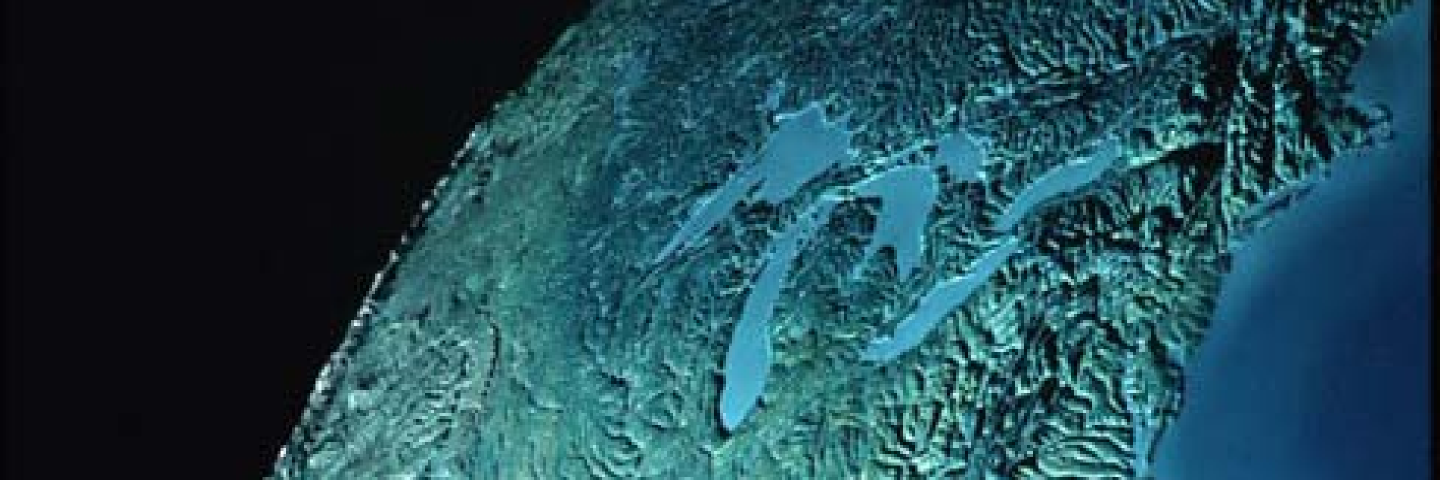
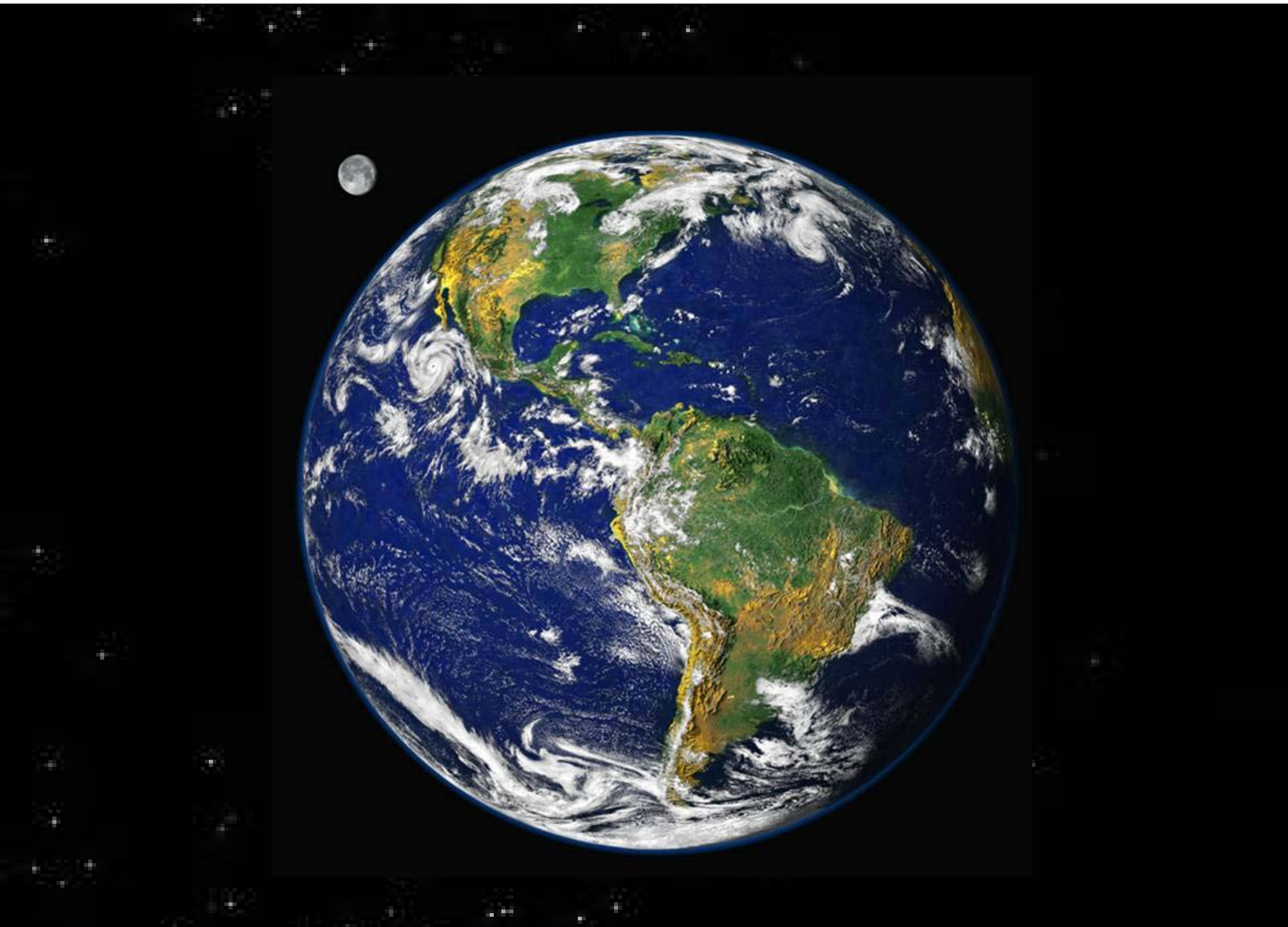


Michigan Climate Action Council

Climate Action Plan



Michigan Department of Environmental Quality
Steven E. Chester, Director

March 2009
Jennifer M. Granholm, Governor

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Members of the Michigan Climate Action Council

The Michigan Climate Action Council (MCAC) comprises 35 representatives from public interest groups, environmental organizations, utilities, the manufacturing sector and other key industries, universities, and state, local, and tribal government. Governor Granholm appointed the following individuals to the MCAC:

Jon Allan, Manager, Next Generation, Consumers Energy
Jeff Andresen, Ph.D., State of Michigan Climatologist**,** Department of Geography, Michigan State University
Guy Bazzani, President, Bazzani & Associates
Dr. Rosina Bierbaum, Ph.D., Dean, School of Natural Resources and Environment, University of Michigan; (**Duncan Callaway**, alternate)
Skiles Boyd, Vice President, Environmental Management and Resources, DTE Energy
Dwight Brady, Ph.D., Department of Communication, Northern Michigan University
Jim Byrum, President, Michigan Agri-Business Association
Steve Chester, Director, Department of Environmental Quality
Norman Christopher, Director of Sustainability, Grand Valley State University
Keith Cooley, Chief Executive Officer, NextEnergy
Dana Debel, Delta Air Lines
Doug Parks, representing **Jim Epolito,** President and CEO, Michigan Economic Development Corporation
Frank Ettawageshik, Tribal Chairman, Little Traverse Bay Bands of Odawa Indians
Michael Garfield, The Ecology Center of Ann Arbor
George Heartwell, Mayor, City of Grand Rapids
Chuck Hersey, Manager of Environmental Programs, Southeast Michigan Council of Governments
John Hiefje, Mayor, City of Ann Arbor
Rebecca Humphries, Director, Department of Natural Resources
Dana Kirk, Wilcox Inc.
Don Koivisto, Director, Michigan Department of Agriculture
Curt Magleby, Director of State and Local Governmental Affairs, Ford Motor Company
Brad Markell, United Auto Workers
Monica Martinez, Commissioner, Michigan Public Service Commission
Reginald Modlin, Director of Environmental and Energy Planning, Chrysler, LLC
Dennis Muchmore, Executive Director, Michigan United Conservation Clubs
Leonard Parker, Safety and Environmental Manager, Cliffs Natural Resources, Inc.
Lana Pollack, Former President, Michigan Environmental Council
Stanley Pruss, Director, Department of Energy, Labor and Economic Growth
Kirk Steudle, Director, Michigan Department of Transportation
Lisa Webb Sharpe, Director, Department of Management and Budget
Jim Weeks, Michigan Municipal Electric Association
Rich Wells, Vice President, Energy, The Dow Chemical Company

Al Weverstad, Executive Director, Environment and Energy Public Policy Center, General Motors Corporation
Willa Williams, Interim Director, Department of Environmental Affairs, City of Detroit
Dr. Gregg Zank, Vice President, Chief Technology Officer and Executive Director of Science and Technology, Dow Corning

The following individuals were appointed by Governor Granholm and served on the MCAC for a portion of its tenure:

Karen Cooper-Boyer, Denso Manufacturing
Pete Madden, Senior Resources Manager, Michigan Operations, Plum Creek Timber Company
Dr. Vincent Nathan, Ph.D., M.P.H., Director, Department of Environmental Affairs, City of Detroit

Acronyms and Abbreviations

$/kWh	dollars per kilowatt-hour
$MM	millions of dollars
$/MWh	dollars per megawatt-hour
$/t	dollars per metric ton
$/t$CO_2$e	dollars per metric ton of carbon dioxide equivalent
ACEEE	American Council for an Energy Efficient Economy
AEO 2007	*Annual Energy Outlook 2007*
AEO 2008	*Annual Energy Outlook 2008*
AES	alternative energy supplier
AEZ	alternative energy zone
AFV	alternative-fuel vehicle
AFW	Agriculture, Forestry, and Waste Management
AII	Athena Institute International
AIS	aquatic invasive species
AMI	advanced metering infrastructure
ANL	Argonne National Laboratory
APU	auxiliary power unit
ASAs	Agricultural Security Areas
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ATRI	American Transportation Research Institute
BACT	best available control technology
BAU	business as usual
Btu	British thermal unit
C	Carbon
C&D	construction and demolition
C&T	cap and trade
CCI	Cross-Cutting Issues
CCS	Center for Climate Strategies
CCSR	carbon capture and storage/sequestration or reuse
CCX	Chicago Climate Exchange
CH_4	Methane
CHP	combined heat and power
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
COD	commercial operation date
COEE	Centers of Energy Excellence
COLA	combined operating and licensing application
CREP	Conservation Reserve Enhancement Program [USDA]
CRP	Conservation Reserve Program [USDA]
CTIC	Conservation Technology Information Center

DG	distributed generation
DOE	[United States] Department of Energy
DSM	demand-side management
Dth	decatherms
E10	fuel blend of 10% ethanol and 90% gasoline
E85	fuel blend of 85% ethanol and 15% gasoline
EE	energy efficiency
EERE	[Office of] Energy Efficiency and Renewable Energy [US DOE]
eGRID	Emissions & Generation Resource Integrated Database [US EPA]
EIA	Energy Information Administration [US DOE]
EISA	Energy Independence and Security Act of 2007
EO	energy optimization
EOR	enhanced oil recovery
EOS	energy optimization standard
EPA	[United States] Environmental Protection Agency
ES	Energy Supply
ESCO	energy service company
FACTA	Food, Agriculture, Conservation, and Trade Act of 1990
FEED	front-end engineering and design
FERC	Federal Energy Regulatory Commission
FHWA	Federal Highway Administration
FIA	Forest Inventory and Analysis [USFS]
FJD	First Jurisdiction Deliverer
FRPP	Farm and Ranch Lands Protection Program
g	gram
gal	gallon
GHG	greenhouse gas
GIS	geographic information system
GPO	[United States] Government Printing Office
GREET	Greenhouse [gases] Regulated Emissions and Energy [use in] Transportation [model]
Gt	gigatons
GWh	gigawatt-hour [one million kilowatt-hours]
HB	House Bill
HDPE	high-density polyethylene
HFC	hydrofluorocarbon
I&F	inventory and forecast
IECC	International Energy Conservation Code
IGCC	integrated gasification combined cycle
IOGCC	Interstate Oil and Gas Compact Commission
IOU	investor-owned utility
IPCC	Intergovernmental Panel on Climate Change
IPP	independent power provider
IRP	integrated resource planning

ISO	International Standard Organization
ITS	intelligent transportation system
kg	kilogram
kV	kilovolt
kW	kilowatt
kWh	kilowatt-hour
lb	pound
LCA	life-cycle analysis
LDPE	low-density polyethylene
LED	light-emitting diode
LEED	Leadership in Energy and Environmental Design [Green Building Rating System™]
LFG	landfill gas
LFGcost	landfill gas cost model
LFGTE	landfill gas-to-energy
LIEEF	Low-Income and Energy Efficiency Fund
LMOP	Landfill Methane Outreach Program [US EPA]
LPG	liquefied petroleum gas
LRR	low-rolling-resistance [tires]
MAC	[California] Market Advisory Committee
MAEAP	Michigan Agriculture Environmental Assurance Program
MAHB	Michigan Association of Home Builders
MAREC	Michigan Alternative and Renewable Energy Center
MBP	Market-Based Policies
MCAC	Michigan Climate Action Council
MCF	thousand cubic feet
MCCI	Michigan Conservation and Climate Initiative
MCCP	Michigan Climate Challenge Program
MCLs	Michigan Compiled Laws
MDA	Michigan Department of Agriculture
MDEQ	Michigan Department of Environmental Quality
MDELEG	Michigan Department of Energy, Labor and Economic Growth
MDMB	Michigan Department of Management and Budget
MDNR	Michigan Department of Natural Resources
MDOT	Michigan Department of Transportation
MEDC	Michigan Economic Development Corporation
metric ton	1,000 kilograms or 22,051 pounds
MGA	Midwestern Governors Association
MIFFS	Michigan Food & Farming Systems
MISO	Midwest Independent Transmission System Operator
MM	million
MMBtu	million British thermal units
MMtC	million metric tons of carbon

$MMtCO_2$	million metric tons of carbon dioxide
$MMtCO_2e$	million metric tons of carbon dioxide equivalent
MPO	metropolitan planning organization
MPSC	Michigan Public Service Commission
MRCSP	Midwest Regional Carbon Sequestration Partnership
MSU	Michigan State University
MSW	municipal solid waste
MUEC	Michigan Uniform Energy Code
MW	megawatt [one thousand kilowatts]
MWh	megawatt-hour [one thousand kilowatt-hours]
N	nitrogen
N_2O	nitrous oxide
N/A	not applicable
NASS	National Agricultural Statistics Service [USDA]
NGO	nongovernmental organization
NO_x	oxides of nitrogen
NPV	net present value
NQ	not quantified
NRC	[United States] Nuclear Regulatory Commission
NRCS	Natural Resources Conservation Service [USDA]
NREL	National Renewable Energy Laboratory [US DOE]
NREPA	Natural Resources and Environmental Protection Act
NRI	National Resources Inventory [USDA]
NSR	New Source Review
O&M	operation and maintenance
OEM	original equipment manufacturer
ORNL	Oak Ridge National Laboratory
P2 Loans	[Small Business] Pollution Prevention Loan Program
PA	Public Act
PCORP	Plains CO_2 Reduction Partnership
PET	polyethylene terephthalate
PFC	perfluororocarbon
PHEV	plug-in hybrid electric vehicle
PLA	polylactic acid
PM	particulate matter
PSD	Prevention of Significant Deterioration
psi	pounds per square inch
PTC	production tax credit
PV	photovoltaic
R&D	research and development
RBEG	Rural Business Enterprise Grant

RCDG	Rural Cooperative Development Grant
RBOG	Rural Business Opportunity Grant
RCI	Residential, Commercial, and Industrial
REC	renewable energy credit
REP	renewable energy payment
RFP	request for proposal
REFIT	renewable energy feed-in tariff
RETAP	Retired Engineers Technical Assistance Program
RFC	[Michigan] Renewable Fuels Commission
RGGI	Northeast Regional Greenhouse Gas Initiative
ROI	return on investment
RPS	renewable portfolio standard
SB	Senate Bill
SO_2	sulfur dioxide
SRWC	short-rotation woody crop
t	metric ton
TBD	to be determined
tC	metric tons of carbon
tCO_2e	metric tons of carbon dioxide equivalent
tCO_2e/MWh	metric tons of carbon dioxide equivalent per megawatt-hour
TCR	The Climate Registry
TDR	transfer of development rights
TLU	Transportation and Land Use
TSE	truck-stop electrifications
TTI	Texas Transportation Institute
TWG	Technical Work Group
TWh	terawatt-hours
UIC	underground injection control
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
US DOE	United States Department of Energy
US EPA	United States Environmental Protection Agency
USFS	United States Forest Service [USDA]
VMT	vehicle miles traveled
WARM	WAste Reduction Model [US EPA]
WCI	Western Climate Initiative
WTO	World Trade Organization
yr	year

Michigan Climate Action Council's Recommended Policy Positions on Michigan Climate Action Strategy

Michigan is in a period of extraordinary transition and faces unprecedented challenges. Among the most compelling of these challenges is the urgent need to reduce greenhouse gas (GHG) emissions to address climate change and its impact on our health, our natural resources and our way of life. As part of this challenge, the economic core of our prosperity, the automobile industry, is undergoing tumultuous change as we move from a high carbon to a low carbon economy and a new energy future. Revenues to address government services are declining and are expected to do so in the foreseeable future. In addressing these issues, in response to climate change, we have the unique opportunity to also encourage deployment of new investment and technologies, save energy and money, create new jobs and income, promote energy independence and sustainability, and diversify and grow our economy. The magnitude of the challenge will require a remarkable level of cooperation among all levels of government.

The policy direction is clear. Michigan should seize this moment and take a leadership role in formulating and promoting efficient, effective national, regional and state polices to address climate change. These policies should holistically address the economy, renewable energy, climate change, energy efficiency and independence.

There are two integrated parts to Michigan's Climate Action Strategy. The first is based on state-based advocacy for strong national and international action on climate change. A framework describing the key elements of a national climate policy is summarized in Part One below.

The second part requires integration of national climate action policies and efforts with those that the Michigan Climate Action Council (MCAC) recommends for implementation in Michigan to achieve significant reductions in GHG emissions. This represents a call to action by State government, business, and the general public to confront the issue of climate change. It contains actions that we can take now within our state to simultaneously address climate change while transitioning our economy by, promoting new technology development, improving energy efficiency, conserving natural resources, and developing clean and renewable energy sources. These two policy trajectories are essential, coequal and intertwined.

Part One: Michigan Platform on Climate Change

The purpose of this platform is to assist Governor Granholm and other Michigan leaders as they represent Michigan in various forums on the topic of climate change. This includes the New Administration, U.S. Congress as well as the existing and emerging industry-based, non-governmental, and multi-state alliances on global warming.

- Michigan should take action now to address climate change. That action should take two forms: 1) specific actions to reduce GHG emissions in the state and region, and 2) active engagement in the development of a national climate policy.
- Governor Granholm is already taking steps to diversify Michigan's economy using alternative energy to create and retain jobs. Michigan should pursue policies and programs that leverage the State's existing knowledge and expertise to strengthen the auto and other manufacturing sectors and to further diversify the economic base of the State in the renewable energy, energy efficiency and natural resource conservation sectors.
- A national commitment to make significant reductions in GHG emissions will require a transformation of our energy, manufacturing and transportation systems. There will be economic costs and benefits associated with this transformation. Therefore, it is critical that a national climate policy optimizes economic efficiency, equity, and cost effectiveness. Michigan should advocate for the development of such a policy within the framework of a federal-state partnership. While the design, implementation and integration of federal, state and local GHG reduction policies present important issues to be resolved by federal and state policymakers, there is broad agreement that, in our system of government, all levels of government must work together in partnership if the nation is to effectively address this challenge.
- Although national climate policy could be based on alternatives to or additions to "cap and trade" (such as tax, subsidy, standards, and technical assistance policies), federal legislation is most likely to focus on a cap and trade and sector based programs.[1] Michigan therefore should advocate for a national cap and trade program that is efficient, equitable, economy wide, and based on a federal-state partnership. This should include sector based policies and measures that reduce market and institutional barriers to GHG reduction. The state should press for enactment of this legislation by 2010.
- Federal legislation should include national emission reduction targets.
- Federal legislation must be structured in a manner that drives immediate GHG reductions.

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[1]Although the New Administration and Congress are likely to pursue a nationwide cap and trade policy, other options remain available. The alternative most often mentioned is a carbon tax. If this alternative becomes the preferred approach, the comments and recommendations made herein also largely apply to a carbon tax, i.e., it must be fair from a revenue standpoint, efficient, equitable and effective, and not place Michigan residents and businesses at a disadvantage.

- Federal legislation should ensure GHG emissions are truly reduced and not just shifted from one state or region to another nor from one sector to another.
- The national program should encourage rapid technology development and deployment through the adoption of technology supporting and inducing policies. Cost efficiency and co-benefits should also be considered in achieving reductions of GHG emissions to assure that the timing of reductions coincides with the successful commercialization of emerging technologies. Major reductions from certain sectors may most effectively be accomplished if based on aggressive yet appropriate lead times that allow the necessary infrastructure to be put in place. Examples include carbon sequestration, low-carbon fuels, and commercial viability of high-density energy storage systems.
- While the need for action is now, there are remaining uncertainties regarding the pace at which technologies and markets will develop. Instead of waiting to act, the federal legislation should provide for periodic review so that adjustments can be made based on evolving knowledge of technologies, markets, emission reduction needs and other circumstances.
- Recognizing that effective measures to address climate change depend on international action, the United States should take the lead in facilitating global participation.
- Market forces and current federal legislation already are increasing vehicle fuel economy. Any federal policies adopted should not put the domestic auto industry at a competitive disadvantage**.**
- To the extent reasonably practical and feasible, the costs and benefits of achieving varying degrees of GHG reductions should be fully disclosed and discussed as part of a deliberative process in the State and nationally, including health, environment, energy and economic impacts, as well as recognition of both monetized and non-monetized impacts.
- A national cap-and-trade program should include appropriate measures to provide a degree of long-term cost certainty and temper wide fluctuations in the price of allowances that would be economically harmful to the U.S. while guarding against any negative impact on GHG emission reductions targets and timetables. Without approving any particular measure, the MCAC notes that examples of such potential measures are identified in Market Based Policy -1.
- Care should be taken to avoid unintended consequences. For example, the national program should not result in actions that make it more difficult to protect human health and the environment through attaining national air quality standards or is hampered by inconsistent policies in other areas.
- Revenue derived from the regulation of GHGs should be used to assist with the transformation to a low carbon economy through appropriate incentives and subsidies for the development and deployment of GHG-reducing technologies and to mitigate increased costs to the consumers. The revenues that exit the state should return at the same proportion, with the exception of that percentage dedicated to technology research, development, and deployment at the national level.

Part Two: Michigan Emission Reduction Proposals

1. The Michigan Climate Action Council (MCAC) has developed a comprehensive list of policy recommendations to reduce GHG emissions in Michigan. Michigan should take immediate steps to implement the policy recommendations of the MCAC establishing priorities to significantly reduce GHG emissions in the State. To begin this, the State should immediately calculate and publish the expected GHG reductions expected from the recent comprehensive energy legislation related to the Renewable Portfolio Standard (RPS) and Energy Efficiency programs as well as other recent and planned actions.
2. The MCAC also recommends that public education be a top priority in the State's climate action plan. A number of the MCAC recommendations are achievable in the short run. However, success is predicated on the will of the public to change its behavior. Michigan should aggressively move to inform the public of its choices for achieving GHG reductions and the cost of those choices. The public should be encouraged to participate in order to reduce costs. The success or failure of this effort should be tracked as part of evolving implementation of the State's climate change efforts, and the results should be disclosed to the public.
3. The MCAC further suggests that Michigan leverage the resources of its outstanding higher education system to promote international cooperative research pacts for the development of alternative energy sources and energy efficiency technologies.
4. Additionally, the MCAC recommends a multi-year strategy for inventorying, tracking and verifying GHG emissions and progress against state goals and targets must be developed and implemented so that progress towards state goals and targets can be accurately assessed.

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 as an initial step in establishing a basis for moving forward on the implementation of climate change policies in Michigan. Evaluation of key factors such as cost effectiveness, economic impacts, and harmonization with other Michigan programs and policies will be critical to the next stage of climate policy implementation.

The following key elements and recommendations were identified by the MCAC during this initial process:

- 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 reviewed over 330 multi-sector policy options and approved for inclusion in this report a package of 54 policy recommendations to reduce GHG emissions and address related energy and commerce issues in Michigan. 52 of these 54 recommendations were approved unanimously and only one option was rejected. The recommended policy options cover a wide range of costs and GHG reduction potentials.
- In moving towards implementation to achieve these goals, Michigan must prioritize these 54 policy recommendations during 2009 in order to set the stage for strategic implementation of the most promising options. The prioritization should take into account the GHG reduction potential, costs and savings, feasibility, co-benefits, and a macro-economic analysis of selected recommendations, and consistency with other Michigan programs and policies.
- 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_2e cost savings. Those policy options that show negative costs[1] (i.e. benefits) should be evaluated as quickly as possible. All policy options, particularly those that show a net cost, should be evaluated thoroughly, using tools such as regional economic modeling, before being implemented.
- 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

[1] Policy options that are "negative cost" are not necessarily better than other potential investments. In capital constrained situations only a limited number of investments can be made. There may be structural or policy barriers to the adoption of options identified as negative cost.

based upon a business as usual scenario. These documents were completed prior to the severe downturn in the global economy. To account for fluctuations such as changes in the economy, updates to this inventory should be performed annually with the projections evaluated every three years.

- The MCAC recommends that Michigan further analyze actions needed for adaptation. The MCAC was unable to 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.
- MCAC recommends that Michigan position itself as a leader in the national and regional dialogue on climate change policy as described in the MCAC's Recommended Policy Positions Section of this report.

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.miclimatechange.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_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). Emissions of these GHGs are presented using a common metric, CO_2 equivalence (CO_2e), which indicates the relative contribution of each gas, per unit mass, to global average radiative forcing on a global warming potential- (GWP-) weighted basis[2].

As illustrated in Figure ExS-1, below, activities in Michigan accounted for approximately 248 million metric tons (MMt) of gross[3] CO_2e emissions (consumption basis) in 2005, an amount

[2] 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 Panel on Climate Change. Cambridge University Press. Cambridge, United Kingdom. Available at: http://www.grida.no/climate/ipcc_tar/wg1/212.htm.

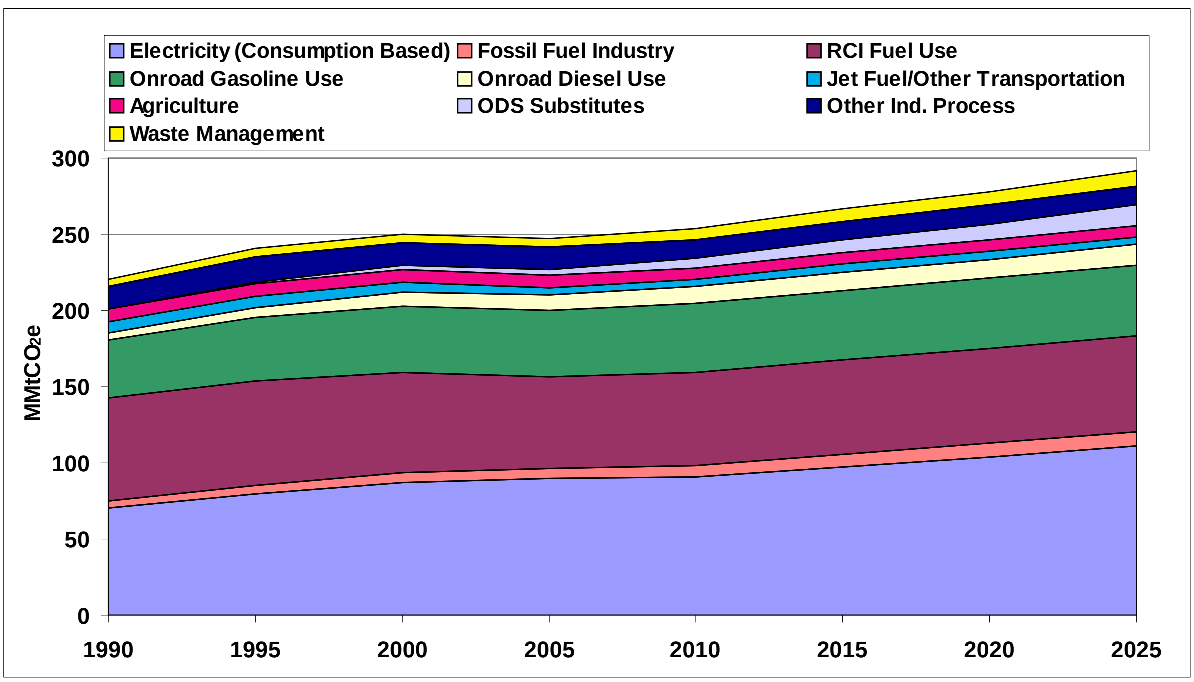
[3] Excluding GHG emissions removed due to forestry and other land uses and excluding GHG emissions associated with exported electricity.

equal to about 3.5% of total US gross GHG emissions (based on 2005 US data).[4] 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 $MMtCO_2e$ by 2025, 32% above 1990 levels. While these projections are made over the long term (e.g. to 2025), they do not account for the current severe global economic downturn and how this will impact future growth projections.

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



$MMtCO_2e$ = 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.)

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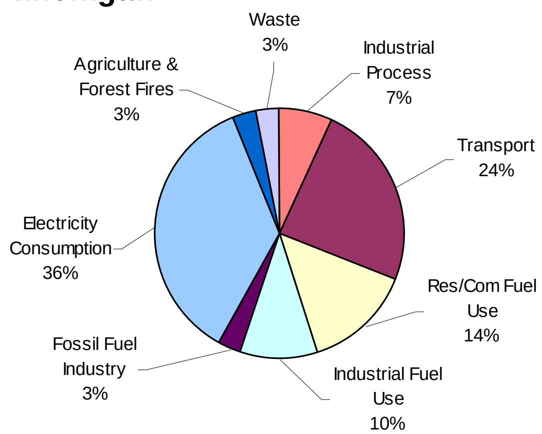
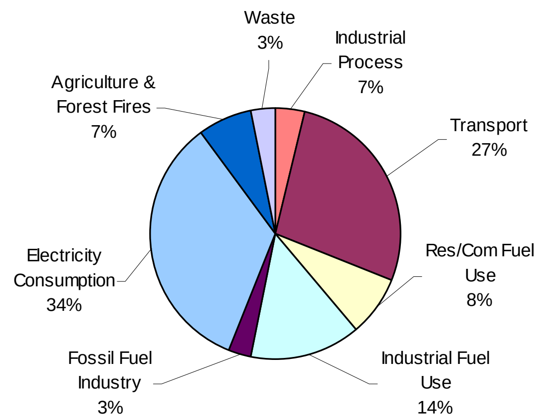
[4] The national emissions used for these comparisons are based on 2005 emissions from *Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2006*, April 15, 2008, US EPA #430-R-08-005, (http://www.epa.gov/climatechange/emissions/usinventoryreport.html).

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





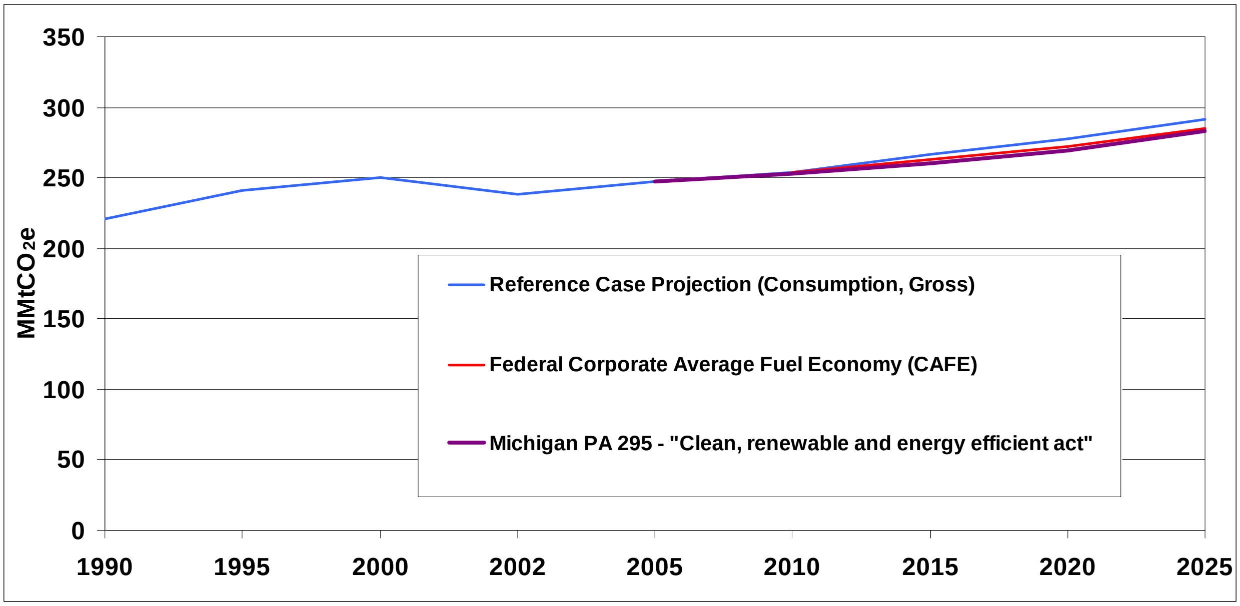
Recent Actions

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[5]. 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$_2$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.

[5] PA 295 The Clean Renewable and Energy Efficient Act of 2008

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



$MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

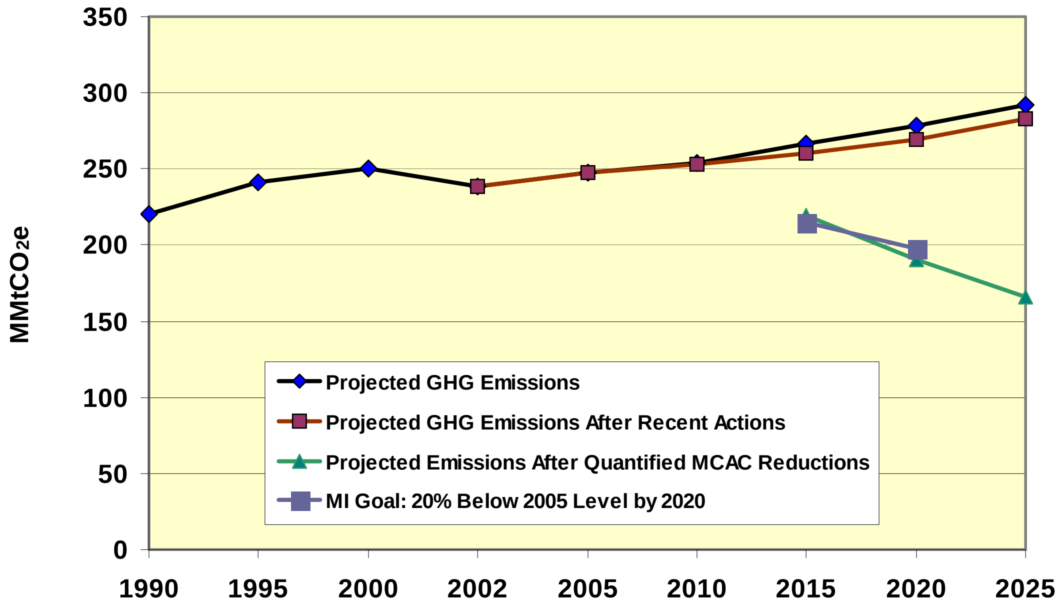
MCAC Policy Recommendations (Beyond Recent Actions)

The MCAC approved 54 policy recommendations for action in Michigan. Of these, 33 were analyzed quantitatively to calculate both emission reductions and either 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 ($MMtCO_2e$) in 2015 and by 117 $MMtCO_2e$ in 2025. The additional policy recommendations were not readily quantifiable but are considered valuable recommendations to support the overall Climate Action Plan. Several of the non-quantified policy recommendations may have the potential to achieve GHG emission reductions.

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)



$MMtCO_2e$ = 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. In summary, if all of the Policy Recommendations are fully implemented and successful in achieving all of the GHG reductions projected then MI should over-achieve its GHG reduction goals by 7.3 $MMtCO_2e$ in 2020. Another way to look at this is that the MCAC package of policy recommendations entails a surplus of GHG reductions of about 7.3$MMTCO_2e$.

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 ($MMtCO_2e$)			Net Present Value 2009–2025 (Million $)	Cost-Effective-ness ($\$/tCO_2e$)
	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				
TOTAL (includes all adjustments for overlaps)	**41.2**	**116.6**	**987.0**	**-$10,093**	**-$10.2**

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = 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 ($MMtCO_2e$) 2015	2025	Total 2009–2025	Net Present Value 2009–2025 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support
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[6]
ES-7	Integrated Resource Planning (IRP), Including Combined Heat & Power (CHP)	*Not Quantifiable*					Unanimous
ES-8	Smart Grid, Including Advanced Metering	*Not Quantifiable*					Unanimous
ES-9	CCSR Incentives, Requirements, R&D, and/or Enabling Policies	*Not Quantifiable*					Unanimous
ES-10	Technology-Focused Initiatives (Biomass Co-firing, Energy Storage, Fuel Cells, Etc.), Including Research, Development, & Demonstration						Majority[7]
	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	

[6] 6 opposing votes [Pollack, Ettawageshik, Garfield, Heifje, Bazzani, Overmeyer] and 2 abstentions [Martinez and Calloway for Bierbaum]

[7] 3 opposing votes [Garfield, Pollack and Heifje]

Policy No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value 2009–2025 (Million $)	Cost-Effective-ness ($/tCO_2e$)	Level of Support
		2015	2025	Total 2009–2025			
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	*ES-12 Fully incorporated in distributed generation "carve-out" under ES-1.*					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	*Not Quantifiable*					Unanimous
	Sector Totals	**8.1**	**37.2**	**306.6**	**$6,348**	**$22**	
	Sector Total After Adjusting for Overlaps	**8.1**	**23.6**	**220.3**	**$7,980**	**$36**	
	Reductions From Recent Actions	**2.7**	**1.9**	**30.1**	**$1,025**	**$34**	
	Sector Total Plus Recent Actions	**10.8**	**25.5**	**250.4**	**$9,005**	**$36**	

$MMtCO_2e$ = millions of metric tons of carbon dioxide equivalent; $/tCO_2e$ = 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 ($MMtCO_2e$)			Net Present Value 2009–2025 (Million $)	Cost-Effective-ness ($/tCO_2e$)	Level of Support
			2020	2025	Total 2009–2025			
MBP-1	Cap and Trade	20% below 2005 by 2020 (*Free-Granting Allowances*)[8]	92.48				–$25.83	Unanimous
		20% Below 2005 by 2020 (*Auctioning Allowances*)[9]	92.48				–$19.33	
MBP-3	Michigan Joins Chicago Climate Exchange		*Not Quantified*					Unanimous
MBP-6	Market Advisory Group		*Not Quantifiable*					Unanimous

[8] These results include the direct cost of reducing emissions, plus costs associated with purchase of emissions allowances from entities outside of Michigan, minus revenues from the sale of allowances to entities outside Michigan.

[9] These results include the direct cost of reducing emissions, but do not include payments by Michigan to entities for the purchase of allowances at auction, nor do they include revenues to the state from the sale of those allowances. The full cost and revenue implications of allowance distribution by auction can be found in Table G-1-2 and Annex G-1.

Transportation and Land Use (TLU) Policy Recommendations

Policy No.	Policy Option	GHG Reductions ($MMtCO_2e$) 2015	2025	Total 2009–2025	Net Present Value 2009–2025 (Million $)	Cost-Effective-ness ($\$/tCO_2e$)	Level of Support
TLU-1[10]	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	**4.76**	**10.5**	**95.1**	**–$3,425**	**–$36**	**N/A**
	Sector Total After Adjusting for Overlaps	**4.76**	**10.5**	**95.1**	**–$3,425**	**–$36**	**N/A**
	Reductions From Recent Actions	**0**	**0**	**0**	**$0**	**$0**	**N/A**
	Sector Total Plus Recent Actions	**4.76**	**10.5**	**95.1**	**–$3,425**	**–$36**	**N/A**

[10] 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 ($MMtCO_2e$)			Net Present Value 2009–2025 (Million $)	Cost-Effective-ness ($/t$CO_2$e)	Level of Support
		2015	2025	Total 2009-2025			
RCI-1	Utility Demand-Side Management for Electricity and Natural Gas	0.0	13.6	86.3	–1,632	–19	Unanimous
RCI-2	Existing Buildings Energy Efficiency Incentives, Assistance, Certification, and Financing	17.6	53.8	428.6	–12,107	–28	Unanimous
RCI-3	Regulatory (PSC) Changes to Remove Disincentives and Encourage Energy Efficiency Investments by IOUs	*Not Quantifiable*					Unanimous
RCI-4	Adopt More Stringent Building Codes for Energy Efficiency	3.6	9.8	82	–2,865	–35	Unanimous
RCI-5	MI Climate Challenge & Related Consumer Education Programs	*Not Quantifiable*					Unanimous
RCI-6	Incentives to Promote Renewable Energy Systems Implementation	0.7	1.5	14.0	1,958	140	Unanimous
RCI-7	Promotion and Incentives for Improved Design and Construction in the Private Sector	15.6	47.6	380	–11,693	–31	Unanimous
RCI-8	Net Metering for Distributed Generation	Fully incorporated into RCI-6					Unanimous
RCI-9	Training & Education for Bldg. Design, Construction, and Operation	*Not Quantifiable*					Unanimous
RCI-10	Water Use and Management	*Not Quantifiable*					Unanimous
	Sector Total After Adjusting for Overlaps*	**21.8**	**64.9**	**523.9**	***–13,014***	***–24.8***	
	Reductions From Recent Actions	**Figures adjusted include recent actions**					
	Sector Total Plus Recent Actions	**21.8**	***64.9***	***523.9***	***–13,014***	***–24.8***	

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 ($MMtCO_2e$) 2015	2025	Total 2009–2025	Net Present Value 2009–2025 (Million 2005$)	Cost-Effective-ness ($\$/tCO_2e$)	Level of Support
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		*Included in the Results of TLU-1*					Unanimous
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†	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

Policy No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$) 2015	2025	Total 2009–2025	Net Present Value 2009–2025 (Million 2005$)	Cost-Effective-ness ($/$tCO_2e$)	Level of Support
	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
	Sector Totals†	**9**	**23**	**201**	**–$548**	**–$3**	
	Sector Total After Adjusting for Overlaps††	**6**	**17**	**147**	**–$1,634**	**–$11**	
	Reductions From Recent Actions	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	
	Sector Total Plus Recent Actions	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 ($MMtCO_2e$) 2015	GHG Reductions ($MMtCO_2e$) 2025	GHG Reductions ($MMtCO_2e$) Total 2009–2025	Net Present Value 2009–2025 (Million $)	Cost Effectiveness ($/tCO_2e$)	Level of Support
CCI-1	GHG Inventories, Forecasting, Reporting, and Registry	*Not Quantified*					Unanimous
CCI-2	Statewide GHG Reduction Goals and Targets	*Not Quantified*					Unanimous
CCI-3	State, Local, and Tribal Government GHG Emission Reductions (Lead-by-Example)	*Not Quantified*					Unanimous
CCI-4	Comprehensive Local Government Climate Action Plans (Counties, Cities, Etc.)	*Not Quantified*					Unanimous
CCI-5	Public Education and Outreach	*Not Quantified*					Unanimous
CCI-6	Tax and Cap/ Cap and Trade	*MCAC approved creation of a new Market-Based Policies Technical Work Group as the lead for this policy* recommendation.					Transferred to MBP TWG
CCI-7	Seek Funding for Implementation of MCAC Recommendations	*Not Quantified*					Unanimous
CCI-8	Adaptation and Vulnerability	*Not Quantified*					Unanimous
CCI-9	Participate in Regional, Multi-State, and National GHG Reduction Efforts	*Not Quantified*					Unanimous
CCI-10	Enhance and Encourage Economic Growth and Job Creation Opportunities Through Climate Change Mitigation	*Not Quantified*					Unanimous
CCI-11	Enhance and Encourage Community Development Through Climate Change Mitigation: Address Environmental Justice	*Not Quantified*					Unanimous

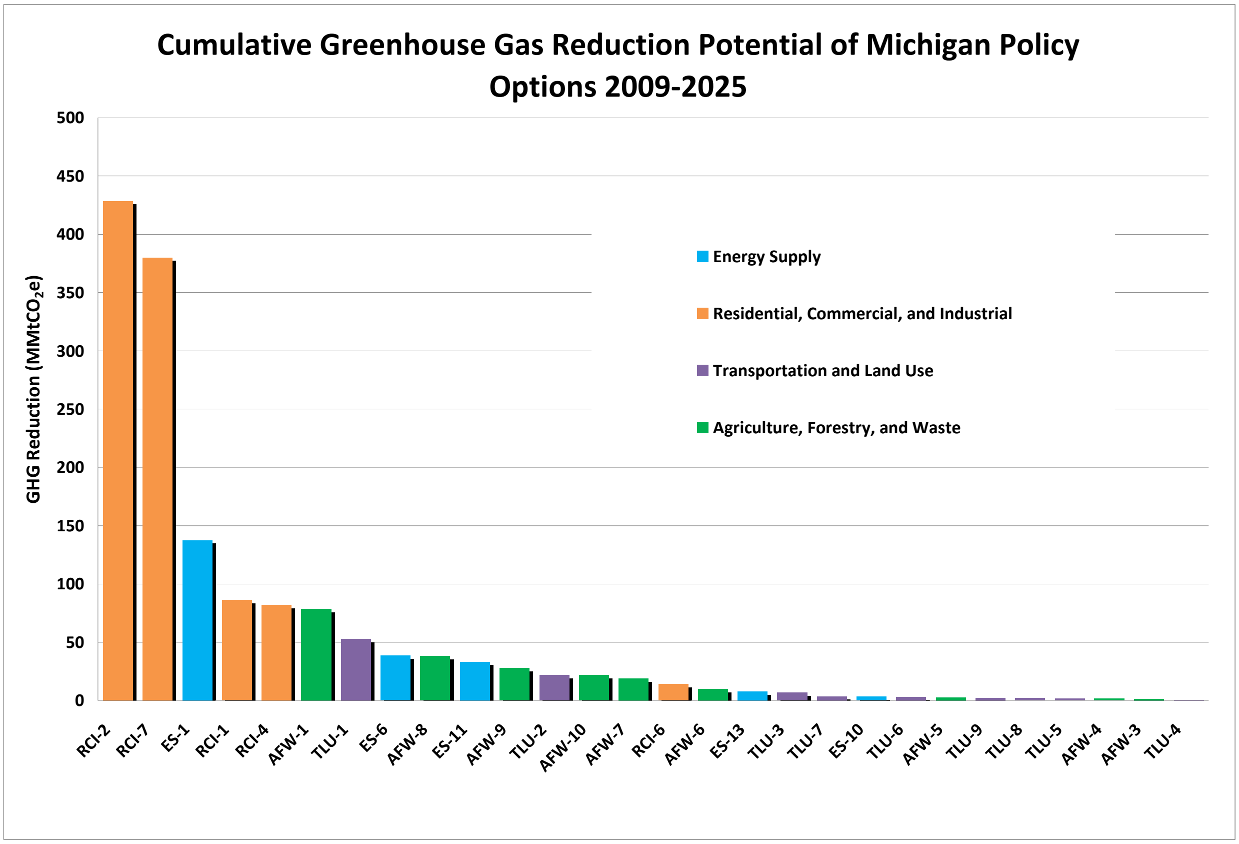
GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/$tCO_2e$ = dollars per metric ton of carbon dioxide equivalent

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.

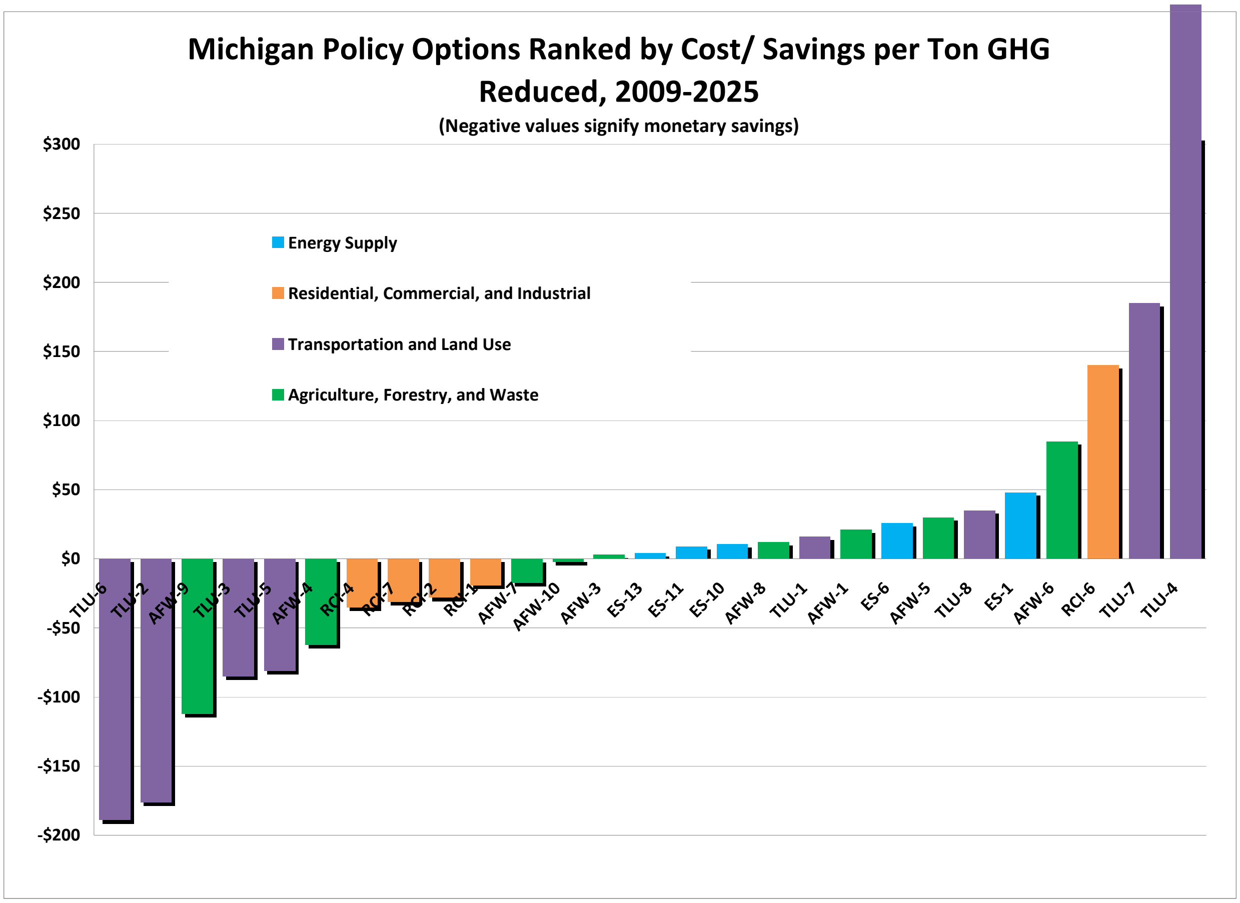
It is important to note that there is some level of uncertainty in projecting GHG reductions and estimating exact costs (or cost savings) per ton of reductions achieved for the time periods of this analysis.

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



GHG = greenhouse gas; $MMtCO_2e$ = 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

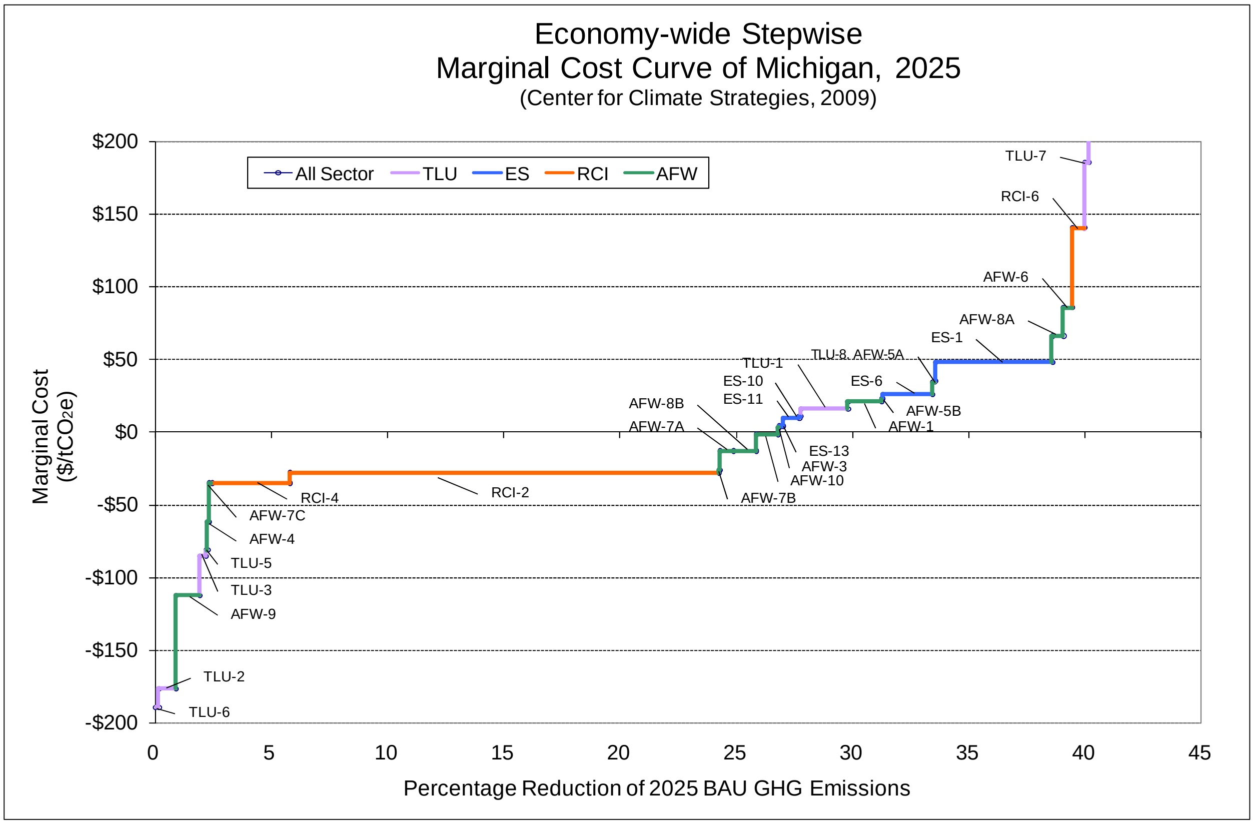
Figure ExS-6. MCAC policy recommendations ranked by cumulative (2009–2025) net cost/cost savings per ton of GHG removed



GHG = greenhouse gas; $MMtCO_2e$ = 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 $MMtCO_2e$ of GHG emissions through implementation of the option. For instance, for RCI-2-Energy Efficiency- this policy recommendation should result in approximately a 54 $MMTCO_2e$ (19%) reduction of GHG emissions in 2025 below the BAU reference case with an average cost savings of approximately $28/ton.

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



BAU = business as usual; GHG = greenhouse gas; tCO_2e = 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

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. For example, RCI-7 reductions overlap with both RCI-2 and RCI-4 assuming all three policies are implemented. The curve, therefore, includes RCI-2 and RCI-4 but not RCI-7 to avoid overstating the combined benefits of the recommendations.

Chapter 1
Background and Overview

Creation of the Michigan Climate Action Council (MCAC)

On November 14, 2007, Governor Jennifer M. Granholm signed Executive Order 2007-42 establishing the Michigan Climate Action Council (MCAC). The purpose of the MCAC is to assist Michigan in identifying the best opportunities to mitigate and adapt to climate change, reduce costs associated with climate change activities, and foster economic growth in Michigan. Governor Granholm charged the advisory group to:

- Produce an inventory and forecast of Greenhouse Gas (GHG) sources and emissions from 1990-2020.
- Consider potential state and multi-state actions to mitigate and adapt to climate change in various sectors including energy supply, residential, commercial and industrial, transportation, land use, agriculture, forestry, and waste management.
- Compile a comprehensive climate action plan with specific goals and recommendations for reducing GHG emissions in Michigan by state and local units of government, businesses, and Michigan residents to minimize climate change and better prepare for the effects of climate change in Michigan.
- Advise state and local government on measures to address climate change.

MCAC's Response

In fulfillment of the requirements of this Executive Order, the MCAC held eight meetings over the last fifteen months. Additionally, the Council formed six Technical Work Groups (TWGs) to assist the MCAC in formulating options. These TWGs met numerous times between the MCAC meetings. The MCAC developed this Climate Action Plan as an initial step in establishing a basis for moving forward on the implementation of climate change policies in Michigan. Evaluation of key factors such as cost effectiveness, economic impacts, and harmonization with other Michigan programs and policies will be critical to the next stage of climate policy implementation.

The following key elements and recommendations were identified by the MCAC during this initial process:

- MCAC reviewed over 330 multi-sector policy options and approved for inclusion in this report a package of 54 policy recommendations to reduce GHG emissions and address related energy and commerce issues in Michigan. 52 of these 54 recommendations were approved unanimously and only one option was rejected. The recommended policy options cover a wide range of costs and GHG reduction potentials.

- In moving towards implementation to achieve these goals, Michigan should prioritize these 54 policy recommendations during 2009 in order to set the stage for strategic implementation of the most promising options. The prioritization should take into account the GHG reduction potential, costs and savings, feasibility, co-benefits, a macro-economic analysis of the selected recommendations, public health and safety and consistency with other Michigan programs and policies.

- 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 $10.2/ t$CO_2$e cost savings. Those policy options that show negative costs[1] (i.e. benefits) should be evaluated as quickly as possible, for implementation. All policy options, particularly those that show a net cost, should be evaluated thoroughly, using tools such as regional economic modeling, before being implemented.

- 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. These documents were completed prior to the severe downturn in the global economy. To account for fluctuations such as changes in the economy, updates to this inventory should be performed annually with the projections evaluated every three years.

- The MCAC recommends that Michigan further analyze actions needed for adaptation. The MCAC was unable to 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.

- MCAC recommends that Michigan position itself as a leader in the national and regional dialogue on climate change policy as described in the MCAC Recommended Policy Positions section.

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 Public Act (PA) 295[2]. 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

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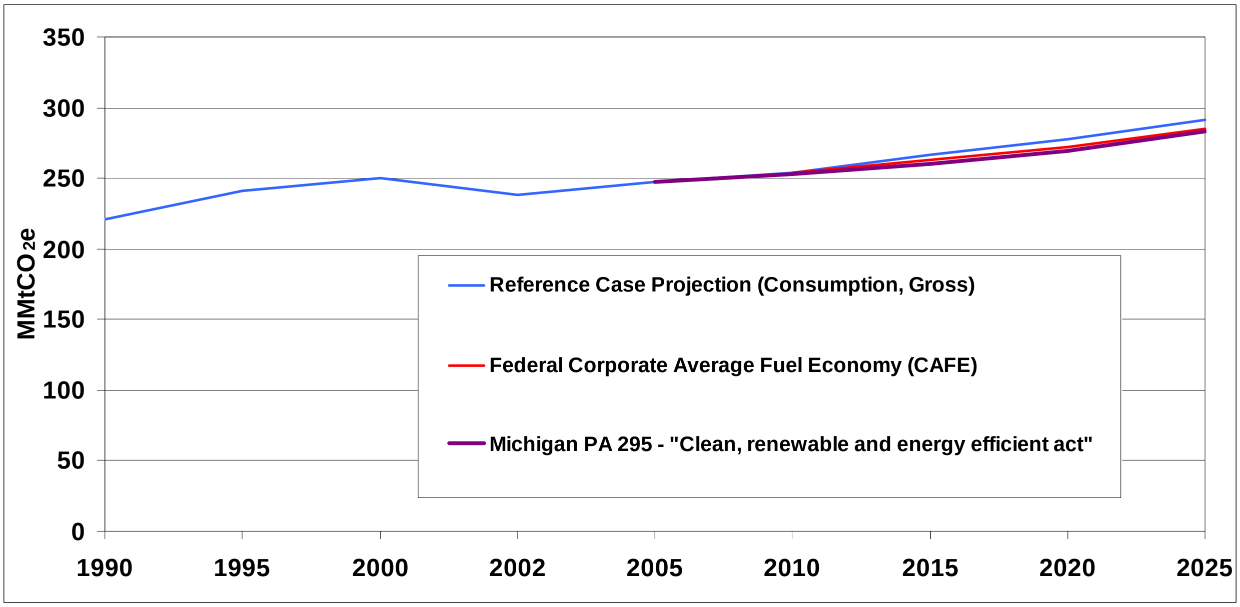
[1] Policy options that are "negative cost" are not necessarily better than other potential investments. In capital constrained situations only a limited number of investments can be made. There may be structural or policy barriers to the adoption of options identified as negative cost.

[2] Public Act 295 is The Clean Renewable and Energy Efficient Act of 2008

8.9 MMtCO$_2$e (3.1%) in 2025 from the business-as-usual reference case emissions is projected. These GHG emission reductions are summarized in Figure 1-1.

Figure 1-1. Estimated emission reductions associated with the effect of recent federal and state actions in Michigan (consumption-basis, gross emissions)



MMtCO$_2$e = million metric tons of carbon dioxide equivalent.

Table 1-1. Estimated GHG emission reductions associated with the effect of recent federal and state actions in Michigan (consumption-basis, gross emissions)

Reductions from Existing Action **Recent Actions**	1990	2005	2010	2015	2020	2025
Federal CAFÉ	0.00	0.00	0.18	3.55	6.22	6.92
Michigan PA 295 - "Clean, renewable and energy efficient act"	0.00	0.00	0.51	2.65	2.13	2.01
Totals	**0.00**	**0.00**	**0.69**	**6.20**	**8.34**	**8.92**

	1990	2005	2010	2015	2020	2025
Reference Case Projection (Consumption, Gross)	220.7	247.5	253.8	266.4	278.0	291.6
Federal Corporate Average Fuel Economy (CAFE)			253.6	262.9	271.7	284.7
Federal Improved Standards for Appliances and Lighting			253.6	262.9	271.7	284.7
Michigan PA 295 - "Clean, renewable and energy efficient act"		247.5	253.1	260.2	269.6	282.7

The MCAC Process

The MCAC began its deliberative process at its first meeting on December 12, 2007. MCAC met in person a total of seven times, with the final decisional meeting held on January 28, 2009. A teleconference meeting was held on February 26, 2009 exclusively for the review of this report. An additional 74 teleconference meetings of MCAC's six supporting Technical Work Groups were also held to identify and analyze various potential policy actions in advance of the MCAC's January 28, 2009 final decisional meeting.

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, based on a detailed proposal approved by the MDEQ. 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 options on Michigan-specific policy options to be added to the catalog of existing states actions; Where members of a TWG did not fully agree on the recommendations to the MCAC, the summary of their efforts was reported to the MCAC as a part of its consideration and actions. The MCAC reviewed the TWGs' proposals, modified the proposals, if necessary, and made final decisions on the items before them.

The MCAC process employed a model of informed self-determination through a facilitated, stepwise, fact-based, and consensus-building approach. As noted, the process was facilitated by the Center for Climate Strategies (CCS), an independent, expert facilitation and technical analysis team. It was based on procedures that CCS has used in a number of other state climate change planning initiatives since 2000, but was adapted specifically for Michigan. The MCAC process sought but did not mandate consensus, and it explicitly documented the level of MCAC support for policies and key findings through a voting process established in advance, including barriers to full consensus where they existed on final consideration of proposed actions.

The 54 policy recommendations (out of more than 330 potential options considered) adopted by the MCAC and presented in this report were developed through a stepwise approach that included: (1) expanding a list of existing states actions to include additional Michigan-specific actions; (2) developing a set of "priority for analysis" options for further development; (3) fleshing these proposals out for full analysis by development of "straw proposals" for level of effort, timing and parties involved in implementation; (4) developing and applying a common framework of analysis for options, including sector-specific guidance and detailed specifications for options that include data sources, methods and key assumptions; (5) reviewing results of analysis and modifying proposals as needed to address potential barriers to consensus; (6) finalizing design and analysis of options to remove barriers to final agreement; and (7) developing other key elements of policy proposals such as implementation mechanisms, co-benefits, and feasibility considerations. At Meetings # 6 and 7, policy recommendations receiving unanimous support, a super majority or majority support (defined as less than half of those present objecting) from the MCAC members present were adopted by the MCAC and included in this report. The TWGs' options to the MCAC were documented and presented at each MCAC meeting. All of the MCAC and TWG meetings were open to the public and all materials for and summaries of the MCAC and TWG meetings were posted on the MCAC Web site (www.miclimatechange.us). A detailed description of the deliberative process is included in Appendix B.

Analysis of Policy Recommendations

With CCS providing facilitation and technical analysis, the six TWGs submitted policy recommendations for MCAC consideration using a "policy option template" conveying the following key information:

Policy Description
Policy Design (Goals, Timing, Parties Involved)
Implementation Mechanisms
Related Policies/Programs in Place
Type(s) of GHG Reductions
Estimated GHG Reductions and Net Costs or Cost Savings
Key Uncertainties
Additional Benefits and Costs
Feasibility Issues
Status of Group Approval
Level of Group Support
Barriers to Consensus

In its deliberations, the MCAC reviewed, modified, and reached group agreement on various policy recommendations. The final versions for each sector, conforming to the policy recommendation templates, appear in Appendices F through K and constitute the most detailed record of decisions of the MCAC. Appendix E describes the methods used for quantification of the 33 policy options that were analyzed quantitatively. The quantitative analysis produced estimates of the GHG emission reductions and direct net costs (or cost savings) of implementation of various policies, in terms of both a net present value from 2009 to 2025 and a dollars-per-ton cost (i.e., cost-effectiveness). The key methods are summarized below.

Estimates of GHG Reductions: Using the projection of future GHG emissions (see below) as a starting point, 33 policy options were analyzed by CCS to estimate GHG reductions attributable to each policy in the individual years of 2015 and 2025 and cumulative reductions over the period 2009–2025. The years 2015 and 2025 were chosen as the target years for quantification and analysis as part of the *MCAC Interim Report to the Governor,* in April 2008.[3] The estimates were prepared in accordance with guidance by the appropriate TWG and the MCAC, which later reviewed the estimates and, in some cases, directed that they be revised with respect to such elements as goals, data sources, assumptions, sensitivity analysis, and methodology. Some policies were estimated to affect the quantity or type of fossil fuel combusted. Other policies affected methane or carbon dioxide (CO_2) being sequestered. Sequestered means the gas is stored in plant materials or geologic formations so it is not contributing to global warming. Among the many assumptions involved in this task was identification of the appropriate GHG accounting framework—namely, the choice between taking a "production-based" approach versus a "consumption-based" approach to various sectors of the economy.[4]

Estimates of Costs/Cost Savings: The analyses of 33 policy recommendations included estimates of the direct cost of those policies, in terms of both net costs or cost savings during 2009–2025 and a dollars-per-ton cost (i.e., cost-effectiveness). Following is a brief summary of the approach used to estimate the costs or cost savings associated with the policy recommendations:

- *Discounted and annualized costs or cost savings*—Standard approaches were taken here. The net present value of costs or cost savings was calculated by applying a real discount rate of 5%. Dollars-per-ton estimates were derived as an annualized cost per ton, dividing the present value cost or savings by the cumulative GHG reduction measured in tons. As was the case with GHG reductions, the period 2009–2025 was analyzed.
- *Cost savings*— Total net costs or savings were estimated through comparison of monetized costs and savings of policy implementation over time, using discounting. These net costs could be positive or negative. Negative costs indicated that the policy saved money or produced "cost savings." Many policies were estimated to create net financial cost savings (typically through fuel savings and electricity savings associated with new policy actions).
- *Direct vs. indirect effects*—Estimates of costs and cost savings were based on "direct effects" (i.e., those borne by the entities implementing the policy).[5] Implementing entities could be individuals, companies, and/or government agencies. In contrast, conventional cost-benefit analysis takes the "societal perspective" and tallies every conceivable impact on every entity in society (and quantifies these wherever possible).

Additional Costs and Benefits: The MCAC options were guided by four decision criteria that included GHG reductions and monetized costs and cost savings of various policies, as well as other potential co-benefits and costs (e.g., social, economic, and environmental) and feasibility

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[2] *"MCAC Interim Report to the Governor," April 30, 2008*

[3] A production-based approach estimates GHG emissions associated with goods and services produced within the state, and a consumption-based approach estimates GHG emissions associated with goods and services consumed within the state. In some sectors of the economy, these two approaches may not result in significantly different numbers. However, the power sector is notable, in that it is responsible for large quantities of GHG emissions, and states often produce more or less electricity than they consume (with the remainder attributable to power exports or imports).

[4] "Additional benefits and costs" were defined as those borne by entities other than those implementing the policy option. These indirect effects were quantified on a case-by-case basis, depending on magnitude, importance, need, and availability of data.

considerations. The TWGs were asked to examine the latter two in qualitative terms where deemed important and quantify them on a case-by-case basis, as needed, depending on need and where data were readily available. It should be noted that some of these un-quantified co-benefits and costs could be quite significant and merit further investigation.

Implementation Mechanisms: The analysis for each option (see Appendices F through K) of the MCAC includes guidance on the policy instruments or "mechanisms" that were prescribed or assumed for the policy action. This includes a range of potential mechanisms including, for instance, funding incentives, codes and standards, voluntary and negotiated agreements, market based instruments, information and education, reporting and disclosure, and other instruments. In some cases, the recommended instruments are precise. In other cases, they are more general and envision further work to develop concrete programs and steps to achieve the goals recommended by the MCAC.

Michigan GHG Emissions Inventory and Reference Case Projections

The Center for Climate Strategies (CCS) prepared the Michigan Inventory and Forecast Report[6] for the Michigan Department of Environmental Quality (MDEQ). The report presents an assessment of the State'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 MCAC and TWGs reviewed, discussed, and evaluated the draft inventory and methodologies and offered alternative data and approaches for improving the draft GHG inventory and forecast. 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.miclimatechange.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_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). Emissions of these GHGs are presented using a common metric, CO_2 equivalence (CO_2e), which indicates the relative contribution of each gas, per unit mass, to global average radiative forcing on a global warming potential- (GWP-) weighted basis.[7]

The inventory and reference case projections included detailed coverage of all economic sectors and GHGs in Michigan, including future emission trends and assessment issues related to energy, the economy, and population growth. It is important to note that the emission estimates

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[6] "*Final Michigan Greenhouse Gas Inventory and Reference Case Projections, 1990- 2025,*" Center for Climate Strategies, November 2008.

[7] 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 Panel on Climate Change Cambridge University Press, Cambridge, United Kingdom. Available at: http://www.grida.no/climate/ipcc_tar/wg1/212.htm.

reflect the GHG emissions associated with the electricity sources used to meet Michigan's demands, corresponding to a consumption-based approach to emissions accounting. Another way to look at electricity emissions is to consider the GHG emissions produced by electricity generation facilities in the state—a production-based method. The study covers both methods of accounting for emissions, but for consistency, all total results are reported as consumption-based.

As illustrated in Figure 1-2, activities in Michigan accounted for approximately 248 million metric tons (MMt) of *gross*[8] CO_2e emissions (consumption basis) in 2005, an amount equal to about 3.5% of total US gross GHG emissions (based on 2005 US data).[9] 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 from 1990 to 2005 is primarily associated with the electricity consumption and transportation sectors.

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.

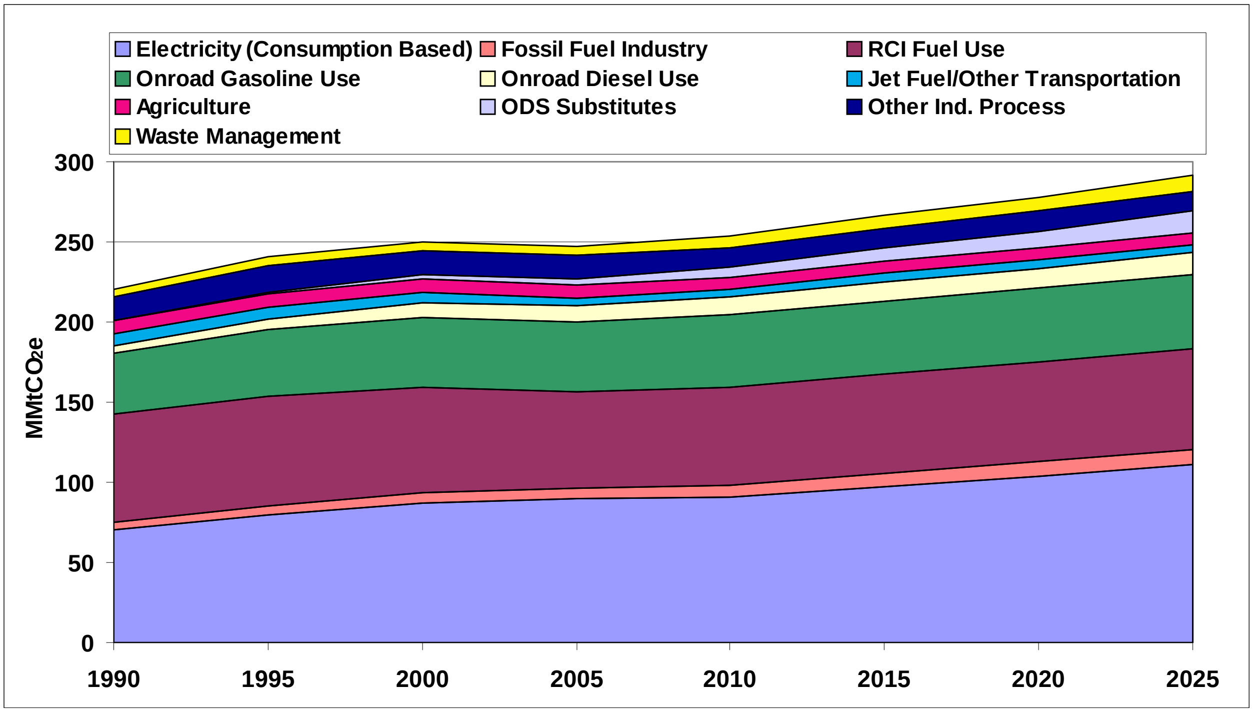
As illustrated in Figure 1-2, below, under the reference case projections, Michigan's gross GHG emissions continue to grow, and are projected to climb to about 292 $MMtCO_2$e by 2025, reaching 32% above 1990 levels. While these projections are made over the long term (e.g. to 2025), they do not account for the current severe global economic downturn and how this will impact future growth projections.

Emissions associated with electricity consumption are projected to be the largest contributor to future GHG emissions growth, followed by emissions associated with the transportation sector. Other sources of emissions growth include the RCI fuel use sector and the increasing use of HFCs and PFCs as substitutes for ozone-depleting substances in refrigeration, air conditioning, and other applications. The agriculture sector is the only sector in which emissions are projected to decrease from 2005 to 2025. Figure 1-3 depicts the 2005 distribution of sources in Michigan compared to the US.

[8] Excluding GHG emissions removed due to forestry and other land uses and excluding GHG emissions associated with exported electricity.

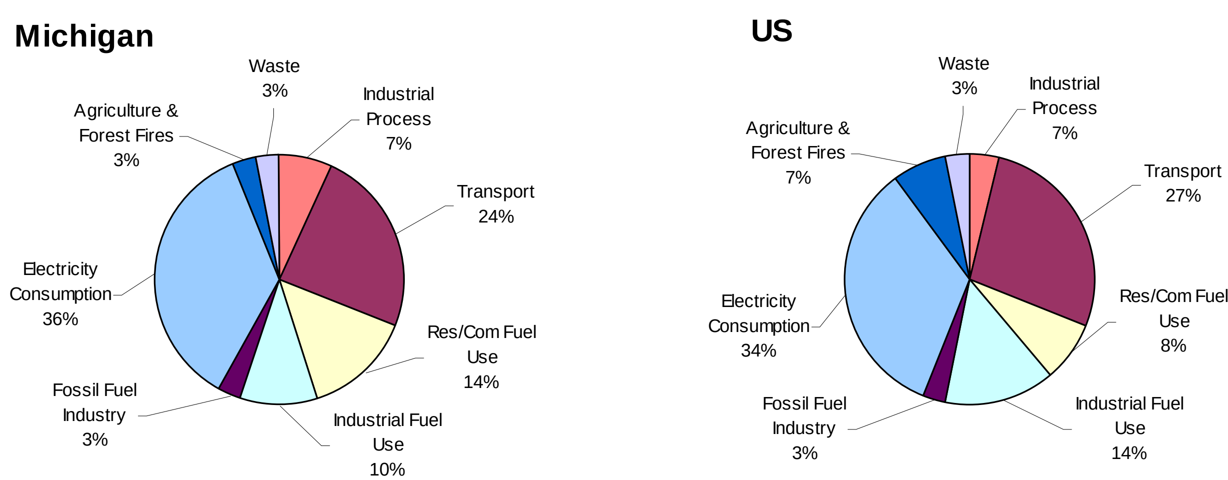
[9] The national emissions used for these comparisons are based on 2005 emissions from *Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2006*, April 15, 2008, US EPA #430-R-08-005, (http://www.epa.gov/climatechange/emissions/usinventoryreport.html).

Figure 1-2. Gross GHG emissions by sector, 1990–2025: historical and projected (consumption-based approach) business as usual / base case



$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; RCI = direct fuel use in residential, commercial, and industrial sectors; ODS = ozone-depleting substance; Ind. = industrial.

Figure 1-3. Gross GHG emissions by sector, 2005: Michigan and U.S.



MCAC Policy Recommendations (Beyond Recent Actions)

The MCAC approved 54 policy recommendations for consideration of further 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 ($MMtCO_2e$) in 2015 and by 117 $MMtCO_2e$ in 2025. The additional policy recommendations were not quantifiable but are considered valuable recommendations to support the overall Climate Action Plan. Several of the non-quantified policy recommendations may have the potential to achieve GHG emission reductions.

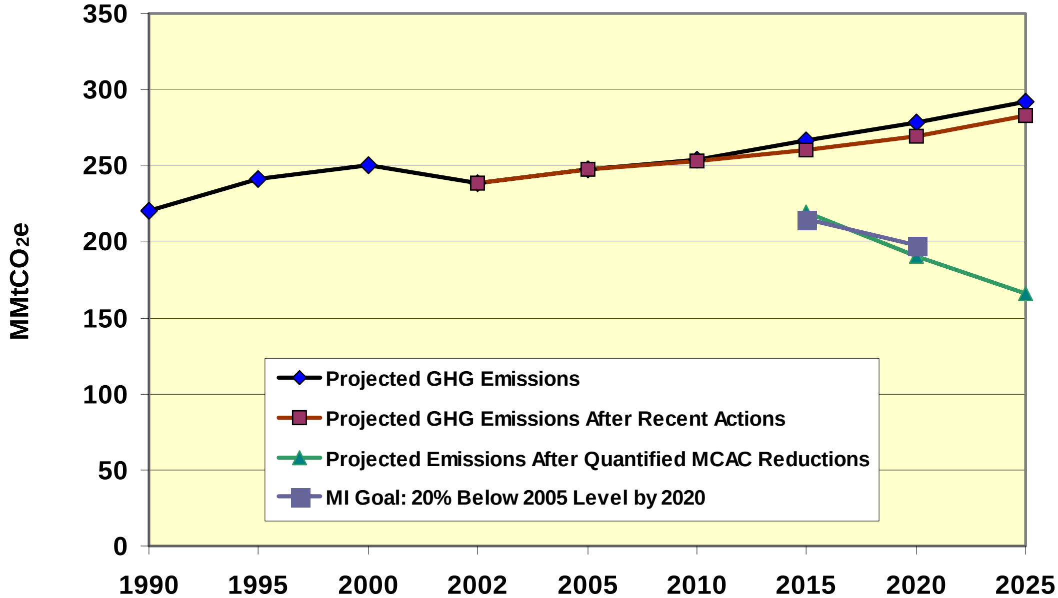
Figure 1-4 presents a graphical summary of the potential cumulative emission reductions associated with the 33 policy options and federal actions relative to the business-as-usual reference case projections.

- 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. This consumption-based approach accounts for emissions associated with the generation of electricity in Michigan to meet the state's demand for electricity.

- The red line shows the projected emissions adjusted for the recent state and federal actions described in Table 1.1.
- 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. While the other MCAC options have the effect of reducing emissions, those reductions were not quantified and are not reflected in the green line.

It is important to note, to yield these emission reductions from the 33 MCAC recommended options, implementation must be timely, aggressive, and thorough. Evaluation of key factors such as cost effectiveness, economic impacts, and harmonization with other Michigan programs and policies will be critical to the next stage of climate policy implementation.

Figure 1-4. Annual GHG emissions: reference case projections and MCAC recommendations (consumption basis, gross emissions)



$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; GHG = greenhouse gas; MCAC = Michigan Climate Action Council.

Table 1-2 provides the numeric estimates underlying Figure 1-4. In summary, if all of the Policy recommendations are fully implemented and successful in achieving all of the GHG reductions projected then MI should over-achieve its GHG reduction goals by 7.3 MMtCO2e in 2020. Another way to look at this is that the MCAC package of policy recommendations entails a surplus of GHG reductions of about 7.3MMTCO2e.

Table 1-2. Annual emissions: reference case projections and impact of MCAC recommended 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.
Notes continued next page.

Reductions from recent actions include the Energy Independence and Security Act of 2007, Title III. GHG reductions from Titles IV and V of this Act have not been quantified because of the uncertainties in how they will be implemented.

Table 1-3 depicts the final policy recommendations of the Council and their associated GHG reductions and costs or savings for each sector.

In Table 1-3 and throughout the Climate Action Plan, negative cost (- $) figures indicate cost savings. For example, in Table 1-3 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 1-3. Summary by sector of estimated impacts of implementing all of the MCAC recommended options (cumulative reductions and costs/savings)

Sector	GHG Reductions ($MMtCO_2e$)			Net Present Value 2009–2025 (Million $)	Cost-Effective-ness ($\$/tCO_2e$)
	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				
TOTAL (includes all adjustments for overlaps)	**41.2**	**116.6**	**987.0**	**-$10,093**	**-$10.2**

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

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 1-4 Summary List Policy Recommendations for all Sectors

Energy Supply (ES) Policy Recommendation

Policy No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$) 2015	2025	Total 2009–2025	Net Present Value 2009–2025 (Million $)	Cost-Effective-ness ($/t$CO_2$e)	Level of Support
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[10]
ES-7	Integrated Resource Planning (IRP), Including combined heat & power.	*Not Quantifiable*					Unanimous
ES-8	Smart Grid, Including Advanced Metering	*Not Quantifiable*					Unanimous
ES-9	CCSR Incentives, Requirements, R&D, and/or Enabling Policies	*Not Quantifiable*					Unanimous
ES-10	Technology-Focused Initiatives (Biomass Co-firing, Energy Storage, Fuel Cells, Etc.), Including Research, Development, & Demonstration						Majority[11]
	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	

[10] 6 opposing votes [Pollack, Ettawageshik, Garfield, Heifje, Bazzani, Overmeyer] and 2 abstentions [Martinez and Calloway for Bierbaum]

[11] 3 opposing votes [Garfield, Pollack and Heifje]

Policy No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value 2009–2025 (Million $)	Cost-Effective-ness ($/t$CO_2$e)	Level of Support
		2015	2025	Total 2009–2025			
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	*ES-12 Fully incorporated in distributed generation "carve-out" under ES-1.*					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	*Not Quantifiable*					Unanimous
	Sector Totals	**8.1**	**37.2**	**306.6**	**$6,348**	**$22**	
	Sector Total After Adjusting for Overlaps	**8.1**	**23.6**	**220.3**	**$7,980**	**$36**	
	Reductions From Recent Actions	**2.7**	**1.9**	**30.1**	**$1,025**	**$34**	
	Sector Total Plus Recent Actions	**10.8**	**25.5**	**250.4**	**$9,005**	**$36**	

$/t$CO_2$e = dollars per metric tons of carbon dioxide equivalent; CCI = Cross-Cutting Issues; CCSR = carbon capture and storage or reuse; CHP = combined heat and power; GHG = greenhouse gas; IGCC = integrated gasification combined cycle; IRP = integrated resource planning; MCAC = Michigan Climate Action Council; $MMtCO_2e$ = millions of metric tons of carbon dioxide equivalent; N/A = not applicable; PA = Public Act; R&D = research and development.

Note: The numbering used to denote all the policy recommendations in Table 1-4 and in other parts of this report is for reference purposes only; it does not reflect prioritization among these important recommendations.

Table 1-4 (cont'd.) Market Based Policy (MBP) Recommendations

No.	Policy Recommendations		GHG Reductions ($MMtCO_2e$)			Net Present Value 2009–2025 (Million $)	Cost-Effective-ness ($/t$CO_2$e)	Level of Support
			2020	2025	Total 2009–2025			
MBP-1	Cap and Trade	20% below 2005 by 2020 (*Free-Granting Allowances*)[12]	92.48				–$25.83	Unanimous
		20% Below 2005 by 2020 (*Auctioning Allowances*)[13]	92.48				–$19.33	
MBP-3	MI Joins Chicago Climate Exchange		*Not Quantified*					Unanimous
MBP-6	Market Advisory Group		*Not Quantifiable*					Unanimous

[12] These results include the direct cost of reducing emissions, plus costs associated with purchase of emissions allowances from entities outside of Michigan, minus revenues from the sale of allowances to entities outside Michigan.

[13] These results include the direct cost of reducing emissions but do not include payments by Michigan entities for the purchase of allowances at auction, nor do they include revenues to the state from the sale of those allowances. The full cost and revenue implications of allowance distribution by auction can be found in Table G-1-2 and Annex G-1.

Table 1-4 (cont'd.) Transportation and Land Use (TLU) Policy Recommendations

Policy No.	Policy Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2009–2025 (Million $)	Cost-Effective-ness ($/t$CO_2$e)	Level of Support
		2015	2025	Total 2009–2025			
TLU-1	Promote Low-Carbon Fuel Use	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	**4.76**	**10.5**	**95.1**	**–$3,425**	**–$36**	**N/A**
	Sector Total After Adjusting for Overlaps	**4.76**	**10.5**	**95.1**	**–$3,425**	**–$36**	**N/A**
	Reductions From Recent Actions	**0**	**0**	**0**	**$0**	**$0**	**N/A**
	Sector Total Plus Recent Actions	**4.76**	**10.5**	**95.1**	**–$3,425**	**–$36**	**N/A**

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/t$CO_2$e = dollars per metric ton of carbon dioxide equivalent. Note: Negative numbers indicate cost savings.

Table 1-4 (cont'd.) Residential, Commercial and Industrial (RCI) Policy Recommendations

	Policy Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2009–2025 (Million $)	Cost-Effective-ness ($\$/tCO_2e$)	Level of Support
		2015	2025	Total 2009-2025			
RCI-1	Utility Demand-Side Management for Electricity and Natural Gas	0.0	13.6	86.3	–1,632	–19	Unanimous
RCI-2	Existing Buildings Energy Efficiency Incentives, Assistance, Certification, and Financing	17.6	53.8	428.6	–12,107	–28	Unanimous
RCI-3	Regulatory (PSC) Changes to Remove Disincentives and Encourage Energy Efficiency Investments by IOUs	*Not Quantifiable*					Unanimous
RCI-4	Adopt More Stringent Building Codes for Energy Efficiency	3.6	9.8	82	–2,865	–35	Unanimous
RCI-5	MI Climate Challenge & Related Consumer Education Programs	*Not Quantifiable*					Unanimous
RCI-6	Incentives to Promote Renewable Energy Systems Implementation	0.7	1.5	14.0	1,958	140	Unanimous
RCI-7	Promotion and Incentives for Improved Design and Construction in the Private Sector	15.6	47.6	380	–11,693	–31	Unanimous
RCI-8	Net Metering for Distributed Generation	Fully incorporated into RCI-6					Unanimous
RCI-9	Training & Education for Bldg. Design, Construction, and Operation	*Not Quantifiable*					Unanimous
RCI-10	Water Use and Management	*Not Quantifiable*					Unanimous
	Sector Total After Adjusting for Overlaps*	**21.8**	**64.9**	**523.9**	***–13,014***	***–24.8***	
	Reductions From Recent Actions	**Figures adjusted include recent actions**					
	Sector Total Plus Recent Actions	**21.8**	***64.9***	***523.9***	***–13,014***	***–24.8***	

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; PSC = Public Service Commission; IOU = investor-owned utility.

Note: The numbering is for reference purposes only; it does not reflect prioritization among these policy options. Negative net present values and cost effectiveness numbers above reflect "negative costs" or net savings.

*The figures listed show totals for the options net of recent legislation.

Table 1-4 (cont'd.) Agriculture, Forestry and Waste (AFW) Management Policy Recommendations

Policy No.	Policy Recommendation		GHG Reductions ($MMtCO_2e$) 2015	2025	Total 2009–2025	Net Present Value 2009–2025 (Million 2005$)	Cost-Effective-ness ($/tCO_2e$)	Level of Support
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		*Included in the Results of TLU-1*					Unanimous
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[†]	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

Policy No.	Policy Recommendation		GHG Reductions ($MMtCO_2e$) 2015	2025	Total 2009–2025	Net Present Value 2009–2025 (Million 2005$)	Cost-Effective-ness ($\$/tCO_2e$)	Level of Support
		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
	Sector Totals†		**9**	**23**	**201**	**–$548**	**–$3**	
	Sector Total After Adjusting for Overlaps††		**6**	**17**	**147**	**–$1,634**	**–$11**	
	Reductions From Recent Actions		**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	
	Sector Total Plus Recent Actions		6	17	147	-$1,634	-$11	

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; TLU = Transportation and Land Use; 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.

Table 1-4 (cont'd.) Cross Cutting Issues (CCI) Policy Recommendations

No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value 2009–2025 (Million $)	Cost Effective-ness ($\$/tCO_2e$)	Level of Support
		2015	2025	Total 2009–2025			
CCI-1	GHG Inventories, Forecasting, Reporting, and Registry	*Not Quantified*					Unanimous
CCI-2	Statewide GHG Reduction Goals and Targets	*Not Quantified*					Unanimous
CCI-3	State, Local, and Tribal Government GHG Emission Reductions (Lead-by-Example)	*Not Quantified*					Unanimous
CCI-4	Comprehensive Local Government Climate Action Plans (Counties, Cities, Etc.)	*Not Quantified*					Unanimous
CCI-5	Public Education and Outreach	*Not Quantified*					Unanimous
CCI-6	Tax and Cap/ Cap and Trade	*MCAC approved creation of a new Market-Based Policies Technical Work Group as the lead for this policy* recommendation*.*					Transferred
CCI-7	Seek Funding for Implementation of MCAC Recommendations	*Not Quantified*					Unanimous
CCI-8	Adaptation and Vulnerability	*Not Quantified*					Unanimous
CCI-9	Participate in Regional, Multi-State, and National GHG Reduction Efforts	*Not Quantified*					Unanimous
CCI-10	Enhance and Encourage Economic Growth and Job Creation Opportunities Through Climate Change Mitigation	*Not Quantified*					Unanimous
CCI-11	Enhance and Encourage Community Development Through Climate Change Mitigation: Address Environmental Justice	*Not Quantified*					Unanimous

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent

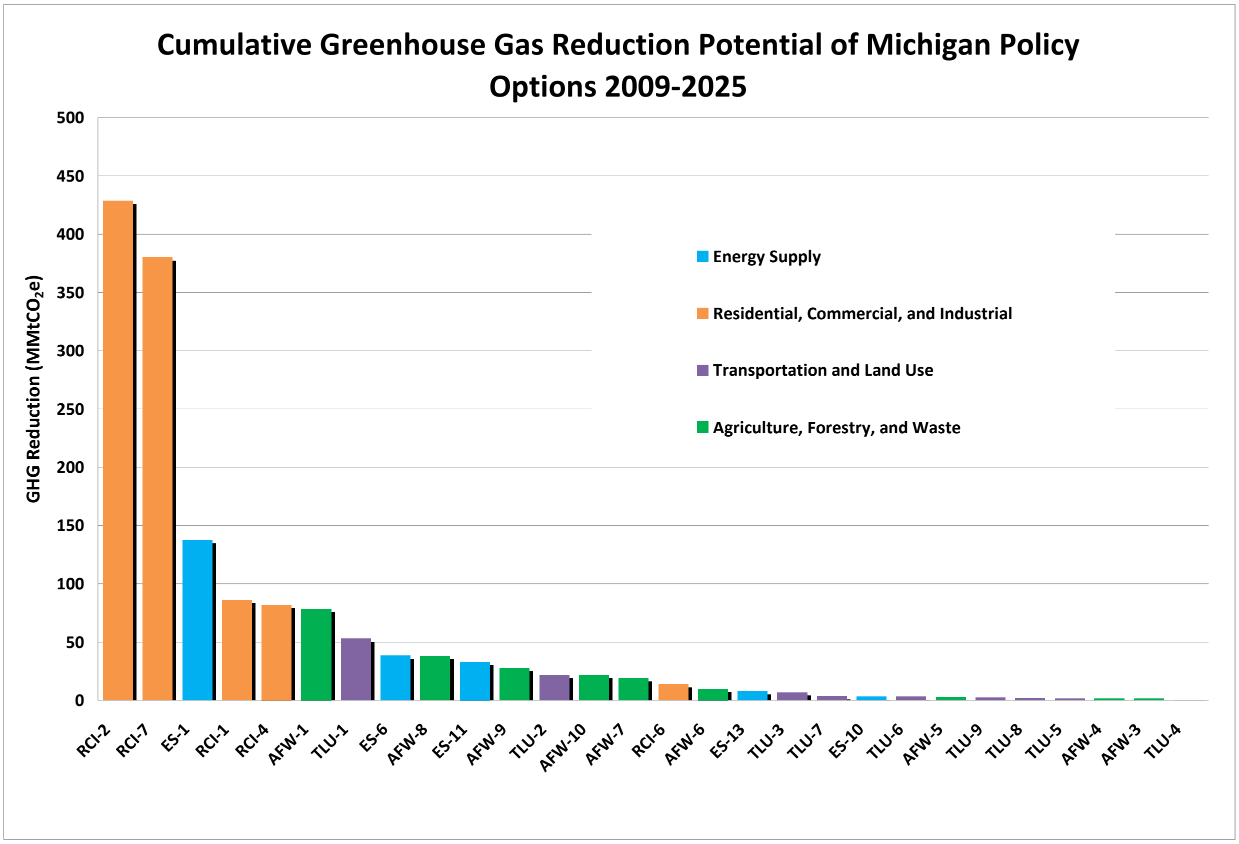
Perspectives on Policy Options

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 1-5, 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 1-6 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.

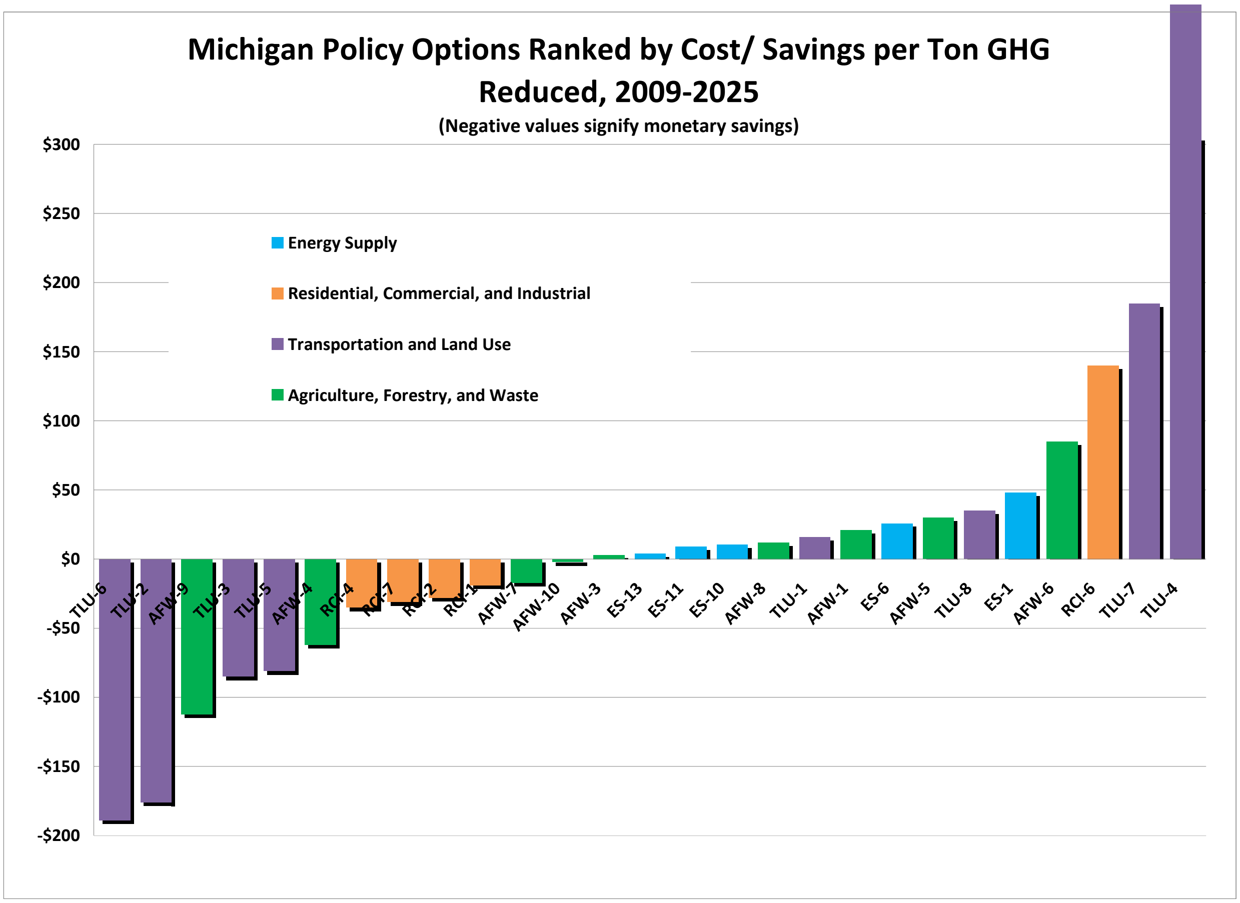
It is important to note that there is some level of uncertainty in projecting GHG reductions and estimating exact costs (or cost savings) per ton of reductions achieved for the time periods of this analysis.

Figure 1-5. MCAC policy recommendations ranked by cumulative (2009–2025) GHG reduction potential



GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; AFW = Agriculture, Forestry, and Waste Management; ES = Energy Supply; TLU = Transportation and Land Use; RCI = Residential, Commercial, Industrial

Figure 1-6. MCAC policy recommendations ranked by cumulative (2009–2025) net cost/cost savings per ton of GHG removed

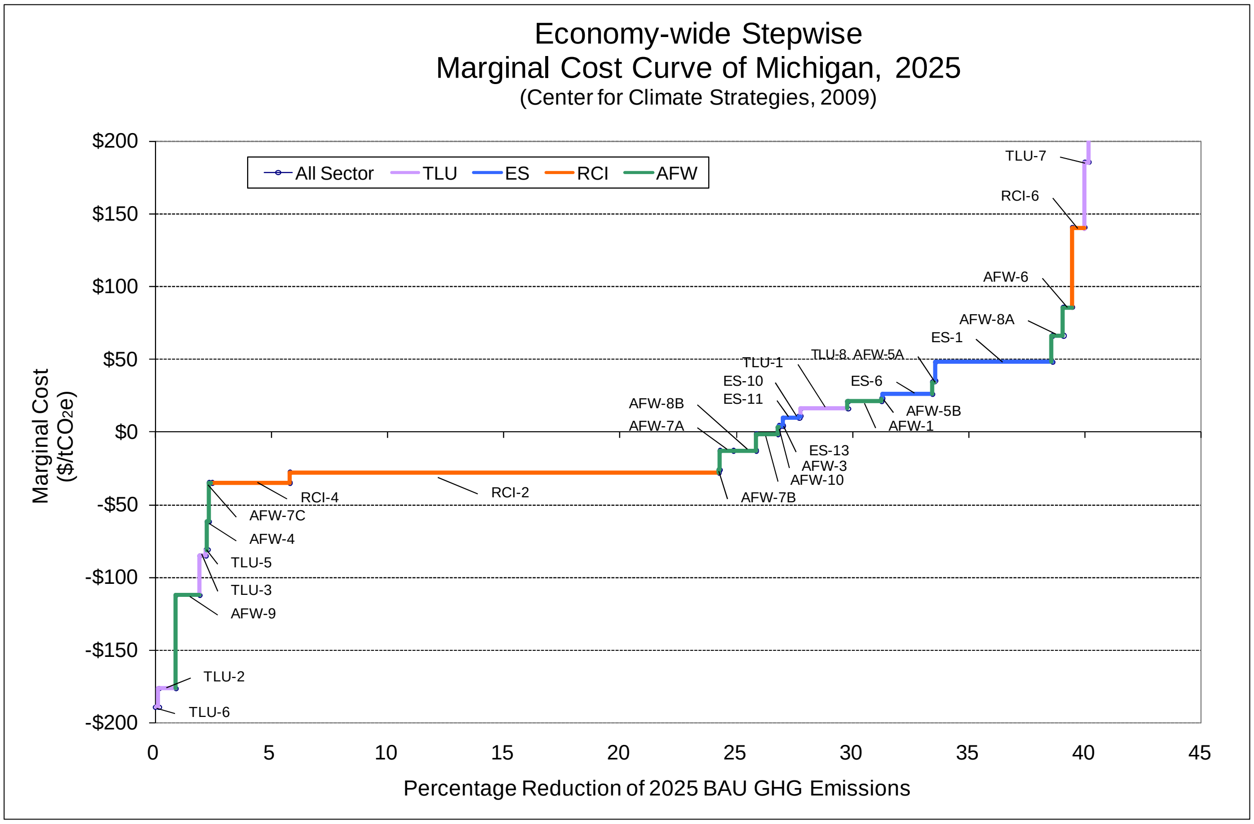


GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; AFW = Agriculture, Forestry, and Waste Management; ES = Energy Supply; TLU = Transportation and Land Use; RCI = Residential, Commercial, Industrial.

TLU 4 cost effectiveness is $1458 per ton.

Figure 1-7, 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 x-axis shows the average cost (saving) of reducing one $MMtCO_2e$ of GHG emissions with the application of the option. For instance, for RCI-2-Energy Efficiency- this policy recommendation should result in approximately a 54 MMTCO2e (19%) reduction of GHG emissions in 2025 below the BAU reference case with an average cost savings of approximately $28/ton.

Figure 1-7. Stepwise marginal cost curve for Michigan, 2025



BAU = business as usual; GHG = greenhouse gas; tCO_2e = metric tons of carbon dioxide equivalent; AFW = Agriculture, Forestry, and Waste Management; ES = Energy Supply; TLU = Transportation and Land Use;

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. For example, RCI-7 reductions overlap with both RCI-2 and RCI-4 assuming all three policies are implemented. The curve, therefore, includes RCI-2 and RCI-4 but not RCI-7 to avoid overstating the combined benefits of the recommendations.

Chapter 2
Inventory and Projections of Michigan's GHG Emissions

Introduction

This chapter summarizes Michigan's greenhouse gas (GHG) emissions and sinks (carbon storage) from 1990 to 2025. The Center for Climate Strategies (CCS) prepared a draft of Michigan's GHG emissions inventory and reference case projections for the Michigan Department of Environmental Quality (MDEQ). The draft inventory and reference case projections, completed in January 2008, provided the MDEQ with an initial, comprehensive understanding of current and possible future GHG emissions. The draft report was provided to the Michigan Climate Action Council (MCAC) and its Technical Work Groups (TWGs) to assist them in understanding past, current, and possible future GHG emissions in Michigan, and thereby inform the policy recommendation development process. The MCAC and TWGs have reviewed, discussed, and evaluated the draft inventory and methodologies, as well as alternative data and approaches for improving the draft GHG inventory and forecast. The inventory and forecast have since been revised to address the comments provided by the MCAC. The information in this chapter reflects the information presented in the final *Michigan Greenhouse Gas Inventory and Reference Case Projections* report (hereafter referred to as the Inventory and Projections report).[1]

Historical GHG emission estimates (1990 through 2005)[2] were developed using a set of generally accepted principles and guidelines for state GHG emission inventories, relying to the extent possible on Michigan-specific data and inputs. The reference case projections (2006-2025) are based on a compilation of various existing projections of electricity generation, fuel use, and other GHG-emitting activities, along with a set of simple, transparent assumptions described in the final Inventory and Projections report.

The Inventory and Projections report covers the six types of gases included in the U.S. GHG inventory: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). Emissions of these GHGs are presented using a common metric, CO_2 equivalence (CO_2e), which indicates the relative contribution of each gas, per unit mass, to global average radiative forcing on a global warming potential-weighted basis.[3]

[1] Center for Climate Strategies. *Final Michigan Greenhouse Gas Inventory and Reference Case Projections: 1990–2025*. Prepared for the Michigan Climate Action Council. November 2008.

[2] The last year of available historical data for each sector varies between 2000 and 2005. The University of Michigan also prepared an inventory and forecast of GHG emissions in conjunction with the MDEQ in 2005.

[3] 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. 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 Panel on

It is important to note that the emission estimates reflect the GHG emissions associated with the electricity sources used to meet Michigan's demands, corresponding to a consumption-based approach to emissions accounting. Another way to look at electricity emissions is to consider the GHG emissions produced by electricity generation facilities in the state, a production-based method. The study covers both methods of accounting for emissions, but for consistency, all total results are reported as consumption-based.

Michigan GHG Emissions: Sources and Trends

Table 2-1 provides a summary of GHG emissions estimated for Michigan by sector for 1990, 2000, 2005, 2010, 2020, and 2025. As shown in this table, Michigan is estimated to be a net source of GHG emissions (positive, or gross, emissions). Michigan's forests serve as sinks of GHG emissions (removal of emissions, or negative emissions). Michigan's net emissions subtract the equivalent GHG reduction from emission sinks from the gross GHG emission totals. The following sections discuss GHG emission sources and sinks, trends, projections, and uncertainties.

Historical Emissions

Overview

In 2005, on a gross emissions consumption basis (i.e., excluding carbon sinks), Michigan accounted for approximately 248 million metric tons (MMt) of CO_2e emissions, an amount equal to 3.5% of total U.S. gross GHG emissions. On a net emissions basis (i.e., including carbon sinks), Michigan residents accounted for approximately 235 $MMtCO_2e$ of emissions in 2005, an amount equal to 3.8% of total U.S. net GHG emissions.[4] Michigan's GHG emissions are rising slower than those of the nation as a whole. From 1990 to 2005, Michigan's gross GHG emissions increased by 12%, while national gross emissions rose by 16%.[5]

On a per-capita basis, Michigan residents emitted about 24 metric tons (t) of gross CO_2e in 2005, similar to the national average of about 24 tCO_2e. Figure 2-1 illustrates the state's emissions per capita and per unit of economic output. Both Michigan and national per-capita emissions remained nearly constant from 1990 to 2005. This consistency in per-capita emission rates in Michigan results from growth in emissions from the electricity supply and transportation sectors, and decline in emissions from the industrial fuel use and industrial processes sectors. In both Michigan and the nation as a whole, economic growth exceeded emissions growth throughout the 1990 – 2005 period. From 1990 to 2005, emissions per unit of gross product dropped by 26% nationally, and by 23% in Michigan.[6]

Climate Change, Cambridge University Press, Cambridge, United Kingdom. Available at: http://www.grida.no/climate/ipcc_tar/wg1/212.htm.

[4] The national emissions used for these comparisons are based on 2005 emissions from U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2006*, April 15, 2008, EPA430-R-08-005. Available at: http://www.epa.gov/climatechange/emissions/usinventoryreport.html.

[5] During this period, population grew by 10% in Michigan and by 19% nationally. However, Michigan's economy grew at the same rate as the nation on a per-capita basis (up 32%).

[6] Based on real gross domestic product (millions of chained 2000 dollars) that excludes the effects of inflation. U.S. Department of Commerce, Bureau of Economic Analysis. "Gross Domestic Product by State." Available at: http://www.bea.gov/regional/gsp/.

Table 2-1. Michigan GHG emissions, historical and reference case projection, by sector*

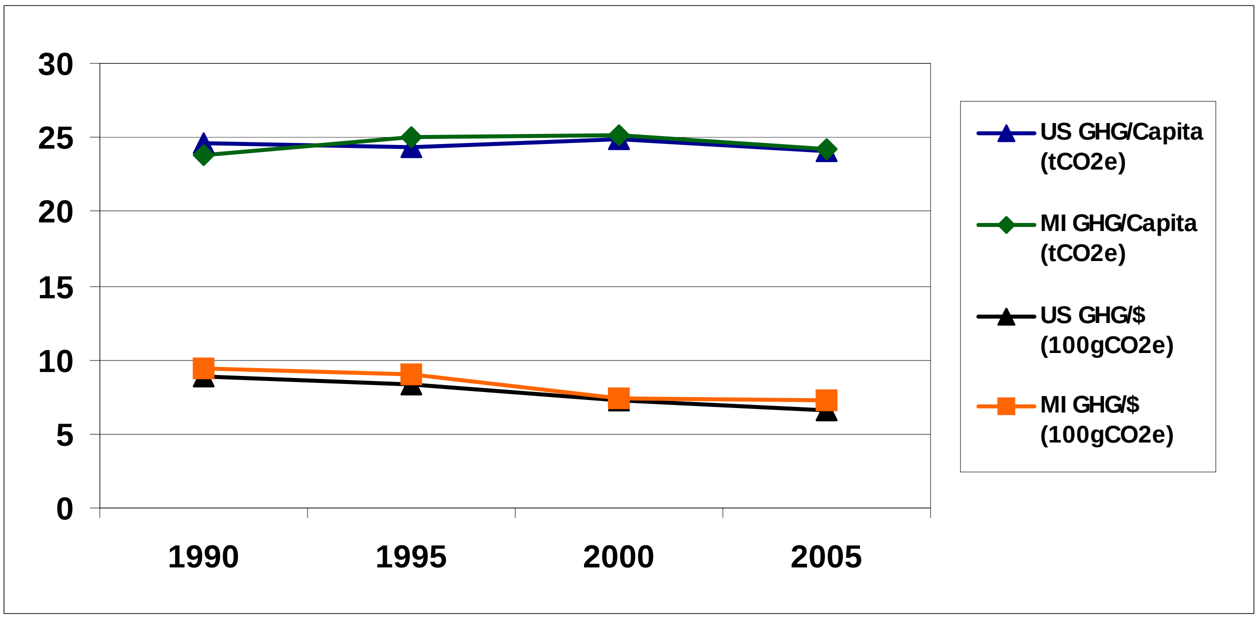
Sector	1990	2000	2005	2010	2020	2025
	MMtCO_2e					
Energy (Consumption Based)	**192.5**	**218.6**	**214.7**	**220.2**	**238.7**	**248.5**
Electricity Use (Consumption)	**70.3**	**86.9**	**90.0**	**91.0**	**103.9**	**111.1**
Electricity Production (in-state)	64.0	68.1	71.4	72.3	85.3	92.6
Coal	*62.8*	*64.9*	*67.7*	*67.6*	*78.8*	*85.3*
Natural Gas	*0.46*	*1.77*	*2.38*	*3.67*	*5.40*	*6.06*
Oil	*0.66*	*0.99*	*0.71*	*0.48*	*0.48*	*0.57*
MSW/Landfill Gas	*0.12*	*0.38*	*0.34*	*0.39*	*0.44*	*0.46*
Biomass	*0.010*	*0.031*	*0.030*	*0.025*	*0.027*	*0.029*
Other Wastes	*0.009*	*0.029*	*0.16*	*0.19*	*0.21*	*0.22*
Imported/Exported Electricity	6.22	18.8	18.7	18.7	18.6	18.5
Residential/Commercial/Industrial (RCI) Fuel Use	**67.5**	**66.1**	**59.9**	**60.5**	**62.1**	**62.4**
Coal	*11.7*	*9.34*	*7.32*	*6.12*	*5.67*	*5.56*
Natural Gas	*42.8*	*43.7*	*40.4*	*42.6*	*44.4*	*44.8*
Petroleum	*12.8*	*12.9*	*12.0*	*11.6*	*11.9*	*11.8*
Wood (CH_4 and N_2O)	*0.28*	*0.17*	*0.19*	*0.20*	*0.20*	*0.20*
Transportation	**49.7**	**59.4**	**58.2**	**61.4**	**64.0**	**65.3**
On-road Gasoline	*37.4*	*43.7*	*43.3*	*45.5*	*46.2*	*46.4*
On-road Diesel	*5.21*	*8.90*	*10.2*	*11.3*	*12.9*	*13.7*
Rail, Natural Gas, LPG, Other	*1.10*	*1.16*	*0.90*	*0.93*	*0.95*	*0.95*
Marine Vessels	*1.87*	*2.61*	*2.25*	*2.18*	*2.52*	*2.70*
Jet Fuel and Aviation Gasoline	*4.15*	*3.00*	*1.52*	*1.45*	*1.50*	*1.51*
Fossil Fuel Industry	**4.94**	**6.13**	**6.64**	**7.25**	**8.70**	**9.66**
Natural Gas Industry	4.69	6.03	6.55	7.19	8.67	9.64
Oil Industry	0.25	0.10	0.086	0.061	0.032	0.024
Industrial Processes	**15.3**	**18.1**	**18.4**	**18.9**	**23.3**	**26.4**
Cement Manufacture (CO_2)	2.27	2.26	2.13	2.12	2.10	2.09
Lime Manufacture (CO_2)	0.43	0.48	0.41	0.41	0.41	0.41
Limestone and Dolomite Use (CO_2)	0.24	0.25	0.31	0.31	0.31	0.31
Soda Ash (CO_2)	0.10	0.094	0.088	0.084	0.076	0.072
Iron & Steel (CO_2)	11.2	11.0	10.2	8.47	8.12	7.95
Taconite Production (CO_2)	0.037	0.28	0.25	0.20	0.14	0.11
Magnesium Production (SF_6)	0.18	0.45	0.45	0.70	1.16	1.50
ODS Substitutes (HFC, PFC)	0.012	2.84	4.16	6.18	10.6	13.6
Electric Power T&D (SF_6)	0.82	0.47	0.40	0.37	0.34	0.33
Semiconductor Manufacturing (HFC, PFC, and SF_6)	0.001	0.004	0.004	0.004	0.003	0.003
Waste Management	**4.67**	**5.30**	**6.28**	**6.98**	**8.70**	**9.74**
Waste Combustion	0.33	1.14	1.20	1.26	1.38	1.45
Landfills	3.16	2.86	3.75	4.34	5.82	6.73
Wastewater Management	1.17	1.30	1.33	1.38	1.50	1.56
Agriculture	**8.33**	**7.99**	**8.07**	**7.71**	**7.25**	**7.03**
Enteric Fermentation	1.53	1.36	1.40	1.38	1.33	1.31
Manure Management	0.92	0.97	1.09	1.07	1.01	0.99
Agricultural Soils	3.71	3.49	3.42	3.09	2.73	2.55
Agricultural Burning	0.022	0.026	0.029	0.030	0.034	0.036
Agricultural Soils (cultivation practices)	2.14	2.14	2.14	2.14	2.14	2.14

Sector	1990	2000	2005	2010	2020	2025
	MMtCO_2e					
Forest Wildfires and Prescribed Burning	**0.020**	**0.020**	**0.020**	**0.020**	**0.020**	**0.020**
Gross Emissions (Consumption Basis)	**220.7**	**250.0**	**247.5**	**253.8**	**278.0**	**291.6**
Increase relative to 1990		*13%*	*12%*	*15%*	*26%*	*32%*
Emissions Sinks	**–37.9**	**–12.5**	**–12.7**	**–12.7**	**–12.7**	**–12.7**
Forestry and Land Use	**–37.9**	**–12.5**	**–12.7**	**–12.7**	**–12.7**	**–12.7**
Forested Landscape	–27.8	–8.77	–8.77	–8.77	–8.77	–8.77
Urban Forestry and Land Use	–10.1	–3.69	–3.91	–3.91	–3.91	–3.91
Net Emissions (Consumption Basis) (including forestry and land use sinks)	**182.9**	**237.5**	**234.8**	**241.1**	**265.3**	**278.9**

MMtCO_2e = million metric tons of carbon dioxide equivalent; CH_4 = methane; N_2O = nitrous oxide; MSW = municipal solid waste; LPG = liquefied petroleum gas; ODS = ozone-depleting substance; HFC = hydrofluorocarbon; PFC = perfluorocarbon; SF_6 = sulfur hexafluoride; T&D = transmission and distribution.

* Totals may not equal exact sum of subtotals shown in this table due to independent rounding.

Figure 2-1. Michigan and U.S. gross GHG emissions, per-capita and per-unit gross product



GHG = greenhouse gas; tCO_2e = metric tons of carbon dioxide equivalent; g = grams.

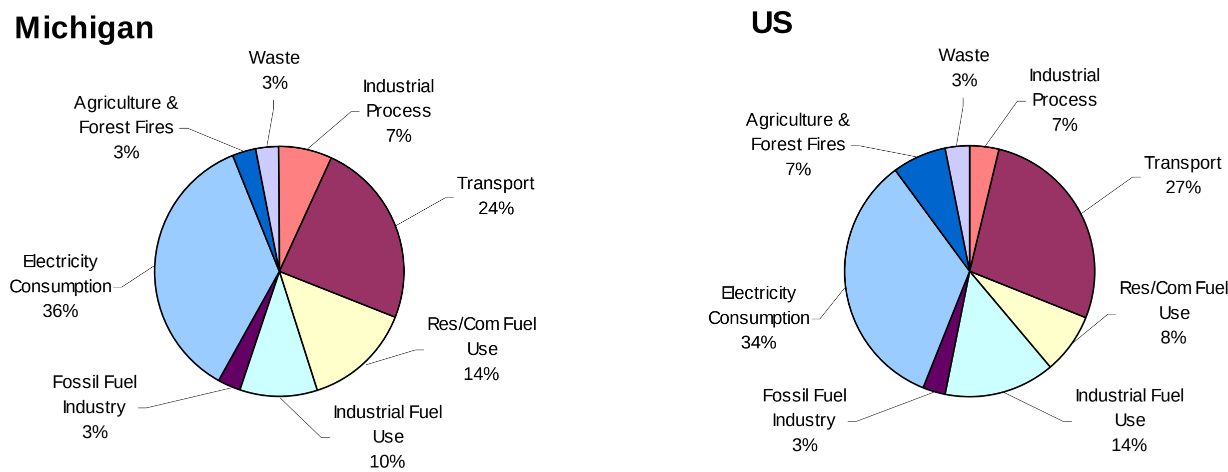
The principal sources of Michigan's GHG emissions in 2005 are electricity consumption, residential, commercial, and industrial (RCI) fuel use, and transportation, accounting for 36%, 24%, and 24% of Michigan's gross GHG emissions, respectively, as shown in Figure 2-2. The next largest contributor is the industrial processes sector, accounting for 7% of gross GHG emissions in 2005; these emissions are rising due to the increasing use of HFCs and PFCs as substitutes for ozone-depleting chlorofluorocarbons.[7] Other industrial process emissions include

[7] Chlorofluorocarbons are also potent GHGs; however, they are not included in GHG estimates because of concerns related to implementation of the Montreal Protocol on Substances That Affect the Ozone Layer. See Appendix I in the Final Inventory and Projections report for Michigan (http://www.miclimatechange.us/stakeholder.cfm).

CO_2 released by cement and lime manufacturing; CO_2 released during soda ash, limestone, and dolomite use; CO_2 released during taconite production and iron and steel production; SF_6 released during magnesium production and from transformers used in electricity transmission and distribution systems; and HFCs, PFCs, and SF_6 released during semiconductor manufacturing.

Figure 2-2 also shows that the agricultural and forest wildfire sectors together accounted for 3% of the gross GHG emissions in Michigan in 2005. These CH_4 and N_2O emissions primarily come from agricultural soils, enteric fermentation, manure management, and agricultural soil cultivation practices. Also, landfills and wastewater management facilities produce CH_4 and N_2O emissions that accounted for 3% of total gross GHG emissions in Michigan in 2005. Similarly, emissions associated with the production, processing, transmission, and distribution of fossil fuels accounted for 3% of the gross GHG emissions in 2005.

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



Notes: Res/Com = Residential and commercial fuel use sectors. Emissions for the residential, commercial, and industrial fuel use sectors are associated with the direct use of fuels (natural gas, petroleum, coal, and wood) to provide space heating, water heating, process heating, cooking, and other energy end-uses. The commercial sector accounts for emissions associated with the direct use of fuels by, for example, hospitals, schools, government buildings (local, county, and state) and other commercial establishments. The industrial processes sector accounts for emissions associated with manufacturing and excludes emissions included in the industrial fuel use sector. The transportation sector accounts for emissions associated with fuel consumption by all on-road and non-highway vehicles. Non-highway vehicles include jet aircraft, gasoline-fueled piston aircraft, railway locomotives, boats, and ships. Emissions from non-highway agricultural and construction equipment are included in the industrial sector. Electricity = Electricity generation sector emissions on a consumption basis, including emissions associated with electricity imported from outside of Michigan and excluding emissions associated with electricity exported from Michigan to other states.

Forestry emissions refer to the net CO_2 flux[8] from forested lands in Michigan, which account for about 53% of the state's land area.[9] Michigan's forests are estimated to be net sinks of CO_2 emissions in the state, reducing net GHG emissions by 13 $MMtCO_2e$ in 2005.

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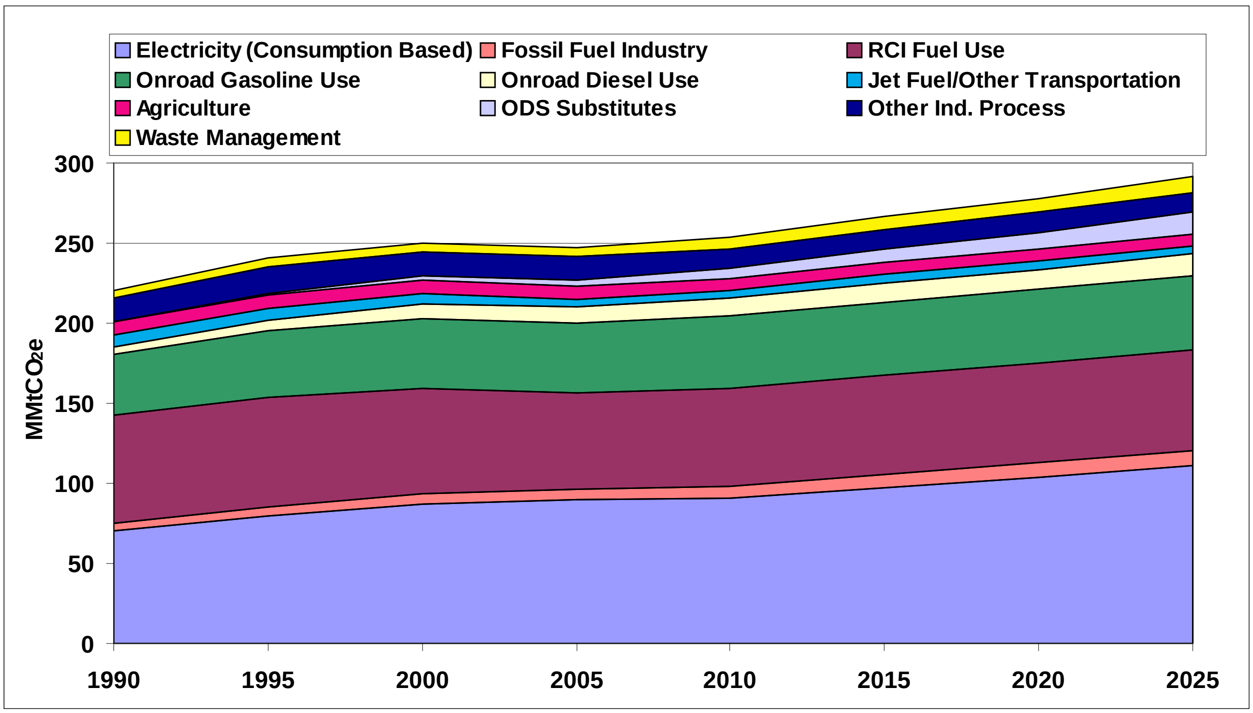
[8] "Flux" refers to both emissions of CO_2 to the atmosphere and removal (sinks) of CO_2 from the atmosphere.

Reference Case Projections

Relying on a variety of sources for projections, as noted in the Inventory and Projections report, a simple reference case projection of GHG emissions through 2025 was developed. As illustrated in Figure 2-3 and shown numerically in Table 2-1, under the reference case projections, Michigan's gross GHG emissions continue to grow steadily, climbing to about 292 $MMtCO_2e$ by 2025, or 32% above 1990 levels. This equates to a 0.8% annual rate of growth from 1990 to 2025. Relative to 2005, the share of emissions associated with electricity consumption and industrial processes both increase slightly to 38% and 9%, respectively, by 2025. The share of emissions from the transportation, RCI fuel use, and agriculture sectors all decrease slightly to 22%, 21%, and 2%, respectively. The emissions from the fossil fuel industries and the waste sector remain the same in 2025 as their shares in 2005.

Figure 2-3. Michigan gross GHG emissions by sector, 1990–2025: historical and projected



$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; RCI = direct fuel use in residential, commercial, and industrial sectors; ODS = ozone-depleting substance; Ind. = industrial.

Emissions associated with electricity consumption are projected to be the largest contributor to future GHG emissions growth, followed by emissions from ozone-depleting substance substitutes (HFCs), and then emissions associated with the transportation sector, as shown in Figure 2-4. Other sources of emissions growth include the fossil fuel industry, the RCI fuel use

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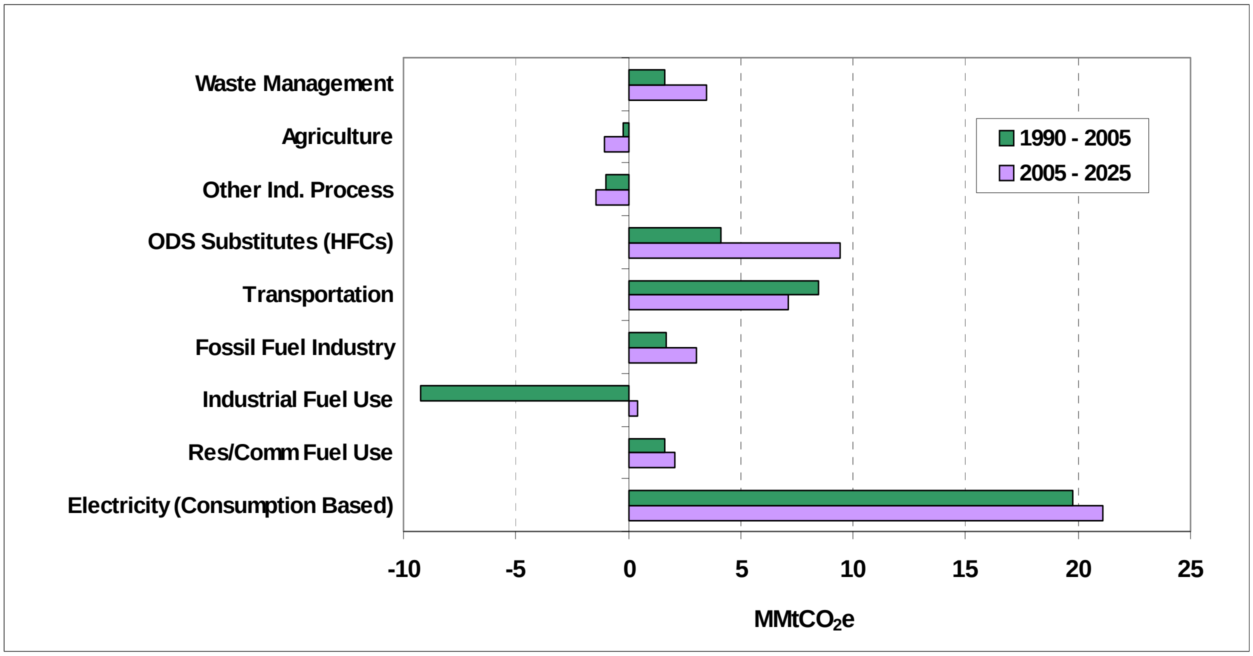
[9] Total forested acreage in Michigan is 19.3 million acres. For acreage by forest type, see: Richard A. Birdsey and George M. Lewis. "Carbon in United States Forests and Wood Products, 1987–1997: State-by-State Estimates." Michigan Estimate for 1987–1997. Available from the U.S. Department of Agriculture, Forest Service, Northern Global Change Research Program, at: http://www.fs.fed.us/ne/global/pubs/books/epa/states/MI.htm. The total land area in Michigan is 36 million acres (http://www.50states.com/michigan.htm).

sector, and the waste management sector. Table 2-2 summarizes the growth rates that drive the growth in the Michigan reference case projections, as well as the sources of these data.

Figure 2-4. Sector contributions to gross emissions growth in Michigan, 1990–2025: reference case projections



$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; ODS = ozone-depleting substance; HFCs = hydrofluorocarbons; Res/Comm = direct fuel use in the residential and commercial sectors.

Table 2-2. Key annual growth rates for Michigan, historical and projected

Annual Growth Rate	1990–2005	2005–2025	Sources
Population	0.63%	0.24%	Michigan population statistics for 1990 and 2000, compiled by Michigan Information Center from US Census Bureau, are available at http://www.michigan.gov/documents/PopByCty_26001_7.pdf. Population data for 2000 to 2004 are available from Michigan Department of History, Arts, and Libraries at http://www.michigan.gov/hal/0,1607,7-160-17451_28388_28392-106981--,00.html. Michigan projections (2005–2030) available from Michigan Department of History, Arts, and Libraries at http://www.michigan.gov/hal/0,1607,7-160-17451_28388_28392-116118--,00.html.
Electricity Sales Total Sales[a] Michigan Sales[b]	 1.97% 1.05%	 0.99% 1.27%	For 1990–2005, annual growth rate in total electricity sales for all sectors combined in Michigan calculated from EIA State Electricity Profiles (Table 8) http://www.eia.doe.gov/cneaf/electricity/st_profiles/michigan.html and sales by Michigan generators calculated by subtracting T&D losses from net generations collected from EIA Annual Electric Utility Data - 906/920 database. For 2005–2025, annual growth rates are based on data that Michigan utilities provided for gross electricity sales for 2006–2025 (see Appendix II, Table 15, page 101 of *Michigan's 21st Century Electric Energy Plan*).
Vehicle Miles Traveled	1.6%	0.37%	Based on historical VMT and projected VMT growth rates provided by Michigan Department of Transportation and the Southeast Michigan Council of Governments.

[a] Represents annual growth in total sales of electricity by generators in Michigan to RCI sectors located within and outside of Michigan.

[b] Represents annual growth in total sales of electricity by generators in Michigan to RCI sectors located within Michigan.

EIA = Energy Information Administration; SIT = State (GHG) Inventory Tool; T&D = transmission and distribution; VMT = vehicle miles traveled.

A Closer Look at the Three Major Sources: Electricity Supply, RCI Fuel Use, and Transportation

As shown in Figure 2-2, electricity use in 2005 accounted for 36% of Michigan's gross GHG emissions (about 90 $MMtCO_2e$), which was higher than the national average share of emissions from electricity consumption (32%).[10] On a per-capita basis, Michigan's GHG emissions from electricity consumption are higher than the national average (in 2005, 8.8 tCO_2e per capita in Michigan, versus 8.1 tCO_2e per capita nationally). Electricity generation in Michigan is dominated by steam units, which are primarily powered by coal and nuclear fuel.

In 2005, emissions associated with Michigan's electricity consumption (90 $MMtCO_2e$) were about 19 $MMtCO_2e$ higher than those associated with electricity production (71 $MMtCO_2e$). The higher level for consumption-based emissions reflects GHG emissions associated with net imports of electricity from other states to meet electricity demand.[11] Projections of electricity sales for 2005–2025 indicate that Michigan will remain a net importer of electricity. Emissions from electricity imports are projected to be constant (19 $MMtCO_2e$/yr) during the 2006–2025 period. The reference case projection indicates that production-based emissions (associated with electricity generated in-state) will increase by about 21 $MMtCO_2e$, and consumption-based emissions (associated with electricity consumed in-state) will also increase by about 21 $MMtCO_2e$ from 2005 to 2025.

While estimates are provided for emissions from both electricity production and consumption, unless otherwise indicated, tables, figures, and totals in this report reflect electricity consumption emissions. The consumption-based approach can better reflect the emissions (and emission reductions) associated with activities occurring in the state, particularly with respect to electricity use (and efficiency improvements), and is particularly useful for decision making. Under this approach, emissions associated with electricity exported to other states would need to be covered in those states' inventories in order to avoid double counting or exclusions.

Activities in the RCI[12] sectors produce GHG emissions when fuels are combusted to provide space heating, process heating, and other applications. From 1990 to 2005, emissions from RCI decreased at an annual rate of 0.8%, largely due to the decrease in industrial fuel use. In 2005, combustion of oil, natural gas, coal, and wood in the RCI sectors contributed about 24% (about 60 $MMtCO_2e$) of Michigan's gross GHG emissions, slightly higher than the RCI sector contribution for the nation (22%).

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[10] For the United States as a whole, there is relatively little difference between the emissions from electricity use and emissions from electricity production, as the US imports only about 1% of its electricity, and exports even less.

[11] Estimating the emissions associated with electricity use requires an understanding of the electricity sources (both in-state and out-of-state) used by utilities to meet consumer demand. The current estimate reflects some very simple assumptions, as described in Appendix A of the Inventory and Projections report.

[12] The industrial sector includes emissions associated with agricultural energy use and fuel used by the fossil fuel production industry.

In 2005, the residential sector's share of total RCI emissions from direct fuel use was 39% (23.6 $MMtCO_2e$), the commercial sector accounted for 18% (11 $MMtCO_2e$), and the industrial sector's share of total RCI emissions from direct fuel use was 42% (25 $MMtCO_2e$). Overall, emissions for the RCI sectors (excluding those associated with electricity consumption) are expected to increase by 4.1% between 2005 and 2025. Emissions from the commercial sector are projected to increase more rapidly than the residential or industrial sectors, with an 18% increase from 2005 to 2025. In contrast, emissions from the residential and industrial sectors are expected to increase by only 0.5% and 1.6%, respectively, during the same period.

Like electricity emissions, GHG emissions from transportation fuel use rose steadily from 1990 to 2005, at an average annual growth rate of 1.1%. In 2005, gasoline-powered on-road vehicles accounted for about 74% of transportation GHG emissions; on-road diesel vehicles for 18%; marine vessels for 4%; aviation fuels, rail and other sources (natural gas- and liquefied petroleum gas-fueled vehicles used in transport applications) for the remaining 4%. As a result of Michigan's population and economic growth and an increase in total vehicle miles traveled, emissions from on-road gasoline use grew at a rate of 0.98% annually between 1990 and 2005. Meanwhile, emissions from on-road diesel use rose by 4.6% per year from 1990 to 2005, suggesting an even more rapid growth in freight movement within or across the state. Emissions from on-road gasoline vehicles in 2025 are projected to increase by 0.35% annually from 2005 levels, and emissions from on-road diesel vehicles are projected to increase by 1.5% annually from 2005 to 2025, with total transportation emissions expected to reach 65 $MMtCO_2e$ by 2025.

MCAC Revisions

The following identifies the revisions that the MCAC made to the inventory and reference case projections, thus explaining the differences between the final Inventory and Projections report and the initial assessment completed in January 2008:

All Sectors: The initial assessment included GHG emission projections to 2020. This was revised to extend the GHG projections to 2025 for all sectors.

Electric Supply:

- Production-based (in-state) and consumption-based generation and emissions:
    - Excluded electricity that Donald Cook nuclear plant exports to other states.
    - Replaced this nuclear generation with electricity imports from outside the state.

- Emissions from pumped storage:
    - Set emissions to zero to avoid double counting of emissions (pumps are operated by electricity purchased from grid),

- Landfill gas (LFG)/municipal solid waste (MSW) and biomass emissions:
    - Added emissions for 1990–2000 (data for non-utilities inadvertently not included in the draft inventory and forecast).
    - For 1990–2000, only the aggregated non-utility generation (generation from independent power producers) can be obtained from the Energy Information Administration (EIA)

Web site (EIA Electric Power Annual 2006). To get the disaggregated generation of LFG, MSW, and biomass for 1990–2000 from the aggregated Other Renewable Generation number in Electric Power Annual (this number excludes hydro electricity), we applied the proportions by fuel and by plant type in 2001 to the aggregated renewable numbers of 1990–2000.

- Transmission & distribution (T&D) line losses of Michigan:
  - The T&D line losses used in the draft analysis were revised based on the data provided by the Michigan Public Service Commission. The T&D loss rate of Consumers Energy/METC, Detroit Edison/ITC, and Upper Peninsula were collected. The weighted-average T&D loss rate of Michigan was computed based on the 2007 peak load on the system in each of the three regions

- Forecast for biomass net generation:
  - The forecast of biomass in the draft inventory and forecast used EIA regional projections, which show big increases in biomass generation in the forecast years. The EIA regional projections could be influenced by the existing renewable portfolio standard (RPS) in other states of the region. The electricity generation from biomass has been flat over the past 10 years or so in Michigan, about 1% of the total generation of the state. Biomass generation would be unlikely to significantly increase in Michigan in the forecast years unless there are strong policy regulations, such as an RPS. Therefore, in this report, for the business-as-usual condition in the forecast years, we assumed the same generation capacity from biomass as the existing capacity indicates (an average level of 2001–2005).

Transportation: MCAC approved the use of a new set of vehicle miles traveled (VMT) growth rates (for 2005–2010, 2010–2015, 2015–2020, and 2020–2025), provided by the Michigan Department of Transportation; this replaces the previous VMT growth rates used in the draft inventory and forecast.

Industrial Process: The MCAC revised iron and steel emissions by replacing the default State Inventory Tool (SIT) steel production data with crude steel production data provided by MDEQ for 1990–2005.

Fossil Fuel Industry: The MCAC added new estimates of the CO_2, CH_4, and N_2O emissions from the combustion of natural gas by internal combustion engines used to operate pipeline compressor stations. These emissions were not included in the initial assessment. These pipeline natural gas fuel use emissions were estimated using SIT emission factors and Michigan 1990–2005 natural gas data from EIA.

Agriculture: Projections for livestock populations were revised based on feedback from the Agriculture, Forestry, and Waste TWG. Projections for beef cattle, swine, sheep, goats, and horses were estimated based on logarithmic forecasts of the historical 1990–2005 populations. Poultry populations were held at 2005 levels based on input from the poultry industry.[13]

[13] C. Vollmer-Sanders, MI Farm Bureau, communicated to R. Anderson, CCS, via telephone, May 2008.

Waste Sector: In the initial assessment, CH_4 captured for flaring and use in landfill gas to energy (LFGTE) plants were estimated with SIT defaults. The revised estimates are based on waste emplacement data for controlled landfills and date of emission capture equipment installation. Information on controlled landfills was obtained from MDEQ and a database of LFGTE projects compiled by the U.S. Environmental Protection Agency (EPA).

Open burning of MSW at residential sites was not estimated in the initial assessment. The revised report includes these emissions, which were obtained from EPA's 2002 National Emissions Inventory for estimates of the quantity of waste burned at residential sites in Michigan.[14]

Forestry: CO_2 flux estimates for 1994–2005 were revised to be based on the average calculated flux during this period using the Carbon Calculation Tool. This was done to minimize the influence of estimates in individual years and shifts between U.S. Forest Service Forest Inventory and Analysis (FIA) measurements.

Key Uncertainties

Some data gaps exist in this inventory, particularly in the reference case projections. Key tasks for future refinement of this inventory and forecast include review and revision of key drivers, such as the transportation, electricity demand, and RCI fuel use growth rates that will be major determinants of Michigan's future GHG emissions (see Table 2-2 and Figure 2-4). These growth rates are driven by uncertain economic, demographic, and land-use trends (including growth patterns and transportation system impacts), all of which deserve closer review and discussion.

[14] EPA, ftp://ftp.epa.gov/EmisInventory/2002finalnei/documentation/nonpoint/2002nei_final_nonpoint_documentation0206version.pdf.

Chapter 3
Energy Supply Sector

Overview of GHG Emissions

The energy supply (ES) sector includes greenhouse gas (GHG) emissions from the production, processing, transmission, and storage of electricity and fossil fuels. Electricity generation accounts for the vast majority of these emissions, representing 93% of Michigan's total ES sector emissions in 2005. Nearly all of the remainder comes from the production, processing, transmission, and distribution of natural gas. GHG emissions from the ES sector represented 45% of Michigan's total consumption-based emissions in 2005.

Michigan has historically been a net importer of electricity. Electricity imports increased from about 8,500 gigawatt-hours (GWh) in 1990 to about 25,000 GWh in 2000, which is comparable to total imports in 2005, or 21% of all electricity consumed in Michigan[1]. GHG emissions from imported electricity represented the same percentage (21%) of total consumption in 2005.

In the absence of any mitigation efforts, GHG emissions from Michigan's ES sector are expected to increase from 2005 base year levels of 90 million metric tons of carbon dioxide equivalent ($MMtCO_2e$) to 111 $MMtCO_2e$ in 2025, or about a 23.3% increase. Compared with estimated current (2009) emissions of 89.5 $MMtCO_2e$, a 26% increase is expected.[2] Projections of future electricity generation requirements are taken from *Michigan's 21st Century Electric Energy Plan*, prepared by the Michigan Public Service Commission (MPSC). Projections assume electricity imports throughout the forecast period will remain at 2005 levels, and that in-state and imported generation fuel mix will also remain unchanged. Figure 3-1 shows historical and projected GHG emissions from power generation by fuel source.

Key Challenges and Opportunities

The biggest challenge facing Michigan's ES sector is the state's high reliance on coal-fired generation, and the age of the coal generation fleet, which is the second oldest in the nation. GHG emissions from the combustion of coal for the generation of electricity represent 95% of all electricity emissions, with almost all of the remainder being natural gas. Figure 3-2 shows the breakdown of in-state gross electricity generation and in-state GHG emissions by fuel type for 2005. Another challenge is increasing demand, which is projected at 1% per year (2005–2025) and assumed to be fully met through new in-state generation. This rate incorporates the current demand-side management programs in Michigan.

While the age of Michigan's coal-burning power generation fleet is a challenge, it is also an opportunity. Many plants will be candidates for retrofit or replacement within the forecast period, so the opportunity to move to lower-GHG fuels and advanced coal combustion technology is substantial. Michigan is blessed with significant wind and biomass generation

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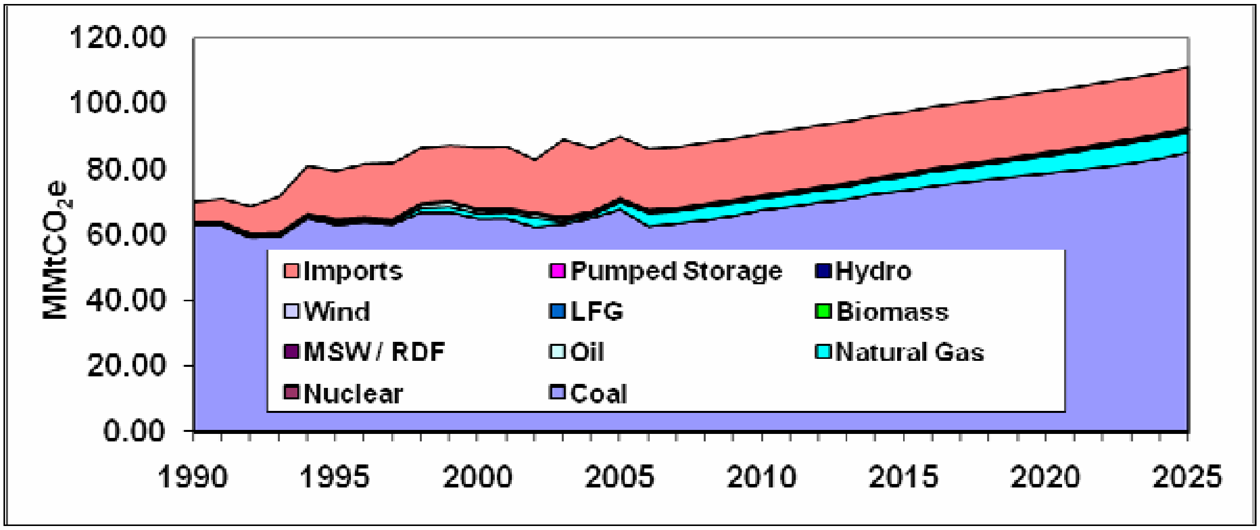
[1] Imports are estimated by taking the difference between the total electricity sales in Michigan and the sales from the in-state power generation. The data sources for the total electricity sales and the sales from in-state sources are EIA Annual Energy Outlook, 1996-2007 Editions.

[2] A more comprehensive treatment of Michigan's ES inventory and forecast projections can be found in Appendix A1 of the companion document, *Final Michigan Greenhouse Gas Inventory and Reference Case Projections 1990–2025*, Center for Climate Strategies, November 2008.

potential, and contains unusual geologic formations that offer significant potential for in-ground CO_2 storage. Several demand-side management, energy efficiency, and conservation measures recommended in the residential, commercial, and industrial sectors are detailed in Chapter 5 of this report.

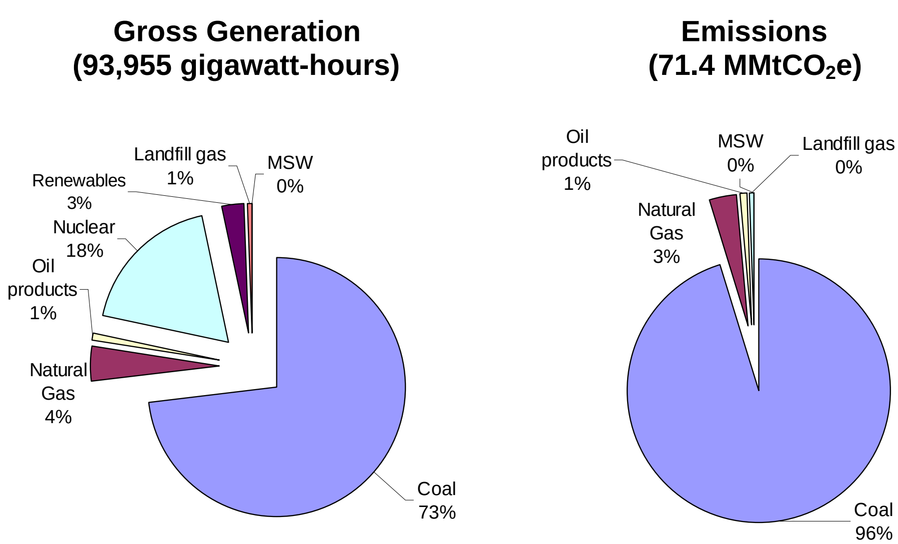
Figure 3-1. Recent and projected GHG emissions from the electricity sector, Michigan, 2005–2025 (consumption basis)



Source: *Final Michigan Greenhouse Gas Inventory and Reference Case Projections 1990–2025,* Center for Climate Strategies, November 2008.

LFG = landfill gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; MSW = municipal solid waste, RDF = refuse-derived fuel.

Figure 3-2. Breakdown of Michigan in-state generation and CO_2 emissions—2005 base year



$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; MSW = municipal solid waste.

Overview of Policy Recommendations and Estimated Impacts

The Michigan Climate Action Council analyzed and is recommending several policies for the ES sector that offer the potential for significant GHG emission reductions, as summarized in Table 3-1.

Table 3-1. Summary results for energy supply policy recommendations and existing actions

Policy No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value 2009–2025 (Million $)	Cost-Effective-ness ($/$tCO_2e$)	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
	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 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[3]
ES-7	Integrated Resource Planning (IRP), Including CHP	*Not Quantifiable*					Unanimous
ES-8	Smart Grid, Including Advanced Metering	*Not Quantifiable*					Unanimous
ES-9	CCSR Incentives, Requirements, R&D, and/or Enabling Policies	*Not Quantifiable*					Unanimous
ES-10	Technology-Focused Initiatives (Biomass Co-firing, Energy Storage, Fuel Cells, Etc.), Including Research, Development, & Demonstration						Majority[4]
	Co-firing at 5%	0.2	0.2	3.3	$34.48	$10.6	

[3] 6 opposing votes [Pollack, Ettawageshik, Garfield, Heifje, Bazzani and Overmeyer] and 2 abstentions [Martinez and Calloway for Bierbaum]

[4] 3 opposing votes [Garfield, Pollack and Heifje]

Policy No.	Policy Recommendation	GHG Reductions (MMtCO$_2$e)			Net Present Value 2009–2025 (Million $)	Cost-Effective-ness ($/tCO$_2$e)	Level of Support
		2015	2025	Total 2009–2025			
	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, EE, 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 - TOTAL	*ES-12 Fully incorporated in distributed generation "carve-out" under ES-1.*					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	*Not Quantifiable*					Unanimous
	Sector Totals	**8.1**	**37.2**	**306.6**	**$6,348**	**$22**	
	Sector Total After Adjusting for Overlaps	**8.1**	**23.6**	**220.3**	**$7,980**	**$36**	
	Reductions From Recent Actions	**2.7**	**1.9**	**30.1**	**$1,025**	**$34**	
	Sector Total Plus Recent Actions	**10.8**	**25.5**	**250.4**	**$9,005**	**$36**	

$/tCO$_2$e = dollars per metric tons of carbon dioxide equivalent; CCI = Cross-Cutting Issues; CCSR = carbon capture and storage or reuse; CHP = combined heat and power; EE = energy efficiency; GHG = greenhouse gas; IGCC = integrated gasification combined cycle; IRP = integrated resource planning; MCAC = Michigan Climate Action Council; MMtCO$_2$e = millions of metric tons of carbon dioxide equivalent; N/A = not applicable; PA = Public Act; PV = photovoltaic; R&D = research and development.

Note: The numbering used to denote the policy recommendation is for reference purposes only; it does not reflect prioritization among these important recommendations.

These recommendations include efforts to extend and expand Public Act (PA) 295, the Clean, Renewable and Energy Efficiency Act (ES-1 and ES-3), promote the development and use of advanced fossil fuel technologies (ES-5 and ES-9), expand the use of nuclear power (ES-6), promote integrated resource planning and combined heat and power (ES-7 and ES-13), convert to a "smart grid" (ES-8), advance the use of emerging technologies (ES-10), promote improved efficiency or replacement of older generating units (ES-11), promote the expanded use of small-scale distributed generation, including renewable energy payments (ES-1 and ES-12), and improve transmission and distribution system efficiency and access. In addition to the recent actions contained in PA 295, these policy recommendations contribute to GHG emission reductions during 2009–2025, as outlined in Table 3-1.

Overall, the ES mitigation recommendations and recent actions yield annual GHG emission reductions from reference case projections of about 25.5 MMtCO$_2$e in 2025 and cumulative reductions of 250.4 MMtCO$_2$e from 2009 through 2025, at a net cost of approximately $9 billion through 2025 on a net present value basis. The weighted-average cost of reduced carbon for the ES measures is about $36/tCO$_2$e avoided. An overview of each policy recommendation is provided in this chapter. Additional details regarding the application of these recommendations to Michigan (targets, implementation mechanisms, parties involved, modeling approach, etc.) are provided in Appendix F.

Energy Supply Sector Policy Descriptions

The ES sector has several opportunities for mitigating GHG emissions from electricity generation, including mitigation activities associated with the generation, transmission, and distribution of electricity—whether generated through the combustion of fossil fuels, renewable energy sources in a centralized power station supplying the grid, or distributed generation facilities.

ES-1. Renewable Portfolio Standard (RPS)

A renewable portfolio standard (RPS) is a requirement that utilities supply a certain amount of annual retail sales from eligible renewable energy sources by a certain date and each year thereafter. This recommendation endorses the RPS contained within PA 295 through 2015, and then adopts the Midwestern Governors Association platform goals from 2015 through 2025. Beyond reducing utility-sector emissions of CO_2, benefits to Michigan would include lower emissions of smog and soot precursors, improved energy balance of trade, diversified fuel supply, and economic development potential. Twenty-four states plus the District of Columbia have adopted some form of an RPS. In the Midwest, these include Illinois (25% by 2025), Minnesota (27.4% by 2025), Ohio (12.5% by 2025), and Wisconsin (10% by 2015). This policy assumes that the provisions of ES-12, Distributed Generation (DG), are included here. The DG policy design in ES-12 is incorporated through a "carve-out," or guarantee, within ES-1 for both the 2015 and the 2025 goals.

ES-3. Energy Optimization Standard (EOS)

Energy optimization means energy efficiency, load management that reduces overall energy use, and related energy conservation. An energy optimization standard (EOS) requires energy savings as a percentage of total annual retail electricity sales in megawatt-hours and total annual retail natural gas sales in decatherms or equivalent thousand cubic feet in a specified year. To accomplish this, electric and natural gas providers are to develop energy optimization plans sufficient to ensure the achievement of applicable EOSs. In the Midwest, states that have adopted this policy mechanism include Minnesota (1.5% annual energy savings), Illinois (1% annual energy savings by 2011, 2% annual energy savings by 2015), and Ohio (1% annual energy savings by 2014, 2% annual energy savings by 2019). EOS goals mirror requirements under PA 295 through 2012, and then expand and extend the requirements through 2025.

ES-5. Advanced Fossil Fuel Technology

Advanced fossil fuel-based electric generation technologies include those that can be more efficient and thus lower emitting than current or older technologies. Advanced technologies combined with carbon capture and sequestration (and geostorage) or reuse (CCSR), may have the potential to materially lower CO_2 emissions associated with fossil fuel-based electricity generation. Such technologies include (but are not limited to) circulating fluidized-bed combustors, integrated gasification combined-cycle units, and pulverized coal (advanced supercritical and ultra-supercritical units). The proposed policy has three elements: a post-combustion technology pilot and demonstration project applied to a single coal unit; analysis and report on a Michigan-specific comparison of the costs and benefits of advanced methods against existing coal technologies from a GHG reduction and cost perspective; and use of financial incentives, performance requirements, mandates, or other measures to encourage or require the early adoption of CCSR.

ES-6. New Nuclear Power

Nuclear power is a large-scale low-GHG, baseload source of electricity that could complement renewable energy resources in a mix of low-GHG-emitting electric generating options. *Michigan's 21st Century Electric Energy Plan* notes that nuclear power cannot meet the need for new generation for at least 12 years due to the extremely long lead time required to bring a new nuclear plant on line. Nuclear power can, however, play a significant role in reducing GHG emissions in conjunction with other low-GHG-emitting generating technologies in the time period beyond 2020.The issue of proper storage of both existing and new nuclear waste in the Great Lakes basin is a serious issue and must be addressed. Policies that address the barriers to implementation and encourage the licensing of new nuclear plants in Michigan, as well as relicensing of existing plants, may be considered. These policies could also address opportunities for reducing the long time frame required to license and construct a new nuclear power plant. Costs and GHG reduction benefits were calculated based upon a single new plant sized at 1,550 megawatts (MW) going on line in 2020. This recommendation was approved by a majority of the MCAC but was not unanimous. There were six opposing votes [Pollack, Ettawageshik, Garfield, Heifje, Bazzani and Overmeyer] and two abstentions [Martinez and Calloway for Bierbaum]

ES-7. Integrated Resource Planning (IRP), Including CHP

Integrated Resource Planning (IRP) is a process that develops plans to meet needs for electricity services in a manner that meets multiple objectives, such as least-cost generation, emission standards, fuel diversity, and RPS requirements. An IRP process includes the evaluation of all feasible options, from both the supply and the demand sides, in a fair and consistent manner. In the IRP process, companies or the state can highlight supply-side (generation capacity) options to meet a forecasted growth in electricity demand, and can also evaluate equally technology and policy options on the demand side to satisfy the anticipated demand. In this fashion, supply and demand analyses are paired and evaluated jointly in a least-cost planning environment.

ES-8. Smart Grid, Including Advanced Metering

Smart Grid systems promote efficiency through improvements in system monitoring, control technology, and systems integration. Combining advanced metering and two-way communication to end users with the Smart Grid technology provides a system where both the utility and the customer can engage in integrated decisions, thus enabling and improving energy efficiency. In addition, a Smart Grid system allows enhanced opportunities for demand response and optimizes the deployment of distributed resources and renewable energy. This policy will provide guidelines to utilities for evaluating advanced metering infrastructure and Smart Grid technology projects, including cost-benefit analysis methodologies for determining the policy's GHG emissions benefits.

ES-9. Carbon Capture, Storage and Reuse Incentives, Requirements, R&D, and/or Enabling Policies

CCSR is a process that includes separation of CO_2 from industrial and energy-related sources, transport to a storage location, and permanent or long-term storage in isolation from the atmosphere. Michigan should initially encourage enhanced oil recovery and the accompanying modest carbon storage from this activity, and sequestration in depleted oil and gas fields within the 2–5-year time frame. By 2015, Michigan should encourage and support additional pilot/demonstration activity for deep carbon geostorage in several locations in the state. By 2020, Michigan should have a robust legal and policy framework consistent with national intent that enables full-scale industrial carbon geostorage capabilities. Some key implementation issues that will need to be explored regarding the establishment of a CCSR infrastructure include an infrastructure build-out that extends beyond Michigan, a legal and regulatory framework for geologic storage of CO_2, state-based incentives for CCSR, and comprehensive assessments of geologic reservoirs at the state and federal levels to determine CO_2 storage potential.

ES-10. Technology-Focused Initiatives

These initiatives focus on developing, promoting, and/or implementing one or more specific technologies that have the potential to reduce GHG emissions. Technologies could include (among others) hydrogen production and fuel cells for electricity storage, compressed air energy storage systems (to enable greater penetration of intermittent renewable technologies, such as wind), or biomass co-firing. This policy would provide state government and other private and public parties with resources and incentives for analysis, targeted research and development, market development, and adoption of GHG-reducing technologies that are not covered by other policies. The specific goal would be to maximize effective use of biomass for co-firing at appropriate coal plants as soon as practicable. This recommendation was approved by a majority of the MCAC but was not unanimous. There were three opposing votes [Garfield, Pollack and Heifje].

ES-11. Power Plant Replacement, EE, and Repowering

Michigan has the second-oldest fleet of power plants in the nation. The state will most likely be facing the retirement or repowering of a number of old, less efficient units within the time frame of this planning process. The opportunity to replace aging units and reduce GHG-intensive imports with more efficient in-state generation could offer a reduction in GHG emissions from this sector. Furthermore, existing coal-based generation technologies may benefit from additional technologies and upgrades to make their fuel burning more energy efficient (EE), resulting in more electric output for the amount of fuel burned. Policies to encourage generation efficiency improvements, repowering of existing plants, or power plant replacement(s) could include incentives or regulations as described in other options, with adjustments for financing opportunities and emission rates of existing plants.

ES-12. Distributed Renewable Energy

This recommendation focuses on removing barriers to and providing incentives to encourage the development of distributed renewable energy throughout the state. Distributed renewable energy is generally defined as small scale (generally less than 10 MW), located at or near the point of end use, interconnected to the distribution (as opposed to transmission) system, and more likely to have homeowner or community ownership. Increasing the use of distributed renewable energy provides electricity reliability, security, and environmental benefits. The preferred policy design would include a well-designed and fully implemented renewable energy payment (REP) program. A REP program may be designed to promote and encourage development of renewable energy projects of all sizes, ranging from small residential up to the largest utility-scale projects. The costs and benefits of this policy are incorporated into the DG “carve-out” under ES-1.

ES-13. Combined Heat and Power (CHP)

Every business in Michigan that uses energy to heat and/or cool its buildings or as part of a production process is technically a candidate to simultaneously also generate electricity at its site, using one of several commercially proven and widely used combined heat and power (CHP) technologies. CHP technologies, also referred to as “co-generation,” include steam turbines with steam extraction or back pressure, gas turbines with waste heat recovery boilers, combined-cycle units, reciprocating engines with manifold exhaust and cooling heat recovery, as well as less proven technologies, such as fuel cells and Stirling engines. To achieve this goal, it will be necessary to revise regulatory policies and remove institutional barriers to allow distributed renewable energy and CHP systems to compete on a level playing field with other sources of electric and thermal energy.

ES-15a. Transmission Access and Upgrades

Various efficiency measures can be implemented to reduce transmission line losses of electricity. By reducing constraints in the transmission system, improved transmission facilities reduce congestion, hence reducing energy costs and GHG emissions and improving the efficiency of the transmission and generation system. To facilitate widespread adoption of renewable energy technologies, the current transmission system requires upgrades and additions. Renewable energy facilities may require the addition of new or improved transmission lines that must be seamlessly integrated into the transmission grid. Among other things, the policy calls for Michigan to implement a “transmission system efficiency study” to determine the most cost-effective measures to reduce line losses and improve overall system reliability and management, including improving access for new generation assets, such as renewable energy, CHP, and DG projects.

ES-15b. Distribution System Access and Upgrades

Various energy efficiency measures can be implemented to reduce distribution line losses of electricity. Regulations, incentives, and/or support programs can be applied to achieve greater efficiency of distribution system components. Such distribution system improvements will help reduce line losses and improve and manage outages, as well as enable renewable energy systems, including DG and CHP projects, to interconnect to the grid. Among other things, this policy calls for implementation of a distribution system efficiency study for Michigan to determine the most cost-effective measures to reduce line losses and improve overall distribution system reliability and management, including improving access for new generation assets, such as renewable energy, CHP, and DG projects.

Chapter 4
Market Based Policies

Overview of Market Based Policies

The Market Based Policies (MBP) technical working group (TWG) was created mid-way through the MCAC planning process in response to concerns from members of the Cross Cutting Issues (CCI) and Energy Supply (ES) TWGs that some of the policies under consideration in both TWGs required more time and attention than either could provide. After reviewing a variety of options, the MCAC decided to create a new Market Based Policies (MBP) TWG and transfer selected policies under the new group's jurisdiction. The policies of principle concern were the cap-and-trade proposal and the carbon tax proposal, but a handful of related policies were also moved. The MBP TWG renumbered and reorganized the transferred policies. The MBP TWG members were self-selected volunteers from the ES, CCI and Residential, Commercial and Industrial (RCI) TWGs.

These policies selected for approval by the MCAC are different from most other recommendations in that they are not sector-specific and they rely upon economic incentives to achieve GHG mitigation targets. One of the three recommendations requires interstate action and one is a process recommendation. During the TWG's discussions several options were merged. One policy option [a carbon tax] was not approved by a majority of the MCAC.

Key Challenges and Opportunities

Congress is expressing renewed interest in national cap-and-trade legislation, and President Obama has indicated his support for the approach. Three regions within the US are moving ahead with the development and implementation of interstate or international programs – the Northeastern Regional Greenhouse Gas Initiative (RGGI), the Western Climate Initiative (WCI) and the Midwestern Greenhouse Gas Reduction Accord (MGA).

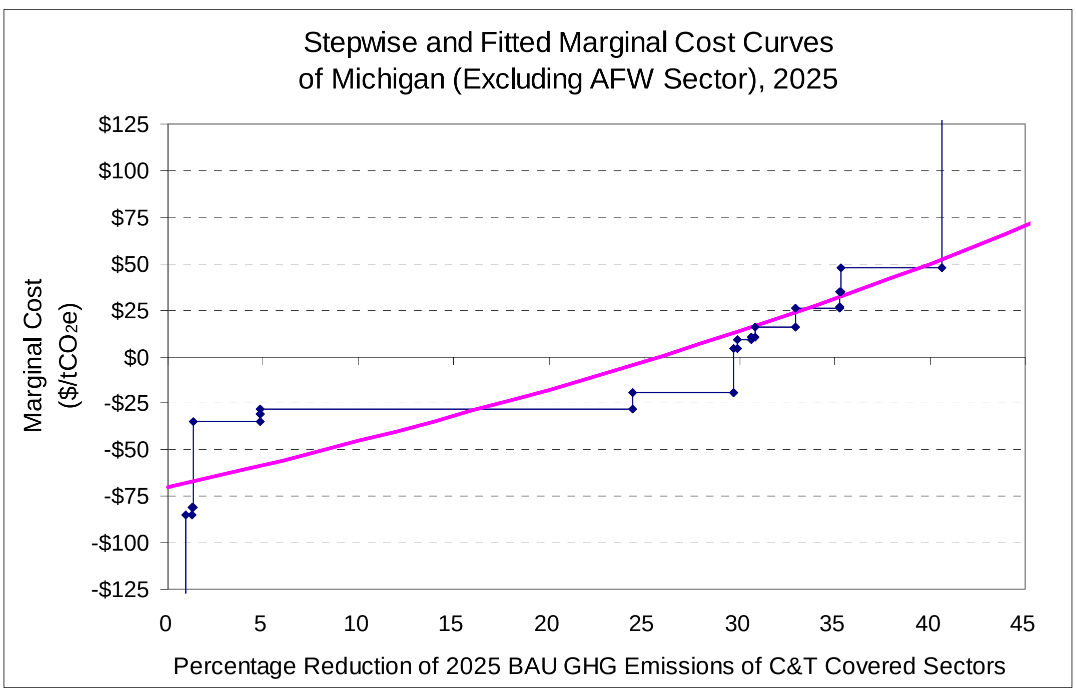
Michigan is actively participating in the development of the Midwestern Regional Greenhouse Gas Reduction Accord. The policy issues confronting the Midwestern Accord Partners will need to be evaluated regionally and by each Partner jurisdiction, and then negotiated until agreement is reached. These recommendations are offered to advise Michigan on the key program design features that Michigan should support in these regional negotiations.

It is believed that Michigan and all other participating jurisdictions in the cap-and-trade program will benefit from the combination of non-market based policies and measures such as those proposed for the sectors and the cap-and-trade program. The cap-and-trade program allows the achievement of GHG mitigation goals (the "cap") at lower cost than would otherwise be possible, and many of the non-market based policies and measures serve to remove barriers that otherwise would obstruct access to many of the low cost options. The cap also serves to ensure that GHG reduction goals are achieved even if the non-market based policies fail to perform as expected.

The relationship between the policies and measures recommended elsewhere in this report and the benefit offered by the overlay of a cap-and-trade program can be seen in a marginal cost curve as shown in Figure 4-1. This figure ranks each of the recommended policies from left to right in ascending order of cost. The horizontal (x) axis represents the percentage of GHG emission reduction, and the vertical axis represents the measure's marginal cost or savings. In the figure, each horizontal segment represents an individual mitigation option. The width of the segment indicates the GHG emission reduction potential of the option in percentage terms. The height of the segment relative to the x-axis shows the average cost or saving of reducing one metric ton of GHG with the application of the policy. The figure indicates that, collectively, the reduction potential of recommended policies from all economic sectors (excluding Agriculture, Forestry and Waste Management in this example) can avoid about 40% of 2025 baseline emissions in Michigan.

When regulated sources have the opportunity to purchase and sell emissions credits through an interstate market, the relative costs and benefits from comparable mitigation measures in all participating states become fungible. Lower cost options in one state can be developed in surplus with funding coming from sources facing higher cost options in another state. The market 'seeks out and finds' the lowest cost mitigation necessary to achieve the cap. In this way, both the sources in the states with low cost mitigation opportunities, and the sources in the states with high cost mitigation realize an economic benefit from the transaction.

Figure 4-1. Stepwise and fitted marginal cost curve of Michigan (excluding AFW sector), 2025[1]



AFW = agriculture, forestry, and waste management; BAU = business as usual; C&T = cap and trade; GHG = greenhouse gas.

[1] It should be noted that the data represented in this cost curve were derived from the Council's quantified policy recommendations, as approved. Due to the fact the Council included only a subset of all possible measures that could be taken to reduce CO2, they do not represent the full range of potential policies for an economy-wide cost curve.

Overview of Policy Recommendations and Estimated Impacts

The MCAC analyzed and is recommending three market-based policies of which only MBP-1, Cap-and-Trade, was quantified. Cap-and-trade modeling is limited to a single year, therefore cumulative costs and benefits are not available. The analysis does, however, project the program's total net economic benefit to Michigan in the target year, cost effectiveness, the flow of emissions allowances (permits) between participating jurisdictions and the allowance price. Two initial allowance distribution scenarios were modeled: free granting of allowances to regulated sources (grandfathering) and the sale of 100% of allowances by auction. Table 4-1 gives Michigan's GHG reductions and cost savings in 2020 for both the free granting and auction cases. Note that auction-case costs do not include the payments from the bidder to the state for the purchase of allowances at auction. This information can be found in table G-1-2 and Annex-1 in Appendix G.

Table 4-1. Summary results for energy supply policy recommendations and existing actions

No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value 2009–2025 (Million $)	Cost-Effective-ness ($\$/tCO_2e$)	Level of Support
		2020	2025	Total 2009–2025			
MBP-1	Cap-and-trade: 20% below 2005 by 2020 (*free granting allowances*)[2]	92.48				–$25.83	Unanimous
	Cap-and-trade: 20% below 2005 by 2020 (*auctioning allowances*)[3]	92.48				–$19.33	
MBP-3	Michigan Joins Chicago Climate Exchange	*Not Quantified*					Unanimous
MBP-6	Market advisory group	*Not Quantifiable*					Unanimous

Note: The numbering used to denote the policy recommendation is for reference purposes only; it does not reflect prioritization among these important recommendations. (Gaps in numbers are due to merger of several MBP policies and rejection of one.)

Market Based Policy Descriptions

The three recommended MBP policies include the cap-and-trade program, a Michigan "lead-by-example" policy and a cap-and-trade supporting policy . They are summarized below and presented in greater detail in Appendix G.

[2] These results include mitigation costs, including payments or revenues resulting from the purchase or sale of allowances between MI emitters and out-of-state MGA partners.

[3] These results include mitigation costs but do not include payments to the state by MI 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-1 in Appendix G.

MBP-1. Cap-and-Trade

A cap-and-trade system works by setting an overall limit on emissions (the "cap") and either selling or distributing, at no cost, emissions "allowances," or permits, to regulated entities or sources. These regulated entities must periodically surrender enough allowances to match their reported emissions or face a penalty. Cap-and-trade creates a financial incentive for emitters to continually seek out new emission-reducing options and cut their emissions as much as possible. By creating a market for the allowances, regulated entities have the choice of either purchasing allowances or directly reducing emissions and, as a result, resources are directed to the most cost-effective emissions reduction investments. To achieve overall emissions reductions over time, programs gradually lower the emissions "cap" by reducing the total number of available allowances.

The MCAC encourages national action in the implementation of a cap and trade program for the regulation of greenhouse gas emissions. In lieu of national action, or in advance of future action, Michigan should continue to participate in and encourage the development of the Midwestern Accord program. Michigan should not seek to create its own one-state cap and trade program. It is recommended that the program have the broadest possible sector coverage as soon as possible to include the maximum possible number of low cost mitigation and sequestration options. The MCAC does not make a specific recommendation on the method by which allowances are initially distributed (free granting, auction, both, etc.), but regardless of distribution method, the MCAC agrees that the *value* represented by the allowance should benefit the residents of Michigan.

MBP-3. Michigan Joins the Chicago Climate Exchange (CCX)

The Chicago Climate Exchange (CCX), launched in 2003, is the world's first and North America's only active voluntary, legally binding integrated trading system to reduce emissions of all six major greenhouse gases (GHGs), with offset projects worldwide. CCX emitting Members make a voluntary but legally binding commitment to meet annual GHG emission reduction targets. Those who reduce below the targets have surplus allowances to sell or bank; those who emit above the targets comply by purchasing CCX Carbon Financial Instrument® (CFI®) contracts. The states of New Mexico and Illinois are Members of CCX.

By joining the CCX Michigan state government will lead by example. Michigan will inventory and quantify all greenhouse gas emissions from sources that result from state government operations and are under the control of state government. State government's primary sources of GHG are typically energy usage in office buildings and transportation.

MBP-6. Market Advisory Group

GHG policies have broad based impacts and implications. As a result it is helpful to look at current and future policies from a variety of viewpoints. Some states have looked at forming groups of experts to help them evaluate both the intended and unintended consequences of GHG policies. The MCAC recommends the creation of a formal Market Advisory Group, appointed by the governor or appropriate agency head and approved by the Legislature, and working in support of the governmental agency charged with the program. The advisory group would hold regular meetings and have defined responsibilities, to include looking at the economic feasibility of implementing GHG reduction policies. In addition to offering expert advice on the design of market-based policies, the group would catalog current policies and laws in state and local government, assess how each contributes to or reduce GHGs, and provide guidance to the state's policy makers on the design of any future compliance programs to manage GHG emissions.

Chapter 5
Residential, Commercial, and Industrial Sectors

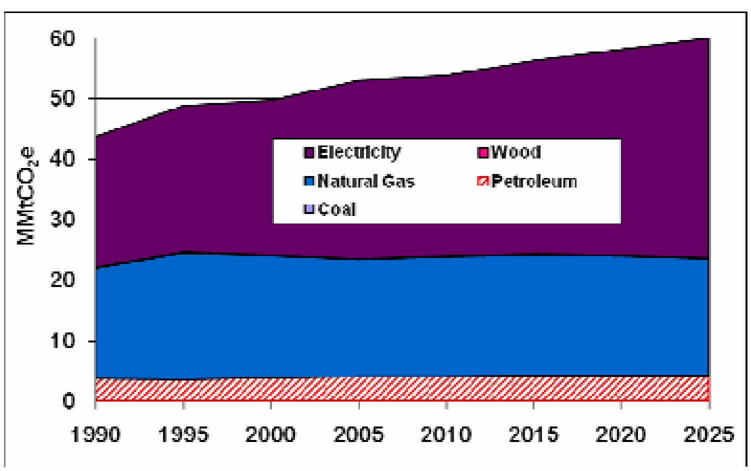
Overview of Greenhouse Gas Emissions

Activities in the residential, commercial, and industrial (RCI) sectors produce greenhouse gas (GHG) emissions when fuels are combusted to provide space heating, process heating, and other applications. In 2005, combustion of oil, natural gas, and coal in the RCI sectors contributed about 60 million metric tons of carbon dioxide equivalent ($MMtCO_2e$) to Michigan's gross GHG emissions. These sectors contributed 24% of the 248 MMt of GHG that the state emitted overall, slightly higher than the national average of 22% for these sectors. Residential sector emissions make up approximately 40% of RCI GHG emissions; commercial sector emissions, approximately 18%;, and industrial sector emissions, approximately 42%.

Considering only the direct emissions that occur within buildings and industries, however, ignores the fact that nearly all electricity sold in Michigan is consumed for RCI activities. If the emissions from all three subsectors of RCI are included (i.e., direct fuel use, emissions associated with electricity consumption, and industrial processes), they total about 68% of the state's gross GHG emissions in 2005. Therefore, the state's future GHG emissions will depend heavily on future trends in the consumption of electricity and other fuels in the RCI sectors.

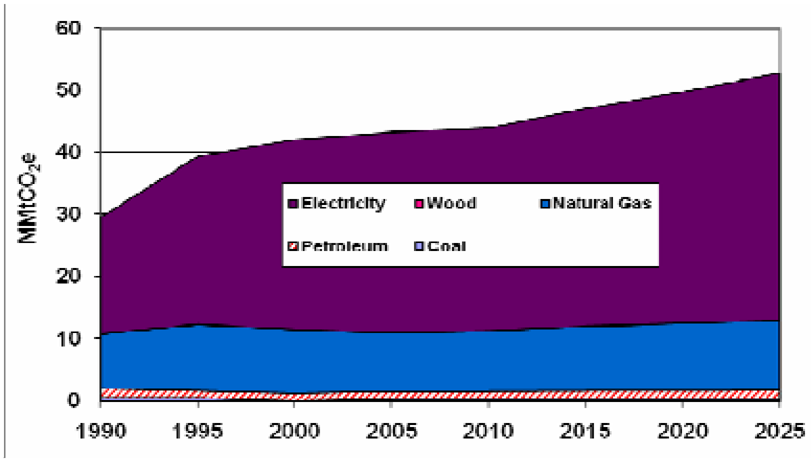
Figures 5-1 through 5-3 show the trend in GHG emissions from the RCI sectors through 2025. The figures also show the relative shares of GHG emissions, by fuel. Overall, emissions for the RCI sectors (excluding those associated with electricity consumption) are expected to increase by 4.1% between 2005 and 2025. For the 20-year period beginning in 2005 and ending in 2025, the fastest growth in GHG emissions is in the commercial sector, which is forecast to grow by 1.0% annually. GHG emissions in the residential and industrial sectors are expected to grow by 0.6% per year during this period.

Figure 5-1. Historical and projected residential greenhouse gas emissions in Michigan: 1990–2025*



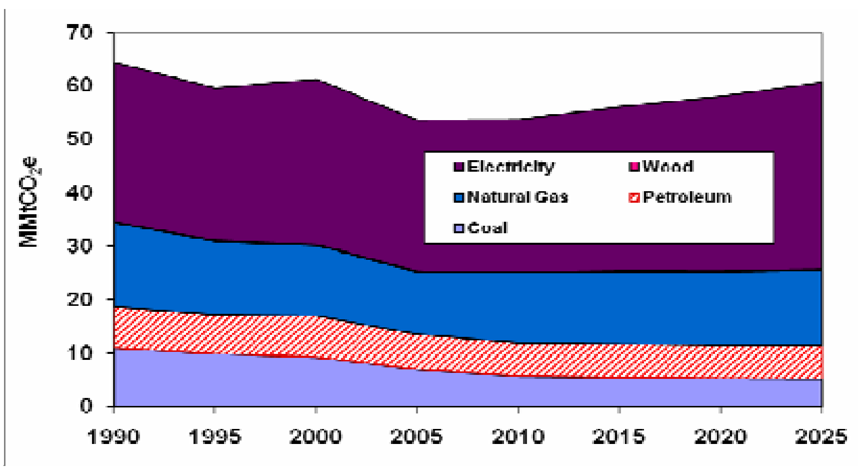
* Emissions associated with the direct use of natural gas, petroleum, coal, and wood and the consumption of electricity. Source: Consolidated Michigan Inventory and Forecast.

Figure 5-2. Historical and projected commercial sector greenhouse gas emissions in Michigan: 1990–2025*



* Emissions associated with the direct use of natural gas, petroleum, coal, and wood and the consumption of electricity. Source: Consolidated Michigan Inventory and Forecast.

Figure 5-3. Historical and projected industrial greenhouse gas emissions in Michigan: 1990–2025*



* Emissions associated with the direct use of natural gas, petroleum, coal, and wood and the consumption of electricity. Source: Consolidated Michigan Inventory and Forecast.

The projections for the period beginning in 2005 show almost no change in the overall shares of emissions that the different sectors produce. The residential sector produces 35% of total RCI GHG emissions in both 2005 and 2025; the commercial sector, produces 29% in 2005 and 30% in 2025; and the industrial sector, 36% in 2005 and 35% in 2025.

Much of the growth in GHG emissions over the period can be attributed to an average 0.94% annual growth in electricity demand over the 2005–2025 period for the RCI sectors. GHG emissions from electricity for each of the three sectors are projected to grow by 1.1% per year between 2005 and 2025.

Emissions associated with the generation of electricity to meet RCI demand account for about 55% of the emissions for the residential sector, 72% of the emissions for the commercial sector, and 52% of the emissions for the industrial sector, on average, over the 1990–2025 period. From 1990 to 2025, natural gas consumption is the next-highest source of emissions for the residential and commercial sectors, accounting, on average, for about 38% and 24% of total emissions, respectively. For the industrial sector, emissions associated with the combustion of coal, natural gas, and petroleum account for about 13%, 23%, and 12%, respectively, on average, from 1990 to 2025.

Key Challenges and Opportunities

The principal means to reduce RCI emissions include improving energy efficiency, substituting electricity and natural gas with lower-emission energy resources (such as biomass and wind), and various strategies to decrease the emissions associated with electricity production (see Chapter 3, Energy Supply Sectors). The state's limited pursuit of energy efficiency until recent years offers abundant opportunities to reduce emissions through programs and initiatives to improve the efficiency of buildings, appliances, and industrial practices. The advantages of having "low-hanging fruit" in the form of low-cost energy efficiency opportunities in the RCI sectors are countered by an underdeveloped private sector that will likely be responsible for scoping, implementing, and evaluating energy efficiency projects. These "green collar" jobs require special training and equipment that will take time for firms within the state to acquire.

Michigan has recently embarked on statewide energy efficiency programs in response to concerns about energy costs and carbon emissions. Public Act (P.A.) 295, enacted in 2008, adopted a requirement that electric providers achieve annual incremental energy savings in 2012, 2013, 2014, and 2015, and each year thereafter, equivalent to 1% of total annual retail electricity sales in megawatt hours in the preceeding year. Additionally, natural gas providers must achieve annual incremental energy savings in 2012, 2013, 2014, and 2015, and each year thereafter, equivalent to 0.75% of total annual retail natural gas sales in decatherms or equivalent thousands of cubic feet (MCF) in the preceeding year. It should be noted that incremental energy savings begin ramping up in 2008 and continue through and beyond 2015 as stipulated in P.A. 295. Further, in order to ensure this outcome, each provider must file an annual report of its progress in meeting the energy optimization portfolio with the Michigan Public Service Commission. The Commission is now developing rules and guidance to implement these programs.

The Michigan Climate Action Council (MCAC) has identified significant opportunities for reducing GHG emissions growth attributable to the RCI sectors in the state. These include expanding or launching utility demand-side management programs for electricity and natural gas and removing disincentives to efficiency investments by utilities; adopting incentives, assistance, and updated building codes to increase energy efficiency in buildings; adopting incentives and net metering for renewable energy systems implementation; enhancing consumer education and professional training and certification programs; and devoting greater attention to the energy requirements associated with water use and management in the state. The MCAC has also identified significant opportunities to reduce GHG emissions through policies addressing electricity production; these are detailed in Chapter 3.

Overview of Policy Recommendations and Estimated Impacts

The MCAC unanimously recommends a set of 10 policies for the RCI sectors, several of them in close concert with parallel policies in the energy supply (ES) sector. These policies offer significant, cost-effective GHG emissions reductions within the state. These recommendations and results are summarized in Table 4.1. The GHG emission reductions and costs per ton of GHG reductions for five of these policies were quantified. The quantified policy recommendations could lead to emission savings from reference case projections of:

- 64.9 MMtCO_2e per year by 2025, and a cumulative savings of 523.9 MMtCO_2e from 2009 to 2025, and
- Net cost savings of over $13 billion through 2025 on a net present value basis.[1] The weighted-average costs of these policies are a net savings of nearly $25/t$CO_2$e.

Because most energy use occurs in buildings, the recommended policies center on improving energy efficiency in buildings. There is overlap among the policies as to the types of activities and equipment they cover, but the text following Table 5-1 provides general guidance on how the policies complement each other. In brief, however, the policies focus on the following:

- RCI-1 provides for utility-operated incentives for energy efficiency that will reduce energy use.
- RCI-2 and RCI-7 lay out a set of policies to reduce overall, statewide energy use in buildings.
- RCI-3 focuses on setting regulatory policies that will establish rate structures to incentivize utilities to invest in energy efficiency, or remove disincentives that are inherent in existing utility rate structures for utilities to invest in energy efficiency.
- RCI-4 focuses on making building energy codes more stringent.
- RCI-5 and RCI-9 increase the human capital component of energy efficiency by providing education and training for energy users and energy professionals across the state.
- RCI 6 and RCI-8 focus on encouraging small-scale renewable energy capacity and generation in the state.
- RCI-10 focuses on reducing energy use among water utilities in the state.

Table 5-1. Summary list of policy recommendations

Policy No.	Policy Recommendation	GHG Reductions (MMtCO_2e)			Net Present Value 2009–2025 (Million $)	Cost-Effective-ness ($/t$CO_2$e)	Level of Support
		2015	2025	Total 2009–2025			
RCI-1	Utility Demand-Side Management for Electricity and Natural Gas	0.0	13.6	86.3	–$1,632	–$19	Unanimous
RCI-2	Existing Buildings Energy Efficiency	17.6	53.8	428.6	–$12,107	–$28	Unanimous

[1] The net cost savings, shown in constant 2005 dollars, are based on fuel expenditures; operations, maintenance, and administrative costs; and amortized, incremental equipment costs. All net present value analyses here use a 5% real discount rate.

Policy No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value 2009–2025 (Million $)	Cost-Effective-ness ($/tCO_2e$)	Level of Support
		2015	2025	Total 2009–2025			
	Incentives, Assistance, Certification, and Financing						
RCI-3	Regulatory (PSC) Changes To Remove Disincentives and Encourage Energy Efficiency Investments by Investor Owned Utilities (IOUs)	*Not Quantifiable*					Unanimous
RCI-4	Adopt More Stringent Building Codes for Energy Efficiency	3.6	9.8	82	–$2,865	–$35	Unanimous
RCI-5	Michigan Climate Challenge and Related Consumer Education Programs	*Not Quantifiable*					Unanimous
RCI-6	Incentives To Promote Renewable Energy Systems Implementation	0.7	1.5	14.0	$1,958	$140	Unanimous
RCI-7	Promotion and Incentives for Improved Design and Construction in the Private Sector	15.6	47.6	380	–$11,693	–$31	Unanimous
RCI-8	Net Metering for Distributed Generation	*Fully incorporated into RCI-6*					Unanimous
RCI-9	Training and Education for Building Design, Construction, and Operation	*Not Quantifiable*					Unanimous
RCI-10	Water Use and Management	*Not Quantifiable*					Unanimous
	Sector Total After Adjusting for Overlaps*	**21.8**	**64.9**	**523.9**	**–13,014**	**–24.8**	
	Reductions From Recent Actions	**Figures adjusted include recent actions**					
	Sector Total Plus Recent Actions	**21.8**	**64.9**	**523.9**	**–13,014**	**–24.8**	

PSC = Public Service Commission; IOUs = Investor Owned Utilities; GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/$tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

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

The numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these important policy recommendations.

There is overlap in the expected emission reductions and costs among some of the policies within the RCI sectors, as well as between policies in the RCI and ES sectors. The goals laid out in RCI-2 for a 50% decrease in residential and commercial energy use and a 20% decrease in overall industrial energy use are more ambitious than similar, but smaller, goals laid out in RCI-1 and RCI-7. As a result, there is overlap among these three goals, and the most ambitious goals that are laid out in RCI-2 overlap completely with those in RCI-1 and RCI-7. The final accounting for emission reductions avoids double counting by subtracting emission reductions from RCI-1 and RCI-7 from the total. RCI-1 also overlaps with ES-3, but to avoid double counting, the emission reductions produced by ES-3 are subtracted from the total.

RCI-4, focusing on new building energy codes rather than financial incentives, does not overlap with other policies.

RCI-6, focusing on the effect of a renewable energy generation requirement from small-scale renewable energy resources, does not overlap with other policies.

There are two primary interactions between the RCI and ES sector policies, both concerning the clean energy portfolio components in policy recommendation ES-1 (Renewable Portfolio

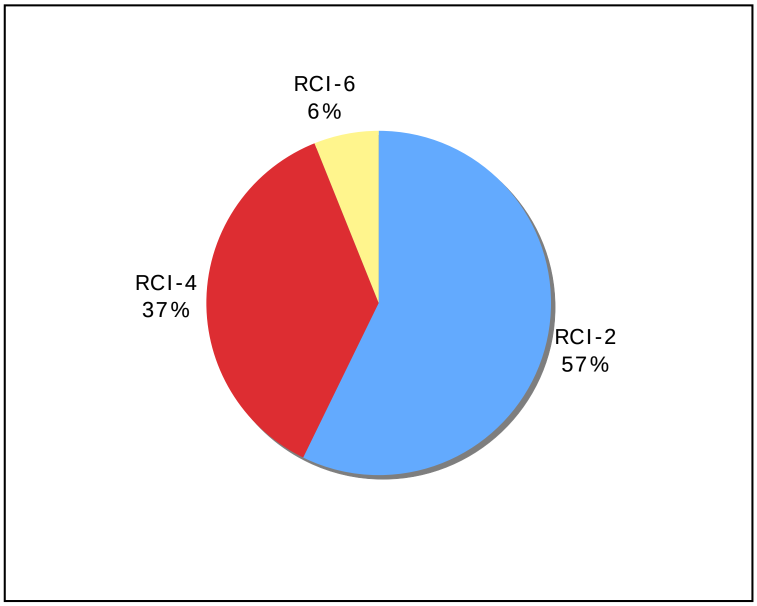
Standard). Most of the RCI policies (especially RCI-2) decrease overall electricity demand. As the renewable energy portfolio requirements are based on meeting a percentage of load with specific renewable energy, co-firing, or nuclear resources, the costs of ES-1 would be reduced by decreasing energy demand through these RCI policies. Also, an additional “feedback loop” effect is that certain ES policies (including ES-1) will have the effect of reducing GHG emissions associated with energy production, so that RCI policies that target electricity use will have a correspondingly lower impact on overall emissions. However, this impact has not been reflected in the analysis.

The policy recommendations for the RCI sectors are affected by both state and federal policies that incentivize or mandate more efficient use of energy. The federal Energy Independence and Security Act of 2007 was signed into law in December 2007. This law contains several requirements that will reduce GHG emissions as it is implemented over the next few years. These reductions were factored into the MCAC’s quantification of GHG emission reductions and costs or savings.

The GHG reductions for these savings are projected to be 73.7 $MMtCO_2e$, for 2025 using the RCI Technical Work Group's (TWG's) CO_2 methodology. In addition, through P.A. 295 of 2008, Michigan enacted energy efficiency programs that will reduce GHG emissions by 3.3 $MMtCO_2e$ in 2015 using the RCI TWG CO_2 methodology and 24.6 $MMtCO_2e$ in 2025. The GHG emission reductions reported here are *net of and additional to* these existing actions. Appendix I details the assumptions and approach used to estimate reductions from these existing actions in Michigan.

Figure 5-4 shows the cumulative emission reductions from the five policy recommendations that have been quantified for the entire planning period for 2009–2025, after accounting for overlaps among these policies. There is a great deal of variation in the emission reductions from the policy recommendations. RCI-2, with its ambitious targets for energy efficiency, will have by far the greatest effect. RCI-4 will be important, but because it applies only to new construction, will be limited in its overall effect. RCI-6 is focused most heavily on new, but small-scale, generation.

Figure 5-4. Aggregate cumulative GHG emission reductions: 2009–2025*



* These are the reductions from the policy recommendations, net of overlaps between recommendations. Note, options not shown in this chart were either unquantifiable or were not counted because of overlap. Also, results have been adjusted to remove overlaps between policies; for example, RCI-7 reductions overlap with both RCI-2 and RCI-4 assuming all three policies are implemented. The chart, therefore, includes RCI-2 and RCI-4 but not RCI-7 to avoid overstating the combined benefits of the recommendations.

The policy recommendations described briefly below, and in more detail in Appendix I, not only result in significant emission reductions and overall cost savings, but offer a host of additional benefits as well. These benefits include savings to consumers and businesses on energy bills, which can have macroeconomic benefits; reduction in spending on energy by low-income households; reduced peak demand, electricity system capital and operating costs, risk of power shortages, energy price increases, and price volatility; improved public health as a result of reduced pollutant and particulate emissions by power plants; reduced dependence on imported fuel sources and correspondingly greater energy security; and green collar employment expansion and economic development.

It is also important to note that while the GHG reductions and costs or savings of these policy recommendations have been developed according to best estimates, there remains some uncertainty (e.g., due to timing, technology development, and/or more refined analysis) regarding the actual GHG reductions and costs or savings that will be revealed in their ultimate implementation. This uncertainty should be considered in the course of the state's policy prioritization and implementation decisions.

For the RCI policies recommended by the MCAC to yield the levels of savings described here, they must be implemented in a timely, aggressive, and thorough manner. This means, for example, not only putting the policies themselves in place, but also attending to the development of supporting policies that are needed to help make the recommended policies effective. While the adoption of the recommended policies can result in considerable benefits to Michigan's environment and citizens, careful, comprehensive, and detailed planning and implementation, as well as consistent support, of these policies will be required if these benefits are to be achieved.

Residential, Commercial, and Industrial Sectors Policy Descriptions

RCI-1. Utility Demand-Side Management for Electricity and Natural Gas

By unanimous consent, the MCAC recommends increasing investment in electricity and natural gas demand-side management (DSM) programs through programs run by investor owned, municipal, and co-operative utilities, as well as energy service companies, large customers, or others. Decreasing consumption will have immediate impacts on GHG emissions. DSM activities may be designed to work in tandem with other recommended strategies that can also encourage efficiency gains.

This policy recommendation focuses on improving energy efficiency through such DSM efforts as energy efficiency, energy conservation, and peak demand reduction actions. Energy efficiency and conservation are the lowest-cost resources for reductions in electricity and natural gas use by the RCI sectors and thus for reduction of GHGs. There is a long track record of cost-effective energy efficiency initiatives at the local, state, and regional levels around the country and in Michigan. There is vast potential for improving the energy efficiency of homes, appliances, businesses, and industry in Michigan. A number of DSM efforts are already underway or mandated in Michigan, and important new energy efficiency legislation—P.A. 295 of 2008—was adopted as the MCAC was concluding its efforts.

This policy recommendation considers energy-saving goals for electricity and natural gas, and the policy, program, and funding mechanisms that might be used to achieve these goals. It is intended to work in tandem with other RCI and ES policies recommended by the MCAC; in particular, it echoes ES-3, the Energy Optimization Standard.

The goal of this policy is to bring the *total overall* demand reduction of existing actions, recent actions (including notably newly adopted P.A. 295), plus new, additional DSM activities in Michigan to save in each year 2% of the prior year’s electricity use and 0.75% of the prior year’s natural gas use by the residential, commercial, institutional, municipal, and industrial sectors, compared to a 3-year, weather-normalized, business-as-usual forecast that does not incorporate these goals. The policy would be implemented in three phases between 2009 and 2015, followed by a fourth, long-term phase. This goal derives in part from the efficiency goal identified in the Midwestern Governors Association’s November 15, 2007, Energy Security and Climate Stewardship Platform.

RCI-2. Existing Buildings Energy Efficiency Incentives, Assistance, Certification, and Financing

By unanimous consent, the MCAC recommends improving the energy efficiency of existing buildings in Michigan. Because Michigan has one of the weakest energy codes in the nation, and currently utilizes many of its World War II-era industrial buildings, energy efficiency improvements provide a significant opportunity to reduce Michigan's carbon footprint. This policy would reduce energy use in existing buildings by encouraging energy efficiency upgrades and operating improvements in existing institutional, municipal, commercial, residential, and industrial buildings. Incentives, rebates, and property tax abatements are imperative to foster state-wide participation in implementing energy-efficient measures to reduce future energy generation and GHG emissions. This policy is intended to support and work in conjunction with other policies (e.g., RCI-1) to help create a sustainable and cost-effective energy efficiency program for Michigan.

The recommended goal is to reduce energy consumption per square foot of floor space in existing residential, commercial, institutional, and municipal buildings by 50% from 2002 levels by 2030, and to reduce energy consumption in the industrial sector, where building systems and process systems are often intertwined, by 20% by 2030.

RCI-3. Regulatory (PSC) Changes To Remove Disincentives and Encourage Energy Efficiency Investments by Investor-Owned Utilities (IOUs)

The MCAC unanimously recommends that regulatory changes be implemented to remove disincentives and encourage energy efficiency investments by investor-owned utilities (IOUs). Economic regulation of IOUs by the Michigan Public Service Commission (MPSC) limits their earnings potential by determining an authorized level of earnings and by establishing the allowed earnings as a percentage of the utility rate base (i.e., the value of assets, such as power plants and distribution networks used in the business). In designing the rates charged to customers to recover the utility's "revenue requirement" (expenses plus investment return on the rate base), regulators typically assign most of the revenue requirement to predicted unit sales of gas or electricity. This method creates financial incentives for the utility to increase—not decrease—its unit sales and to make investments in the traditional physical assets of the business.

Successful energy conservation and efficiency programs reduce unit sales and could thus reduce utility revenues. If program costs are expensed, there can be no incremental earnings on the program investment, no matter how successful it is. Thus, an energy efficiency program offers limited "upside" potential to utilities and poses a significant risk of harming profitability. Cooperative and municipal systems apply a different earnings model, but may risk diminished cash flow from reduced sales. Utilities' financial incentives are to maximize unit sales, not reduce them.

This financial disincentive can be offset by: (1) providing a possible incentive financial benefit for a successful efficiency program; (2) changing the rate method so that expenses and earnings are recovered by a fixed-rate charge based on the number of customers, rather than units sold; (3) allowing sales figures to be updated between rate cases; and (4) applying a system benefits charge to all distribution service customers to pay for the efficiency program. Items (2) and (3) are examples of “decoupling” revenue requirements from a projected unit sales level. Decoupling utility unit sales from profits in rate setting and/or providing the opportunity to earn profits from successful program outcomes can realign incentives to encourage effective utility investment in DSM, energy efficiency, and conservation and reduce the incentive to maximize unit sales. Item (4) ensures that all customers receiving deliveries from the local distribution utility contribute to the program costs, since the benefits are societal.

This policy is not quantifiable at this time. Its goal is to have the MPSC undertake and complete as soon as possible, but no later than December 2010, a comprehensive study identifying disincentives to energy efficiency investments by utilities and ways to remove them, as well as opportunities to encourage additional energy efficiency investment by utilities. This should be conducted in close coordination with the MCAC’s ES policy recommendations, and in keeping with the provisions of P.A. 295.

RCI-4. Adopt More Stringent Building Codes for Energy Efficiency

The MCAC unanimously recommends that a higher energy standard should be required for newly constructed buildings in the state in order to reduce energy costs—the largest operations and maintenance expense. Newly constructed buildings today become the energy-consuming building stock of tomorrow. Strong building energy codes can be an effective way to eliminate the use of “least-efficient” energy practices in new or renovated buildings.

The 2030 Challenge is a global initiative that targets all new buildings and major renovations to reduce their fossil-fuel consumption by 50% by 2010 and incrementally increase this standard for new buildings to “carbon neutrality” in 2030. The 2030 Challenge has been adopted by the U.S. Conference of Mayors; National Association of Counties; American Institute of Architects; U.S. Green Building Council; International Council for Local Environmental Initiatives; Congress for the New Urbanism; states of Illinois, Minnesota, California, and New Mexico; and numerous counties and cities. Also, the 2030 Challenge is supported by the American Society of Heating, Refrigerating & Air-Conditioning Engineers. New building standards that meet the 2030 Challenge are currently being developed. To meet or exceed the 2030 Challenge for a 50% GHG reduction by 2010 would require Michigan to achieve a 30% improvement beyond the requirements of the 2006 International Energy Conservation Code (IECC).

The goal of this policy is to strengthen Michigan’s energy building codes for residential, commercial, institutional, municipal, and covered industrial construction to match those of the 2030 Challenge. To meet the initial 2030 Challenge goal of 50% GHG reduction by 2010, Michigan should adopt an energy code that requires 30% energy performance improvement beyond the requirements of the 2006 IECC. In addition, thermal envelope inspections should be mandatory for all new building construction to ensure that they are built as designed and energy efficiency performance objectives are met in the completed structures. Michigan’s current codes and standards can be used as baseline references; the baseline year for energy-saving comparisons should be 2008. Michigan should also adhere to periodic upgrades of the national standards for new residential, commercial, institutional, municipal, and industrial buildings, and review and upgrade existing state and local building codes accordingly.

RCI-5. Michigan Climate Challenge and Related Consumer Education Programs

The MCAC unanimously recommends that the state lead by example regarding education and outreach by fully implementing the Michigan Climate Challenge (MCC) as one of its key efforts in this area. Doing so would encourage Michigan businesses, institutions, local and regional governments, and the general public to make a voluntary public commitment to undertake actions to reduce GHG emissions in their communities.

The Michigan Department of Environmental Quality, working in conjunction and consultation with other state agencies, will develop and launch the MCC and include a Web-based "Online Pledge" to encourage voluntary GHG reductions throughout Michigan. The MCC will provide Web-based resources and information in the form of a "Climate Action Toolkit" for individuals and organizations to consider implementing. The toolkit will contain specific recommendations for reducing GHG emissions and identify measures that can minimize the impacts of climate change, so as to be better prepared to adapt to its effects.

Each local government official, small business owner, and citizen plays an integral part in this effort. Together, these individual actions will reduce the risks to the environment now and in the future. The MCC will provide the opportunity and resources for communities, organizations, businesses, and individuals to recognize climate change risks and commit to specific actions to reverse those changes, enabling Michigan to move forward in addressing climate change.

RCI-6. Incentives To Promote Renewable Energy Systems Implementation

By a unanimous vote, the MCAC recommends that Michigan set as a minimum target the addition of small-scale, customer-sited, renewable distributed generation (DG) consistent with its overall annual goals for renewable generation. Customer-sited DG powered by renewable energy sources provides electricity system benefits, such as avoided capital investment and avoided transmission and distribution losses, while also displacing fossil-fuel generation and thus reducing GHG emissions. Increasing the use of renewable DG in Michigan can be achieved through a combination of regulatory changes and incentives.

DG technologies exist across the spectrum of RCI facilities. Customer-sited renewable DG can include solar photovoltaic systems, wind power systems, biogas and landfill gas-fired systems, geothermal generation systems, and systems fueled by biomass wastes or biomass collected or grown as fuel. Policies to encourage and accelerate the implementation of customer-sited renewable DG can include direct incentives or requirements for power purchases, market incentives related to the pricing of electricity output by renewable DG, state goals or directives, and favorable rules for interconnecting renewable generation systems with the electricity grid. Incentives for non-electric renewable energy applications should also be included.

Supporting measures for this policy include training and certification of installers and contractors, net metering and other pricing arrangements, interconnection standards, and the creation or support of markets for biomass fuels. Through an educational campaign (see policy recommendations RCI-5 and Cross-Cutting Issues [CCI]-5), individuals and businesses can also gain a better understanding of renewable energy options and of the requirements of the program ultimately adopted in Michigan.

The goal of this recommendation is to increase total annual electrical generation from small-scale, customer-sited distributed renewable sources in Michigan by 2% by 2025. This recommendation is designed to be accomplished in parallel with and as an addition to the 25% Renewable Portfolio Standard goal set out in policy recommendation ES-1. Total energy supply as a result of these two policies would be 27% from renewable sources.

RCI-7. Promotion and Incentives for Improved Design and Construction in the Private Sector

Revolving loan funds are proven and effective tools for promoting energy efficiency in state and local government facilities. The MCAC unanimously recommends that this tool should be utilized in the private sector as well. This recommendation would facilitate investment in energy efficiency improvements by providing zero-interest loans to local governments, which, in turn, would extend the program to private entities. Energy cost savings for private-sector participants would provide cash flow for repaying the principal, with the cost of the program for the local governments limited to interest payments and loan administration.

Incentives, such as permitting and fee advantages, tax credits, and financing incentives (e.g., “green mortgages” or property tax abatements for buildings certified to Leadership in Energy and Environmental Design standards) should be used to encourage retrofit of existing residential, commercial, institutional, municipal, and industrial buildings or the development of non-traditional, off-grid, low- carbon, and carbon-neutral energy sources. The state can work with financial institutions to develop loan tools for these programs. Eligibility for the loans would be based on the energy standards chosen. Michigan jurisdictions that have adopted enforceable standards will be eligible for managing the loans. The IECC, or alternative standard, must be enforced. This policy assumes a gradually increasing energy efficiency code for new construction, backed up by strong, consistent enforcement measures.

Encouraged by the incentives offered, the goal of this recommendation is to have all residential, commercial, institutional, municipal, and industrial buildings achieve 15% better energy efficiency than that required by the 2006 IECC by 2015 and 30% better efficiency than that required by the 2006 IECC by 2025.

RCI-8. Net Metering for Distributed Generation

By a unanimous vote, the MCAC recommends implementing aggressive net metering policies to encourage increased electric generation capacity from DG sources. Net metering enables individuals or businesses to obtain financial benefits from small electricity generators installed at their home or business location. It allows consumers to deliver any excess generation from their small generators to the utility through the standard energy meter, which runs both forward and backward during the billing period. The utility charges customer generators only for the net amount of energy they take from the utility during the period, recognizing at retail rates all the electricity the customer generators produce. There are several variations on this basic form of net metering that may be considered.

A voluntary, statewide net metering program was adopted by the MPSC in March 2005 (Case No. U-14346), but was limited to renewable energy facilities under 30-kilowatt (kW) capacity and was capped at 100 kW or 0.1% of a utility's peak load. Qualifying facilities could be sized no larger than necessary to meet the customer's needs. Several billing configurations are permitted at the option of the utility, starting with the basic net metering form, with credits for excess generation being for allowed up to one year. Any excess credits after one year go to the utility to offset program costs. All regulated investor-owned and cooperative electric utilities are participating. The federal Energy Policy Act of 2005 requires the state to consider adopting a new standard, whereby all public utilities would have to offer net metering service to their customers. The MPSC is considering whether to adopt this standard and is also considering other possible changes to the voluntary program described above.

The Michigan legislature is considering requiring a statewide program with larger size limits on the facilities and the total program cap, a mandate to use the basic net metering form, and related measures on interconnection of facilities. The goal of this recommendation is to have 392 megawatts (MW) of electric generation capacity from DG sources installed by 2015, increasing to 1,344 MW by 2025.

RCI-9. Training and Education for Building Design, Construction and Operation

The MCAC unanimously recommends that Michigan provide up-to-date building performance, code compliance, and mechanical equipment training, and develop a certification program for code officials, builders, and contractors and facility operators who successfully complete energy efficiency and related green building training programs. Such training programs should be offered to building code officials, homebuilders, commercial construction contractors, heating/ventilation/air conditioning contractors, electricians, plumbers, carpenters, remodelers, other construction trade professionals, and facility operators. Training programs should focus on: (1) proper construction and maintenance practices with building envelope and mechanical performance standards, as established in revised Michigan building energy codes (see recommendations RCI-4 and RCI-7); and (2) proper construction and maintenance practices with building envelope and mechanical performance standards, as identified in "beyond code" building programs.

Proactive education programs for building trade professionals are a necessary component for successfully improving energy-efficient construction practices. Improved construction standards resulting in energy-efficient buildings can only be accomplished if building code officials and building trade contractors, subcontractors, and facility operators are properly educated in building envelope and mechanical performance building and maintenance techniques. Properly trained building code officials, building trade professionals, and facility operators will help ensure consistent quality control and enforcement of Michigan's enhanced building codes and market-based building performance practices. Training programs are also needed to respond to periodic upgrades of national standards, as well as to changes in state and local building codes. Training should cover new RCI buildings, plus retrofits that are subject to building energy codes. The goal of this recommendation is to begin initial training under such a program in 2009.

RCI-10. Water Use and Management

By unanimous vote, the MCAC recommends that water utilities be required to track and report their energy use, and that a comprehensive study be conducted to identify and adopt potential energy efficiency improvements by water utilities. A considerable amount of energy is used to pump, treat, and deliver water across the state. However, too little is currently known about water utilities' energy use and how greater efficiency could be achieved. This recommendation aims to fill those knowledge voids and reduce energy consumption by: (1) reducing overall water use, and (2) improving the efficiency and management of the water supply and management facilities (wastewater treatment, potable water, irrigation, etc.) in the state.

The state's primary users of water are currently agricultural consumers, municipal consumers, and industrial users. Energy is necessary to pump this water from underground aquifers and open-water sources to users, and to treat it in wastewater facilities after it is used. Improved water use and handling efficiencies will reduce the amount of electricity used for water distribution, and thus reduce energy costs for users and associated GHG emissions from power plants.

Five specific recommendations are detailed in Appendix I: (1) accelerate investment in water use efficiency; (2) increase the energy efficiency of all water and wastewater treatment operations; (3) increase energy production by water and wastewater agencies from renewable sources, such as in-conduit hydropower and biogas; (4) encourage and create incentives for technologies with the capability to reduce water use associated with power generation; and (5) ensure that power plants use the best management practices and economically feasible technology available to conserve water (via siting, evaluation, permitting, or other processes).

The goal of this recommendation is to improve the average energy efficiency of water utilities in the state (in terms of kilowatt-hours used per gallon pumped) by 20% between 2010 and 2013, and to achieve a 10% overall water savings by 2025.

Chapter 6
Transportation and Land Use Sectors

Overview of Greenhouse Gas Emissions

The transportation sector, which includes light- and heavy-duty (on-road) vehicles, aircraft, rail engines, and marine engines, is one of the largest contributors of gross greenhouse gas (GHG) emissions in Michigan. This sector accounted for 24% of Michigan's gross GHG emissions in 2005, which was slightly under the national average of 27%. By 2025, the share of emissions associated with the transportation sector is anticipated to decrease slightly to 22%, primarily due to low growth in the number of vehicle miles traveled (VMT) and the more stringent fuel economy standards of the Energy Independence and Security Act.

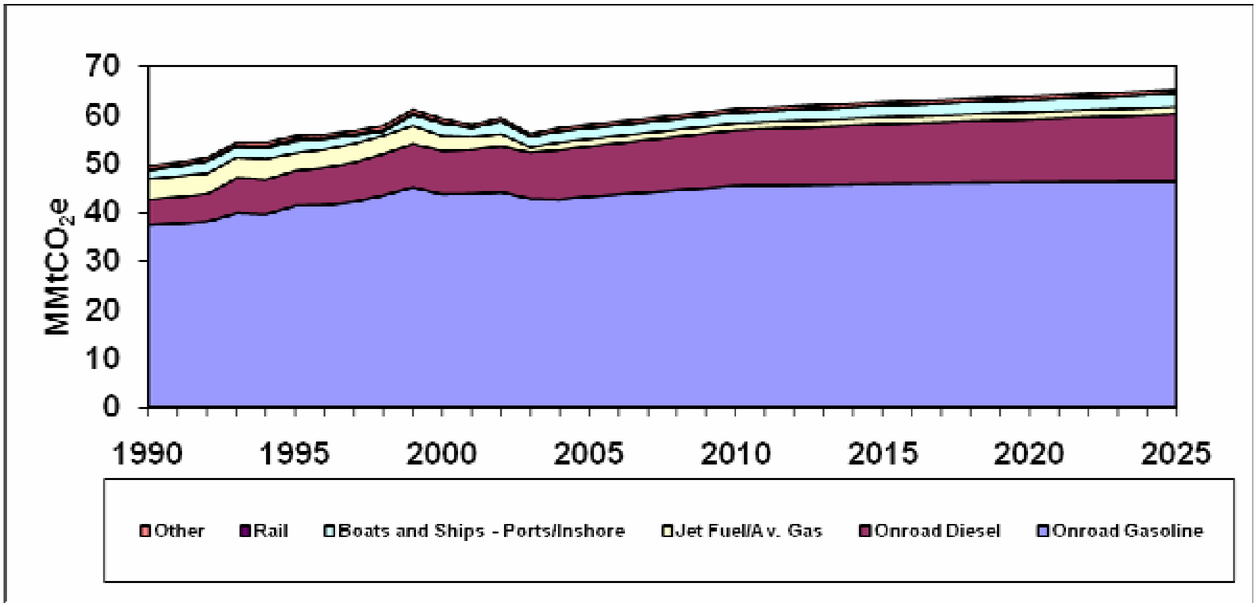
From 1990 to 2005, Michigan's GHG emissions from transportation fuel use have risen steadily at an average rate of about 1.1% annually. The GHG emissions associated with Michigan's transportation sector also rose accordingly, increasing by 8 million metric tons of carbon dioxide equivalent ($MMtCO_2e$) emissions during the same time period from about 50 $MMtCO_2e$ to 58 $MMtCO_2e$.

Carbon dioxide (CO_2) accounts for about 98% of transportation GHG emissions, with most of the remaining transport-related GHG emissions coming from nitrous oxide (N_2O) emissions from gasoline engines. Emissions released from on-road gasoline consumption account for approximately 74% of the transportation sector's GHG emissions. This has historically been the largest share of transportation GHG emissions, and this trend is forecast to continue.

Figure 6-1 shows historic and projected transportation GHG emissions by fuel and source. As a result of an increase in total vehicle miles traveled (VMT), on-road gasoline consumption increased by about 16% between 1990 and 2005. Meanwhile, on-road diesel fuel consumption rose by 96% during that period, accounting for 18% of GHG emissions from the transportation sector in 2005, suggesting an even more rapid growth in freight movement within or across the state.

Growth in VMT is expected to be very low in Michigan, primarily due to limited economic and population growth in the future. GHG emissions from on-road gasoline consumption are projected to increase by about 7%, and GHG emissions from on-road diesel consumption are expected to increase by 34% between 2005 and 2025. The consumption of these fuels will significantly contribute to the projected 12% increase in transportation emission levels for the entire state of Michigan over 2005 levels by 2025.

Figure 6-1. Transportation GHG emissions by fuel source, 1990–2025



$MMtCO_2e$ - million metric tons of carbon dioxide equivalent; av. gas = aviation gas.

Key Challenges and Opportunities

Michigan has substantial opportunities to reduce transportation emissions. The principal means to reduce emissions from transportation and land use (TLU) are:

- Improving vehicle operations efficiency,
- Replacing conventional gasoline and diesel with lower-emission fuels, and
- Reducing the growth of VMT.

The use of fuels with lower per-mile GHG emissions is growing in Michigan, and larger market penetration is possible. Conventional gasoline- and diesel-fired vehicles can use low-level blends of biofuels. Alternative-technology vehicles can also use higher-level blends of biofuels, as well as other types of alternative fuels, such as natural gas and hydrogen. The type of fuel used is a crucial determinant of impact on emissions, as some alternative fuels have relatively little GHG benefit. Currently, the most prevalent biofuel in Michigan is corn-based ethanol, which has minimal GHG benefit from a life-cycle perspective.[1] Key determinants of impact will be the development and deployment of fuel types. At present, fuel distribution infrastructure is a constraining factor.

Reducing the growth of VMT is crucial to mitigating GHG emissions from transportation. Developing smarter land-use and transportation development patterns that reduce trip length and support transit, ride sharing, biking, and walking can contribute substantially to this goal.

[1] Biofuels analysis was based on information from the Argonne National Laboratory's GREET model, version 1.8, which indicates a life-cycle emission reduction of 15.9% for E85 corn ethanol. See Appendix I for more details on assumed reduction factors for various types of biofuels.

Developing better planning methods and regulations, and increasing funding of multiple modes of transportation will be key components in achieving these goals.

Overview of Policy Recommendations and Estimated Impacts

The Michigan Climate Action Council (MCAC) recommends a set of 10 policies for the TLU sector that offer the potential for major economic benefits and emission savings. Implementing these policy recommendations could lead to emission reductions of:

- 10.5 MMtCO_2e per year by 2025, and
- 95.1 MMtCO_2e cumulative from 2009 through 2025.

The weighted-average cost effectiveness of the recommended policies is about –\$36/tCO_2e, representing a cost savings. This average value includes policies that have both much lower and much higher likely costs per ton.

The estimated impacts of the individual policies are shown in Table 6-1. The MCAC policy recommendations are described briefly here and in more detail in Appendix I of this report. The recommendations not only result in significant emission reductions, but offer a host of additional benefits as well. These benefits include reduced local air pollution; more livable, healthier communities; and economic development and job growth from in-state biofuel production. To yield the levels of savings described here, the recommended policies need to be implemented in a timely, aggressive, and thorough manner.

There are three complementary TLU policy options that serve to reduce single occupancy vehicle travel. Congestion mitigation (TLU-5) is designed to improve traffic flow and travel time via expanding the use of intelligent transportation systems. Land use planning and incentives (TLU-6) strategies include promoting and expanding regional growth management options that result in more compact, mixed-use, transit-oriented, walkable development as well as transportation system management and pricing that allows for greater investment in alternatives to the single occupancy vehicle, such as public transit. The transit and travel options of TLU-7 complement TLU-5 and TLU-6 by providing the increased public transit capacity and service improvements needed to achieve the aggressive statewide goals for increasing transit ridership as well as carpool and vanpool participation.

Two policy options recognize that Michigan can reduce GHG emissions in the transportation sector by encouraging more energy-efficient freight movement – (TLU-8) Increase Rail Capacity and Address Rail Freight System Bottlenecks, and (TLU-9) Great Lakes Shipping. These options seek to improve rail and marine infrastructure to take advantage of opportunities to move freight via the most efficient means of transport possible in the Midwest.

TLU-1 focuses on further developing biofuels and expanding the biofuels market can significantly reduce GHG emissions, while boosting the state’s economy.

Table 6-1. Summary list of MCAC Transportation and Land Use (TLU) policy recommendations

Policy No.	Policy Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2009–2025 (Million $)	Cost-Effective-ness ($/t$CO_2$e)	Level of Support
		2015	2025	Total 2009–2025			
TLU-1	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	**4.76**	**10.5**	**95.1**	**–$3,425**	**-$36**	**N/A**
	Sector Total After Adjusting for Overlaps	**4.76**	**10.5**	**95.1**	**–$3,425**	**-–36**	**N/A**
	Reductions From Recent Actions	**0**	**0**	**0**	**$0**	**$0**	**N/A**
	Sector Total Plus Recent Actions	**4.76**	**10.5**	**95.1**	**–$3,425**	**–$36**	**N/A**

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/t$CO_2$e = dollars per metric ton of carbon dioxide equivalent; NQ = not quantified.

Note: Negative numbers indicate cost savings.

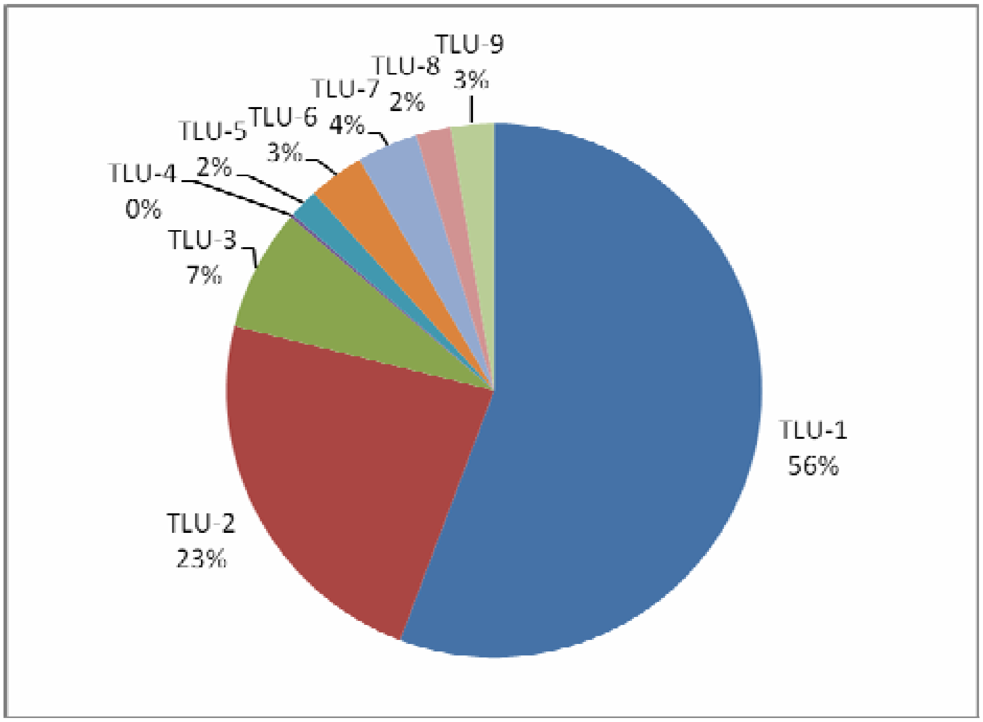
Michigan can achieve greater alternative fuel use through a combination of research and development, as well as through implementing voluntary and mandatory measures. Promoting Low-Carbon Fuel Use in Transportation (TLU-1) can help make biofuels more efficient and more available, while at the same time providing an economic benefit to the Michigan economy by promoting in-state development and production of these fuels.

Public education, towards more efficient driving practices in TLU-2 (Eco-Driver Program), works in conjunction with a number of the other recommended policies. Educating citizens on how they can minimize their impact, operate their vehicle more efficiently, and cut their GHG emissions can be a key to the success of many of these policies. Reducing truck idling (TLU-3) can also serve to reduce the GHG impact of transportation without any change in VMT.

The advanced vehicle technology option (TLU-4) seeks to achieve per vehicle GHG emission benefits beyond those expected to be achieved via the new CAFÉ standards, by providing incentives for public fleet owners to purchase advanced technology vehicles. This policy could serve to strengthen Michigan as a leader of automotive research, which would have benefits across the state. In addition, progress on advanced vehicle technology can have benefits beyond Michigan for energy security, economic growth and environmental quality.

Figure 6-2 shows the breakdown of the projected impacts of the recommended TLU policies, taken together, in terms of avoided GHG emissions. For the TLU policies recommended by the MCAC to yield the levels of savings described here, the policies must be implemented in a timely, aggressive, and thorough manner. This means, for example, not only putting the policies themselves in place, but also attending to the development of supporting policies that are needed to help make the recommended policies effective. While adoption of the recommended policies can result in considerable benefits to Michigan's environment and consumers, careful, comprehensive, and detailed planning and implementation, as well as consistent support of these policies will be required if these benefits are to be achieved.

Figure 6-2. Aggregate GHG emission reductions from all MCAC Transportation and Land Use (TLU) recommendations, 2009–2025



Transportation and Land Use Sectors
Policy Descriptions

The policy recommendations summarized here not only result in significant emission reductions and cost savings but also offer a host of additional benefits, such as reduced local air pollution; more livable, healthier communities; and increased transportation choices.

TLU-1. Promote Low-Carbon Fuel Use in Transportation

This policy recommendation promotes low-carbon transportation fuels through a package of incentives, education, and standards, including recommendations by the Michigan Renewable Fuels Commission (RFC). The goal is to reduce the average "carbon intensity" of on-road transportation fuels sold within the state to achieve a 5% reduction of GHG emissions on a life cycle carbon dioxide basis by 2015 and 10% reduction by 2025. The policy follows the June 2007 report of the Michigan RFC that recommended a variety of actions to stimulate the production and use of renewable, low-carbon fuels within the state. These include: (1) a low-carbon fuels program to encourage federal policy in this area and consider establishing a state policy; (2) establish a next-generation renewable fuels feedstock program with a goal of achieving 10% use of renewable fuels by 2012 and 25% by 2025; and (3) create a green retailers program with tax incentives for E85 and biodiesel sales that rewards retail and wholesale outlets that attain benchmarks in the sale of biofuels.

TLU-2. Eco-Driver Program

Because driving behavior can significantly influence a vehicle's fuel economy performance, this policy would establish an eco-driving program. This program would incorporate a wide range of initiatives that can help drivers maximize the fuel efficiency from their existing vehicles by better understanding the direct impact that driving style, driving patterns, vehicle technologies, and vehicle maintenance (such as proper tire inflation) have on a vehicle's fuel economy. The primary focus of an eco-driving campaign would target light-duty vehicles, where driver education on eco-driving principles would have the greatest benefit. An integrated eco-driving program in Michigan would be designed to achieve a fuel-economy increase of at least 10% in the mid-term and up to 20% in the long-term.

A properly designed eco-driving program must move beyond a list of driver "tips" and focus on providing the appropriate tools and programs to systematically change driver behavior. Key eco-driving principles would cover: driving style, starting and idling, trip planning, vehicle drag/weight, proper maintenance and vehicle technology applications. The eco-driving program would include program initiatives on direct driver training, general eco-driving education, vehicle maintenance, and vehicle applications such as real-time fuel economy indicators. The program would also consider a low-rolling-resistance tire initiative, options to have currently licensed drivers to undergo additional driver training and options to incorporate direct eco-driver training in the process of commercial truck licensing.

TLU-3. Truck Idling Policies

This policy option aims to reduce GHG and other emissions from unnecessary idling of heavy-duty vehicles, including trucks and buses. Much of this idling takes place during mandatory rest periods to provide heating or cooling of the truck's cabin air. Additional idling occurs during vehicle operation, for example, when loading and unloading buses and trucks. The implementation of public and private fleet anti-idling policies and ordinances, targeted education of bus and truck operators, and creation of low-cost means to access available EPA-verified technologies will help encourage emissions reductions from heavy-duty diesel engines.

Heavy-duty engine idling can be reduced by (1) providing increased availability of electrification at privately owned truck stops or encouraging greater use of auxiliary power units (APUs; on-board generators) for heating, cooling, and other creature comforts on heavy-duty vehicles, (2) providing financial assistance (e.g., low-interest revolving loans) to truck-stop operators and truck owners/operators for infrastructure development or equipment purchase and (3) providing targeted educational activities as appropriate with truck, bus, and truck-stop owners and operators.

This policy has a goal of achieving diesel idling reductions from heavy-duty diesel engines of 40% by 2015 and 80% by 2025. It would also promote the adoption of a Michigan anti-idling law based on the EPA Model State Idling Law and/or encourage adoption of local ordinances to address idling during operation of buses and heavy trucks.

TLU-4. Advanced Vehicle Technology

This recommendation calls for the creation of a policy that will expand the development and use of more efficient vehicle design and/or hybrid propulsion systems. The goal is to make loans and subsidies available to municipalities, local governments, and waste management organizations to encourage more rapid adoption of advanced vehicles by public fleets (transit agencies and schools) to achieve the use of advanced vehicle technologies (hybrid or hydrogen technology) in 10% of the fleet by 2025.

This policy could serve to reestablish Detroit as a leader of automotive research, which would have benefits across the State. In addition, progress on advanced vehicle technology can have benefits for beyond the borders of Michigan in terms of energy security, economic growth, and environmental quality.

TLU-5. Congestion Mitigation

The goal of this policy recommendation is to improve traffic flow and travel time through expanding the use of intelligent transportation systems (ITS). In conjunction with expanding ITS, the following actions should also be considered: identifying and improving key bottlenecks, constructing modern roundabouts at appropriate intersections, and continuing the use of the MDOT courtesy patrol on congested roadways. A 4-day workweek and flex-time should be encouraged to reduce congestion. All of these elements contribute to reducing travel delay for both recurring and nonrecurring congestion.

Promoting the development of intermodal freight terminals will facilitate freight shipment on rail and air thus reducing the volume of freight on Michigan roadways. By supporting these efforts, the congestion mitigation policy option will allow for more efficient travel and increased economic output.

The goals for this policy are to reduce travel time delay from recurring and nonrecurring congestion in Michigan's major urban areas (Metro Detroit and Grand Rapids) by 10% by 2025 and to reduce travel time related to nonrecurring congestion (i.e., road construction) by continuing to implement and refine the Michigan Work Zone Safety and Mobility Policy.

TLU-6. Land Use Planning and Incentives

State policies and programs need to be implemented that encourage local and regional planning and development strategies in order to reduce the projected growth of VMT and corresponding GHG emissions. The state will enable each region to adopt a unique mixture of policies to reach reduction goals in its own manner. Strategies include promoting and expanding regional growth management options that result in more compact mixed-use, transit-oriented, walkable development; transportation system management and pricing that allows for greater investment in alternatives to the single-occupancy vehicle, such as public transit; and use of other land-use–related economic development tools as recommended in the Michigan Land Use Leadership Council's Report (2003).

The goals are (1) to reduce low density development and the conversion of greenfield open land to development 25% by 2015, 50% by 2025, and 80% by 2050; (2) to encourage communities to utilize an "infill" approach for both new and redevelopment projects by focusing on areas where infrastructure already exists; and (3) to work to ensure that at least 60% of new/future statewide growth utilizes more compact development or transit-oriented development design.

These goals can be accomplished through: (1) multi-jurisdictional land use planning and zoning policies, tax base sharing, and providing state and local incentives; (2) market-based approaches in future land development and housing policies that focus investments toward achieving higher density, transit-oriented, and compact or mixed-use development; (3) integrated transportation policies, investments, system management, and pricing; and (4) enactment of a new Statewide Comprehensive Planning Law.

TLU-7. Transit and Travel Options

This policy recommendation focuses on reducing the number of single-occupant vehicle trips and improving the efficiency of daily travel by: (1) creating, enhancing, and promoting public transit options such as commuter rail, light rail, streetcars, and bus rapid transit; (2) enhancing transit service through route expansion, increased service frequency, longer service hours, and/or better system coordination; and (3) facilitating increased carpooling, vanpooling, biking, and walking. These actions will reduce GHG emissions by decreasing VMT, thus reducing fuel consumption. The first goal is to double transit ridership by 2015 and double it again by 2025 (for longer line-haul systems). The second goal is to double the number of carpool and vanpool participants by 2015 and double again by 2025.

A number of actions are included to help achieve the goals, including amending the Michigan Constitution to provide a broader range of funding mechanisms for public transit, building additional park-and-ride lots, provide incentives for transit-oriented development, incorporate bike lanes into roadway construction/reconstruction, encourage/require sidewalks in new developments and encourage their addition in areas where they are now absent, implement metropolitan transit plans, pursue implementation of inter-city transit service where it is cost-effective and undertake a public education campaign to effectively communicate the benefits of public transit to people who are not current users.

TLU-8. Increase Rail Capacity and Address Rail Freight System Bottlenecks

This policy encourages more energy efficient freight movement via railroads, where it is practical to do so. Making or facilitating transportation infrastructure improvements that increase rail capacity, support connectivity, and reduce rail freight system bottlenecks will help accomplish this shift. For short hauls, truck freight is, and will likely continue to be, the mode of choice; intermodal rail freight tends to be most effective for trips of 700-800 miles or longer. This policy will reduce transportation sector GHG emissions from freight movement by making system improvements with the goal of increasing the tonnage of rail freight traveling to, through and from Michigan an additional 50% by 2020.

Freight tonnage for shipments to, through, and from Michigan is expected to increase on all freight modes, but by far the majority of this increase is anticipated to be truck freight. Increasing the projected tonnage of rail freight an additional 50% by 2020 potentially shifts million of tons of cargo that would otherwise travel by truck. It is important to recognize that shipping decisions are made by the private sector, and are not under the control of government. Investment to encourage greater use of rail lines and intermodal shipping must be made with that reality in mind. A variety of approaches are suggested to accomplish this, including construction of intermodal terminals, preserving existing service and preserving right-of-ways for future new service.

TLU-9. Great Lakes Shipping

This policy recommendation promotes the use of marine transportation as the most energy-efficient form of surface transportation to move cargo over long distances (150 miles or more). While Great Lakes shipping decisions and services are private sector responsibilities, the public sector has a role in providing navigation channels and related infrastructure. Actions include maintaining the existing marine infrastructure, maintaining federal navigation channels to their congressionally authorized depths, improving the marine infrastructure by deepening commercial navigation channels at selected commercial ports, encouraging the development or expansion of “short sea shipping” (also known as “marine highway”) within the Great Lakes, as well as considering the use of ferry boats to move people and cars and consider a biodiesel program at Michigan ports if it is feasible to burn this fuel in marine diesel engines. The focus of this policy is on increasing shipping within the Great Lakes – not on increasing traffic through the St. Lawrence Seaway.

Chapter 7
Agriculture, Forestry, and Waste Management Sectors

Overview of GHG Emissions

The agriculture, forestry, and waste management (AFW) sectors are responsible for moderately low amounts of Michigan's current greenhouse gas (GHG) emissions. The total AFW contribution to carbon dioxide equivalent (CO_2e) gross emissions in 2005 was 14 million metric tons (MMt), or about 6% of the state's total. It is important to note that the AFW sector emissions exclude combustion-related GHGs, such as diesel fuel consumption in the agriculture sector. These fuel combustion emissions are included as part of the industrial fuel combustion sector (and covered in the Residential, Commercial, and Industrial Sectors chapter). The AFW contribution to net emissions in 2005 was less than 1% of the state's total after accounting for the net sequestration of carbon in the forestry sector.

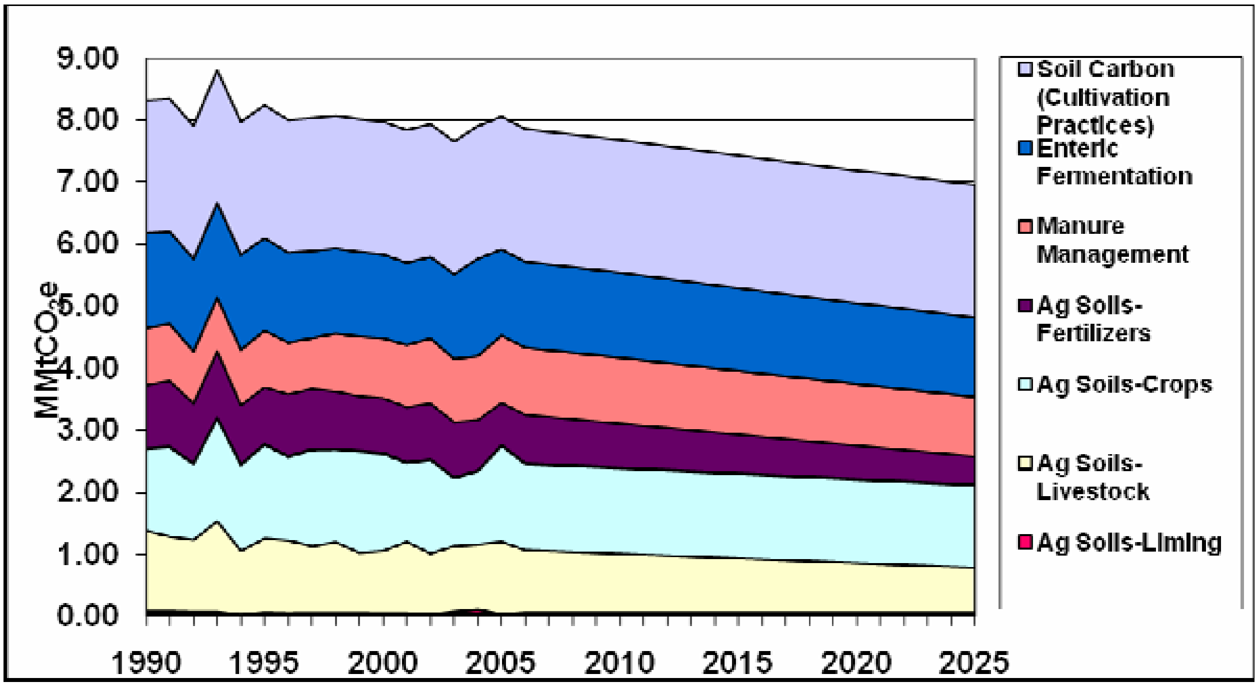
Agricultural emissions include methane (CH_4) and nitrous oxide (N_2O) emissions from enteric (intestinal) fermentation, manure management, agriculture soils, and agriculture residue burning. As shown in Figure 7-1, emissions from soil carbon losses from agricultural soils, livestock soils, manure management, enteric fermentation, and fertilizer application all make significant contributions to the sector totals. Emissions include CO_2 emissions from oxidized soil carbon, application of urea, and application of lime. Sector emissions also include (N_2O emissions resulting from activities that increase nitrogen in the soil, including fertilizer (synthetic and livestock manure) application, production of nitrogen-fixing crops (legumes), and agricultural burning activity.

Note that, in keeping with U.S. Environmental Protection Agency (EPA) methods and international reporting conventions, the Michigan inventory and forecast covers sources of GHGs from human activities. There could be some natural sources of GHGs that are not represented in the inventory and forecast; however these are not addressed in the Michigan Climate Action Council (MCAC) process. In the forestry sector, since all of the state's forests are managed in some way, all emissions are treated as "anthropogenic," or from human activities. GHG reporting conventions treat all managed forests as anthropogenic sources. Sources, such as CO_2 from forest fires and decomposing biomass, are captured within the inventory and forecast (as part of the carbon stock modeling performed by the U.S. Forest Service [USFS]). However, CH_4 emissions from decomposition of organic matter/biomass in forests are not currently captured due to a lack of data. This methane is from decomposition in oxygen-free (anaerobic) areas, particularly marshes and bogs.

The CO_2 emissions occurring from the cultivation of organic soils are a large contributor to the state's total agricultural GHG emissions. By 2025, the contribution from this source is estimated to be about 30% of the total agriculture emissions. The next-highest contributor in 2025 is estimated to be agricultural soils from crop production, at about 19% (including N_2O from decomposition of crop residue). Methane emissions from digestive processes in ruminant animals, known as enteric fermentation, are declining slightly due to lower animal populations; however, they are estimated to be the third-highest contributor to agriculture sector totals in 2025, also at around 19%.

Forestry and land use emissions refer to the net CO_2 flux[1] from forested lands in Michigan, which account for about 53% of the state's land area. The inventory is divided into two primary subsectors: the forested landscape and urban forestry and land use. Both subsectors capture net carbon sequestered in forest biomass, urban trees, landfills, and harvested wood products. In addition, other GHG sources, such as N_2O emissions from fertilizer application in urban areas and CH_4 and N_2O emissions from prescribed burns and wildfires, are included.

Figure 7-1. Historical and projected gross GHG emissions from the agriculture sector, Michigan, 1990–2025



$MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

As shown in Table 7-1, USFS data suggest that Michigan's forests sequestered about 12.7 $MMtCO_2e$ per year in 2005 (this excludes estimates of carbon flux from forest soils based on recommendations from the USFS). The negative numbers in Table 7-1 indicate a CO_2 sink rather than a source. Even after accounting for the GHG sources from urban soils and prescribed burns/wildfires, the forestry and land use sectors are still estimated to have been a net GHG sink. Hence, during this period, forest carbon losses due to forest conversion, wildfire, and disease were estimated to be smaller than the CO_2 sequestered in forest carbon pools, such as live trees, debris on the forest floor, and forest soils, as well as in harvested wood products (e.g., furniture and lumber) and the disposal into landfills of forest products. The forecast for the sector out to 2025 remains a net sequestration of –12.7 $MMtCO_2e$.

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[1] "Flux" refers to both emissions of CO_2 to the atmosphere and removal (sinks) of CO_2 from the atmosphere stored in plant tissue or soils.

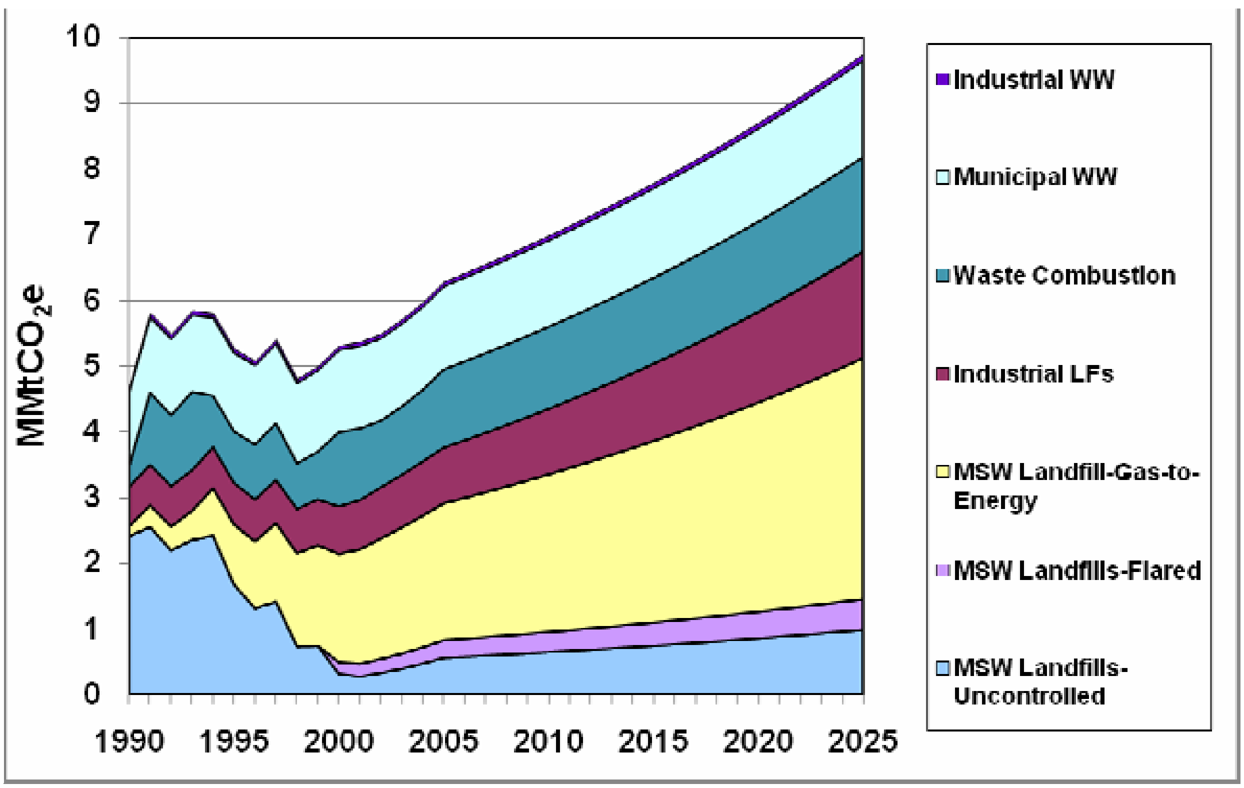
Table 7-1. Forestry and land use flux and reference case projections ($MMtCO_2e$)

Sector	1990	2000	2005	2010	2020	2025
Forested Landscape (excluding soil carbon)	–27.8	–8.77	–8.77	–8.77	–8.77	–8.77
Urban Forestry and Land Use	–10.1	–3.69	–3.91	–3.91	–3.91	–3.91
Forest Wildfires	0.02	0.02	0.02	0.02	0.02	0.02
Sector Total	**–37.9**	**–12.4**	**–12.7**	**–12.7**	**–12.7**	**–12.7**

Note: Positive numbers indicate net emission. Based on USFS input, emissions from soil organic carbon are left out of the forestry sector summary due to a high level of uncertainty.

Figure 7-2 shows estimated historical and projected emissions from the management and treatment of solid waste and wastewater. Emissions from waste management consist largely of CH_4 emitted from landfills, while emissions from wastewater treatment include both CH_4 and N_2O. Emissions are also included for municipal solid waste (MSW) combustion. Overall, the waste management sector accounted for about 3% of Michigan's total gross emissions in 2005. While emissions are expected to grow significantly by 2025, the contribution to the state's total is expected to remain at about 3%.

Figure 7-2. Estimated historical and projected GHG emissions from waste and wastewater management in Michigan, 1990–2025



$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; MSW = Municipal Solid Waste; LFs = landfills; WW = wastewater.

Key Challenges and Opportunities

Michigan has substantial opportunities to reduce emissions in the AFW sectors. The principal means to reduce emissions in these areas are:

- Improving methods for managing municipal solid waste,
- Adopting management practices to increase carbon sequestration in both forestlands and urban canopies,
- Improving production and utilization of biomass for use in both solid fuel and liquid fuel applications, and
- Promoting farming practices that result in GHG savings.

Opportunities for GHG mitigation in the AFW sectors involve measures that can reduce emissions within these sectors or reduce emissions in other sectors. Within these sectors, changes in crop cultivation can reduce GHG emissions by building soil carbon (indirectly sequestering carbon from the atmosphere) or through more efficient nutrient application (reducing N_2O emissions and embedded GHG emissions within those nutrients). The implementation of improved farming and harvesting techniques, as well as utilization of biomass for bio-based products, has the potential to reduce future emissions relative to current emissions from this sector and other sectors.

Enhanced management of the state's forests can lead to higher levels of carbon sequestration. These enhancements can be achieved through afforestation projects and enhanced stocking in existing forests. Conversion of land to development results in a loss of current and future carbon sequestration potential. Slowing or stemming conversion rates provides opportunities for carbon sequestration. In the waste management sector, waste reduction measures and landfill gas capture and utilization can reduce landfill CH_4 emissions.

Actions taken within the AFW sectors can also lead to GHG reductions outside the sectors: the establishment of short-rotation woody crops (for example, on marginal agricultural lands) for producing biomass energy feedstocks can replace fossil fuel consumption, including transportation fuels and fuels used to produce electricity or steam in the energy supply (ES) sector. Similarly, actions that promote solid waste reduction, recycling, or use of waste sources for energy or bio-based products can reduce emissions within the sector (future landfill CH_4 as noted above), as well as emissions associated with the production of products and packaging (recycled products often require less energy to produce than similar products from virgin materials). Finally, urban forestry projects can reduce energy consumption within buildings through shading and wind protection.

Overview of Policy Recommendations and Estimated Impacts

The MCAC recommends a set of 10 policies for the AFW sector that offer the potential for major economic benefits and emission savings. Implementing these policy recommendations could lead to emission reductions of:

- 17 $MMtCO_2e$ per year by 2025, and

- 147 $MMtCO_2e$ cumulative from 2009 through 2025, after adjusting for overlaps with other sectors.

The weighted-average cost-effectiveness of the recommended policies is about –$11/$tCO_2e$, representing a cost savings. This average value includes policies that have both much lower and much higher likely costs per ton.

The 10 policy recommendations for the AFW sectors address a diverse array of activities capturing emission reductions both within and outside of these sectors (e.g., energy consumption in the ES and Transportation and Land Use [TLU] sectors). The estimated impacts of the individual policies are shown in Table 7-2. The MCAC policy recommendations are described briefly here and in more detail in Appendix J of this report. The recommendations not only result in significant emission reductions, but also offer a host of additional benefits, including protection of biodiversity, reduced local air pollution, and economic development and job growth. To yield the levels of savings described here, the recommended policies need to be implemented in a timely, aggressive, and thorough manner.

The following are primary opportunities for GHG mitigation identified by the MCAC:

- **Agricultural crop production:** Programs can be implemented with growers to utilize cultivation practices that build soil carbon and reduce nutrient consumption. By building soil carbon, CO_2 is indirectly sequestered from the atmosphere. New technologies in the area of precision agriculture offer opportunities to reduce nutrient application and fossil fuel consumption. Promotion of local food production could reduce the transportation miles and fossil fuel use associated with importing food products from other areas.
- **Production of liquid biofuels:** Production of renewable fuels, such as ethanol from crop residue, forestry biomass, or municipal solid waste and biodiesel from waste vegetable oils, can produce significant reductions when they are used to offset consumption of fossil fuels (e.g., gasoline and diesel in transportation and other combustion sources). This is particularly true when these fuels are produced using processes and/or feedstocks that have much lower fossil fuel inputs than those from conventional sources (sometimes referred to as “advanced” or “next generation” biofuels). The goals to produce more biofuels in-state are linked to the recommendations under TLU-1, Promote Low Carbon Fuel Use in Transportation. The costs and benefits of liquid biofuels production are combined with the TLU policy on biofuels consumption and presented with the results for that sector.
- **Expanded use of forest, agricultural, and MSW biomass:** Expanded use of renewable energy and bio-based products from biomass removed from forests, crop residues, lawn and garden waste, or MSW can achieve GHG benefits by offsetting fossil fuel consumption (to produce either electricity or heat/steam) and replacing fossil-based products. Programs to expand sustainably produced biomass fuel production will most likely be needed to supply a portion of the fuel mix for the renewable energy goals of policy recommendation ES-1, Renewable Portfolio Standard.
- **Enhancement/protection of forest carbon sinks:** Through a variety of programs, enhanced levels of CO_2 sequestration can be achieved and carbon can be stored in the state’s forest

biomass. These include afforestation[2] projects, reforestation programs (restocking of poorly stocked forests), urban tree programs, and wildfire risk reduction. Programs aimed at reducing the conversion of forested lands to non-forest cover will also be important to retain what is currently a net forest CO_2 sink in Michigan.

- **Changes in MSW management practices:** By promoting source reduction, advanced MSW recycling practices, improved organics management, and increased collection and utilization of landfill methane, the GHG emissions associated with collecting, transporting, and managing MSW can be reduced. The emissions reduced in this sector would come primarily from waste management but may also provide a reduction in the fossil fuel used to transport waste. When the life-cycle GHG reductions of source reduction/recycling/organics management are considered, the results are substantial: over 35 $MMtCO_2e$/yr could be reduced by 2025.

Table 7-2. Summary list of AFW policy recommendations

Policy No.	Policy Recommendation		GHG Reductions ($MMtCO_2e$)			Net Present Value 2009–2025 (Million 2005$)	Cost-Effective-ness ($/$tCO_2e$)	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		*Included in the Results of TLU-1*					Unanimous
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	NQ					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†	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

[2] Afforestation refers to the establishment of forest on lands that have not historically been under forest cover.

Policy No.	Policy Recommendation		GHG Reductions ($MMtCO_2e$)			Net Present Value 2009–2025 (Million 2005$)	Cost-Effective-ness ($\$/tCO_2e$)	Level of Support
			2015	2025	Total 2009–2025			
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
	Sector Totals[†]		**9**	**23**	**201**	**–$548**	**–$3**	
	Sector Total After Adjusting for Overlaps[††]		**6**	**17**	**147**	**–$1,634**	**–$11**	
	Reductions From Recent Actions		**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	
	Sector Total Plus Recent Actions		**6**	**17**	**147**	**–$1,634**	**–$11**	

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; TBD = to be determined; 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 below for discussion of overlap adjustments.

Overlap Discussion

The amount of GHG emissions reduced or sequestered and the costs of a policy recommendation within the AFW sectors in some cases overlap with other AFW policies or policies in other sectors. For the MCAC recommendations, overlap occurs between AFW-9 and AFW-10 in the waste management sector. One of the policy elements of AFW-9 covers enhanced management of organic wastes in the MSW sector. To the extent that these wastes are being diverted from landfills to other waste management facilities (e.g., composting facilities), less organic waste is available to generate landfill methane. This effect has been accounted for in the quantification of AFW-10; hence, the values shown for AFW-10 above assume successful implementation of AFW-9.

Overlap also occurs with some of the quantified benefits and costs of policy recommendations within other sectors. Every effort has been made to determine where those overlaps occur and to eliminate double counting. As displayed in the table above, the AFW sector totals have been adjusted accordingly, as follows:

- AFW-1 outlines how biomass may be utilized for energy production. The ES Technical Work Group (TWG) also quantified the use of biomass for energy production (specifically ES-1 and ES-10). AFW-1 utilizes a greater amount of biomass than the ES policies post-2011. The biomass demand requirements for ES (in millions of British thermal units) and the GHG reductions and costs associated with its use were removed from the AFW sector totals in the table above, as these were considered to be accounted for under the ES analyses.
- AFW-2 outlines how biofuels could be produced in-state to offset GHG emissions from fossil-based fuels (primarily in the transportation sector). The TLU TWG also quantified the benefits and costs of increased use of biofuels in TLU-1. To avoid double counting, the goals of biofuel production in AFW-2 and biofuel consumption in TLU-1 were aligned, and then the estimated AFW-2 biofuel production volumes and costs were used as input to the analysis of biofuel consumption under TLU-1. Hence, the benefits and costs of AFW-2 are captured in the overall results of TLU-1. To avoid confusion, those results are left out of the summary table above. The quantification of production volumes and costs is still included in the AFW-2 documentation shown in Appendix J.

Agriculture, Forestry, and Waste Management Sector Policy Descriptions

The AFW sectors include emission mitigation opportunities related to the use of biomass energy, protection and enhancement of forest and agricultural carbon sinks, control of agricultural N_2O emissions, production of renewable liquid fuels, afforestation and forest management, and lower municipal solid waste management emissions.

AFW-1. Expanded Use of Biomass Feedstocks for Electricity, Heat, or Steam Production

This policy dedicates a sustainable quantity of biomass from agricultural crop residue, wood industry process residues, unused forestry residues, and MSW biomass resources for efficient conversion to energy and economical production of heat, steam, or electricity. This biomass should be used in an environmentally acceptable and sustainable manner, considering proper facility siting and feedstock use, including co-location of production facilities with heat- and steam-utilizing facilities. The objective is to create concurrent reduction of CO_2 due to displacement of fossil fuels, considering life-cycle GHG emissions associated with viable collection, hauling, and energy conversion and distribution systems. This policy includes a recommendation for a complete inventory of the state's biomass resources. The primary goal of this policy is to produce 10% of total in-state electric generation from sustainable biomass feedstock by 2025.

AFW-2. In-State Liquid Biofuels Production

This recommendation promotes sustainable in-state production and consumption of transportation biofuels from agriculture, forestry, and MSW feedstocks to displace the use of gasoline and diesel. This recommendation also promotes the in-state development of feedstocks, such as cellulosic material, and production facilities to produce either liquid or gaseous biofuels with low carbon content. As with AFW-1, production of biomass for biofuel production must be done in a sustainable manner. Adoption of biofuel production must be done in a way that maintains the sustainability of feedstock, food, and other commodity supplies and natural resources. Upon successful implementation of this policy, Michigan consumption of biofuels produced in-state will result in better GHG benefits than these same fuels obtained from a national or international market due to lower embedded CO_2 (resulting from out-of-state fuels produced using feedstocks/production methods with lower GHG benefits, and from transportation of biodiesel, ethanol, other fuels, or their feedstocks from distant sources). Successful implementation of AFW-1 and AFW-2 will also lead to higher levels of in-state energy expenditures remaining in Michigan.

AFW-3. Methane Capture and Utilization From Manure and Other Biological Waste

This policy seeks to reduce the amount of methane emissions and recapture energy from organic waste materials from livestock, agricultural residues, and solid waste through the promotion of anaerobic digestion, gasification, and other similar technologies. Co-mingling of organic wastes with manure can substantially increase biogas production, while providing a sustainable method for treatment and disposal. In addition, co-products may be created by these technologies, such as stable fertilizer products and building materials. These technologies make a twofold contribution to climate protection: the usual discharge of methane into the atmosphere is prevented, and the burning of fossil fuels is replaced with renewable energy (biogas). The goal of this policy is to reduce GHG emissions from handling, treatment, and storage of livestock manure and organic waste by 15% by 2015 and 25% by 2025 through improved manure management practices and methane utilization.

AFW-4. Expanded Use of Bio-based Materials

This policy seeks to promote the manufacture, use, recycling, and reuse of materials made from biological products, such as wood, fiber, wheat board, agricultural by-products, biodegradable plastics, and green chemistry applications. These products reduce GHG emissions by sequestering carbon and displacing the production of fossil-based products. Additional GHG reductions can be achieved by promoting the use of Michigan-produced materials, which results in lower transport-associated emissions. This policy does not refer to energy uses, such as electricity or ethanol production, which are covered in AFW-1 and AFW-2. The goals associated with this policy are to utilize 100,000 tons of bio-based products annually by 2025, and to reclaim 150,000 tons of solid wood residues from manufacturing processes, deconstruction sites, and urban/suburban trees annually by 2025.

AFW-5. Promote Continuous Vegetative Cover

This recommendation is the maintenance and promotion of continuous vegetative cover, such as wind breaks and winter cover crops to prevent soil erosion, increase carbon sequestration, and provide new biomass sources. It also promotes the planting of cover crops with higher carbon content than current cover on marginal lands, including buffer strips, roadsides, on-off ramp areas, and transportation medians. GHG savings occur from carbon sequestration in the vegetative cover, indirect sequestration via carbon accumulation in soil, and reduced fertilizer application. The goals associated with this policy are to increase the acreage of lands with permanent cover by 10% by 2025 (existing land that is not under forest cover); retain 90% of lands coming out of the federal Conservation Reserve Program by 2025 in some type of permanent cover; and reduce rates of carbon loss by restoring or enhancing the maximum feasible percentage of wetlands by 2025.

AFW-6. Forestry and Agricultural Land Protection

This policy seeks to reduce the rate at which agricultural and forestlands and wetlands are converted to developed uses. The protection of these lands through conservation tools, such as land grants and easements and tax benefits, will retain the above- and below-ground carbon on these lands, as well as the future carbon sequestration potential of these lands. Markets for natural products from agriculture, forests, and wetlands also serve as incentives to keep these lands in their current state rather than convert them to development. GHG reductions come from the prevention of release of carbon from conversion of these lands. Additionally, indirect benefits occur through the reduction of urban sprawl, thus avoiding additional emissions from vehicle miles traveled. The goals associated with this policy are to reduce the rate of conversion from agriculture to developed use by 50% by 2025; maintain or increase forestland acreage by 2025, without converting agricultural land to forest, unless it has higher carbon sequestration potential; and protect and restore northern peatlands and other wetlands to prevent releases of GHGs, which will allow existing peatlands to continue to sequester carbon.

AFW-7. Promotion of Farming Practices That Achieve GHG Benefits

This recommendation addresses both agricultural soil carbon management, as well as nutrient management to achieve GHG benefits. For soil carbon management, conservation-oriented management of agricultural lands, cropping systems, crop management, and agricultural practices may regulate the net flux of CO_2 from soil. This recommendation has four separate elements: (1) soil carbon management, where CO_2 reductions occur indirectly via the building of soil carbon levels; (2) nutrient management, where GHG reductions occur through more efficient use of fertilizer, which lowers fossil fuel use though lower application energy requirements in addition to reduced N_2O emissions following application; also, life-cycle GHG reductions associated with the production and transportation of fertilizers are reduced; (3) an energy efficiency element that seeks to reduce GHG emissions by reducing the amount of fossil fuel consumed by farming and harvesting practices through improved technologies and increases in efficiency; and (4) the promotion of locally produced food, which reduces fossil fuel consumption by reducing food miles. The specific goals associated with these four policy elements are: increase conservation tillage farming to 4 million acres by 2025; adopt soil management and nutrient management practices on 5 million acres by 2025; reduce the net on-farm fossil fuel energy consumption by 50% by 2025; and increase the local/regional purchasing of locally grown agricultural produce and products by 50% by 2025.

AFW-8. Forest Management for Carbon Sequestration and Biodiversity

This recommendation focuses on the state's existing forested lands, recognizing the significant role that Michigan's forests play in lowering the state's net GHG emissions (a sink of ~13 $MMtCO_2e$/yr) and that management could be enhanced to achieve greater net GHG benefits. The goals associated with this policy are: enhance forestland management (including improved stocking of understocked stands) across the state on 1 million acres through afforestation and reforestation by 2025; achieve 40% canopy cover in urban communities by 2025 (this element also provides energy savings through shading and wind protection); and implement wildfire reduction community-wide protection plans for 10–12 identified communities at risk by 2025 (reducing wildfire risk protects forest carbon stores and maintains forest carbon sequestration levels).

AFW-9. Source Reduction, Advanced Recycling, and Organics Management

This recommendation seeks to improve the GHG profile of MSW management in the state by reducing waste generation, increasing recycling, and improving organics management. GHG savings occur through the reduction in landfill methane generation due to lower amounts of waste being landfilled in the future. Even more important from a GHG reduction perspective are the life-cycle emission reductions achieved via source reduction and recycling. Reducing or recycling products and packaging reduces the GHG emissions associated with their manufacture and transport, leading to significant overall reductions. While a large portion of these reductions would occur out of state, the MCAC recognizes the importance of this recommendation in achieving net GHG benefits. The policy goals are to achieve a 75% MSW recycling and enhanced organics management rate by 2025, and a 50% recycling rate for industrial, commercial, and new construction waste by 2025.

AFW-10. Landfill Methane Energy Programs

The renewable energy (methane) created at landfills during anaerobic degradation of wastes unable to be utilized in recycling and compost programs can be used to displace fossil fuel through the installation of methane control and collection systems. The goal of this policy is to implement controls or waste management options at MSW landfills, such that 50% of the methane emissions are avoided by 2025 that would be generated under business-as-usual conditions.

Chapter 8
Cross-Cutting Issues

Overview of Cross-Cutting Issues

Some issues relating to climate policy cut across multiple sectors. The Michigan Climate Action Council (MCAC) addressed such issues explicitly in a separate Cross-Cutting Issues (CCI) Technical Work Group (TWG). Cross-cutting recommendations typically encourage, enable, or otherwise support emission mitigation activities and/or other climate actions. The types of policies considered for this sector are not readily quantifiable in terms of greenhouse gas (GHG) reductions and costs or cost savings. Nonetheless, if successfully implemented, they help build a foundation for other recommendations and will contribute to GHG emission reductions and implementation of the MCAC's policy recommendations described in Chapters 3–7 of this report.

The CCI TWG developed recommendations for 10 policies (see Table 8-1) that were then reviewed, revised, and ultimately adopted by the MCAC members present and voting. Nine of the recommendations are focused on enabling GHG emission reductions and mitigation activities, while one (CCI-8–Adaptation and Vulnerability) addresses adaptation to the changes expected from the effects of GHGs that will remain in the atmosphere for decades.

Key Challenges and Opportunities

The MCAC was charged with developing proposed GHG reduction goals for Michigan, along with a set of policy recommendations designed to achieve such goals. The MCAC established 2005 as the baseline year and identified a mid-term goal of reducing the 2005 GHG baseline by 20% by 2020 and a long-term goal of an 80 % reduction by 2050.

The MCAC based its recommendations on its review of the potential overall emission reduction estimates (as compared to the GHG emissions inventory and forecast for business as usual) for 33 of 54 policy recommendations for which emission reductions were quantified. It also considered the goals and targets adopted by several other states in its deliberations. While 21 other MCAC policy recommendations were not readily quantifiable, some of them would most likely achieve or contribute to additional reductions, including several of the CCI policy recommendations.

A key challenge for the state in seeking to achieve these GHG reduction goals will be to identify available resources needed to implement many of the initiatives outlined in this report, particularly given the struggling economic conditions in the state and across the country. The MCAC will need to work closely with other state, local, federal, and tribal governmental entities, the private sector, institutions of higher education, citizens, and others to examine these opportunities.

Another key challenge for the state is the need to proactively engage with the federal government in developing appropriate federal programs and policies, while simultaneously working with other state and regional entities to design and implement strategies most effectively employed at this level.

In spite of these challenges, the nexus between seeking a new energy economy and significantly reducing GHG emissions in the state offers a rare opportunity for Michigan to be a leader in developing selected renewable energy technologies and enhancing economic and employment conditions.

Table 8-1. Summary list of CCI policy recommendations

Policy No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value 2009–2025 (Million $)	Cost Effective-ness ($/tCO_2e$)	Level of Support
		2015	2025	Total 2009–2025			
CCI-1	GHG Inventories, Forecasting, Reporting, and Registry	*Not Quantified*					Unanimous
CCI-2	Statewide GHG Reduction Goals and Targets	*Not Quantified*					Unanimous
CCI-3	State, Local, and Tribal Government GHG Emission Reductions (Lead by Example)	*Not Quantified*					Unanimous
CCI-4	Comprehensive Local Government Climate Action Plans (Counties, Cities, Etc.)	*Not Quantified*					Unanimous
CCI-5	Public Education and Outreach	*Not Quantified*					Unanimous
CCI-6	Tax and Cap/ Cap and Trade	*MCAC approved creation of new Market-Based Policies Technical Work Group as the lead for this policy.*					Transferred
CCI-7	Seek Funding for Implementation of MCAC Recommendations	*Not Quantified*					Unanimous
CCI-8	Adaptation and Vulnerability	*Not Quantified*					Unanimous
CCI-9	Participate in Regional, Multi-State, and National GHG Reduction Efforts	*Not Quantified*					Unanimous
CCI-10	Enhance and Encourage Economic Growth and Job Creation Opportunities Through Climate Change Mitigation	*Not Quantified*					Unanimous
CCI-11	Enhance and Encourage Community Development Through Climate Change Mitigation: Address Environmental Justice	*Not Quantified*					Unanimous

GHG = greenhouse gas; MCAC = Michigan Climate Action Council; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Overview of Policy Recommendations and Estimated Impacts

Cross-cutting issues include policies that apply across the board to all sectors and activities. Cross-cutting recommendations typically encourage, enable, or otherwise support emission mitigation activities and/or other climate actions. The MCAC recommends that 10 such policies be adopted and implemented in Michigan. All are enabling policies that are not quantified in terms of metric tons of GHG reduction or costs.

Detailed descriptions of the individual CCI policy recommendations as presented to and approved by the MCAC can be found in Appendix K of this report. Following are highlights of some of the policies recommended by MCAC:

Michigan is currently participating in the multi-state Climate Registry. The state needs to institute formal GHG inventory, forecast, and reporting functions to be carried out by a state agency. Using standardized protocols, the state should prepare annual inventories of emission sinks and sources and should develop forecasts of future GHG emissions in at least 5- and 10-year increments extending at least 20 years into the future. The state should also develop reporting protocols for facility-level reporting of all significant GHG emissions. Where possible, the state should coordinate these efforts with other states, regions, tribes, and the federal government.

Table 8-2 presents the MCAC's proposed GHG reduction goals for Michigan. These goals are consistent with goals being considered by the Midwestern Governors Regional Greenhouse Gas Reduction Accord process: achieve a 20% reduction of GHGs below 2005 levels by 2020 and an 80% reduction below 2005 levels by 2050. The MCAC recommends that these goals be established through executive or legislative action. The state should also develop a tracking system to measure progress over time in achieving GHG reductions against its recommended goals.

Table 8-2. MCAC-recommended goals for GHG reduction

Year	Reduction From 2005 Levels
2005	Baseline
2020	20%
2050	80%

The MCAC encourages other governmental entities and academic institutions to establish GHG reduction goals for their respective jurisdictions, and to develop plans, programs, and other initiatives to achieve their respective goals. The state is already engaged in numerous “Lead by Example” initiatives to find additional energy efficiencies and GHG reductions in state procurements for buildings, vehicle fleets, and office equipment. These initiatives, which are detailed in CCI-3, Appendix K, should be compiled, tracked, and shared among entities in Michigan. This should help stimulate private-sector and individual citizen actions as well.

A public education and outreach effort will be a key to building a broad base of awareness and support for the recommendations of this report. The MCAC has identified numerous strategies over several years to do so in conjunction with academic, business, local government, and other partners in this process. These outreach efforts are spelled out in CCI-5, Appendix K and are targeted to the following audiences: state government, policymakers, future generations, community leaders and community-based organizations, citizens, industrial and economic sectors, and tribal governments.

While many of the MCAC recommendations will save resources over the next 11 years, as documented through this MCAC process, some policy recommendations will require additional resources to implement. The state should immediately seek and establish capital investments and other funding sources for the implementation of the MCAC's recommendations. State government should lead the efforts to generate investment and financial support. Other sectors, including local government, industry, services, agriculture, consumers, and higher education, should also be involved. The state should examine alternative financing mechanisms, such as those listed in CCI-7, Appendix K, and develop proposals to implement those that are the most promising.

Given Michigan's vulnerability to impacts of climate change, the state should undertake a comprehensive planning effort to assess and address the impact of climate change on the Great Lakes, the state's natural resources, and wildlife and fisheries. The state should start by developing a scoping document that identifies technical and financial resources and research needed to undergo a comprehensive planning process in 2009. When applicable and feasible, the scoping document should identify ongoing and intended research efforts that could contribute to the planning process. A multi-agency and diverse stakeholder team should be formed to follow through with the planning process in 2009 and beyond. A detailed list of tasks is included in CCI-8, Appendix K.

The state is a participant in the Midwestern Governors Regional Greenhouse Gas Reduction Accord and Energy Security and Climate Stewardship Platform. The state should continue this proactive engagement with other states in the region in developing cost-effective, multi-state reduction strategies. At the same time, the state will be pushing for progressive action at the federal level to address climate change. Michigan will also work with the 12 federally recognized tribes in the state to help coordinate local climate change strategies (see CCI-9, Appendix K). This will be accomplished through either existing agencies or a designated state entity charged with climate change issues, and through the use of existing agreements between the Michigan Department of Environmental Quality (MDEQ) and tribes, such as the Water Accord, or newly created mechanisms that allow government-to-government dialog on environmental issues of mutual interest. Likewise, Michigan will welcome and seek out a mechanism to coordinate its climate change and GHG reduction efforts with national tribal organizations, such as the climate mitigation and adaptation dialog recently initiated by the National Congress of American Indians, the Council of Energy Resource Tribes, and others. Michigan should also further investigate, and if it is determined to be in the state's best interest, join The Climate Registry (TCR) and the Chicago Climate Exchange (CCX).

It has been demonstrated that there are numerous economic and employment opportunities associated with implementation of many of the MCAC-recommended GHG reduction policies. The MCAC recommends that the state implement robust measures to retain existing clean tech business and attract new investment. Some categories for attention may include: provide more attractive financial incentives, implement policies that enhance and encourage economic growth, seek more federal support, utilize Michigan's existing resources and economic opportunities, protect water resources, invest in walk-able neighborhoods and transportation mode choices, support a diverse agricultural base, maintain traditional support for Michigan's excellent public research universities, and encourage and facilitate Michigan's strong social infrastructure. Appendix K, CCI-10 presents numerous additional examples and details about these initiatives.

Finally, there is an opportunity to enhance sustainable community development and address environmental justice issues in Michigan as climate change mitigation is addressed at the local level. To do so, the state needs a collaborative planning process—transformational responses that allow for distribution of costs and benefits and opportunities for change. Numerous examples and initiatives to do so are outlined in CCI-11, Appendix K.

Cross-Cutting Issues
Policy Descriptions

CCI-1. Inventories, Forecasting, Reporting, and Registry

GHG emission *inventories* track statewide emission trends and quantify emissions from individual sources and sinks (both anthropogenic and natural). They can be used to inform state leaders and the public and to verify GHG reductions associated with GHG reduction programs.

GHG *forecasts* are scenario-based predictions of future emission trends built on inventories and projected economic trends. These forecasts are useful for identifying the factors that affect trends and highlighting opportunities for mitigating emissions or enhancing sinks.

Detailed GHG *reporting* is needed from all major GHG sources[1] in order to develop accurate inventories. Reporting is also required for sources to participate in GHG reduction programs, such as market-based systems like cap and trade and carbon taxation. Participation in a reporting program prior to the establishment of a GHG reduction program establishes an early baseline that can be used to avoid disincentives to abate emissions prior to establishment of the reduction program.

A GHG *registry* enables recording of GHG emission reductions in a central repository. Registries can establish "ownership" of emission reductions, protect baselines, and provide a mechanism for regional cooperation. Registries can also provide a foundation for future trading programs and facilitate the identification of opportunities for reductions.

CCI-2. Statewide GHG Reduction Goals and Targets

In Executive Order No. 2007-42, the Governor directed the MCAC to recommend specific short-term, mid-term, and long-term GHG reduction goals or targets for Michigan. Additionally, the Midwestern Regional Greenhouse Gas Reduction Accord, signed by Governor Granholm on November 15, 2007, establishes a requirement for its staff and appropriate state agency

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[1] According to The Climate Registry, individual sources are defined either as "entities" (i.e., any corporation, institution, or organization) recognized under U.S. law, or as "facilities" (i.e., any installation or establishment located on a single site or on contiguous or adjacent sites that are owned or operated by an entity). See http://www.theclimateregistry.org/downloads/GRP.pdf for additional details. The official definition of a "source" is left to MDEQ, but facility-level reporting is strongly recommended.

representatives to set regional GHG reduction targets that are consistent with member states' targets. The establishment of a Michigan statewide goal or target can provide vision and direction, a framework within which implementation of MCAC policy recommendations can proceed effectively, and a basis of comparison for periodic assessments of progress. GHG reduction goals or targets recommended by the MCAC should be consistent with the parallel goal of an efficient, robust Michigan economy. In pursuit of similar climate progress, approximately 20 other states have established GHG reduction goals or targets.

The Intergovernmental Panel on Climate Change (IPCC) determined that atmospheric GHGs must remain below 400–450 parts per million of carbon dioxide equivalent (CO_2e) to have a reasonable chance of staying below 2^oF of warming. This concentration is considered the stabilization target. The IPCC further calculated that the industrialized nations' cumulative emissions over the 2000–2050 period must remain less than 700 gigatons (Gt) of CO_2e. This means that the world's industrialized nations must reduce emissions 70%–80% below 2000 levels by 2050 to help prevent global temperature increases. For its share, the United States needs to reduce its GHG emissions by about 80% by 2050 in order to stay within its estimated "safe" range of 160–265 $GtCO_2e$ for that same 50-year period. That comes to a 20% per decade reduction, or 2% per year.

The target years and GHG reduction goals included in this policy recommendation reflect a high level of uncertainty regarding the costs and benefits of implementing GHG reduction policies in Michigan. These goals have been examined in the second phase of the process and considered in combination with the results of the modeling and evaluation of the selected policy recommendations.

In accordance with the *Michigan Climate Action Council Interim Report*, "the strategy development process must evaluate and consider economic and environmental impacts, including the implementation costs or cost savings for individuals, communities, businesses, and jobs in Michigan." The policy recommendations detailed by the six TWGs (Agriculture, Forestry, and Waste Management; Energy Supply; Residential, Commercial, and Industrial; Transportation and Land Use; Cross-Cutting Issues; and Market-Based Policies) include policies to reduce GHG emissions at low net cost, and identify opportunities for substantial net savings. Implementation of carefully crafted policy recommendations should bring significant economic benefits to the Michigan economy, by reducing fuel costs through efficiency measures, by reducing the export of capital from the state, and by stimulating the Michigan economy through the creation of new opportunities and jobs in energy efficiency, clean energy technologies, renewable energy development, transportation, and land-use planning.

The MCAC has modified the preliminary target year and GHG reduction goals from those originally proposed in the MCAC Interim Report to those consistent with the goals being considered by the Midwestern Governors Association. They are presented in Table 8-2. The policies recommended by the MCAC appear to be able to achieve a 20% reduction below 2005 levels by 2020. To do so, however, it will be necessary for the state to move expeditiously forward with near-term implementation of the policy initiatives outlined in this MCAC Final Report. This includes instituting formal mechanisms to monitor and verify GHG reduction progress and periodically adjusting reduction goals and strategies when needed.

The MCAC also recommends that a formal performance tracking mechanism be developed to gauge progress in Michigan toward achievement of the goals and targets.

CCI-3. State, Local, and Tribal Government GHG Emissions (Lead by Example)

The state of Michigan and many local and tribal governments have undertaken various policy and program actions in several key areas to obtain GHG emission reductions and improve energy efficiency. Many of these ongoing and future efforts can provide practical and working examples of what can be done by nongovernmental organizations, academic institutions, and even private citizens to reduce GHG emissions. Much more effort is planned and should be undertaken to further improve Michigan's energy efficiency and reduce our carbon dependency and emission rate, as outlined in Appendix K of this report.

State, local, and tribal governments are responsible for providing a multitude of services for the public that are delivered through very diverse operations. This also makes them responsible for overseeing wide-ranging GHG emission activities and provides leadership opportunities to work with universities, nonprofit organizations, and the private sector to reduce emissions and increase energy efficiency. For example, the state of Michigan is a major consumer of electricity and, as such, can promote the development of environmentally benign generation and purchase a significant portion of its power through a certified “green power” program.

While the incentive for this action will be, in part, market driven as energy costs increase, it will only be achievable through a continued comprehensive analysis of current operations, identification of significant GHG sources, and implementation of changes in technology, procedures, behavior, operations, and the services provided. State, local, and tribal governments must find ways to encourage and provide incentives for reducing GHG emissions in a variety of ways. One of the most important is to link GHG reductions to energy expenditures, and demonstrate that reduction in one leads to reduction in the other.

CCI-4. Comprehensive Local Government Climate Action Plans

A number of local and regional cities and municipalities in Michigan have already taken steps and initiated programs and activities to mitigate climate change in their communities. Many of these cities and communities—23 in Michigan and over 900 cities nationwide—are also signatories to the U.S. Mayors Climate Protection Agreement, and have a stated goal of reducing CO_2 emissions by 7% below 1990 baseline levels by 2012. Furthermore, cities and communities in Michigan are helping to develop and support additional climate change accountability programs, such as the Midwestern Regional Greenhouse Gas Reduction Accord, TCR, and the Michigan Renewable Energy Program.

The state and tribal governments, regional metropolitan councils (e.g., the Grand Valley Metro Council), Michigan Municipal League, and others could all help create awareness about climate change issues and lead by example in developing climate change programs that are coordinated with the MCAC. Additionally, these organizations and entities could help communicate best practices and success stories through a variety of outlets, such as workshops, conferences, summit meetings, a Web site clearinghouse, education and outreach to public and municipal officials, as well as recognizing local government GHG and CO_2 emission reduction achievements.

CCI-5. Public Education and Outreach

Public education and outreach is essential to cultivating broad support for GHG reduction activities. Education and outreach will target at least seven specific audiences in Michigan according to policy recommendations made by MCAC members. These efforts will seek to create awareness of climate change issues, along with providing justification for policies designed to reduce GHG emissions. Public education and outreach efforts should build upon existing work being done by state, tribal, and local agencies, utility companies, and nonprofit organizations.

CCI-6. Tax and Cap Policies / Cap and Trade

The lead for developing this policy recommendation was transferred by the MCAC to the Market-Based Policies TWG (see Chapter 4).

CCI-7. Seek Funding and Financing for Implementation of MCAC Recommendations

Michigan will seek and stimulate funding and investment to implement the MCAC climate solution recommendations. Accordingly, Michigan will position itself to successfully compete for federal and international assistance and matching funds in adaptation and mitigation of climate change impacts. Funding decisions will take into account both economic and environmental impacts, including the implementation costs or cost savings for individuals, communities, and businesses, as well as similar funding actions made by other Midwest states and regions. As Michigan allocates funding for MCAC recommendations, the state will work to identify choices that provide the best opportunities for mitigation of, and adaptation to, climate change. Concurrently, Michigan will implement initial funding investments that require few long-term costs. In addition, Michigan aims to reduce the costs associated with climate change activities, while fostering economic growth within the state.

CCI-8. Adaptation and Vulnerability

Climate change is a potentially serious threat to communities, natural resources, and wildlife in Michigan, the United States, and around the world. While addressing the source of climate change and related GHG mitigation options is critical, it is also important that decision makers and the citizens of Michigan understand how climate change is affecting and will affect the natural resources and natural resource-based economic activity in the state. Additional attention, research, and funding are needed to assess the impact of climate change on Michigan's fisheries and wildlife and help them adapt, while also reducing the other stressors on their habitats and ecosystems. Communications, research, and funding are also needed to assess and moderate climate change's impact on Michigan's land and other natural resource-based industries (forestry, agriculture, tourism, and recreation).

The state of Michigan should undertake a comprehensive planning effort to assess and address the state's vulnerability to climate change and adaptation opportunities. Various organizations and agencies in the state are already collecting some of the information needed for such an assessment and efforts should be made to coordinate and consolidate these information-gathering activities.

CCI-9. Participate in Regional, Multi-State, and National GHG Reduction Efforts

The MCAC recognizes that collaboration is a key to the successful implementation of the state climate change strategies. Because the execution of policies designed to reduce climate change affects all sectors of society, actions must be broad-based and inclusive. For this reason, collaborative regional and multi-state reduction efforts offer promising possibility for accomplishing the MCAC's target goals. Joint regional, multi-state, multi-province, and in some cases, national approaches to GHG emission reductions and energy efficiency options can provide greater opportunities for success, particularly because the issue of climate change is not constrained to political boundaries. Accordingly, Michigan recognizes, has considered, and has joined other regional and national, market-based GHG reduction strategies. Such strategies propose to mitigate and adapt to climate change in various sectors, including energy supply, residential, commercial, industrial, transportation, land use, agriculture, forestry, and waste management.

The current initiatives include the state's membership in the Midwestern Regional Greenhouse Gas Reduction Accord, whereby the member governors and Canadian prime minister agreed to establish a midwestern GHG reduction program with targets and time frames that are consistent with state policies. Also included in this initiative is the development of a market-based, multi-sector cap-and-trade program to achieve reductions. An additional joint initiative is MDEQ's participation on the Steering Committee for the development of TCR. The multi-state TCR was designed to be an essential piece of infrastructure for the development of state and federal climate change programs by forming a partnership to produce a protocol for measuring GHG emissions. A third significant initiative offering opportunities for multi-state collaboration is the CCX. Michigan, as well as all other members of the CCX, must achieve a minimum 6% reduction in GHG emissions from 2000 levels by 2010. This goal is in accordance with Michigan reduction targets.

These developments will be continued and will function as models to form the basis of future Michigan GHG reduction programs. Michigan should consider developing supplementary or ancillary registry capacities or opportunities to meet all of the state's needs. Michigan will continue to examine the decisions made by other states and regions, particularly in the Midwest states and in Canada, to identify opportunities for collaboration with other GHG reduction efforts. Michigan will also implement regional climate reduction initiatives, such as a regional carbon cap-and-trade system (unless a national system supersedes this need).

The Governor and the Michigan legislature should aggressively push for and continue to encourage federal action to reduce GHG emissions and to ensure that Michigan is well represented and protected at the federal level. An aggressive approach to GHG reductions within the United States will have a significant effect on the international reductions needed to begin reversing global warming trends. Ultimately, many of the climate protection issues need to be addressed at the national level. Michigan must help shape these national initiatives.

CCI-10. Enhance and Encourage Economic Growth and Job Creation Opportunities Through Climate Change Mitigation

Michigan's response to climate change can serve as a catalyst for increasing economic activity, in addition to reducing GHG emissions. Michigan is already home to two of the world's leading solar power manufacturers, and over 25 businesses provide components for the growing commercial wind energy industry. Investors in the clean tech sector are constantly seeking locations that offer the most advantageous markets. Texas, Colorado, New York, and Pennsylvania have recently added thousands of green collar jobs by offering start-up capital, tax breaks, and energy policy that welcomes clean energy. Michigan has a capable workforce, engineering expertise, and substantial manufacturing capacity. The state also possesses considerable natural resources that could establish it as a leader in renewable energy. Given the intense competition from other states and nations, however, additional incentives and supportive government policies will be necessary to maximize investment in Michigan.

CCI-11. Enhance and Encourage Community Development Through Climate Change Mitigation: Address Environmental Justice

Climate change is predicted to cause significant changes in both the atmosphere and the natural environment, including increases in extreme weather events and droughts, as well as rises in sea level in some regions and lower water levels in the Great Lakes.

Although all segments of Michigan's population and economy will be affected by climate change, certain communities run the risk of being disproportionately burdened by costs and challenges, particularly poor communities and communities of color. As evidenced by the impact of Hurricane Katrina in New Orleans, communities in the United States continue to be unprepared—socially, financially, and environmentally—for major natural events.

Even in the absence of major natural disasters, climate change has the potential to devastate an unprepared economy. Transitional costs will likely be regressive and could further burden populations already suffering from economic hardship with unbearable costs.

To encourage community development through climate change mitigation and ensure that vulnerable communities are protected, the state must engage a range of communities in a collaborative planning process that works toward a transformational response to climate change. This response must be tailored to the regressive costs posed by climate change, and must act to address the economic and health impacts of a warming climate.