A COMPARATIVE ANALYSIS OF THE MACROECONOMIC IMPACTS OF STATE CLIMATE ACTION PLANS

by

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Abstract

More than thirty U.S. states currently have or are developing comprehensive, multi-sector plans to mitigate greenhouse gas (GHG) emissions and to achieve other goals, such as health, energy, and economic improvement. There has been considerable debate and discovery over whether climate change mitigation policies can advance all of these goals simultaneously, particularly job growth. In this paper, we compare the macroeconomic impact analyses we have done in five major states and regions (Florida, Michigan, Pennsylvania, New York, and Southern California) over the past five years to determine how well specific policies and portfolio-based plans have achieved macroeconomic goals, and how the approaches have varied or converged. We trace the selection, design, and analysis of specific policy options in these sub-national plans over time and identify how they have addressed competing goals and objectives, prioritized choices from a range of potential GHG mitigation options and mechanisms, included stakeholders and used collaborative technique, applied integrative metrics and tools of analysis, and been affected by the role and level of government support. Additionally, we perform a sensitivity analysis on our Southern California results with respect to two particularly important factors that affect the macroeconomic outcome: the price of natural gas and the capital and operating costs of renewable electricity generation alternatives. We compare the results we obtained using 2012 values of the key variables with results that would have been obtained had the 2008 values continued through 2012 to isolate baseline shift effects between periods. We apply the Regional Economic Models, Inc., (REMI) Policy Insight Plus Model to perform our analysis. The major input to the REMI model in each state is detailed, disaggregated data on the direct net costs or savings and effectiveness of GHG mitigation options estimated through a rigorous stepwise consensus-building process involving a broad range of stakeholders and technical experts.

I. INTRODUCTION

Lack of significant progress in comprehensive climate policy at the federal level in the U.S. over the past dozen years has left a void partially filled by actions at sub-national levels of government. More than thirty states and several hundred municipalities currently have or are developing comprehensive plans to mitigate greenhouse gas (GHG) emissions and to achieve other public policy goals, such as health, energy, and economic improvement. There has been considerable debate and discovery over whether climate change mitigation policies can advance all of these goals simultaneously, particularly job growth. In this paper, we compare the macroeconomic impact analyses we have performed for government agencies in five major states/regions over the past five years: Florida, Michigan, Pennsylvania, New York, and Southern California. We explain the similarities and differences in impacts in relation to several factors. First, we trace the selection, design, and analysis of specific policy options in these sub-national plans over time and identify how they have addressed competing goals and objectives, prioritized choices from a range of potential GHG mitigation options and mechanisms, the inclusion of stakeholders and used of collaborative technique, application of integrative metrics and tools of analysis, and the role and level of government support. We next analyze the differences in GHG reduction targets and timetables, as well as differences in the mitigation options used in each state. Then we examine the conditions affecting the estimation of the direct costs or cost-savings of mitigation options, ranging from how the estimates were made to how background conditions affect costs between states. Finally, we analyze the differences in the application of our macroeconomic modeling approach, ranging from changes in the methodology to background economic conditions. Additionally, we perform a sensitivity analysis on our Southern California results with respect to two particularly important factors that affect the macroeconomic outcome: the price of natural gas and the capital and operating costs of renewable electricity generation alternatives. We compare the results we obtained using 2012 values of the key variables with results that would have been obtained had the 2008 values continued through 2012 to isolate baseline shift effects between periods using the Regional Economic Models, Inc., (REMI) Policy Insight Plus Model to perform our analysis. REMI is the most widely used macroeconomic modeling software package in the U.S, particularly at the subnational level.

Macroeconometric forecasting models typically cover the entire economy in a “top-down” manner, based on aggregate relationships such as consumption and investment at broad macroscopic levels within sectors. The REMI Model differs in that it includes key relationships, such as local supply chains, in a granular bottom-up approach that can be applied to highly specific, locally customized policy actions and mechanisms within sectors. REMI also brings into play features of input substitution, labor and capital markets, as well as trade with other states or countries, including changes in competitiveness factors. The major input to the REMI model in each state is detailed, disaggregated data on the direct net costs or savings and effectiveness of GHG mitigation options estimated through a rigorous stepwise consensus-building process involving a broad range of stakeholders and technical experts.

II. Climate Action Planning

Comprehensive state climate action planning in the U.S. began in the 1990s in the U.S. following the decision to become a signatory to the UNFCC Rio Accord, and in the build-up to Kyoto international climate treaty negotiations. As an initiative of the U.S. EPA, many states were provided modest support to develop internal, agency-based climate mitigation plans. Since the year 2000, however, U.S. states and localities intensified their political interest and actions on climate mitigation, and shifted to more independent, stringent and standardized approaches to climate change mitigation, particularly the use of comprehensive, multi-objective, stakeholder-based planning processes that develop and analyze a range of sector-specific and cross-cutting policy actions and mechanisms. These processes borrowed heavily from techniques in corporate planning, community collaboration, and alternative conflict resolution, as well as advanced facilitative techniques used to build local and agency consensus in hazardous waste remediation (Peterson et al., 2008).

While the processes used in formulation of state climate action plans since 2000 have varied to a degree, most used similar process formats with consistent overall design and technique, but were customized to state and local conditions and characteristics. More variation exists in local government approaches, due in part to issues of scale and capacity. Some larger localities, including major metropolitan areas, have used processes quite similar to state comprehensive planning. The President's 2013 Climate Action Plan includes a range of federal agency actions similarly combined into a comprehensive format. Globally, green growth planning, Low-Emissions Development Strategies (LEDS), Low-Carbon Development (LCD), integrated economic/energy/environmental security (E3) planning, and clean energy and clean economic growth are all related to the fundamental goals, techniques, and structures of comprehensive climate action planning.

State level climate action planning processes have been open-ended to a greater or lesser degree in terms of key elements of self-determination, including the selection of policy actions to ultimately be included in a plan or portfolio, the design specifications and implementation mechanisms for each policy option, and the analysis of actions at an individual and aggregate level, including specific choices for each policy option analysis with regard to data sources, methods, key assumptions, and methods for addressing uncertainty. In turn, these decisions have been influenced by design of the decision-making process, including leadership goals and objectives, stakeholder selection and role, agency participation and role, consensus-building decision models, decision criteria, timing, and the level and type of technical and facilitative assistance.

Each of the four states and the region analyzed in this study were drawn from a sample of 24 comprehensive planning and analysis processes supported by the Center for Climate Strategies (CCS). Each used a similar format, but with potentially important variations in design, context, and outcome. In general the processes were structured in a logical sequential decision-making system involving the steps outlined in Appendix A:

Table 1 provides a comparison of key elements of process design and analysis used by each of the five planning processes in this study. Overall, each used a similar format for comprehensive, multi-objective, stepwise planning and analysis, as well as common and generally accepted principles and guidelines for analysis, and an organized group process for customizing actual selection, design, and analysis of individual policy actions to local preference. They also used a significant amount of third party facilitative and technical assistance to support and leverage the expertise and interests of local stakeholders and technical practitioners. In addition, each of the jurisdictions faced similar dilemmas in terms of reconciling emissions reduction goals with energy and economic dependency, and the need to tread carefully in order to find synergistic solutions. This overall system is well documented for each process in the form of an MOU and work plan that details all elements of the decisional process. The processes also have some differences and other contextual circumstances that could affect outcomes. We have profiled a key set of these variables in Table 1 and discuss some of their potential implications in Appendix B:

Table 1. Summary Characteristics of Planning Process Design and Outcomes

State/ Region	Convening Authority	Consensus Model	Stakeholders	Technical Work Groups	Time Frame	Facilitator and Technical Analysts	Levels of Consensus
FL	Governor, via Executive Order; Chaired by Secretary of Florida Department of Environmental Protection	Open process, nonbinding recommendations by stakeholders based on work group recommendations, evaluative facilitation, independent & neutral facilitation & technical analysis, formal voting that sought but did not mandate consensus	28 members from within state appointed by governor's office on agency recommend- ation	100 additional members appointed similarly; stakeholders & additional work group members self- appointed to one or two technical work groups with agency approval	9 mos	CCS; five of 15 analysts worked on no other states/regions in this sample study	50 quantified recommendations; unanimous consent ultimate reached for all but a few options, with the remainder by super majority
MI	Governor, via Executive Order; Chaired by Director of Michigan Department of Environment	Open process, nonbinding recommendations by stakeholders based on work group recommendations, evaluative facilitation, independent and neutral facilitation and technical analysis, formal voting that sought but did not mandate consensus	33 members from within state appointed by governor's office on agency recommend- ation	50 additional members appointed similarly; stakeholders and additional work group members self- appointed to one or two technical work groups with agency approval	12 mos	CCS; six of 19 analysts worked on no other states/regions in this sample study	33 quantified recommendations; unanimous consent ultimate reached for all but 2 options, which were by simple majority

NY	Governor via Executive Order; Chaired by Senior Staff of New York State Energy and Research Administration	Open process for early decisions and closed agency process thereafter	15 government members to an oversight council with final decisional authority 20 citizen stakeholders appointed by governor's office on agency recommend-ation	Stakeholders and agency staff appointed by agency to one or two technical work groups with agency approval	24 mos	CCS; seven of 17 analysts worked on no other states/regions in this sample study	
PA	Legislation, Chaired by Secretary of Pennsylvania Department of Environmental Protection	Open process for early decisions and closed agency process thereafter	18 members from within state appointed by agency under legislative guidelines	No additional members appointed; stakeholders appointed to one or two technical work groups by agency	12 mos	Agency staff with CCS assistance; half of the analysts worked on no other states/regions in this sample study	52 recommendations by work groups; formal voting not used; agency determined when and how to proceed
SCAG	Directive of Executive Director with Approval of Governing Council, Chaired by Executive Director	Open process for early decisions and closed agency process thereafter	30 members from within state appointed by agency director	No additional members appointed; stakeholders appointed to one or two technical work groups by agency	24 mos	CCS; four of 14 analysts worked on no other states/regions in this sample study	42 quantified recommendations made by agency decision following unanimous consent to study all 42 by stakeholders

Convening authority. Without leadership from the top collaborative processes have difficulty tacking high stakes, controversial, and complex issues as is often the case with climate change. High level stakeholders and experts will not typically invest the time and trouble needed in such negotiations without knowing that their voice is important and will be heard. Each of the five processes we study here were directed convened by a governor or agency head acting in response to executive or legislative authority at the highest levels, or both. So the small variation in convening authority should not have resulted in significant change in process outcome. All were formal, public, high profile convenings.

Consensus model. The design of the decisional process and the facilitative techniques to achieve consensus, as well as its definition, have a major impact on process outcomes, including policy selection, design, and analysis. The role of the facilitator as a neutral and expert party that enables self-determination and evaluative capacity of stakeholders versus an inside partial and or non-substantive process manager is one of the most critical. Often agencies will opt for the latter when controlling processes directly, by appointing a chair, or by selecting a facilitator, and this practice is frequently encouraged by advisory group rules and requirements for states that stipulate minimum standards for openness without providing best practice guidance to match issues.

Facilitators. One key determinants of success in resolving conflict and finding expert solutions is the role and quality of facilitation. In each of the five processes, the neutral evaluative facilitation role was used for all or most of the early stages of policy screening and selection. This has proven to be the most important phase of planning processes in terms of setting a detailed agenda for policy design and analysis that follows. In some of the processes, agencies took over the remainder of the process, or most of it, while in others open stakeholder process was continued. The effects of this shift are probably less significant that if the early stages of the processes were conducted with different facilitative approaches, but could have impacted some of the approaches at later stages by removing the drive for local customization, and relying on current, conventional, or standardized approaches. The facilitators for the early stages of each of the processes were either members of CCS, or coached by CCS through the process according to the work plan and neutral, evaluative facilitation model. Each CCS facilitator was required to abide by model codes of conduct for mediators that ensure competence, impartiality, freedom of conflicts of interest.

Analysts. One of the hallmarks of ineffective advisory group processes is the lack of adequate technical support to analyze key issues, or the potential bias injected by analysts. Both can lead to a lack of credibility and commitment, and can reduce the reliability of estimates of the feasibility of policy options. To guard against this, procedural safeguards can be used that ensure a combination of competence, impartiality, freedom of conflicts of interest (such as model codes of conduct for mediators) and that they are working at in true collaboration with stakeholders as opposed to a separate client, such as an agency or vested interest. In each of the five processes analysts were subjected to all of these safeguards. In addition, a significantly different group of analysts was used across processes, typically involving a quarter to half who did not work on more than one process, and an equal percent that did not work on more than two. So, the membership of the analyst group does not appear likely as driver of variation across processes. It is more likely that stakeholder and agency decisions varied.

The methods used by analysts could have forced convergence or divergence of outcomes, potentially. In each of the five processes, methods of analysis were stakeholder or agency driven and resulted in a blend of similar and different tools, but not a strong pattern in either direction. This was true also for data source selection, and the establishment of key assumptions. Each varied by process but had common elements that could have been affected by time period (e.g., pre versus post-recession), or regional trends. However, the processes were diversified over time, region, and other variables so it does not appear these were a major determinant of differences or commonality across processes.

Stakeholders and Technical Work Groups. The size of the stakeholder group could also play a role. Where too few stakeholders and work group members exist, they lack sufficient expertise across issue areas to problem solve, and will often default to agency or consultant recommendations, or to a risk-averse approach. Where too many are involved the process may truncate the number of issues it covers due to overload of participation. Each of the five processes avoided overload, but some had a small enough number of participants that, when combined with agency facilitative control, could have resulted in agency and consultant driven approaches that were not fully localized or optimized across opportunities for synergy. Voting methods can play a key role, particularly where voting is not explicit, it is not coerced, or where it is not combined with the capacity to take issues back to the drawing board for further conflict resolution. In some of the five processes, voting was either implicit or not combined with much iterative conflict resolution (using analysis as a performance testing procedure) and may have resulted in higher costs, and lower benefits to options than otherwise possible.

Of course, using the same stakeholders and technical work group members across processes could lead to possible convergence. Each of the five processes used completely separate groups. The same is possible where agency control dominated certain phases, but the agencies involved were independent and of different parties. On the other hand, it is possible that the independence of participants and agencies could lead to divergence, but the CCS team provided each robust information about activities in other jurisdictions such that every process had access to information about activities outside their jurisdiction. This combination of full information as well as full opportunity to customize with locally preferred or derived information makes it unlikely that the information base drove either convergence or divergence. It is more likely attributed to underlying issues and context in each process.

Timing. The lack of sufficient time to accommodate a learning curve and iterative conflict resolution process that proceeds through numerous steps can limit the degree of difficulty that the planning process can address. Time was not a major limiting factor as an isolated variable in the five planning processes – although the nine-month period for Florida pressed the limit. But the quality use of the time by process managers may have varied since some of the longer processes were the result of project pauses and slow-downs that could have affected continuity and depth of stakeholder involvement.

Level of Consensus. Many advisory group processes do not use voting procedures and make it difficult, if not impossible, to determine the level of support for a specific recommendation. As a result, it is difficult to determine political feasibility. In addition, the lack of formal voting (a number of techniques can be used) also makes it difficult to assess the need for alternative approaches to policy selection, design, or analysis to resolve conflicts and or capture synergies. Recommendations may thus lack reliability and or quality, particularly in terms of fully achieve cost minimization and benefit maximization. The lack of formal voting, combined with steering behavior by agencies or facilitators, can also disenfranchise a stakeholder group rapidly. Inappropriately or ineffectively used voting can also lead to suboptimal results and disenfranchisement. The five processes used a combination of techniques. In some, formal open voting with iterations to improve results was used throughout. In others it was only used to a greater or lesser degree at early stages of policy screening, leaving agencies and analysts to collaborate on the most feasible policy design and analysis approaches. It is not clear what effect this had on results. It does appear that final policy recommendations, including selection, design, and analysis were widely supported by stakeholders in all processes, with minor exceptions.

III. Progress and Current Status of State Climate Action Planning and Implementation

State climate action planning expanded in 2003 with early initiatives by Connecticut, Arizona, California, Maine and Rhode Island and peaked in 2008 with the advent of the change in Presidential leadership and the recession. By then, more than half of the U.S. states had completed plans. Since that time, states have been more reluctant to seize leadership on the issue and have turned to other priorities, including the economy. Many have preferred to play a wait and see game with respect to Presidential actions, unlike the previous era

However, important related activities have progressed during this time, including implementation, innovation, integration with national programs, and integration of economic and energy activities. The American Recovery Act of 2009 (ARA) provided historic levels of investment in energy efficiency and renewable energy that have been used by states, tribes, and localities to implement GHG mitigation and clean energy actions. The inclusion of these elements in ARA occurred during a period in which the outcomes of state climate action planning macroeconomic analysis and other policy processes were documenting the positive potential links between GHG mitigation and economic development (CCS White papers on climate and economic stimulus, 2009). Since that time states and stakeholders have turned more toward the recognition that energy and environmental policy may be a significant pathway to economic growth and jobs, and that global trends toward sustainability and security may be a market opportunity. For instance, the West Coast Clean Economy Report (CCS, Globe 2012) articulated the use of policy instruments for GHG mitigation as a tool to capture and enhance regional growth and investment associated with the emerging “clean economy”, estimated at $2.3 trillion by 2020 (Bloomberg, 2012).

In addition to the four states and one region of focus in this paper, forward movement on climate actions planning is once again gaining momentum. In 2011 Kentucky completed a comprehensive climate action plan. In July 2013 Maryland Governor O’Malley released the implementation plan for the Maryland Greenhouse Gas Reduction Act. In Pennsylvania, mandatory review and updates to the state climate action plan were completed in September 2013. In Minnesota, Governor Dayton is reconvening the Minnesota Climate Action Advisory Group in effort to refresh and target actions toward economic development. Incoming Governor Garcia of Puerto Rico launched five executive orders on climate change on February 28, 2013, including mandates for a GHG mitigation plan. Oregon launched and completed the first phase of its 2010 Energy Plan, including GHG mitigation options as a part of a new paradigm for 21st Century Energy Plans that are fully comprehensive.

Many other examples of targeted implementation actions, or new energy and economy initiatives exist and show the influence of comprehensive state climate action plans. This includes resistance to rollbacks of existing policies, such as RPS programs. In North Carolina, legislative attempts to repeal the state RPS were beaten largely by economic interests, such as local solar power technology producers, that have prospered as a consequence of the law.

States have also used the results of state climate action planning processes to inform their choices on the application of Clean Air Act authority, including current deliberations over Section 111d rules for emission standards for existing power plants. The interest by states in creative, customized use of the State Implementation Plan (SIP) mechanism to meet new standards is heavily influence by the feasibility analysis and consensus building on multi sector approaches to GHG mitigation. For instance, Kentucky Governor Beshears, as well as the Northeastern Regional Greenhouse Gas Initiative (RGGI) states, have called for mass-based (tonnage versus emissions rate) standards that will, in their experience, better enable supply and demand side actions across sectors that also provide economic and energy benefits.

As we look forward to the next political and economic cycle in the U.S., states and stakeholders face a bit of a paradox. They recognize on the one hand that past experience has shown positive macroeconomic results and potential for carefully selected, stakeholder based GHG mitigation policies. Yet they also understand that the economic recession has fundamentally redefined U.S. perspectives on climate, energy, and economic policy, and that not all attempts at policy development were successful at engineering job gains or gaining acceptance by the economic community. At the same time, they also know that climate change vulnerability concerns are growing in the face of extreme weather and other events, and are refocusing public and policy maker awareness on climate change. And international interest in climate change policy is not declining. As a result, the issue is not going away, but may require a fresh look. This is an important time to learn as a much as possible about the underlying drivers for past success and failure on GHG mitigation as we navigate new circumstances and actions at the national and subnational levels.

IV. MICROECONOMIC ANALYSIS

A. Estimation of Direct Costs of Mitigations Options

As previously described, microeconomic analysis of each of the sector-based and cross-cutting policy options in each of the five plans was conducted through an organized stepwise process that first established a set of priority actions for further development, then draft policy design specifications, and next a series of analysis decisions for each action regarding data sources, methods, assumptions and uncertainty. These decisions were made within a set of overarching principles and guidelines to ensure consistency and adherence to best practice standards for energy and economic modeling. They were further analyzed by sector-based guidelines for common assumptions and approaches. And they followed by open, individual consideration of the best approaches for each option. Individual option analysis was followed by aggregate, or interactive analysis. All of these decisions were supported by independent facilitative and technical assistance by qualified, impartial experts coordinated by CCS, as well as agency personnel, and the very substantial practitioner expertise of stakeholders and work group members. The degree to which agencies controlled decisions varied across the five processes.

The documentation of policy design and analysis choices for each of the policy options analyzed in the five plans is documented in a standard Policy Option Document (POD) that delineates a series of key elements that include: 1) a general lay description of the action; 2) technical policy design specifications and associated metrics for level of effort, timing, coverage of parties, eligibility definitions, and mechanisms; 3) a policy-specific definition of the baseline, including key related policies and programs already in place or planned; 4) choices of data sources, methods, key assumptions, and uncertainty techniques; 5) results of analysis for direct impacts, including GHG reductions and net costs/savings, and references to work sheets and other models and modeling results; 6) results of macroeconomic and other secondary impact analysis, including model use and specification; 7) level of consensus reached by the group, either simple majority (rarely sufficient for acceptance), super majority of about 80 percent (the typical threshold for acceptance), or unanimous consent; and 8) disclosure of specific barriers to consensus in technical terms (e.g. costs viewed as too high by some who object, etc.).

The results of analysis are aggregated in table form for each plan as a series of line items, individual policy results, as well as aggregate/interactive results within and across sectors to capture dynamics between options. Results are also portrayed as a Marginal Abatement Cost (MAC) curve that shows the cost-effectiveness and magnitude of each option on a comparative scale.

The results across the five processes can be compared numerically as well as circumstantially by examining process design and analytical choices for each, provided in summary form. Statistical review and sensitivity analysis can be conducted, including comparison of macroeconomic results. Meta-analysis of state climate action plan REMI analysis (Wei, Roe and Dormady, 2011) shows six key factors from microeconomic results and linkages that affect macroeconomic outputs. These include: 1) the degree to which policy options are low cost or cost-effective in comparison to alternatives and expand economic efficiency and corollary effects on labor spending; 2) the degree to which they cut energy needs and costs and free up capital for reinvestment in labor and other uses, particularly in high energy cost situations; 3) the degree to which actions shift energy supply away from imports (such as oversees petroleum) and to indigenous sources (such as local bioenergy) and cut capital outflows and macroeconomic output; 4) the degree to which mitigation actions cause shifts to local versus distant supply chains and support local labor; 5) the degree to which policy actions stimulate additive new investment to the jurisdiction and expand macroeconomic inputs; and 6) the degree to which new actions are labor-intensive in comparison to current and conventional actions, even if at a higher cost (up to a point).

By focusing on these underlying drivers for macroeconomic performance, stakeholders and agencies can more proactively select and design policies with the best microeconomic characteristics to support positive macroeconomic results.

B. Comparison of Micro Results

Figure 1 presents the marginal cost curves for the direct mitigation of GHGs in four states and the Southern California Association of Governments (SCAG) Region (including two versions for New York State). They are in the form of “step functions”, where the horizontal axis represents the percentage of GHGs that can be reduced, and each horizontal line segment of the “curve” represents the amount that can be reduced at the site by a given mitigation option (the length of each segment represents that percentage of total GHG emissions in that state). The vertical axis represents the cost of mitigation, beginning with negative costs (or cost-savings) below the $0 axis and moving successively up through the positive cost (cost-incurring) range. The cost for any single mitigation option (line segment) is actually an average cost for it over all applications in a given state. The term “marginal cost curve” pertains to the entirety of the cost curve, which depicts the increasing per unit GHG mitigation costs incurred as higher percentage reductions are attained. This shape reflects the diminishing returns from GHG mitigation, and practically every economic (and physical) activity. The curve starts at cost savings of about $150/tCO2e to cost-incurring of more than $100/ tCO2e (the higher cost options are not shown in the figure to conserve space, but the reader is referred to Appendix Table B).

Several aspects of the curves should be noted for comparison:

- Each state has an option that results in a marginal cost savings of more than $100/
- Each state has an option that results in a marginal cost higher than $150/
- Each state has numerous cost-saving options; specifically, the following percentages of GHG emissions can be obtained by cost-saving options: New York 10%; Pennsylvania 16%; SCAG 20%; Michigan 24%; and Florida 26%

Not shown in Figure 1, but presented in Appendix Table B, and discussed in more detail below, is the similarity in the costs of many of the individual mitigation options across jurisdictions.

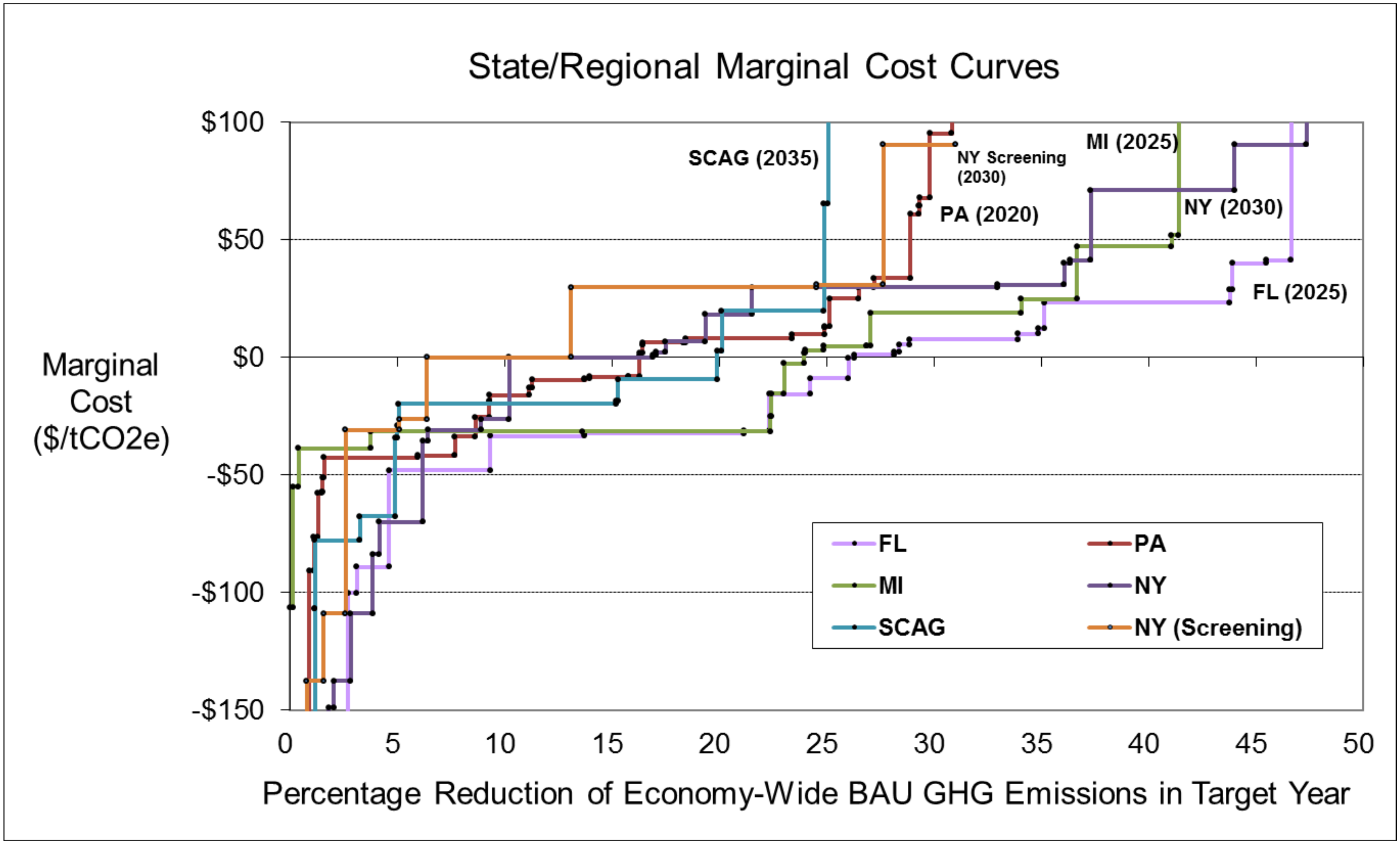

Figure 1. Comparison of State/Regional Marginal Cost Curves

V. MACROECONOMIC IMPACTS

A. Macroeconomic Modeling

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 (Rose and Dormady, 2011).

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 results, REMI PI+ 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 Pennsylvania, Michigan, New York, and Florida (Miller et al., 2010; Rose et al., 2011; Wei and Rose, 2011; Rose and Wei, 2012).

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 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, and capture the substitution effects and other price-quantity interactions. 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.

B. Micro-Macro Linkages

Before undertaking the macroeconomic 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 involves the selection of appropriate policy levers and economic linkages in the REMI Model to simulate the channels of influence of each policy. The input data include sectoral spending and savings over the full planning period for each option. In Table 2, we present the RPS policy option as an example to illustrate how we translate, or map, the TWG results into REMI economic variable inputs.

In Table 2, the first column lists the various micro to macro modeling linkages included in the analysis. Column 2 presents the micro level quantification analysis results of each mitigation option in terms of its costs and savings. The third column presents the corresponding economic variables in the REMI Model used in the simulation and their position within the Model (i.e., to which one of the five major REMI Model blocks the policy variables belongs). The last column indicates whether or not the policy shock would yield positive or negative impacts on the economy.

C. Comparison of Macro Results

Some aspects of the macroeconomic impacts of the CAPS in our five states/regions are presented in Table 3. Though the planning periods, target years, emission reduction requirements, and number of mitigation options differ a bit, we can still undertake a worthwhile comparison as follows:

- Each state/region is projected to achieve direct cost savings ranging from $6.2 billion to $31.2 billion in the target year.
- Each state/region is projected to achieve GSP gains ranging between $2.6 billion to $14.4 billion.
- The percentage change in GSP ranges from a low of 0.11% in New York and 0.12% in the SC AG Region to a high of 2.3% in Michigan. More specifically, the per capita GSP gains range from a low of $133 in New York to a high of $1,103 in Michigan. While the spread between the highest and lowest impact is only about five times for GSP gains in terms of total dollars, the spread of the per capita gains is about eight. Moreover, the only reversal in rank order of states between the total GSP levels and per capita levels is between Florida and Michigan.
- All states/regions are projected to benefit from r sizable employment gains in the target year, ranging from a low of 53 K jobs in Pennsylvania to a high of 148 K jobs in Florida. The rank order between GSP gains and job gains among the states is the same in terms of job levels, though in percentage terms Michigan comes out on top.

Table 2. 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

Linkage	Microeconomic Quantification Results	Policy Variable Selection in REMI	Positive or Negative Stimulus to the Economy
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
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

Table 3. Comparison of State Climate Action Plan Micro and Macro Impact Results

State / Study Year	Planning Period	Number of Policy Options	GHG Reduction Target	Direct Net Costs/Savings by Target Year	Net Job Gain in Target Year	GSP Gain in Target Year	GSP Gain in Target Year per Capita
Florida (2008)	2008-2025	50	33% below 1990 levels by 2025	$31.2 billion savings	148,300 (1.13%)	$14.4 billion (0.87%)	$745.7
Pennsylvania (2009)	2009-2020	52	1990 levels by 2020	$12.7 billion savings	53,000 (0.71%)	$3.6 billion (0.48%)	$280.6
Michigan (2009)	2009-2025	53	20% below 2005 levels by 2020	$11.5 billion savings	129,486 (2.7%)	$10.9 billion (2.3%)	$1,103.0
New York (2010)	2011-2030	41 (12 in macro screening)	40% below 1990 levels by 2030	$6.2 billion savings	66,352 (0.49%)	$2.6 billion (0.11%)	$132.9
SCAG (2012)	2012-2035	30	1990 levels by 2020	$26.3 billion savings	89,367 (0.71%)	$2.6 billion (0.12%)	$141.1

In Table 4, we compare the top two individual options in terms of positive and negative impacts on GSP and employment:

- In general, Residential, Commercial, and Industrial (RCI) mitigation options (in terms of energy efficiency and process improvements) dominate the top positive impact options. Transportation and Land Use (TLU) policies (in terms of Smart-Growth and Land-Use policies) are on top for NY and SC AG, respectively. Perhaps not surprisingly, the RPS is the most favorable option in Florida, because the state has such prime biomass, solar and wind renewable resources, and does not have much indigenous fossil fuel extraction activities to displace.
- The top two options in terms of employment gains are similar to the GSP gains, an even greater representation of GSP options. TLU options other than integrated transit and land use drop out because they are not very labor-intensive.
- The two major options leading to declines in GSP are most prevalently Energy Supply (ES) options (six of the 10 options including New York's PSD-10), followed by TLU options (three of 10). The remaining top negative option is Urban forestry in Michigan.
- The two major options leading to declines in jobs are most prevalently ES options (seven of 10, including two Power Supply and Demand (PSD-labeled, actually generically ES) options in New York. Again, the transportation options drop out because they are not labor-intensive.

Except for some of the more minor options in the New York study, we assume in the Base Case analysis that 50% of the private capital investment will come from the displacement of ordinary business investment on plant and equipment. In other words, only 50% of the private capital investment is additive to the state/regional economy. For New York, a 0% investment displacement assumption was adopted for the more minor options. In the Michigan, New York and SCAG studies, interest payments were separated out from the annualized capital costs, and simulated as stimulus effect to the financial sector. In the Florida and Pennsylvania studies, the entire amount of annualized capital investment was simulated as a stimulus to the sectors that provide GHG mitigation goods and services (such as Construction and Renewable or Energy-Efficiency Equipment Manufacturing sectors).

Table 4. Top 2 and Bottom 2 Policy Options in Terms of GSP and Employment Impacts

		Florida	Pennsylvania	Michigan	New York	SCAG
GSP Impacts	Top 1	ESD-5 RPS (+0.354%)	I-2 Industrial NG & Electricity Best Mgt (+0.151%)	RCI-1 DSM (+0.423%)	TLU-9/10/11 Smart Growth Policies (+0.075%)	TLU-1/2/3/7/9 Land Use Policies (+0.13%)
	Top 2	AFW-2 Urban Forestry (+0.161%)	RC-6 Re-Light PA (+0.136%)	RCI-2 High-Performance Bldgs (+0.359%)	RCI-7 Building Codes (+0.068%)	RCI-6 Water Recycling & Conservation (+0.11%)
	Bottom 1	ESD-6 Nuclear Power (-0.079%)	E-9 CHP (-0.135%)	AFW-7 Urban Forestry (-0.098%)	PSD-10 Nuclear (-0.010%)	ES-1 RPS (-0.17%)
	Bottom 2	ESD-8 CHP (-0.078%)	T-5a Pay As You Drive Insurance (-0.048%)	TLU-2 Vehicle Purchase Incentives (-0.013%)	TLU-2 Vehicle Purchase Incentives (+0.012%)	ES-2 Distributed Solar PV (-0.12%)
Employment Impacts	Top 1	ESD-5 RPS (+0.280%)	F-7 Urban Forestry (+0.208%)	RCI-1 DSM (+0.398%)	RCI-2 Energy-Efficiency Incentives (+0.152%)	RCI-2 Building Codes (+0.23%)
	Top 2	AFW-2 Urban Forestry (+0.305%)	RC-6 Re-Light PA (+0.177%)	RCI-2 High- Performance Bldgs (+0.339%)	RCI-7 Building Codes (+0.125%)	RCI-1 DSM (+0.23%)
	Bottom 1	ESD-6 Nuclear Power (-0.054%)	E-9 CHP (-0.094%)	TLU-2 Vehicle Purchase Incentives (-0.016%)	PSD-10 Nuclear (-0.013%)	ES-1 RPS (-0.15%)
	Bottom 2	ESD-8 CHP (-0.088%)	T-5e Speed Limit Reduction (-0.080%)	AFW-6 Reforestation /Afforestation (-0.008%)	PSD-6 Low-Carbon Portfolio Standards (+0.014%)	ES-2 Distributed Solar PV (-0.05%)

Table 5. Development of Methodology in the REMI Macroeconomic Impact Analysis

Climate Action Plan Study	Development in Methodology	Effect of Modification
Florida	Used a 70-sector REMI Policy Insight Model	n.a.
Pennsylvania	1. Started using the 169-sector REMI Policy Insight Plus (REMI PI+) Model, which has the Utilities sector disaggregated into Electric Power Generation, Natural Gas Distribution, and Water and Sewage Services.	Improves accuracy
	2. Corrected the missing linkage in the REMI model between the capital and production cost changes in the energy supply sectors and the energy prices to the downstream commercial and industrial customer sectors.	Properly incorporates impacts of energy price change
Michigan	Started separating the interest payments from the annualized capital costs, and added appropriate linkages to the financial sector.	Improves accuracy in simulating stimulus effect to the appropriate sectors
New York	1. Started using the upfront capital investment costs (calculated backwards from the annualized capital costs), rather than the annualized capital costs, to simulate the impacts on the policy investment stimulating sectors (such as Construction sector and Equipment Manufacturing sectors).	Improves accuracy in simulating stimulus effect in investment years
	2. Started using decomposition analysis in the REMI model to better reveal the impacts of various economic factors that affect the bottom-line macroeconomic performance of major policy options.	No effect on results
	3. Improved the methodology to simulate the impact of ordinary investment displacement; corrected the missing linkage in the REMI model between ordinary investment displacement and foregone productivity improvement.	Improves accuracy; Decreases the impacts

VI. ANALYSIS OF THE RPS

The results for the RPS are among the most variable across the states/region. These results in terms of GHG reduction potential, direct net cost, cost-effectiveness, and the job and GSP impacts are presented in Table 6. The macroeconomic impact for the SCAG region is the only one projected to incur negative impacts, and sizable ones at that. We analyze the differences in the RPS results in two ways: a direct comparison of potential causal factors and a sensitivity analysis for the SCAG results.

A. Direct Comparison of Causal Factors

Looking at year 2025, Table 9 shows that Florida and Pennsylvania have the lowest and SCAG and Michigan have the highest weighted average renewable generation costs. This consideration helps explain why the RPS policies in FL and PA yield the highest positive macroeconomic impacts among the five states/region and why the RPS policy in SCAG yields negative GSP and job impacts. However, this alone does not help explain why the RPS policy in MI also yields slightly positive macroeconomic impacts.

In terms of avoided costs of generation shown in Table 8, we note that Pennsylvania has the lowest and SCAG has the highest in year 2025, but this should make the SCAG RPS all the more beneficial, since the higher the avoided generation cost, the more attractive are renewables.

We can also examine natural gas prices (in Table 7), since gas generation, typically in the form of natural gas combined-cycle (NGCC), is the most prevalently displaced alternative. Again, focusing on the year 2025, we see that the natural gas costs in Michigan and the New York are just slightly higher than those in Southern California. Note that the higher the NG price, and thus the generation cost of displaced NGCC generation, the more attractive are the renewables. Of course, the comparison with New York is unfair, because our analysis there did not include any investment displacement effects, thereby biasing the results upward in comparison with other states/regions.

Thus, among the above three major contributing factors, only the renewable electricity generation cost helps explain the highly negative SCAG results in comparison with other states. In fact, the SCAG region has a natural advantage over three of the others, in that shift to renewables will not displace any coal miners and very few natural gas fieldworkers in the region, unlike Pennsylvania, for example.

Table 6. Impacts of State RPS/AEPS Options

Option / Planning Period	Total GHG Reductions in Planning Period (MMtCO2e)	Direct Cost Net Present Value (billion 2012$)	Cost-Effectiveness (2012$/tCO2e)	Net Job Impact in Target Year (person yrs)	GSP Impact in Target Year (billion 2012$)
FL ESD-5 (2009-2025)	319.0	-$10.3	-$32	23,370	$5.8
PA Electricity-4 (2007-2020)	75.9	-$0.7	-$9	8,863	$0.9
MI ES-1 (2009-2025)	129.5	$6.4	$49	2,021	$0.4
NY PSD-2 (2010-2030)	100.4	$1.9	$18	2,016	$0.2
SCAG ES-1 (2012-2035)	265.0	$5.2	$20	-15,962	-$3.1

Table 7. Comparison of NG Price Projections (2012$/MMBTU)

State/Region	2011	2015	2020	2025	2030	2035
Florida	$8.11	$7.86	$8.10	$8.59		
Pennsylvania	$6.34	$6.75	$7.89	$7.97		
Michigan	$8.60	$8.69	$9.83	$9.87		
New York	$8.02	$8.53	$9.17	$9.81	$10.51	
SCAG		$6.23	$7.68	$9.56	$11.04	$12.80

Table 8. Comparison of Avoided Generation Costs (2012$/MWh)

State/Region	2011	2015	2020	2025	2030	2035
Florida						
Avoided Generation Costs of NGCC	$74.21	$74.21	$74.21	$74.21		
Pennsylvania						
Pulverized Coal (Existing)	$50.37	$50.26	$50.68	$50.68	$50.99	
Peaker Gas (Existing)	$64.59	$67.92	$77.16	$82.04	$92.84	
Avoided Generation Costs (wtg avg)[1]	$51.82	$52.03	$53.38	$53.79	$55.14	
Michigan						
Avoided Generation Costs[2]	$66.98	$66.98	$66.98	$66.98		
New York						
Avoided Generation Costs (wtg avg)[3]			$74.76	$79.20	$76.87	$79.09
SCAG						
Avoided Generation Costs of NGCC	$91.18	$90.14	$90.14	$90.14	$90.14	$90.14

[1] 90% existing pulverized coal and 10% existing peaking gas.
[2] From Midwest ISO (technology not specified).
[3] Mix of Coal Steam, NG Steam, Oil Steam, and NGCC.

Table 9. Comparison of Weighted Average Renewable Generation Costs (2012$/MWh)

State/Region	2011	2015	2020	2025	2030	2035
Florida	$91.70	$85.68	$74.32	$73.09		
Pennsylvania	$97.41	$81.52	$80.38	$77.37	$72.69	
Michigan	$108.31	$112.98	$121.19	$125.65		
New York			$112.74	$108.26	$104.49	$104.18
SCAG	$136.83	$136.49	$134.02	$134.02	$134.02	$134.02

B. Sensitivity Tests

The RPS in the SCAG Region is the only one where the impacts are negative. The simulation of this option analyzes the impact of moving from the current 20% renewable electricity generation target to a 33% target by the year 2020 and to 40% by the year 2035. Our results (see Table 10) project an annual average loss of nearly 16 thousand jobs. As analyzed in Section VI.A., there are two major factors that affect the results. First is the generation cost of the renewable electricity generation. Comparing the weighted average renewable electricity generation in all the jurisdictions analyzed the SCAG Region has a much higher weighted average generation cost , especially with respect to FL and PA (FCAT, 2008; PA DEP, 2009; Miller et al.; 2011; Wei and Rose, 2012; CEDP, 2012).

Table 10. Macroeconomic Impact Analysis Results for Renewable Portfolio Standard in SCAG

Category	Units	2015	2020	2025	2030	2035	Jobs per Year / NPV
Total Employment	Jobs	-11,856	-15,762	-16,773	-17,813	-18,701	-15,962
GDP	M 2010$	-1,280	-2,010	-2,381	-2,690	-3,001	-23,908

Second, the price of the fuel used in the displaced electricity generation technology, the price of natural gas in the SCAG case, 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.

Several sensitivity tests were run to analyze how the changes in some key assumptions would affect the macroeconomic impact analysis results for the RPS option. We present the major ones below.

1. Renewable Electricity Generation 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. Conversely, increasing a baseline RPC can represent the attraction of new business into the region, due to aggressive industrial targeting efforts.

In the Base Case, the REMI Model utilizes projected RPCs, estimated using historical data, for the manufacturing sectors of renewable electricity equipment. For the RPS option, the weighted average of the default RPCs of the renewable electricity generation equipment manufacturing sectors 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.

The second and third numerical columns in Table 11 show the sensitivity test results of RPC. The results indicate that a 50% increase in the in-region supply of renewable generation equipment would improve the macroeconomic performance of the option but only slightly: the negative employment impact of RPS can be improved by 7%. In contrast, with 50% lower RPCs, the negative employment impact of ES-1 would be increased by 8%.

Table 11. Sensitivity Analysis Results for the RPS Policy Option in the SCAG Region

Category	Units	Base Case	50% Lower Equipment RPC	50% Higher Equipment RPC	50% Lower Capital Cost of Renewable Generation	50% Higher Capital Cost of Renewable Generation	50% Lower NG Price	50% Higher NG Price
Average Annual Employment	Jobs per year	-15,962	-17,341	-14,811	-311	-31,490	-20,047	-11,394
Gross Domestic Product (NPV)	M 2010$	-23,908	-27,282	-21,043	1,966	-49,322	-31,348	-15,621

2. 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 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 fourth and fifth numerical columns of Table 11. They indicate that, if the capital cost of renewable electricity generation can be decreased by 50%, the macroeconomic impacts of the RPS in the SCAG Region 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 would be more than doubled.

3. Projected Price of Natural Gas

In this sensitivity test, we assume that the price of natural gas for the displaced NGCC generation in the SCAG RPS policy option is 50% lower or higher than the price used in the Base Case analysis. Table 12 presents NG prices for various milestone years of the planning horizon in relation to our sensitivity bounds. MPR/2006 represents the prices that were assumed in background studies for the passage of AB 32, while MPR/2011 (Reference Case) is the data series used in the Base Case analysis. MPR-AEO/2013 represents the latest NG price forecasts. We can see that NG price forecasts have continued to drop over time, but are still within the +/- 50% of our sensitivity analysis. There has been a slight reversal in NG prices recently, but this has not yet affected future projections significantly.

The lower the price of natural gas, the less competitive are renewable electricity generation alternatives. As shown in the last two columns of Table 11, with a 50% lower projected NG price, the negative employment impact of RPS would be increased by about 25%. A 50% higher projected NG price would improve the macroeconomic performance of RPS by about 30% in terms of employment impact. Current projections of natural gas prices are mid-way between the Base Case and the 50% lower price case, and the associated economic impacts would be mid-way as well.

Overall, the results are most sensitive to capital costs of renewable electricity generation and least sensitive to changes in the RPCs. The negative impacts from the RPS on the SCAG Regional economy

Table 12. Alternative Natural Gas Price Forecasts (in 2010$)

Forecast/Year	**2015**	**2020**	**2025**	**2030**	**2035**
MPR/2011 (+50%)	8.22	8.54	9.12	9.29	9.42
MPR/2006	6.25	6.59	6.60	6.59	n.a.
MPR/2011 (Reference Case)	5.48	5.70	6.08	6.19	6.28
MPR-AEO/2013	3.54	4.50	4.80	4.65	4.83
MPR/2011 (-50%)	2.74	2.85	3.04	3.10	3.14

Source: California Public Utilities Commission (CPUC) Market Price Referent (MPR) (2006 and 2011); EIA AEO (2011 and 2013).

presented here are upper bounds, because they do not include the effects of California's Cap & Trade Program initiated in late 2012. All utilities in California will benefit from the program whether they are net buyers or sellers of allowances. Net sellers will earn revenues to offset their costs, and net buyers will be able to use allowances to avoid mitigation costs (including shifts to renewables) that exceed the equilibrium allowance price.

VII. CONCLUSION

We offer the following preliminary conclusions:

- It is more likely that stakeholder and agency decisions varied than did the membership of analyst groups that assessed GHG mitigation options.
- It is more likely that underlying issues and context in each state/region decision process caused greater variations in results than did the underlying information base.
- There are considerable similarities in the policy options implemented across the states. Many major options, such as RPS, DSM, CHP, Building Codes, Alternative Transportation Fuels, Transit, Land-Use, Soil Carbon Management, Afforestation/Reforestation, Waste Recycling, etc. are implemented in most of the states. There are also options that are only implemented in just one or two of the five states/region; however, they are mostly minor options in terms of both GHG reduction potentials and macroeconomic impacts.
- Many of the options yield similar impacts in terms of both per ton GHG reduction cost and GSP and job impacts. For example, in all the states, the major RCI options are estimated to result in net cost savings and GSP/ job gains over the entire planning period.
- There are also cases where similar options yield very different impacts across states. This can be explained by the differences in mitigation goal, policy design, and background conditions. For example, RPS is a cost-incurring option in all states except for Florida, due to the availability of abundant and relatively cheap renewable resources in that state. The SCAG region is the only one projected to incur negative GDP and job impacts from implementing RPS. This is largely because of the region's much more stringent RPS goal and high renewable generation cost..

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Appendix A. Decision-making system for Climate Action Planning

- **Goals and Objectives**. These are established by the convening party, typically through a directive (such as an executive order) made by the governor or a director of the primary agency of jurisdiction. The goals and objectives of the process are translated into a work plan and facilitative process that is designed to achieve end results subject to a set of conditions and requirements, such as collaboration by stakeholders, feasibility analysis, relevant decision making criteria, time frame, and definition of a final product in the form of a report and record of decisions. The directives and work plans for each of the five states and regions are available at the CCS website.
- **Early Assessments.** Preliminary fact-finding to support launch of the collaborative planning process, including the development of a GHG emissions inventory and forecast (baseline) assessment, and the development of a catalog of potential mitigation response options. The catalog of potential actions establishes a framework of sectors and sub-sector activities that provides a full range of possible choices on the selection of policy options.
- **Stakeholder and Work Group Membership.** Other important organizational decisions are made that can affect process outcomes. This includes the selection of stakeholders and their designation to one of more technical work groups. The size of these advisory groups has ranged from less than 20 to over 50, and the addition of other participants to work groups to ensure full representation and local expertise has ranged from an additional 20 to 100 participants. The level of participant may vary but frequently involves senior executives or managers from organizations, supported by their management and technical staff.
- **Roles and Responsibilities.** Roles and responsibilities of stakeholders and other parties can affect process outcomes as well. In a fully open process, stakeholders are free to exercise individual choice when voting on decisions at each stage of the process and can select from a full-range of options. In closed processes, these decisions are constrained, and stakeholders may only be allowed to provide review and comments, without any explicit decisional role. In such cases, decisions are made either exclusively or predominantly by agencies and their assistance providers, such as consultants. Processes led by CCS have been used an open process model and been independently reviewed (Mazmanian et al., 2012) to determine the degree to which stakeholder selection differences explained variation in outcome, with findings generally indicating that effects are minor within the bounds of the general levels of diversity and seniority used.
- **Decision Procedures.** The methods by which decisions are made are also important, including whether or not formal voting procedures are used, the degree to which decisions are explicit and supported by full information, the freedom of stakeholders to express views and make choices, the degree to which decisions are constrained and or guided by agencies, and facilitative technique. Processes that are highly constrained lack the capacity to innovate and or build consensus. The role and technique of the facilitator can range from an impartial party who enables informed and open choices, to an inside partial who is expected to advance predetermined outcomes by the convener. In addition, facilitative technique can range from evaluative mediation, whereby participants are provided enabling information and assistance to evaluate their own choices and work with facilitative assistance on complex technical issues, to procedure assistance that does not provide technical knowhow and support. In the latter case, stakeholders are less able to contribute expertise and commitment. Where stakeholders have a higher degree of control and technical support, they are likely to be more expert and ambitious. In each of the five processes used for this sample study, CCS served as an impartial facilitative

and technical assistance provider using evaluative facilitation techniques (see, e.g., Booher and Ennis, 2012).

- **Review of Early Assessments.** Following the early assessment and organizational phase, participants are asked to work their way through a series of policy and technical-oriented decisions. The first is to review the draft GHG baseline assessment, and identify potential needs for modification in terms of best available data sources, methods and key assumptions, or issues of uncertainty. Group decisions are facilitated regards modifications and directed toward analysts for revision and additional review. The second major decision is the review of the catalog actions to become familiar with its contents and the underlying concepts and drivers of emissions reductions. These catalogs, available for each of the five processes on the CCS website, started with several hundred potential actions across sectors, drawn from actual examples inside or outside the jurisdiction, of activities that can reduce GHG emissions, whether as a direct objective or by-product. This early learning curve period, assisted by review of the GHG baseline assessment, is critical in building common ground and expertise among the group.
- **Policy Option Screening and Priorities.** Following a learning stage, the group is asked to identify additional actions that may be missing but of potential interest. This can include entirely new and innovative actions, or enhancements to existing or planned activities. Next, each of these actions is benchmarked to the degree possible on a range of screening criteria. Benchmarks may be assigned through database review, or expert practitioner judgment within the group. Finally, multi-criteria analysis (MCA) is used to narrow the long list of potential policy options to a shorter list of top priorities for further development. This selection process enables participants the opportunity to find the best fit potential solutions for their jurisdiction, subject to additional development and testing of policy options. Experience in each of the processes has shown that this MCA procedure, when fully participatory and informed, is robust in terms of screening for actions that ultimately meet stringent feasibility and consensus requirements. Where processes are not fully participatory or informed, or where screening criteria are inadequate or misapplied, both type 1 and type 2 errors are significantly more likely.
- **Policy Design**. In order for each draft policy action to be subjected to feasibility analysis, it needs to become explicit in terms of key design parameters that include level of effort, timing, coverage of parties, eligibility definitions, and mechanism. Mechanisms can affect both political and economic performance, and include a range of choices, such as codes and standards, funding assistance, price incentives, technical assistance, disclosure, information and education, voluntary agreements, or hybrids of these and other approaches. The design of each policy measure is an open process (likened to making a statue from a ball of clay) unless the option in question is a standard measure that can only be adopted or not adopted in a predetermined design format (such as state clean car standards established under the Clean Air Act). Decisions on how to custom design and implement each policy measure are crucial in terms of their performance against metrics of analysis, as well as their level of consensus. It is very typical for actions to be highly customized to local needs in terms of design and implementation mechanism, and the role of stakeholders, resident technical experts, and third party experts is paramount. It is also typical for draft policy design decisions to be modified repeatedly following testing through an iterative work group procedure in order to reach optimal end points.
- **Policy Analysis Guidelines. This** follows initial design of each option and involves direct impact analysis, followed by indirect or secondary impact analysis (such as macroeconomic analysis using the REMI model). A number of key decisions affect the use and outcome of analysis. These include the overarching principles and guidelines for analysis and the degree to which they are accepted, explicit, and appropriate for the issues being examined. In the five processes

underlying this study a set of principles and guidelines for analysis were provided for review and comment by agencies and stakeholders, and were based on generally accepted principles and guidelines for regulatory impact analysis by federal and state agencies and generally accepted energy and economic modeling. In addition, sector-specific guidelines and common assumptions are needed to ensure consistency and accuracy. Finally, option-specific decisions on best available data sources, methods, key assumptions, and techniques for handling uncertainty can be made to ensure consistency of each separate policy option analysis with overall principles and guidelines and relevant standards, but also enables customization.

- **Data Sources.** Data sources can affect outcomes significantly and may vary by source. For instance, during the Florida Climate Action Plan process participants made a decision on cost data for solar power from a range of potential sources, and agreed ultimately to use figures from U.S. Department of Energy (DOE) labs that were mid-range compared to other estimates. The cost of renewable power is a potentially sensitive performance variable, and the stakes were potentially high since the renewable portfolio standard (RPS) was estimated to provide the majority of macroeconomic gains from more than 50 policy options, and solar power shifts were responsible for most of the gains with the RPS. Sensitivity analysis of 50 percent higher and lower capital costs of solar power ultimately showed that job gains were not highly sensitive to this variable, but the decision process was critical nonetheless.
- **Methods.** The methods for analysis can affect results and levels of consensus significantly. Methods range from transparent spreadsheet based worksheets to closed, complex systems models, and from methods that allow full customization of inputs and calculations to standardized methods. More than one approach may also be used. For instance, early stage analysis might be conducted with simplified, transparent procedures, and then tested at a systems level with more complex models that are provided customized inputs. It is not uncommon for states to use standard models for policy planning for transportation, energy supply, etc. and to prefer to use the same models for GHG impact analysis. In these cases, standard models can be fed customized specifications and inputs for policy testing. For instance, many states have established transportation travel models, or power dispatch models. Each of the five planning processes used a combination of methods that were driven by the technical requirements of the option in question, and by work group preferences. Resource limitations did not play a major role in the selection of methods and tools of analysis in state processes, whereas they have been a significant limiting factor for local plans.
- **Assumptions.** The choice of economy-wide, sector level, or policy specific assumptions can be critical to the reliability of analysis and feasibility of actions and must be made at all three levels. Sensitivity analysis often involves the modification and testing of alternate assumptions (see application below).
- **Time Frame.** One key question for analysis is also the amount of time that is available to support iterative use. If sufficient time is available, work groups will often use models for extensive testing of design alternatives to eliminate conflicts and improve performance.[1] Planning processes that are significantly less than one year in duration may not provide adequate time for stakeholders and work groups to advance on a learning curve, and move through each step of the policy selection, design, and analysis process, including iterations to identify and remove barriers to consensus. As a result, the outcomes of policy and analysis are influenced by total duration of the process. This is not atypical for high involvement decisions by individuals and groups, or for complex sequential processes, such as development of state budgets. Each of the five processes used in this review were one year or longer.

Appendix B. List of Policy Options in the Five States/Region

A list of all options is presented in Appendix Table B, in more generic terms, to facilitate comparison across states. The table indicates that many options have applicability in most of the states, though to varying degrees, depending on background conditions (e.g., weather, history of building practices, road network configurations, and resource bases (e.g., availability of renewables). These major options that have been widely adopted include RPS, CHP, and Power Plant Efficiency Improvements from the ES sector, DSM, Appliance Standards, Building Codes, and Customer-Sited Renewable Energy from the RCI sector, Alternative Fuels, Transit, Vehicle Purchase Incentives, and Land Use from the TLU sector, and Soil Carbon Management, Forest Protection/Restoration, Afforestation/Reforestation, Urban Forestry, AFW Biomass Utilization, and Waste Recycling from the AFW sector. Many of these options yield similar cost-effectiveness (i.e., per ton GHG reduction cost) across the states. Good examples are those major options from the RCI sector. In all the states, the energy efficiency RCI options are expected to result in net cost savings over the entire planning period. There are also cases that similar options yield very different cost-effectiveness in different states. For example, RPS is a cost-incurring option in all states except for Florida, due to the availability of abundant and relatively cheap renewable resources in Florida.

Appendix Table B. List of Policy Options

Policy Option	Policy Name	FL		PA		MI		NY		SCAG	
		% GHG Reduction in Target Year	Cost-Effective-ness in Target Year	% GHG Reduction in Target Year	Cost-Effective-ness in Target Year	% GHG Reduction in Target Year	Cost-Effective-ness in Target Year	% GHG Reduction in Target Year	Cost-Effective-ness in Target Year	% GHG Reduction in Target Year	Cost-Effective-ness in Target Year
ES Options											
FL_ESD-5; MI_ES1-CO, NY_PSD-2, SCAG_ES-1	Renewable Portfolio Standard (RPS)	7.45%	-$32.3	3.73%	$21.0	4.42%	$47.1	3.12%	$30.9	4.78%	$19.7
ESD-6, PA_E-10, MI_ES2-CO	Nuclear Power	1.58%	$40.1	4.96%	$8.2	2.59%	$24.8				
FL_ESD-8, PA_E-9, MI_ES4-CO, NY_RCI-2b,SCAG_ES-6	Combined Heat and Power (CHP) Systems	0.47%	$5.6	1.47%	$9.8	0.17%	$5.1	0.43%	$2.3	2.10%	-$77.9
FL_ESD-9, PA_E-6, MI_ES3-CO	Power Plant Efficiency Improvements	1.92%	-$15.6	1.83%	-$16.1	0.85%	$3.1				
FL_ESD-11	Landfill Gas-To-Energy (LFGTE)	1.88%	$1.1								
PA_E-3	Stabilized Load Growth			0.93%	-$33.7						
PA_E-5	Carbon Capture and Sequestration in 2014			1.70%	$33.7						
PA_E-7	Sulfur Hexafluoride (SF6) Emission Reductions from the Electric Power Industry			0.03%	$0.4						
NY_PSD-4	Distribution System Upgrades							0.32%	-$83.7		
NY_PSD-6	Low Carbon Portfolio Standard (LCPS): High penetration of renewables							11.44%	$29.8		
SCAG_ES-2	Customer Sited Renewable Energy Incentives and/or Barrier Removal									1.22%	$127.7
RCI Options											
FL_ESD-12, PA_RC-10/11/13, MI_RCI1-CO, NY_RCI-2a, SCAG_RCI-1	Demand-Side Management (DSM)	4.71%	-$47.9	4.45%	-$16.3	9.87%	-$31.4	6.70%	$0.0	10.15%	-$19.7
ESD-13a	Energy Efficiency in Existing Residential Buildings	1.17%	-$31.2								
FL_ESD-14, PA_RC-5, MI_RCI3-CO, NY_RCI-8, SCAG_RCI-2	Building Codes	4.38%	-$33.4	0.51%	-$8.0	3.37%	-$38.7	1.30%	-$26.4	4.61%	-$9.3

PA_RC-6	Re-Light PA			4.35%	-$42.5						
PA_RC-7	Re-Roof PA			0.49%	$255.7						
PA_RC-8, MI_RCI2-CO, NY_RCI-7	Appliance Standards			0.64%	-$25.5	8.75%	-$31.4	2.48%	-$30.9		
PA_RC-9, NY_RCI-3a/3b/3c, SCAG_RCI-3	Customer-Sited Renewable Energy			0.48%	$67.8			4.42%	$17.1	0.17%	$65.4
PA_Ind-1	Coal Mine Methane (CMM) Recovery			0.19%	-$8.8						
PA_Ind-2	Industrial NG & Electricity Best Management Practices			1.74%	-$41.7						
PA_Ind-3	Reduce Lost and Unaccounted for Natural Gas			0.05%	-$57.4						
NY_RCI-11	Industrial Process Incentives							1.03%	-$108.9		
SCAG_RCI-6	Increase Water Recycling and Water End-use Efficiency and Conservation									1.64%	-$67.5
TLU Options											
FL_TLU-1, MI_TLU4-CO, NY_TLU-4, SCAG_TSI-3/TLU-4	Alternative Fuels	2.72%	-$158.2			2.02%	$4.8	3.35%	$90.5		
FL_TLU-2, PA_T-3	Low Rolling Resistance Tires and Other Add-On Technologies	0.40%	-$100.3	0.23%	-$216.6						
FL_TLU-4	Improving Transportation System Management (TSM)	1.51%	-$89.1								
FL_TLU-8, PA_T-8	Increasing Freight Movement Efficiencies/Cutting Emissions from Freight Transportation	0.24%	$2.2	0.34%	-$154.9						
PA_T-5a	Eco-Driving 5A PAYD Insurance			0.15%	-$401.0						
PA_T-5c	Eco-Driving 5C Driver Training			0.21%	-$90.6						
PA_T-5d	Eco-Driving 5E Tire Inflation			0.03%	-$163.2						
PA_T-5e	Eco-Driving 5H Speed Limit Reduction			0.66%	$320.5						
PA_T-6	Utilizing Existing Public Transportation Systems			0.02%	$3,902.8						
PA_T-9, MI_TLU5-CO, NY_TLU-7/10	Transit			0.40%	$61.0	0.15%	$117.9	2.13%	$286.9	0.11%	-$436.2
MI_TLU1-CO	Anti-Idling Technologies and Practices					0.25%	-$54.9				
PA_T-5b, MI_TLU2-CO, NY_TLU-2, TSI-6/TLU-5	Vehicle Purchase Incentives/Promote Alt Vehicles			0.14%	-$214.2	0.01%	$1,617.4	0.79%	-$137.5	0.01%	-$107.0

MI_TLU3-CO	Mode Shift from Truck to Rail					0.07%	$106.7				
MI_TLU6-CO, NY_TLU-11, SCAG_TLU-1/2/3/7/9	Land Use					0.15%	-$106.4	0.47%	-$997.0	0.96%	-$640.7
NY_TLU-1	Vehicle Technology and Operations							6.70%	$71.1		
NY_TLU-3	Fleet Incentives and Disincentives							0.24%	-$149.0		
NY_TLU-6a	Commuter & Traveler assistance							0.39%	-$997.0		
NY_TLU-6d	Telecommuting							0.39%	-$997.0		
NY_TLU-6e	Congestion Pricing							0.08%	-$527.2		
NY_TLU-9	Priority Growth Centers							0.12%	-$699.1		
SCAG_TSI-1/TSI-4A	Employer-Based Commute Option Programs									0.21%	$2.7
SCAG_TSI-4B	Car-sharing Programs									0.08%	-$793.4
SCAG_TSI-5/8/9 TLU-8/10	Increased Bike/Walk Trips, including Complete Streets and Bike share									0.00%	$1,760.2
NY_TLU6b/6c, SCAG_TSI-7/ TLU-6	Parking Management Strategies/Parking Pricing							0.28%	$184.6	0.02%	-$421.6
AFW Options											
FL_AFW-1, PA_F1/3, NY_AFW-7a	Forest Protection/Restoration	0.13%	$29.0	0.78%	$21.6			1.85%	$6.9		
FL_AFW-2A1/2A2, PA_F-4, MI_AFW6-CO, NY_AFW-7c	Afforestation/Reforestation	3.17%	$5.6	1.35%	$25.0	0.32%	$52.1	0.95%	$41.3		
FL_AFW-2B, PA_F-7, MI_AFW7-CO, NY_AFW-7b, SCAG_AFW-2	Urban Forestry	1.88%	$11.1	1.01%	$95.4	1.04%	$210.0	0.79%	$160.4	0.12%	$440.3
FL_AFW-3A	Pine Plantation Management	0.19%	$12.3								
FL_AFW-3B	Non-Federal Public Land Management	0.09%	$12.3								
FL_AFW-4, PA_F-8/9a/9b/W-1/5/6, NY AFW-6, SCAG_AFW-5a	Expanded Use of Agriculture, Forestry, and Waste Management (AFW) Biomass Feedstocks for Electricity, Heat, and Steam Production	8.63%	$23.4	0.60%	-$17.0			0.16%	$1.1	0.08%	-$18.7
FL_AFW-5A, PA_Ag-5b, MI_AFW1-CO	Soil Carbon Management	0.19%	-$10.0	0.15%	-$13.0	0.59%	-$15.4				
FL_AFW-5B, MI_AFW2-CO	Nutrient Management	0.06%	$29.0			0.05%	-$25.1				

FL_AFW-6, NY_AFW-5	Reduce the Rate of Conversion of Agricultural Land and Open Green Space to Development	0.11%	$103.6					2.17%	$18.3		
FL_AFW-7	In-State Liquid/Gaseous Biofuels Production	1.77%	-$8.9								
FL_AFW-8, MI_AFW4-CO	MSW Landfill Gas Management	0.95%	$10.0			0.93%	-$2.5				
FL_AFW-9A, PA_Ag-4b, MI_AFW3-CO	Manure Digestion/Other Waste Energy Utilization	0.02%	-$18.9	0.10%	$5.3	0.05%	$2.0				
FL_AFW-9B	WWTP Biosolids Energy Production & Other Biomass Conversion Technologies	1.08%	$49.0								
FL_AFW-9C	Bio-Products Technologies and Use	0.06%	-$69.1								
PA_Ag-3	Management Intensive Grazing			0.21%	-$76.4						
PA_Ag-5a	Regenerative Farming Practices			0.02%	$64.6						
PA_W-2, MI_AFW5-CO, NY_AFW-3	Waste Recycling			1.84%	-$8.2	7.03%	$18.9	0.28%	$40.1		
PA_W-4	Improved Efficiency at Wastewater Treatment Facilities			0.00%	-$160.7						
NY_AFW-4	Integrated Farm Management Planning and Application							0.24%	-$35.5		
SCAG_AFW-1	Improve Agricultural Irrigation Efficiency									0.09%	-$34.3
SCAG_AFW-5b	Increase On-Farm Energy Efficiency									0.07%	-$29.1