MACROECONOMIC IMPACTS OF AB 32 ON THE SCAG ECONOMY

by

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June 16, 2014
California Assembly Bill 32
Global Warming Solutions Act

• Intended to make CA a leader in Climate Policy
• Regulates 6 GHGs
• Elec + large industrial; then Transp, R&C, Small Ind
• GHG reduction 15% below 2005 levels by 2020
• Emphasizes Cap & Trade (auction version)
• Includes a 33% RPS Target by Year 2020
GHG Mitigation Benefits

• Direct benefits – avoided damages of climate change
  – scientific consensus of vulnerability (IPCC Report)
  – coastal erosion, wildfires, drought, public health issues

• Co-benefits
  – reduction in ordinary (EPA “criteria”) pollutants
  – decrease in energy use & hence improved energy security
  – “double-dividend” from fiscal adjustments
  – increase in economic activity, especially jobs
    (of course, these impacts could be negative)
Overview

• Background on AB32
• Microeconomic Analysis
• REMI Modeling
• Macroeconomic analysis
• Sensitivity analysis for RPS
Objectives of Macro Analysis

Use a macroeconomic model to evaluate the total and sectoral economic impacts of GHG mitigation policy options on the SCAG Region economy

• Micro level analysis of costs and benefits only pertains to the site of mitigation option application

• Both increases and decreases in economic activity generate “ripple” effects throughout the economy

• Macroeconomic impact is usually some multiple of original direct on-site impact (but reversals do happen)

• Substitutions and price changes also have macro effects
## Microeconomic Impacts of GHG Mitigation Policy Options

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>RCI-1</td>
<td>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</td>
<td>8.6</td>
<td>24.2</td>
<td>297</td>
<td>-5,652</td>
<td>-19</td>
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<td>RCI-2</td>
<td>Improved Building Codes for Energy Efficiency</td>
<td>3.1</td>
<td>11</td>
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<td>RCI-3</td>
<td>Incentives for Renewable Energy Systems at Residential, Commercial, and Industrial Sites</td>
<td>0.16</td>
<td>0.41</td>
<td>5.1</td>
<td>325</td>
<td>63</td>
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<tr>
<td>RCI-4</td>
<td>Consumer, Student, and Decision-maker Education Programs</td>
<td>Not Quantified</td>
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<tr>
<td>RCI-5</td>
<td>GHG Emissions Reductions through Changes in Goods Production, Sourcing, and Delivery</td>
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<tr>
<td>RCI-6</td>
<td>Increase Water Recycling and Water End-use Efficiency and Conservation Goals and Programs</td>
<td>2.0</td>
<td>3.9</td>
<td>54</td>
<td>-3,528</td>
<td>-65</td>
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<tr>
<td>ES-1</td>
<td>Central Station Renewable Energy Incentives including Project Development Barrier Removal Issues</td>
<td>11.4</td>
<td>11.4</td>
<td>265</td>
<td>5,025</td>
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<td>ES-2</td>
<td>Customer Sited Renewable Energy Incentives and/or Barrier Removal</td>
<td>1.2</td>
<td>2.9</td>
<td>37.5</td>
<td>4,624</td>
<td>123</td>
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<tr>
<td>ES-3</td>
<td>Transmission System Upgrading, Reduce Transmission and Distribution Line Loss</td>
<td>Not Quantified</td>
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<tr>
<td>ES-4</td>
<td>CCSR Incentives and Infrastructure including R&amp;D and Enabling Policies</td>
<td>Not Quantified</td>
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<td>ES-5</td>
<td>Public Benefits Charge Funds</td>
<td>Moved to RCI-1</td>
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<td>ES-6</td>
<td>Combined Heat and Power (CHP) Incentives and/or Barrier Removal, including Co-location or Integration of Energy-Producing Facilities</td>
<td>1.3</td>
<td>5.0</td>
<td>66.2</td>
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<tr>
<td>AFW-1</td>
<td>Improve Agricultural Irrigation Efficiency</td>
<td>0.22</td>
<td>0.22</td>
<td>4.4</td>
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<td>-33</td>
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<tr>
<td>AFW-2a</td>
<td>Improve Urban Forestry and Green Space Management through Expansion and Effective Management: Urban Forestry</td>
<td>0.05</td>
<td>0.28</td>
<td>2.7</td>
<td>1,359</td>
<td>424</td>
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<tr>
<td>AFW-2b</td>
<td>Improve Urban Forestry and Green Space Management through Expansion and Effective Management: Xeriscaping</td>
<td>Not Quantified</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AFW-3</td>
<td>Biomass to Energy Innovation through In-Situ Underground Decomposition</td>
<td>Not Quantified</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AFW-4</td>
<td>Preserve and Expand the Carbon Sequestration Capabilities of Open Space, Wildlands, Wetlands, and Agricultural Lands</td>
<td>Not Quantified</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>AFW-5a</td>
<td>Increase On-Farm Energy Efficiency &amp; Renewable Energy Production: Renewable Energy</td>
<td>0.02</td>
<td>0.04</td>
<td>0.65</td>
<td>-6</td>
<td>-9</td>
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<tr>
<td>AFW-5b</td>
<td>Increase On-Farm Energy Efficiency &amp; Renewable Energy Production: Energy Efficiency</td>
<td>0.05</td>
<td>0.16</td>
<td>2.3</td>
<td>-47</td>
<td>-28</td>
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<tr>
<td><strong>All</strong></td>
<td>Total Stand-Alone Results</td>
<td>28.0</td>
<td>59.7</td>
<td>854</td>
<td>-4,041</td>
<td>n/a</td>
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<tr>
<td><strong>All</strong></td>
<td>Total Estimated Policy Overlaps</td>
<td>0.03</td>
<td>0.18</td>
<td>1.73</td>
<td>883</td>
<td>n/a</td>
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<tr>
<td><strong>All</strong></td>
<td>Total After Overlap Adjustments</td>
<td>28.0</td>
<td>59.5</td>
<td>853</td>
<td>-3,157</td>
<td>-4</td>
</tr>
</tbody>
</table>
GHG Reduction Potentials of Mitigation Policy Options
Cost-Effectiveness of GHG Mitigation Policy Options

Cost Effectiveness of SCAG Policy Options ($/ton) (2012-2035)

- Combined Heat and Power Incentives (CHP)
- Water Recycling and Conservation
- Agricultural Irrigation Efficiency
- On-Farm Energy Efficiency, Renewables
- Demand Side Management (DSM)
- Building Codes
- Renewable Energy Incentives (RPS)
- Solar Water Heater
- Distributed Solar PV
- Urban Forestry

Cost Per Ton CO2 Reduced (2010$ / ton CO2e)
Marginal Cost Curve of Mitigation Policy Options

Marginal Cost Curve of SCAG ECR Options, 2035

- ES
- AFW
- RCI

Marginal Cost ($/tCO2e)
- $500
- $400
- $300
- $200
- $100
- $0
- $-100
- $-200

Percentage Reduction of 2035 Economy-Wide BAU GHG Emissions

- AFW-2 Urban Forestry
- ES-2 Distributed Solar PV
- RCI-3 Solar Water Heater
- ES-1 RPS
- AFW-5 On-Farm EE & Renewable
- RCI-2 Building Codes
- AFW-1 Irrigation Efficiency
- RCI-1 DSM
- RCI-6 Water Recycling and Conservation
- ES-6 CHP
Major Microeconomic Analysis Results Used in REMI Simulations

- Change in upfront capital investment by sector
- Change in annualized capital cost
- Change in operation and maintenance cost
- Change in fuel expenditures
- Program implementation and administrative costs
- Proportion of public funding and private debt financing
- Federal or state subsidies/tax credits
Macroeconomic Impact Results

- Overall employment increase of 61,191 jobs in 2035, or 0.5% over the baseline level

- Average gain of 20,781 additional jobs per year over the entire planning period

- Net increase in disposable personal income of about $10.5 billion in NPV over the entire planning period

- Decrease in GDP of $1.16 billion in 2035, or 0.06% below the baseline level

- Net decrease in GDP of $17.8 billion in NPV over the entire planning period
Macroeconomic Impact Results

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Policy Option</th>
<th>2,013</th>
<th>2015</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
<th>2035</th>
<th>Average Jobs /Year</th>
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<tbody>
<tr>
<td>ES1</td>
<td>-9,643</td>
<td>-11,856</td>
<td>-15,762</td>
<td>-16,773</td>
<td>-17,813</td>
<td>-18,701</td>
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<tr>
<td>ES2</td>
<td>3,088</td>
<td>1,853</td>
<td>-2,719</td>
<td>-4,525</td>
<td>-5,798</td>
<td>-5,764</td>
<td>-2,871</td>
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<tr>
<td>ES6</td>
<td>106</td>
<td>336</td>
<td>1,254</td>
<td>3,705</td>
<td>7,442</td>
<td>9,859</td>
<td>4,087</td>
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<tr>
<td><strong>Subtotal- ES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-6,449</td>
<td>-9,667</td>
<td>-17,227</td>
<td>-17,593</td>
<td>-16,169</td>
<td>-14,606</td>
<td>-14,746</td>
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<tr>
<td>RCI1</td>
<td>-2,410</td>
<td>-732</td>
<td>3,873</td>
<td>10,673</td>
<td>19,247</td>
<td>29,015</td>
<td>10,237</td>
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<tr>
<td>RCI2</td>
<td>3,530</td>
<td>6,786</td>
<td>12,523</td>
<td>16,044</td>
<td>22,751</td>
<td>29,170</td>
<td>16,158</td>
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<tr>
<td>RCI3</td>
<td>346</td>
<td>289</td>
<td>-356</td>
<td>-416</td>
<td>-444</td>
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<tr>
<td>RCI6</td>
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<td>3,446</td>
<td>6,181</td>
<td>10,374</td>
<td>15,237</td>
<td>19,986</td>
<td>10,127</td>
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<tr>
<td><strong>Subtotal - RCI</strong></td>
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<td></td>
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<tr>
<td></td>
<td>3,921</td>
<td>9,789</td>
<td>22,221</td>
<td>36,675</td>
<td>56,791</td>
<td>77,699</td>
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<tr>
<td>AFW1</td>
<td>16</td>
<td>14</td>
<td>21</td>
<td>19</td>
<td>19</td>
<td>20</td>
<td>16</td>
<td></td>
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<tr>
<td>AFW2</td>
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<td>16</td>
<td>899</td>
<td>1,091</td>
<td>1,440</td>
<td>1,282</td>
<td>871</td>
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<tr>
<td>AFW5</td>
<td>68</td>
<td>59</td>
<td>44</td>
<td>44</td>
<td>28</td>
<td>43</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal - AFW</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-272</td>
<td>89.0</td>
<td>964.0</td>
<td>1,154.0</td>
<td>1,487.0</td>
<td>1,345.0</td>
<td>934.3</td>
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</tr>
</tbody>
</table>

**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
## Macroeconomic Impact Results

### Gross Domestic Product Impact (millions of 2010$)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Policy Option</th>
<th>2013</th>
<th>2015</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
<th>2035</th>
<th>NPV</th>
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<tbody>
<tr>
<td>ES1</td>
<td></td>
<td>-$1,026</td>
<td>-$1,280</td>
<td>-$2,010</td>
<td>-$2,381</td>
<td>-$2,690</td>
<td>-$3,001</td>
<td>-$23,908</td>
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<tr>
<td>ES2</td>
<td></td>
<td>$391</td>
<td>$226</td>
<td>-$532</td>
<td>-$1,064</td>
<td>-$1,615</td>
<td>-$2,084</td>
<td>-$7,336</td>
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<tr>
<td>ES6</td>
<td></td>
<td>-$21</td>
<td>-$49</td>
<td>-$64</td>
<td>-$62</td>
<td>$67</td>
<td>$314</td>
<td>-$73</td>
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<tr>
<td>RCI1</td>
<td></td>
<td>-$329</td>
<td>-$326</td>
<td>-$316</td>
<td>-$169</td>
<td>$116</td>
<td>$475</td>
<td>-$3,056</td>
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<td>RCI2</td>
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<td>$261</td>
<td>$499</td>
<td>$868</td>
<td>$965</td>
<td>$1,303</td>
<td>$1,565</td>
<td>$10,667</td>
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<td>RCI3</td>
<td></td>
<td>$42</td>
<td>$34</td>
<td>-$47</td>
<td>-$77</td>
<td>-$109</td>
<td>-$147</td>
<td>-$516</td>
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<tr>
<td>RCI6</td>
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<td>$134</td>
<td>$155</td>
<td>$271</td>
<td>$696</td>
<td>$1,259</td>
<td>$1,889</td>
<td>$7,086</td>
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<td><strong>Subtotal - RCI</strong></td>
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<td>$108</td>
<td>$363</td>
<td>$776</td>
<td>$1,416</td>
<td>$2,570</td>
<td>$3,781</td>
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<td>AFW1</td>
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<td>$1</td>
<td>$2</td>
<td>$2</td>
<td>$2</td>
<td>$3</td>
<td>$20</td>
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<td>AFW2</td>
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<td>-$45</td>
<td>-$31</td>
<td>$17</td>
<td>$11</td>
<td>$29</td>
<td>-$2</td>
<td>-$54</td>
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<td>AFW5</td>
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<td>$9</td>
<td>$8</td>
<td>$4</td>
<td>$2</td>
<td>-$4</td>
<td>-$4</td>
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<td><strong>Subtotal - AFW</strong></td>
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<td>-$35</td>
<td>-$22</td>
<td>$23</td>
<td>$16</td>
<td>$27</td>
<td>-$3</td>
<td>$11</td>
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<tr>
<td><strong>Summation Total</strong></td>
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<td>-$583</td>
<td>-$762</td>
<td>-$1,807</td>
<td>-$2,075</td>
<td>-$1,642</td>
<td>-$994</td>
<td>-$17,126</td>
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<tr>
<td><strong>Simultaneous Total</strong></td>
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<td>-$582</td>
<td>-$763</td>
<td>-$1,830</td>
<td>-$2,155</td>
<td>-$1,782</td>
<td>-$1,162</td>
<td>-$17,814</td>
</tr>
</tbody>
</table>
Employment Impact Results

Average Annual Employment Impact of Selected SCAG Policies (jobs per year)
GDP Impact Results

Net Changes to SCAG GDP by Policy Option (2012-2035 NPV) ($millions)
Sectoral Impacts

• Most positively stimulated sectors:
  – Sectors related to household spending (e.g., Retail Trade, Restaurant/Accommodation, Health Services)
  – Sectors related to the implementation of renewable energy (e.g., Semiconductor and Other Electric Components Manufacturing)

• Most negatively affected sectors:
  – Electric Power Generation
  – Fossil Fuel Production and Delivery
Sensitivity Analysis for RPS

• Sensitivity variables
  – Lower projected price of natural gas
  – Lower capital cost of renewable electricity generation
  – Higher percentage of regional production and supply of renewable electricity generation equipment

• Guide to policy refinement -- use sensitivity analysis to enact policies that improve outcomes:
  – Attract outside investment in renewables to California
  – Attract support industries to California
  – Support R&D to lower the capital cost of renewables
# Sensitivity Analysis Results for RPS

<table>
<thead>
<tr>
<th>Category</th>
<th>Units</th>
<th>Base Case</th>
<th>50% Lower Equipment RPC</th>
<th>50% Higher Equipment RPC</th>
<th>50% Lower Capital Cost of Renewable Generation</th>
<th>50% Higher Capital Cost of Renewable Generation</th>
<th>50% Lower NG Price</th>
<th>50% Higher NG Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Annual Employment</td>
<td>Jobs/yr</td>
<td>-15,962</td>
<td>-17,341</td>
<td>-14,811</td>
<td>-311</td>
<td>-31,490</td>
<td>-20,047</td>
<td>-11,394</td>
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</table>
## Alternative Natural Gas Price Forecasts
(in 2010$)

<table>
<thead>
<tr>
<th>Forecast/Year</th>
<th>2015</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
<th>2035</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPR/2011 (+50%)</td>
<td>8.22</td>
<td>8.54</td>
<td>9.12</td>
<td>9.29</td>
<td>9.42</td>
</tr>
<tr>
<td>MPR/2011 (Ref Case)</td>
<td>5.48</td>
<td>5.70</td>
<td>6.08</td>
<td>6.19</td>
<td>6.28</td>
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<tr>
<td>MPR-AEO/2013</td>
<td>3.54</td>
<td>4.50</td>
<td>4.80</td>
<td>4.65</td>
<td>4.83</td>
</tr>
<tr>
<td>MPR/2011 (-50%)</td>
<td>2.74</td>
<td>2.85</td>
<td>3.04</td>
<td>3.10</td>
<td>3.14</td>
</tr>
</tbody>
</table>
Conclusions

• Group of ECR GHG mitigation options yield a net positive impact on the regional economy in terms of employment & personal income, though a net negative impact on GDP.

• More than half the individual options yield positive impacts:
  – improving energy efficiency and thus reducing production costs and raising consumer purchasing power
  – increasing investment in plant and equipment

• Sensitivity analyses indicate possible ways to improve economic performance of the mitigation options.

• Reminder: Primary objective is reduction of GHG emissions. Job creation is a co-benefit, or “frosting on the cake”.
Input Data Requirements

• Which sectors bear the investment costs?

• What proportion of investment comes from in-region?

• What proportion of investment comes from public funding?

• What proportion of investment is equity vs. debt financing?

• How much would GHG investment displace ordinary?

• How are the fuel cost savings distributed among sectors?
REMI Policy Insight Plus Model

• Regional Economic Models, Inc. (REMI) Model has evolved over the course of 30 years of refinement

• Most widely used state level & regional level macroeconometric modeling tool in the U.S.

• Structural economic forecasting & policy analysis model:
  - integrates I-O, CGE, econometric & economic geography
  - dynamic, with annual forecasts & simulations
  - behavioral responses to changes in wages, prices, etc.

• Refined the REMI model for application to climate policy
  - studies in FL, MI, WI, PA, NM, CA
  - refinements for linkages and assumptions
  - published in Climate Policy, RSPP, EEEP
REMI Model Linkages
SCAG REMI PI+ Model

• SCAG REMI PI+ Model includes three regions: SCAG Region, Rest of CA, and Rest of U.S.

• Includes 169 sectors
  – 83 manufacturing sectors
  – 6 energy sectors
  – 8 transportation sectors
  – 59 commercial and services sectors
  – 13 other sectors

• Based on time series econometric estimation
Sequence of Macroeconomic Analysis of GHG Mitigation Policies

• Obtain data on mitigation options from micro analysis

• Establish comprehensive set of linkages between micro analysis & REMI Model for macro analysis

• Run REMI Model to produce macro impacts
  – simulate impacts on each individual policy option
  – simulate impacts on all policy options simultaneously
  – analyze economy-wide aggregate results
  – evaluate sectoral impacts
Policy Simulation in REMI

1. Policy question formulation
2. Identification of relevant external policy variables
3. Baseline, or Control, Forecast
4. Generation of Alternative Policy Forecast
5. Measurement of policy impacts
Macro Outputs of the REMI Model

- Economic growth (change in Gross Product, GRP)
- Employment (job creation or loss)
- Personal Income
- Output (or sale revenues)
- Price Index
- Population
Economic Impacts
Outside the SCAG Region

• Rest of the State and Rest of the U.S. are predicted to experience slightly negative impacts:
  – In-flows of capital investment from rest of CA & rest of U.S. to SCAG region reduce investment activities elsewhere.
  – Portions of renewable deployment under RPS will take place elsewhere in CA & other states outside SCAG region.
  – Relatively more of the positive re-spending effects of energy savings to businesses & households remain in the SCAG region, while the dampening effect on utility & energy supply sectors are greater in other regions.