MICHIGAN CLEAN ENERGY REPORT

Statewide Profile of Energy Use and Deployment of Four Clean Energy Technologies

June, 2015

Michigan Saves' analysis of clean energy technologies in Michigan comprises two major works: this statewide overview of energy use and clean energy technology deployment throughout Michigan, and a profile of clean energy efforts in seven Michigan communities titled "Michigan Clean Energy Report: A Profile of Clean Energy Efforts in Seven Michigan Communities."

Both reports were released on June 1, 2015.

Funding for the Clean Energy Report was provided to Michigan Saves by the C.S. Mott Foundation.

Introduction

Over the past century, advances in technology have propelled innovations that have made energy an inextricable component of modern life. Energy powers our cars, charges our computers, lights our homes and insulates us from extreme temperatures. Americans—on average—consume more energy than any other nationality (U.S. EIA April 25, 2014). To meet this large (and growing) energy demand, providers have traditionally relied predominately on finite, carbon based resources, including coal, natural gas, and petroleum products. Not only are these resource stocks limited, but there is growing awareness of the external consequences of consuming these fuels. The recognition that energy consumption is impacting the environment has led to a substantial push to develop new technologies that decrease dependence on carbon based fuels by finding alternative energy resources and investing in technologies that curb consumption patterns.

Greenhouse gas emissions are recognized as a primary driver of global climate change and, in the United States more than 62 percent of these emissions come from transportation and electric generation (U.S. EPA).

Clean energy technologies*, services, or processes are defined as those that broadly reduce energy consumption and/or enable the transition to a renewable-based energy economy by increasing the supply of renewable energy, improving the efficiency of energy utilization at the consumer and industrial scale, improving the processes and systems that use energy, or more effectively enabling energy solutions to permeate the marketplace.*

—Massachusetts Institute of Technology Clean Energy Prize

The transition to clean energy technologies creates opportunities for local economic development, increases energy security, and helps produce a cleaner, more livable environment. For communities, investing in clean energy technologies can save money by eliminating energy waste and create new employment opportunities. The growing availability and understanding of the benefits of clean energy create an opportunity for communities to evaluate what resources are right for them and how to best implement clean energy strategies. These goals and strategies will be most effective when they are based on current community-specific data, ensuring that communities can best meet their needs.

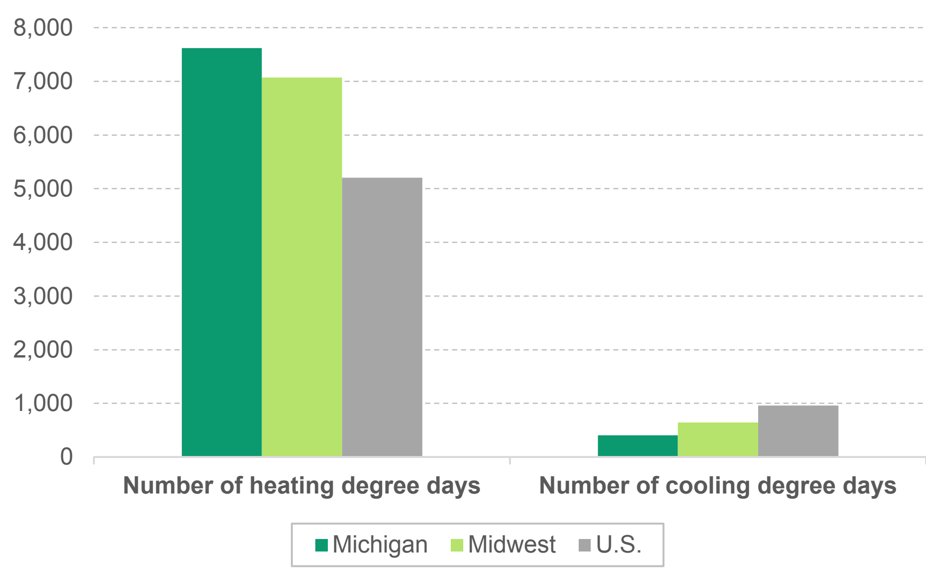
The Michigan Clean Energy Report is designed to serve as a reference for communities, providing a profile of the state's current energy landscape and easily accessible, accurate information about energy use and the deployment of clean energy technologies. National and regional data will be included in the report to provide context for Michigan's energy profile. For the purposes of this report, the Midwest will be defined as Ohio, Indiana, Illinois, and Wisconsin. Providing an accurate energy baseline will help ensure that any progress can be correctly measured. In addition to providing information about energy production and consumption, the Michigan Clean Energy Report will give an overview of four clean energy categories and the deployment of technologies in these areas. The categories identified for inclusion in this report are energy optimization, distributed generation, smart grid advances, clean economy jobs, and electric vehicles.

Energy Overview

A state's total energy use depends, in large part, on the size of its population and level of industrial activity. Population change drives demand for housing, commercial activity, and transportation. The nation's most populated states—Texas and California—consume the most energy each year (U.S. EIA June 27, 2014). Michigan, the eighth largest state, has a population of 9,883,640 and ranks eleventh in total energy consumption (U.S Census August 2011, U.S. EIA September 27, 2012). Industrial activity consumes more than one-third of all energy in the United States. Michigan's manufacturing industry has many energy-intensive segments, including automotive manufacturing, forest products, machinery manufacturing, fabricated metal products, and petroleum refining industries (U.S. EIA May 1, 2014). In 2014, Michigan's manufacturing output ranked seventh, making up 19 percent of gross state product (NMA n.d.).

Another factor that impacts total energy consumption is regional climate. Residential heating and cooling accounts for almost half of an average household's total energy consumption (U.S. EIA January 11, 2013). In an effort to measure the impacts of regional climate conditions on energy demand, the National Weather Service uses the degree day index. Degree days are a measure of the daily temperature variation from 65 degrees Fahrenheit[1]. The index divides degree days into heating and cooling days. In 2014, Michigan experienced fewer cooling degree days and more heating degree days than the averages of both the U.S. and the Midwest (NWS January 2, 2015). This leads to less energy demand for seasonal cooling and more energy consumed for home heating.

Heating and Cooling Degree Days, 2014



SOURCE: Source: National Weather Service (NWS). January 2, 2015. Degree Day Statistics. Available at: ftp://ftp.cpc.ncep.noaa.gov/htdocs/degree_days/weighted/daily_data/. (accessed on 2/24/15)

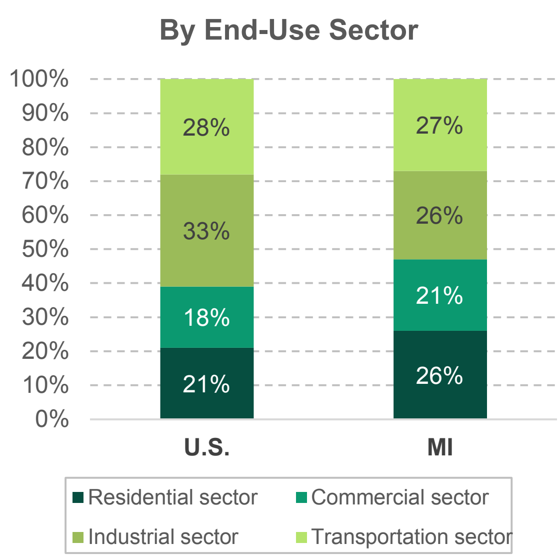
[1] A "heating degree day" is not a calendar day, but an index that measures the difference of a daily average temperature from 65 degrees Fahrenheit. For example, heating degree days for a station with daily mean temperatures during a seven-day period of 59, 50, 42, 36, 20, 10 and 45, are 6, 15, 23, 29, 45, 55, and 20, for a weekly total of 193 heating degree days (over the seven calendar days).

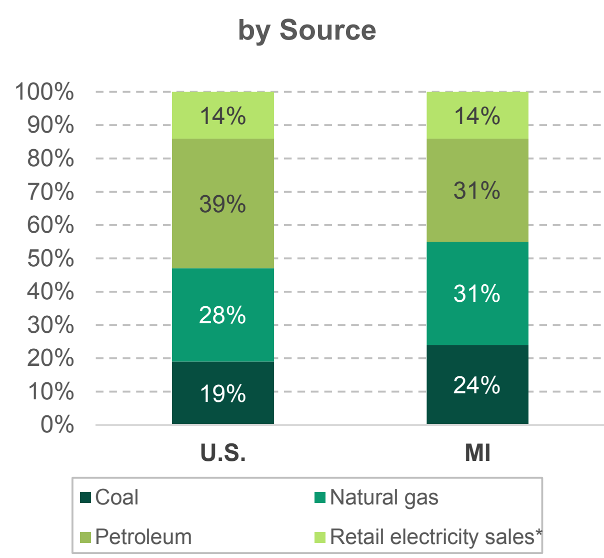
State-level Energy Consumption, Expenditure, and Price Estimates, 2010

	Michigan		Midwest	U.S.
Consumption (trillion Btu)	2798.1	11th	3110.4	1492.3*
Consumption per capita (million Btu)	283.3	35th	442.3	315.9
Expenditures (million dollars)	$34,540	10th	$33,282	$37,429
Expenditures per capita (dollars)	$3,497	41st	$3,850	$3,895
Prices (dollars/million Btu)	$18.22	26th	$17.02	$18.73

*Median consumption
SOURCE: U.S. Energy Information Administration. September 27, 2012. *State-Level Energy Consumption, Expenditure, and Price Estimates*. Available at: http://www.eia.gov/totalenergy/data/annual/pdf/sec1_15.pdf. (accessed on 1/18/15)

Energy Consumption, 2012



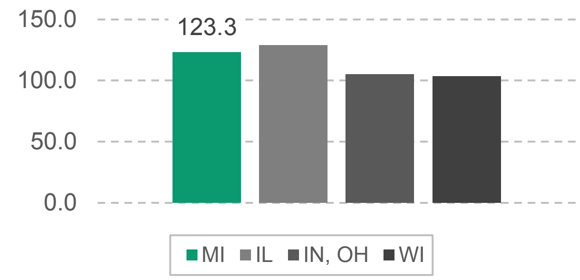


*Retail electricity sales combines energy produced from nuclear power, hydroelectric, wood, waste, geothermal, wind, photovoltaic, and solar thermal.
SOURCE: U.S. Energy Information Administration. June 27, 2014. *Energy Consumption per Capita by End-Use Sector, Ranked by State*. Available at: http://www.eia.gov/state/seds/sep_sum/html/pdf/rank_use_capita.pdf. (accessed on 1/18/15) and U.S. Energy Information Administration. June 27, 2014. *Energy Consumption by Source, Ranked by State, 2012*. Available at: http://www.eia.gov/state/seds/data.cfm?incfile=/state/seds/sep_sum/html/rank_use_source.html&sid=US pdf. (accessed on 1/18/15)

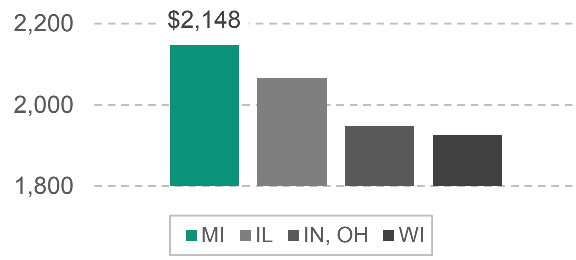
Household Energy Consumption

Michigan households use 38 percent more energy than the national average, according to the 2009 Residential Energy Consumption Survey performed by the U.S. Energy Information Administration. Due to Michigan's temperate climate and mild summers, residents consume less energy for air conditioning than the national average; however, Michigan residents consume 14 percent more energy for space heating (U.S. EIA January 11, 2013).

Total Site Energy Consumption per Household (mBtu), 2009

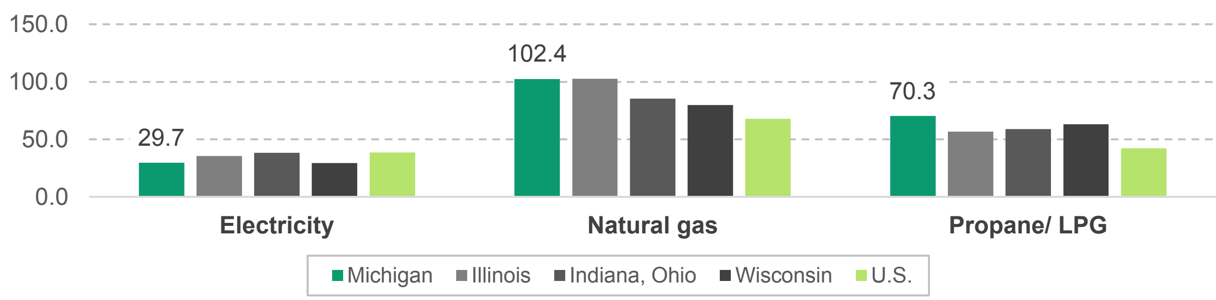


Energy Expenditure per Household (dollars), 2009

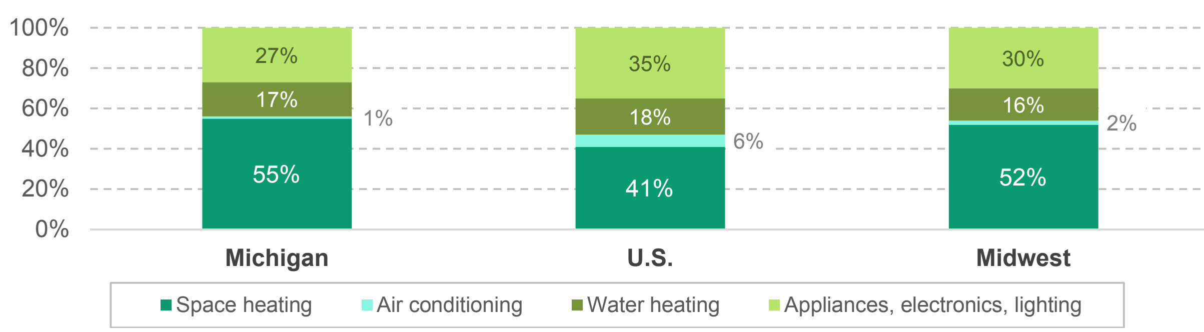


Data for Indiana and Ohio was combined in the 2009 Residential Energy Consumption Survey.
SOURCE: U.S. Energy Information Administration. January 11, 2013. *2009 Residential Energy Consumption Survey*. Available at: http://www.eia.gov/consumption/residential/data/2009/index.cfm?view=consumption. (Accessed on 1/18/15)

Average Household Energy Consumption by Fuel (mBtu), 2009



Household Energy Consumption by End Use, 2009

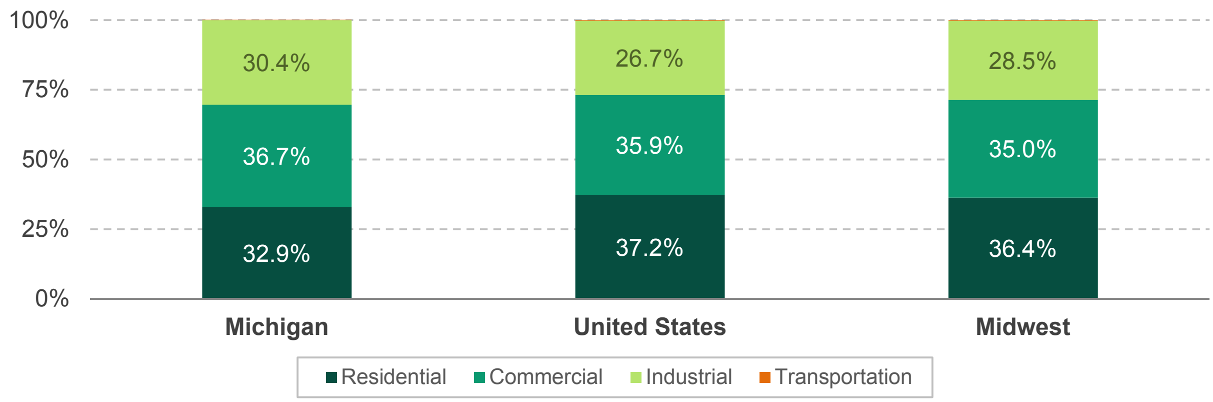


Electricity Consumption

There are three primary customer classes for electric consumption: industrial customers, commercial customers, and residential customers. These groups are organized by the characteristics of their energy use. Each customer class has a different rate structure based on the cost of providing electric service.

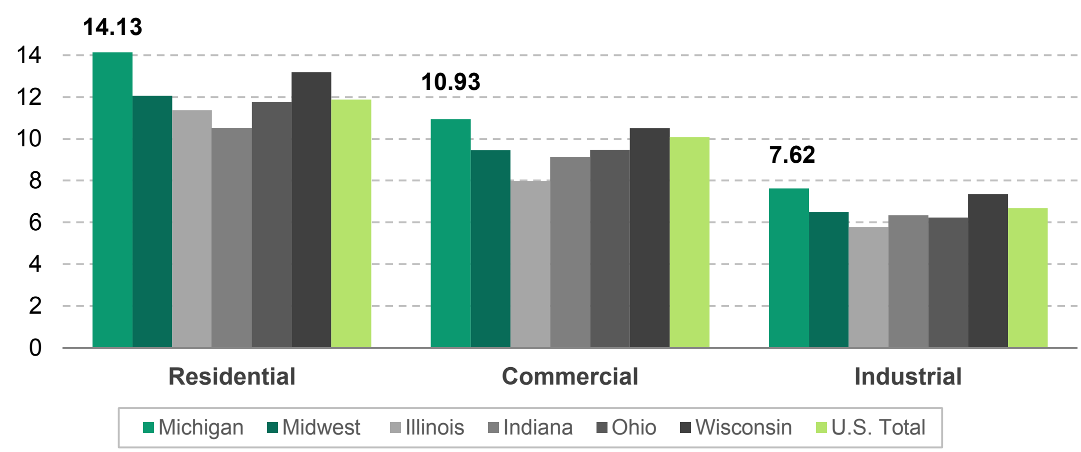
- In Michigan, residential customers consume less electricity than both the national and regional average.
- Michigan's electricity prices are above the national and regional average (U.S. EIA November 8, 2014).

Retail Sales of Electricity (MWhs), 2012



SOURCE: U.S. Energy Information Administration. November 8, 2013. Electric Sales, Revenue, and Price. Available at: http://www.eia.gov/electricity/data/state/sales_annual.xls. (Accessed on 1/18/15)

Average Retail Price of Electricity (cents/kWh), 2012



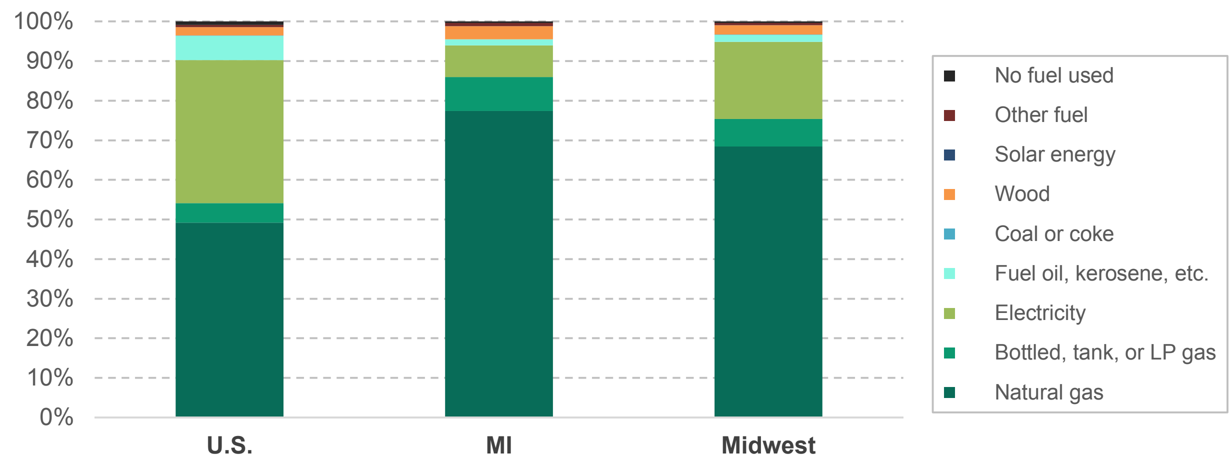
SOURCE: U.S. Energy Information Administration. November 8, 2013. *Electric Sales, Revenue, and Price.* Available at: http://www.eia.gov/electricity/data/state/sales_annual.xls. (Accessed on 1/18/15)

Natural Gas Consumption

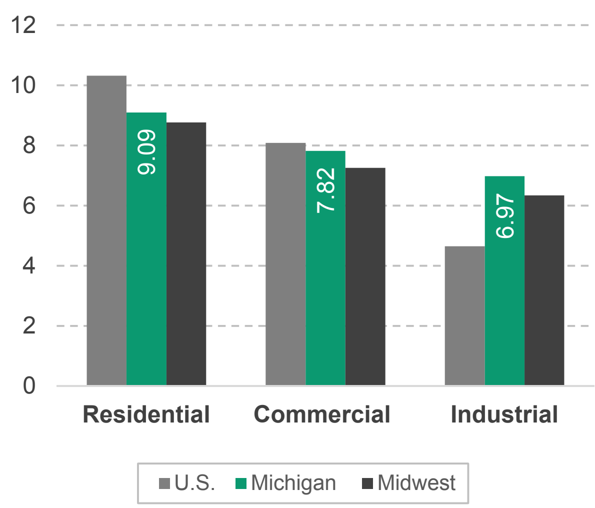
Cold Michigan winters drive the demand for home heating. In 2014, the state experienced 7,616 heating degree days—46.3 percent more than the national average (NWS January 2, 2015).

- Home heating makes up more than 50 percent of Michigan residents' total energy consumption.
- Michigan ranks in the top five for residential natural gas consumption.
- Nearly 80 percent of homes use natural gas as their primary heating fuel.
- Residential natural gas prices are lower than the national average.

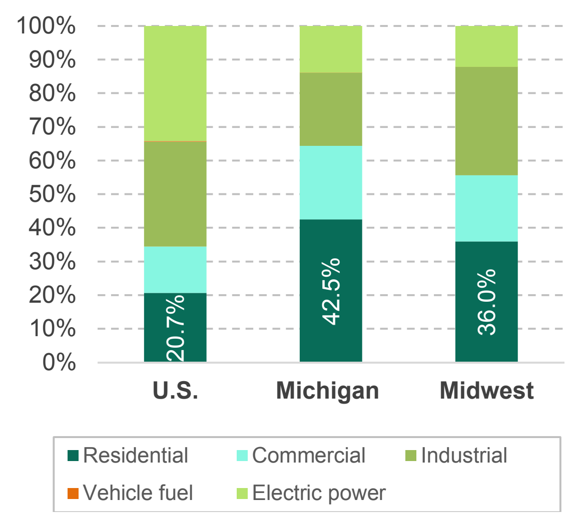
Household Heating Source, 2013



2013 Natural Gas Prices ($ / thousand cubic feet)



Natural Gas Consumption by End Use (million cubic feet, or Mcf)



SOURCES: U.S. Energy Information Administration. January 30, 2015. *Natural Gas Prices*. Available at: http://www.eia.gov/dnav/ng/ng_pri_sum_dcu_SMI_a.htm. (accessed on 1/18/15); U.S. Census Bureau. *2009-2013 5-Year American Community Survey*. Available at: http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=CF. (accessed on

1/14/15); and U.S. Census Bureau. *2009-2013 5-Year American Community Survey*. Available at: http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=CF. (accessed on 1/14/15)

Electric Generation Resources

Michigan's regulatory structure is referred to a "hybrid market," because it combines aspects of traditional regulation while allowing for a portion of customers to choose their supplier. Because of this market structure, there are two types of electric generators in Michigan: regulated utilities and independent power producers (IPPs) (U.S. EIA May 1, 2014).

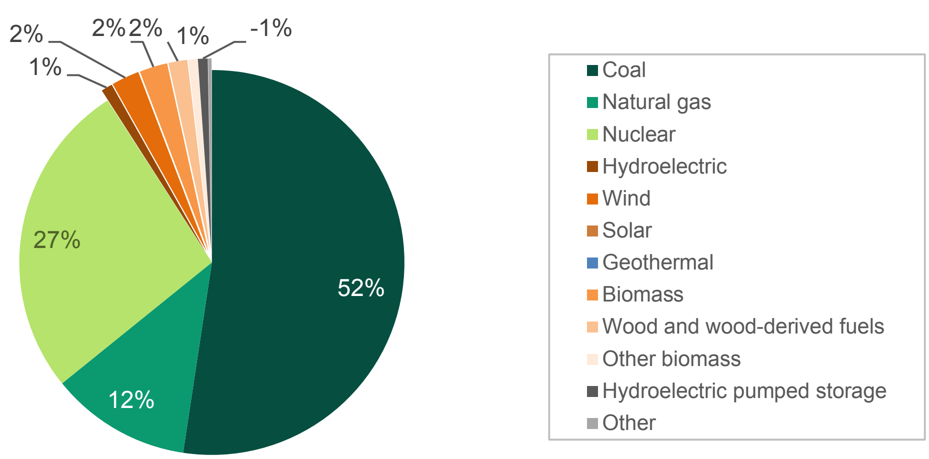
Michigan Electric Generating Capacity, 2012

	Capacity	State ranking
Net summer capacity (megawatts)	30,332	12
Electric utilities	22,517	9
Independent power producers and combined heat and power	7,815	14

SOURCE: U.S. Energy Information Administration. May 1, 2014. *State Electricity Profiles.* Available at: http://www.eia.gov/electricity/state/Michigan/. (accessed on 11/19/14)

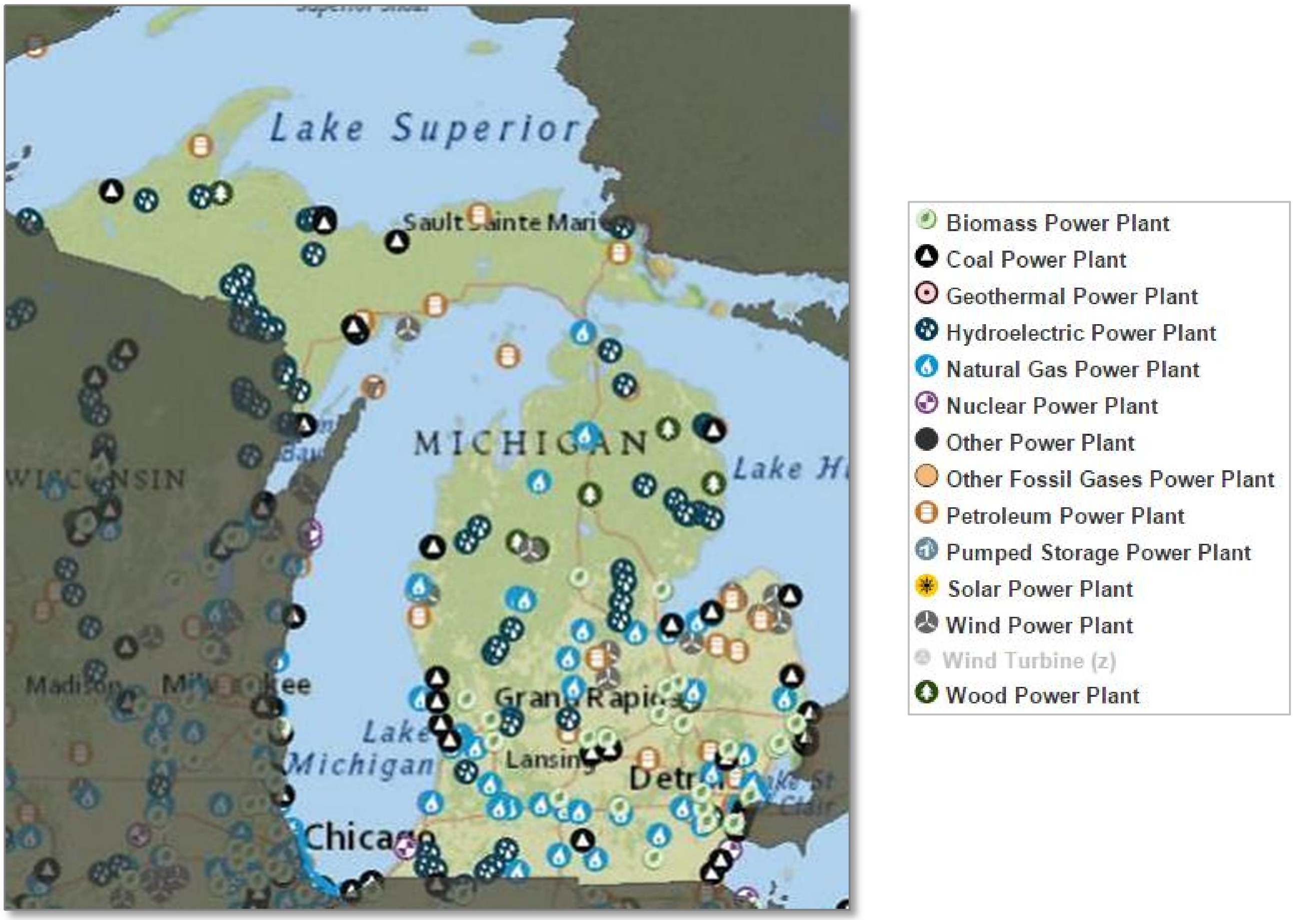
The main fuel sources for electric generation in Michigan are coal, natural gas, and nuclear. Together, these fuels are responsible for producing more than 90 percent of the state's electricity. In 2013, coal power plants produced 52 percent of the state's electricity (U.S. EIA November 2014).

Electricity Generation by Fuel Type, 2013



SOURCE: U.S. Energy Information Administration. November 2014. *Michigan State Profile and Energy Estimates*. Available at: http://www.eia.gov/state/?sid=MI. (accessed on 11/22/14).

Electric Generating Facilities

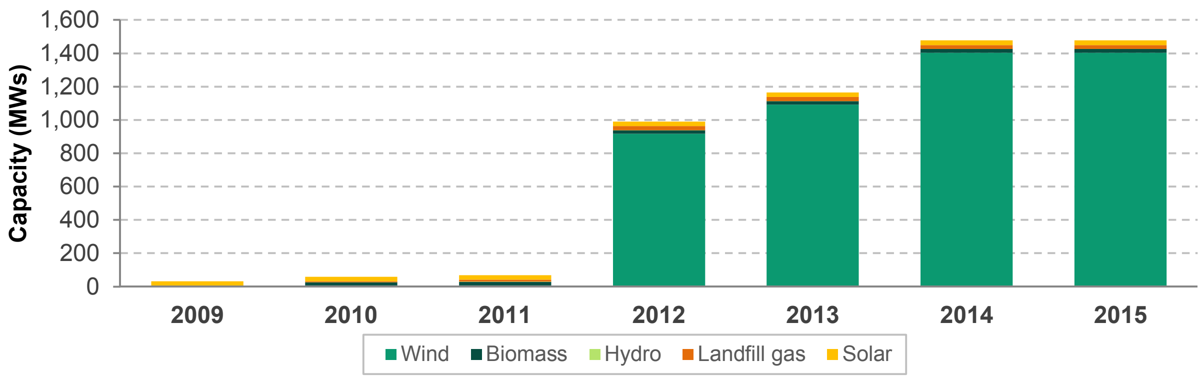


SOURCE: U.S. Energy Information Administration. November 2014. Michigan State Profile and Energy Estimates. Available at: http://www.eia.gov/state/?sid=MI. (accessed on 11/22/14)

Renewable Energy

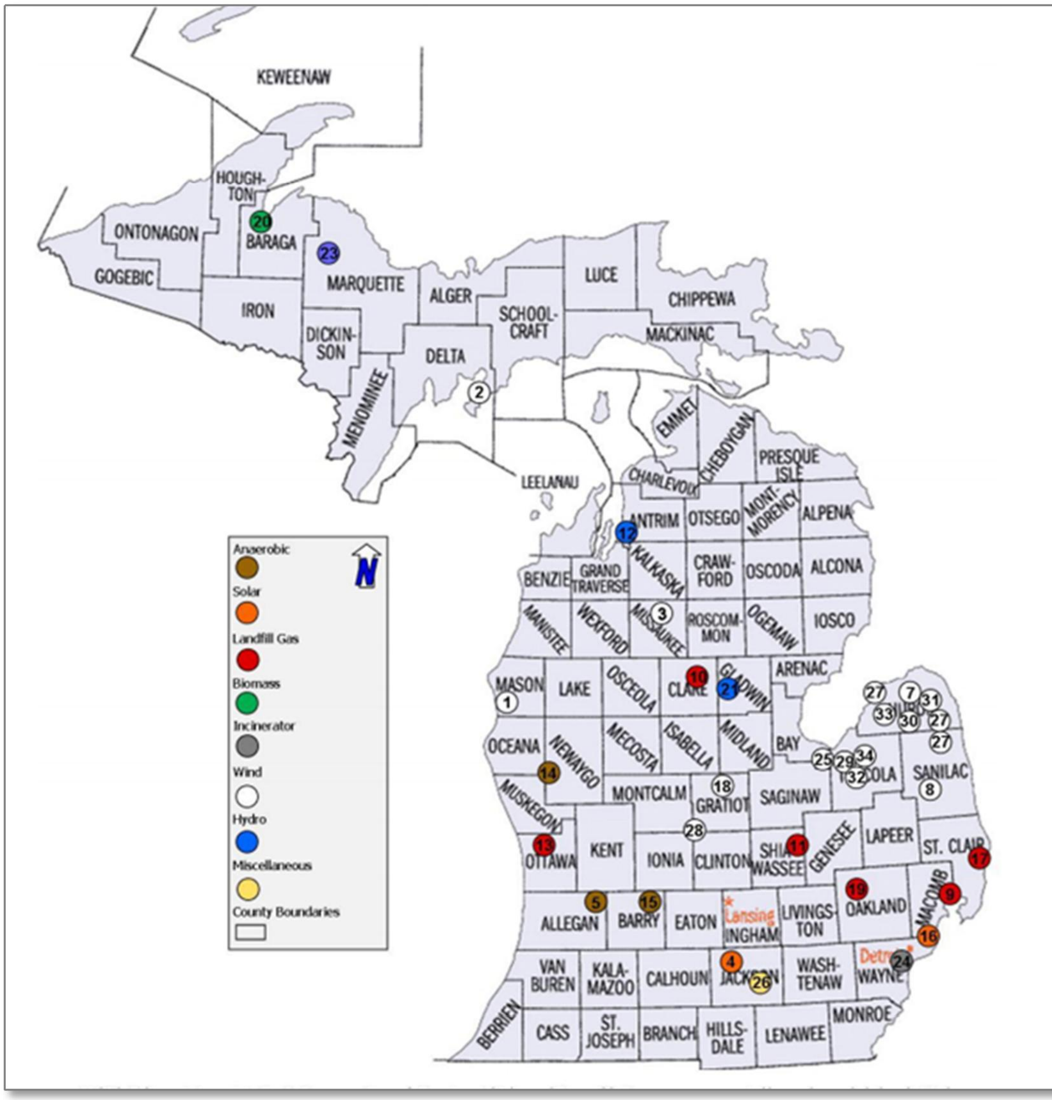
Renewable energy technologies have experienced a dramatic increase in deployment over the past decade. Since 2002, 29 states and the District of Columbia have enacted Renewable Portfolio Standards (RPS) and nine others have created renewable energy goals (DSIRE 2014). In 2008, the Michigan Legislature adopted Public Act 295—the Clean, Renewable, and Efficient Energy Act—which mandated that 10 percent of retail electric sales in the state be supplied by renewable sources (MPSC February 14, 2014). In response to this mandate, Michigan has experienced a growth in the deployment of clean energy technologies, especially wind turbines. Since 2008, nearly 1500 MW of renewable energy capacity has been installed and the MPSC expects that all providers will meet the ten percent requirement by 2015 (MPSC February 14, 2014).

PA 295 Contract Renewable Energy Capacity



SOURCE: Michigan Public Service Commission. February 14, 2014. *Report on the Implementation of the P.A. 295 Renewable Energy Standard and the Cost-Effectiveness of the Energy Standards.* Available at: http://www.michigan.gov/documents/mpsc/pa295report_447680_7.pdf. (accessed on 11/17/14)

Renewable Energy Projects (Based on PA 295 Contracts)



SOURCE: Michigan Public Service Commission. February 14, 2014. *Report on the Implementation of the P.A. 295 Renewable Energy Standard and the Cost-Effectiveness of the Energy Standards*. Available at: http://www.michigan.gov/documents/mpsc/pa295report_447680_7.pdf. (accessed on 11/17/14)

Planned Electric Generation

Michigan has historically been dependent on coal for generating electricity, but by investing in new generating sources the state's energy providers can shift away from coal and adopt cleaner technologies. In 2014, two new utility scale wind farms began producing electricity. There are plans for additional utility scale wind developments underway. In addition to planned renewable energy projects, there are also several new natural gas plants currently under construction in the state.

In their most recent projections, the Energy Information Administration (EIA) estimated that 74 percent of new electric capacity will be fueled by natural gas and 24 percent will come from renewable sources (U.S. EIA July 16, 2014).

New Utility Scale Generating Units in Service, 2014

Year in service	Entity name	Plant producer type	Plant name	Net summer capacity	Technology
2014	DTE Electric Company	Electric Utility	Echo Wind Park	60.8 MWs	Onshore Wind Turbine
2014	Pheasant Run Wind II, LLC	IPP	Pheasant Run Wind II	74.8 MWs	Onshore Wind Turbine

SOURCE: U.S. Energy Information Administration. October 24, 2014. Electric Power Monthly. Chapter 6.3. Available at: http://www.eia.gov/electricity/monthly/#tabs_unit-4. (accessed on 11/22/14).

Planned Electric Generating Capacity, August 2014

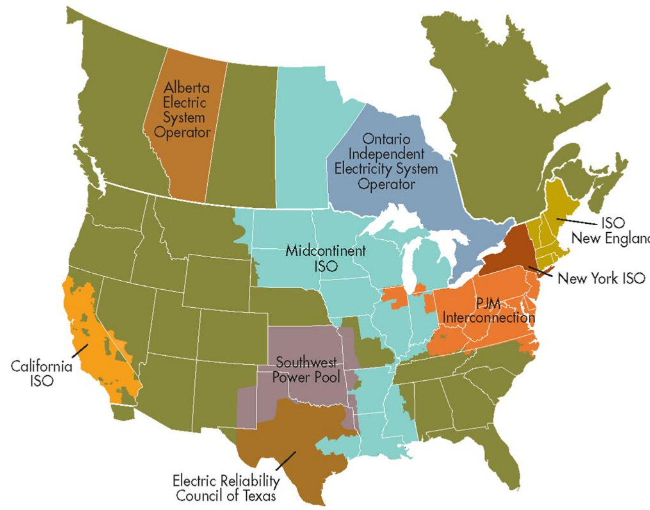
Expected completion year	Entity name	Plant producer type	Plant name	Net summer capacity (MW)	Technology
2014	Beebe 1B Renewable Energy, LLC	IPP	Beebe 1B	50.4	Wind turbine
Status: Under construction, more than 50 percent complete					
2014	Consumers Energy Co	Electric utility	Cross Winds Energy Park	105.4	Wind turbine
Status: Under construction, more than 50 percent complete					
2014	Heritage Garden Wind Farm I LLC	IPP	Big Turtle Wind Farm, LLC	20.0	Wind turbine
Status: Under construction, less than or equal to 50 percent complete					
2015	City of Lowell - (MI)	Electric utility	Chatham	3.2	Natural gas—CC
Status: Under construction, less than or equal to 50 percent complete					
2015	Enel North America, Inc.	IPP	Apple Blossom Wind Farm	100.0	Wind turbine
Status: Regulatory approvals pending. Not under construction.					
2016	City of Holland	Electric utility	Holland Energy Park	43.1	Natural gas–CC
Status: Under construction, less than or equal to 50 percent complete					

Expected completion year	Entity name	Plant producer type	Plant name	Net summer capacity (MW)	Technology
2016	City of Holland	Electric utility	Holland Energy Park	43.1	Natural gas–CC
Status: Under construction, less than or equal to 50 percent complete					
2016	City of Holland	Electric utility	Holland Energy Park	40.9	Natural gas–CC
Status: Under construction, less than or equal to 50 percent complete					

SOURCE: U.S. Energy Information Administration. October 24, 2014*. Electric Power Monthly. Chapter 6.5.* Available at: http://www.eia.gov/electricity/monthly/#tabs_unit-4 . (accessed on 11/22/14).

Regional Reliability Projections

Standards for reliability are governed by the North American Electric Reliability Corporation (NERC) and administered by Regional Transmission Organizations (RTOs). Michigan is served by two RTOs: the Midcontinent Independent System Operator (MISO) serves the majority of the state, while a portion of southwest Michigan belongs to the Pennsylvania, New Jersey, and Maryland Interconnection (PJM).

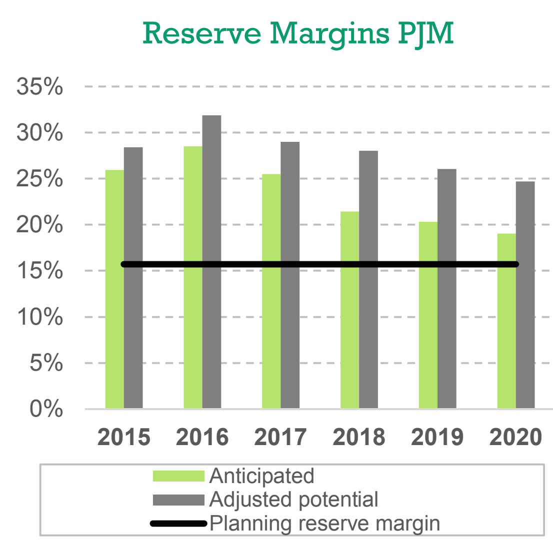


SOURCE: California ISO. N.d. *Opening Access.* Available at: http://www.caiso.com/about/Pages/OurBusiness/UnderstandingtheISO/Opening-access.aspx. (accessed on 1/22/15)

In order to ensure the reliable supply of electricity, providers need to maintain adequate resources to respond to increased consumer demand, unexpected generation outages, and numerous other factors that impact their ability to deliver electricity. RTOs assess their anticipated peak energy demand for the coming years and establish requirements for electric suppliers. These planning reserve margin requirements (PRMR) are designed to make sure that resources are available at all times.

In MISO, the PRMR for 2014–2015 is set at 14.8 percent. MISO projects that the reserve margin will drop below the 14.8 percent requirement by 2016. The primary driver of MISO's deficiency is the retirement of power plants in the RTO (NERC 2014).

PJM's PRMR for the same time period is 15.7 percent. PJM is expected to have an adequate reserve margin through the year 2020 (NERC 2014).

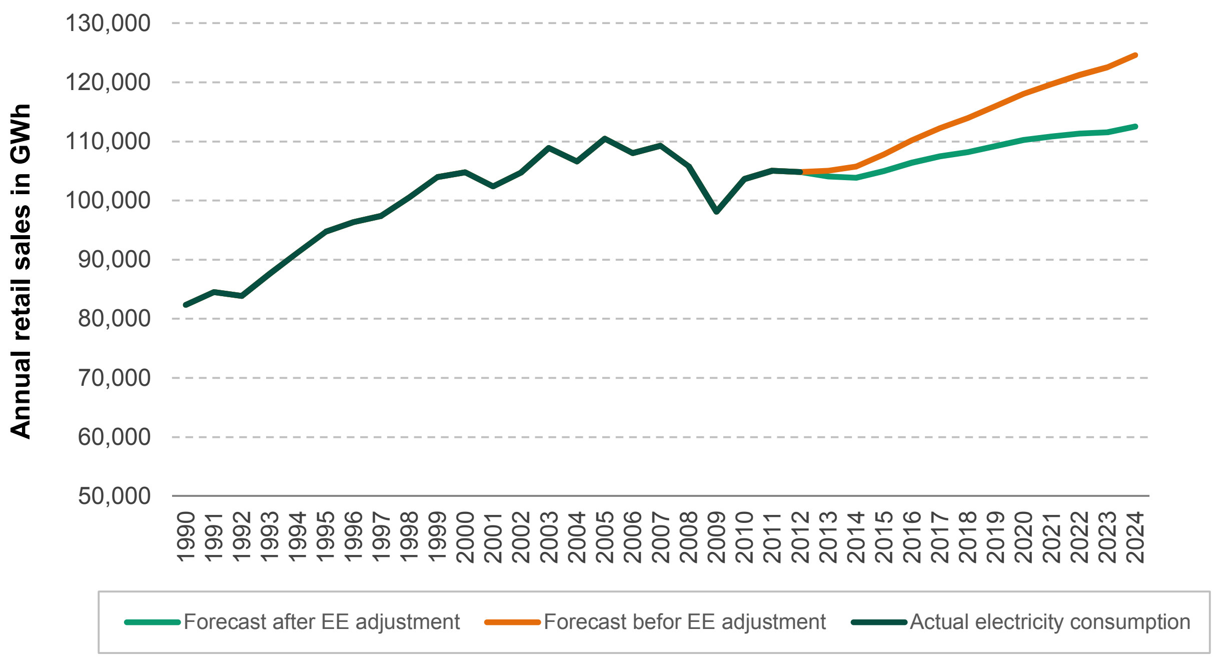


SOURCE: North American Electric Reliability Corporation. November 2014. *2014 Long-Term Reliability Assessment.* Available at: http://www.nerc.com/pa/RAPA/ra/Reliability%20Assessments%20DL/2014LTRA_ERATTA.pdf. (accessed on 12/1/14)

Electric Load Forecasts

Building a power plant can take years and, in some cases, cost billions. For energy providers to make wise investments, they must be able to accurately predict the growth in demand for electricity. Forecasting energy demand is a complex task that relies on a series of computer models and statistical tools. A recent forecast published by the State Utility Forecasting Group predicts that demand for electricity will grow at a modest pace of 1.62 percent over the next two decades. Like many other states, Michigan has established a target for energy-efficiency savings. When the demand forecast accounts for Michigan's 1 percent reduction in energy consumption, the state's projected growth slows to 0.77 percent for the next ten years (Gotham 2014).

Michigan Electric Load Forecast, 2014–2024



SOURCE: Douglas J Gotham et al. November 2014. *MISO Independent Load Forecast.* Available at: https://www.misoenergy.org/Library/Repository/Meeting%20Material/Stakeholder/PAC/2014/20141217/20141217%20PAC%20Supplemental%202014%20Independent%20Load%20Forecast.pdf. (accessed on 12/1/14)

Electric Transmission System

Electric transmission lines are like the interstate highways for energy delivery. These lines transport power from generators to the communities they serve. Due to Michigan's unique geographic composition, the state's two peninsulas are served by separate electric transmission companies. There are two primary electric transmission companies in Michigan; ITC Holdings Corporation (ITC) serves the Lower Peninsula and America Transmission Company (ATC) serves the Upper Peninsula. American Electric Power Company (AEP) operates the transmission system in the portion of southwest Lower Michigan that belongs to the PJM Interconnection. Below is a map of their service territories.

Service Territory Maps

ATC

ITC

AEP

SOURCES: American Transmission Company. N.d. *Service Territory.* Available at: http://www.atcllc.com/about-us/service-area/. (accessed on 1/22/15); ITC. N.d. *ITC Michigan.* Available at: http://www.itc-holdings.com/itc-michigan.html. (accessed on 1/22/15); and Indiana Michigan Power. N.d. *Service Territory.* Available at: https://www.indianamichiganpower.com/info/facts/ServiceTerritory.aspx. (accessed on 1/22/15)

Electric Transmission Line (≥345kV)

Major Electric Transmission Lines (≥ 345kV)

SOURCE: U.S. Energy Information Administration. November 2014. Michigan State Profile and Energy Estimates. Available at: http://www.eia.gov/state/?sid=MI. (accessed on 11/22/14)

Planned Electric Transmission Projects

Although Michigan's transmission lines are privately owned, due to federal laws, they are operated by RTOs. These regional entities coordinate the supply and delivery of electricity across their service territories. As a part of their role in overseeing the transmission grid, RTOs also coordinate regional transmission enhancement planning. Investments in the transmission grid are designed to improve regional reliability and lower the costs of energy delivery.

Nearly 90 percent of Michigan's transmission system is managed by the MISO. The MISO Transmission Expansion Planning (MTEP) process works to identify projects that will help meet reliability standards and enable competitive energy supply. The costs associated with expanded transmission are allocated to regions based on the benefit they will receive from a project. MISO's planning process identifies several Multi-Value Value Projects (MVP) during the annual planning process. These projects provide a range of economic and reliability benefits across the region. There are currently 17 regional multiple value transmission projects underway in MISO, see map below.

Each year, MISO participants submit projects for consideration. Projects are evaluated based on their ability to enhance local and regional reliability and produce economic benefits for consumers. The 2015 MTEP plan identified 14 transmission projects in Michigan. Similar to the transmission planning process used by MISO, the PJM Interconnection's Regional Transmission Expansion Planning (RTEP) seeks to improve reliability and enhance performance of the electric grid. The 2013 RTEP process identified eight transmission enhancement projects in southwest Michigan. A list of transmission expansion projects in Michigan is available in Appendix A.

Energy Optimization Programs

Energy optimization (EO) programs help eliminate energy waste and promote efficient energy use. In 2008, the Michigan Legislature created mandatory EO targets as a part of Public Act 295. The law requires that natural gas and electric utilities achieve annual reductions in energy sales of 0.75 percent for natural gas and one percent for electricity (MPSC November 26, 2014). The annual reduction targets will be maintained in perpetuity until spending on EO programs reaches the cap imposed by the Legislature. To control costs for EO programs in the state, utilities' EO spending is capped at 2 percent of total sales revenue per year.

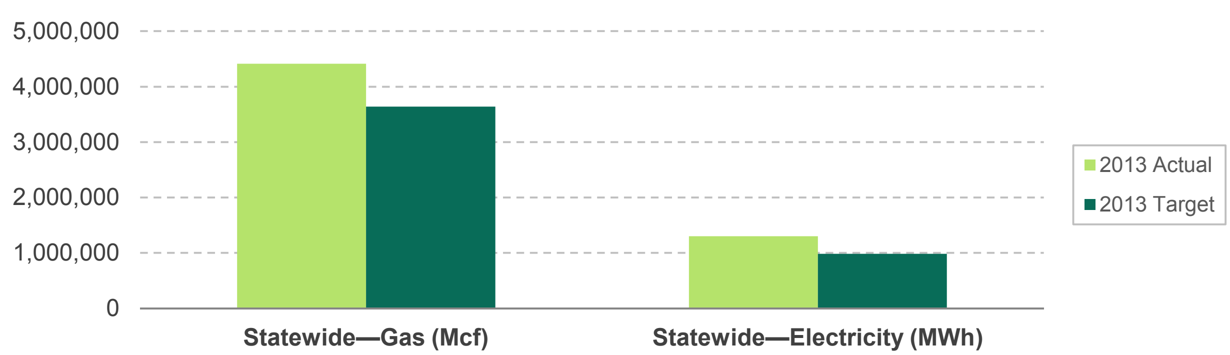
Energy efficiency can refer to any number of improvements that help reduce the amount of energy needed to continue providing the same service (Lawrence Berkley National Laboratory n.d. b). Examples of energy-efficient products include new lighting technologies, double-paned windows, and Energy Star appliances.

In compliance with the law the Michigan Public Service Commission (MPSC) publishes an annual report detailing the success of energy-efficiency programs within the state (MPSC November 26, 2014). By 2013, Michigan energy providers had achieved 132 percent of their electric energy-efficiency targets and 121 percent of their gas energy-efficiency targets.

- The average electric residential customer is expected to save $3.61 each month of the Energy Optimization program life.
- The average natural gas residential customer is expected to save $2.91 each month of the Energy Optimization program life.

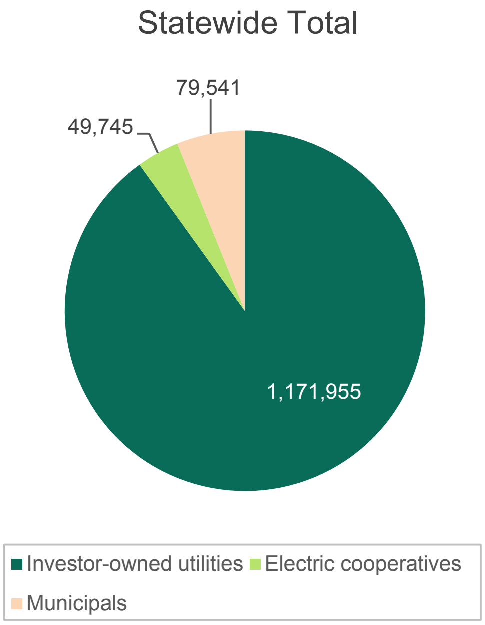
> In 2013, aggregate EO program expenditures of $253 million by all natural gas and electric utilities in the state are estimated to result in lifecycle savings to customers of $948 million. For every dollar spent on EO programs in 2013, customers should expect to realize benefits of $3.75.
>
> *– 2014 Report on the Implementation of P.A. 295 Utility Energy Optimization Programs*

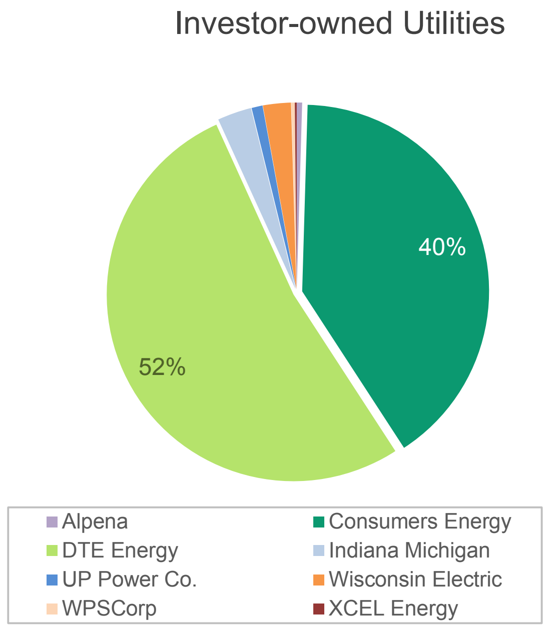
Implementation of Energy Optimization Programs in Michigan



SOURCE: Michigan Public Service Commission. November 26, 2014. 2014 Report on the Implementation of P.A. 295 Utility Energy Optimization Program. Available at: http://michigan.gov/documents/mpsc/2014_eo_report_475141_7.pdf. (accessed on 12/10/14)

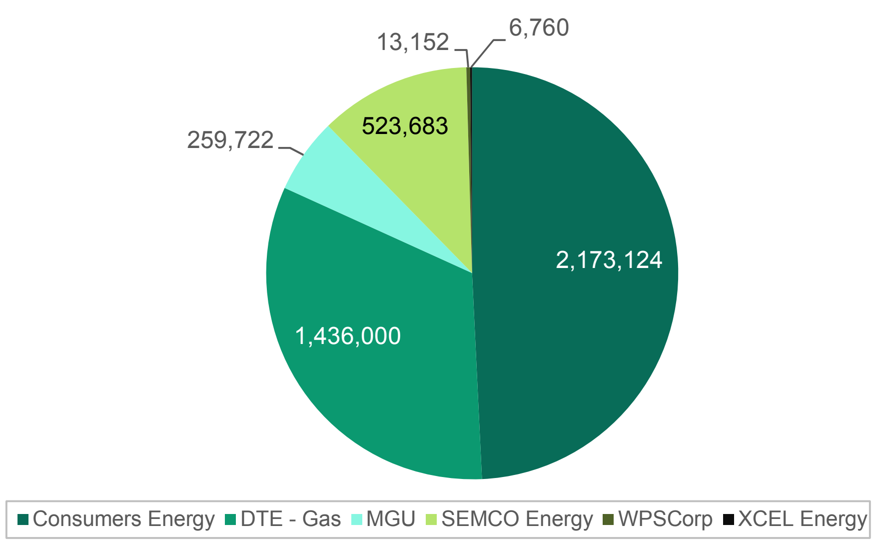
2013 Energy Efficiency Program Savings—Electric (MWhs)





SOURCE: Michigan Public Service Commission. November 26, 2014. *2014 Report on the Implementation of P.A. 295 Utility Energy Optimization Program.* Available at: http://michigan.gov/documents/mpsc/2014_eo_report_475141_7.pdf. (accessed on 12/10/14)

2013 Energy Efficiency Program Savings—Gas (Mcf)



SOURCE: Michigan Public Service Commission. November 26, 2014. *2014 Report on the Implementation of P.A. 295 Utility Energy Optimization Program.* Available at: http://michigan.gov/documents/mpsc/2014_eo_report_475141_7.pdf. (accessed on 12/10/14)

Smart Grid Technologies

Developments in making the electric grid more intelligent will play a major role in shaping peoples consumption patterns. The first of its kind, the GridWise Alliance (GWA) and the Smart Grid Policy Center (SGPC) published a “Grid Modernization Index” (GMI) to rank and analyze states and the District of Columbia based upon the degree to which those jurisdictions have moved toward a modernized electric “Grid of the Future.” The GMI consists of three components (GridWise Alliance 2014):

- **State support**: State policies and regulatory mechanisms that facilitate grid investment
- **Customer engagement:** Investments throughout the state in customer-enabling technologies and capabilities
- **Grid operations:** Investments throughout the state in grid-enhancing technologies and capabilities

Michigan scored **1st quartile** performance in the 2014 Grid Modernization Index.

> The “smart grid” refers to the process of integrating modern technology into the existing electrical power grid to improve reliability, power quality, and efficiency. This process will enable each component of the grid the ability to "talk" and "listen" in order to improve electricity delivery from the utility companies to consumers.
>
> *—MPSC, December 2011*

One aspect of the smart grid is the deployment of Advanced Metering Infrastructure (AMI), commonly referred to as smart meters. Traditionally, utilities would read an energy meter every billing period and customers would be charged for the number of units consumed. Smart meters allow utilities to collect accurate information about when energy is used. This information enables customers to participate in demand response programs where they can tailor their electricity consumption during peak use periods. Because energy supply needs to match demand at all times, when energy consumption peaks during the day, additional power plants are dispatched to meet high demand. These peaking plants are generally more expensive to run, but by reducing peak energy demand through demand response, both utilities and customers save money.

The two largest utilities in Michigan—Consumers Energy and DTE Energy—are currently in the process of upgrading to AMI. DTE Energy’s deployment plan was initiated through a pilot in 2009. The company currently has nearly 700,000 meters installed. In total, DTE Energy is scheduled to install 2.6 million smart meters. The company received a Department of Energy grant through the American Recovery and Reinvestment Act (ARRA) that will reimburse 50 percent of costs up to a predetermined grant cap (MPSC June 2012). Consumers Energy also began pilot testing smart meters in 2009. As of 2012, the company has installed more than 50,000 meters and intends to replace 1.9 million meters by 2017.

Advanced Metering Infrastructure Deployment by Utility, 2012

Utility Name	Number of Meters
The DTE Electric Company	693,870
Great Lakes Energy Coop	123,356
Consumers Energy Co	53,134
Cherryland Electric Coop Inc.	34,807
Tri-County Electric Coop	25,555
City of Marquette - (MI)	16,539
City of Lowell - (MI)	205
Bayfield Electric Coop, Inc.	68
Presque Isle Elec & Gas Coop	12

SOURCE: U.S. Energy Information Administration. October 29, 2013. Electric power sales, revenue, and energy efficiency Form EIA-861 detailed data files. Available at: http://www.eia.gov/electricity/data/eia861/. (Accessed on 11/19/14)

Statewide Net Metering

Net metering enables customers to develop onsite renewable energy projects that produce electricity to meet their individual needs and reduce their electric bills.

Michigan allows net metering projects that fit into one of three categories (MPSC August 2014).

- **Category 1 net metering:** Projects up to 20 with inverter.
- **Category 2 net metering:** Projects greater than 20 kW and no larger than 150 kW and noninverter based 20 kW and under projects.
- **Category 3 net metering:** Methane digester projects up to 550 kW.

Net Metering Program—Customer and Capacity Data

2012	
Number of customers	1,330
Installations	1,406
Capacity (kw)	9,583

2013	
Number of customers	1,527
Installations	1,631
Capacity (kw)	11,339
% Change in capacity	+ 18.3%

SOURCE: Michigan Public Service Commission. August 2014. *Net Metering and Solar Pilot Program Report for Calendar Year 2013.* Available at: http://www.michigan.gov/documents/mpsc/netmetering_report_2013_464591_7.pdf?20141113104742. (accessed on 11/13/14)

Net Metering Program Customer and Capacity Data, 2013

	Category 1		Category 2		Category 3	
Company	Customers	Nameplate generation (kW)	Customers	Nameplate generation (kW)	Customers	Nameplate generation (kW)
Alger Delta	21	71				
Alpena	19	54				
Cherryland	31	94				
Cloverland Electric Coop	27	93				
Consumers Energy	244	1,255	13	842		
DTE Energy	897	6,621	15	719		
Direct Energy	1	3				
Great Lakes Energy	65	298			1	400
Homeworks Tri-County	11	45				
Indiana Michigan (AEP)	29	116				
Midwest	21	102				
Ontonagon	14	48				
Presque Isle	22	93				

Company	Category 1		Category 2		Category 3	
	Customers	Nameplate generation (kW)	Customers	Nameplate generation (kW)	Customers	Nameplate generation (kW)
Thumb	13	124	1	40		
UPPCo	54	205				
We Energies	22	102				
WPSC	5	12				
Xcel	1	4				
Total	**1,497**	**9,338**	**29**	**1,601**	**1**	**400**

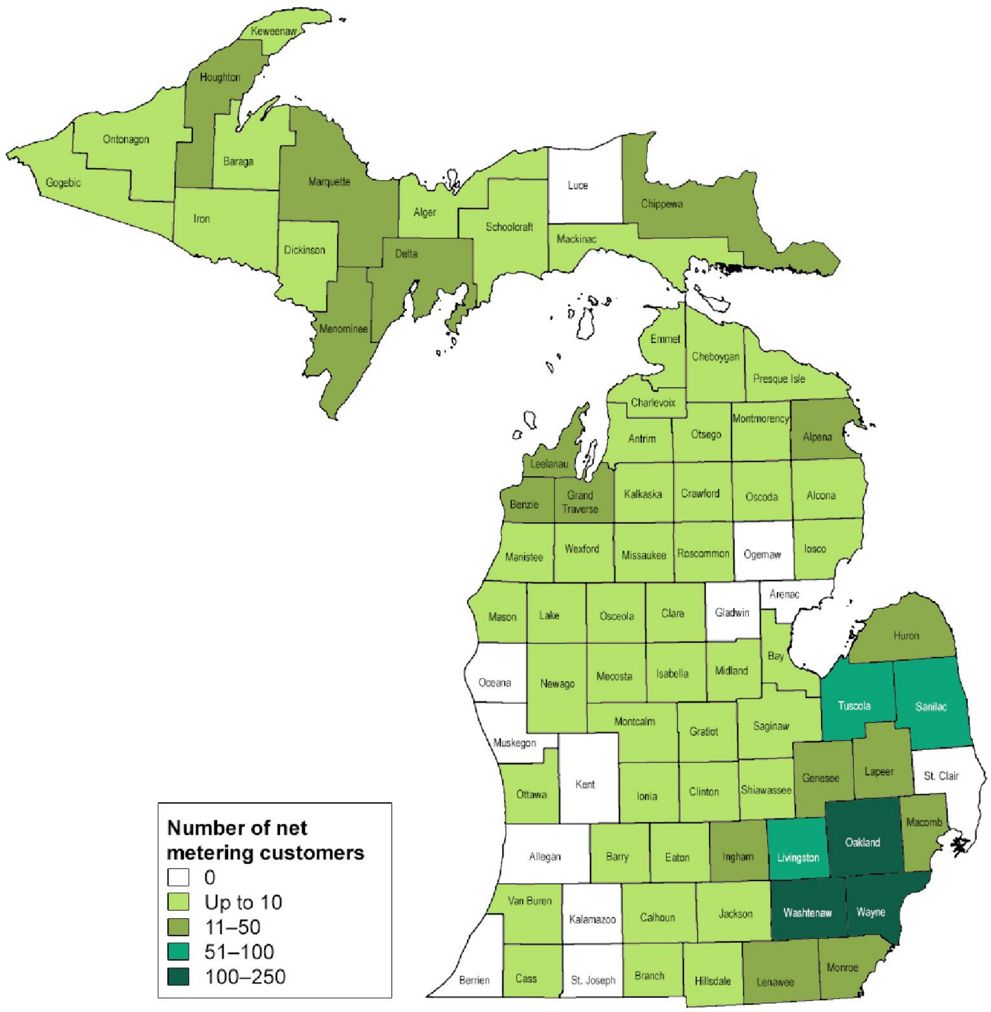
Alger Delta, Cherryland, Great Lakes, Ontonagon, Presque Isle, and Tri-County are member-regulated cooperatives and are not required to offer net metering.

Type of Net Metering Project by Service Provider, 2012

Utility Name	Solar (Photovoltaic)		Wind	
	# of meters	Capacity KW	# of meters	Capacity KW
The DTE Electric Company	703	6,920	58	575
Consumers Energy Co	143	1,130	96	501
Great Lakes Energy Coop	38	140	28	128
Upper Peninsula Power Co	29	100	21	58
Alger-Delta Coop Electric Assn	14	50	4	13
Midwest Energy Cooperative	14	30	7	272
Cherryland Electric Coop	12	30	15	42
Indiana Michigan Power Co	12	60	14	48
Tri-County Electric Coop	10	30	1	6
Cloverland Electric Coop	6	20	20	66
Wisconsin Electric Power Co	5	10	7	57
Wisconsin Public Service Corp	3	10	2	5
City of Escanaba	3	110	2	103
City of Traverse City - (MI)	2	40	0	0
City of Norway	1	10	0	0
Presque Isle Elec & Gas Coop	1	0	20	54
Alpena Power Co	0	0	18	507
Hillsdale Board of Public Wks	0	0	1	10
City of Holland	0	0	4	16

SOURCE: U.S. Energy Information Administration. October 29, 2013. Electric power sales, revenue, and energy efficiency Form EIA-861 detailed data files. Available at: http://www.eia.gov/electricity/data/eia861/. (accessed on 11/19/14)

Number of Net Metering Customers by County, 2013



SOURCE: Michigan Public Service Commission. August 2014. *Net Metering and Solar Pilot Program Report for Calendar Year 2013.* Available at: http://www.michigan.gov/documents/mpsc/netmetering_report_2013_464591_7.pdf?20141113104742. (accessed on 11/13/14)

Microgrids

A microgrid is a localized power grid that has the ability to disconnect from the bulk power grid and operate autonomously. Microgrids can play an important role in transforming the nation's electric grid away from large centrally located power producers to distributed energy resources (U.S. DOE n.d. a).

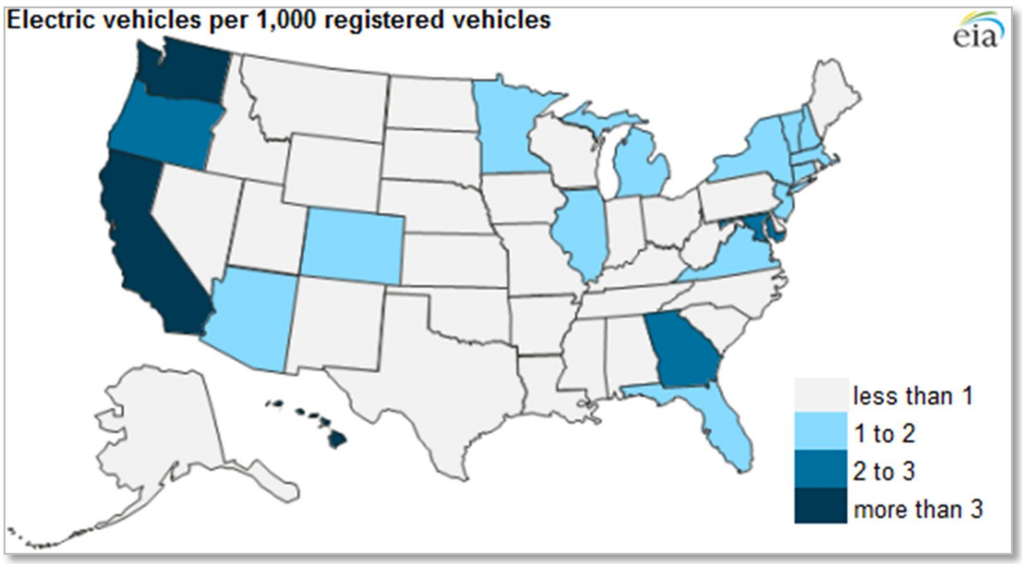
> Advantages of microgrids include: improved energy efficiency, minimization of overall energy consumption, reduced environmental impact, improvement of reliability of supply, network operational benefits such as loss reduction, congestion relief, voltage control, or security of supply and more cost efficient electricity infrastructure replacement.
>
> *— "About Microgrids," Lawrence Berkley National Laboratory*

Currently, there is one microgrid in Michigan: the Microgrid Power Pavilion, which is operated by NextEnergy. It was completed in 2005, and serves as a host site for research and development of innovative energy technologies (Science Direct 2003). Analysis of the Next Energy microgrid shows that the project will produce a 34 percent reduction in total energy use and reduce nitrous oxide and carbon dioxide emissions by more than 65 percent, when compared with the conventional system (Baron 2004).

Electric Vehicle Infrastructure

Of the more than 226 million registered vehicles in the United States, only 70,000 are battery electric vehicles (EVs) and 104,000 are plug-in hybrid electric vehicles (PHEVs). While sales of new plug-in electric vehicles (PEVs) have grown slightly over the past five years, they only accounted for 0.7 percent of new vehicle sales in 2014(U.S EIA December 2014). Michigan ranks seventh for the adoption of electric vehicles (Clean Energy Coalition n.d.).

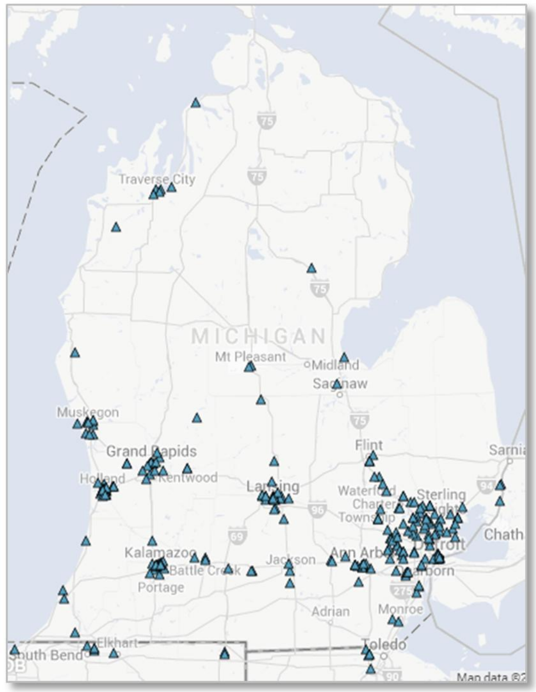
Adoption of Electric Vehicles



SOUCE: U.S. EIA. December 2014. *California leads the nation in the adoption of electric vehicles.* Available at: http://www.eia.gov/todayinenergy/detail.cfm?id=19131#. (accessed on 1/19/15)

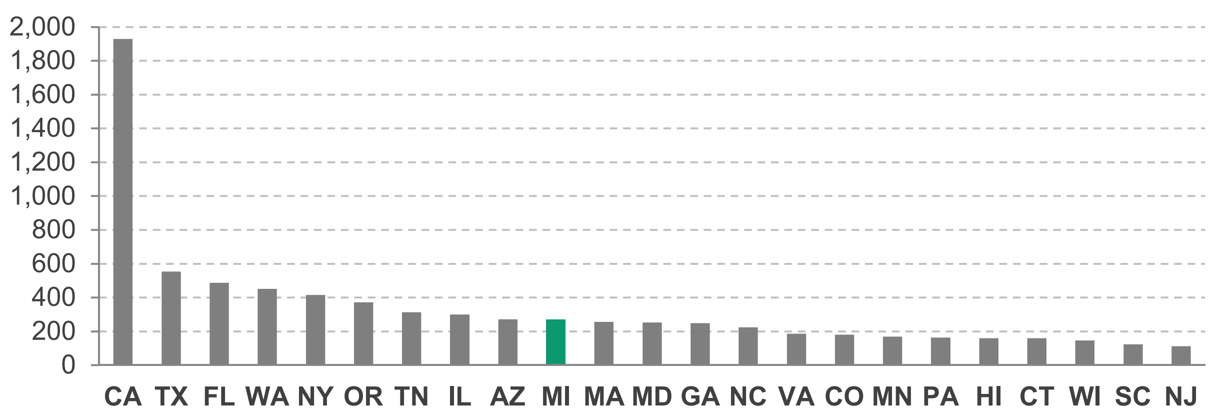
According to the Department of Energy's database, Michigan has 270 public charging stations and 711 public electric vehicle charging outlets (U.S. DOE n.d. b). There are currently no state incentives for the purchase of PEVs, but DTE Energy, Consumers Energy, and Indiana Michigan Power have programs offering special rates for PEV charging or rebates on charging stations.

Electric Vehicle Charging Stations



SOURCE: U.S. DOE. N.d. *Alternative Fueling Station Locator.* Available at: http://www.afdc.energy.gov/fuels/electricity_locations.html. (accessed on 11/18/14)

Number of Charging Stations (excluding private)



SOURCE: U.S. DOE. N.d. *Alternative Fueling Station Locator.* Available at: http://www.afdc.energy.gov/fuels/electricity_locations.html. (accessed on 11/18/14)

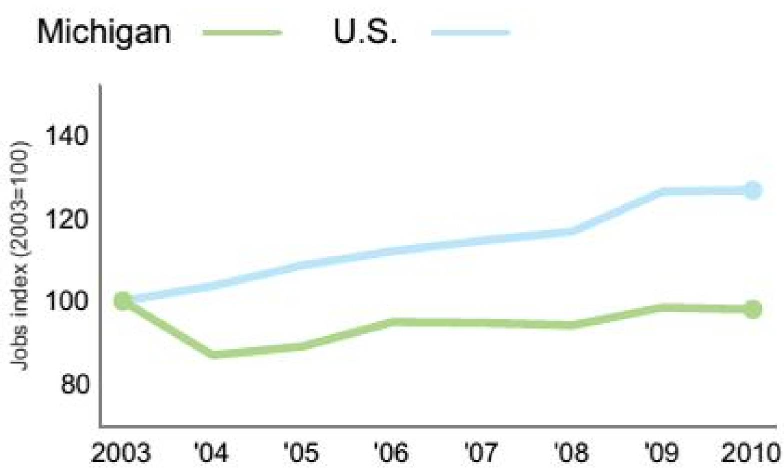
Clean Energy Jobs

One aspect of the growth in clean energy technologies that is particularly attractive to state and local officials is the promise of job creation. The Michigan Green Jobs Report, published in 2009, stated, “The new green economy provides Michigan a dynamic opportunity to rebuild the state’s job base, attract new investment, and diversify the state’s economy. We may be at a tipping point of awareness, understanding, and opportunities that a green economy can provide for Michigan’s workforce, businesses, and communities” (MI DELEG May 2009). Reporting about clean energy jobs has been limited. Michigan’s 2009 report was the first and only state-sponsored survey conducted. The national Green Goods and Services Survey, conducted by the Bureau of Labor and Statistics, was last published in 2011. In the absence of government-sponsored surveys, there is no recent information about the changes in green employment.

A 2011 study conducted by the Metropolitan Policy Program at the Brookings Institute represents the most recent information available. The report, *Sizing the Clean Economy,* provides a state-by-state breakdown of employment in the clean economy (Muro 2011). Not all clean economy jobs captured in the study specifically relate to clean energy. The largest employment sectors in the clean economy are green consumer products, waste management and treatment, public mass transit, energy-saving building materials, and organic farming. Approximately 41 percent of employment in the clean economy is in energy-related fields (Muro 2011 p. 20).

- Michigan ranks 12th with 76,941 clean jobs in 2010.
- Clean jobs represent 1.9 percent of total employment.

Clean Economy Job Growth, 2003–2010



SOURCE: Mark Muro et al. July 13, 2011. *Sizing the Clean Economy: A National and Regional Green Jobs Assessment*. Available at http://www.brookings.edu/~/media/research/files/reports/2011/7/13%20clean%20economy/0713_clean_economy.pdf. (accessed on 2/10/15)

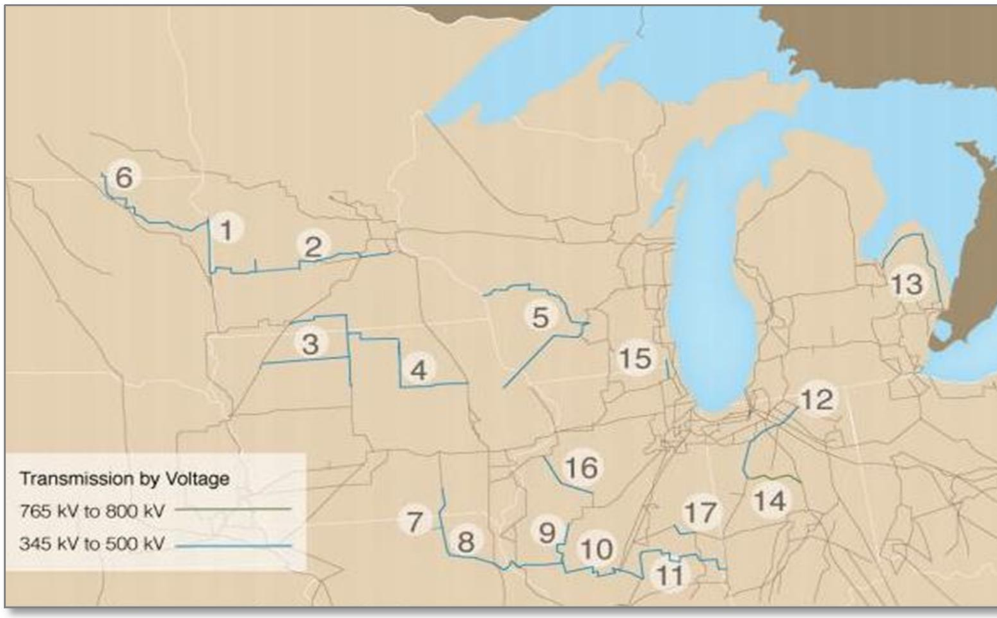
Appendix A: Planned Transmission Upgrades

2014 MTEP Michigan Projects

Project name	Project description	Sum of estimated cost ($)	Submitting company
Hersey to Weidman	Hersey to Weidman line rebuild	$11,700,000	Wolverine Power Supply Cooperative Inc.
Goss 345/138 kV Transformer #2	Install a second 345/138 kV transformer and install/upgrade station equipment at Goss	9,300,000	Michigan Electric Transmission Co.
Advance Station Upgrade	Replace one oil breaker and replace electromechanical relaying with digital relaying	2,250,000	Wolverine Power Supply Cooperative Inc.
Vestaburg Transmission	Convert transfer bus to straight bus, replace old station switches, and upgrade relaying to add a sparing scheme	170,000	Wolverine Power Supply Cooperative Inc.
Atlanta Transmission	Replace outdated and unreliable switches on the bus and replace transformer bushings	250,000	Wolverine Power Supply Cooperative Inc.
Gaylord OCB	Replace oil breaker and upgrade battery bank and relaying for 125VDC operation	350,000	Wolverine Power Supply Cooperative Inc.
Temple Substation	Interconnection request for a new 120 kV, 3 transformer distribution substation named Temple	18,400,000	ITC Transmission
Install 138 kV Presque Isle Redundant Bus Differentials	This project consists of installing redundant bus differential protection on the Presque Isle buses 1 through 7.	549,026	American Transmission Co. LLC
69101—Howe to Sturgis	Rebuild Circuit 69101	2,200,000	Northern Indiana Public Service Company
Amber—Donaldson Creek 138 kV Rebuild	Rebuild approx. 19.8 miles of the Amber to Donaldson Creek 138 kV circuit.	19,500,000	Michigan Electric Transmission Co.
Beals Road 138 kV Station Equipment Replacement	Replace 138 kV terminal equipment within the Beals Road Substation	400,000	Michigan Electric Transmission Co.
Brownstown—Monroe #2 345 kV Sag Remediation	Remediate the sag limit on the Brownstown to Monroe #2 345 kV line	1,200,000	ITC Transmission
Warren—Bard Road 138 kV Rebuild	Rebuild approximately 19.6 miles of the Warren to Bard Road 138 kV circuit to 230 kV double circuit construction using 954 ACSR	27,800,000	Michigan Electric Transmission Co.
Chase - Mecosta 138kV Rebuild	Rebuild 7.2 miles of 138kV 110 and 115 CU to 954 ACSR. Prebuild to 230kV construction	8,900,000	Michigan Electric Transmission Co.

SOURCE: Midcontinent Independent System Operator, Inc. November 11, 2014. *MISO Transmission Expansion Planning 2015.* Available at: https://www.misoenergy.org/Planning/TransmissionExpansionPlanning/Pages/MTEP15.aspx. (accessed on 1/5/15)

MTEP 2014 Multi-Value Projects



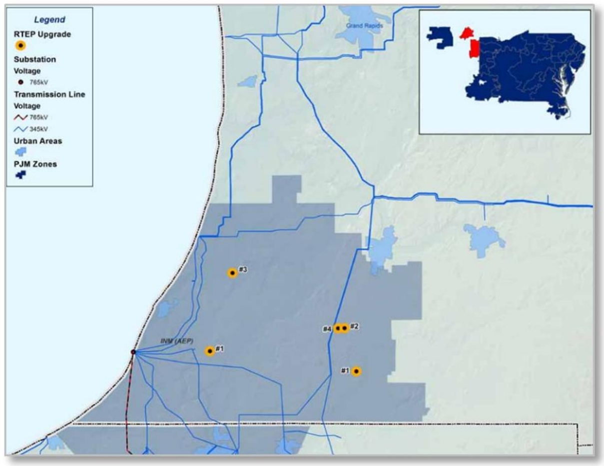
SOURCE: Midcontinent Independent System Operator, Inc. November 11, 2014. *MISO Transmission Expansion Planning 2015.* Available at: https://www.misoenergy.org/Planning/TransmissionExpansionPlanning/Pages/MVPAnalysis.aspx (accessed on 1/5/15)

2013 PJM Interconnection RTEP Michigan Projects

Project Name	Project description	Sum of estimated cost ($)	Submitting company
Riverside 138 kV station	Revise the capacitor setting at Riverside 138 kV station	$100,000	AEP Transmission
New Galien station	Retire the existing Galien station and move its distribution load to New Galien station. Retire the Buchanan Hydro—New Carlisle 34.5 kV line	0	AEP Transmission
Cook 69 kV	Implement an in-and-out scheme at Cook 69 kV by eliminating the Cook 69 kV tap point and by installing two new 69 kV circuit breakers	0	AEP Transmission
Bridgman–Cook 69 kV and the Derby–Cook 69 kV lines	Rebuild the Bridgman—Cook 69 kV and the Derby—Cook 69 kV lines	0	AEP Transmission
Pokagon - Corey 69 kV	Rebuild the Pokagon—Corey 69 kV line as a double circuit 138 kV line with one side at 69 kV and the other side as an express circuit between Pokagon and Corey stations	65,000,000	AEP Transmission
Moore Park–Schoolcraft 69 kV line	Rebuild about eight miles of existing Moore Park - Schoolcraft 69 kV line as 138 kV	6,500,000	AEP Transmission
Hartford to Keeler	Construct a new 69 kV line from Hartford to Keeler (~eight miles)	30,000,000	AEP Transmission
Establish a new 138/12 kV station	Establish a new 138/12 kV station, transfer and consolidate load from its Nicholsville and Marcellus 34.5 kV stations at this new station	$15,000,000	AEP Transmission

SOURCE: PJM Interconnection. 2014. *2013 PJM Regional Transmission Plan.* Available at: http://www.pjm.com/documents/reports/rtep-documents/2013-rtep.aspx. (accessed on 1/5/15)

RTEP 2013 Projects



SOURCE: PJM Interconnection. 2014. *2013 PJM Regional Transmission Plan.* Available at: http://www.pjm.com/documents/reports/rtep-documents/2013-rtep.aspx. (accessed on 1/5/15)

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