

# Executive Summary

## Background

Governor Jennifer Granholm signed Executive Order 2007-42 creating the Michigan Climate Action Council (MCAC) on November 14, 2007. The MCAC was charged with producing a Greenhouse Gas (GHG) emissions inventory and forecast, compiling a comprehensive Climate Action Plan with recommended GHG reduction goals and potential actions to mitigate climate change in various sectors of the economy, and advising state and local governments on measures to address climate change.

The MCAC began its deliberations in December 2007. The MCAC held eight meetings leading to this Final Report which constitutes the Michigan Climate Action Plan (Climate Action Plan).

In order to provide a broad range of technical expertise and stakeholder involvement in development of the Climate Action Plan, the MCAC formed six Technical Work Groups (TWGs) to assist in the process. The six TWGs considered information and potential options in the following sectors:

- Energy Supply (ES);
- Market Based Policies (MBP);
- Residential, Commercial and Industrial (RCI);
- Transportation and Land Use (TLU);
- Agriculture, Forestry, and Waste Management (AFW); and
- Cross-Cutting Issues (CCI) (i.e., issues that cut across the above sectors).

The Center for Climate Strategies (CCS) provided facilitation and technical assistance to the MCAC and each of the TWGs. The TWGs served as advisors to the MCAC and consisted of MCAC members and additional individuals with interest and expertise. Members of the public were invited to observe and provide input at all meetings of the MCAC and TWGs. The TWGs assisted the MCAC by generating initial Michigan-specific policy options to be added to the catalog of existing states actions; developing priority policy options for analysis; drafting proposals on the design characteristics and quantification of the proposed policy options; reviewing specifications for analysis of draft policy options (including best available data sources, methods and assumptions); and evaluating the other key elements of policy option proposals, including related policies and programs, key uncertainties, co-benefits and costs, feasibility issues, and potential barriers to consensus.

## Key Elements and Recommendations

The MCAC developed this Climate Action Plan which includes but is not limited to the following key elements and recommendations:

- The MCAC's proposed GHG reduction goals for Michigan are to achieve a 20% reduction of GHGs below 2005 levels by 2020 and an 80% reduction below 2005 levels by 2050. These goals are consistent with goals being considered by the Midwestern Governors Regional Greenhouse Gas Reduction Accord process. The MCAC recommends that they be officially established as the states' GHG reduction goals.
- MCAC approved a package of 54 multi-sector policy recommendations to reduce GHG emissions and address related energy and commerce issues in Michigan.
- The MCAC approved policy recommendations are estimated to generate a net cumulative savings of about \$10 billion between 2009 and 2025. The weighted-average cost-effectiveness of these policies is estimated to be approximately a \$10.2/ tCO<sub>2</sub>e cost savings.
- Michigan must prioritize these 54 policy recommendations during 2009 in order to set the stage for strategic implementation of the most promising options. This must take into account the GHG reduction potential, costs and cost savings, feasibility, additional economic analysis of selected recommendations, and other contributing factors.
- The MCAC recommends periodic review of Michigan's progress with appropriate adjustments made in the Climate Action Plan to assure the approaches taken and GHG reductions are on target. Michigan's GHG Inventory and Forecast has been prepared which outlines historical conditions for 1990-2005 and projected emissions through 2025 based upon a business as usual scenario. Updates to this inventory should be annually with the projections evaluated every three years.
- The MCAC recommends that Michigan further analyze actions needed for adaptation. The MCAC was unable to thoroughly examine the impacts of climate change on Michigan's natural resources and the Great Lakes due to time and resource constraints. Therefore, the MCAC recommends that Michigan conduct additional analyses of the state's vulnerability to the impacts of climate change and develop specific adaptation plans for key sectors.

## Michigan GHG Emissions Inventory and Reference Case Projections

The Center for Climate Strategies (CCS) prepared the Michigan Inventory and Forecast Report for the Michigan Department of Environmental Quality (MDEQ). The report presents an assessment of Michigan's greenhouse gas (GHG) emissions and anthropogenic sinks (carbon storage) from 1990 to 2025. The preliminary draft inventory and forecast estimates in January 2008 served as a starting point for the Michigan Climate Action Council (MCAC) and Technical Work Groups (TWGs). The inventory and forecast were revised to address the comments received. The final Inventory and Forecast Report was approved by the MCAC at the November

2008 meeting and is available at:

[http://www.miclimatchange.us/Inventory\\_Forecast\\_Report.cfm](http://www.miclimatchange.us/Inventory_Forecast_Report.cfm) .

The inventory and projections cover the six types of gases included in the United States (US) Greenhouse Gas Inventory: carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF<sub>6</sub>). Emissions of these GHGs are presented using a common metric, CO<sub>2</sub> equivalence (CO<sub>2</sub>e), which indicates the relative contribution of each gas, per unit mass, to global average radiative forcing on a global warming potential- (GWP-) weighted basis<sup>1</sup>.

As illustrated in Figure ExS-1, below, activities in Michigan accounted for approximately 248 million metric tons (MMt) of *gross*<sup>2</sup> CO<sub>2</sub>e emissions (consumption basis) in 2005, an amount equal to about 3.5% of total US gross GHG emissions (based on 2005 US data).<sup>3</sup> Gross emissions exclude carbon sinks, such as forests. Michigan's gross GHG emissions are rising slower than those of the nation as a whole. From 1990 to 2005, Michigan's gross GHG emissions increased by about 12%, while national emissions rose by 16%. The growth in Michigan's emissions was primarily associated with electricity consumption and the transportation sector.

The principal sources of Michigan's GHG emissions are electricity consumption; residential, commercial, and industrial (RCI) fuel use; and transportation accounting for 36, 24, and 24% of Michigan's gross GHG emissions in 2005, respectively.

Also illustrated in Figure ExS-1 under the reference case projections, Michigan's gross GHG emissions are projected to continue growing, to approximately 292 MMtCO<sub>2</sub>e by 2025, 32% above 1990 levels.

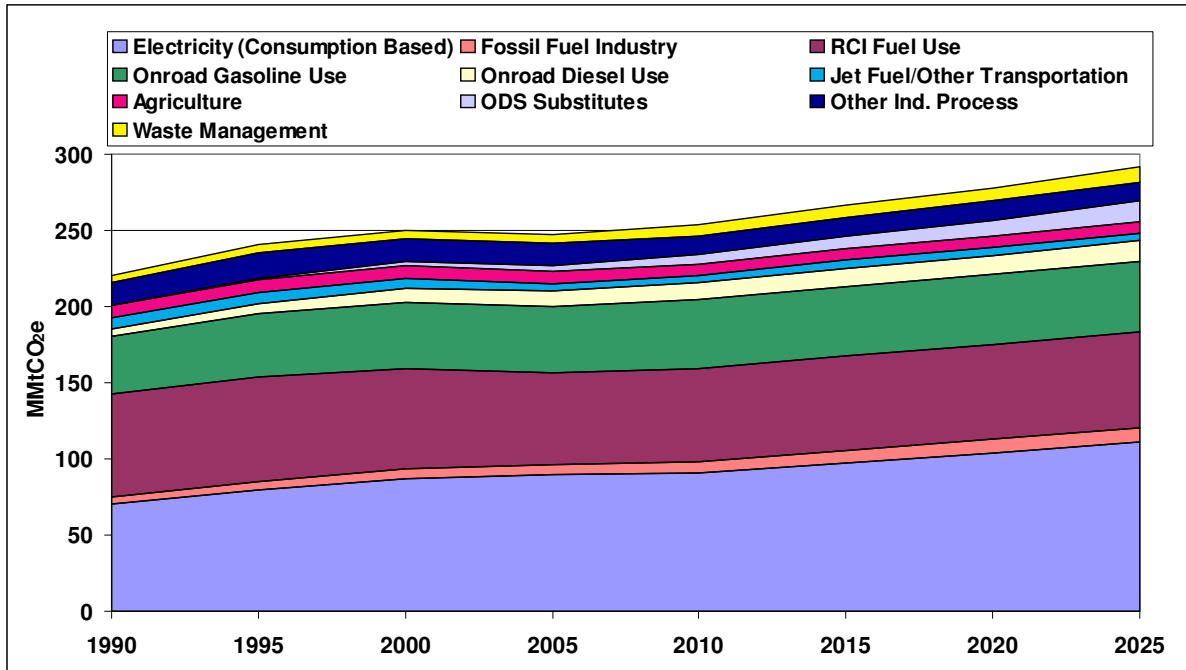
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<sup>1</sup> Changes in the atmospheric concentrations of GHGs can alter the balance of energy transfers between the atmosphere, space, land, and the oceans. A gauge of these changes is called radiative forcing, which is a simple measure of changes in the energy available to the Earth-atmosphere system (IPCC, 2001). Holding everything else constant, increases in GHG concentrations in the atmosphere will produce positive radiative forcing (i.e., a net increase in the absorption of energy by the Earth), See: Boucher, O., et al. "Radiative Forcing of Climate Change." Chapter 6 in *Climate Change 2001: The Scientific Basis*. Contribution of Working Group 1 of the Intergovernmental

<sup>2</sup> Excluding GHG emissions removed due to forestry and other land uses and excluding GHG emissions associated with exported electricity.

<sup>4</sup> The national emissions used for these comparisons are based on 2005 emissions from *Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2006*, April 15, 2008, US EPA #430-R-08-005, (<http://www.epa.gov/climatechange/emissions/usinventoryreport.html>).

**Figure ExS-1. Gross GHG emissions by sector, 1990–2025: historical and projected (consumption-based approach) business as usual / base case**

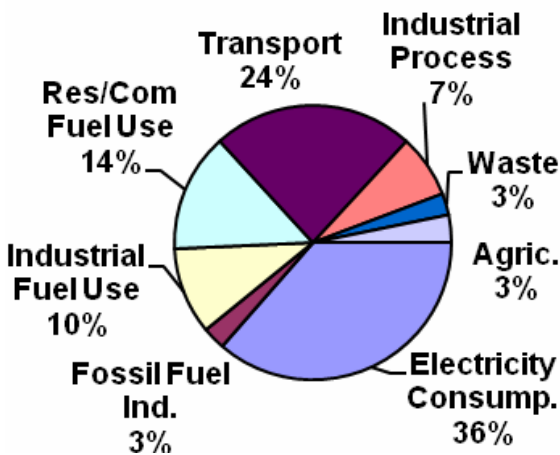


MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; RCI = direct fuel use in residential, commercial, and industrial sectors; ODS = ozone-depleting substance; Ind. = industrial.

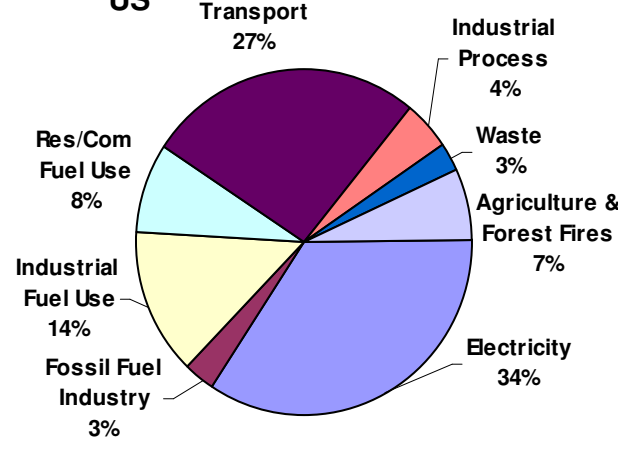
Figure ExS-2 depicts the 2005 distribution of sources in Michigan and the United States (U.S.)

**Figure ExS-2. Gross GHG emissions by sector, 2005: Michigan and U.S.**

**Michigan**



**US**

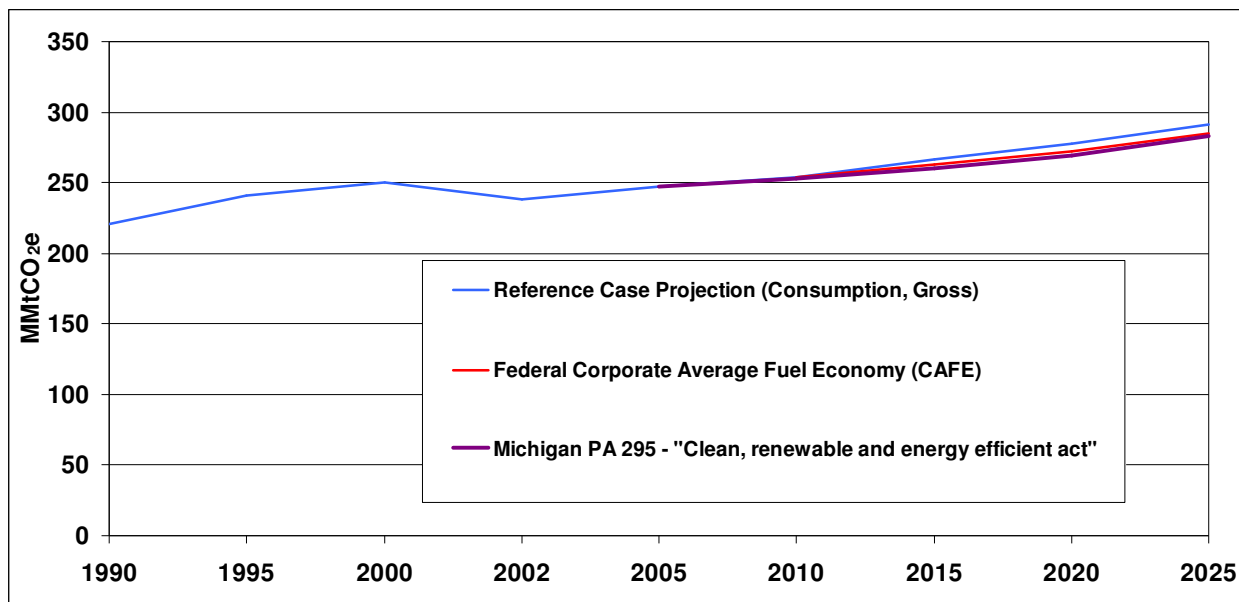


## Recent Actions

### GHG Reductions Associated With Recent Federal and State Actions

The MCAC identified recent actions undertaken in Michigan that will reduce GHG emissions while conserving energy and promoting the development and use of renewable energy sources. One such action was the adoption of PA 295<sup>4</sup>. The resultant emission reductions were estimated. Reductions associated with federal actions, such as the federal Energy Independence and Security Act (EISA) of 2007 and the implementation of the Act's Corporate Average Fuel Economy (CAFE) requirements, were also estimated. A total reduction of about 8.9 MMtCO<sub>2</sub>e (3.1%) in 2025 from the business-as-usual reference case emissions is projected. These GHG emission reductions are summarized in Figure ExS-3.

**Figure ExS-3. Estimated emission reductions associated with the effect of recent federal and state actions in Michigan (consumption-basis, gross emissions)**



MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent.

### MCAC Policy Recommendations (Beyond Recent Actions)

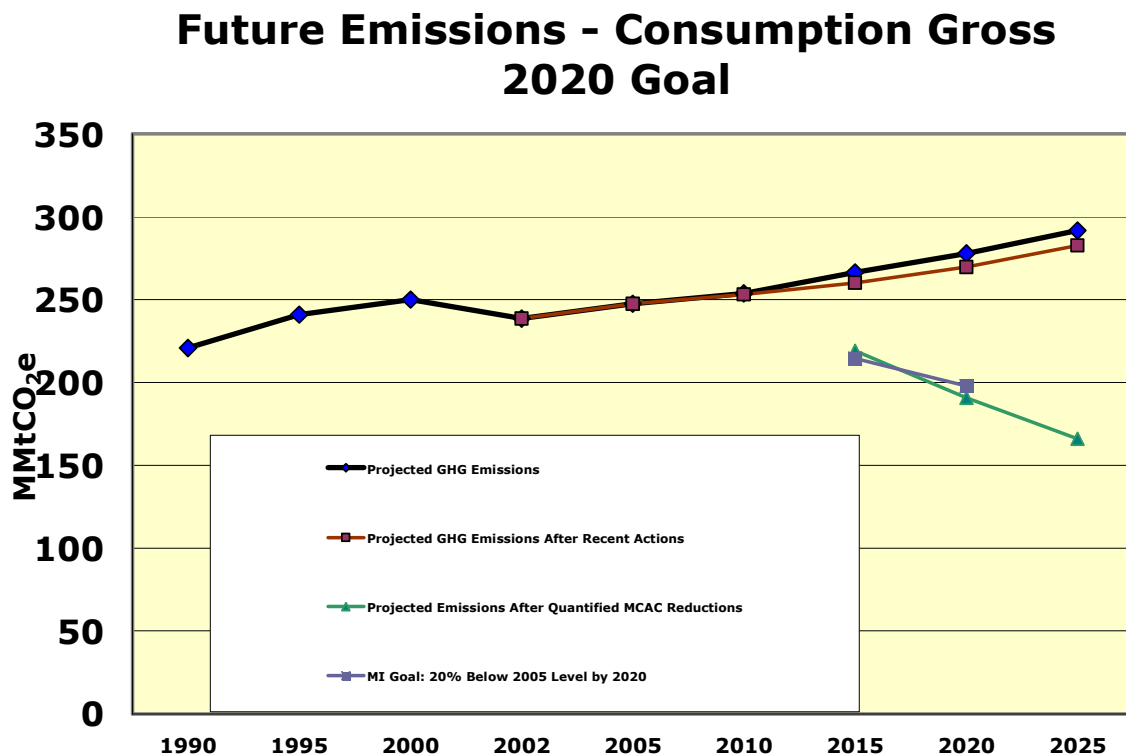
The MCAC approved 54 policy recommendations for action in Michigan. Of these, 33 were analyzed quantitatively to calculate both emission reductions and costs or savings. Based on this analysis, the 33 quantified policies have the cumulative effect of reducing annual GHG emissions by approximately 41 million metric tons of carbon dioxide equivalent (MMtCO<sub>2</sub>e) in 2015 and by 117 MMtCO<sub>2</sub>e in 2025. The additional policy recommendations were not quantifiable but are considered valuable recommendations to support the overall Climate Action Plan.

<sup>5</sup> PA 295 The Clean Renewable and Energy Efficient Act of 2008

Figure ExS-4 presents a graphical summary of the potential cumulative emission reductions associated with the 33 quantified policy options and federal actions relative to the business-as-usual reference case projections.

- The blue line shows actual (for 1990, 1995, 2000, and 2005) and projected (for 2010, 2015, 2020 and 2025) levels of Michigan’s gross GHG emissions on a business as usual basis.
- The red line shows the projected emissions adjusted for the recent state and federal actions described in Figure ExS-3.
- The green line shows the projected emissions if all of the MCAC’s 33 recommended options are implemented and the estimated reductions are fully achieved. It is important to note, to yield these emission reductions from the 33 MCAC recommended options, implementation must be timely, aggressive, and thorough.

**Figure ExS-4. Annual GHG emissions: reference case projections and MCAC recommendations (consumption basis, gross emissions)**



MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; GHG = greenhouse gas; MCAC = Michigan Climate Action Council.

Table ExS-1, below, provides the numeric estimates underlying Figure ES-4.

**Table ExS-1. Annual emissions: reference case projections and impact of MCAC options (consumption basis, gross emissions)**

| Consumption Basis - Gross Emissions                                      |       |       |       |       |       |       |       |
|--|-------|-------|-------|-------|-------|-------|-------|
|  | 1990  | 2000  | 2005  | 2010  | 2015  | 2020  | 2025  |
| Projected GHG Emissions  | 220.7 | 250.0 | 247.5 | 253.8 | 266.4 | 278.0 | 291.6 |
| Reductions from Recent Actions   |       |       | 0.0   | 0.7   | 6.2   | 8.3   | 8.9   |
| Projected GHG Emissions After Recent Actions                             |       |       | 247.5 | 253.1 | 260.2 | 269.6 | 282.7 |
| GHG Reduction Goal Recommended by MCAC                                   |       |       |       |       | NA    | 198.0 | NA    |
| Total GHG Reductions from MCAC Policies                                  |       |       |       |       | 41.2  | 78.9  | 116.6 |
| Difference Between MCAC 2020 Goal & Remaining Emissions after Reductions |       |       |       |       | NA    | 7.3   | NA    |
| Projected Emissions After Quantified MCAC Reductions                     |       |       |       |       | 219.0 | 190.7 | 166.1 |

GHG = greenhouse gas; MCAC = Michigan Climate Action Council; N/A = not applicable.

Reductions from recent actions include the EISA of 2007, Title III. GHG reductions from Titles IV and V of this Act have not been quantified because of the implementation uncertainties.

Table ExS-2 depicts the final policy recommendations of the Council and their associated GHG reductions and costs or savings for each sector.

**What do the numbers mean?** In Table ExS-2 and throughout the Climate Action Plan, **positive cost figures ( \$ ) indicate costs; negative cost ( - \$ ) figures indicate cost savings.** For example, in Table ExS-2 the column totals for the Net Present Value (NPV) of (-\$10,093 million) portrays a cost savings of \$10,093,000,000 over the 2009- 2025 period of analysis.

**Table ExS-2. Summary by sector of estimated impacts of implementing all of the MCAC recommended options (cumulative reductions and costs/savings)**

| Sector   | GHG Reductions (MMtCO <sub>2</sub> e) |              |                 | Net Present Value 2009–2025 (Million \$) | Cost-Effectiveness (\$/tCO <sub>2</sub> e) |
|--|---------------------------------------|--------------|-----------------|--|--|
|  | 2015                                  | 2025         | Total 2009–2025 |  |  |
| Residential, Commercial and Industrial               | 21.9                                  | 65.1         | 524.6           | -\$13,014                                | -\$25                                      |
| Energy Supply  | 8.1                                   | 23.6         | 220.3           | \$7,980                                  | \$36                                       |
| Transportation and Land Use                          | 4.8                                   | 10.5         | 95.1            | -\$3,425                                 | -\$36                                      |
| Agriculture, Forestry, and Waste Management          | 6.4                                   | 17.4         | 147.0           | -\$1,634                                 | -\$11.1                                    |
| Cross-Cutting Issues                                 | Non-quantified, enabling options      |              |                 |  |  |
| <b>TOTAL (includes all adjustments for overlaps)</b> | <b>41.2</b>                           | <b>116.6</b> | <b>987.0</b>    | <b>-\$10,093</b>                         | <b>-\$10.2</b>                             |

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

Notes for Table ExS-2 are continued on the next page.

Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings associated with the policy options.

Within each sector, values have been adjusted to eliminate double counting for policies or elements of policies that overlap. In addition, values associated with policies or elements of policies within a sector that overlap with policies or elements of policies in another sector have been adjusted to eliminate double counting. Appendix F (for the ES sectors), Appendix H (for the RCI sectors), Appendix I (for the TLU sectors), and Appendix J (for the AFW sectors) of this report provide documentation of how sector-level emission reductions and costs (or cost savings) were adjusted to eliminate double counting associated with overlaps between policies.

Table ExS-3, which begins below and continues through page ES-14, depicts the MCAC policy recommendations and the associated GHG reductions and costs/savings for each sector.

Note: The numbering used to denote the policy recommendation in Table ExS-3 and in other parts of this report is for reference purposes only; it does not reflect prioritization among these important recommendations. Negative numbers indicate cost savings.

**Table ExS-3 Summary List of MCAC Policy Recommendations for all Sectors**  
**Energy Supply (ES) Policy Recommendations**

| Policy No.    | Policy Recommendation   | GHG Reductions (MMtCO <sub>2</sub> e) |      |                 | Net Present Value 2009–2025 (Million \$) | Cost-Effectiveness (\$/tCO <sub>2</sub> e) | Level of Support |
|---------------|---|---------------------------------------|------|-----------------|--|--|------------------|
|               |   | 2015                                  | 2025 | Total 2009–2025 |  |  |                  |
| RECENT ACTION | PA 295, Clean, Renewable, and Efficient Energy Act                                      | 2.7                                   | 2.0  | 30.8            | \$1,024                                  | \$33                                       | N/A              |
| ES-1          | Renewable Portfolio Standard and Distributed Generation "Carve-Out"                     | 5.0                                   | 14.6 | 137.5           | \$6,600                                  | \$48.00                                    | Unanimous        |
|               | Renewable Portfolio Standard (RPS)  | 4.6                                   | 13.7 | 129.5           | \$5,546                                  | \$42.83                                    |                  |
|               | Wind  | 3.7                                   | 10.3 | 100.4           | \$4,748                                  | \$47.31                                    |                  |
|               | Biomass   | 0.9                                   | 2.7  | 25.2            | \$376                                    | \$15                                       |                  |
|               | Solar Photovoltaic (PV)   | 0.0                                   | 0.4  | 2.6             | \$392                                    | \$152                                      |                  |
|               | Plasma Gasification   | 0.0                                   | 0.3  | 1.3             | \$29                                     | \$22                                       |                  |
|               | Distributed Generation "Carve-Out"  | 0.4                                   | 0.9  | 8.0             | \$1,054                                  | \$131.51                                   |                  |
|               | Solar Hot Water   | 0.0                                   | 0.2  | 1.2             | \$26                                     | \$22.27                                    |                  |
|               | Geothermal  | 0.1                                   | 0.2  | 1.5             | \$82                                     | \$55                                       |                  |
|               | Wind (distributed)  | 0.1                                   | 0.3  | 2.7             | \$503                                    | \$186                                      |                  |
|               | Solar PV (distributed)  | 0.1                                   | 0.2  | 1.84            | \$508                                    | \$276                                      |                  |
|               | Biogas  | 0.1                                   | 0.2  | 2.3             | \$17                                     | \$7  |                  |
| ES-3          | Energy Optimization Standard  | 0.0                                   | 13.6 | 86.3            | –\$1,632                                 | –\$19                                      | Unanimous        |
| ES-5          | Advanced Fossil Fuel Technology (e.g., IGCC, CCSR) Incentives, Support, or Requirements | Not Quantifiable                      |      |                 |  |  | Unanimous        |
| ES-6          | New Nuclear Power   | 0.0                                   | 6.3  | 38.5            | \$1,001                                  | \$25.98                                    | Majority         |
| ES-7          | Integrated Resource Planning (IRP), Including Combined Heat & Power (CHP)               | Not Quantifiable                      |      |                 |  |  | Unanimous        |

| Policy No. | Policy Recommendation  | GHG Reductions (MMtCO <sub>2e</sub> )   |             |                 | Net Present Value 2009–2025 (Million \$) | Cost-Effectiveness (\$/tCO <sub>2e</sub> ) | Level of Support |
|------------|--|---|-------------|-----------------|--|--|------------------|
|            |  | 2015  | 2025        | Total 2009–2025 |  |  |                  |
| ES-8       | Smart Grid, Including Advanced Metering  | <i>Not Quantifiable</i>   |             |                 |  |  | Unanimous        |
| ES-9       | CCSR Incentives, Requirements, R&D, and/or Enabling Policies   | <i>Not Quantifiable</i>   |             |                 |  |  | Unanimous        |
| ES-10      | Technology-Focused Initiatives (Biomass Co-firing, Energy Storage, Fuel Cells, Etc.), Including Research, Development, & Demonstration |   |             |                 |  |  | Super Majority   |
|            | Co-firing at 5%  | 0.2   | 0.2         | 3.3             | \$34.48                                  | \$10.6                                     |                  |
|            | Co-firing at 10%   | 0.5   | 0.5         | 6.5             | \$69.43                                  | \$10.7                                     |                  |
|            | Co-firing at 20%   | 0.9   | 0.9         | 13.0            | \$134.09                                 | \$10.3                                     |                  |
| ES-11      | Power Plant Replacement, Energy Efficiency, and Repowering   | 2.5   | 2.0         | 33.2            | \$313                                    | \$9.4                                      | Unanimous        |
| ES-12      | Distributed Renewable Energy Incentives, Barrier Removal, and Development Issues, Including Grid Access                                | <i>ES-12 Fully incorporated in distributed generation "carve-out" under ES-1.</i> |             |                 |  |  | Unanimous        |
| ES-13      | Combined Heat and Power (CHP) Standards, Incentives and/or Barrier Removal   | 0.4   | 0.5         | 7.8             | \$31.91                                  | \$4.09                                     | Unanimous        |
| ES-15      | Transmission Access and Upgrades   | <i>Not Quantifiable</i>   |             |                 |  |  | Unanimous        |
|            | <b>Sector Totals</b>   | <b>8.1</b>  | <b>37.2</b> | <b>306.6</b>    | <b>\$6,348</b>                           | <b>\$22</b>                                |                  |
|            | <b>Sector Total After Adjusting for Overlaps</b>   | <b>8.1</b>  | <b>23.6</b> | <b>220.3</b>    | <b>\$7,980</b>                           | <b>\$36</b>                                |                  |
|            | <b>Reductions From Recent Actions</b>  | <b>2.7</b>  | <b>1.9</b>  | <b>30.1</b>     | <b>\$1,025</b>                           | <b>\$34</b>                                |                  |
|            | <b>Sector Total Plus Recent Actions</b>  | <b>10.8</b>   | <b>25.5</b> | <b>250.4</b>    | <b>\$9,005</b>                           | <b>\$36</b>                                |                  |

MMtCO<sub>2e</sub> = millions of metric tons of carbon dioxide equivalent; \$/tCO<sub>2e</sub> = dollars per metric tons of carbon dioxide equivalent; CCI = Cross-Cutting Issues; CCSR = carbon capture and storage or reuse; GHG = greenhouse gas; IGCC = integrated gasification combined cycle; MCAC = Michigan Climate Action Council; N/A = not applicable; PA = Public Act; R&D = research and development.

### Market Based Policy (MBP) Recommendations

| No.   | Policy Recommendations   | GHG Reductions (MMtCO <sub>2e</sub> ) |      |                 | Net Present Value 2009–2025 (Million \$) | Cost-Effectiveness (\$/tCO <sub>2e</sub> ) | Level of Support |
|-------|--|---------------------------------------|------|-----------------|--|--|------------------|
|       |  | 2020                                  | 2025 | Total 2009–2025 |  |  |                  |
| MBP-1 | Cap and Trade<br>20% below 2005 by 2020 ( <i>Free-Granting Allowances</i> ) <sup>5</sup> | 92.48                                 |      |                 |  | -\$25.83                                   | Unanimous        |
|       | 20% Below 2005 by 2020 ( <i>Auctioning Allowances</i> ) <sup>6</sup>                     | 92.48                                 |      |                 |  | -\$19.33                                   |                  |

<sup>5</sup> These results include mitigation costs, including payments or revenues resulting from the purchase or sale of allowances between Michigan emitters and out-of-state Midwestern Governors Association (MGA) partners.

| No.   | Policy Recommendations                  | GHG Reductions (MMtCO <sub>2</sub> e) |      |                 | Net Present Value 2009–2025 (Million \$) | Cost-Effective-ness (\$/tCO <sub>2</sub> e) | Level of Support |
|-------|---|---------------------------------------|------|-----------------|--|---|------------------|
|       |   | 2020                                  | 2025 | Total 2009–2025 |  |   |                  |
| MBP-3 | Michigan Joins Chicago Climate Exchange | <i>Not Quantified</i>                 |      |                 |  |   | Unanimous        |
| MBP-6 | Market Advisory Group                   | <i>Not Quantifiable</i>               |      |                 |  |   | Unanimous        |

### Transportation and Land Use (TLU) Policy Recommendations

| Policy No.         | Policy Option   | GHG Reductions (MMtCO <sub>2</sub> e) |             |                 | Net Present Value 2009–2025 (Million \$) | Cost-Effective-ness (\$/tCO <sub>2</sub> e) | Level of Support |
|--------------------|---|---------------------------------------|-------------|-----------------|--|---|------------------|
|                    |   | 2015                                  | 2025        | Total 2009–2025 |  |   |                  |
| TLU-1 <sup>7</sup> | Promote Low-Carbon Fuel Use in Transportation                       | 2.6                                   | 5.9         | 53              | \$820                                    | \$16  | Unanimous        |
| TLU-2              | Eco-Driver Program  | 1.1                                   | 2.2         | 22              | –\$3,921                                 | –\$176                                      | Unanimous        |
| TLU-3              | Truck Idling Policies   | 0.36                                  | 0.76        | 7.0             | –\$596                                   | –\$85                                       | Unanimous        |
| TLU-4              | Advanced Vehicle Technology   | 0.01                                  | 0.03        | 0.19            | \$281                                    | \$1,458                                     | Unanimous        |
| TLU-5              | Congestion Mitigation   | 0.08                                  | 0.18        | 1.7             | –\$135                                   | –\$81                                       | Unanimous        |
| TLU-6              | Land Use Planning and Incentives                                    | 0.14                                  | 0.43        | 3.2             | –\$598                                   | –\$189                                      | Unanimous        |
| TLU-7              | Transit and Travel Options  | 0.13                                  | 0.54        | 3.5             | \$655                                    | \$185                                       | Unanimous        |
| TLU-8              | Increase Rail Capacity, and Address Rail Freight System Bottlenecks | 0.10                                  | 0.19        | 2.0             | \$69                                     | \$35  | Unanimous        |
| TLU-9              | Great Lakes Shipping  | 0.24                                  | 0.27        | 2.5             | NQ                                       | NQ  | Unanimous        |
|                    | Sector Totals   | <b>4.76</b>                           | <b>10.5</b> | <b>95.1</b>     | <b>–\$3,425</b>                          | <b>–\$36</b>                                | <b>N/A</b>       |
|                    | <b>Sector Total After Adjusting for Overlaps</b>                    | <b>4.76</b>                           | <b>10.5</b> | <b>95.1</b>     | <b>–\$3,425</b>                          | <b>–\$36</b>                                | <b>N/A</b>       |
|                    | <b>Reductions From Recent Actions</b>                               | <b>0</b>                              | <b>0</b>    | <b>0</b>        | <b>\$0</b>                               | <b>\$0</b>                                  | <b>N/A</b>       |
|                    | <b>Sector Total Plus Recent Actions</b>                             | <b>4.76</b>                           | <b>10.5</b> | <b>95.1</b>     | <b>–\$3,425</b>                          | <b>–\$36</b>                                | <b>N/A</b>       |

<sup>6</sup> These results include mitigation costs but do not include payments to the state by Michigan emitters for the purchase of allowances at auction. The cost and revenue implications of distribution of allowances by auction can be found in Table G-1-2 and Annex G-1.

<sup>7</sup> TLU-1 addresses the consumption of biofuels in Michigan. The quantification results for AFW-2 (biofuel production volumes and costs), were used as inputs to the estimates for low-carbon fuel use in TLU-1.

### Residential, Commercial and Industrial (RCI) Policy Recommendations

|               | Policy Option  | GHG Reductions (MMtCO <sub>2</sub> e)          |             |                 | Net Present Value 2009–2025 (Million \$) | Cost-Effectiveness (\$/tCO <sub>2</sub> e) | Level of Support |
|---------------|--|--|-------------|-----------------|--|--|------------------|
|               |  | 2015   | 2025        | Total 2009–2025 |  |  |                  |
| <b>RCI-1</b>  | Utility Demand-Side Management for Electricity and Natural Gas                                       | 0.0  | 13.6        | 86.3            | –1,632                                   | –19  | Unanimous        |
| <b>RCI-2</b>  | Existing Buildings Energy Efficiency Incentives, Assistance, Certification, and Financing            | 17.6   | 53.8        | 428.6           | –12,107                                  | –28  | Unanimous        |
| <b>RCI-3</b>  | Regulatory (PSC) Changes to Remove Disincentives and Encourage Energy Efficiency Investments by IOUs | <i>Not Quantifiable</i>                        |             |                 |  |  | Unanimous        |
| <b>RCI-4</b>  | Adopt More Stringent Building Codes for Energy Efficiency  | 3.6  | 9.8         | 82              | –2,865                                   | –35  | Unanimous        |
| <b>RCI-5</b>  | MI Climate Challenge & Related Consumer Education Programs   | <i>Not Quantifiable</i>                        |             |                 |  |  | Unanimous        |
| <b>RCI-6</b>  | Incentives to Promote Renewable Energy Systems Implementation  | 0.7  | 1.5         | 14.0            | 1,958                                    | 140  | Unanimous        |
| <b>RCI-7</b>  | Promotion and Incentives for Improved Design and Construction in the Private Sector                  | 15.6   | 47.6        | 380             | –11,693                                  | –31  | Unanimous        |
| <b>RCI-8</b>  | Net Metering for Distributed Generation  | Fully incorporated into RCI-6                  |             |                 |  |  | Unanimous        |
| <b>RCI-9</b>  | Training & Education for Bldg. Design, Construction, and Operation                                   | <i>Not Quantifiable</i>                        |             |                 |  |  | Unanimous        |
| <b>RCI-10</b> | Water Use and Management   | <i>Not Quantifiable</i>                        |             |                 |  |  | Unanimous        |
|               | <b>Sector Total After Adjusting for Overlaps*</b>  | <b>21.8</b>                                    | <b>64.9</b> | <b>523.9</b>    | <b>–13,014</b>                           | <b>–24.8</b>                               |                  |
|               | <b>Reductions From Recent Actions</b>  | <b>Figures adjusted include recent actions</b> |             |                 |  |  |                  |
|               | <b>Sector Total Plus Recent Actions</b>  | <b>21.8</b>                                    | <b>64.9</b> | <b>523.9</b>    | <b>–13,014</b>                           | <b>–24.8</b>                               |                  |

PSC = Public Service Commission; IOU = investor-owned utility.

\*The figures listed show totals for the options net of recent legislation. Negative numbers indicate cost savings.

### Agriculture, Forestry and Waste (AFW) Management Policy Recommendations

| Policy No. | Policy Recommendation   | GHG Reductions (MMtCO <sub>2</sub> e)   |      |                 | Net Present Value 2009–2025 (Million 2005\$) | Cost-Effectiveness (\$/tCO <sub>2</sub> e) | Level of Support |
|------------|---|---|------|-----------------|--|--|------------------|
|            |   | 2015                                    | 2025 | Total 2009–2025 |  |  |                  |
| AFW-1      | Expanded Use of Biomass Feedstocks for Electricity, Heat, or Steam Production | 3.3                                     | 10   | 79              | \$1,649                                      | \$21                                       | Unanimous        |
| AFW-2*     | In-State Liquid Biofuels Production   | <i>Included in the Results of TLU-1</i> |      |                 |  |  | Unanimous        |

| Policy No.                       | Policy Recommendation  |   | GHG Reductions (MMtCO <sub>2</sub> e) |           |                 | Net Present Value 2009–2025 (Million 2005\$) | Cost-Effectiveness (\$/tCO <sub>2</sub> e) | Level of Support |
|----------------------------------|--|---|---------------------------------------|-----------|-----------------|--|--|------------------|
|                                  |  |   | 2015                                  | 2025      | Total 2009–2025 |  |  |                  |
| AFW-3                            | Methane Capture and Utilization From Manure and Other Biological Waste |   | 0.09                                  | 0.14      | 1.5             | \$4.7  | \$3  | Unanimous        |
| AFW-4                            | Expanded Use of Bio-based Materials                                    | A. Use of Bio-based Products                                | .08                                   | .21       | 1.7             | –\$108                                       | –\$62                                      | Unanimous        |
|                                  |  | B. Utilization of Solid Wood Residues                       | Not Quantified                        |           |                 |  |  | Unanimous        |
| AFW-5                            | Land Use Management That Promotes Permanent Cover                      | A. Increase in Permanent Cover Area                         | 0.08                                  | 0.21      | 1.8             | \$63   | \$34                                       | Unanimous        |
|                                  |  | B. Retention of Lands in Conservation Programs <sup>†</sup> | 0.05                                  | 0.11      | 1.1             | \$24   | \$23                                       | Unanimous        |
|                                  |  | C. Retention/Enhancement of Wetlands                        | Not Quantified                        |           |                 |  |  | Unanimous        |
| AFW-6                            | Forestry and Agricultural Land Protection                              | A. Agricultural Land Protection                             | 0.46                                  | 1.1       | 10              | \$864  | \$85                                       | Unanimous        |
|                                  |  | B. Forested Land Protection                                 | Not Quantified                        |           |                 |  |  | Unanimous        |
|                                  |  | C. Peatlands/Wetlands Protection                            | Not Quantified                        |           |                 |  |  | Unanimous        |
| AFW-7**                          | Promotion of Farming Practices That Achieve GHG Benefits               | A. Soil Carbon Management                                   | 0.7                                   | 1.7       | 15              | –\$200                                       | –\$13                                      | Unanimous        |
|                                  |  | B. Nutrient Efficiency                                      | 0.05                                  | 0.12      | 1.1             | –\$27  | –\$26                                      | Unanimous        |
|                                  |  | C. Energy Efficiency  | 0.13                                  | 0.32      | 2.9             | –\$102                                       | –\$35                                      | Unanimous        |
|                                  |  | D. Local Food   | Not Quantified                        |           |                 |  |  | Unanimous        |
| AFW-8                            | Forest Management for Carbon Sequestration and Biodiversity            | A. Enhanced Forestland Management                           | 0.53                                  | 1.42      | 12.05           | \$800  | \$66                                       | Unanimous        |
|                                  |  | B. Urban Forest Canopy                                      | 1.2                                   | 2.9       | 26              | –\$346                                       | –\$13                                      | Unanimous        |
|                                  |  | C. Reduce Wildfire  | Not Quantified                        |           |                 |  |  | Unanimous        |
| AFW-9**                          | Source Reduction, Advanced Recycling, and Organics Management          |   |                                       |           |                 |  |  | Unanimous        |
|                                  | In-State GHG Reductions  |   | 1.4                                   | 3.0       | 28              | –\$3,136                                     | –\$112                                     |                  |
|                                  | Full Life-Cycle Reductions   |   | 14.5                                  | 35.3      | 314             | –\$3,136                                     | –\$10                                      |                  |
| AFW-10                           | Landfill Methane Energy Programs                                       |   | 0.91                                  | 2.7       | 22              | –\$35  | –\$2                                       | Unanimous        |
| <b>Sector Totals<sup>†</sup></b> |  |   | <b>9</b>                              | <b>23</b> | <b>201</b>      | <b>–\$548</b>                                | <b>–\$3</b>                                |                  |

| Policy No. | Policy Recommendation   | GHG Reductions (MMtCO <sub>2</sub> e) |      |                 | Net Present Value 2009–2025 (Million 2005\$) | Cost-Effectiveness (\$/tCO <sub>2</sub> e) | Level of Support |
|------------|---|---------------------------------------|------|-----------------|--|--|------------------|
|            |   | 2015                                  | 2025 | Total 2009–2025 |  |  |                  |
|            | <b>Sector Total After Adjusting for Overlaps<sup>††</sup></b> | 6                                     | 17   | 147             | –\$1,634                                     | –\$11                                      |                  |
|            | <b>Reductions From Recent Actions</b>                         | N/A                                   | N/A  | N/A             | N/A  | N/A  |                  |
|            | <b>Sector Total Plus Recent Actions</b>                       | 6                                     | 17   | 147             | –\$1,634                                     | –\$11                                      |                  |

N/A = not applicable. Note that negative costs represent a monetary savings.

\* The quantification results for AFW-2 (biofuel production volumes and costs) were used as inputs to the quantification of the results of TLU-1, which covers consumption of biofuels in Michigan.

\*\* The analyses for AFW-5, AFW-7, and AFW-9 include the full life-cycle costs of the policies. In the case of AFW-9, it is estimated that a significant fraction of the reductions will occur out of state. In-state reductions refer only to those occurring from reduced landfilling and waste combustion (these are broken out separately in the table above).

† The reductions from AFW-5B (Retention of Lands in Conservation Programs) have been left out of the sector totals, since they relate to a soil carbon protection measure where the estimated emissions (from conservation acres being returned to active cultivation) are not included in the business as usual (BAU) inventory and forecast (I&F). The costs have been included in the sector totals, since these will be incurred in order to retain the level of emissions in the BAU I&F. For AFW-5, AFW-7, and AFW-9, these include the reductions that are expected to occur within the state.

†† See the section below for discussion of overlap adjustments.

### Cross Cutting Issues (CCI) Policy Recommendations

| No.   | Policy Recommendation   | GHG Reductions (MMtCO <sub>2</sub> e)   |      |                 | Net Present Value 2009–2025 (Million \$) | Cost Effectiveness (\$/tCO <sub>2</sub> e) | Level of Support       |
|-------|---|---|------|-----------------|--|--|------------------------|
|       |   | 2015  | 2025 | Total 2009–2025 |  |  |                        |
| CCI-1 | GHG Inventories, Forecasting, Reporting, and Registry                         | <i>Not Quantified</i>   |      |                 |  |  | Unanimous              |
| CCI-2 | Statewide GHG Reduction Goals and Targets                                     | <i>Not Quantified</i>   |      |                 |  |  |                        |
| CCI-3 | State, Local, and Tribal Government GHG Emission Reductions (Lead-by-Example) | <i>Not Quantified</i>   |      |                 |  |  | Unanimous              |
| CCI-4 | Comprehensive Local Government Climate Action Plans (Counties, Cities, Etc.)  | <i>Not Quantified</i>   |      |                 |  |  | Unanimous              |
| CCI-5 | Public Education and Outreach   | <i>Not Quantified</i>   |      |                 |  |  | Unanimous              |
| CCI-6 | Tax and Cap/ Cap and Trade  | <i>MCAC approved creation of a new Market-Based Policies Technical Work Group as the lead for this policy recommendation.</i> |      |                 |  |  | Transferred to MBP TWG |
| CCI-7 | Seek Funding for Implementation of MCAC Recommendations                       | <i>Not Quantified</i>   |      |                 |  |  | Unanimous              |
| CCI-8 | Adaptation and Vulnerability  | <i>Not Quantified</i>   |      |                 |  |  | Unanimous              |

| No.    | Policy Recommendation  | GHG Reductions (MMtCO <sub>2</sub> e) |      |                 | Net Present Value 2009–2025 (Million \$) | Cost Effectiveness (\$/tCO <sub>2</sub> e) | Level of Support |
|--------|--|---------------------------------------|------|-----------------|--|--|------------------|
|        |  | 2015                                  | 2025 | Total 2009–2025 |  |  |                  |
| CCI-9  | Participate in Regional, Multi-State, and National GHG Reduction Efforts                                     | <i>Not Quantified</i>                 |      |                 |  |  | Unanimous        |
| CCI-10 | Enhance and Encourage Economic Growth and Job Creation Opportunities Through Climate Change Mitigation       | <i>Not Quantified</i>                 |      |                 |  |  | Unanimous        |
| CCI-11 | Enhance and Encourage Community Development Through Climate Change Mitigation: Address Environmental Justice | <i>Not Quantified</i>                 |      |                 |  |  | Unanimous        |

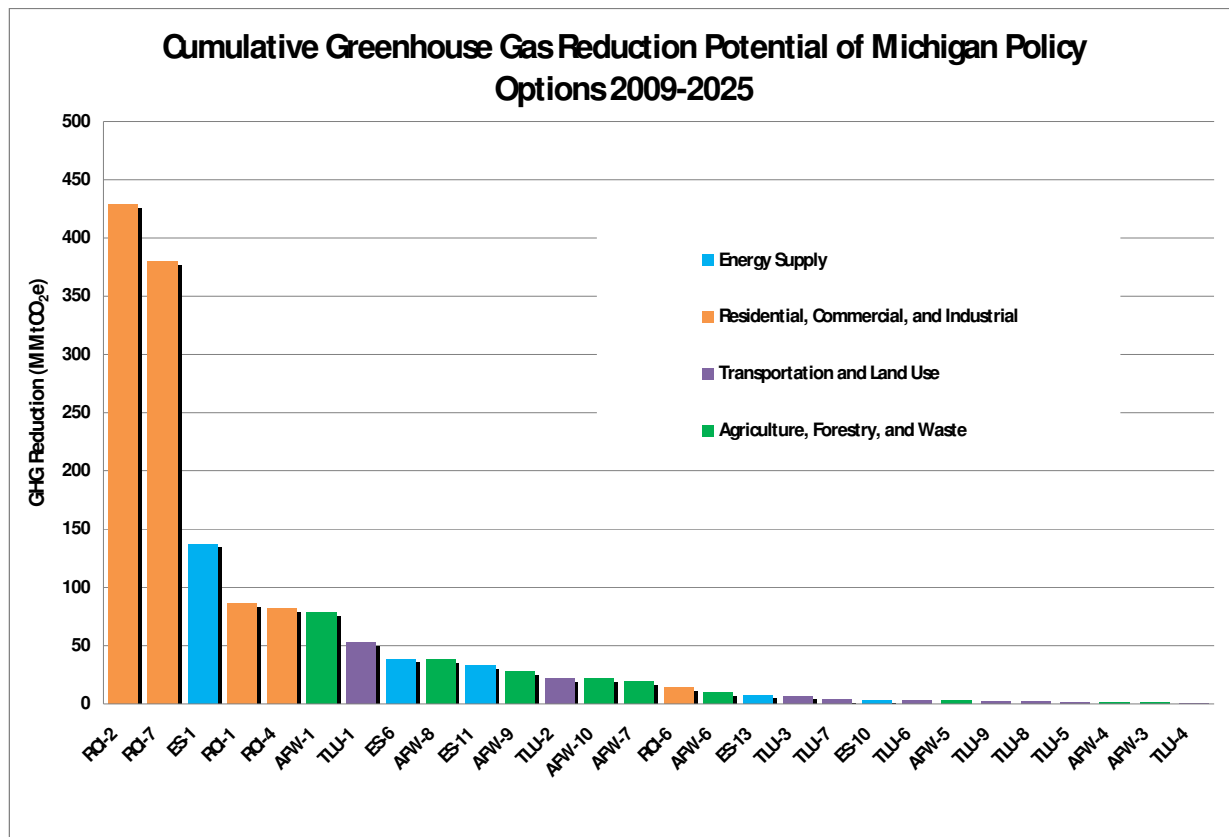
GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent

As explained previously, the MCAC considered the estimates of the GHG reductions that could be achieved and the costs (or cost savings) for the 33 options that were quantifiable. Figure ExS-5, below, presents the estimated tons of GHG emission reductions for each of these policy recommendations, expressed as a cumulative figure for the period 2009–2025.

Figure ExS-6 presents the estimated dollars-per-ton cost (or cost savings, depicted as a negative number) for each quantified policy recommendation. The dollars per ton value is calculated by dividing the net present value of the cost of the policy recommendation by the cumulative GHG reductions, all for the period 2009–2025.

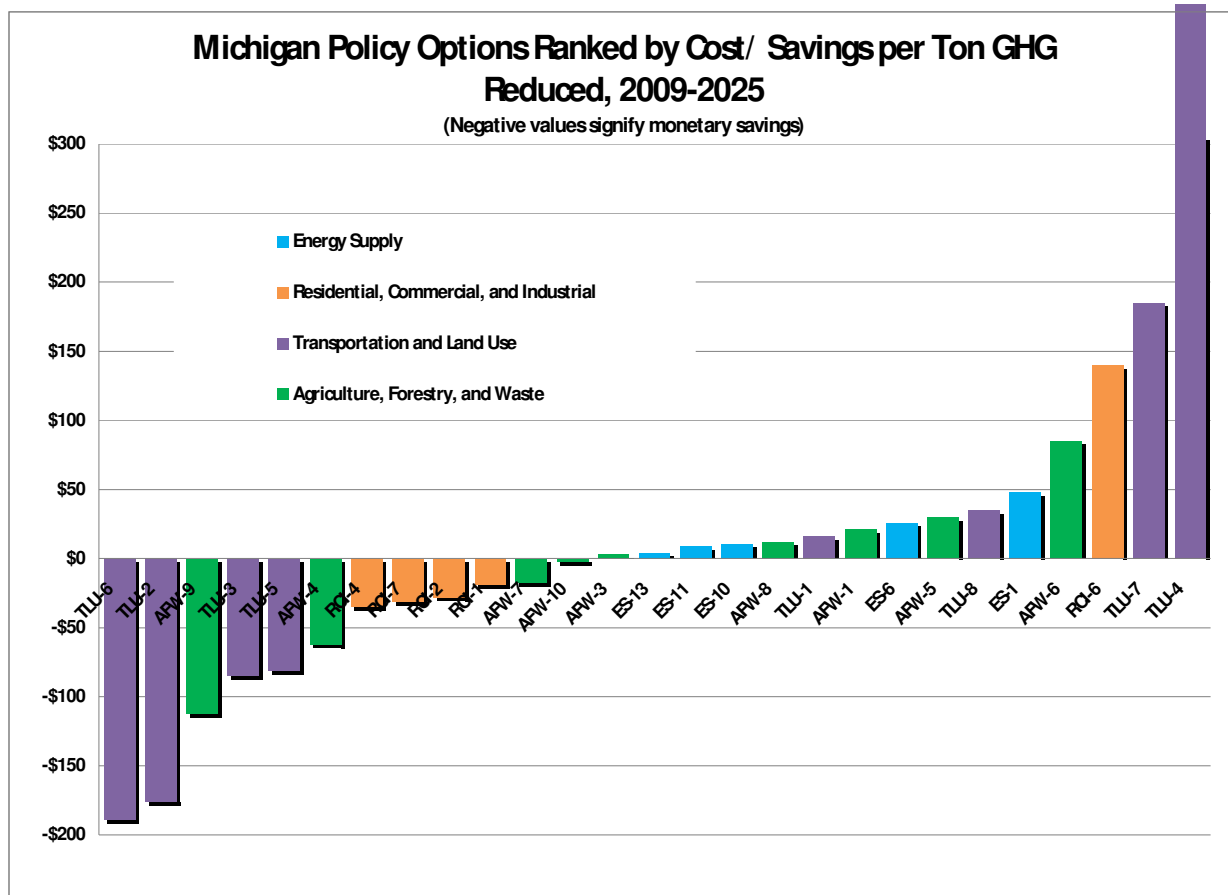
It is important to note that there is some level of uncertainty in projecting GHG reductions and estimating exact costs (or cost savings) per ton of reductions achieved for the time periods of this analysis.

**Figure ExS-5. MCAC policy recommendations ranked by cumulative (2009–2025) GHG reduction potential**



GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; AFW = Agriculture, Forestry, and Waste Management; ES = Energy Supply; TLU = Transportation and Land Use; RCI = Residential, Commercial and Industrial

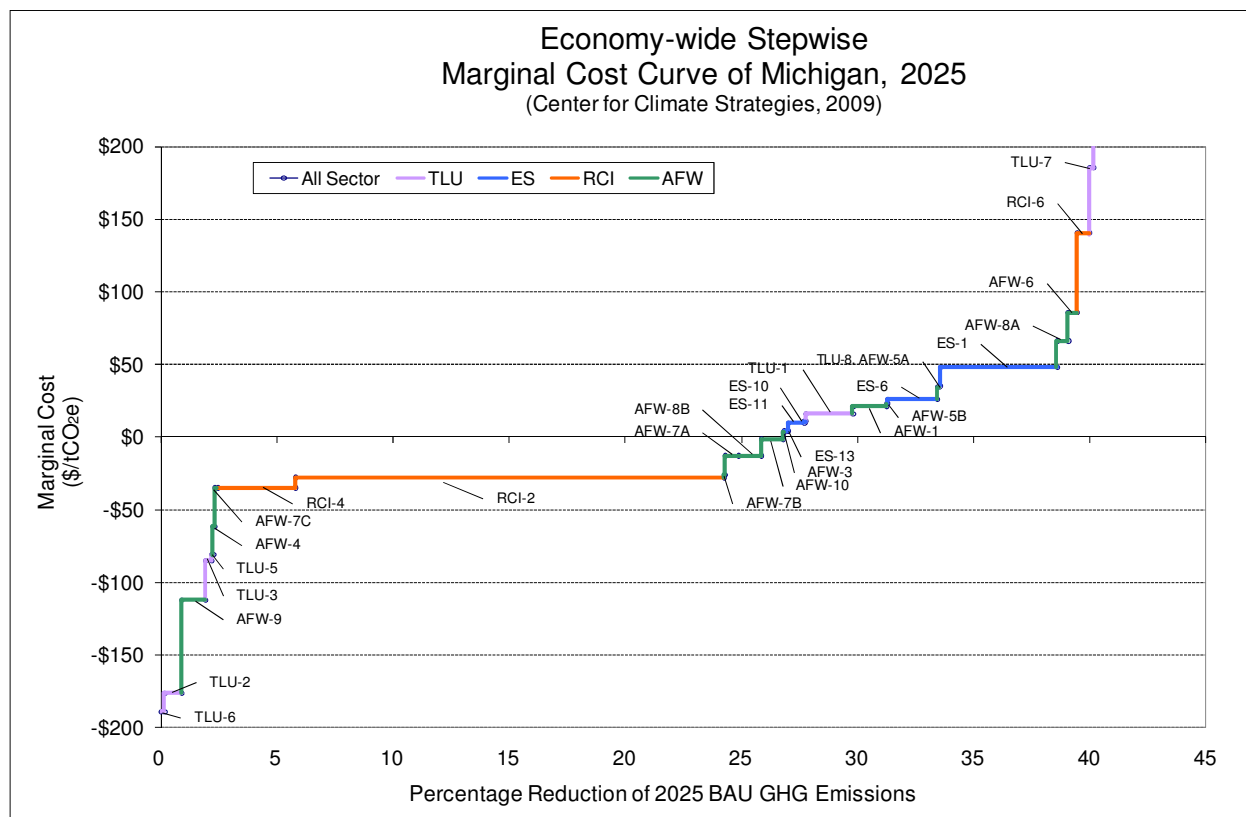
**Figure ExS-6. MCAC policy recommendations ranked by cumulative (2009–2025) net cost/cost savings per ton of GHG removed**



GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; AFW = Agriculture, Forestry, and Waste Management; ES = Energy Supply; TLU = Transportation and Land Use; RCI = Residential, Commercial and Commercial, Industrial

Figure ExS-7, below, presents a stepwise marginal cost curve for Michigan. The horizontal axis represents the percentage of GHG emissions reduction in 2025 for each option relative to the business as usual (BAU) forecast. The vertical axis represents the marginal cost of mitigation (expressed as the cost-effectiveness of each policy option on a cumulative basis, 2009-2025). In the figure, each horizontal segment represents an individual policy. The width of the segment indicates the GHG emission reduction potential of the option in percentage terms. The height of the segment relative to the horizontal x-axis shows the average cost (saving) of reducing one MMtCO<sub>2</sub>e of GHG emissions through implementation of the option.

**Figure ExS-7. Stepwise marginal cost curve for Michigan, 2025**



BAU = business as usual; GHG = greenhouse gas; tCO<sub>2</sub>e = metric tons of carbon dioxide equivalent; AFW = Agriculture, Forestry, and Waste Management; ESES = Energy Supply; TLU = Transportation and Land Use; RCI = Residential, Commercial and Industrial

Negative values represent net cost savings and positive values represent net costs associated with the policy option.

Note: Results have been adjusted to remove overlaps between policies.