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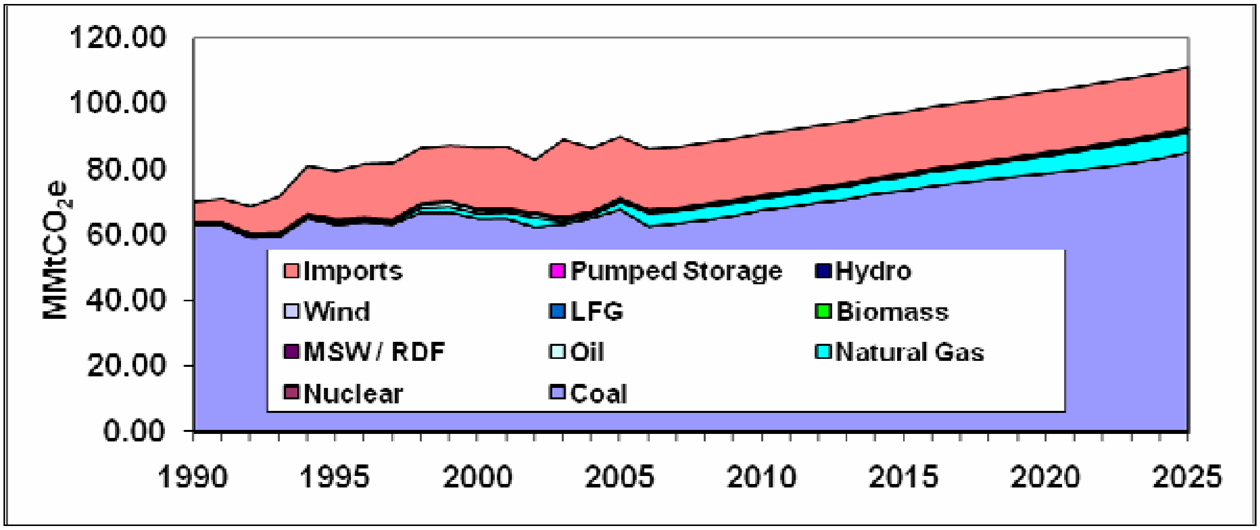
[1] Imports are estimated by taking the difference between the total electricity sales in Michigan and the sales from the in-state power generation. The data sources for the total electricity sales and the sales from in-state sources are EIA Annual Energy Outlook, 1996-2007 Editions.

[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.

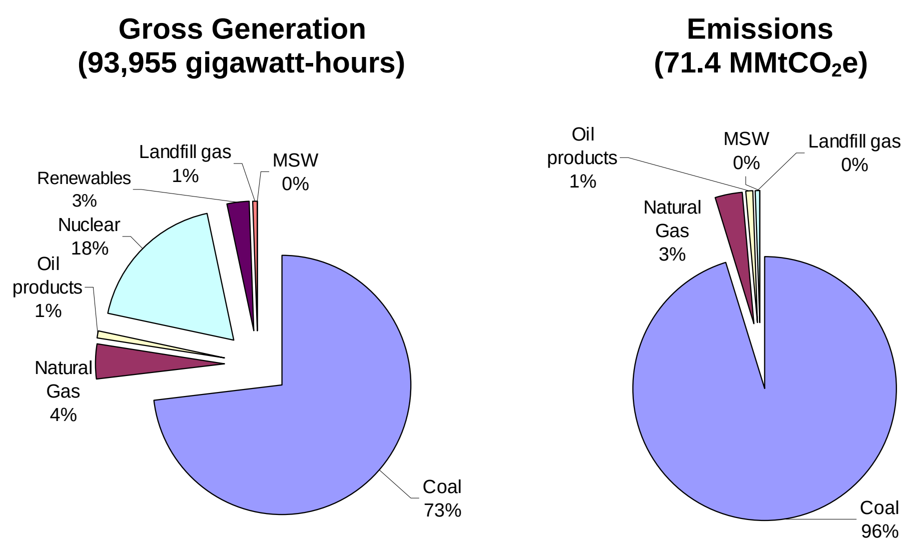
Figure 3-1. Recent and projected GHG emissions from the electricity sector, Michigan, 2005–2025 (consumption basis)



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 ($MMtCO_2e$)			Net Present Value 2009–2025 (Million $)	Cost-Effective-ness ($/tCO_2e$)	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**	

$/tCO_2e$ = 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; $MMtCO_2e$ = 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 $MMtCO_2e$ in 2025 and cumulative reductions of 250.4 $MMtCO_2e$ 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_2e$ 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.