricultural water use, inclusion of the additional non-energy savings would provide a net present value of -534 million $2010 and a cost effectiveness of -$\$123/tCO_2e$. These additional monetary benefits were not included in the summary above due to the lack of a well-established value for non-energy water system delivery costs.

Data Sources:

California Water Plan Update: Agricultural Water Use Efficiency Measure; CA Department of Water Resources.

Agricultural Water Use in California: A 2011 Update; CSU Fresno, Center for Irrigation Technology.

California Agricultural Water Electrical Energy Requirements; December 2003, Irrigation Training and Research Center (IRTC).

December 2008 *Climate Change Scoping Plan*; California Air Resources Board.

Additional data sources are footnoted in the discussion below.

Quantification Methods:

1. *Estimate baseline regional agriculture water (AW) use:* the data shown in Table IV-1 were used to estimate county-level AW use in the SCAG region. These included 2007 data on irrigated cropland,[16] data from the CA Department of Water Resources (DWR) on 2005 county-level AW use by crop type,[17] and the SCAG RTP/SCS draft PEIR on the amounts of urban and agricultural water delivered via groundwater or surface water. An average AW use by county (acre-feet per acre or AF/acre) was developed from the values provided for each crop. Multiplying the irrigated acreage by the average AW use yields an estimate of the amount of AW applied in each county for 2007. The year 2007 is

[16] USDA National Agricultural Statistics Service: http://www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_2_County_Level/California/st06_2_010_010.pdf.
[17] Jim Lin, CA DWR, personal communication with E. Lim, SEI, 4/18/2012.

used in the analysis as a proxy for 2006, which is the year that the policy design is based on, since these were readily available from United States Department of Agriculture (USDA).

Table IV-1. Estimate of County-Level AW Use

County	2007 Irrigated (Acres)	Average AW Use (AF/acre)	Total AW Use (AF)
Imperial	375,902	4.05	1,523,754
Los Angeles	25,611	3.10	79,519
Orange	7,823	1.85	14,444
Riverside	159,354	3.31	527,022
San Bernardino	81,050	2.98	81,050
Ventura	180,370	1.96	180,370
Regional Totals	**687,838**		**2,406,149**

2. *Divide counties into separate subregions:* AW use in SCAG subregions has differing supply characteristics including the amount of AW supplied by groundwater versus surface water and the embedded GHGs within these supply sources. For example, the South Coast Hydrologic Region (HR) receives most of its surface water via the State Water Project via the CA Aqueduct. In the Colorado River Hydrologic Region covering Imperial County agricultural lands, AW is primarily supplied by surface water diversion from the river with much lower embedded GHGs. For this analysis, all counties except Imperial were assigned to the South Coast HR. AW supply for each HR are summarized in Table IV-2;

Table IV-2. Estimate of County-Level AW Use

Hydrologic Region	% Groundwater[18]	Groundwater Embedded Energy[19] (kWh/AF)	Surface Water Embedded Energy[20] (kWh/AF)
South Coast	25	566	3,604
Colorado River	11	446	10

3. *Calculate water savings:* in each year by meeting the targets of this policy; total water savings needed are 20% of 2006 use (~481,000 AF); water saving projects are assumed to begin in 2013 and to ramp up linearly to the end of 2020, when the full target is achieved. Hence, for each of these 8 years, 60.2 thousand acre-feet (TAF) of new reductions are achieved.

4. *Calculate energy and GHG savings:* this was done by multiplying the water volume reductions by the energy intensity of baseline water (either groundwater or surface water) to yield electricity savings (note that a simplifying assumption for this analysis is that all water is delivered via electrical pumps, although diesel pumps are used in some instances); calculate GHG savings by multiplying the electricity savings times the emission factor for avoided electricity (these future values are based on the SCAG GHG I&F for the electricity sector);

5. *Calculate net annualized costs:* these include net capital costs and operations & maintenance costs for applying PI in each HR; adjusting for any financial incentives; and subtracting energy and water savings. PI covers a variety of technologies including shifting from furrow/flood irrigation methods to micro-drip or micro-spray, or variable rate irrigation systems. Different PI technologies were selected for developing these top-down cost estimates in the two HRs based on predominant crop types. It was

[18] 2012-2035 SCAG RTP/SCS, Draft PEIR, Section 3.13.
[19] Jim Lin, CA DWR, personal communication with E. Lim, SEI, 4/18/2012; and Jim Lin, CA DWR, personal communication with S. Roe, CCS, 5/1/2012.
[20] Ibid.

assumed that installation of micro-drip/spray systems would be the most common approach in the South Coast HR. For the Colorado River HR, application of variable rate irrigation (VRI) on existing center pivot systems was the assumed technology. VRI allows for precise irrigation to portions of a field based on the water needs of each area (note that VRI technology can also be paired with variable rate fertilizer application; however, that is not addressed here).

For VRI technology, an annualized cost of $46/acre (range of $35-$70/acre) was provided by a Texas A&M study.[21] For micro-drip/spray installation, a study by the Pacific Institute[22] provided an average estimate of $1,250/acre. Assuming a 10-year life and a 5.5% interest rate, the annualized cost would be about $166/acre. Application of PI has been estimated to produce reductions in water use by up to 30-45% in some instances[23] (e.g., switching from gravity fed irrigation to micro-drip in orchards and vineyards); however, the literature also suggests that values could be lower when factoring in all of the water needs of a crop (e.g., excess water used to leach salts out of the root zone). Therefore, we selected a lower value of 20% water use reduction for application of PI in both hydrologic regions.

Additional non-energy cost benefits are expected from reduced water consumption due to lower infrastructure, operations & maintenance, and possibly administrative costs. No estimates for these were identified in the literature; however, estimates were derived by subtracting the estimated energy costs (developed using ~$0.09/kWh levelized avoided electricity costs and the embedded electricity in delivered water) from the total costs paid by farmers (~$475/AF in the South Coast HR and ~$10/AF in the Colorado River HR).[24] In the South Coast HR, these non-energy costs could exceed $200/AF. Due to the uncertainty in these estimates, the additional savings are provided separately from the overall summary of benefits, which only captures the energy savings.

Results from the analysis are provided in the tables below. Dividing the total discounted costs from Table IV-4 (net present value costs for the policy) of -$320MM by the total GHG reductions from Table IV-3 (4.3 $MMtCO_2e$) yields a cost effectiveness estimate of -$74/$tCO_2e$. This value excludes the potential additional cost savings for non-energy water system deliveries (infrastructure, operations & maintenance, administration). As shown in Table IV-4, the NPV for the policy including those costs could be as high as a savings of -$709MM, which would yield a cost effectiveness of -$163/$tCO_2e$.

Table IV-3. Energy and GHG Reductions Summary

Year	New AW Use Reductions Achieved (TAF)	Cumulative AW Reductions (TAF)	Total Energy Reductions (MWh)	Total GHG Reductions ($MMtCO_2e$)
2012	0.0	0.0	0	0.00
2013	60.2	60.2	64,950	0.03
2014	60.2	120.3	129,899	0.06
2015	60.2	180.5	194,849	0.08
2016	60.2	240.6	259,799	0.11
2017	60.2	300.8	324,748	0.14
2018	60.2	360.9	389,698	0.17
2019	60.2	421.1	454,648	0.20
2020	60.2	481.2	519,597	0.22
2021	0.0	481.2	519,597	0.22

21 http://ageconsearch.umn.edu/bitstream/35249/1/sp03al02.pdf, the mid-point selected was for VRI application on a center pivot irrigation system on a 284 acre field.
22 Sustaining California Agriculture in an Uncertain Future, Pacific Institute, July 2009; http://www.pacinst.org/reports/california_agriculture/.
23 http://giannini.ucop.edu/media/are-update/files/articles/v7n5_2.pdf.
24 http://www.lao.ca.gov/2008/rsrc/water_primer/water_primer_102208.aspx#chapter5.

Year	New AW Use Reductions Achieved (TAF)	Cumulative AW Reductions (TAF)	Total Energy Reductions (MWh)	Total GHG Reductions ($MMtCO_2e$)
2022	0.0	481.2	519,597	0.22
2023	0.0	481.2	519,597	0.22
2024	0.0	481.2	519,597	0.22
2025	0.0	481.2	519,597	0.22
2026	0.0	481.2	519,597	0.22
2027	0.0	481.2	519,597	0.22
2028	0.0	481.2	519,597	0.22
2029	0.0	481.2	519,597	0.22
2030	0.0	481.2	519,597	0.22
2031	0.0	481.2	519,597	0.22
2032	0.0	481.2	519,597	0.22
2033	0.0	481.2	519,597	0.22
2034	0.0	481.2	519,597	0.22
2035	0.0	481.2	519,597	0.22
Totals			**10,132,149**	**4.3**

Table IV-4. Cost Analysis Summary

Year	New Acres Addressed	South Coast PI Annualize d Costs (MM$)	CO River PI Annualize d Costs (MM$)	Total Electricity Savings ($MM)	Total Non-Energy Water Delivery Savings ($MM)	Total Policy Costs (MM$)*	Discounted Costs (2010MM$)*	Discounted Costs with Non-Energy H_2O (2010MM$)*
2012	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0
2013	14,631	1.07	2.5	5.7	5.1	-2.1	-1.8	-6.3
2014	14,631	2.13	5.1	11.5	10.2	-4.3	-3.5	-11.9
2015	14,631	3.20	7.6	17.2	15.4	-6.4	-5.0	-17.1
2016	14,631	4.26	10.1	23.0	20.5	-8.6	-6.4	-21.7
2017	14,631	5.33	12.7	28.7	25.6	-10.7	-7.6	-25.8
2018	14,631	6.39	15.2	34.4	30.7	-12.8	-8.7	-29.5
2019	14,631	7.46	17.7	40.2	35.8	-15.0	-9.7	-32.8
2020	14,631	8.52	20.3	45.9	41.0	-17.1	-10.5	-35.7
2021	0	8.52	20.3	45.9	41.0	-17.1	-10.0	-34.0
2022	0	8.52	20.3	45.9	41.0	-17.1	-9.5	-32.3
2023	0	8.52	22.8	45.9	41.0	-14.6	-7.7	-29.5
2024	0	8.52	25.3	45.9	41.0	-12.1	-6.1	-26.8
2025	0	8.52	25.3	45.9	41.0	-12.1	-5.8	-25.5
2026	0	8.52	22.8	45.9	41.0	-14.6	-6.7	-25.5
2027	0	8.52	20.3	45.9	41.0	-17.1	-7.5	-25.3
2028	0	8.52	22.8	45.9	41.0	-14.6	-6.1	-23.1
2029	0	8.52	25.3	45.9	41.0	-12.1	-4.8	-21.0
2030	0	8.52	25.3	45.9	41.0	-12.1	-4.5	-20.0
2031	0	8.52	22.8	45.9	41.0	-14.6	-5.2	-19.9
2032	0	8.52	20.3	45.9	41.0	-17.1	-5.9	-19.9
2033	0	8.52	22.8	45.9	41.0	-14.6	-4.8	-18.1
2034	0	8.52	25.3	45.9	41.0	-12.1	-3.7	-16.4
2035	0	8.52	25.3	45.9	41.0	-12.1	-3.6	-15.7
Totals						**-291**	**-145)**	**-534**

* Negative values represent a net cost savings.

Key Assumptions: Assignments of all county-level crops to either the South Coast or Colorado River HRs; use of county-level average AW application rates instead of a bottom-up assessment using crop-specific values; static values used for future groundwater versus surface water agricultural use; static values for future embedded energy content of groundwater and surface water deliveries; cost estimates based on application of a single technology in each HR; literature suggests some potential for yield improvements for PI application, but these were not included in this analysis.

Key Uncertainties

See Key Assumptions in the previous section. Due to uncertainties on the levels of federal and state funding assistance that could be available to farmers to implement PI projects during the policy period, these funding sources have not been included in this analysis. Inclusion of these would not change the results shown for net societal costs, but could shed some light on needed sources of funding within the SCAG region. Any incremental costs required for administering or provision of technical assistance are assumed to be covered through existing programs and government agency staff.

Improvements to irrigation efficiencies could also have an effect on soil nitrous oxide emission rates. While additional research is needed to quantify these effects, a recent study found reductions in N_2O emissions when comparing furrow irrigation to drip irrigation systems.[25]

Additional Benefits and Costs

- Lower air pollution emissions from power plants due to lower electricity needs.
- Potential for higher crop yields.
- Greater water availability for other uses (urban and environmental).

[25] http://www.sciencedirect.com/science/article/pii/S0038071708000874.

AFW-2 Improve Urban Forestry and Green Space through Expansion and Effective Management

Policy Description

This policy includes two separate, but related, programs designed to reduce GHGs. The first aspect of this program addresses the expansion and maintenance of urban tree canopies. By maintaining the health and longevity of existing shade trees and planting additional trees in residential, commercial and municipal areas, indirect emissions will be reduced as a result of a decrease in heating and cooling needs. This program is also designed to promote carbon sequestration, thus reducing GHGs.

The second aspect of this program involves promoting urban and suburban xeriscape landscaping. The seven xeriscape principles involve landscaping and gardening practices which reduce or eliminate the need for supplemental water for irrigation. This, in turn, results in a reduction in energy use needed for water treatment and transport and a corresponding reduction in emissions.

Policy Design

Goals or Level of Effort:

- **Urban Forestry:** In order to effectively implement the urban forestry aspect of this strategy, it is necessary to design a program to increase the number of trees planted, such that the majority of them approach maturity by the end of the planning period (2035). The overall goal is to double the urban canopy cover over the next 40 years. Approximately, 8.4 million new trees would be needed to achieve this goal. At least 75% of the new trees planted should be strategically sited to achieve energy benefits through shading of residences or commercial/public structures. Also to enhance energy savings potential of this policy, 80% of plantings should be medium to large deciduous trees (the remaining 20% evergreen).
- **Xeriscaping:** Increase levels of xeriscaping in new and large retrofit landscape projects, such that baseline evapotranspiration is reduced by at least 28% from current levels.

Timing (Start, Phase In, End):

- **Urban Forestry:** begin planting in 2013, plant 5 million new trees by 2020, complete remaining 3.4 million trees by 2030.
- **Xeriscaping:** begin implementation in 2013 with full compliance by 2018.

Parties Involved: SCAG municipalities and county governments, non-profit organizations, businesses and residents, landscape designers and installers.

Other: The urban forestry goals are assumed to incorporate other existing SCAG region programs, such as the Million Trees LA Initiative. The goal of doubling the canopy cover was selected to mirror the goal set by the 2001 GreenPrint Initiative covering a six county area in the Sacramento region within its Urban Forest Compact (estimated to require 5 million new urban trees). From the SCAG GHG I&F, the current canopy cover is assumed to be 11% of urbanized areas, which is taken from an U.S. Environmental Protection Agency (EPA) default for the state of CA. Current urban area in the region is about 1.5 million acres.

The xeriscaping goals build off of the model ordinance requirements of AB1881, which targets irrigation efficiency, by addressing water demand of a landscape. This is measured by the plant factor (PF). The statewide PF assumed in AB1881 is assumed to be 0.5 based on a 1/3:1/3:1/3 mix of high:moderate:low water demand plants (e.g. turf grass is considered high). A PF of 0.3 would shift plantings to a lower water demand mix and should reduce water use by ~28% as compared to the AB1881 model ordinance (assuming the same 0.71 irrigation efficiency). As with the model ordinance, this policy only addresses new residential and commercial buildings.

Type(s) of GHG Reductions

Urban forestry: CO_2 is reduced indirectly through sequestration in urban trees; CO_2, CH_4, and N_2O are also indirectly reduced through enhanced shading and wind protection of residential and commercial buildings, which reduces electricity and heating fuel use.

Xeriscaping: emissions of CO_2, CH_4, and N_2O are indirectly reduced when less water is used for irrigating homes and businesses, since energy is required to pump, treat, and distribute this water.

Estimated Net GHG Reductions and Net Financial Costs or Savings

Summary of Analysis Results

Policy	Description	GHG Reductions ($MMtCO_2$)			Net Present Value (million 2010$)	Cost-Effectiveness ($/t$CO_2$)	Fuel Savings (TJ, 2013-2035)	Electricity Reduction (MWh, 2013-2035)
		2020	2035	Total (2013-2035)				
AFW-2a	Urban Forestry	0.050	0.28	2.66	$1,359	$424	15,193	5,784,092
AFW-2b	Xeriscaping	*Not Quantified*						

Data Sources: Urban Forestry-

- E.G. McPherson, J.R. Simpson, Q. Xiao, and C. Wu. "Million trees Los Angeles canopy cover and benefit assessment", *Landscape and Urban Planning,* 99 (2011), pp. 40-50. Available at: http://www.fs.fed.us/psw/publications/mcpherson/psw_2011_mcpherson001.pdf.
- Temperate Interior West Community Tree Guide, from E. Vargas, E.G. McPherson, J.R. Simpson, P.J. Peper, S.L. Gardner, and Qingfu Xiao. Benefits, Costs, and Strategic Planting. United States Forest Service (USFS) PSW-GTR-206. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, November 2007. Available at: http://www.fs.fed.us/psw/programs/uesd/uep/products/2/psw_cufr721_TempIntWestTG.pdf.
- SCAG GHG I&F: urban area; 11% urban canopy cover (assumed; this is the state average).

Xeriscaping- *this component was not quantified due to a current lack of information on housing unit builds and ownership turnover during the policy period in the SCAG region.*

- CA 20x2020 Plan: http://www.water.ca.gov/wateruseefficiency/sb7/docs/20x2020plan.pdf;
- CA AB1881 (Water Efficient Landscape Ordinance) Background: http://www.water.ca.gov/wateruseefficiency/landscapeordinance/updatedOrd_history.cfm.

Quantification Methods: Urban Forestry –

Based on the policy design, the first step was to determine the total amount of new area requiring canopy cover at maturity. The current I&F default for the region (based on the State default) is 11% and doubling this per the policy design would get the region to 22% cover. An additional 946 square kilometers (km^2) of cover would be needed based on the current SCAG urban area of 6,084 square kilometers (km^2) and an estimated future SCAG urban area of 8,604 km^2 (in 2052 based on extrapolation of urban growth from the Forestry GHG I&F). To estimate the number of new trees needed, a tree density of 8,850 trees/km^2 was derived using an assumed 12 meter diameter at maturity, which is the average of medium and large trees cited in the Million Trees LA paper.[26] Using the values of urban canopy cover needed and urban tree density, an estimate of 8,375,994 new trees was derived.

[26] http://www.fs.fed.us/psw/publications/mcpherson/psw_2011_mcpherson001.pdf.

The next step was to determine the number of trees that would be strategically sited to achieve energy benefits (in southern CA, mainly via shading). The policy design requires that at least 75% are planted in locations that will achieve such benefits. Primarily, these will occur in residential and low rise commercial areas, although some savings are also possible in the urban core (high rise areas). This 75% of plantings was further broken down into two groups, one referred to as "suburban strategic plantings", where a fraction of 0.90 is the target. The remaining 0.10 will be planted in the urban core. This distinction is important for both GHG reduction and cost issues, as described further below. For the remaining 25% ("other plantings"), these will be placed in parks and other open areas (e.g. medians); however, no energy benefits will accrue. The planting schedule shown in Table IV-5 also conforms to the policy design in terms of timing in that 5 million of the new trees are planted by 2020.

Table IV-5. Urban Tree Planting Schedule

Year	Total Planted	Suburban Strategic Plantings	Cumulative Suburban Strategic Plantings	Urban Core Plantings	Cumulative Urban Core Plantings	Other Plantings	Cumulative Other Plantings
2013	714,286	482,143	482,143	53,571	53,571	178,571	178,571
2014	714,286	482,143	964,286	53,571	107,143	178,571	357,143
2015	714,286	482,143	1,446,429	53,571	160,714	178,571	535,714
2016	714,286	482,143	1,928,571	53,571	214,286	178,571	714,286
2017	714,286	482,143	2,410,714	53,571	267,857	178,571	892,857
2018	714,286	482,143	2,892,857	53,571	321,429	178,571	1,071,429
2019	714,286	482,143	3,375,000	53,571	375,000	178,571	1,250,000
2020	337,599	227,880	3,602,880	25,320	400,320	84,400	1,334,400
2021	337,599	227,880	3,830,759	25,320	425,640	84,400	1,418,800
2022	337,599	227,880	4,058,639	25,320	450,960	84,400	1,503,200
2023	337,599	227,880	4,286,518	25,320	476,280	84,400	1,587,599
2024	337,599	227,880	4,514,398	25,320	501,600	84,400	1,671,999
2025	337,599	227,880	4,742,278	25,320	526,920	84,400	1,756,399
2026	337,599	227,880	4,970,157	25,320	552,240	84,400	1,840,799
2027	337,599	227,880	5,198,037	25,320	577,560	84,400	1,925,199
2028	337,599	227,880	5,425,916	25,320	602,880	84,400	2,009,599
2029	337,599	227,880	5,653,796	25,320	628,200	84,400	2,093,999
2030	**-**	**-**	**5,653,796**	**-**	**628,200**	**-**	**2,093,999**

For all trees planted, carbon sequestration was estimated based on USFS data for an estimated mix of trees called for by the policy design.[27] From literature sources or SCAG contacts, estimate tree planting and maintenance costs assuming financing of planting costs over 20 years.

[27] Temperate Interior West Community Tree Guide: Benefits, Costs, and Strategic Planting. USFS PSW-GTR-206. U.S. Department of Agriculture, Forest Service Pacific Southwest Research Station, November 2007. Available at: http://www.fs.fed.us/psw/programs/uesd/uep/products/2/psw_cufr721_TempIntWestTG.pdf.

Table IV-6. Sequestration Rates

Tree Type; Model Species (% plantings)	Sequestration Rates by Age Group (lb CO_2/yr)							
	Yr 1-5	Yr 6-10	Yr 11-15	Yr 16-20	Yr 21-25	Yr 26-30	Yr 31-35	Yr >36
Md. Deciduous; White Ash (40%)	0.05	0.26	0.50	0.72	0.88	1.02	1.10	1.17
Evergreen; Blue Spruce (20%)	0.15	0.32	0.45	0.54	0.59	0.64	0.65	0.65
Norway Maple; Lg. Deciduous (40%)	0.21	0.52	0.83	1.09	1.29	1.42	1.48	1.53
Weighted Avg based on Policy Design	**0.13**	**0.38**	**0.62**	**0.83**	**0.99**	**1.10**	**1.16**	**1.21**

Using assumptions that urban trees will reach maturity after 35 years and the average lifespan of an urban tree is 50 years, the sequestration rates shown in Table IV-6 were applied to the planting schedule shown in Table IV-5. Annual sequestration estimates were then summed for each year for suburban strategic, urban core, and other plantings.

Table IV-7 provides a summary of the energy savings and cost variables used. The energy savings variables are 40-yr averages taken from the USFS Temperate Interior West Community Tree Guide referenced above. Tree planting and maintenance costs were also taken from the same reference with the exception of urban core planting costs.[28] The weighted averages are based on an assumed mix of 40% medium deciduous, 40% large deciduous and 20% evergreen trees consistent with the policy design.

Table IV-7. Energy Savings and Cost Variables

Energy Savings or Cost Variable	White Ash	Blue Spruce	Norway Maple	Weighted Average
Energy Savings				
Cooling savings (kWh/tree-yr)	294	67	242	228
Heating savings (MMBtu/tree-yr)	0.583	0.871	0.399	0.567
Capital and Maintenance Costs				
Maintenance costs Suburban/Other (2007$spent/year/tree)	$6.73	$3.42	$5.38	$5.53
Maintenance costs Urban Core (2007$spent/year/tree)	$15.31	$19.98	$18.54	$17.54
Suburban/Other planting costs (2007$spent/tree)	$158	$158	$205	$177
Urban Core planting costs (2006$spent/tree)	$983	$983	$983	$983

The energy savings benefits were calculated each year only for the suburban strategic plantings (no energy benefits are assumed for the urban core or other plantings, as these are assumed not to appreciably affect buildings). The heating savings were all assumed to be for natural gas. Electricity benefits were calculated using the total MWh estimated in each year and the SCAG region carbon intensity for that year. A natural gas emission factor of 0.0529 tCO_2/MMBtu was used along with the heating savings in each year to estimate those energy reduction benefits.[29] Total reductions through 2035 are 2.66 $MMtCO_2e$. The vast majority of these reductions come through energy savings, rather than carbon sequestration.

The approach to annualizing capital costs assumes that these will be financed through a 20-year municipal bond program (4.0% yield). The cost effectiveness estimated for complete policy implementation (2013-

[28] Source: Peter Savio, personal communication with Jackson Schreiber, CCS, 5/12/2009. Estimates come from the Greening the Bronx program. Costs are ~$800 for trees planted on pervious surfaces (2/3 of total) and ~$1,350 for trees planted on impervious surfaces (1/3 of total). Averages to $983.

[29] The emission factor was taken from The Climate Registry's General Reporting Protocol.

2035) is $376/t$CO_2$e. If cost effectiveness is calculated based on the total expected life of the enhanced urban forest program, then the value is $34/t$CO_2$e.

Xeriscaping – *not quantified.*

Key Assumptions:

Urban Forestry-

- Existing tree canopy cover in the SCAG region;
- Urban tree planting and maintenance costs.

Xeriscaping-

- Urban water use per day in SCAG region (180 gal/capita-day); outdoor water use (40%); these could be conservative, since urban usage in Colorado River Region is 346 gal/capita-day with 70% outdoor use;
- Lowering the plant factor (PF) from 0.5 to 0.3 through higher levels of xeriscaping yields a 28% reduction in irrigation water use;
- A PF of 0.5 (default statewide average) is representative of the SCAG region;
- Costs for increased xeriscaping in new landscaping projects or large retrofit projects is net neutral ($0.00). Costs then are only related to the savings from lower water use.

Key Uncertainties

See Key Assumptions subsection above. Additional key uncertainties are:

- Urban Forestry: current estimates do not account for tree mortality within the planning period. It is also assumed that program administrative costs are not significant or are absorbed through existing municipal urban forest programs. Current estimates also do not include a full life-cycle based analysis that would capture the energy and emissions associated with nursery production of trees and other materials to support the planting programs[30], as well as the energy used for ongoing irrigation and maintenance of trees.
- Xeriscaping: representation of the impacts of AB 1881 on urban water use in the SCAG GHG I&F. Growth in electricity consumption (which is tied here to water use) is based on a CEC forecast. For a future analysis, it could be assumed to be captured, and the reductions in plant factor associated with xeriscaping are incremental, which lead to water reductions and GHG benefits.

Additional Benefits and Costs

Many ecosystem services and social co-benefits can accrue from expanding and managing urban forests, such as:

- Reduction in the urban heat island effect.
- Reduction in surface water run-off and potential savings at water treatment plants for portions of this run-off that end up in sanitary sewer systems.

---

[30] A recent US Forest Service study concluded that the tree production operation emissions were small compared to the full life-time benefits (CO_2 sequestration) for each tree; however this study did not address urban tree maintenance emissions: (http://www.fs.fed.us/psw/publications/mcpherson/psw_2011_mcpherson007(kendall).pdf).

- An improvement in the aesthetic appeal (i.e., quality of life) of urban landscapes developed due to increased tree canopy cover and associated increases in property values.

For xeriscaping, the most important non-GHG benefit is reduced water consumption and the ancillary benefits that accrue through the reduction in embedded energy. These would include energy security (reduced need for imported electricity), air quality, and protection of water supplies for other uses by man and nature.

AFW-3 Biomass to Energy Innovation through In-Situ Underground Decomposition

Policy Description

Promote research and field-testing to determine the efficacy of sequestering bio-solids and brines underground to then capture methane from their in-situ decomposition**.** This would promote the sequestration of residual biosolids from wastewater treatment plants to contain methane from biosolids instead of their releasing methane if placed in landfills or carbon if left to oxidize. Reduce methane emissions associated with landfilling by reducing the biodegradable fraction of waste emplaced.

This option is being retained as a non-quantified policy; see the footnote below[31] regarding additional information needs to estimate GHG reductions and costs.

Policy Design

When sufficient background information is available on the technology and its technical potential in the SCAG region, goals can be defined in the form of million gallons of wastewater treated with the new technology or some similar form. Alternatively, a goal to convert a specified set of treatment plants by 2020 or 2030 to the new technology could be used.

Goals or Level of Effort: See above.

Timing (Start, Phase In, End): Example: "Assume linear growth toward the goal between 2013 and 2030."

Parties Involved: Future work on policy development in this area should identify two sets of parties involved: those affected by the policy and those involved in its implementation. If it is not apparent please explain the interest or role of the parties identified. Please also note any exemptions or thresholds which include or exclude involved entities.

Other: Nothing noted.

Type(s) of GHG Reductions

Methane and nitrous oxide released during typical sewage treatment plant biosolids management processes. Potential for lower electricity and fuel consumption as a result from on-site processing and reductions in the associated GHG emissions. Potential for offsetting grid electricity or fuel use with additional on-site methane generation and beneficial use (yielding reductions in the associated GHGs).

Estimated Net GHG Reductions and Net Financial Costs or Savings

Not Quantified.

Data Sources: not applicable.

Quantification Methods: not applicable.

Key Assumptions: not applicable.

Key Uncertainties

Not applicable.

Additional Benefits and Costs

None identified.

---

[31] This option might be quantifiable depending on the amount of research that has been done to date on this type of technology. Some information was found on-line about the Terralog, Inc. process/project with Los Angeles County; CCS needs more background on the process, capital and operating costs, and changes in operating costs from business as usual operations. This information might be available in feasibility studies.

AFW-4 Preserve and Expand the Carbon Sequestration Capabilities of Open Space, Wildlands, Wetlands, and Agricultural Lands

Policy Description

Reduce the rate at which open lands, wildlands, and agricultural lands are converted to developed uses (with all due consideration for private property rights). This prevents release of the above- and below-ground carbon, as well as preserving the land's carbon sequestration potential. Preserve native vegetation during development, to reduce the initial carbon losses and allow for their continued carbon sequestration action. Undisturbed soil also reduces erosion risk and protects soil carbon stocks from aeration and subsequent carbon dioxide emissions. Likewise, parks and green spaces provide carbon sequestration in urban and suburban neighborhoods. Implement wetlands protection programs to preserve and restore wetlands to improve biodiversity conservation and improve carbon sequestration. Create a mitigation/offset program that ensures long-term conservation of forest or agricultural acreage equivalent to acres of lands converted to other uses ("no net loss"). This mitigates the carbon impact of development, while providing a revenue stream for conservation activities. Indirectly, this option supports smart development patterns which lead to lower transportation emissions through reductions in vehicle miles driven.

This option is being retained as a non-quantified policy; see the footnote below regarding additional information needs to estimate GHG reductions and costs[32].

Policy Design

Goals or Level of Effort: This policy has two different goals. Suggestions for further consideration are:

1. Reduce the rate of forest and agricultural land conversion (possibly achieving "no net loss" by some future year). The goals could be expressed by stating a reduction in conversion by certain years, e.g., 30% reduction by 2020, no net loss by 2030.
2. For lands that are converted, reduce the loss of native vegetation/soil carbon. This should be expressed as a fraction of native lands that are developed; e.g. 50% of converted area in 2020; 100% in 2030.

Timing (Start, Phase In, End): *Identify timing requirements, assumptions or concerns*.

Parties Involved: *Identify two sets of parties involved: those affected by the policy and those involved in its implementation. If it is not apparent please explain the interest or role of the parties identified. Please also note any exemptions or thresholds which include or exclude involved entities.*

Other: Nothing noted.

Type(s) of GHG Reductions

Terrestrial carbon losses in the form of above and below ground biomass and soil carbon (net emission of CO_2). Indirectly, reductions of transportation fuel use and associated GHG emissions as a result of more compact development indirectly achieved by this policy (e.g., as a companion policy to smart growth or transit oriented development).

Estimated Net GHG Reductions and Net Financial Costs or Savings

Not quantified.

[32] Indirect GHG benefits, such as those associated with smart development patterns or retention of local agricultural production, will have to be discussed qualitatively due to the time and effort needed to address them.

Data Sources: If this option is to be quantified in the future, then data on historical and/or projected rates of conversion of the region's forested and agricultural acreage will be needed. Also, needed are data on the costs for conservation acquisitions or easements in the SCAG region.

Quantification Methods: Not applicable.

Key Assumptions: Not applicable.

Key Uncertainties

Not applicable.

Additional Benefits and Costs

While this policy would achieve direct GHG benefits by reducing losses of terrestrial carbon, it is possibly even more important as a companion policy to land use policies in the areas of smart growth. This is because land conservation around the urban fringe can help to direct more compact growth.

AFW-5 Increase On-Farm Energy Efficiency & Renewable Energy Production

Policy Description

This policy aims to improve agricultural practices relating to increasing on-farm energy production and energy efficiency (EE). Renewable energy can be produced and used on-site at agriculture operations. Potential renewable energy options available for Southern California farmers include solar photovoltaics (PV), solar thermal, wind, and geothermal. The use of energy efficient technologies should also be promoted. This could include improved grain dryers, heat exchangers (dairy), electric motors, and energy-efficient lighting and building design. Achieving meaningful GHG reductions through EE will require a coordinated approach which addresses all forms of on-farm energy consumption and will often-times require significant shifts in farm-level management practices. The use of more energy efficient practices and equipment and renewable generation will displace the use of fossil-based fuels and reduce GHG emissions. Note that agricultural irrigation efficiency is being addressed under AFW-1.

Policy Design

Goals or Level of Effort:

Reduce on-farm electricity consumption by 50% by 2030 through a combination of renewable energy production and EE measures.

Timing: Begin implementation in 2013 and ramp up in linear fashion to the full goal by 2030.

Parties Involved: SCAG, regional utilities, local agricultural extension offices, farmers.

Other: For the purposes of quantifying GHG reductions and costs, 25% of the reductions are assumed to occur through renewable energy (RE) projects and 75% through EE measures. The overall 50% reduction is taken against the electricity consumption for 2007.

Type(s) of GHG Reductions

CO_2, CH_4, N_2O reductions through reducing electricity consumption on-farm or displacement of grid electricity; reduction of these gases as well from reduced fossil fuel consumption (e.g., diesel pumps).

Estimated Net GHG Reductions and Net Financial Costs or Savings

Quantification results are summarized here.

Policy	Description	GHG Reductions ($MMtCO_2$)			Net Present Value (million 2010$)	Cost-Effective-ness ($/t$CO_2$)	Grid Electricity Reduction (MWh, 2013-2035)
		2020	2035	Total (2013-2035)			
AFW-5a	On-Farm RE	0.020	0.043	0.65	-5.8	-9	1.3MM
AFW-5b	On-Farm EE	0.053	0.16	2.3	-47	-28	3.9MM

Data Sources:

- USDA, *On-Farm Renewable Energy Production Survey (2009)*.
- USDA, 2011:*Solar Energy Use in U.S. Agriculture Overview and Policy Issues*;
- USDA, March 2012; *The Impact of the Rural Energy for America Program on Promoting Energy Efficiency and Renewable Energy:* http://www.rurdev.usda.gov/Reports/rdREAPReportMarch2012.pdf.

Additional data sources are cited as footnotes within the discussion below.

Quantification Methods:

The steps used to generate GHG reduction and cost estimates for both the RE and EE components of this policy are provided below. For the RE component, installation of on-farm photovoltaic (PV) generation systems was selected as a likely technology to be employed to meet most of the RE goal. So, capital and O&M costs for PV were used to estimate the annualized costs.

1. *Estimate agriculture sector energy use*: SCAG region-specific estimates of agricultural energy use were not identified (area for future refinement, potentially using utility survey data). Hence, based on USDA statistics, estimates of county level electricity use were developed based on energy expenditures. The starting point for these estimates was the USDA 2007 California agriculture electricity expenditure estimate of $670MM[33]; This estimate was allocated to each of the SCAG counties share of 2007 utility expenses (state total expenses were $1.23 billion in 2007)[34]; utility expenses were then converted to electricity use by dividing by the Southern California Edison 2007 commercial rate (similar to the total off-peak agriculture rate) of $0.135/kWh.[35] Results are shown in Table IV-8.

Table IV-8. 2007 County-level Agricultural Electricity Use Estimates

County	Utility Expenses (1,000 $2007)	Estimated Electricity Expense (1,000 $2007)	Estimated Electricity Usage (MWh)
Imperial	39,147	21,314	165,773
Los Angeles	11,931	6,496	50,523
Orange	7,637	4,158	32,340
Riverside	49,972	27,207	211,612
San Bernardino	16,393	8,925	69,418
Ventura	39,935	21,743	169,110
Regional Totals	**165,015**	**89,843**	**698,776**

2. *Estimate annual renewable energy production/EE needs:* based on the estimated SCAG regional agricultural electricity usage estimate shown in Table IV-8, the 50% reduction policy goal is therefore 349,388 MWh annually (with half being met through RE and the other half through EE). Based on the policy goals and timing, the amount of new RE and EE for each year from 2013-2030 is shown in Table IV-9.

Table IV-9. RE and EE Requirements and Associated GHG Reductions

Year	Renewable Energy		Energy Efficiency		Total GHG Reductions ($MMtCO_2e$)
	PV Generation Needed (MWh)	RE GHG Reductions ($MMtCO_2e$)	EE Project Needs (MWh)	EE GHG Reductions ($MMtCO_2e$)	
2012	-	-	-	-	-
2013	5,138	0.003	15,414	0.007	0.01
2014	10,276	0.005	30,828	0.013	0.02
2015	15,414	0.008	46,243	0.020	0.03

[33] USDA Data: C. McGath, USDA ERS, personal communication with S. Roe, CCS, 5/3/2012.
[34] USDA 2007 Census of Ag State & County Data: http://www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_2_County_Level/California/cav1.pdf; note that "utility" expenses include electricity, telephone/internet, and water purchases, which adds uncertainty to this allocation method. It is possible the USDA could provide special county-level break-outs of electricity expenses, which would improve these initial estimates.
[35] http://www.sce.com/NR/sc3/tm2/pdf/ce86-12_2007.pdf.

Year	Renewable Energy		Energy Efficiency		Total GHG Reductions ($MMtCO_2e$)
	PV Generation Needed (MWh)	RE GHG Reductions ($MMtCO_2e$)	EE Project Needs (MWh)	EE GHG Reductions ($MMtCO_2e$)	
2016	20,552	0.010	61,657	0.026	0.04
2017	25,690	0.013	77,071	0.033	0.05
2018	30,828	0.015	92,485	0.040	0.05
2019	35,966	0.018	107,899	0.046	0.06
2020	41,104	0.020	123,313	0.053	0.07
2021	46,243	0.023	138,728	0.060	0.08
2022	51,381	0.025	154,142	0.066	0.09
2023	56,519	0.028	169,556	0.073	0.10
2024	61,657	0.030	184,970	0.079	0.11
2025	66,795	0.033	200,384	0.086	0.12
2026	71,933	0.036	215,798	0.093	0.13
2027	77,071	0.038	231,213	0.099	0.14
2028	82,209	0.041	246,627	0.106	0.15
2029	87,347	0.043	262,041	0.112	0.16
2030	87,347	0.043	262,041	0.112	0.16
2031	87,347	0.043	262,041	0.112	0.16
2032	87,347	0.043	262,041	0.112	0.16
2033	87,347	0.043	262,041	0.112	0.16
2034	87,347	0.043	262,041	0.112	0.16
2035	87,347	0.043	262,041	0.112	0.16
Totals	**1,310,204**	**0.65**	**3,930,613**	**1.69**	**2.33**

3. *Estimate GHG reductions for each year:* based on emission factors for electricity in the I&F: the values shown for RE and EE in Table IV-9 are slightly different since average SCAG region emission factors were used for EE projects, but a peak value was used for estimating RE project reductions (PV projects would produce electricity during peak energy use hours). This leads to slightly higher GHG reduction estimates for RE[36];

4. *Estimate the costs of renewable energy and EE projects:*

   - *for renewable energy projects*: PV costs were taken from the analysis conducted for the Electricity Supply Sector in this project. These costs include both capital and O&M costs for PV;
   - *for energy efficiency:* the USDA report on results from the REAP (Rural Energy for America) program were used to derive an average cost for EE measures in the agricultural sector to achieve electricity reductions. From these results, a weighted average value of $621/MWh was derived. The data used to derive this estimate are shown in Table IV-10 below and were selected from all 10 of the western states represented in the study. The REAP report provided the amounts granted during 2011 and the electricity savings for groups of projects by technology group. To develop total capital costs, the REAP program grants cover up to 25% of each project, and it was assumed that each project sought and received the full 25%. No incremental O&M costs are assumed for EE projects. The capital costs were annualized assuming financing over 15 years and a 5.5% interest rate.

[36] The peak avoided electricity rate is 494 kilograms of carbon dioxide per megawatt-hour ($kgCO_2/MWh$) compared to 429 $kgCO_2/MWh$ for the SCAG average. The peak value is based on a simple-cycle natural gas turbine peaker plant emission rate.

Table IV-10. Estimated EE Capital Costs

State	$/MWh	# Projects	Fractional Avg ($/MWh)
CA	674	3	11
CO	243	10	14
ID	622	67	233
MT	1032	7	40
NV	764	2	9
NM	519	5	14
OR	760	24	102
TX	642	48	172
UT	222	5	6
WA	444	8	20
		Weighted Average	**621**

Costs for both the RE and EE components of this option are summarized in Tables IV-11 and IV-12 below. The cost effectiveness of both components and the overall policy are shown at the bottom of Table IV-12. These are derived by dividing the total net present value (total discounted costs) by the total GHG reductions from Table IV-9.

Key Assumptions:

- Results assume all RE is met by solar PV installations to reduce on-farm consumption from the grid. Building in other RE technologies (e.g., wind) would change the results.
- USDA REAP data provide a reasonable estimate of potential electricity savings and costs for the array of technologies needed by the agricultural sector in the SCAG region.

Key Uncertainties

See Key Assumptions in the previous section. Estimates of agricultural electricity use are currently allocated from state-level USDA data. It is possible that more precise estimates at the county level could be provided by USDA; however, they were not available in time for this analysis. Even better estimates could also be made from the bottom-up data on electricity use for the agricultural sector from SCE, especially if these were available by agricultural subsector (e.g., dairy, poultry, crop production, etc.).

Additional Benefits and Costs

- Reduced air pollution from lower fossil fuel power plant generation.
- More stable production expenses from agricultural producers taking part in the programs of this policy.

Table IV-11. AFW-5 Summary of Cost Analysis ($MM)

Year	PV Annual-ized Capital Costs	PV Capital Costs	PV O&M Costs	PV Avoided Electricity	Total Annual PV Costs	EE Capital Costs	EE Annual-ized Capital	EE O&M Costs	EE Avoided Electricity	Total EE Costs
2012	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.00	0.0	0.0
2013	1.0	12.8	0.01	0.7	0.3	9.6	1.0	0.00	1.4	-0.4
2014	1.9	12.6	0.02	1.5	0.4	9.6	1.9	0.00	2.7	-0.8
2015	2.8	12.4	0.03	2.3	0.5	9.6	2.9	0.00	4.1	-1.2
2016	3.7	12.2	0.04	3.2	0.6	9.6	3.8	0.00	5.4	-1.6
2017	4.6	12.1	0.05	4.1	0.6	9.6	4.8	0.00	6.8	-2.0
2018	5.5	11.9	0.06	5.0	0.5	9.6	5.7	0.00	8.2	-2.5
2019	6.4	11.7	0.07	6.1	0.4	9.6	6.7	0.00	9.5	-2.9
2020	7.2	11.5	0.08	7.1	0.2	9.6	7.6	0.00	10.9	-3.3
2021	8.1	11.3	0.09	8.2	0.0	9.6	8.6	0.00	12.3	-3.7
2022	8.9	11.2	0.10	9.3	-0.2	9.6	9.5	0.00	13.6	-4.1
2023	9.7	11.0	0.11	10.4	-0.5	9.6	10.5	0.00	15.0	-4.5
2024	10.5	10.8	0.12	11.5	-0.9	9.6	11.4	0.00	16.3	-4.9
2025	11.3	10.6	0.13	12.1	-0.6	9.6	12.4	0.00	17.7	-5.3
2026	12.1	10.5	0.14	13.1	-0.8	9.6	13.4	0.00	19.1	-5.7
2027	12.9	10.3	0.15	14.1	-1.1	9.6	14.3	0.00	20.4	-6.1
2028	13.6	10.1	0.16	15.1	-1.4	19.1	15.3	0.00	21.8	-6.5
2029	14.4	9.9	0.17	16.2	-1.7	19.1	16.2	0.00	23.2	-6.9
2030	14.4	0.0	0.17	16.3	-1.8	9.6	16.2	0.00	23.2	-6.9
2031	14.4	0.0	0.17	16.7	-2.1	9.6	16.2	0.00	23.2	-6.9
2032	14.4	0.0	0.17	17.0	-2.4	9.6	16.2	0.00	23.2	-6.9
2033	14.4	0.0	0.17	17.3	-2.8	9.6	16.2	0.00	23.2	-6.9
2034	14.4	0.0	0.17	17.6	-3.1	9.6	16.2	0.00	23.2	-6.9
2035	14.4	0.0	0.17	18.0	-3.4	9.6	16.2	0.00	23.2	-6.9

Table IV-12. AFW-5 Cost Summary Discounted Costs and Cost Effectiveness

Year	Discounted RE Costs	Discounted EE Costs	Total Discounted Costs	RE CE	EE CE	Total CE
	$2010MM			($2010/$tCO_2e$)		
2012	0.00	0.00	0.00			
2013	0.22	-0.35	-0.13			
2014	0.35	-0.67	-0.32			
2015	0.42	-0.96	-0.54			
2016	0.44	-1.22	-0.78			
2017	0.42	-1.45	-1.03			
2018	0.35	-1.66	-1.31			
2019	0.25	-1.84	-1.59			
2020	0.12	-2.01	-1.89			
2021	0.00	-2.15	-2.15			
2022	-0.14	-2.27	-2.41			
2023	-0.29	-2.38	-2.67			
2024	-0.45	-2.48	-2.92			
2025	-0.29	-2.55	-2.84			
2026	-0.38	-2.62	-2.99			
2027	-0.47	-2.67	-3.14			
2028	-0.57	-2.72	-3.28			
2029	-0.67	-2.75	-3.41			
2030	-0.68	-2.62	-3.30			
2031	-0.76	-2.49	-3.25			
2032	-0.83	-2.37	-3.21			
2033	-0.90	-2.26	-3.16			
2034	-0.96	-2.15	-3.11			
2035	-1.01	-2.05	-3.06			
Totals	**-5.8**	**-46.7**	**-52.5**	**-9.0**	**-28**	**-22**

Note: the cost effectiveness (CE) estimates are derived by dividing the total discounted costs by the GHG reductions shown in Table IV-9.

APPENDIX G. SENSITIVITY ANALYSIS ON POTENTIAL IMPACTS ASSOCIATED WITH PROJECTED NATURAL GAS PRICES FOR ES-1 (CENTRAL STATION RENEWABLE ENERGY INCENTIVES INCLUDING PROJECT DEVELOPMENT BARRIER REMOVAL ISSUES)

Memo

To: Frank Wen, Southern California Association of Governments (SCAG)

From: Randy Strait, Paul Aldretti, Hal Nelson, Dan Wei, and Adam Rose, Center for Climate Strategies (CCS)

CC: Jacob Lieb, Grieg Asher, and Kimberly Clark, SCAG
Thomas D. Peterson, Randy Strait and Paul Aldretti, CCS

Re: Sensitivity Analysis on Potential Impacts Associated with Projected Natural Gas Prices for ES-1 (Central Station Renewable Energy Incentives including Project Development Barrier Removal Issues (zoning, siting, etc.))

Date: November 7, 2012

Background

At the request of SCAG per comments received from the Technical Review Committee (TRC), a low-gas-price sensitivity analysis on ES-1 (Central Station Renewable Energy Incentives including Project Development Barrier Removal Issues (zoning, siting, etc.)) was performed to compare the effects of natural gas price forecasts on the micro- and macro-economic impacts associated with ES-1. Table 1 shows the natural gas price forecasts for the reference case (used for the original ES-1 analysis) plus two additional scenarios. For the original analysis of ES-1, the natural gas prices in the reference case are based on the 2011 California Market Price Referent (MPR) model. The low-gas prices selected by the TRC are $2.29/MMBTU in 2012 rising linearly to $5.00/MMBTU in 2035. These prices were apparently selected based on Henry's Hub gas prices from mid-2012 to reflect a low-gas price future. However, the Henry's Hub prices exclude many California-specific costs that are relevant and that the 2011 MPR appropriately included in its natural gas price forecast. These costs include the basis, or transportation costs, between Henry's Hub and California, as well as Utility Average Distribution Rates, Average Franchise Fee Surcharges, as well as Hedging Transaction Costs. In the 2011 MPR, these costs added $2.59 to the Henry's Hub gas price by 2035. Note that these costs would increase the $5.00/MMBTU gas price in 2035 by over 50%.

Microeconomic Sensitivity Analysis

The avoided costs of electricity in California are set by the MPR, a combined cycle gas turbine. Since fuel costs are the largest component of electricity generation from a combined cycle plant, the net effect of excluding the natural gas related fees is to lower the forecasted avoided price of electricity.

To estimate the new avoided costs based on lower gas prices, the TRC price assumptions were input into the 2011 MPR model. The 2011 MPR produces price forecasts through 2023, so avoided costs from 2024-2035 were held constant, as in the original analysis. Lower avoided costs subsequently reduce the cost effectiveness of renewable electricity.

Table 1. Natural Gas Price Forecasts for Original Reference Case and two Additional Scenarios

Gas Price Scenarios	2012	2015	2020	2025	2030	2035
2011 California Market Price Referent Gas Price (Reference or Base Case)[a]	\$5.26	\$6.12	\$7.54	\$9.39	\$10.84	\$12.57
TRC Gas Price Sensitivity Analysis[b]	\$2.29	\$2.64	\$3.23	\$3.82	\$4.41	\$5.00
TRC Gas Price Sensitivity Analysis with Relevant Costs[c]	\$3.31	\$3.71	\$4.83	\$5.88	\$6.68	\$7.59

[a] Baseline 2011 MPR reference case natural gas price forecast.

[b] Gas price forecast provided by TRC for sensitivity analysis excluding additional gas transportation costs, distribution costs, and franchise fees.

[c] Gas price forecast provided by TRC for sensitivity analysis plus additional gas transportation costs, distribution costs, and franchise fees.

Table 2. Estimated Net GHG Reductions and Net Financial Costs for ES-1

	GHG Reductions ($MMtCO_2e$)			Net Present Value 2010–2035 (Million 2010\$)	Cost-Effectiveness (\$/tCO_2e)
Gas Price Scenarios	2020	2035	Total 2010–2035		
2011 California Market Price Referent Gas Price (Reference or Base Case)	11	11	265	\$5,025	\$19
TRC Gas Price Sensitivity Analysis	11	11	265	\$21,230	\$80
TRC Gas Price Sensitivity Analysis with Relevant Costs	11	11	265	\$15,912	\$60

Macroeconomic Sensitivity Analysis

The macroeconomic analysis was conducted for the TRC Gas Price Sensitivity Analysis scenario (without additional relevant costs) using the microeconomic impact results as inputs to the 3-region SCAG REMI PI+ 169-sector model. Table 3 presents the results for the reference case and the low natural gas price sensitivity case. The results indicate that with an assumption of about 50% to 60% lower natural gas prices throughout the entire forecast period, the macroeconomic performance of ES-1 will become worse as compared to the reference case. Compared with the reference case results, the losses in employment and GDP will be 31% and 38% higher, respectively. This is because the lower natural gas prices would lead to lower avoided costs of the displaced natural gas combined-cycle (NGCC) generation, and thus reduce the cost effectiveness of the renewable electricity comparatively. In other words, the lower price of natural gas makes renewables relatively more expensive and less competitive compared with the displaced NGCC generation.

Table 3. Sensitivity Test on the Projected Price of Natural Gas used in the Displaced NGCC Generation for ES-1 (RPS)—TRC Natural Gas Price Assumptions

		2011 California Market Price Reference Gas Price (Reference or Base Case)	**TRC Gas Price Sensitivity Analysis**
Differences from Baseline Level (2011-2035)			
Employment (annual average)	Jobs per Year	-15,962	-20,973
Gross Domestic Product (NPV)	Millions 2010$	-23,908	-32,981
Output (NPV)	Millions 2010$	-36,643	-50,238
Disposable Personal Income (NPV)	Millions 2010$	-17,792	-27,337
Percent Change from Baseline Level (2035)			
Total Employment	Jobs	-0.1494%	-0.1980%
Gross Domestic Product	Millions 2010$	-0.1718%	-0.2326%
Output	Millions 2010$	-0.1745%	-0.2341%
Disposable Personal Income	Millions 2010$	-0.1649%	-0.2435%

In the "*Draft Macroeconomic Impact Analysis Results for Energy, Commerce, and Resources (ECR) Policies*" memorandum submitted to SCAG on June 11, 2012 (and a revised version submitted on July 25, 2012), a sensitivity test was also performed for ES-1 with the assumption that natural gas prices for the forecast period would be 50% higher than the prices used in the reference case. The changes in the natural gas price projections affect avoided natural gas expenditures of the displaced NGCC generation in ES-1. Table 18 in the July memorandum presents the macroeconomic impact results of this sensitivity test. The results indicate that a 50% higher projection on natural gas prices would improve the macroeconomic performance of ES-1 by about 30% in terms of both employment and gross domestic product (GDP) impacts. The higher price of natural gas makes renewables more competitive.