

# **A Roadmap for Michigan's Energy Markets and Planning Program**

**Baseline Research**

**Prepared for the Michigan Energy Office on behalf of the  
Michigan Agency for Energy and National Association of State  
Energy Officials**

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## LIST OF TERMS

AES – Alternative energy supplier	MEO – Michigan Energy Office
ACEC – Advanced Cleaner Energy Credit	MIRECS – Michigan Renewable Energy Certification System
ALJ – Administrative law judge	MISO – Midcontinent Independent System Operator
AMI - Advanced metering infrastructure	Mcf – Thousand cubic feet
ATC – American Transmission Company	MMcf – Million cubic feet
BTU – British thermal unit	MPSC – Michigan Public Service Commission
CAA – Clean Air Act	MW – Megawatt
CCR – Coal combustion residuals	MWh – Megawatt hour
CDD – Cooling degree day	NAAQS – National Ambient Air Quality Standards
CHP – Combined heat and power	NERC – North American Electric Reliability Corporation
CON – Certificate of necessity	NREL – National Renewable Energy Laboratory
CPP – Clean Power Plan	NUG – Nonutility generator
CSAPR – Cross-state Air Pollution Rule	O&M – Operating and maintenance
CWA – Clean Water Act	PA – Public Act
CWIS – Cooling water intake structures	PBR – Performance-based regulation
DER – Distributed energy resources	PFD – Proposal for decision
DG – Distributed generation	PJM – PJM Interconnection
EE – Energy efficiency	PPA – Power purchase agreement
EERS – Energy-efficiency resource standards	PRMR – Planning reserve margin requirement
EIA – Energy Information Administration	PSCR – Power supply cost recovery
EO – Energy optimization	PV – Photovoltaic
EWR – Energy waste reduction	REC – Renewable energy credit
FERC – Federal Energy Regulatory Commission	REP – Renewable energy plan
GW – Gigawatt	ROA – Retail open access
GWh – Gigawatt hour	ROW – Right-of-way
HDD – Heating degree day	RPS – Renewable portfolio standard
I&M – Indiana Michigan Power Company	RTO – Regional transmission organization
IEEE – Institute of Electrical and Electronics Engineers	SAIDI – System Average Interruption Duration Index
IPP – Independent power producer	SAIFI – System Average Interruption Frequency Index
IREC – Incentive renewable energy credits	SWG – Solar Working Group
IRP – Integrated resource planning	U.P. – Upper Peninsula
kW – Kilowatt	UCT – Utility cost test
kWh – Kilowatt hour	UPPCo – Upper Peninsula Power Company
LCOE – Levelized Cost of Electricity	UCRT - Utility consumer representation fund
LSE – Load-serving entity	U.S. DOE – United States Department of Energy
MAE – Michigan Agency for Energy	U.S. EPA – United States Environmental Protection Agency
MATS – Mercury and Air Toxics Standard	USRCT – Utility System Resource Cost Test
MCL – Michigan Common Law	VOS – Value of solar
MED – Major event day	

## SECTION I. INTRODUCTION

After several years of careful crafting and vigorous debate, in December 2016, the Michigan Legislature passed the state’s first substantial energy policy overhaul in nearly a decade. Michigan’s new energy policies were signed into law as Public Acts (PAs) 341 and 342 of 2016 ([PA 341](#) and [PA 342](#)). In signing the bills Gov. Rick Snyder proclaimed, “this legislation will make it easier for our state to meet its energy needs while protecting our environment and saving Michiganders millions on their energy bills. I thank my partners in the Legislature for the bipartisan support of these bills that will help ensure a better and brighter future for all Michiganders” (Snyder December 2016).

With new energy policies in hand, the Michigan Agency for Energy (MAE) and Michigan Public Service Commission (MPSC) set out to implement the various new aspects of the law. PA’s 341 and 342 went into effect on April 20, 2017. The MAE and MPSC have established a page on its website dedicated to tracking the implementation of the law, available at the following [link](#).

With grant support from the National Association of State Energy Officials the MAE is working in cooperation with the MPSC and Public Sector Consultants to develop this comprehensive energy profile driven by research and stakeholder input.

## WHERE ARE WE NOW?

### Michigan’s Energy Policy Evolution

Michigan’s energy policy has undergone dramatic changes over the past 20 years. Historically, utility companies have been vertically integrated, operated, and regulated as natural monopolies. These firms controlled the generation, transmission, and distribution of electricity across geographically defined service territories. Beginning in the early 1990s—following policy decisions at the national level—states and parts of the energy industry began to seek, explore, and implement alternatives to this traditional regulatory structure. The belief that a competitive supply of electricity, made available through open and comparable access to transmission, would improve efficiency and lead to lower prices led states—including Michigan—to implement policies that would allow retail customers to choose their energy provider.

In June 2000, following several attempts to implement elements of retail restructuring by the MPSC,<sup>1</sup> the Michigan Legislature passed PA 141. Known as the Customer Choice and Electricity Reliability Act—PA 141 restructured Michigan’s electric power industry to allow customers to choose service from licensed alternative energy suppliers (AESs). The law also limited the share of generating capacity a Michigan utility could control, implemented a 5 percent residential rate reduction, froze residential rate increases for five years, and required regulated utilities to divest their transmission assets or join a regional transmission organization (RTO).<sup>2</sup> Michigan’s approach to restructuring was different from restructuring efforts in other states in that distribution utilities were allowed to maintain ownership of generation assets. These policy changes led to Michigan’s hybrid market structure where both regulated utilities and AESs sell electricity directly to customers.

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<sup>1</sup> In June 1999, the Michigan Supreme Court ruled that the MPSC lacked statutory authority to require a utility to transmit third-party provider’s electricity through its system to a customer. For more information, see [www.dleg.state.mi.us/mpsc/orders/courts](http://www.dleg.state.mi.us/mpsc/orders/courts).

<sup>2</sup> Utilities divested their transmission assets, and transmission operators joined the Midcontinent Independent System Operator (MISO).

Following several summers of tightly constrained power supplies, the MPSC initiated an investigation into the state's future energy needs (MPSC 2004). The commission's report—released after the yearlong Capacity Needs Forum—determined that Michigan would need new baseload generation<sup>3</sup> to meet growing electricity demand by 2009. Given the state's current market structure, the MPSC stated, “it is unlikely that either traditional utilities or independent power producers (IPPs) will build new additional baseload generation without some departure from past practices for regulatory approval and rate treatment” (MPSC 2006). Following this determination, Gov. Jennifer Granholm directed the MPSC to develop a comprehensive energy plan to address Michigan's short- and long-term electric needs (Granholm 2006).

*Michigan's 21<sup>st</sup> Century Electric Energy Plan* (referred to as the Plan) echoed the commission's earlier findings with regard to the need for new generating capacity and presented a range of policy recommendations to deal with the challenges presented by Michigan's hybrid market structure. The plan proposed policy changes designed to stabilize utilities' customer base and provide the regulatory certainty required to plan and finance new generation. In addition to the recommendations altering Michigan's regulatory framework, the commission's plan also proposed that the state adopt a renewable energy standard and establish targets for energy optimization (EO).

In response to the MPSC's findings, the Legislature overhauled Michigan's energy laws with the passage of PAs 286 and 295 of 2008. These bills changed the regulatory landscape and established new objectives for electric utilities in Michigan. PA 286 capped the number of customers who could choose to receive service from an AES, created the certificate of necessity (CON) process, and required utilities to institute cost-of-service rates.<sup>4</sup> PA 295—known as the Clean, Renewable, and Efficient Energy Act—aimed to diversify Michigan's energy supply portfolio, increase consumption of indigenous resources, encourage private investment, and improve the quality of the environment (MCL 460.1001 2008). PA 295 established a renewable energy standard mandating that electric providers obtain 10 percent of their supply from renewable sources. The law also established an EO standard requiring electric and gas utilities to implement programs designed to reduce energy usage.

At the same time these reforms were being debated in the legislature, the nation was entering a prolonged economic recession. Instead of the projected growth in electricity consumption and subsequent need for new generation, statewide electricity consumption fell by more than 10 percent during the recession (U.S. EIA March 25, 2015).<sup>5</sup>

In November 2012, Governor Snyder delivered a special message, “Ensuring our Future: Energy and the Environment.” In it, he laid out his goals for Michigan's next energy policies. The governor's plan centers on designing policies that are adaptable, and allowing the state and energy providers to make the right decisions even as conditions change. Starting with an approach that offers flexibility, the governor's plan also emphasizes improving reliability, making energy affordable, and protecting the environment (Snyder 2012).

In his address, Governor Snyder directed the MAE and MPSC to facilitate a review of Michigan's current energy landscape through a comprehensive stakeholder engagement process. Over the course of 2013, as

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<sup>3</sup> Baseload generation is the electricity needed to supply round-the-clock energy demand.

<sup>4</sup> Until 2008, regulated rates were skewed, meaning that actual rates were not set at the cost of providing a service, and certain customer classes were subsidizing others.

<sup>5</sup> The “Great Recession” officially lasted from December 2007 to June 2009, and was the longest period of economic downturn since the Great Depression (Isidore 2010).

a part of the “Readying Michigan to Make Good Energy Decisions” process, the MEO and the MPSC conducted seven public meetings across the state and collected input from dozens of stakeholders. At the end of this process, the MEO and the MPSC published four reports: one on renewable energy, one on electric choice (deregulation), one on energy efficiency, and one on other issues, such as reliability and rates. These reports continue to inform the ongoing discussion of Michigan’s energy policy.

The governor’s second special energy address delivered on March 13, 2015, built on the foundation described in his earlier message reiterating the importance of an adaptable energy plan. The governor delineated the following actions he believes will secure the state’s energy future (Snyder 2015).

- We should meet at least 15 percent more of Michigan’s energy needs in the next decade by eliminating energy waste.
- We need to eliminate artificial limits to the amount of waste reduction for utilities. Right now, our law prevents utilities from spending more than 2 percent of their budget on waste reduction, even if that forces them to buy more expensive equipment instead.
- We need to make sure the MPSC can weigh the benefits of energy waste reduction (EWR) in the same way it can weigh other kinds of expenses.
- We need to break out of the thinking that says the only compensation for EWR programs is to offset a loss, and instead make our smartest option a place where utilities want to invest. Capital invested in stopping energy waste should not be less valuable than capital invested in a new plant.
- We should repeal the on-bill financing<sup>6</sup> ban for nonmunicipal utilities.
- When utilities propose big-dollar investments, we need to make sure those investments will keep down costs, provide reliability, and protect our environment.
- Some users, especially energy-intensive industries, may be able to manage their energy use to go down when the grid starts to get strained, which will hold down costs and lower risks for everyone. We should create an opportunity and a reward for them to partner with our utilities to capture that savings.
- Michigan needs to deploy smart meters that help utilities locate outages and restore power quickly.
- Michigan needs to continue investing in infrastructure and maintenance to keep our power grid and pipeline system working smoothly and safely.
- We must change our market structure to ensure all electric providers are protecting their customers from massive outages due to lack of supply.
- We need to act now to make sure we have the tools to solve our own problems and keep decision making in Michigan, not in Washington D.C.
- Finalize the transactions that will solve the Upper Peninsula’s (U.P.’s) power crisis.
- Prevent the Lower Peninsula from developing the same crisis the U.P. is living through by reforming our electrical market to require every electric provider to protect its customers.

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<sup>6</sup> “An on-bill program is a financial collection mechanism whereby financing for clean energy improvements is repaid by the building owner on their monthly utility bill” (Michigan Saves 2017).

## Michigan's New Energy Policy

On December 21, 2016, Governor Snyder signed into law Michigan's new energy policy, incorporating many of the principles outlined in his prior public statements on energy policy.

The key changes made by PA 341 and 342 are as follows:

### PA 341

- Creates an integrated resource planning (IRP) process applicable to all rate-regulated electric utilities, and allows for MPSC preapproval of costs for projects approved in an IRP
- Establishes an electric generation capacity reliability construct that allows MPSC to evaluate whether to use a three-year forward auction, prevailing state compensation mechanism (if implemented by MISO), or a backstop state reliability mechanism to ensure adequate capacity is available to serve customer load
- Lowers the project threshold for CON projects to \$100 million, and requires that all projects 225 megawatts (MW) and above submitted as part of an IRP must also submit a CON application
- Orders the MPSC to conduct a cost-of-service study on net metering and distributed generation (DG) and to create a tariff that would be included in all electric rate cases after June 1, 2018
- Retains existing 10 percent cap on electric choice, but adds a provision that orders the MPSC to lower the cap under conditions described in the act
- Requires MPSC to issue a final order in a rate case within ten months, and eliminates the ability of a utility to self-implement a rate increase
- Allows MPSC to approve a revenue decoupling mechanism for small electric utilities
- Establishes a shared savings mechanism to provide incentives for EWR activities
- Relaxes electric utility code of conduct provisions
- Provides additional funding to the Utility Consumer Participation Board and Attorney General through the Utility Consumer Representation Fund (URCF) and allows for UCRF to fund participation in rate cases, CON, and IRP proceedings on behalf of residential customers

### PA 342

- Retains EO standards (EWR) for electric and natural gas providers through the end of 2021; these standards only apply to natural gas providers from 2022 onward
- From 2022 onward, allows the MPSC to set EWR targets for rate-regulated electric providers in biennial EWR plan proceedings where "most reasonable and prudent" level would be set; municipal utilities and co-ops would be exempt after 2021
- Retains the Renewable Energy Portfolio Standard and increases it from 10 percent to 15 percent by 2021
- Includes a goal that not less than 35 percent of Michigan's electric needs should be met through a combination of EWR and renewable energy by 2025
- Eliminates current net-metering program and replaces with a new DG program;
- Maintains existing participation caps and system allowing behind-the-meter generation and crediting customers for excess generation placed onto the grid

- Provides that any grid charge established by the MPSC may not be reduced by any credit or other ratemaking mechanism
- Existing net-metering customers are grandfathered in at current terms of service for 10 years from enrollment date
- Allows rate-regulated utilities to implement on-bill financing programs to allow customers to finance and pay off the costs of residential energy projects on their utility bills
- Requires rate-regulated electric utilities to offer customers voluntary “green-pricing”<sup>7</sup> programs

#### Resource Adequacy

One of the driving forces behind this most recent energy policy overhaul was the expected need for new generating capacity across the state. In the years leading up to new energy laws, Michigan utilities retired a number of older generating units, which caused policymakers to demand action to ensure the state would be able to meet its energy needs. As recently as July 2015, the MPSC was calling attention to a projected shortfall by 2016 (MPSC July 23, 2015). While the latest investigation into the adequacy of Michigan’s electric supplies shows that the state will be able to meet its needs during the next five years, the MPSC described the region’s supply outlook as “critical” because Michigan will be reliant on out of state power production to meet its needs (MPSC July 31, 2017).

#### Federal Environmental Regulations

A major factor in the considerations for Michigan’s new energy policy was the introduction of federal environmental regulations. While the electric power sector has faced increasingly robust regulation over recent decades, the proposed Clean Power Plan (CPP), with its emphasis on regulating power plants powered by fossil fuels, stood to have a dramatic impact on the future of electric power in the U.S. However, on March 26, 2017, President Donald Trump signed an executive order calling on the United States Environmental Protection Agency (U.S. EPA) to dismantle the CPP (The White House March 2017). For a full discussion of the impacts of federal environmental regulations, see Section IV of this report.

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<sup>7</sup> Allows customers to enroll in programs where they may specify the amount of electricity that will be attributable to renewable energy.

## SECTION II. UTILITY PERFORMANCE MEASURES

This section summarizes how regulated utilities in Michigan are performing with respect to a number of key indicators. Defining a baseline for utility performance will allow us to compare and monitor over time how performance is impacted by regulatory and rate design changes.

### RELIABILITY AND GRID RESILIENCE

#### Distribution Reliability

A reliable electric supply is vital to both utilities and their customers. The MPSC requires regulated utilities to annually report on their performance, based on two metrics commonly used to measure reliability. The two metrics—System Average Interruption Frequency Index (SAIFI) and the System Average Interruption Duration Index (SAIDI)—measure the number and length of service interruptions, respectively. These standards are defined by the Institute of Electrical and Electronics Engineers (IEEE) Standard 1366 Guide for Electric Power Distribution Reliability Indices (IEEE 2012).

SAIFI is the average number of interruptions per customer for the year. It is determined by dividing the sum total number of customers interrupted by the total number of customers served during the year.

$$\frac{\text{Total Number of Customers Interrupted}}{\text{Total Number of Customers Served}}$$

SAIDI is the average number of minutes of interruptions in a year per customer served. It is calculated by dividing the sum customer minutes interrupted by the total number of customers served.

$$\frac{\text{Total Customer Minutes Interrupted}}{\text{Total Number of Customers Served}}$$

The IEEE 1366 reliability metrics allow Michigan to compare itself to national performance benchmarks compiled by IEEE’s *Distribution Reliability Working Group Annual Benchmark Study*. This enables the MPSC to compare Michigan’s distribution reliability performance against other peer utilities across the country. Governor Snyder, with support from the MPSC, has established the goal that Michigan’s utilities average no more than one customer interruption per year (SAIFI), and an average outage duration (SAIDI) of 150 minutes or less. MPSC staff analyzes these reliability metrics annually and provides updates to the governor’s Energy and Environment Dashboard.<sup>8</sup>

#### Weather and Reliability/Resiliency

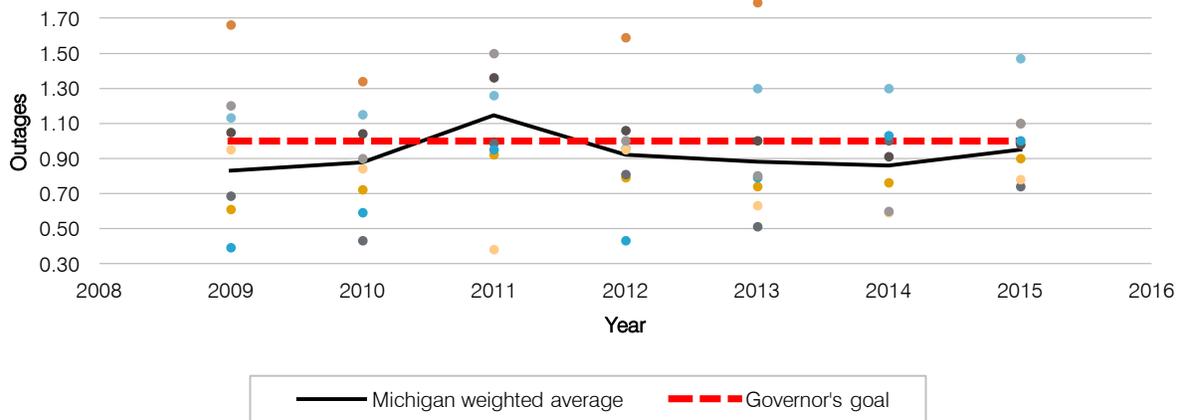
SAIDI and SAIFI metrics are normally reported by utilities with and without major event days (MEDs) included. The definition of those events varies throughout the industry. The IEEE 1366 standard defines a major event as one that exceeds a specific threshold found by adding 2.5 standard deviations to the average of the natural logarithms of the electric utilities’ daily SAIDI performance during the most recent five-year period (Warren n.d.). Stated simply, an MED is an event that dramatically impacts the size and duration of an outage. Exhibits 2.1 and 2.2 show how Michigan’s utilities perform on the SAIFI and SAIDI

<sup>8</sup> Governor Snyder created a set of online dashboards to provide a quick assessment of the state’s performance in key areas, including energy and the environment, health and education, and public safety. The dashboards can be accessed at [midashboard.michigan.gov](http://midashboard.michigan.gov).

indices compared to the goals outlined by the governor; in 2015, Michigan utilities met these reliability goals. Exhibits 2.3 and 2.4 show Michigan’s average performance on SAIDI and SAIFI indices when MEDs are included.

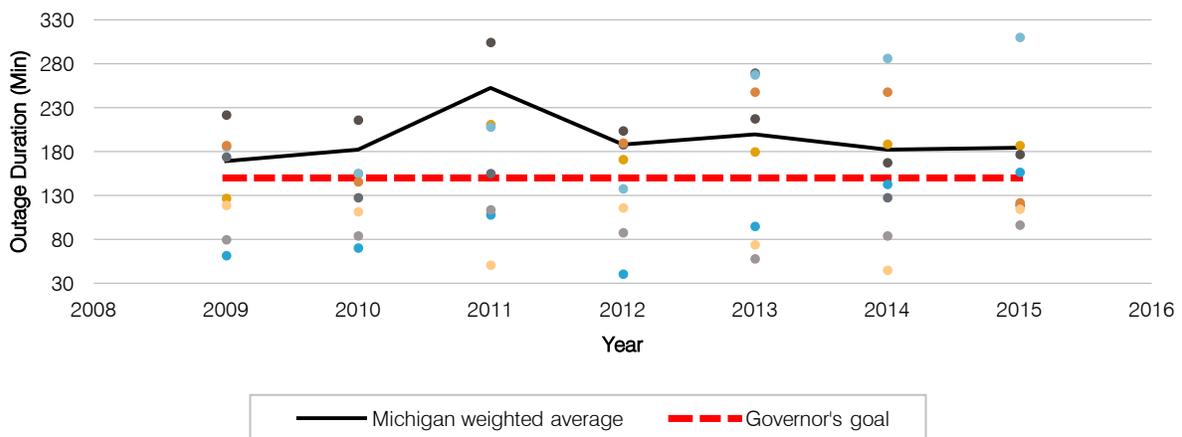
Power restoration during major weather events varies significantly from typical system restorations, often due to the scale of the outages and the restoration conditions utility workers are exposed to. These major events can significantly alter system outage metrics, such as SAIDI and SAIFI, and are often excluded to normalize data and separate operations into daily operations and emergency operations. Analysis of the past decade has found the frequency of MEDs has been increasing (Eto 2015).

**EXHIBIT 2.1. Outage Frequency (SAIFI), Excluding MEDs**



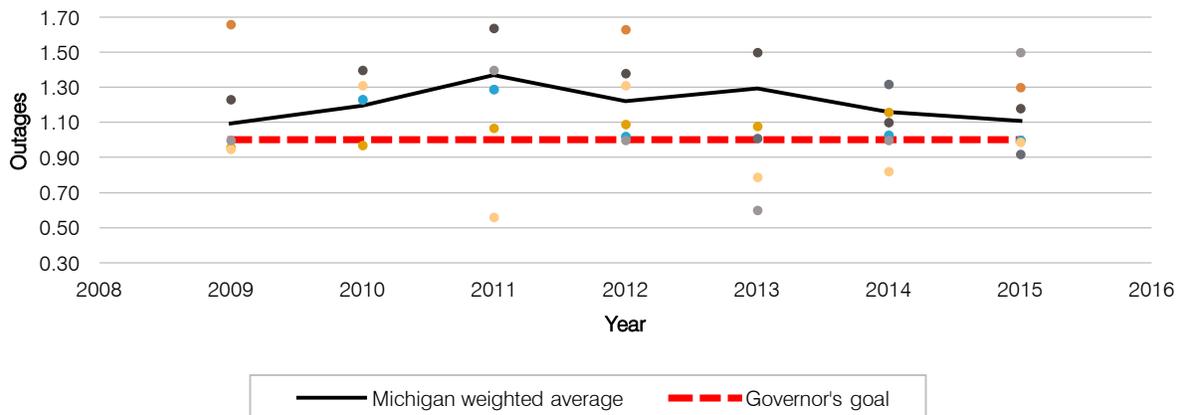
NOTE: A major event day is an event that dramatically impacts the size and duration of an outage.  
 SOURCE: MPSC. n.d. *Utility Performance Data Filed Under Case No. U-12270*. Accessed August 13, 2017.  
<https://efile.mpsc.state.mi.us/efile/viewcase.php?casenum=12270&submit.x=12&submit.y=13>

**EXHIBIT 2.2. Outage Duration (SAIDI), Excluding MEDs**



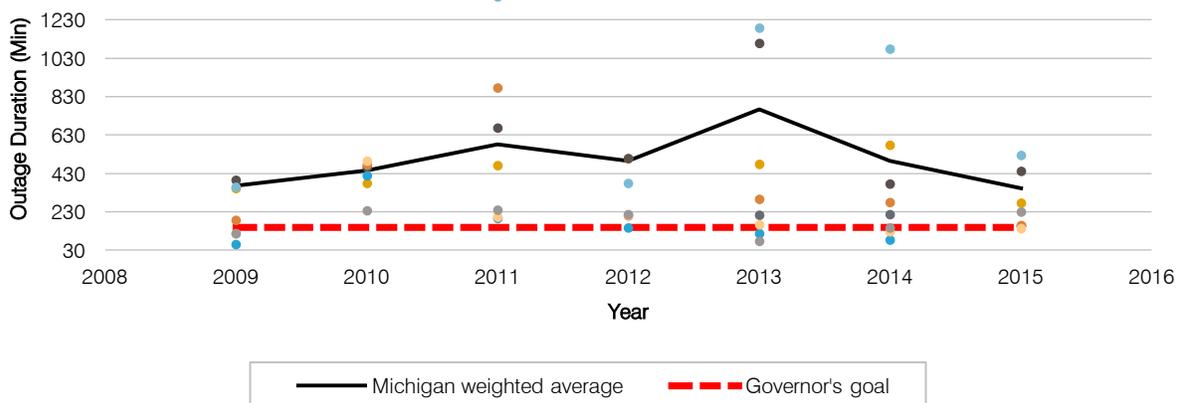
NOTE: A major event day is an event that dramatically impacts the size and duration of an outage.  
 SOURCE: MPSC. n.d. *Utility Performance Data Filed Under Case No. U-12270*. Accessed August 13, 2017.  
<https://efile.mpsc.state.mi.us/efile/viewcase.php?casenum=12270&submit.x=12&submit.y=13>

### EXHIBIT 2.3. Michigan Outage Frequency (SAIFI), Including MEDs



SOURCE: MPSC. n.d. *Utility Performance Data Filed Under Case No. U-12270*. Accessed August 13, 2017. <https://efile.mpsc.state.mi.us/efile/viewcase.php?casenum=12270&submit.x=12&submit.y=13>

### EXHIBIT 2.4. Michigan Outage Duration (SAIDI), Including MEDs



SOURCE: MPSC. n.d. *Utility Performance Data Filed Under Case No. U-12270*. Accessed August 13, 2017. <https://efile.mpsc.state.mi.us/efile/viewcase.php?casenum=12270&submit.x=12&submit.y=13>

## Improving Reliability

In an attempt to combat this growing number of MEDs, utilities are increasing investments in resilient distribution assets that are capable of diagnosing, reporting, and sometimes repairing themselves without the need for utility employees to address the issue. These advanced distribution assets will provide system operators increased insight into utility outages, thereby improving the efficiency of future outage restoration efforts. Given the size of Michigan’s distribution infrastructure, wholesale replacement of all distribution assets with the latest technology would not be economically feasible. However, as these advanced technologies become more prominent in the distribution system, through the natural attrition of outdated distribution assets, it would be expected that significant improvements in outage response will emerge.

Another way in which utilities are combating this increase in major events is to modify current operating and maintenance (O&M) programs to address concerns that typically arise during these major events, such as trees outside of the utilities' right-of-way (ROW). Hazardous trees<sup>9</sup> outside the utility ROW pose a significant threat to utility infrastructure during periods of heavy snow/ice loads. High winds often associated with MEDs and removal of hazardous trees have not been addressed in typical maintenance. In 2015, DTE Energy and Consumers Energy deployed hazardous tree removal programs to limit the effect these trees have on outages during major events (MPSC December 4, 2014a). These special O&M programs, as well as consistent investment in distribution systems, will play a large part in mitigating the reliability/resiliency issues caused by major events on the electric grid.

Michigan's two largest utilities have initiated programs to make their electric grid more resilient and decrease the average time customers are without power. For example, in addition to hazardous tree removal programs and investments in advanced distribution technology, Consumers and DTE are also investing more money in existing programs that increase reliability. The two utilities have proposed to spend more money on vegetation management to increase miles of ROW trimmed and decrease the cycle time on their electric circuits. Consumers has also proposed to significantly increase spending on reliability, asset relocations, and technology projects. These investments will strengthen the system and enable quick restoration.

DTE's Efficient Frontier program is designed to improve reliability and customer satisfaction through four measures:

- Enhancing the vegetation management program to prevent outages
- Continuously improving the company's Repetitive Outage Program
- Reducing the number of customers affected and improving the restoration time when outages do occur
- Increasing the maintenance activity for key distribution assets

As a result of Consumers' and DTE's programs, reliability indices should improve noticeably in the next few years.

March 2017 Windstorm

On March 7, 2017, Michigan experienced one of the largest electric outages in its history as the result of a massive storm that brought 60-mile-per-hour winds and severe thunderstorms to Michigan's Lower Peninsula. One-third of the state's electric customers were impacted by the storm and restoration efforts took more than a week to complete. Consumers Energy had 358,000 customers without power, or roughly 20 percent of their customer base. DTE Energy reported that 750,000 customers were knocked offline, the single largest outage in the company's history. Due to the size and severity of the outage, the MPSC initiated an investigation into the event. The MPSC's investigation concluded that "each company made good faith, diligent efforts to prepare for and respond to the power outages and damage caused by the storm" (MPSC August 23, 2017). However, the commission did identify four areas for utilities to improve their preparedness and response:

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<sup>9</sup>Hazardous trees are identified as those that are structurally unsound, dead, or diseased trees that pose an imminent threat to utility assets.

- Complete integration of advanced metering infrastructure (AMI) with outage management software systems to unlock the technology’s full potential to assist with communication, restoration, and protecting health and safety
- Continue commitment to vegetation management practices
- Develop long-term capital and operations plans for upgrading electric distribution systems
- Enable two-way communication and information exchange with customers to share accurate information related to service and restoration

## **Transmission Reliability**

ITC Transmission, METC,<sup>10</sup> American Transmission Company (ATC), Indiana Michigan Power Company (I&M), and Wolverine Power Cooperative are the most prominent transmission companies in Michigan. Although these companies own the transmission facilities, their use of these facilities in Michigan are managed by regional transmission operators (RTOs). These regional entities oversee the transmission grid, coordinate reliability across their regional footprint, as well as manage the dispatch of generators for energy markets. RTOs also play a major role in planning transmission expansion and enhancements. Michigan belongs to two RTOs—MISO and PJM Interconnection (PJM). Each of these RTOs conducts annual transmission planning for their service territories.

Michigan’s transmission system is a part of the Eastern Interconnection—the transmission grid covering states from the Rocky Mountains to the Atlantic Ocean and including neighboring Canadian provinces. Michigan has high-voltage connections to neighboring states including Wisconsin, Ohio, and Indiana. Currently, there is no high-voltage transmission connection between the Upper and Lower Peninsulas.<sup>11</sup> Exhibit 2.5 shows the three North American interconnections. Exhibit 2.6 shows where Michigan’s major transmission lines are located.

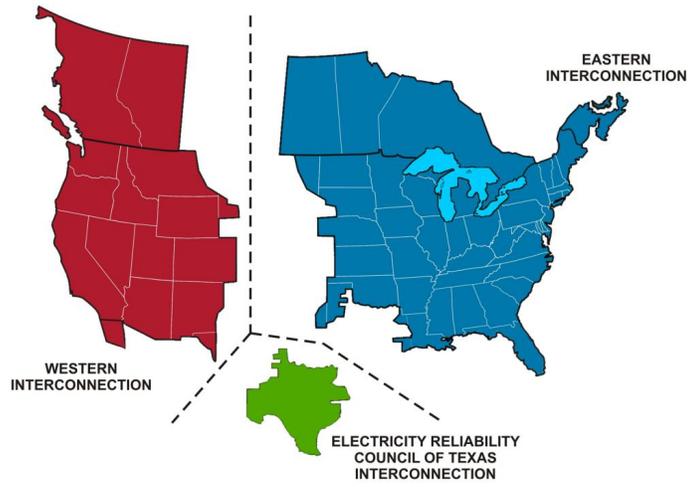
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<sup>10</sup> ITC Transmission and METC are both wholly owned subsidiaries of ITC Holdings Corporation, and for the purposes of this report will be referred to as ITC Michigan.

<sup>11</sup> A recent MISO Michigan Transmission Expansion Study (done in cooperation with the Independent Electric System Operator of Ontario) was requested by Michigan’s governor and the MAE. The study explored and evaluated the potential cost savings, reliability, and resource adequacy benefits of possible transmission upgrades to link the UP to Ontario and strengthen the electrical ties between the UP and the Lower Peninsula at the Straits of Mackinac. None of the transmission options studied by MISO provided enough benefit to cover the high construction costs of linking Michigan’s transmission system to IESO. Similarly, the cost of expanding transmission capability between the UP and the Lower Peninsula projected more cost than benefit.

**EXHIBIT 2.5. North American Transmission Interconnections**

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SOURCE: North American Electric Reliability Corporation. n.d. *North American Electric Reliability Corporation Interconnections*. Accessed September 9, 2017. [https://energy.gov/sites/prod/files/oeprod/DocumentsandMedia/NERC\\_Interconnection\\_1A.pdf](https://energy.gov/sites/prod/files/oeprod/DocumentsandMedia/NERC_Interconnection_1A.pdf)

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## EXHIBIT 2.6. Major Electric Transmission Lines



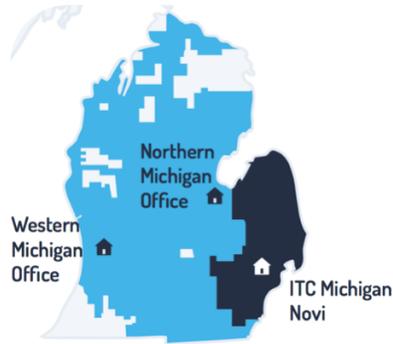
SOURCE: U.S. Energy Information Administration. May 2017. *U.S. Energy Mapping System*. Accessed August 30, 2017.  
<https://www.eia.gov/state/maps.php>

ITC Michigan is the primary transmission owner in the Lower Peninsula.<sup>12</sup> Its service territory is depicted in Exhibit 2.7.

<sup>12</sup> In 2015, Consumers Energy requested authority from the MPSC and the FERC to reclassify certain facilities from distribution to transmission, and be subsequently subject to, pending approval of additional filings, to FERC regulation. Both regulatory approvals were granted in MPSC docket U-12690 and FERC docket ER15-910. Consumers Energy is again a generation, distribution, and transmission-owning entity.

**EXHIBIT 2.7. ITC Michigan Service Area**

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SOURCE: ITC Transmission. n.d. ITC Michigan. Accessed October 17, 2017. <http://www.itc-holdings.com/op/itc-michigan>

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ATC is the primary transmission owner for the U.P. Its service territory is depicted in Exhibit 2.8.

**EXHIBIT 2.8. American Transmission Company Service Area**

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SOURCE: American Transmission Company. n.d. Service Territory. Accessed October 16, 2017. <http://www.atcllc.com/about-us/service-area/>

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I&M owns transmission in the southwestern portion of Michigan’s Lower Peninsula (see Exhibit 2.9).

### EXHIBIT 2.9. I&M Power Company Service Area

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SOURCE: Indiana Michigan Power. n.d. *Service Territory*. Accessed January 22, 2015. <https://www.indianamichiganpower.com/info/facts/ServiceTerritory.aspx>

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The Wolverine Power Cooperative’s transmission network has five member utilities that together serve customers in 40 counties in Michigan’s Lower Peninsula (see Exhibit 2.10).

### EXHIBIT 2.10. Wolverine Power Cooperative Service Area

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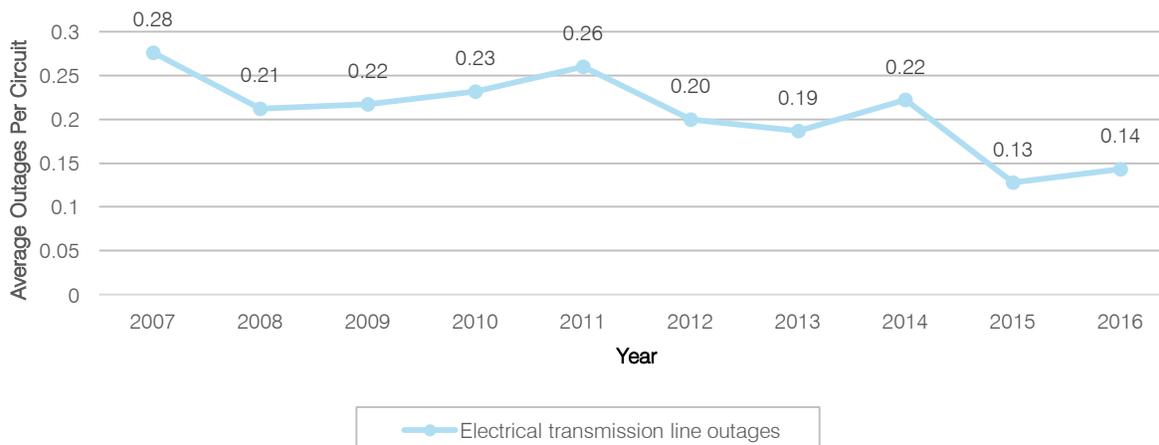


SOURCE: Wolverine Power Cooperative. n.d. *Members*. Accessed October 15, 2017. <http://www.wolverinepowercooperative.com/our-members/>

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As a part of his Energy and Environment Dashboard, Governor Snyder has asked the MPSC to track performance of Michigan’s transmission system and report the number of electric transmission line outages that occur each year. Michigan’s system performed consistently on this metric over the past ten years. While transmission line outages in 2016 were below Michigan’s ten-year average, they increased slightly from 2015 to 2016. This information is displayed in Exhibit 2.11.

**EXHIBIT 2.11. Michigan Electrical Transmission Line Outages, Weighted Average Per Circuit**



NOTE: The average outages per circuit refers to the number of outages each system sees each year divided by the number of circuits. This is then weighted based on the number of line miles each company has in Michigan.

SOURCE: State of Michigan. 2017. *Energy and Environment Dashboard*. Accessed August 30, 2017. <https://midashboard.michigan.gov/Energy-Environment-Dashboard/Energy-And-Environment-Dashboard/6z39-xj7h/data>

## **Transmission Reliability—North American Electric Reliability Corporation**

The North American Electric Reliability Corporation (NERC) is a not-for-profit international regulatory authority whose mission is to assure the reliability and security of the bulk power system in North America. NERC develops and enforces reliability standards; annually assesses seasonal and long-term reliability; monitors the bulk power system through system awareness; and educates, trains, and certifies industry personnel. NERC’s area of responsibility spans the continental United States, Canada, and the northern portion of Baja California, Mexico. NERC is the electric reliability organization for North America, subject to oversight by FERC and governmental authorities in Canada. NERC’s jurisdiction includes users, owners, and operators of the bulk power system, which serves more than 334 million people.

## **Transmission Reliability—Vegetation Management**

Transmission companies and other owners of transmission are presented with the unique challenge of balancing vegetation management and environmental stewardship during construction and full operation. The risks associated with vegetation interference with transmission lines are significant. Failure to adequately trim and maintain trees on a rural 345 kV line in Ohio left 50 million people in the U.S. and Canada without power for two days during August 2003. In the wake of that and other smaller outages, Congress passed the Energy Policy Act of 2005. This required FERC to review, develop, and enforce mandatory reliability standards pertaining to vegetation management for the bulk power system. FERC delegated the development of these standards, and many others, to NERC. Specific standards require a minimum clearance distance from the transmission line to prevent vegetation encroachments; preparation and updates to a formal transmission vegetation management program; implementation of an annual work plan; and reports of sustained outages for qualified lines (FERC 2013).

Michigan’s transmission companies continue to improve vegetation management practices and apply industry best practices within their respective companies—while balancing efforts to preserve the state’s diverse topography, beautiful scenery, and natural resources. Michigan transmission companies evaluate

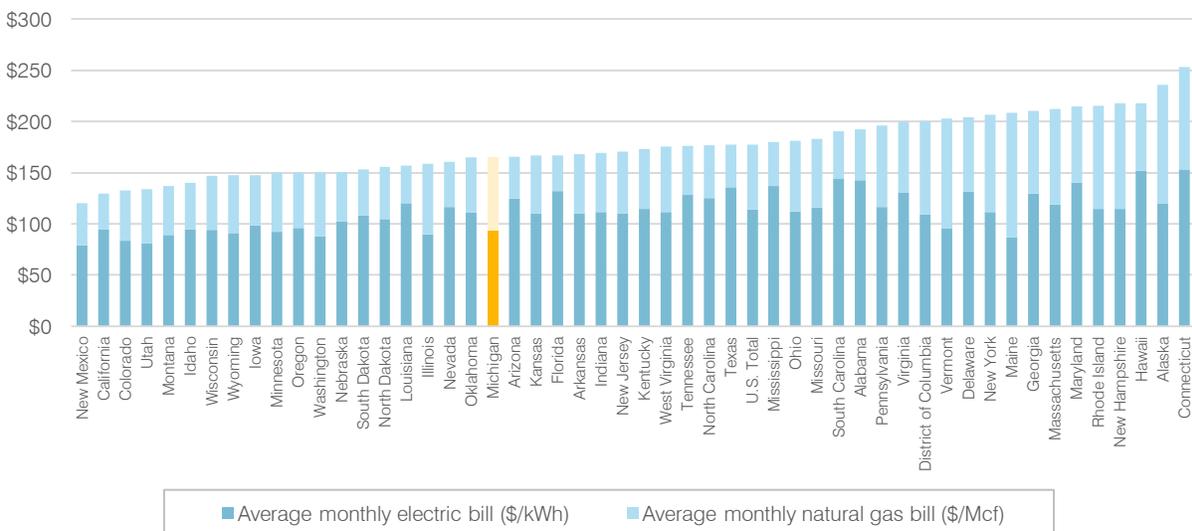
transmission ROW distances for adequate clearance and vegetation trimming cycles that may be impacted by local vegetation growth rates, diseases, and invasive species, such as the emerald ash borer.

Transmission-owning companies are required to follow all environmental rules and regulations that apply in the area during construction and ongoing operation of the transmission system.

## AFFORDABILITY

Governor Snyder has set a goal for energy affordability in Michigan—that state residents’ total energy bills (electricity and heating) should not be higher the national average (Snyder 2015). Through 2015, that goal has been achieved; the average Michigan residential customer’s energy bill is 7 percent lower than the U.S. average, as shown in Exhibit 2.12.

**EXHIBIT 2.12. Average Monthly Residential Electric and Natural Gas Bills by State, 2015**



Note: PSC calculations using U.S. EIA data.  
 SOURCE: U.S. Energy Information Administration (U.S. EIA). September 30, 2016. *Natural Gas Annual*. "Table 24. Average Price of Natural Gas Delivered to Consumers by State and Sector, 2015." Accessed September 8, 2017. [https://www.eia.gov/naturalgas/annual/pdf/table\\_024.pdf](https://www.eia.gov/naturalgas/annual/pdf/table_024.pdf); U.S. EIA. September 30, 2016. *Natural Gas Annual*. "Table 16. Natural Gas Delivered to Consumers by Sector, 2011-2015, and by State and Sector, 2015." Accessed September 8, 2017. [https://www.eia.gov/naturalgas/annual/pdf/table\\_016.pdf](https://www.eia.gov/naturalgas/annual/pdf/table_016.pdf); U.S. EIA. August 14, 2017. *Form EIA-861*. "2015 Average Monthly Bill- Residential." Accessed September 8, 2017. [https://www.eia.gov/electricity/sales\\_revenue\\_price/pdf/table5\\_a.pdf](https://www.eia.gov/electricity/sales_revenue_price/pdf/table5_a.pdf)

Another way to look affordability is to compare the percentage of income that customers spend on energy compared to the median household income. The portion of household income Michigan residents spend on electricity and natural gas bills is very near the national average. The median household income for Michigan is \$49,576. The average Michigan customer spends 4.57 percent of their income on electricity and natural gas. The median household income for the U.S. is \$53,889. Combined electric and natural gas spending accounts for 4.52 percent of median household income (U.S. Census Bureau 2016).

## Consumption Patterns

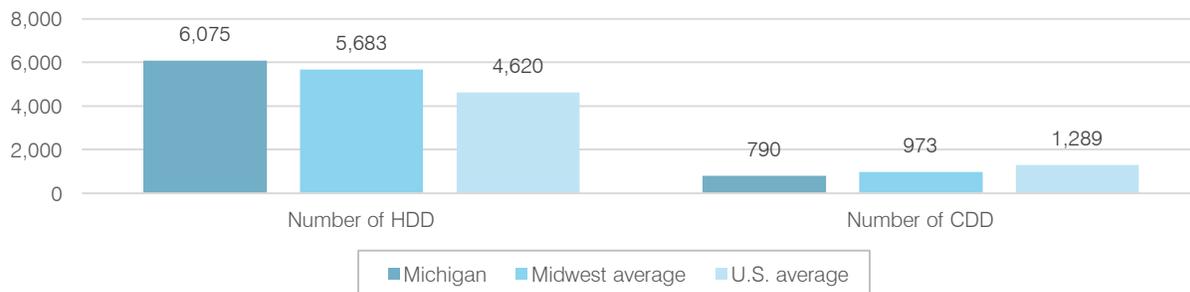
To get a better understanding of affordability, it is helpful to look at factors that contribute to energy consumption. Total energy bills are a function of consumption and price. A major driver impacting energy consumption is regional climate. Residential heating and cooling account for almost half of an average

household’s total energy consumption (U.S. EIA January 2013). Heating degree days (HDDs) and cooling degree days (CDDs) are common measures of weather-related energy usage.<sup>13</sup> An HDD is calculated as 65 minus the daily average temperature, while a CDD is calculated as the daily average temperature minus 65. When the average temperature is below 65, there are no CDDs; when it is above 65, there are no HDDs. Further, HDDs and CDDs are often weighted by the population of the region they are describing. The National Weather Service explains:

“The energy demand for a region, such as a state, depends on where people live. Temperatures in sparsely populated regions, such as the mountains, have less impact on regional energy demand than temperatures within large cities. Thus, regional energy demand is often estimated by population weighted statistics, rather than area averages.” (NWS n.d.)

As shown in Exhibit 2.13, in 2016, Michigan experienced fewer CDDs and more HDDs than the averages of both the U.S. and the Midwest (NWS 2015). This leads to less energy demand for seasonal cooling and more energy consumed for home heating. Exhibit 2.14 shows the ten-year population-weighted average annual HDDs and CDDs by census region. Michigan is in the East North Central (ENC) region, along with Illinois, Indiana, Ohio, and Wisconsin. This region experiences 54 percent more HDD and 44 percent fewer CDDs than the U.S. average.

**EXHIBIT 2.13. Heating and Cooling Days, 2016**



NOTE: In charts where the term Midwest is used, the term refers to Michigan, Indiana, Illinois, Ohio, and Wisconsin.  
 SOURCE: National Weather Service (NWS). January 1, 2017. *Degree Days Daily Data*. Accessed August 30, 2017.  
[http://ftp.cpc.ncep.noaa.gov/htdocs/degree\\_days/weighted/daily\\_data/2016/](http://ftp.cpc.ncep.noaa.gov/htdocs/degree_days/weighted/daily_data/2016/)

<sup>13</sup> 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 location 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. This results in a weekly total of 193 heating degree days (over the seven calendar days).

**EXHIBIT 2.14. Ten-year Population-weighted Averages, 2016**

Region	HDD	CDD	HDD Compared to U.S. Average	CDD Compared to U.S. Average
New England	6,273	501	1.46	0.36
Middle Atlantic	5,650	722	1.31	0.52
East North Central	6,266	766	1.46	0.56
West North Central	6,534	969	1.52	0.70
South Atlantic	2,668	2,144	0.62	1.55
East South Central	3,450	1,688	0.80	1.22
West South Central	2,123	2,688	0.49	1.94
Mountain	4,982	1,456	1.16	1.05
Pacific	3,406	891	0.79	0.65
U.S. Average	4,292	1,380	1.00	1.00

SOURCE: U.S. EIA. June 2017. *Short-Term Energy Outlook Table 9c*. Accessed on June 15, 2017. <http://www.eia.gov/forecasts/steo/tables/pdf/9ctab.pdf>

Due to the temperate climate, relatively mild summers, and cold winters, households in Michigan consume relatively little energy for air conditioning, and more energy for seasonal heating, as shown in Exhibit 2.15 (U.S. EIA January 2013). Lower demand for air conditioning and high seasonal heating needs contribute to Michiganders consuming less electricity and more of other heating fuels than the national average, as shown in Exhibit 2.16. Nearly 80 percent of homes rely on natural gas for heat, far more than the national average, as shown in Exhibit 2.17. Michigan’s residential natural gas consumption is fourth highest in the nation, and the state is the ninth in total natural gas consumption. See Exhibit 2.18 for complete electric and natural gas consumption rankings for Michigan by sector.<sup>14</sup>

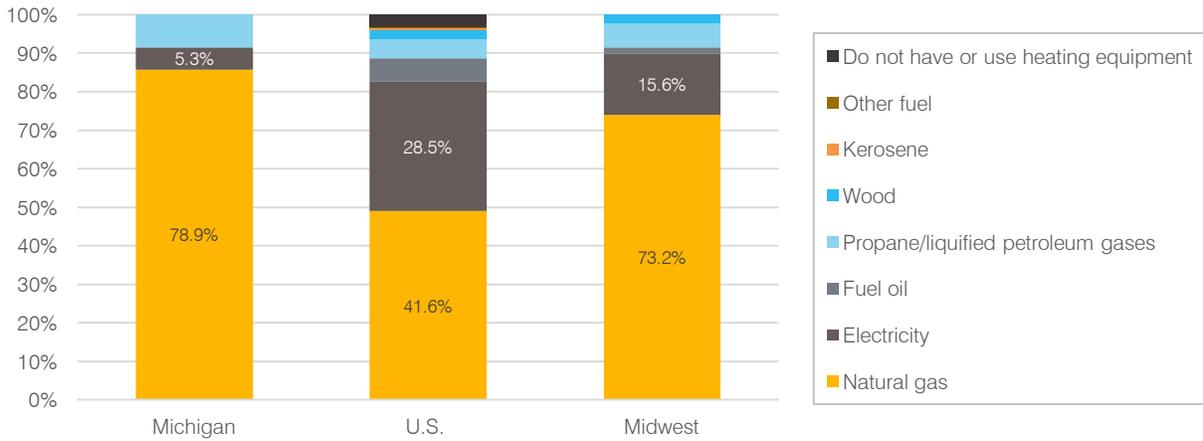
**EXHIBIT 2.15. Household Energy Consumption by End Use, 2009**



SOURCE: U.S. EIA. January 11, 2013. *2009 Residential Energy Consumption Survey*. Accessed January 18, 2015. [www.eia.gov/consumption/residential/data/2009/index.cfm?view=consumption](http://www.eia.gov/consumption/residential/data/2009/index.cfm?view=consumption)

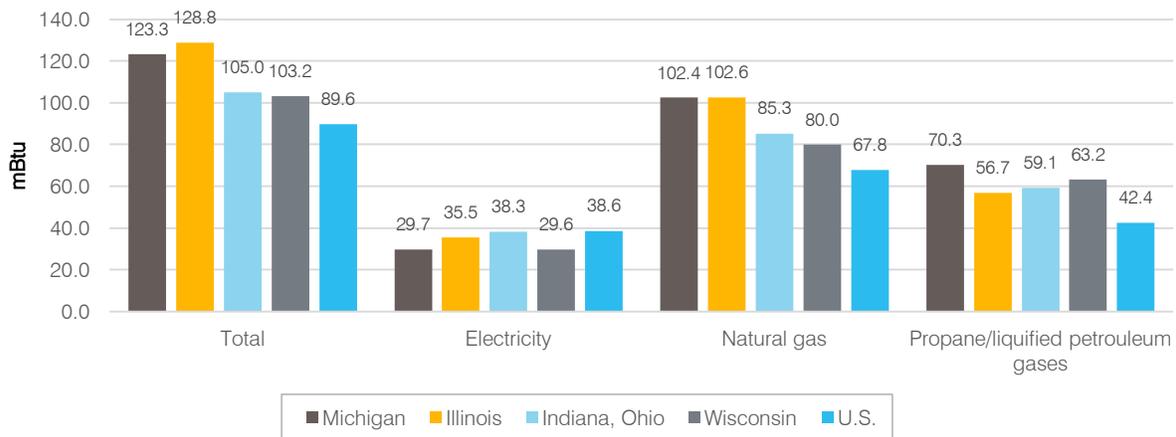
<sup>14</sup> This section of the report relies on data presented in the U.S. EIAs Residential Energy Consumption Survey. The most recent final Residential Energy Consumption Survey was completed in 2013. Data from the 2015 Residential Energy Consumption Survey is anticipated by 2018.

**EXHIBIT 2.16. Household Heating Source, 2013**



SOURCE: U.S. EIA. January 11, 2013. *2009 Residential Energy Consumption Survey*. Accessed January 18, 2015. [www.eia.gov/consumption/residential/data/2009/index.cfm?view=consumption](http://www.eia.gov/consumption/residential/data/2009/index.cfm?view=consumption)

**EXHIBIT 2.17. Average Household Energy Consumption by Fuel, 2009**



NOTE: Data for Indiana and Ohio was combined in the 2009 Residential Energy Consumption Survey.  
 SOURCE: U.S. EIA. January 11, 2013. *2009 Residential Energy Consumption Survey*. Accessed January 18, 2015. <http://www.eia.gov/consumption/residential/data/2009/index.cfm?view=consumption>

**EXHIBIT 2.18. 2016 Natural Gas and 2015 Electricity Consumption National Rank, Michigan**

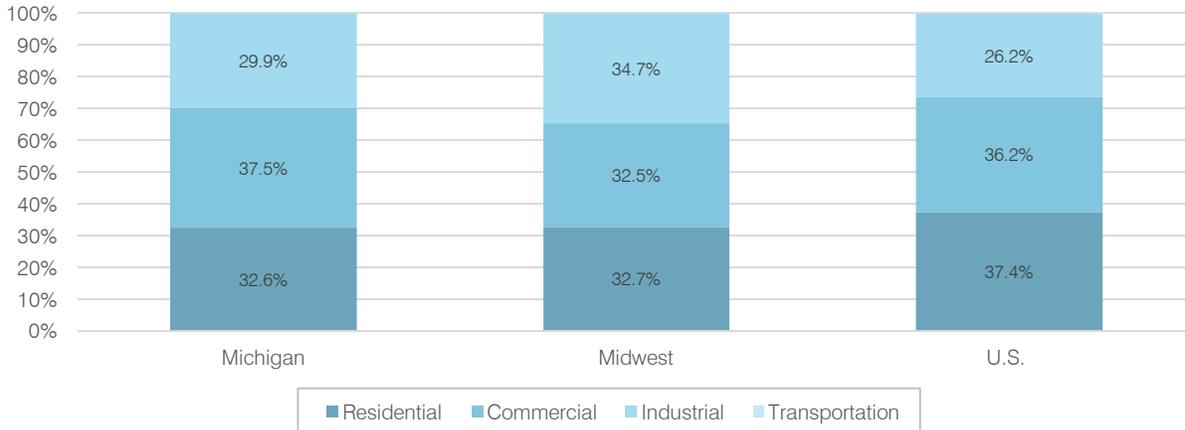
	Residential Consumption	Commercial Consumption	Industrial Consumption	Electric Power Consumption	Transportation Consumption	Total Consumption
Natural gas	4	4	9	15	12	7
Electric	14	12	10	n/a	27	12

SOURCE: U.S. EIA. November 21, 2016. *Electric Sales, Revenue, and Price*. Accessed August 30, 2017. Available at: [https://www.eia.gov/electricity/data/state/sales\\_annual.xlsx](https://www.eia.gov/electricity/data/state/sales_annual.xlsx) and U.S. EIA. July 31, 2017. *Natural Gas Consumption and End Use*. Accessed August 30, 2017. [https://www.eia.gov/dnav/ng/ng\\_cons\\_sum\\_dcunus\\_a.htm](https://www.eia.gov/dnav/ng/ng_cons_sum_dcunus_a.htm)

## Electricity Prices

Electric customers are generally divided into three categories—industrial, commercial, and residential. These groups are organized based on the characteristics of their energy needs and the costs of providing various services to them. Prices charged to customer classes will vary based on their electric supplier’s individual rates. Exhibit 2.19 shows the distribution of energy consumption between different customer classes.

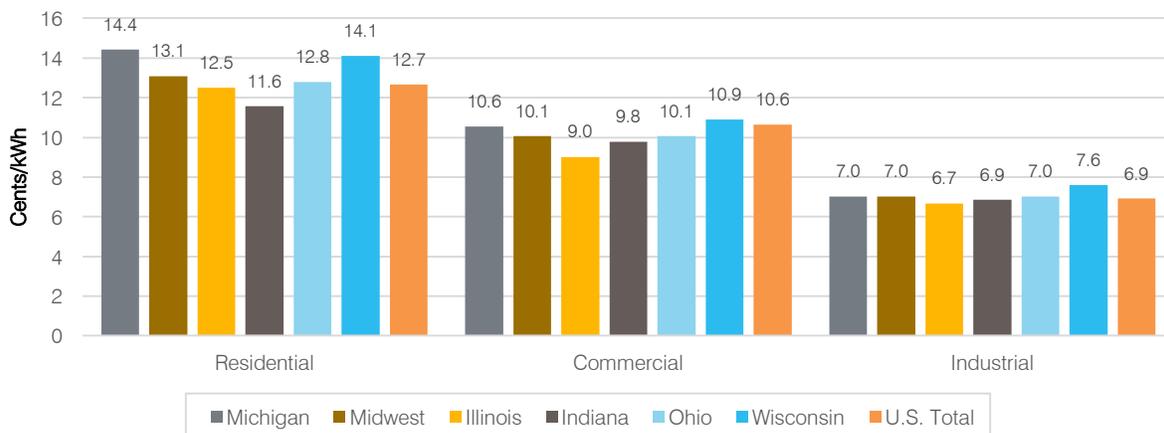
**EXHIBIT 2.19. Percentage of Total Retail Electricity Sales by End Use, 2014**



SOURCE: U.S. EIA. November 21, 2016. *Electric Sales, Revenue, and Price*. Accessed August 30, 2017 Available at: [https://www.eia.gov/electricity/data/state/sales\\_annual.xlsx](https://www.eia.gov/electricity/data/state/sales_annual.xlsx)

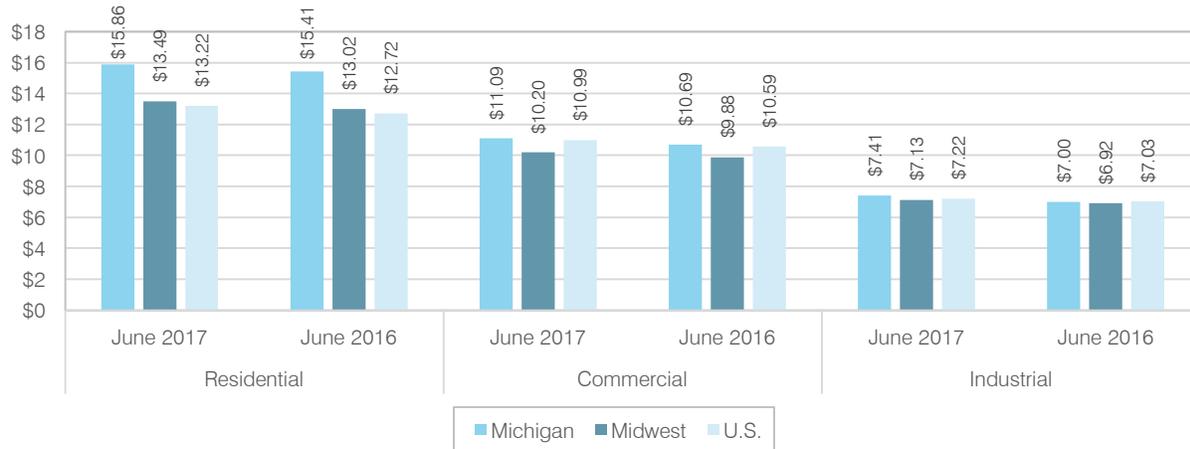
As shown in Exhibit 2.20 and 2.21, Michigan’s electric rates are above the national average, and the highest among most neighboring states for each customer class. Michigan’s average residential price is 13.99 percent higher than the U.S. average, which is the 12<sup>th</sup> highest among the states. For commercial and industrial prices, Michigan ranks 16<sup>th</sup> and 22<sup>th</sup> highest, respectively.

**EXHIBIT 2.20. Average Annual Retail Price of Electricity, 2015**



SOURCE: U.S. EIA. July 25, 2017. *Electric Power Monthly*. Accessed August 30, 2017. [https://www.eia.gov/electricity/monthly/xls/table\\_5\\_05\\_a.xlsx](https://www.eia.gov/electricity/monthly/xls/table_5_05_a.xlsx)

**EXHIBIT 2.21. Average Monthly Retail Price of Electricity**

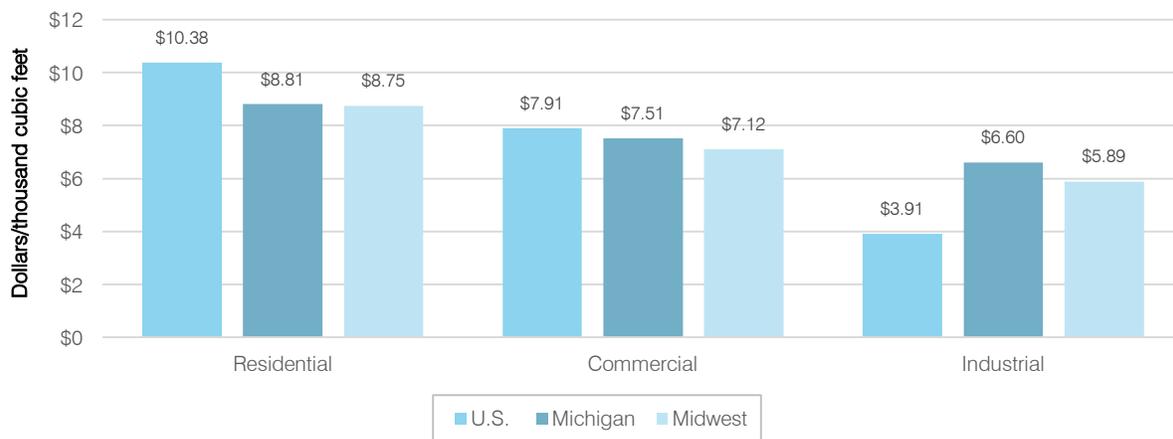


SOURCE: U.S. EIA. October 12, 2016. *Form EIA-861 Annual Survey Data*. Accessed August 30, 2017. [http://www.eia.gov/electricity/sales\\_revenue\\_price/pdf/table4.pdf](http://www.eia.gov/electricity/sales_revenue_price/pdf/table4.pdf)

**Natural Gas Prices**

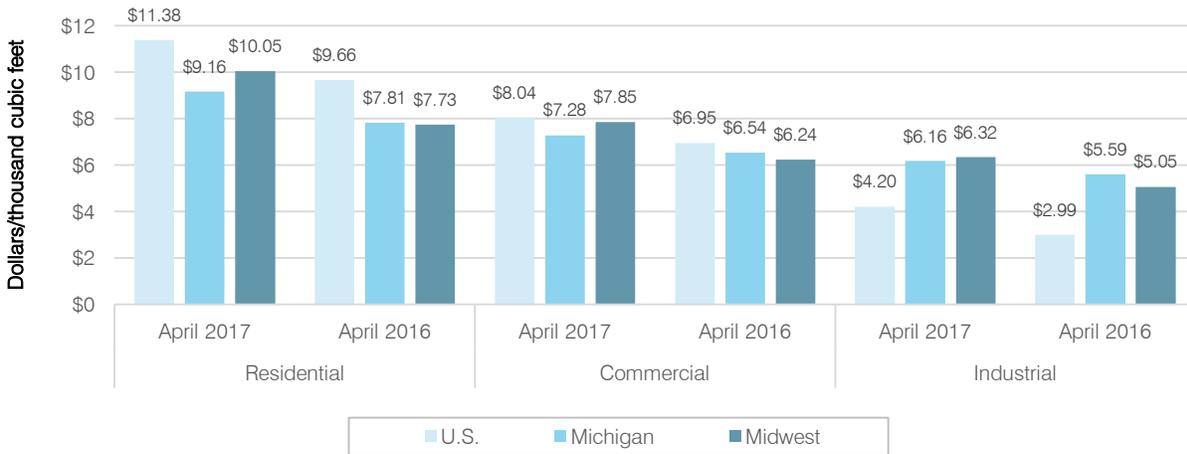
Residential natural gas consumption in Michigan is higher than the national average, due largely to seasonal heating demands. As shown in Exhibit 2.22 and 2.23, the annual average price of natural gas for residential and commercial customers is below the national average, but still slightly higher than the prices in neighboring states. However, monthly average prices from April 2017 show that natural gas prices in Michigan were lower than both the national and regional average (U.S. EIA July 2017).

**EXHIBIT 2.22. Average Annual Natural Gas Prices, 2015**



Source: U.S. EIA. July 31, 2017. *Natural Gas Prices*. Accessed August 30, 2017. [http://www.eia.gov/dnav/ng/ng\\_pri\\_sum\\_dc\\_u\\_SMI\\_a.htm](http://www.eia.gov/dnav/ng/ng_pri_sum_dc_u_SMI_a.htm)

**EXHIBIT 2.23. Average Annual Natural Gas Prices**



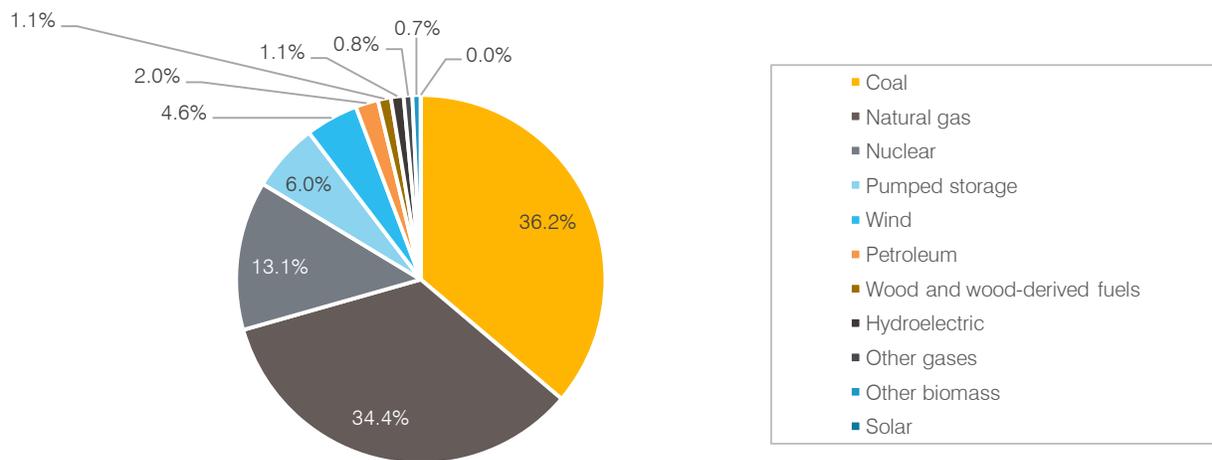
SOURCE: U.S. EIA. July 31, 2017. *Natural Gas Prices*. Accessed August 30, 2017. [http://www.eia.gov/dnav/ng/ng\\_pri\\_sum\\_dcu\\_SMI\\_a.htm](http://www.eia.gov/dnav/ng/ng_pri_sum_dcu_SMI_a.htm)

**RESOURCE DIVERSITY AND RENEWABLES**

**Michigan’s Portfolio**

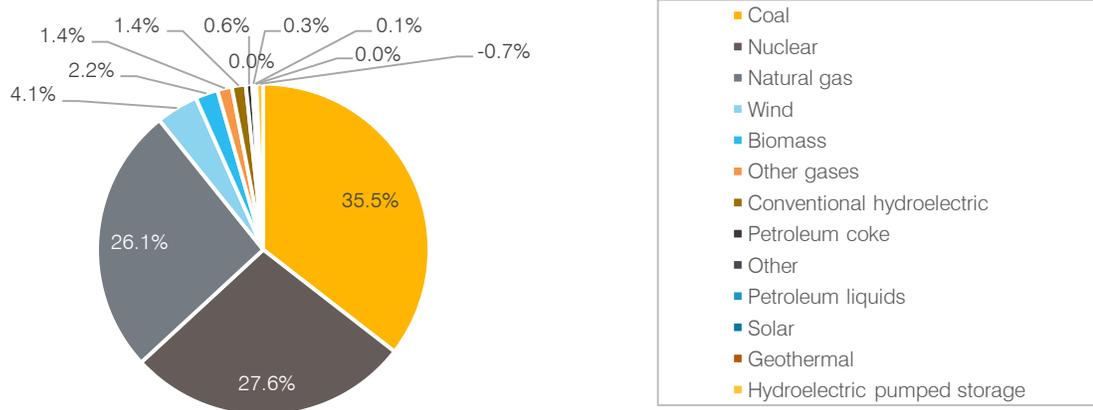
Michigan’s electric generating portfolio is dominated by three main fuel sources—coal, natural gas, and nuclear. Exhibit 2.24 shows the generation capacity by fuel source in 2013, and Exhibit 2.25 shows actual amount of electricity generated by fuel source in 2013.

**EXHIBIT 2.24. Michigan Generation Nameplate Capacity in MW by Fuel Type, 2015**



SOURCE: U.S. EIA. November 21, 2016. *Form EIA-860*. Accessed August 30, 2017. <https://www.eia.gov/electricity/data.php#gencapacity>

**EXHIBIT 2.25. Total Electricity Generated, All Producers, 2016**

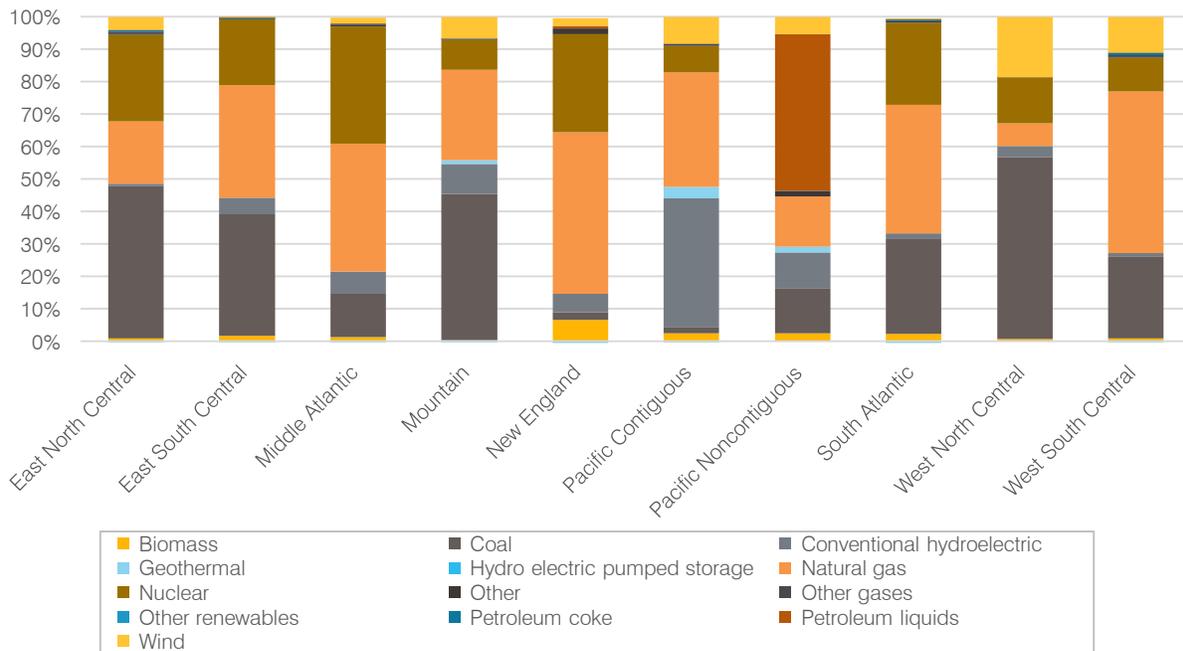


SOURCE: U.S. EIA. August 30, 2017. Form EIA-923. Accessed September 6, 2017. <http://www.eia.gov/electricity/data/eia923/>

**Fuel Mix for Electric Generation by Region**

The fuels used for electricity generation vary widely across the country. As shown in Exhibit 2.26, coal dominates the fuel mix in the Mountain, West North Central, and East North Central (which includes Michigan) regions. Natural gas is the primary fuel source in New England, West South Central, and in the Pacific Contiguous regions. The largest share of nuclear generation is in the Middle Atlantic (U.S. EIA March 25, 2015). A map explaining which states are in which regions is included in Appendix A.

**EXHIBIT 2.26. Fuel Mix for Electric Generation, 2016**

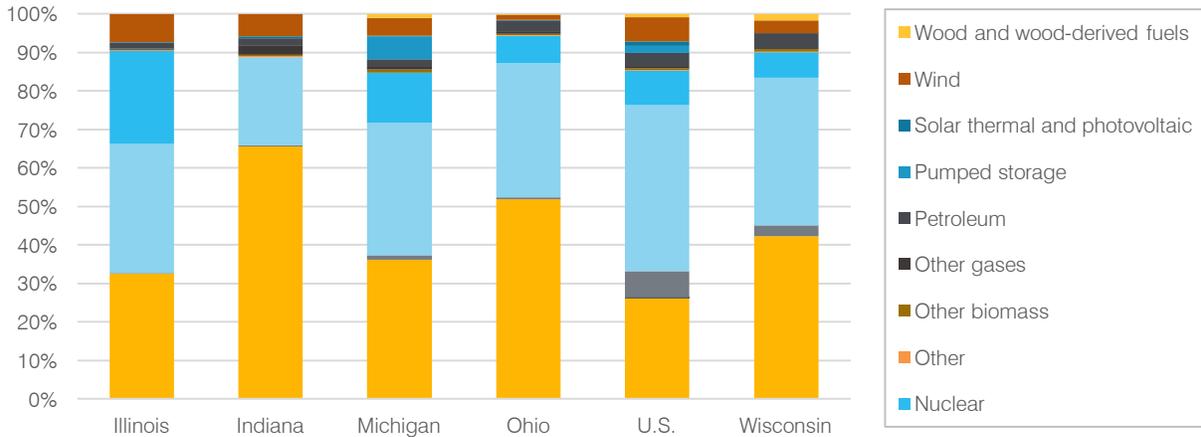


SOURCE: U.S. EIA. November 21, 2016. Form EIA-860. Accessed August 30, 2017. <https://www.eia.gov/electricity/data.php#gencapacity>

## East North Central States

The U.S. Census Bureau groups Indiana, Illinois, Ohio, Wisconsin, and Michigan together in the ENC region. As shown in Exhibit 2.27, the regional average fuel mix is very similar to Michigan's generation portfolio, but the ENC region has more coal resources than the national average.

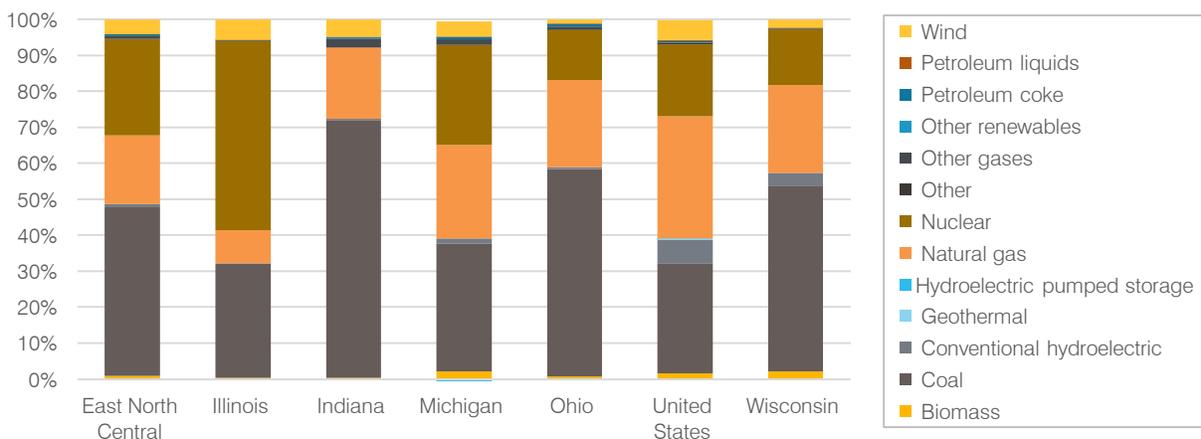
**EXHIBIT 2.27. Generation Nameplate Capacity by Fuel Type, 2015**



SOURCE: U.S. EIA. November 21, 2016. *Form EIA-860*. Accessed August 30, 2017. <https://www.eia.gov/electricity/data.php#gencapacity>

The fuel mix for electricity generated looks very similar to the capacity fuel mix, as shown in Exhibit 2.28. Coal and nuclear facilities make up the bulk of generation in these states. Due to market conditions and environmental regulation, states across the nation are utilizing greater amounts of natural gas generation than in previous years. Historically, natural gas has provided 10–15 percent of Michigan's electric generation. In 2015, natural gas made up 37.9 percent of the state's generating mix.

**EXHIBIT 2.28. Comparison of Annual Net Generation by Fuel Type**



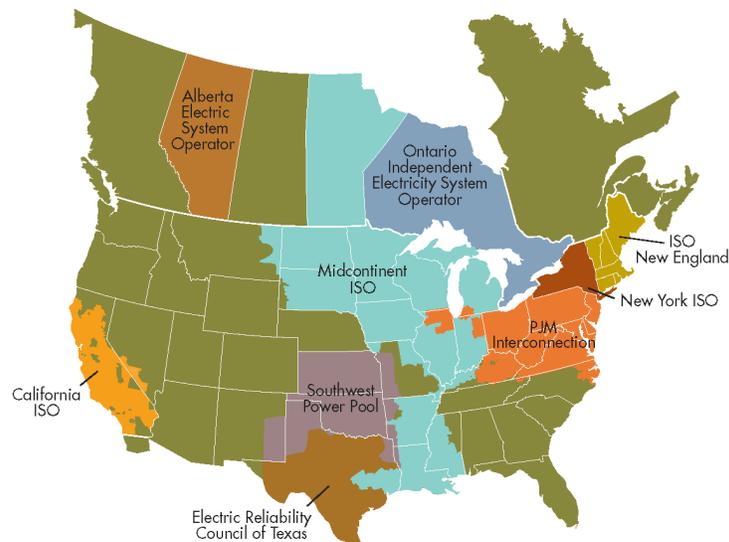
SOURCE: U.S. EIA. August 30, 2017. *Form EIA-923*. Accessed September 6, 2017. <http://www.eia.gov/electricity/data/eia923/>

## Regional Transmission Organization

Since Michigan's electricity providers belong to RTOs, the electricity generated in Michigan is not exclusively consumed in the state. Instead, RTOs dispatch electric generation across their footprint to achieve the most economic and reliable supply of energy based on bids and offers in the RTOs' energy markets. This means that generation from outside of Michigan can be consumed in the state and vice versa, depending on transmission capability and constraints; thus, it is useful to look at the fuel mix for these regional entities when examining electricity resources.

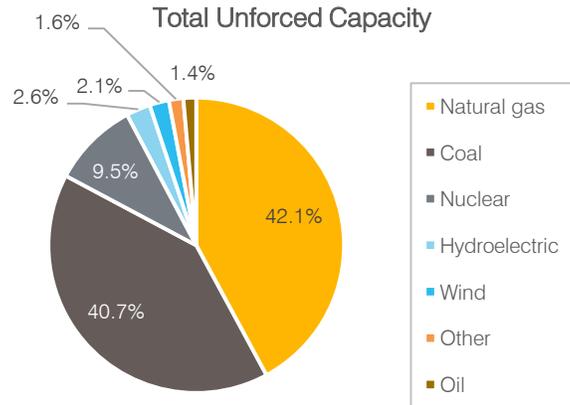
As shown in Exhibit 2.29, there are two RTOs with service territory in Michigan: MISO and PJM. Exhibits 2.30 and 2.31 show the installed generating capacity and generation by fuel source for the MISO and PJM RTOs.

**EXHIBIT 2.29. Regional Transmission Organization Service Territories**

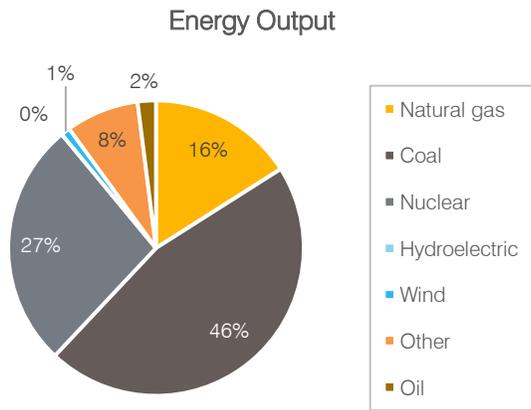


SOURCE: Sustainable FERC Project. n.d. *ISO RTO Operating Regions*. Accessed May 5, 2015. <http://sustainableferc.org/wp-content/uploads/2013/10/ISO-RTO-Operating-Regions.jpg>

**EXHIBIT 2.30. MISO Installed Capacity and Energy Output by Fuel Type, 2016**



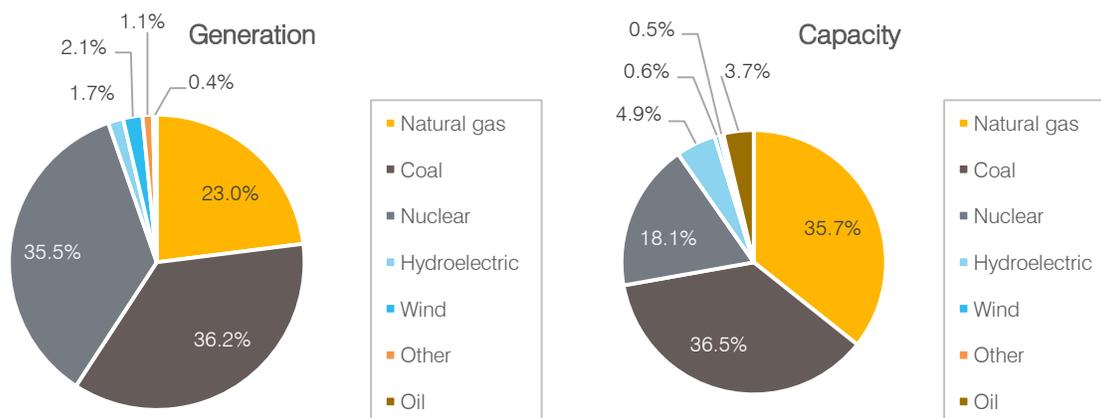
15



NOTE: Other is comprised of hydro, oil, other, pet coke, and waste. Gas includes units with gas and gas/oil fuel type.  
 SOURCE: Potomac Economics. June 2017. *2016 State of the Market Report for the MISO Electricity Markets*. Accessed August 31, 2017.  
<https://www.misoenergy.org/Library/Repository/Report/IMM/2016%20State%20of%20the%20Market%20Report.pdf>

<sup>15</sup> Unforced capacity is a generator availability rating. It adjusts the installed nameplate generation capacity down based on generator performance.

**EXHIBIT 2.31. PJM Installed Capacity and Generation by Fuel Type, 2016**

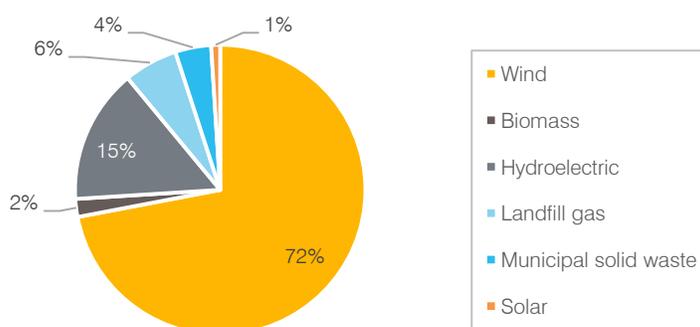


SOURCE: Monitoring Analytics. March 9, 2017. *2016 State of the Market Report for PJM*. Accessed August 30, 2017. [http://www.monitoringanalytics.com/reports/PJM\\_State\\_of\\_the\\_Market/2016/2016-som-pjm-volume2.pdf](http://www.monitoringanalytics.com/reports/PJM_State_of_the_Market/2016/2016-som-pjm-volume2.pdf)

## Renewable Generation

Since Michigan adopted a renewable portfolio standard (RPS) in 2008, there has been significant investment in renewable generation in the state. As shown in Exhibit 2.32, more than 1,800 MWs of renewable generation have been added since the standard was put in place. The majority of this added capacity is from onshore wind capacity. Michigan’s other renewable energy sources include more than 100 hydroelectric facilities, rooftop- and ground-mounted solar, methane capture landfill gas facilities, anaerobic digesters, and wood waste facilities. Overall, renewable resources contribute about 9.6 percent to the state's net electricity generation (MPSC February 2017).

**EXHIBIT 2.32. Renewable Capacity, 2016**

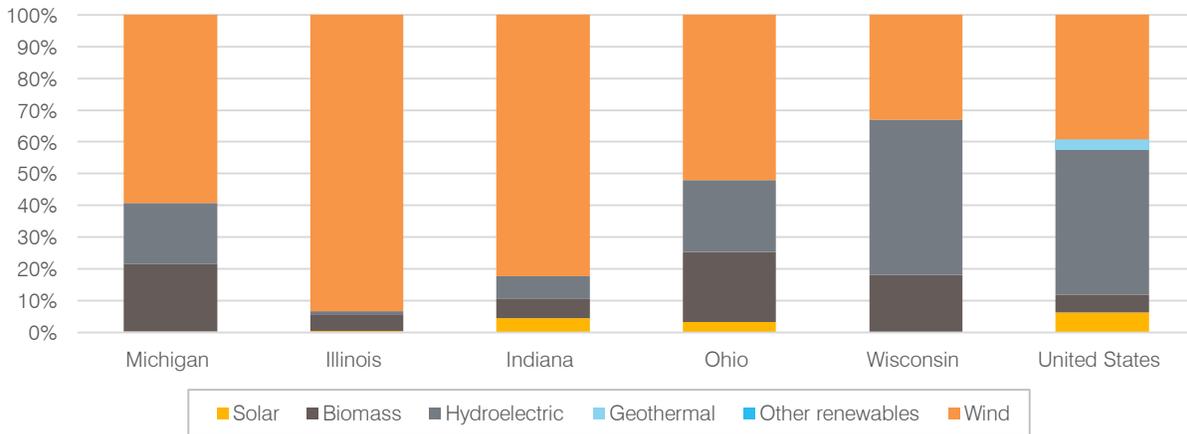


SOURCE: MPSC. February 15, 2017. *Report on the Implementation of the P.A. 295 Renewable Energy Standard and the Cost-effectiveness of the Energy Standard*. Accessed August 31, 2017. [http://www.michigan.gov/documents/mpsc/MPSC\\_PA295\\_Renewable\\_Energy\\_Report\\_Feb\\_2017\\_552081\\_7.pdf](http://www.michigan.gov/documents/mpsc/MPSC_PA295_Renewable_Energy_Report_Feb_2017_552081_7.pdf)

As shown in Exhibit 2.33, renewable generators produced 7.9 gigawatt hours (GWhs) of electricity in 2015. Compared to neighboring states, only Illinois generated more electricity from renewables than Michigan. Onshore wind energy is the most common renewable energy resource for ENC states (U.S. EIA

March 25, 2015). A map showing the location of renewable energy projects in Michigan, is available in Appendix B.

**EXHIBIT 2.33. Comparison of Annual Net Generation of Renewables by Fuel Type, 2015**



SOURCE: U.S. EIA. August 30, 2017. *Form EIA-923*. Accessed August 31, 2017. <https://www.eia.gov/electricity/data/eia923/>

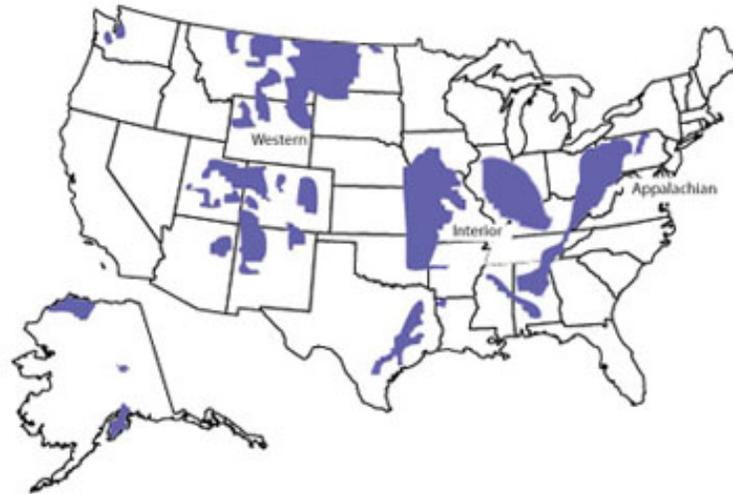
## FUEL SUPPLY

Access to a diverse, cost-effective supply of fuel resources is vital to ensuring reliable and affordable electricity. Fuels used for electricity production come from a variety of resources. Many of them must be transported from the source to a processing facility and then on to the end user. Energy delivery relies on a series of interactions; when the delivery system—be it wires, trains, ships—becomes congested or breaks down, customers face the prospect of increased prices or reduced service quality.

### Coal Supply and Delivery

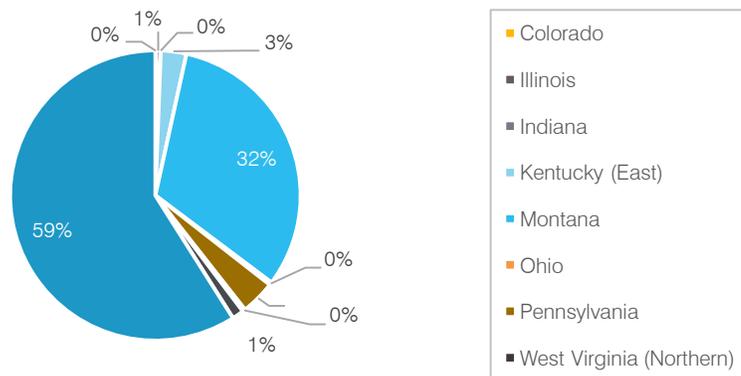
Coal is the primary energy source for production of electricity in Michigan. Since Michigan has only minimal in-ground coal reserves or active coal production, electric producers must bring in coal from other states. As shown in Exhibit 2.34, there are three main regional coal deposits in the United States. Despite the proximity of coal deposits in the U.S. interior region and Appalachia, the majority of the coal that Michigan consumes comes from the less expensive western producers, in Wyoming and Montana, as shown in Exhibit 2.35 (U.S. EIA December 2014).

### EXHIBIT 2.34. Coal Resource Regions



SOURCE: U.S. EIA. January 21, 2015. *U.S. Coal Reserves*. Accessed April 6, 2015. <http://www.eia.gov/coal/reserves/>

### EXHIBIT 2.35. State of Origin for Coal Delivered to Electric Power Sector in Michigan, 2015



SOURCE: U.S. EIA. November 14, 2016. *Annual Coal Distribution Report*. Accessed June 20, 2017. <http://www.eia.gov/coal/distribution/annual/>

Compared to other energy sources, coal has the advantage of being easily stored at power plants. Unlike nuclear fuel, coal storage does not require additional physical security, and unlike natural gas, it can be stored onsite without additional infrastructure. Power plants typically maintain a stockpile of coal that allows them to operate without interruption between deliveries or during periods of increased demand. Even so, supplies can become strained under certain circumstances. A recent example occurred during the “polar vortex” in the winter of 2013. Railroads normally move nearly 70 percent of coal shipments in the United States (AAR 2014) with great reliability, but during that winter, the expected shipments of coal from western producers were delayed—due to extreme cold weather and previous increased demand for limited railroad capacity from competing commodities. The delayed coal shipments caused operators throughout the Midwest to burn through their reserves (and in some cases, nearly run out) of fuel (Shaffer and Spencer 2014).

The challenges that electric producers and customers faced during that period of extreme winter weather generated outrage among producers and elected officials, especially in the PJM area, who called on federal regulators to address the problem (Johnson 2014). On December 30, 2014, the U.S. Surface Transportation Board directed the BNSF Railway—the primary rail service provider for western coal shipments—to develop contingency plans designed to address coal shortages at Midwest power plants (U.S. STB 2014). BSNF responded by outlining various measures that can be taken when customer drops below the ten-day supply threshold. These measures included the increase/decrease in number of trainsets, locomotive allocation, route adjustments, alternate gateways, and contract modification (Bobb 2015).

## Natural Gas Supply and Storage

The electric power sector is the largest consumer of natural gas. In 2015, 37.9 percent of Michigan’s electricity was generated from natural gas, as illustrated in Exhibit 2.36 below (U.S. EIA March 25, 2015). In 2015, Michigan imported 1,715,735 million cubic feet (MMcf) of natural gas. Unlike coal, which can be stored easily on site at power plants, natural gas is typically delivered as it is consumed. According to the U.S. Department of Energy (U.S. DOE), natural gas delivery is coordinated across more than 200,000 miles of interstate pipelines that connect producers, processors, and end users (U.S. DOE 2015). An overview of interstate natural gas pipeline capacity and locations is available in Appendix C.

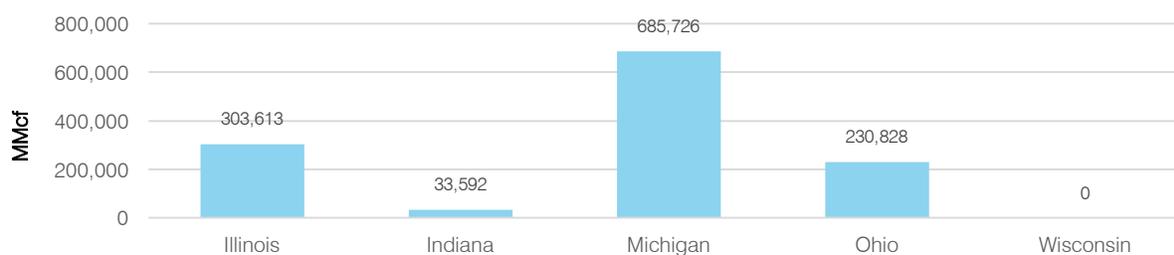
**EXHIBIT 2.36. Natural Gas Delivery, Consumption, Production, and Price, Michigan (MMcf)**

	2009	2010	2011	2012	2013	2014	2015
Interstate receipts	1,862,322	1,860,721	1,906,908	1,805,044	1,662,101	1,775,561	1,715,735
Interstate deliveries	116,961	115,066	56,903	150,868	269,123	229,399	254,493
Dry production	69,803	55,316	70,266	63,357	58,806	113,143	105,841
Consumption	735,340	746,748	776,466	790,642	813,300	861,755	852,903
Consumption by electric power sector	66,246	96,703	99,748	169,806	106,990	110,299	164,114
Electricity generated from natural gas (GWhrs)	8,419.6	12,249.3	12,982.1	21,748.4	12,341.4	12,522.8	20,044.8
Electric power price (dollars/thousand cubic feet)	\$4.55	\$4.97	\$4.76	\$3.21	\$4.58	\$6.71	\$3.21

SOURCE: U.S. EIA. August 31, 2017. *Natural Gas Annual Supply & Disposition by State*. Accessed September 30, 2017. [http://www.eia.gov/dnav/ng/ng\\_sum\\_snd\\_a\\_EPG0\\_FPD\\_Mmcf\\_a.htm](http://www.eia.gov/dnav/ng/ng_sum_snd_a_EPG0_FPD_Mmcf_a.htm) and U.S. EIA. August 30, 2017. *Form EIA-923*. Accessed August 31, 2017. <https://www.eia.gov/electricity/data/eia923/>

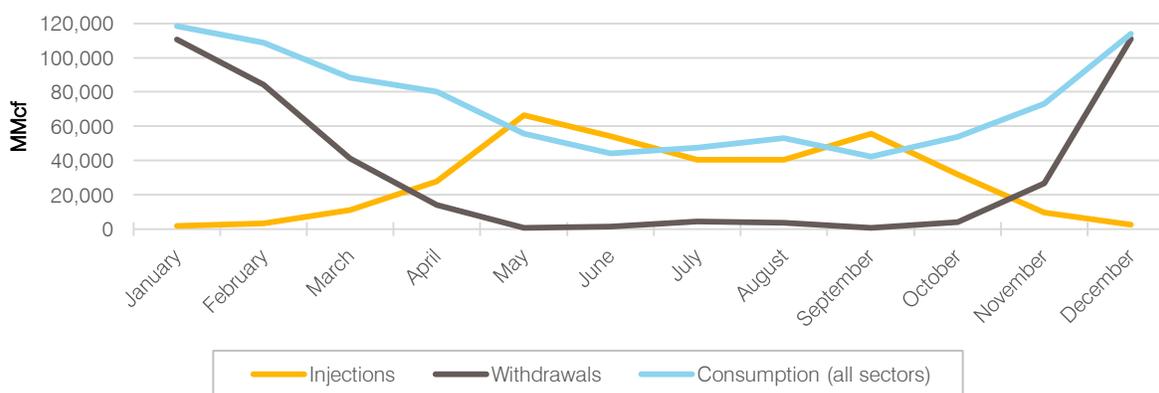
Michigan depends on interstate pipelines for approximately 80 percent of its natural gas supply, but because there is abundant underground storage capacity, the state can limit its exposure to gas supply issues. As displayed in Exhibit 2.37, Michigan has more than 10 percent of the nation’s underground natural gas storage capacity—the most of any state. For an overview of Michigan’s storage capacity and locations, see Appendix D. Underground storage fields allow energy providers to buy and store natural gas during the summer months, when demand is lower. Exhibit 2.38 shows how natural gas storage fields were utilized in 2016 (U.S. EIA August 2017). The stored natural gas can then be withdrawn during seasonal heating months, when demand is higher. This practice helps suppliers avoid potential delivery constraints and seasonal price variations (MPSC May 15, 2014). A summary of annual natural gas storage injections and withdrawals is displayed in Exhibit 2.39.

### EXHIBIT 2.37. Working Underground Natural Gas Storage Capacity by State, 2015



SOURCE: U.S. EIA. August 31, 2017. *Underground Storage Capacity*. Accessed September 1, 2017. [https://www.eia.gov/dnav/ng/ng\\_stor\\_cap\\_a\\_EPG0\\_SACW0\\_Mmcf\\_a.htm](https://www.eia.gov/dnav/ng/ng_stor_cap_a_EPG0_SACW0_Mmcf_a.htm)

### EXHIBIT 2.38. Natural Gas Underground Storage in Michigan, 2016



SOURCE: U.S. EIA. August 31, 2017. *Underground Natural Gas Storage by All Operators*. Accessed September 1, 2017. [https://www.eia.gov/dnav/ng/ng\\_stor\\_sum\\_a\\_EPG0\\_sat\\_mmcfl\\_m.htm](https://www.eia.gov/dnav/ng/ng_stor_sum_a_EPG0_sat_mmcfl_m.htm)

### EXHIBIT 2.39. Natural Gas Storage, Michigan (MMcf)

	2009	2010	2011	2012	2013	2014	2015	2016
Injections into storage	462,022	393,814	457,240	307,948	414,172	587,171	543,203	345,667
Withdrawals from storage	393,748	434,764	385,364	323,187	551,992	511,739	455,481	403,268

SOURCE: U.S. EIA. August 31, 2017. *Underground Storage Capacity by All Operators*. Accessed September 1, 2017. [https://www.eia.gov/dnav/ng/ng\\_stor\\_sum\\_a\\_EPG0\\_saw\\_mmcfl\\_a.htm](https://www.eia.gov/dnav/ng/ng_stor_sum_a_EPG0_saw_mmcfl_a.htm)

Natural gas pipelines have limited transport capacity—on average, only 54 percent of pipeline capacity is used—and in circumstances when demand is extremely high, or a pipeline fails, congestion can occur (U.S. DOE 2015). During the “polar vortex” in 2013, when extreme cold caused demand for natural gas to spike, existing pipeline infrastructure in the Northeastern United States had trouble keeping up with demand, which led to a sharp rise in energy prices (Edwards 2014). Following the polar vortex, the U.S. saw an increased investment in pipeline capacity, and in 2014 alone, there was more than \$18 billion in infrastructure investments in the U.S.—up from the \$10 billion annual average (Smith 2016). A complete inventory of Michigan’s interstate pipelines is available in Appendix C.

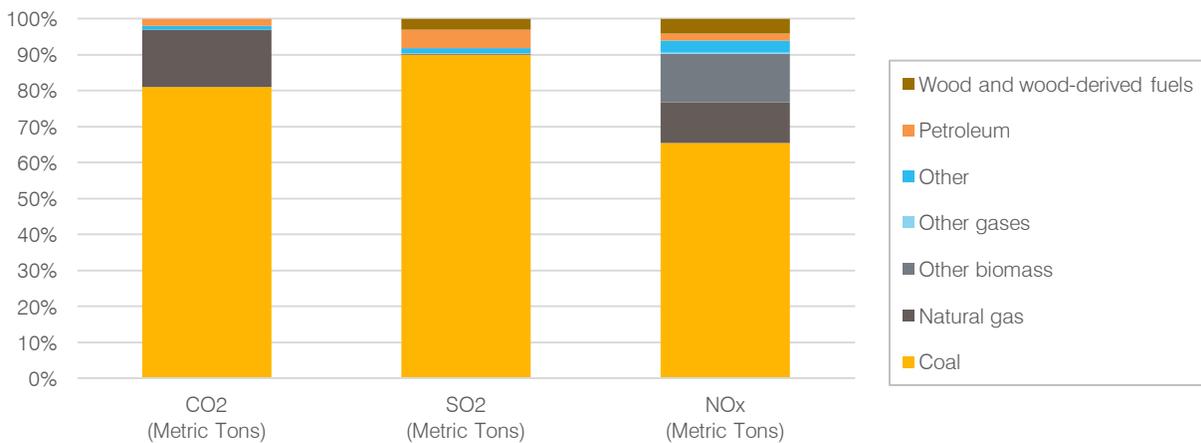
The U.S. DOE recently released a report detailing its expectations for natural gas supply given current trends in electric generation. Despite projections that the natural gas share of electric generation will grow substantially through 2040, the U.S. DOE predicts that infrastructure investment will be modest. According to the findings, increased natural gas consumption can be accommodated by expanding capacity of current pipelines, better utilizing existing capacity, or shifting the flow of natural gas (U.S. DOE 2015).

## ENVIRONMENTAL PERFORMANCE

Nearly 67 percent of the nation’s electricity is generated by burning fossil fuels, mainly coal and natural gas. While it generates energy vital to modern day life, combusting fossil fuels also produces harmful emissions that impact the environment. All sources of electricity have some impact on the environment, but air pollutants from fossil-fueled generation are of particular concern. According to the U.S. EPA, the electric power industry produces 30 percent of all greenhouse gas emissions (U.S EPA February 2017).

As shown in Exhibit 2.40, for electricity generation, coal is the source of most of the carbon dioxide (CO<sub>2</sub>), Sulfur Dioxide (SO<sub>2</sub>), and Nitrogen Oxides (NO<sub>x</sub>) emitted in Michigan. Coal-fired units produced 90 times as much SO<sub>2</sub>, twice as much CO<sub>2</sub>, and over five times as much NO<sub>x</sub> per unit of electricity compared with natural gas units (U.S. GAO 2012).

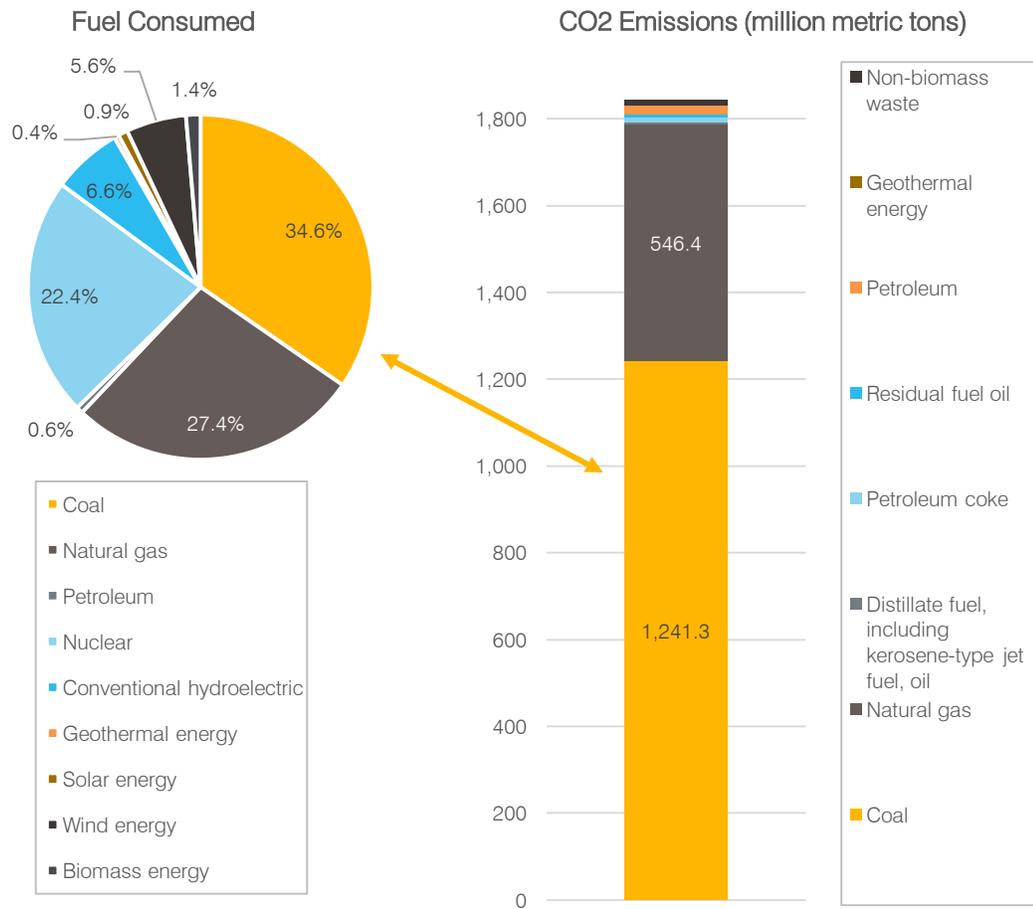
**EXHIBIT 2.40. Percentage of Electric Power Industry Emissions by Fuel Source, Michigan, 2015**



SOURCE: U.S. EIA. March 30, 2017. *U.S. Electric Power Industry Estimated Emissions by State, Back to 1990 (EIA-923)*. Accessed August 30, 2017. [http://www.eia.gov/electricity/data/state/emission\\_annual.xls](http://www.eia.gov/electricity/data/state/emission_annual.xls)

Despite only supplying 34 percent of the total fuel for the electric power sector nationwide, coal is responsible for nearly 67 percent of all CO<sub>2</sub> emissions, as shown in Exhibit 2.41.

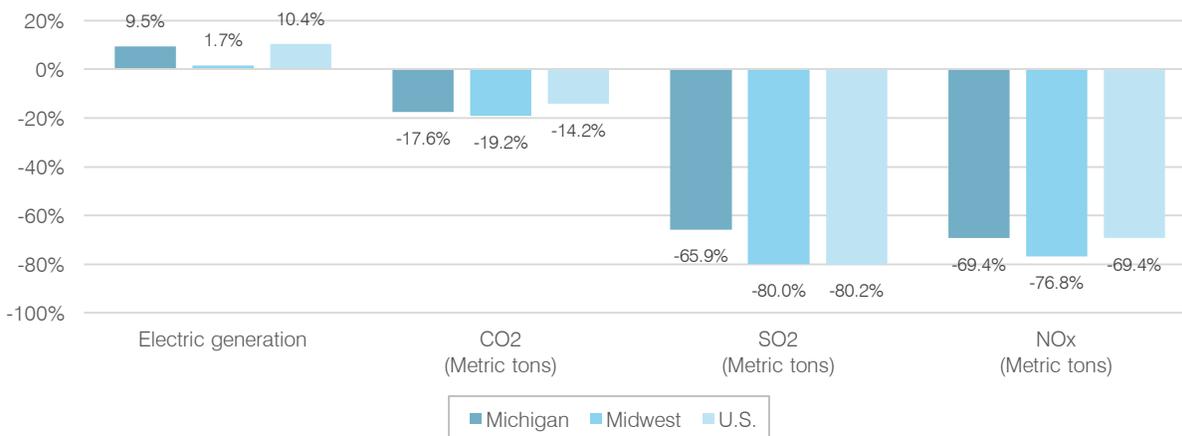
**EXHIBIT 2.41. Fuel Consumed by the Electric Power Industry and CO2 Emissions from the Electric Power Industry by Fuel Source, U.S., 2016**



SOURCE: U.S. EIA. August 30, 2017. Form EIA-923. Accessed September 1, 2017. <http://www.eia.gov/electricity/data/eia923/>

As shown in Exhibit 2.42, overall air pollution has decreased dramatically since 1990 (U.S. EPA February 2012). Increasingly stringent environmental regulations for electric generating units have helped to drive down emissions across the nation and the Midwest. Since 1999, even though total electric generation has gone up, Michigan’s electric generators have reduced CO<sub>2</sub>, SO<sub>2</sub>, and NO<sub>x</sub> emissions at rates similar to the national and region average. For example, Michigan has reduced its CO<sub>2</sub> emissions by 17.62 percent from 2000-2015.

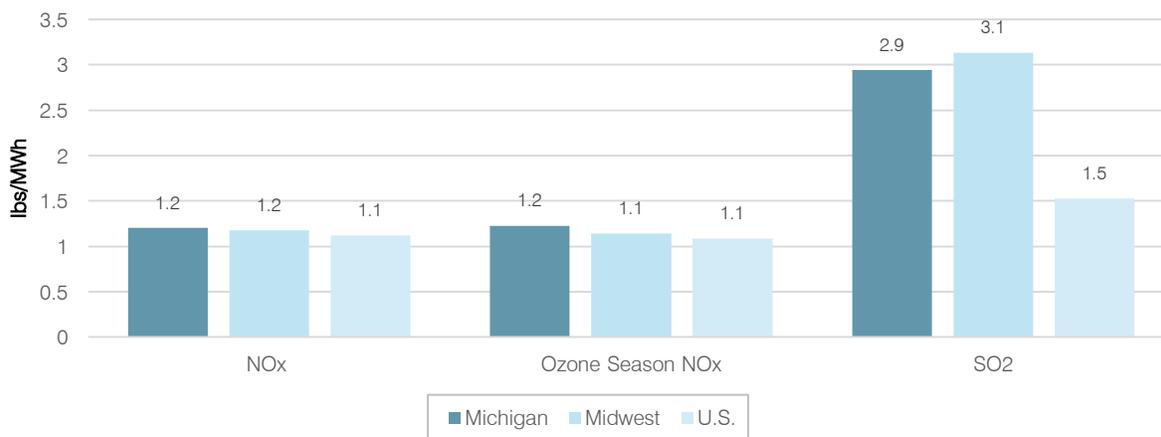
**EXHIBIT 2.42. Percent Change in Electric Generation (MWh) and Emissions (thousand metric tons), 1999–2015**



SOURCE: U.S. EPA. January 13, 2017. *Emissions & Generation Resource Integrated Database (eGRID)*. Accessed September 1, 2017. <https://www.epa.gov/energy/emissions-generation-resource-integrated-database-eGRID>

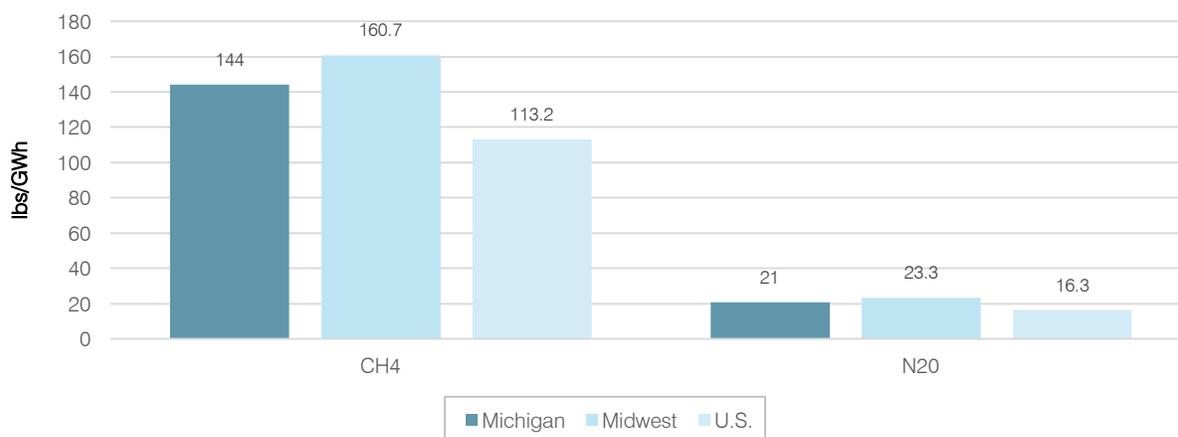
An electric generator’s emissions rate is the amount of air emissions generated from the production of a unit of electricity, commonly displayed as pounds per MWh. Because different fuels produce different levels of emissions, a state’s emissions rate is largely dependent on its generation fuel mix. As shown in Exhibit 2.43, 2.44, and 2.45, the emissions rate for all electric generators in Michigan is similar to the regional average and above the national average (U.S. EPA February 2014).

**EXHIBIT 2.43. Total Emissions Rates for Sulfur Dioxide, Nitrogen Oxides and Ozone**



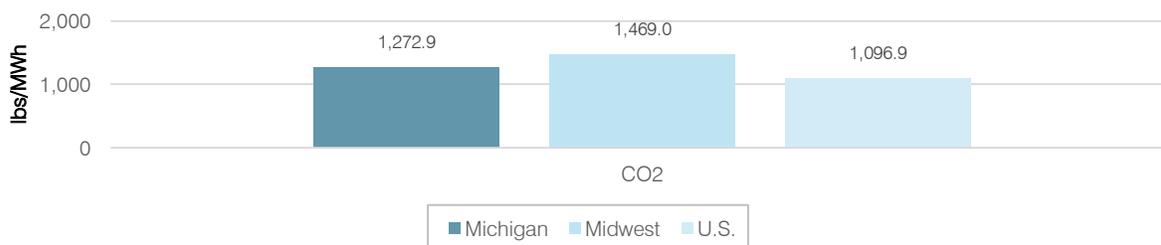
NOTE: Ozone season is from May 1 to September 30, when ozone conditions are of greatest concern.  
 SOURCE: U.S. EPA. January 13, 2017. *Emissions & Generation Resource Integrated Database (eGRID)*. Accessed September 1, 2017. <https://www.epa.gov/energy/emissions-generation-resource-integrated-database-eGRID>

**EXHIBIT 2.44. Total Emissions Rate for Methane (CH<sub>4</sub>) and Nitrous Oxide (N<sub>2</sub>O), and Carbon Dioxide Equivalent (CO<sub>2</sub>e)**



SOURCE: U.S. EPA. January 13, 2017. *Emissions & Generation Resource Integrated Database (eGRID)*. Accessed September 1, 2017. <https://www.epa.gov/energy/emissions-generation-resource-integrated-database-eGRID>

**EXHIBIT 2.45. Total Emissions Rate for Carbon Dioxide Equivalent (CO<sub>2</sub>e)**



SOURCE: U.S. EPA. January 13, 2017. *Emissions & Generation Resource Integrated Database (eGRID)*. Accessed September 1, 2017. <https://www.epa.gov/energy/emissions-generation-resource-integrated-database-eGRID>

## RESOURCE ADEQUACY

The NERC sets reliability standards for the electric transmission grid across the U.S. and Canada. RTOs and states implement those standards. Per the joint federal/state jurisdictional model outlined by the Federal Power Act, states have jurisdiction to set and enforce resource adequacy standards for load-serving entities providing electricity service to customers in their states. With the advent of regional markets, RTOs coordinate regional resource adequacy planning.

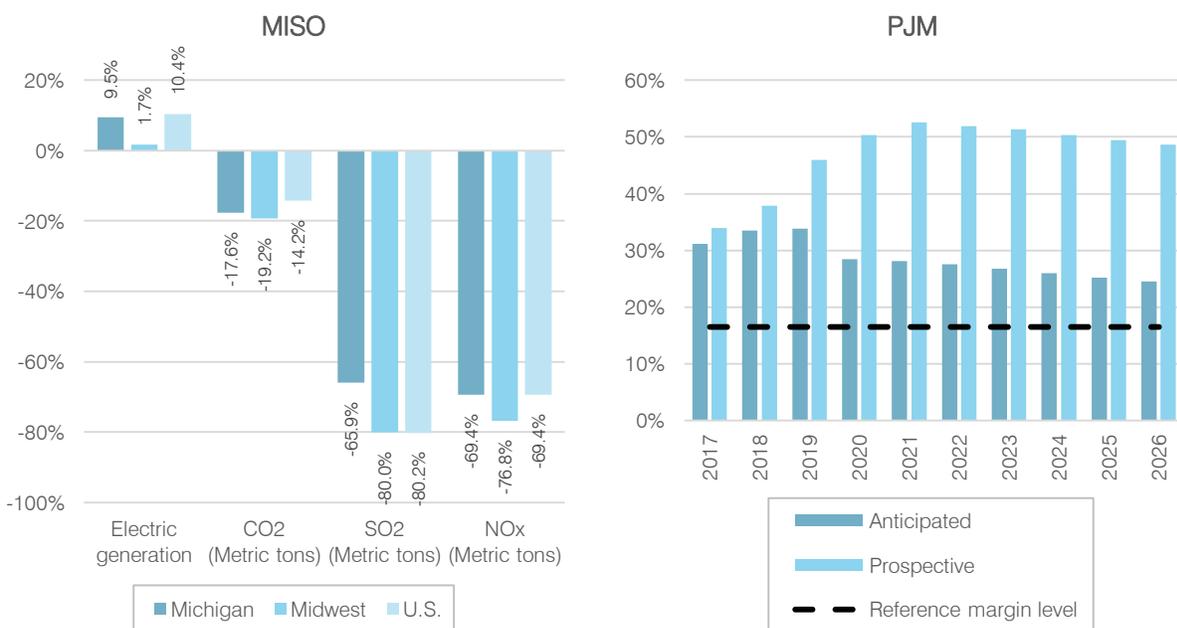
Resource adequacy standards are critical because in order to ensure a reliable supply of electricity, providers need to own or have firm contracts for sufficient resources to respond to varying consumer demand, unexpected generation outages, changing resource mix, and other numerous factors that impact their ability to deliver electricity to end users. RTOs calculate their anticipated peak energy demand for the coming years,<sup>16</sup> and—based on anticipated energy needs, system resources, and transmission

<sup>16</sup> In some RTOs, such as MISO, the demand forecasts are provided by the LSEs for this purpose and compiled by the RTO.

congestion—establish resource requirements to ensure that the amount of available resources exceeds customer demand by an adequate margin to allow for planned contingencies.<sup>17</sup> These annual planning reserve margin requirements (PRMRs) are designed to make sure that resources are planned and subsequently available for dispatch under a variety of electricity grid circumstances and conditions.

As shown in Exhibit 2.46, in MISO, the PRMR for 2017–2018 is set at 15.2 percent. MISO projects that the reserve margin will drop below the 15.2 percent requirement by 2018. The primary driver of MISO’s potential deficiency is the retirement of aging and uneconomic power plants and a decrease in resources committed to the MISO market from IPPs (NERC 2016). PJM’s PRMR for the same time period is 16.5 percent. PJM projects it will meet this reserve margin through the year 2026 (NERC 2016).

**EXHIBIT 2.46. Planning Reserve Margins, PJM and MISO**



SOURCE: North American Electric Reliability Corporation. December 2016. *2016 Long-Term Reliability Assessment*. Accessed September 1, 2017. [http://www.nerc.com/pa/RAPA/ra/Reliability Assessments DL/2016 Long-Term Reliability Assessment.pdf](http://www.nerc.com/pa/RAPA/ra/Reliability%20Assessments%20DL/2016%20Long-Term%20Reliability%20Assessment.pdf)

### Resource Adequacy Self-assessments

Since 1998, the MPSC has conducted annual investigations into the plans of the regulated utilities in Michigan to secure adequate resources to meet customer demand in their respective service territories. In subsequent years, the commission has expanded the scope of these investigations to include, among other things, transmission considerations, the effect of retail open access (ROA) programs, wholesale market issues, and the interconnection of merchant generation. In Case No. U-14087, the commission again expanded its investigation to include all regulated utilities, including member-regulated cooperatives. In its December 2013 order in Case No. U-17523, the commission found that it should conduct a similar

<sup>17</sup> MISO and the Organization of MISO States conduct an annual survey of all their members to review available and planned resources.

investigation that would span the three-year period of 2014 through 2016, due to the expected retirement of older generating units in the state associated with the implementation of new air quality requirements.

The commission has since found it appropriate to further extend the horizon to a five-year period, primarily due to the information submitted in U-17523, and the prospect of significant capacity shortfalls in Michigan beginning as early as 2016. The commission is interested in maintaining a forward-looking picture of the capacity position of the state and proactively helping to address any potential issues that can be reasonably foreseen (MPSC December 4, 2014b).

The newly implemented Michigan Public Act 341 of 2016 required all electric providers—investor-owned utilities, alternative electric suppliers, municipal utilities, and electric cooperatives—to annually demonstrate to the MPSC that they have owned or contracted resources adequate to serve customer needs four years out. The new requirements are consistent with, and intended to complement, federal reliability requirements. With Case No. U-18197, the commission continued its prioritization of resource adequacy by establishing a capacity demonstration process pursuant to the state’s new energy laws. The commission also set the state reliability mechanism capacity charge, which customers of alternative electric suppliers would have to pay if those suppliers do not have enough power to serve customers’ anticipated needs.

The changing generation mix throughout the nation and the closing of many coal plants, including some in Michigan, contribute to this focus on resource adequacy. The results of the commission’s most recent five-year outlook demonstrated the tightening of capacity supplies in Michigan. MPSC analysis found that the near-term supply outlook for the summer of 2018 will be adequate, given the availability of imports from out of state, but it is predicted to fall short of the PRMR absent incremental capacity additions through demand response, energy waste reduction, new generation facilities, and/or continued decline of load forecasts (MPSC July 31, 2017).

Utility reliability plans filed in MPSC Case No. U-17751 show that Michigan energy providers are planning to meet their PRMR through a variety of energy resources, including owned generation, qualifying demand response programs, power purchase agreements (PPAs), purchases from the MISO markets, and other capacity contracts. Five electric utilities—Consumers, DTE, I&M, Upper Peninsula Power Co. (UPPCo), and Wolverine Power Cooperative—collectively serve more than 91 percent of Michigan customers, as shown in Exhibit 2.47. The combined reliability plans for all Michigan electric utilities show that overall, suppliers plan to have sufficient resources through 2022 (see Exhibit 2.48). Their filings explain they plan to procure required resources through capacity auctions or other contracts for capacity. A summary of reliability plans for these five utilities can be found in Appendix F.

## EXHIBIT 2.47. Number of Bundled Customers Served by Five Utilities

Customers Served	Number of Customers Served	Percent of Customers Served
DTE Energy	2,153,990	44.61%
Consumers Energy	1,796,196	37.20%
Wolverine Power Cooperative*	250,496	5.19%
Indiana Michigan Power Company	127,807	2.65%
Upper Peninsula Power Company	47,991	0.99%
<b>Total for Five Companies</b>	<b>4,376,480</b>	<b>90.60%</b>

NOTE: These figures, calculated by PSC, include Cherryland, Great Lakes, HomeWorks Tri-County, Midwest Energy, and Presque Isle.  
SOURCE: U.S. EIA. August 14, 2017. *Form EIA-861*. "Electric Power Sales, Revenue, and Energy Efficiency." Accessed August 24, 2017  
<https://www.eia.gov/electricity/data/eia861/>

## EXHIBIT 2.48. Electric Reliability Supply Plans for Five Utilities, Combined

Planning Year	2017–2018	2018–2019	2019–2020	2020–2021	2021–2022
Total Planning Reserve Margin, MW	24,442.9	24,219.3	24,203.7	23,765.7	23,781.7
Total Planning Resources, MW	24,958.5	24,330.6	25,146.6	25,061.6	25,487.6
Surplus/Shortfall, MW	502.0	97.8	930.4	1,283.4	1,692.4

NOTE: The total planning reserve margin and planning resources shown in this exhibit do not consider load or resources for other utilities or alternative electric suppliers, so they are not representative of the overall supply position of the state. Moreover, information for I&M is included in this summary, but I&M is not part of MISO footprint: it is subject to PJM reserve margin requirements.

SOURCE: MPSC. January 12, 2017. Plans Filed in Case No. U- 18197. Accessed August 24, 2017.  
<http://efile.mpsc.state.mi.us/efile/viewcase.php?casenum=18197+&submit.x=9&submit.y=16>

# SUPPLY AND DEMAND EFFICIENCY

## Generation Efficiency

The measure of efficiency for an electrical generating unit is its heat rate. Heat rate is the amount of energy inputs—measured in British thermal units (BTUs)—a plant uses to generate one kilowatt hour (kWh) of electricity (U.S. EIA April 2, 2015). Michigan’s electric generation portfolio is diverse. Facilities were built in distinct phases that reflect historical, economic, and policy decisions as well as technology changes over the past 60 years.

Michigan’s baseload coal plants were built from the 1950s to the 1980s. Coal-generating facilities are designed to operate most efficiently at full power. These units have typically been relied on to supply round-the-clock electricity needs. On average, heat rate performance has declined in baseload coal plants since the 1960s. Two main contributors to declining efficiency of baseload coal plants are the increased production associated with nuclear facilities<sup>18</sup> constructed during the 1960s and 1970s and the U.S. EPA regulations established following the passage of the Clean Air Act (CAA). The introduction of baseload nuclear facilities resulted in greater variation in the dispatch of coal units. More startups, shutdowns, and alterations of load caused coal units to operate below full power. This reduced their heat rate performance and capacity factors (U.S. EIA March 25, 2015). Likewise, U.S. EPA rules began to require various types of pollution control equipment be installed on these coal plants that ultimately reduced the net output of a plant. The average operating heat rate for coal generation in 2015 was 10,495 BTUs/kWh, a 1.2 percent

<sup>18</sup> Average nuclear facility heat rates remain virtually unchanged since 2002 and are approximately 10,460 BTU/kWh.

increase since 2005 (U.S. EIA March 25, 2015). Recent studies have highlighted several measures that can improve the overall efficiency for coal-fired power plants. Although many of these measures have high costs, studies indicate heat rates could improve by 1.2 to 4 percent through the installation of efficient air heaters, turbine upgrades, pump upgrades, and combustion optimization (Sargent and Lundy 2009).

Driven by lower gas prices from the shale gas discoveries, availability of pipeline infrastructure, and ramp capability,<sup>19</sup> natural gas plants have been the main source of generating capacity built in Michigan since the 1990s. Continued technological improvements in natural gas generation have allowed for increased efficiencies through improved turbine designs and the move from a simple cycle design to a combined cycle design that converts otherwise wasted heat to mechanical energy. Since 2005, the average efficiency of a natural gas generating unit has increased by 7 percent, the average heat rate in 2015 was approximately 7,878 BTUs/kWh. Some recent designs have exhibited the potential to reach a heat rate as low as 6,700 BTUs/kWh, depending upon operating conditions (MPSC July 2013).

The efficiency of renewable resources is not discussed in terms of heat rate because renewables do not rely on heat energy. Instead, the efficiency of renewables is measured by determining their capacity factors. The National Renewable Energy Laboratory (NREL) defines capacity factor as “a measure of how much energy is produced by a plant compared to its maximum output. It is measured as a percentage, generally by dividing the total energy produced during some period of time by the amount of energy it would have produced if it ran at full output over that period of time” (NREL 2012). Since many renewable resources are dependent on atmospheric or environmental conditions, their generation is intermittent. Wind generation has grown considerably since Michigan adopted its RPS as has the transmission that allows wind resources to get to customers. Wind generation technology has grown significantly in the last couple of years. Onshore wind generation has a capacity factor, or operational uptime, of 30 to 39 percent (U.S. EIA April 27, 2015). Taller towers and larger blade diameters allow for much higher capacity factors and optimized operating characteristics.

Michigan also is home to the Ludington Pumped Storage Plant—a unique generating resource that pumps water uphill to a reservoir during low-demand, lower-cost times, then uses that same water released to run downhill to generate electricity during high-demand, higher-cost times. This facility acts like a large battery storage device to provide system stability and pairs well with the nearby wind generation. Due to the availability of more efficient turbines, the facility is currently upgrading all six turbines to more efficient models, which will increase the generating capacity from 1,872 MW to 2,172 MW, an increase of 16 percent (DTE Energy 2011). The project is expected to be complete by spring 2020.

## **Distribution Efficiency**

Electricity is lost as it is transferred from the point of generation across power lines to the ultimate consumer. On average, 6 percent of all electricity generated is wasted through line losses (U.S. EIA May 7, 2014a). The transmission systems accounts for between 2 to 3 percent of line losses, depending upon system configuration and voltage. The remaining line losses can be attributed to the distribution system. Distribution line losses depend on variables like the vintage of the equipment, the distance between customers, and the distance between generation and the customer area. The cost associated with line losses varies depending on when energy is being produced and by what resources. More costly generators

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<sup>19</sup> Average nuclear facility heat rates remain virtually unchanged since 2002 and are approximately 10,460 BTU/kWh.

<sup>19</sup> Ramp rate refers to how quickly a plant can begin generating electricity in response to increased demand. Ramp rates vary based on fuel source and technology.

are needed during peak demand periods, resulting in more costly system losses. Electric utilities across the nation are exploring ways to improve efficiency by reducing line losses. Possible ways to increase the efficiency of the distribution system include the reduction of losses at transformers, reduction of losses in cable wires, and maintaining tight control of voltage and current fluctuations (ABB n.d. and NEMA n.d.). Gains in efficiency can be made by addressing and replacing older or obsolete transformers, installing capacitors in strategic locations, replacing old conductors, and overlaying digital technology to optimize power flow (Dominion Voltage Inc. 2012).

Michigan utilities are beginning to leverage digital technology on the distribution grid. The installation of digital meters has started in some areas (MPSC October 2010 and MPSC 2012). Digital meters have the capability to monitor power quality and provide grid reliability data by identifying the location of system outages. Digital meters working in conjunction with monitoring and control equipment have the potential to help recover from momentary outages. By using voltage conservation,<sup>20</sup> utilities can maintain optimum power flow along the distribution grid, resulting in a reduction of line losses and energy needed at peak times. As utilities continue to upgrade equipment, obsolete equipment will likely be replaced with efficient equipment and integrated digital technology. However, it is important to weigh the cost of reliability and the savings in increased efficiency against the added energy required to operate new digital equipment.

### **Distribution Resiliency and System Hardening**

The importance of system hardening and resiliency is most apparent during extreme weather events. As the distribution infrastructure ages, it is more vulnerable to increased damaged from extreme weather and extended outage periods (MPSC May 30, 2014). In order to maintain the high level of reliability that customers expect, utilities are taking measures to harden the distribution system against extreme damage and increase the system's resiliency to quickly recover. Similar activity is taking place at the regional and national levels. Most notable is a U.S. DOE request to FERC (Docket No. RM18-1) to promulgate rules to protect the U.S. from the threat of energy outages that could result from the loss of traditional baseload generation supply.

The initial step in designing a plan to address system hardening and resiliency is to understand and document the causes of outages that occur throughout the system. Collecting data following a storm or major weather event is one way utilities can work towards improving distribution networks (Quanta Technology 2010). Accurate data and documentation during and after power restoration is critical in understanding the true weaknesses of a distribution system. Storm data is critical in establishing reliability goals and metrics, which will continue to be used as improvements are made to measure system performance and customer benefit. Detailed outage data is also needed to provide a clear understanding of the causes and types of outages that occur and identify potential maintenance, capital investment, and asset management projects that support system reliability. To this end, utilities such as DTE are investing in increasing the number of operating points, which will limit the number of customers affected when something does happen, such as a fallen tree. Utilities are also investing in the ability to share information with their operations centers to understand what happened and where.

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<sup>20</sup> Dominion Energy's (a producer and transporter of energy with headquarters in Richmond, Virginia) demonstration shows an average of 2.8 percent reduction in annual energy loss.

## DEMAND-SIDE EFFICIENCY

### Energy Savings

The EO targets, established by PA 295, have led to significant investment in reducing energy waste and promoting efficient energy consumption. As shown in Exhibit 2.49, Michigan utility EO programs have saved more than 4 million MWhs of electricity and 15.2 thousand cubic feet (Mcf) of natural gas since inception. While some utilities initially struggled to meet targets, on the whole, utilities have exceeded them. PA 342 carried EO targets, renaming them EWR<sup>21</sup> in the process.

#### EXHIBIT 2.49. EWR Programs' Combined Annual Energy Savings

Year	Electric (MWh)	Natural Gas (Mcf)
2009	375,643	647,463
2010	787,474	2,110,246
2011	1,000,437	3,836,008
2012	1,198,644	4,282,874
2013	1,301,241	4,412,441
2014	1,472,148	9,279,116
2015	1,177,277	4,581,082
<b>Total</b>	<b>7,312,864</b>	<b>24,736,789</b>

SOURCE: MPSC. November 30, 2016. *2016 Report on the Implementation of P.A. 295 Utility Energy Optimization Programs*. Accessed September 6, 2017. [http://www.michigan.gov/documents/mpsc/2016\\_Energy\\_Optimization\\_Report\\_to\\_the\\_Legislature\\_with\\_Appendix\\_Nov\\_30\\_543919\\_7.pdf](http://www.michigan.gov/documents/mpsc/2016_Energy_Optimization_Report_to_the_Legislature_with_Appendix_Nov_30_543919_7.pdf)

Currently, 26 states have energy-efficiency resource standards (EERS) in place for electricity, and 15 states have a standard for gas savings. Standards vary from state to state; some standards are based on multiyear goals, and others are tied to spending levels. However, most standards are in the range of 0.7 to 2.5 percent annually for electricity and 0.3 to 2 percent annually for gas (ACEEE 2017).

### Energy Waste Reduction Program Spending

As shown in Exhibit 2.50, total expenditures for EWR programs from 2009–2015 total \$1,426,405,707. Program costs must be approved by the MPSC. To be approved by the commission, costs must be reasonable and prudent, and earn a score of one or higher on the Utility System Resource Cost Test (USRCT). All programs offered during the 2015 program year had a USRCT score greater than one. Total spending for EWR programs is capped at 2 percent of a utility's average retail sales for the year two years prior. Most Michigan utilities are currently spending at or near this cap.

<sup>21</sup> PA 342 of 2016 changed the terminology from EO to EWR. This report uses EWR.

## EXHIBIT 2.50. Total Expenditures for Michigan Utilities for EWR Programs, 2008–2015

Year	Electric Expenditures	Natural Gas Expenditures	Total
2009–2011	\$256,964,741	\$151,302,076	\$408,266,817
2012	\$159,539,215	\$86,863,118	\$246,402,333
2013	\$168,160,945	\$84,422,935	\$252,583,880
2014	\$183,977,204	\$72,926,902	\$256,904,106
2015	\$187,967,771	\$74,280,800	\$262,248,571
<b>Total</b>	<b>\$956,609,876</b>	<b>\$469,795,831</b>	<b>\$1,426,405,707</b>

SOURCE: MPSC. November 30, 2016. *2016 Report on the Implementation of P.A. 295 Utility Energy Optimization Programs*. Accessed September 6, 2017. [http://www.michigan.gov/documents/mpsc/2016\\_Energy\\_Optimization\\_Report\\_to\\_the\\_Legislature\\_with\\_Appendix\\_Nov\\_30\\_543919\\_7.pdf](http://www.michigan.gov/documents/mpsc/2016_Energy_Optimization_Report_to_the_Legislature_with_Appendix_Nov_30_543919_7.pdf)

In 2015, utilities in the United States spent \$6.7 billion on electric EWR programs, and a combined \$1.29 billion on gas EWR programs (Consortium for Energy Efficiency 2017).

## Demand Savings

Only Consumers and DTE are required to report demand savings from EWR programs. Their reported savings were included in their annual EWR reports, filed with the MPSC, and are shown below in Exhibit 2.51.

## EXHIBIT 2.51. Demand Savings, 2016

Utility	Savings (MWs)
Consumers Energy	44.1
DTE Energy	106.4

SOURCE: Energy savings information reported for Consumers Energy in Case No. U-18331 and for DTE Energy in Case No. U-18332 can be accessed electronically at: <https://efile.mpsc.state.mi.us/efile/index.htm>

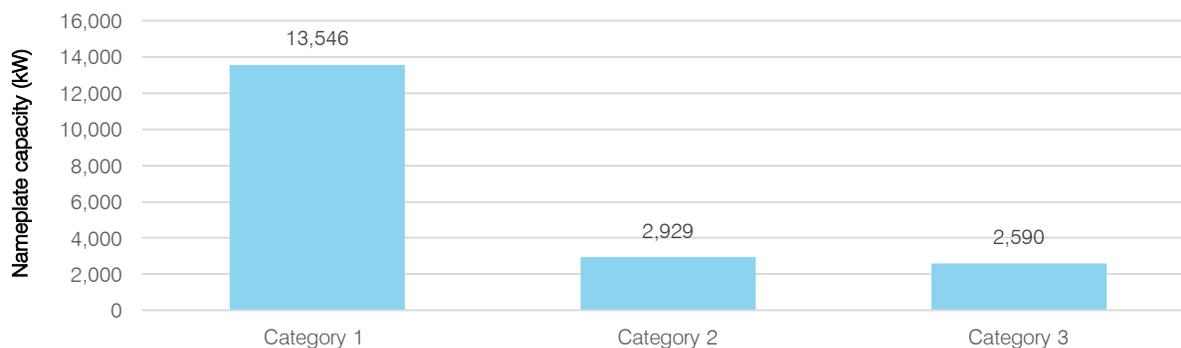
## Distributed Generation

Customers of Michigan's regulated utilities, cooperatives, and AESs are eligible to engage in net-metering programs.<sup>22</sup> These programs encourage the development of onsite renewable energy generation projects that offset some or all of a customer's electric energy needs and reduce their electric bills. Michigan allows net-metering projects that fit into one of three categories. Exhibit 2.52 shows the total capacity (kW) for each category (MPSC August 2014).

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

<sup>22</sup> Net-metering provisions were amended by PA 342 of 2016. A complete discussion of the state's new net-metering policy is available in Section III.A.

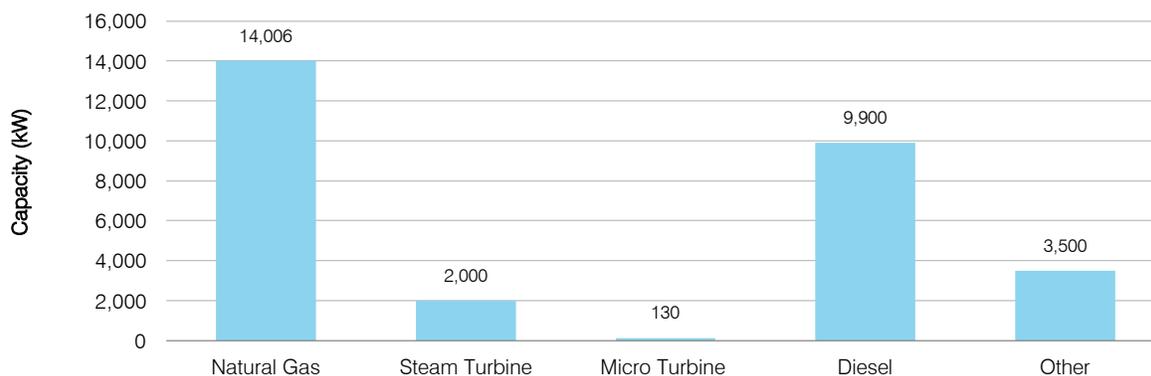
### EXHIBIT 2.52. Net Metering Installed Capacity by Category



SOURCE: MPSC. September 2016. *Net Metering and Solar Program Report for Calendar Year 2015*. Accessed August 23, 2017. [http://www.michigan.gov/documents/mpsc/netmetering\\_report\\_2013\\_464591\\_7.pdf?20141113104742](http://www.michigan.gov/documents/mpsc/netmetering_report_2013_464591_7.pdf?20141113104742)

Based on data provided by DTE and Consumers, nonrenewable self-generation makes up approximately 29.5 MW of the companies' total system. These self-generation projects serve onsite load and are under 10 MWs in size. Exhibit 2.53 shows nonrenewable self-generation by fuel type.

### EXHIBIT 2.53. Nonrenewable Customer Self-generation (kW)

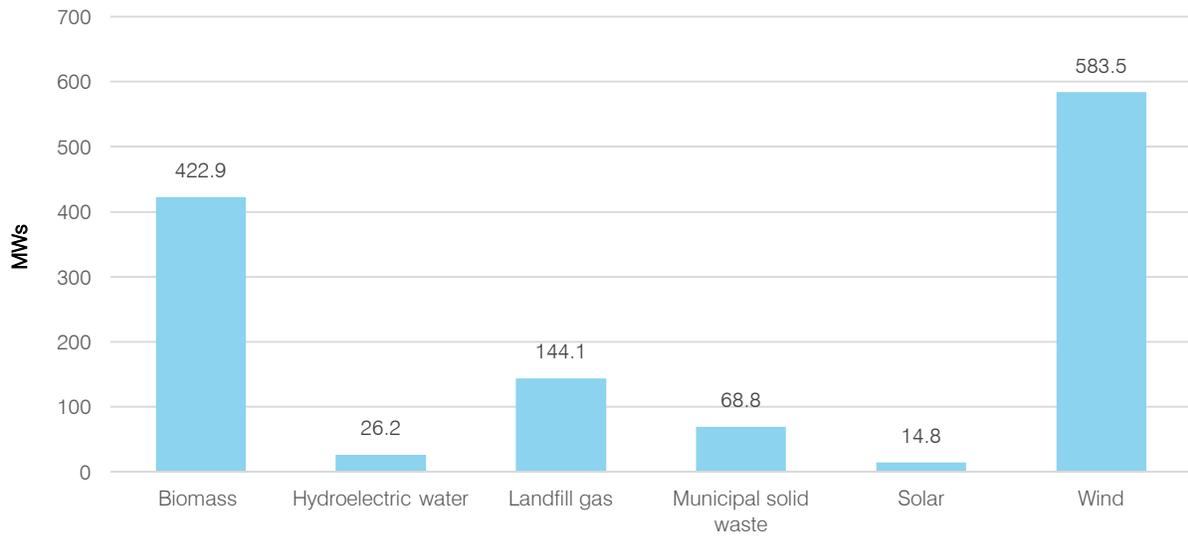


NOTE: The natural gas category includes some combined heat and power (CHP) production.  
SOURCE: Information provided by Consumers and DTE.

Exhibit 2.54 is based on data from the Michigan Renewable Energy Certification System (MIRECS)—a statewide program established by the MPSC—which shows 111 privately owned DG projects, totaling 1260 MWs of renewable DG. Wind and biomass electric generation are the largest contributors to Michigan's renewable DG. Many of these projects are likely IPPs selling power under Public Utilities Renewable Policy Act or through other contracts with utilities (not self-generation directly serving end-use customers).

**EXHIBIT 2.54. MIRECS Privately Owned Renewable DG, Nameplate Generation**

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SOURCE: MIRECS. n.d. *MIRECS Projects*. Accessed June 23, 2017. <https://portal2.mirecs.org/myModule/rpt/myrpt.asp?r=111>

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## SECTION III.A. CURRENT REGULATORY FRAMEWORK

A discussion about Michigan’s current energy policy would not be complete without an overview of the regulatory structures that govern utility behavior. There are 83 electric providers operating in the state—eight investor-owned utilities, nine electric cooperatives, 41 municipal electric utilities, and 25 licensed alternative electric suppliers (AESs)—each provider is subject to some form of regulation by the MPSC (MPSC n.d.). The following section provides an inventory of existing regulation and proceedings electric utilities are subject to.

### **Utility Rate Case Procedures (Michigan Common Law [MCL], Section 460.6a; Amended PA 341 [2016])**

The MPSC regulates the rates charged by public utilities, except municipally owned utilities, member-regulated cooperatives, and AESs. There are eight investor-owned utilities and three electric cooperatives with rates regulated by the commission. Michigan law specifies that a gas or electric utility shall not increase its rates and charges or alter, change, or amend any rate or rate schedules that increase the cost of service to its customers without first receiving commission approval (MCL 460.6a 2016). Rate cases are designed to set reasonable rates by analyzing utility company rate base investment, rate of return, operating expenses, depreciation, and taxes for the test period under review. Rates approved by the commission must be just and reasonable, taking into account the interests of both the utility and its customers. A utility can only file one rate case in a 12-month period, and cannot file a rate case if the commission has yet to issue a final order in a previous case.

To amend rates upward, a utility must file an application before the commission alleging that current revenues collected from rates are insufficient due to the cost increase of providing service. The rate case is a legal proceeding where the two basic issues of utility rates are decided; namely, (1) whether a utility company is to be allowed to change the rates for its service, and (2) if a change is allowed, the dollar amount and how the associated charges are allocated to customers classes (e.g., residential, commercial, or industrial). An administrative law judge (ALJ) presides over a rate case in much the same way a judge presides over a courtroom trial. After receiving and evaluating the testimony and evidence, the ALJ writes a proposal for decision (PFD), which sets forth his or her conclusions as to how the issues should be decided. The commission may accept, reject, or modify the PFD. In certain circumstances, in order to speed the resolution of a case, the commission will dispense with the PFD and read the record. PA 341 decreased the amount of time the MPSC staff has to review utility rate cases, and it stipulated that the commission has to issue a decision from 12 months to ten months. The legislation also removed utilities’ ability to “self-implement” rate increases.

### **Net Metering/Distributed Generation Tariff (MCL, Section 460.6a (14); Amended PA 341 [2016])**

The new energy legislation (PA 341) changed the policies regarding net metering. Within one year of the effective date, the MPSC shall conduct a study on an appropriate tariff reflecting the equitable cost of service for individuals participating in net-metering programs or DG programs under PA 295, Section 6a(14). For any rate case filed after June 1, 2018, the MPSC shall approve such a tariff for inclusion in the rates for all individuals participating in a net metering or DG program. The tariff will not apply to individuals that participate in net metering before the date the MPSC establishes a tariff.

## **Power Supply Cost Recovery (MCL, Section 460.6j; Amended PA 341 [2016])**

As late as 1982, regulated utilities were allowed to bill customers for increases in cost of fuel-related expenses without receiving prior approval from the MPSC. Strong public criticism spawned two ballot proposals aimed at altering this practice. Proposal D’s intent was to eliminate rate adjustment clauses and require all costs to be approved through general rate hearings. Proposal H’s intent was to create separate limited issue hearings to approve rate adjustment clauses for the cost of fuel, purchased power, and purchased gas. At the same time the ballot initiatives were underway, the legislature was working on what became PA 304 of 1982. Both proposals were adopted by voters—resulting in three different solutions to the same problem. In *Michigan State Chamber of Commerce v. State of Michigan*, the Michigan Supreme Court determined that Proposal H prevailed over Proposal D, and was compatible with Act 304.

PA 304 created an alternative regulatory proceeding designed to address the perceived negative aspects of automatic billing adjustments. The new regulatory proceeding permits the monthly adjustment of rates to allow for full recovery of reasonable fuel, power, and transportation costs that utilities incur to serve customers. At least three months prior to an established 12-month period, utilities are required to file a power supply cost recovery (PSCR)<sup>23</sup> plan detailing their projected costs for the period with accompanying support. The utilities can bill amounts that will recover the costs as presented, unless the MPSC stops them by issuing a temporary order setting other billing factors. Utilities can adjust their projections in midstream and roll in past imbalances to allow for a more timely recovery than waiting for a final MPSC order after a contested proceeding. The commission conducts their review as a contested case subject to intervention by appropriate parties, including those funded by the Utility Consumer Representation Board.<sup>24</sup>

Within three months following the completion of the established plan period, utilities are required to file a reconciliation application, where actual costs incurred and revenues collected pursuant to the plan are compared to see if the utility over- or under-collected their costs. In addition, those costs are subject to a reasonableness and prudence review (MCL 460.6[J] 2008).

Over the years, the results of these reconciliations (namely the over- or under-collection of reasonable costs) have been implemented in different ways. Initially, a surcharge or credit for a particular plan period was utilized to provide the utility recovery of their costs and not more or less and essentially close out that period. Currently, the MPSC employs the “roll in” method, whereby estimated over- or under-collections are included in a subsequent plan application and collected from or returned to customers as part of that period’s billing factor.

As the utility cost paradigm has evolved, so has the nature of PA 304 proceedings. In recent years, to respond better to what and to whom the utilities are paying for fuel, power, and transportation, PSCR applications now include transmission expenses, emission allowance expenses, and costs of pollution control chemicals. The PA 304 framework continues, meshing more timely and full recovery of certain costs, with the review of the reasonableness and prudence of those costs, and acknowledging that these costs can vary based on external events and circumstances.

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<sup>23</sup> Gas utilities file a gas cost recovery (GCR) plan.

<sup>24</sup> Per PA 304, the Utility Consumer Representation Board was created, and is funded, through utility assessments.

PA 341 made three changes to PSCR provisions:

- For gas fuel supply contracts or arrangements, a utility’s description of the contract/arrangement shall disclose whether it includes firm gas transportation, and if not, an explanation of how the utility proposes to ensure reliable and reasonably priced gas fuel supply to its generation facilities in the 12-month PSCR plan period. Section 6j(3).
- Remove requirement that the MPSC disallow any capacity charges associated with power purchased for periods in excess of six months without prior approval of the MPSC. Section 6j(13).
- Remove requirement that legislative committees review PSCR law every five years. Section 6j(18).

### **Certificate of Necessity (MCL, Section 460.6s Amended PA 341 [2016])**

The CON process—established by PA 286 in 2008 and amended in PA 341—allows the MPSC to review planned utility investments and determine whether proposed plans merit preapproval. Prior to 2008, the commission could only evaluate utility investments upon completion, and whether or not a facility met the “used and useful” standard. Without commission approval, utilities were unable to recover the costs of an investment through rates.

The voluntary CON process allows an electric utility to apply for approval of plans to construct an electric generation facility, make a significant investment in an existing electric generation facility, or enter into a PPA for the purchase of electric capacity for a period of at least six years—as long as the costs for the proposed construction, investment, or purchase is at least \$100 million and a portion of the costs would be allocable to retail customers in Michigan (MCL 460.6s 341). A significant investment in an electric generation facility includes a group of investments reasonably planned to be made over a period of up to six years for a singular purpose, such as increasing the capacity of an existing generation plant. Previously environmental upgrades for existing electric generation facilities and renewable energy systems<sup>25</sup> were not eligible for a CON proceeding, however, under PA 341 these projects are allowable.

A utility’s application may request a CON based on one or more of the following criteria:

- The power to be supplied as a result of the proposed construction, investment, or purchase is necessary.
- The size, fuel type, and other design characteristics of the existing or proposed facility, or the terms of the PPA, represent the most reasonable and prudent means of meeting that power need.
- The price specified in the PPA will be recovered in rates from the electric utility's customers.
- The estimated purchase or capital costs of the existing or proposed electric generation facility, including the costs of siting and licensing a new facility and the estimated cost of power from it, will be recoverable in rates from the electric utility's customers, subject to a requirement that costs be reasonable.

Following an application’s filing, the commission has 270 days<sup>26</sup> to determine whether to grant or deny a CON. The commission’s determination must follow a contested case hearing, where all interested parties are given an opportunity to intervene. Interested parties must be allowed reasonable discovery before and

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<sup>25</sup> "Renewable energy system" is used here as defined by the Clean, Renewable, and Efficient Energy Act (MCL460.1011 2008).

<sup>26</sup> Within 150 days of filing an application, the utility may update its cost estimates if they have changed materially. Such an update does not alter the length of the review period.

during the hearing, in order to obtain evidence concerning the application—including the reasonableness and prudence of the construction, investment, or purchase for which the CON has been requested. The MPSC must grant approval for the CON if the plan satisfies all of the following requirements:

- The electric utility has demonstrated a need for the power that would be supplied by the existing or proposed facility or pursuant to the proposed PPA through its approved IRP (that complies with certain provisions as described in the next section of this outline).
- The information supplied indicates that the existing or proposed facility will comply with all applicable state and federal environmental standards, laws, and rules.
- The existing or proposed facility or purchase agreement represents the most reasonable and prudent means of meeting the power need relative to other resource options for meeting power demand, including energy-efficiency programs and electric transmission efficiencies.
- To the extent practicable, the construction or investment in a new or existing facility in Michigan is completed using a workforce composed of Michigan residents, as determined by the MPSC (except with regard to a facility located in a county bordering another state).

Following MPSC approval, a utility must provide periodic updates on a project's status, including actual costs and schedule. After the MPSC determines whether the utility's investment is used and useful,<sup>27</sup> or as otherwise provided (for construction work in progress), the MPSC must include in a utility's retail rates all reasonable and prudent costs for a facility or agreement for which a CON has been granted. If the costs have not exceeded those approved, then the MPSC may not disallow recovery of costs a utility incurred pursuant to an agreement for which a CON has been granted. Any additional costs that exceed what was approved in the CON will be considered to have been incurred due to lack of prudence. These costs can be recovered in rates only after the MPSC has reviewed them and made its determinations. Any costs that exceed 110 percent of the CON-approved amount cannot be recovered.

### **Integrated Resource Plan (MCL, Section 460.6t Amended PA 341 [2016])**

In addition to updating existing aspects of the state's energy policy, PA 341 established a requirement for utilities to conduct IRP. The IRP process provides a comprehensive planning projection for utilities to ensure investments meet planning and desired policy outcomes in the most cost-effective manner. PA 341 allows the commission to issue orders that implement IRP filing requirements as well as review criteria and approval standards for electric utilities with fewer than 1,000,000 customers. Every five years the MPSC will conduct an IRP proceeding, in conjunction with MAE, the Michigan Department of Environmental Quality, and other interested parties, to accomplish the following:

- Conduct an assessment of the potential for EWR in Michigan
- Conduct an assessment for the use of demand response programs in Michigan
- Identify significant state or federal environmental regulations, laws, or rules and how they would affect electric utilities in Michigan
- Identify any formally proposed state or federal environmental regulations, laws, or rules that would affect electric utilities in Michigan

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<sup>27</sup> A regulatory principle that investments must be in use and contributing to a utility's provision of service prior to being included in rates.

- Identify any required planning reserve margins and clearing requirements in Michigan
- Establish the modeling scenario(s) and corresponding assumptions each electric utility includes—in addition to its own scenarios and assumptions to develop its IRP

Each rate-regulated electric utility will be required to file an IRP within two years of effective date of PA 342. IRPs must include (a/n):

- Long-term forecast of sales and peak demand under various scenarios
- Generation facility's technology and fuel type and its proposed capacity
- Projected renewable energy purchased or produced (if the level of renewable energy purchased or produced is projected to drop over planning years, the utility must demonstrate why this drop is beneficial to ratepayers)
- Plan for reducing energy waste (this includes expected annual reduction, cost of the plan, and savings for retail customers)
- Analysis of how combined RE and EE will compare to the 35 percent goal in PA 341.
- Projected load management and demand response savings for the electric utility and the projected costs for the programs
- Projected energy and capacity purchased or produced by the electric utility from a cogeneration resource
- Analysis of new or upgraded transmission options
- Data regarding the utility's current generation portfolio
- Plans for meeting current and future capacity needs with cost estimates
- Analysis of the cost, capacity factor, and viability of all reasonable generation options available to meet projected capacity needs, including existing electric generation facilities in the state
- Projected impact on rates for the periods covered
- Plan for complying with state and federal environmental regulations, laws, and rules with projected costs for compliance
- Forecast of the utility's peak demand and details on the expected amount of peak demand reduction
- Projected long-term firm gas transportation contracts or storage to be held to provide an adequate supply of natural for any new generation

Prior to filing an IRP, utilities are required to issue a request for proposals for any new supply-side capacity resources needed over the ensuing three-year period; utilities are not required to accept any proposals, but shall use them to inform the IRP filing, and shall include all proposals received as attachments to the IRP filing. The MPSC shall approve IRP if it determines all of the following:

- Proposed IRP represents the most reasonable and prudent means of meeting the electric utility's energy and capacity needs. To make this determination, the MPSC shall consider whether the plan appropriately balances all of the following:
  - Resource adequacy
  - Compliance with applicable environmental regulations
  - Competitive pricing

- Reliability
- Commodity price risks
- Diversity of generation supply
- Reasonableness and cost effectiveness of proposed levels of peak load reduction and energy waste reduction
- To the extent practicable, construction or investment in new or existing capacity resources is completed using a workforce composed of Michigan residents.

### **Renewable Portfolio Standard (MCL, Section 460.1021–460.1113, Amended PA 342 [2016])**

In 2016, the Michigan Legislature voted to enact PA 342—the Clean and Renewable Energy and Energy Waste Reduction Act. The purpose of the legislation is to promote the development and use of clean, renewable energy resources and the reduction of energy waste through programs that will cost-effectively do the following for Michigan:

- Diversify the resources used to reliably meet the energy needs of consumers
- Provide greater energy security through the use of energy resources available within the state
- Encourage private investment in renewable energy and EWR
- Coordinate with federal regulations to provide improved air quality and other benefits to energy consumers and citizens
- Remove unnecessary burdens on the appropriate use of solid waste as a clean energy source

PA 342 increases Michigan’s renewable energy standard, which requires Michigan electric providers to achieve a retail supply portfolio of 15 percent in 2021. It also sets interim standards of 10 percent per year through 2018, and 12.5 percent per year in 2019 and 2020. Regulated utilities are required to submit a renewable energy plan (REP) to the MPSC to show how they will meet the state’s renewable energy standard.

PA 342 established the goal that not less than 35 percent of Michigan’s electric needs should be met through a combination of EWR and renewable energy by 2025, if such investments are the most reasonable means of meeting an electric utility’s energy and capacity needs relative to other resource options. All of the following count towards the goal:

- All renewable energy, including renewable energy credits (RECs) purchased or otherwise acquired with or without the associated energy
- Any banked RECs on the effective date of this act that counted toward the renewable energy standard
- Any investments in renewable energy by the utility or a utility customer after the effective date
- All EWR measures implemented under an approved EWR plan

Michigan uses RECs to track compliance with the renewables standard. MIRECS certifies all RECs and enables firms to trade or sell them. Seventy-one electric providers are obligated to meet an annual REC

requirement (MPSC 2015). RECs are earned through operating renewable energy systems.<sup>28</sup> Each MWh of electricity generated from qualifying renewable sources is the equivalent of one REC. Another way for firms to meet the renewable standard is with incentive renewable energy credits (IRECs). In addition to the base REC, IRECS are issued for renewable projects that fulfill any of the following characteristics.

- Two RECs for each MWh from solar power generated by a renewable energy system that was in place before April 20, 2017
- One-fifth of an REC for each MWh from a renewable energy system, other than wind, at peak demand time as determined by the commission
- One-fifth of an REC for each MWh from a renewable energy system during off-peak hours, stored using advanced electric storage technology or a hydroelectric pumped storage facility, and used during peak hours. However, the number of RECs shall be calculated based on the number of MWhs of renewable energy used to charge the advanced electric storage technology or fill the pumped storage facility, not the number of MWhs actually discharged or generated by discharge from the advanced energy storage facility or pumped storage facility.
- One-tenth of an REC for each MWh from a renewable energy system constructed using equipment made in Michigan<sup>22</sup>
- One-tenth of an REC for each MWh from a renewable energy system constructed using a workforce composed of Michigan residents<sup>29</sup>

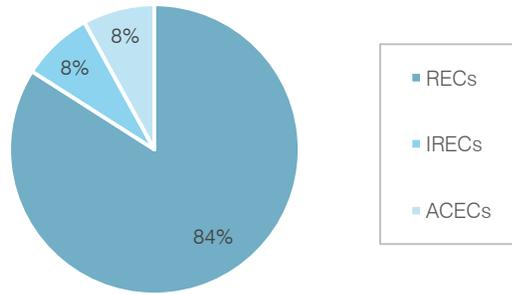
A firm can also substitute energy waste reduction credits (EWRCs) for up to 10 percent of their annual REC requirement. Each MWh of energy savings through EWR earns one EWRC. These credits are nontransferable. Under PA 295 of 2008, Advanced Clean Energy Credits (ACECs) were available for each MWh of electricity generated by a gasification facility, industrial cogeneration facility, or a coal-fired electric generating facility if 85 percent or more of the carbon dioxide emissions were captured and permanently geologically sequestered. ACECs were repealed by PA 342 of 2016. For plasma arc gasification or industrial cogeneration, one ACEC may be substituted for one REC. For other technologies, ten ACECs can be substituted for one REC.

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<sup>28</sup> Defined by PA 295 Section 11, as a facility, electricity generation system, or set of electricity generation systems that use one or more renewable energy resources to generate electricity. Renewable resources include, but are not limited to, biomass, solar and solar thermal energy, wind energy, hydroelectric, wave energy, geothermal energy, municipal solid waste, and landfill gas.

<sup>29</sup> The credit only applies for first three years following the project's completion.

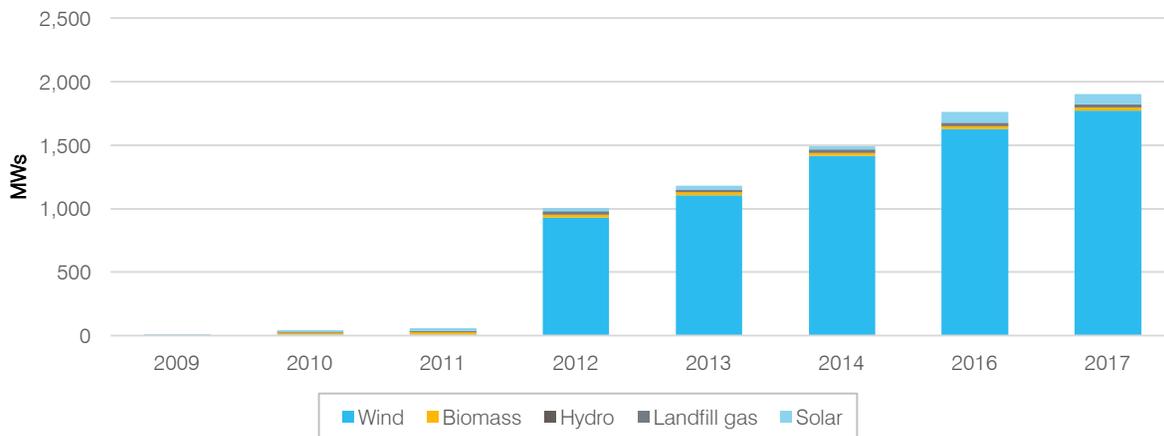
**EXHIBIT 3.1. RECs Issued, 2009–2016 (MIRECS)**



SOURCE: MIRECS. n.d. *Michigan Renewable Energy Certification System Annual Report for 2015-2016*. Accessed September 6, 2017. <http://www.mirecs.org/wp-content/uploads/sites/4/2016/10/MIRECS-2015-Annual-Report-Public-Version.pdf?x99308>

Since adoption, Michigan’s RPS has resulted in the addition of more than 1,800 MWs of new renewable generation (MPSC February 2017). Based upon a review of REPs filed with the commission, all providers were able to meet the 10 percent renewable energy standard in 2016.

**EXHIBIT 3.2. PA 295 Contract Renewable Energy Capacity by Commercial Operation Date**



SOURCE: MPSC. February 15, 2017. *Report on the Implementation of the P.A. 295 Renewable Energy Standard and the Cost-effectiveness of the Energy Standard*. Accessed August 31, 2017. [http://www.michigan.gov/documents/mpsc/MPSC\\_PA295\\_Renewable\\_Energy\\_Report\\_Feb\\_2017\\_552081\\_7.pdf](http://www.michigan.gov/documents/mpsc/MPSC_PA295_Renewable_Energy_Report_Feb_2017_552081_7.pdf)

## Energy Waste Reduction (MCL Section 460.1021–460.1113, Amended PA 342 [2016])

PA 342 also extends the state’s EWR goal to help “customers reduce energy waste and to reduce the future costs of provider service to customers” (MCL 460.1071 2016). From 2022 onward, the “most reasonable and prudent” level of energy waste reduction targets will set by the MPSC in biennial EWR plan proceedings for regulated electric providers. Electric and natural gas utilities are required to submit an EWR plan with details about their programs’ design and estimated costs (MCL 460.1071 2016). Utilities have the option to self-administer their EWR program or collaborate with other utilities in a joint program.

### EXHIBIT 3.3. EO Program Participation by Electric Utility, 2016

	Independent Program	Efficiency United	MECA	MPPA	Total
Electric investor-owned utilities	3	5			8
Municipal utilities	7	8	6	19	40
Electric cooperatives	1	1	8		10
Gas investor-owned utilities	3	3			6
Program totals	13	17	14	19	

SOURCE: MPSC. November 30, 2016. *2016 Report on the Implementation of the P.A. 295 Utility Energy Optimization Programs*. Accessed September 6, 2017. [http://www.michigan.gov/documents/mpsc/2016\\_Energy\\_Optimization\\_Report\\_to\\_the\\_Legislature\\_with\\_Appendix\\_Nov\\_30\\_543919\\_7.pdf](http://www.michigan.gov/documents/mpsc/2016_Energy_Optimization_Report_to_the_Legislature_with_Appendix_Nov_30_543919_7.pdf)

The EWR standards in PA 342 maintain the energy-efficiency goals established with the EO standards developed in PA 295. Electric and gas savings targets are based on prior years sales and are set at 1 percent per year for electric and .75 percent per year for gas, for all load-serving entities (LSEs), including investor-owned entities, cooperatives, and municipals (MCL 460.1077 2016).

### EXHIBIT 3.4. Annual Energy Savings Targets, PA 295 of 2008 and PA 342 of 2016

	2008–2009	2010	2011	2012	2013	2014	2015	2016–2021
Electricity (MWwhs)	0.30%	0.50%	0.75%	1.00%	1.00%	1.00%	1.00%	1.00%
Natural gas (Mcf)	0.10%	0.25%	0.50%	0.75%	0.75%	0.75%	0.75%	0.75%

NOTE: Annual savings goal determined as a percent of retail sales in the year two years prior.

SOURCE: MPSC. November 30, 2016. *2016 Report on the Implementation of the P.A. 295 Utility Energy Optimization Programs*. Accessed September 6, 2017. [http://www.michigan.gov/documents/mpsc/2016\\_Energy\\_Optimization\\_Report\\_to\\_the\\_Legislature\\_with\\_Appendix\\_Nov\\_30\\_543919\\_7.pdf](http://www.michigan.gov/documents/mpsc/2016_Energy_Optimization_Report_to_the_Legislature_with_Appendix_Nov_30_543919_7.pdf)

An EWR plan must include the required level of funding for their proposed program. Rate-regulated utilities recover their program spending through commission approved surcharges on customer bills. To earn commission approval, a program must be cost-effective based on the USRCT. EWR financial incentives are adjusted to include tiered incentives based on the level of energy savings achieved. A summary of EWR incentives paid out is available in Exhibit 3.5. A provider’s financial incentive shall not exceed the lesser of the two amounts described below (mirror shared savings incentives in PA 341):

- 1.0–1.25 percent electric savings or 0.75–0.875 percent gas savings
  - 25 percent of the net present value of life-cycle cost reductions experienced by the provider's customers
  - 15 percent of the provider's actual EWR program expenditures for the year

- 1.25–1.5 percent electric savings or 0.875–1 percent gas savings
  - 27.5 percent of the net present value of life-cycle cost reductions experienced by the provider's customers
  - 17.5 percent of the provider's actual EWR program expenditures for the year
- 1.5 percent and above electric savings or 1 percent and above gas savings
  - 30 percent of the net present value of life-cycle cost reductions experienced by the provider's customers
  - 20 percent of the provider's actual EWR program expenditures for the year

**EXHIBIT 3.5. Utility Performance Incentives Awarded, 2009–2015**

Program Year	Consumers Energy Electric & Gas	DTE Energy (Electric)	DTE Energy (Gas)	Indiana Michigan Power Co.	SEMCO Energy Inc.	Total
2009	\$5,685,305	\$3,008,829	\$913,373	n/a	n/a	\$9,607,507
2010	\$8,483,795	\$6,200,000	\$2,400,000	n/a	n/a	\$17,083,795
2011	\$14,593,977	\$8,400,000	\$3,400,000	n/a	n/a	\$26,393,977
2012	\$17,327,620	\$10,400,000	\$4,300,000	n/a	n/a	\$32,940,431
2013	\$17,530,000	\$10,562,411	\$3,848,020	n/a	n/a	\$31,940,431
2014	\$17,322,230	\$12,716,865	\$3,617,094	\$618,074	\$780,795	\$35,055,088
2015*	\$17,700,000	\$13,100,000	\$3,600,000	\$759,727	\$933,725	\$36,093,452
<b>Total</b>	<b>\$98,642,927</b>	<b>\$64,388,135</b>	<b>\$22,078,488</b>	<b>\$1,377,801</b>	<b>\$1,714,520</b>	<b>\$188,201,871</b>

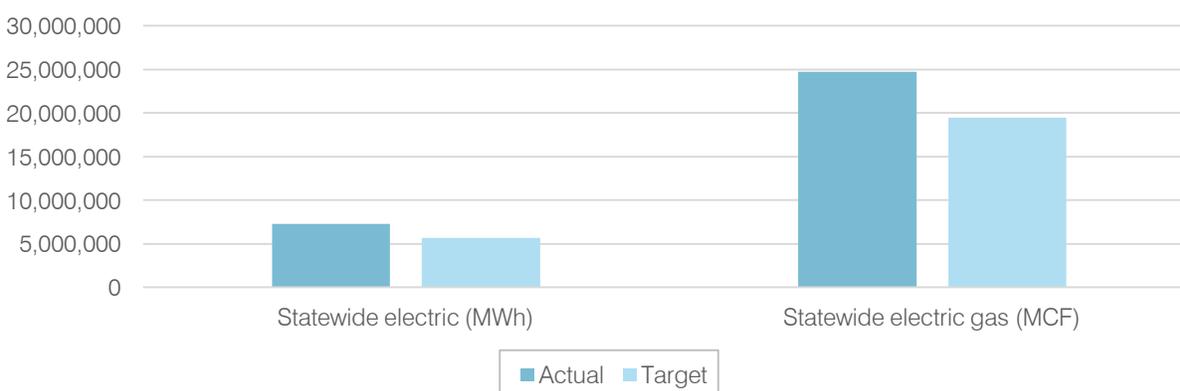
\*Totals for 2015 are anticipated.

SOURCE: MPSC. November 30, 2016. *2016 Report on the Implementation of the P.A. 295 Utility Energy Optimization Programs*. Accessed September 6, 2017. [http://www.michigan.gov/documents/mpsc/2016\\_Energy\\_Optimization\\_Report\\_to\\_the\\_Legislature\\_with\\_Appendix\\_Nov\\_30\\_543919\\_7.pdf](http://www.michigan.gov/documents/mpsc/2016_Energy_Optimization_Report_to_the_Legislature_with_Appendix_Nov_30_543919_7.pdf)

Certain large electric customers are eligible to customize and implement their own EWR plan. Eligible customers must have a peak demand of at least one MW. Twenty customers self-implemented EWR programs in 2015. This number has fallen each year since 2010.

The MPSC publishes an annual report about the implementation of energy-efficiency programs within the state. Michigan's energy providers have delivered consistent results through their EWR programs, exceeding the energy savings targets stipulated in statute (see Exhibit 3.6). Over the next three years, energy-efficiency programs are anticipated to save Michigan utility customers \$1.2 billion. For every dollar spent on energy-efficiency programs, Michigan utility customers will realize benefits of \$4.35 (MPSC November 2016).

### EXHIBIT 3.6. Implementation of EO Programs in Michigan, 2009–2015



SOURCE: MPSC. November 30, 2017. *2016 Report on the Implementation of the P.A. 295 Utility Energy Optimization Programs*. Accessed September 6, 2017. [http://www.michigan.gov/documents/mpsc/2016\\_Energy\\_Optimization\\_Report\\_to\\_the\\_Legislature\\_with\\_Appendix\\_Nov\\_30\\_543919\\_7.pdf](http://www.michigan.gov/documents/mpsc/2016_Energy_Optimization_Report_to_the_Legislature_with_Appendix_Nov_30_543919_7.pdf)

### Transmission Siting (MCLAct 30 of 1995)

The Electric Line Certification Act, PA 30 of 1995, gives MPSC the authority to regulate transmission line siting. An electric utility, affiliated transmission company, or independent transmission company proposing a major transmission project<sup>30</sup> is required to apply for a certificate of public convenience and necessity. Before the company files a CON application, they must meet with elected officials and conduct a public meeting in each municipality impacted by the proposed line (MCL 460.566 2004). Once a company’s application is filed with the MPSC, the commission will conduct a review of the application through a contested case proceeding. During the contested case the commission or other intervening party may suggest a modification to the proposed route. The commission has one year after an application is filed to either grant or deny a certificate (MCL 460.568 2004). An application will be approved if the commission determines the following criteria have been met:

- a. The public benefits<sup>31</sup> from the proposed major transmission line justify its construction.
- b. The proposed or alternative route is feasible and reasonable.
- c. The proposed project does not present an unreasonable threat to public health or safety.
- d. The applicant has accepted the conditions contained in a conditional grant.

PA 295 Section 147 requires an MPSC report “summarizing the impact of establishing wind energy resource zones, expedited transmission line siting applications, estimates for future wind generation within wind zones, and recommendations for program enhancements or expansion.” (MCL 460.1147 2008) The MPSC created an independent Wind Energy Resource Zone (WERZ) Board and accepted the wind energy resource zones the board identified as having the best potential for wind energy development in the state (MPSC January 2010). To facilitate the development of wind energy within these zones, PA

<sup>30</sup> A major transmission line is a line of five miles or more in length through which electricity is transferred at a voltage greater than or equal to 345 kilovolts.

<sup>31</sup> Quantifiable and nonquantifiable.

295 granted the MPSC the ability to expedite certain transmission projects. The commission has 180 days to approve or deny the application for an expedited transmission certificate (MCL 460.153 2008).

### **Mergers, Acquisitions, and Asset Sales (MCL, Section 460.6q; Added 2008, PA 286) MPSC Order No. U-15795, March 18, 2009**

PA 286 expanded the MPSC's authority to include the acquisition, transfer of control, or merger of jurisdictional regulated utilities (MCL 460.6q 2008). Among other factors, the commission's evaluation of a proposed acquisition, merger, transfer, or encumbrance shall consider the following proposed actions:

- a. Any adverse impact on the rates of the customers affected by the proposed transaction
- b. Any adverse impact on the provision of safe, reliable, and adequate energy service in this state
- c. Any subsidization of a nonregulated activity of the new entity through the rates paid by the customers of the jurisdictional regulated utility
- d. Any significant impairment the jurisdictional regulated utility's ability to raise necessary capital or to maintain a reasonable capital structure
- e. Any inconsistency with public policy and interest

The commission must issue an order within 180 days from the date of application and has the ability to impose reasonable terms and conditions on the proposed transaction to protect either the utility or its customers. The utility may reject any terms and conditions imposed by the commission and may decide not to proceed with the transaction.

### **Retail Open Access (MCL, Section 460.10; Amended, PA 341 of 2016)**

PA 141 of 2000 (MCL 460.10) opened Michigan's electric market to generation provided by AESs. Retail customers were allowed for the first time to choose who they buy electricity from under utility ROA programs. All AESs must be licensed by the MPSC before they can begin selling power in the state. The commission evaluates prospective suppliers to ensure they are financially capable, possess the technical competence to engage in energy transactions, can meet safety requirements for electric operations, and comply with all other lawful obligations.

The introduction of ROA required electric utilities to update the way they structured rates. Customers who purchase electricity from an AES still use distribution power lines owned and controlled by regulated utilities.<sup>32</sup> Before ROA electric providers, rates were bundled—meaning that the cost of generation, transmission, and distribution were not separated; rather, prices were based on a utility's overall costs.<sup>33</sup> Unbundled utility rates allow customers to pay only for the services of the portion of the system they use (460.10b(2) 2008).

ROA was amended in 2008 PA 286, which capped choice participation at 10 percent of a utility's weather-adjusted retail sales (MCL 460.10a). The MPSC monitors participation in electric choice programs and requires utilities to furnish information on the status of choice programs on their websites. The

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<sup>32</sup> ROA customers might also use transmission lines managed by RTOs and charged under RTO open-access transmission tariffs. Transmission open access began with FERC's Order 888 in 1996 that promoted wholesale competition through open access nondiscriminatory transmission services and continued with Order 2000 in 1999, which established RTOs.

<sup>33</sup> In Michigan, the majority of transmission assets have been divested from state-regulated generation and distribution utilities to separate FERC-regulated transmission companies.

commission prepares an annual report detailing the status of electric choice programs in Michigan—as required by PA 286 (MCL 460.10u).

PA 341 instituted several changes to the state’s ROA program with the stated purpose of ensuring “that all persons in this state are afforded safe, reliable electric power at a competitive rate” (MCL 460.10). The legislation maintained the cap on participation in ROA at 10 percent of a utility’s load (with rare exceptions), but modified how the cap is enforced. If actual participation in ROA falls below the 10 percent cap, the MPSC shall set the proceeding year’s cap at the actual level of ROA participation. The revised cap will stay in effect for five years. The legislation also allows ROA customers to expand their facilities onsite or at a contiguous site and remain with an AES even if their new load would exceed the 10 percent cap. Utilities are required to file an annual report with the MPSC detailing the order of customers in the ROA queue.

### **Resource Adequacy (Michigan Common Law Section 460.6w; PA 341 of 2016)**

One of the MPSC’s most essential functions is ensuring that the state has adequate energy resources to meet consumer demand. To this end, for the last 20 years the Commission has conducted annual investigations into utilities’ energy supplies. PA 341 granted explicit authority to the MPSC to require all electric suppliers to comply with annual capacity demonstrations. Electric providers must demonstrate they have adequate resources to serve their expected energy needs for the proceeding five years. Investor owned utilities are required to file their annual five-year capacity demonstration by December 1, 2017. AESs, electric co-ops, and municipal utilities have until February 9, 2018 to submit their capacity demonstrations (MCL 460.6w).

In addition to requiring all utilities to demonstrate their capacity, PA 341 also directs the MPSC to determine a capacity charge for nonutility electric providers/ AESs—referred to as the state reliability mechanism (MCL 460.6w).<sup>34</sup> The MPSC’s September 15, 2017, order in Case No. U-18197 detailed the requirements of this mechanism. They include:

- Each LSE in the state must show it owns or has contractual rights to sufficient capacity to meet obligations set by MISO or the commission. Electric cooperatives and municipally owned utilities may aggregate capacity resources to meet requirements.
- Proceedings shall be initiated if an individual LSE does not appear to have sufficient capacity based on the MPSC staff’s assessment.
- The MPSC adopts the calculation methodology for the PRMR for planning years 2018–2021, which utilizes the MISO PRMR data published in the *MISO Loss of Load Expectation Study*, pursuant to Module E of MISO’s FERC-approved tariff.
- A locational requirement will not be applied to individual LSEs during planning years 2018–2021 as part of the transition to the new capacity obligations. The MPSC will conduct a formal contested case proceeding to determine a just and reasonable locational requirement and methodology that is consistent with federally approved tariffs, which will be applied beginning in the 2022 planning year (MPSC September 2017).

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<sup>34</sup> MISO had filed a proposed Competitive Retail Solution at FERC in Docket No. ER16-284, which was rejected—prompting the need to use of the Michigan’s State Reliability Mechanism outlined in PA 341.

### **Certificate of Convenience and Necessity (Michigan Common Law Section 460.501-460.506; PA 69 of 1929)**

Electric and natural gas utilities wishing to construct or operate any public utility plant or system in a territory currently served by another utility must first obtain a certificate of convenience and necessity from the MPSC. The utility's application must include the name of the municipality or municipalities that it intends to serve, the type of service to be rendered, and documentation of proper consent or franchise from such municipality or municipalities authorizing the transaction of local business. Once the petition is received, the MPSC will set a hearing to give the utility currently serving the territory in question an opportunity to present its case and will notify this utility at least ten days prior to the hearing. In an Act 69 filing, supporting information and detail must be filed to determine whether allowing multiple utilities to provide service within the same municipality is in the best interest of the public. Public interest is considered from the standpoints of public safety, duplication of facilities, and economic benefits. The applicant is to submit drawings, maps, and include information regarding the project's environmental impact. If the application is accepted, a certificate shall detail the territory in which the utility may operate. Any party wishing to contest a commission order or decree may file an appeal to the Court of Appeals within 30 days of issuance.

### **Performance-based Regulation (MCL, Section 460.6u; PA 341 of 2016)**

Historically, utility regulation has operated on a cost-plus system, where utility expenditures are reviewed by regulators to ensure they are reasonable and prudent, who then grant the utility the ability to recover their costs plus a reasonable rate of return. While this form of regulation has been dominated for decades, new schools of thought in regulatory economics have begun to offer alternatives to this model. One such alternative that has gained ground is PBR. PBR “provides a regulatory framework to connect goals, targets and measures to utility performance, executive compensation and investor returns. For some enterprises, PBRs determine utility revenue or shareholder earnings based on specific performance metrics and other noninvestment factors. For utilities of all types, PBR can strengthen the incentives of utilities to deliver value to customers” (Littell 2017). PA 341 required the MPSC to study PBR and provide recommendations to the legislature and the governor, based on the results of their study.

## SECTION III.B. UTILITY BUSINESS MODEL

### HOW UTILITIES EARN REVENUE

One of the primary functions of state utility regulation is establishing retail rates. In Michigan, the MPSC regulates retail electric rates for eight investor-owned utilities and nine electric cooperatives (MCL 460.6 and MPSC n.d.). Municipal utilities, member-regulated electric cooperatives, and AESs are not traditionally rate regulated.

When a utility anticipates their existing rates will be insufficient to recover their revenue requirement, they file a general rate case with the MPSC to amend their rates (elements of rate case proceedings in Michigan are described in Section III.A). There are two main aspects of a general rate case. The first is determining a utility's revenue requirement. The revenue requirement is "the total amount of revenue the utility would need to provide a reasonable opportunity to earn a fair rate of return on its investment, given specified assumptions about sales and costs" (Lazar 2011 p.38.). State regulators review all utilities' investments to determine whether they have been incurred to provide service to customers and are reasonable and prudent. The revenue requirement formula is shown in Exhibit 3.8.

#### EXHIBIT 3.8. Utility Revenue Requirement

$$\text{Revenue Requirement} = \text{Rate Base Investment} \times \text{Rate of Return} + \text{Operating Expenses} + \text{Depreciation} + \text{Taxes}$$

$$\text{Rate Base Investment} = \text{Net Plant in Service} (= \text{Total Plant in Service at Original Cost} - \text{Accumulated Depreciation}) + \text{Working Capital Allowances}$$

SOURCE: Formula provided by MPSC based on formula found in Jim Lazar's *Electricity Regulation in the US: A Guide* (March 2011).

Once regulators have established a utility's revenue requirement, the second aspect of a rate case is setting appropriate rates. The general purpose of rate design is "to ensure the provision of safe, adequate, and reliable service at prices (or revenues) that are sufficient, but no more than sufficient, to compensate the regulated firm for the costs (including the opportunity to earn returns on investment) that it incurs to fulfill its obligation to serve" (Lazar 2011 p.6). There is variation in rates between customer classes, but the general formula for rates is a utility's revenue requirement divided by their expected sales volume, see the basic formula in Exhibit 3.9.

#### EXHIBIT 3.9. Basic Rate Formula

$$\text{Customer Rates} = \text{Revenue Requirement} / \text{Volume of Customer Sales}$$

SOURCE: Jim Lazar. March 2011. *Electricity Regulation in the US: A Guide*. Accessed April 20, 2015. <http://www.raponline.org/document/download/id/645>

## UTILITY BEHAVIOR

Rate regulation creates economic incentives that impact how utilities behave and what business decisions they make. The energy industry and public policy objectives related to electricity have changed dramatically in recent years. During most of the 20<sup>th</sup> century, the electric industry expanded rapidly, load grew, and policymakers were focused on helping the industry meet growing demand and reach more customers. Today, policymakers are looking at ways to help customers reduce energy consumption, achieve affordable rates, and promote the development of cleaner energy sources. It is important that, as the industry and public policy objectives change, utility regulation is updated to align incentives with established goals.

“The crux of this issue is that under long-standing, traditional utility regulation and rate structures, utilities’ revenues are determined in large part by charges that vary depending on how much energy consumers use” (MPSC November 2013).

The discussion that follows will explore how the incentives established, either intentionally or unintentionally, by traditional rate regulation impact the decisions utilities make when evaluating different supply and demand-side resources.

### Supply-Side Resources

#### Utility-owned Generation

Traditional regulation is well suited to compensate utilities for their investments in electric generation. As outlined above, a utility’s revenue requirement is based on the size of its rate base. By increasing rate base investment—by building a new power plant, for example—the opportunity to earn a return on a larger amount of rate base increases. This structure has been a common source of criticism for traditional regulation because it can be seen as an incentive for utilities to over-invest in infrastructure instead of considering other lower-cost alternatives. Over-investment is kept in check by state regulators who set the allowed level of utility costs and revenues. The cost of electric generation varies widely among different sources, see Exhibit 3.10 for a summary of the levelized cost for generation resources.

**EXHIBIT 3.10. U.S. Average Estimated Levelized Cost of Electricity (LCOE) for Plants Entering Service in 2022 (2016 dollars/MWh)**

Plant type	Capacity factor (%)	Levelized capital cost	Fixed O&M	Variable O&M (including fuel)	Transmission investment	Total system LCOE	Levelized tax credit <sup>1</sup>	Total LCOE including subsidy
<b>Dispatchable technologies</b>								
Coal 30% with carbon sequestration <sup>2</sup>	85	94.9	9.3	34.6	1.2	140	N/A	140
Coal 90% with carbon sequestration <sup>2</sup>	85	78.0	10.8	33.1	1.2	123.2	N/A	123.2
<b>Natural gas-fired technologies</b>								
Conventional combined cycle (CC)	87	13.9	1.4	40.8	1.2	57.3	N/A	57.3
Advanced combined cycle	87	15.8	1.3	38.1	1.2	56.5	N/A	56.5
Advanced CC with carbon capture and storage	87	29.5	4.4	47.4	1.2	82.4	N/A	82.4
Conventional combustion turbine	30	40.7	6.6	58.6	3.5	109.4	N/A	109.4
Advanced combustion turbine	30	25.9	2.6	62.7	3.5	94.7	N/A	94.7
Advanced nuclear	90	73.6	12.6	11.7	1.1	99.1	N/A	99.1
Geothermal	91	32.2	12.8	0.0	1.5	46.5	-3.2	43.3
Biomass	83	44.7	15.2	41.2	1.3	102.4	NA	102.4
<b>Nondispatchable technologies</b>								
Wind-onshore	39	47.2	13.7	0.0	2.8	63.7	-11.6	52.2
Wind-offshore	45	133.0	19.6	0.0	4.8	157.4	-11.6	145.9
Solar PV <sup>3</sup>	24	70.2	10.5	0.0	4.4	85.0	-18.2	66.8
Solar thermal	20	191.9	44.0	0.0	6.1	242.0	-57.6	184.4
Hydro <sup>4</sup>	59	56.2	3.4	4.8	1.8	66.2	N/A	66.2

Notes: 1. The tax credit component is based on targeted federal tax credits such as the production or investment tax credit available for some technologies. It only reflects tax credits available for plants entering service in 2022. Not all technologies have tax credits, and are indicated as "N/A" or not available. The results are based on a regional model, and state or local incentives are not included in LCOE calculations.  
 2. Due to new regulations (CAA 111b), conventional coal plants cannot be built without CCS because they are required to meet specific CO2 emission standards. Two levels of CCS removal are modeled, 30% and 90 percent. The coal plant with 30 percent removal is assumed to incur a three percentage-point adder to its cost-of-capital to represent the risk associated with higher emissions from a plant of that design.  
 3. Costs are expressed in terms of net AC power available to the grid for the installed capacity.  
 4. As modeled, hydroelectric is assumed to have seasonal storage so that it can be dispatched within a season, but overall operation is limited by resources available by site and season.

SOURCE: U.S. EIA. April 2017. *Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2017*. Accessed September 6, 2017. [https://www.eia.gov/outlooks/aeo/pdf/electricity\\_generation.pdf](https://www.eia.gov/outlooks/aeo/pdf/electricity_generation.pdf)

## Power Purchase Agreements

The creation of competitive open-access wholesale markets allowed nonutility generators (NUGs) to own generation and sell electricity. As an alternative to owning all the resources needed to meet their energy needs, utilities can enter PPAs with NUGs. A PPA is a contract between a buyer and seller to purchase electricity. While the benefits of PPAs vary depending on the specific terms of a contract, generally utilities benefit from these agreements because they can transfer some of the risks associated with constructing and operating power plants, diversify their portfolio, and mitigate volatility (S&P 2007).

In the context of traditional rate regulation, PPAs are treated differently than utility rate base investments. Unlike with rate base investments, utilities are not typically allowed to earn a rate of return on PPAs (PWC 2008). However, PA 341 enables electric utilities to receive a financial incentive for PPAs that are not signed with affiliates before the effective date. The incentive cannot exceed the electric utility's weighted cost of capital (MCL 460.6s).

## Community Renewable Energy

Several terms are used regularly and interchangeably to reference community-based renewable energy resources, including community solar, solar gardens, shared solar, community-shared solar gardens, and more (GLREA 2014). While solar is the most prevalent source of community renewable energy, shared energy resources can come from different renewables. The essential part of these programs is that they allow customers to access shared renewable energy resources, located at a place other than their home. Michigan law already allows customers to generate electricity at their homes to meet their energy needs, through the state-approved utility net-metering programs, but such programs do not work for all customers. Community renewables programs allow people who do not have the right location for renewable energy, renters, and other excluded by net-metering program restrictions to access renewable energy. There are many different ways to design community renewables programs; three design options were discussed during the Solar Working Group (SWG) facilitated by MPSC staff (MPSC June 2014).

The first option that the SWG considered was a utility lease model. Utilities would own and operate a community resource and customers would lease their share of the project's output directly from the utility. This program design aligns with a utility's typical operations and existing rate structures because it doesn't alter a utility's customer base, allows them to recover their costs, and potentially earns a rate of return based on their investment.<sup>35</sup> The next option considered was a community renewables project with shared ownership between a third party and the customer. This option raises concerns for utilities because it reduces their sales volume, and they would still need to supply distribution services and back up energy. There are additional regulatory considerations to implementing models with third-party and customer-owned resources. The third option SWG members discussed was establishing a value of solar (VOS) tariff. According to the NREL, VOS programs should be designed around the following principles:

1. Ensure sufficient utility revenues for grid services are provided to support solar growth
2. Recognize the VOS benefits and costs—not only to the utility system, but to society as well (to the extent the benefits are codified in utility financial structures)—and pay the project owner appropriately
3. Limit cost to customers, both those with solar and those without

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<sup>35</sup> The lease would need to be designed as an operating lease to afford the utility an opportunity to earn a return on its investment (MPSC June 2014).

4. Create a transparent VOS rate calculation methodology, including input assumptions and updates (Taylor 2015)

Community solar programs have been small to date, but their success and the success of community renewable energy projects around the country have propelled discussion about ways to expand access in Michigan.

Both Consumers and DTE have pursued development of subsidy-free community renewable energy projects. In May 2015, the MPSC approved Consumers' request to develop a three-year, ten-MW community solar pilot as a part of its REP (MPSC May 2015). Consumers Energy's "Solar Gardens" projects began operating in 2016 at Grand Valley State and Western Michigan Universities.

## **Demand Side Options**

### Energy Waste Reduction Investments

One of Michigan's policy objectives established by PA 295 was to reduce energy consumption through the implementation of statewide energy-efficiency programs. PA 342 of 2016 continued this policy and more accurately characterized energy efficiency as energy waste reduction. Energy waste reduction can be one of the most cost-effective options for meeting customers' energy needs (Lazar 2011) and allowing customers to manage their electricity bills. Despite this, utilities have a financial disincentive to reduce their sales volume. Lower sales put utilities at risk of not recovering their revenue requirement and not having the opportunity to earn their authorized rate of return on a larger sales volume. This will be the case until rates can be amended to account for decreased sales volume due to increased performance in achieving competitive Michigan energy rates.

This contradiction was addressed by several measures included in PA 295 to make energy efficiency more attractive for utilities. Utilities are allowed to recover the full costs<sup>36</sup> associated with implementing increased energy-efficiency programs—therefore reducing energy waste. They were also allowed to capitalize any equipment, materials, and installation costs with an expected economic life greater than one year (MCL 460.1089). Utilities were also authorized to apply for financial incentives tied to successful program implementation.

### Customer-owned, Behind-the-meter DG and Storage

PA 295 required the MPSC to establish a statewide net-metering program, allowing customers to own and operate electric generation sources in parallel with the grid (MCL 460.1173). PA 342 modified the program. Michigan's net-metering program allows customers to install enough generating capacity to meet their electricity needs. The energy produced by customer-owned resources can be used on site or transferred to the electric grid. Customers receive credits for the electricity they send to the grid, depending on what category their project fits in. Net-metering installations are broken into the following categories:

- True net-metering customers: This category applies to projects that are limited to 20 kW inverter based systems. A true net-metering customer is credited the full retail rate for each kWh they supply to the grid. These credits are applied to the customer's bill, and any excess credits will be carried over to subsequent months.

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<sup>36</sup> Limited to spending cap and subject to commission approval.

- **Modified net-metering customers:** This category applies to DG customers with a project capable of generating more than 20 kilowatts qualify for modified net metering.

These customer-owned, behind-the-meter generation resources represent a new variable that utilities have to consider in their planning process. As with energy waste reduction programs, net-metering results in an overall sales reduction for utilities because customers can avoid purchasing from utility when their behind-the-meter resources are supplying electricity. Utilities contend that net metering presents another issue because it requires a utility to reimburse true net-metering customers at the full retail rate, and results in additional costs being shifted to nonparticipating ratepayers.

Utility retail rates have two essential components: fixed costs and variable costs. When customers receive credit for the full retail rate, they avoid paying for both of these components. Utilities claim that net metering customers still utilize the distribution grid and should be responsible for paying the fixed costs portion of rates (MPSC June 2014).

#### Demand Response Resources

PA 295 also promoted efforts to expand load management efforts within the state. Load management (or demand response) is designed to reduce energy consumption during periods when energy demand is highest. By reducing the amount of energy use at these peak times, utilities can avoid the need to run higher-cost generators or purchase capacity from the market and customers can avoid paying these higher costs. As a part of the Reaching Michigan to Make Good Energy Decisions process, both Consumers Energy and DTE commented that, despite the potential savings from demand response programs, adoption has been limited due to barriers in existing regulation. PA 342 addresses some of the barriers to demand response by directing the MPSC to “promote load management in appropriate circumstances” and “actively pursue increasing public awareness of load management” (MCL 460.1095). The MPSC is currently conducting a statewide potential study for demand response. Going forward, utilities will need to include demand response in their IRP and EWR efforts. The estimated cost for demand response programs is shown in Exhibit 3.11.

#### EXHIBIT 3.11. Unit Cost of Energy Efficiency and Demand Response Measures

<b>Year</b>	<b>Levelized Cost for Energy-efficiency Measures (\$/kWh)</b>	<b>Levelized Cost for Demand Response Measures (\$/kW-year)</b>
2010	\$0.02	\$50.70
2020	\$0.03	\$61.81
2030	\$0.03	\$75.34

SOURCE: Electric Power Research Institute. January 2009. *Assessment of Achievable Potential from Energy Efficiency and Demand Response Programs in the U.S. (2010–2030)*. Accessed May 9, 2015. [http://www.michigan.gov/documents/energy/EPRI\\_EnergyEfficiencyPotential1-2009\\_418129\\_7.pdf](http://www.michigan.gov/documents/energy/EPRI_EnergyEfficiencyPotential1-2009_418129_7.pdf)

## SECTION IV. WHERE ARE WE GOING?

### ENVIRONMENTAL REGULATIONS

One of the most significant drivers of change in the electric power sector has been recent action taken by the federal government to mitigate damage done to the environment. It is commonly recognized that the pollution of the air, water, and land—as a result of human activity—is adversely affecting the environment and human health. Through its research and regulatory programs, the U.S. EPA works to mitigate environmental degradation and restore health to human populations (U.S. EPA 2008). New rules and regulations are changing the way electric power producers operate.

The electric power sector provides nearly 40 percent of the energy consumed in the United States. More than 60 percent of that energy is produced from fossil fuels. Generating electricity from fossil fuels also produces emissions that impact the air, water, and land. The U.S. EPA is attempting to limit these impacts through a series of regulations designed to create a cleaner electric power sector; these regulations are having dramatic effects on the electric power industry. Recent changes in policy from the U.S. executive branch and from within the U.S. EPA administration have placed the future of several environmental regulations in doubt. The White House has ordered a review of the CPP calling on the U.S. EPA to ensure the regulation does not encumber our nation’s energy production through unnecessary regulatory burdens (White House 2017). Additional regulations are expected to face scrutiny from the new administration.

**EXHIBIT 4.1. Environmental Regulations**

Clean Air Act			Clean Water Act (CWA)	Resource Conservation and Recovery Act
<b>Cross-state Air Pollution Rule (CSAPR)</b>	<b>Mercury and Air Toxics Standard (MATS)</b>	<b>Clean Power Plan</b>	<b>Cooling Water Intake Structures (CWIS)</b>	<b>Coal Combustion Residuals (CCR)</b>
110(a)(2)(D)(i)(I)	Sections 111 and 112	Sections 111(d) and 111(b)	316(b)	Subtitle D
Finalized 2011	Finalized 2011	Proposed 2015	Finalized 2014	Finalized 2014

#### The Clean Air Act

The CAA required the U.S. EPA to establish National Ambient Air Quality Standards (NAAQS) for harmful air pollutants. These standards are designed to improve and protect human health by limiting exposure to six common pollutants—carbon monoxide (CO), lead (PB), nitrogen oxides (NOx), ozone (O3), particulate pollution (PM<sub>2.5</sub> and PM<sub>10</sub>), and sulfur dioxide (SO<sub>2</sub>). States are required to develop and enforce air quality programs to reach NAAQS.

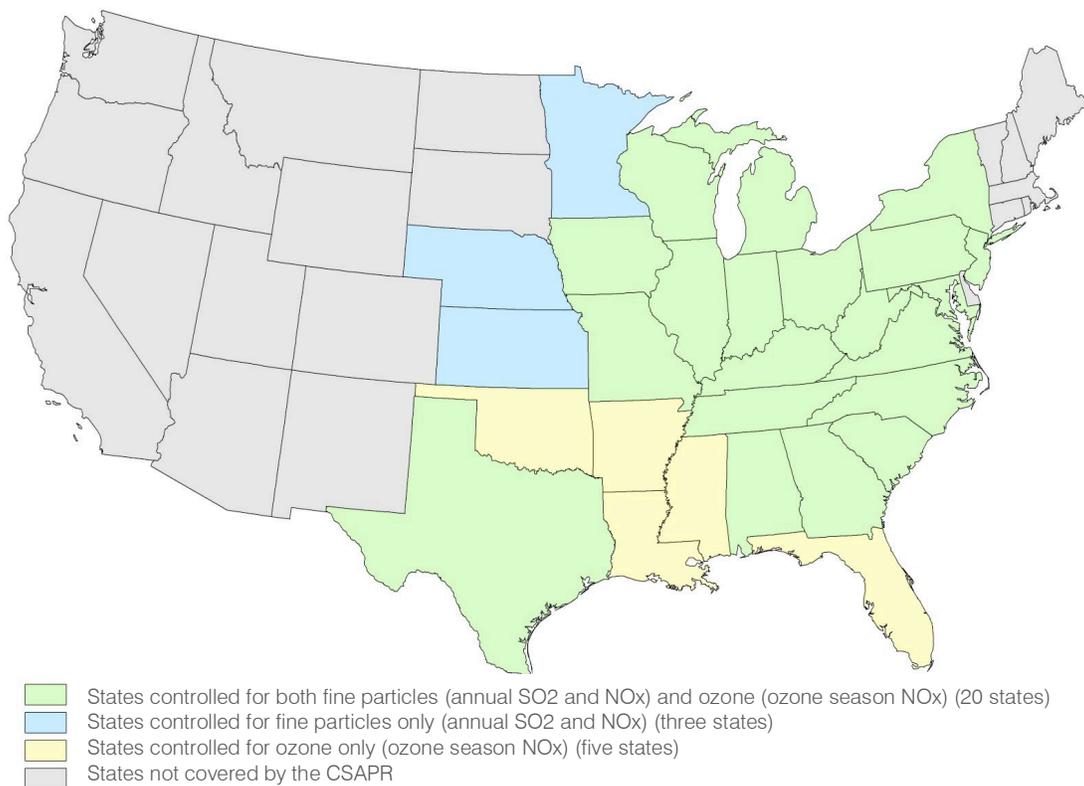
#### Cross-state Air Pollution Rule—CAA 110(a)(2)(D)(i)(I)

The combustion of fossil fuels for electric generation produces 13 percent of all NOx and 70 percent of all SO<sub>2</sub> emissions nationally (U.S. EPA May 2014). Air pollution presents a unique enforcement challenge, because it does not respect state or regional boundaries. The “good neighbor” provision allows the U.S. EPA to regulate a state’s air emissions when they substantially impact the ability of a downwind state to

achieve NAAQS. The CSAPR, finalized in 2011, requires 27 states in the eastern U.S. to reduce SO<sub>2</sub>, NO<sub>x</sub>, and or PM<sub>2.5</sub> emissions from power plants (U.S. EPA 2011). A map of states impacted is shown in Exhibit 4.2. Power plants can achieve the emissions reductions required by CSAPR through any of the following strategies:

- Maintaining effective and frequent operation of already installed control equipment
- Using low sulfur coal
- Increasing generation from relatively cleaner units
- Installing existing, commercially proven technologies that are widely available and frequently used in this industry, such as low NO<sub>x</sub> burners, selective catalytic reduction (NO<sub>x</sub> reduction), scrubbers (flue gas desulfurization), or dry sorbent injection (U.S. EPA 2011)

**EXHIBIT 4.2. States Included in CSAPR**



SOURCE: U.S. EPA. n.d. *Large Map of Transport Rule States*. Accessed March 21, 2015. <http://www.epa.gov/crossstaterule/statesmap.html>

### **Mercury and Air Toxics Standard—CAA Section(s) 111 and 112**

On December 16, 2011, the U.S. EPA finalized the MATS, establishing the first national emission standards for hazardous air pollutants from power plants. Electric generators fueled by coal and oil emit many harmful pollutants, including mercury, acid gases, nonmercury metallic toxins, and organic air toxins. Under MATS, existing units are required to achieve a technology-based emissions standard set by the best performing sources (U.S. EPA April 2012). While many newer facilities already have control

equipment in place to reduce such emissions, many older power plants do not. Power plants have several options to comply with the emissions reductions required by MATS, including:

- Using existing controls technologies to address toxic pollutants, such as flue gas desulfurization, activated carbon injection (ACI), ACI with fabric filter, or electrostatic precipitators
- Fuel switching
- Retiring uneconomic units (U.S. EPA April 2012)

### **Clean Power Plan—CAA Section(s) 111(b) and 111(d)**

Fossil fuels consumed for electric generation are the largest source of carbon emissions in the nation (U.S. EPA January 2014). In June 2014, the U.S. EPA announced its plan to reduce carbon emissions from the nation's power plants. As currently written, by 2030, the targets set by the CPP will reduce CO<sub>2</sub> emissions from power plants by 30 percent—relative to their levels in 2005. The proposed plan sets emission reduction goals for individual states and allows states to develop their own strategies to meet those goals. The U.S. EPA proposed four primary building blocks for complying with the plan:

1. Make fossil fuel plants more efficient through a 6 percent reduction in heat rates
2. Increase the capacity factor of natural gas combined cycle plants
3. Utilize zero carbon generation, such as renewables and nuclear plants more frequently
4. Increase energy efficiency and demand-side management (U.S. EPA June 2014)

The U.S. EPA received over four million submissions during the plan's public comment period. The final rule was released on August 3, 2015. The rule was later stayed by the Supreme Court until the court could review it. The Supreme Court's review may be moot, because President Donald Trump signed the Executive Order on Energy Independence, which calls for further review of the CPP (White House 2017).

### **The Clean Water Act**

The recognition that the nation's waterbodies were being adversely affected by human activity prompted Congress to pass the CWA. The law established the U.S. EPA's authority to implement regulations and standards aimed at restoring the quality of the nation's water resources. Of main concern in the CWA was the elimination of point source pollution and the discharge of toxic chemicals, but the law also expressed the desire to protect aquatic organisms and ecosystems (CWA 33 U.S.C § 1251(a)(2)).

### **Cooling Water Intake Structures—CWA Section 316(b)**

Chemical pollution is only one factor posing a threat to aquatic life. Many industrial facilities and electric power generators that produce large amounts of heat rely on water resources to cool their plants. These facilities withdraw millions of gallons per day through CWIS. Aquatic organisms face physical threats from these withdrawals as they are pulled into the cooling system or impinged on filters.

Pursuant to CWA Section 316(b), the U.S. EPA requires that facilities with CWIS are evaluated and permitted through the National Pollutant Discharge Elimination System. The location, design, construction, and capacity of these structures must reflect the best technology available to minimize environmental impacts (U.S. EPA May 2014). The final rule governing CWIS at new and existing facilities was released on May 19, 2014, and it will impact more than 1,000 facilities. Facilities covered under the

rule must comply with national best technology available standards for entrainment and impingement. The rule has three primary components:

1. Facilities withdrawing more than two million gallons per day must reduce fish impingement through approved technologies.
2. Facilities withdrawing at least 125 million gallons per day must conduct a study evaluating ways to reduce impacts on fish populations and design a site-specific approach to reduce impingement.
3. New electric generating units can pursue one of two national standards to reduce entrainment<sup>37</sup> and impingement (U.S. EPA May 2014).

## **Coal Combustion Residuals—Resource Conservation and Recovery Act Subtitle D**

More than 850 million tons of coal was consumed for the generation of electricity in 2014 (U.S. EIA January 2015). Burning coal results in CCR, commonly referred to as coal ash. Each year, the United States produces more than 100 million tons of coal ash, making it one of the largest sources of industrial waste (ACCA n.d.). The U.S. EPA encourages the beneficial reuse of coal ash; it is commonly repurposed into concrete, building materials, or other products. Unfortunately, the majority of coal ash is disposed of in landfills or surface impoundments at electric generating facilities. If stored improperly, coal ash contaminants could leach into groundwater or blow into the air. Following an unprecedented coal ash spill in 2008, the EPA began creating new safety standards to regulate the storage of coal ash (U.S. EPA March 2015).

On December 19, 2014, the EPA issued the final rule establishing minimum requirements for coal ash storage in landfills and surface impoundments. The rule—established under the Resource Conservation and Recovery Act, Subtitle D—requires storage facilities to meet minimum structural design criteria, place restrictions on where new facilities can be sited, and have site owners install monitoring wells (U.S. EPA December 2014).

## **AGING INFRASTRUCTURE**

The demand for electricity grew dramatically during the second half of the 21<sup>st</sup> century. Annual electric generation doubled between 1949 and 1956, again between 1956 and 1967, and for a third time between 1967 and 1985 (U.S. EIA February 24, 2015). This growth sparked huge investments in electric infrastructure and technology to keep up with demand. Many of these investments are still a part of the nation's generation portfolio. Across the country, 73 percent of coal plants and 51 percent of all electric generation is at least 35 years old (U.S. EIA 2011). The electric grid built to supply electricity to more homes and businesses is connected via transmission and distribution lines. The resulting electric grid connects more than 146 million customers across six million miles of transmission and distribution lines (MIT 2011). This electric infrastructure is also aging. As it ages and is subsequently replaced, there is significant potential to update the electric grid and expand the use of emerging technologies, even in a low load growth period.

Combined coal, natural gas, and nuclear accounted for more than 90 percent of all electricity produced in Michigan (U.S. EIA February 17, 2015). Michigan's coal power plants were predominantly built between

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<sup>37</sup> Entrainment is used here as the transport of water across an interface between two bodies of water.

1950 and 1980. The last major<sup>38</sup> coal power plant—DTE’s Belle River—was finished in 1985. Michigan’s coal fleet—on average—has been in service more than 50 years (U.S. EIA February 17, 2015). Michigan’s four nuclear reactors were built between 1972 and 1988. DTE’s Fermi nuclear plant was the most recent addition. No new baseload coal or nuclear facilities have been built in the state in over 25 years. Since 1990, the majority of new generating capacity—nearly 8,000 MWs—built within the state has been fueled by natural gas. Since the establishment of Michigan’s RPS in 2008, the state has added 1,800 MWs of new renewable capacity (MPSC February 2017). Information about Michigan’s generating fleet is shown in Exhibits 4.3 and 4.4.

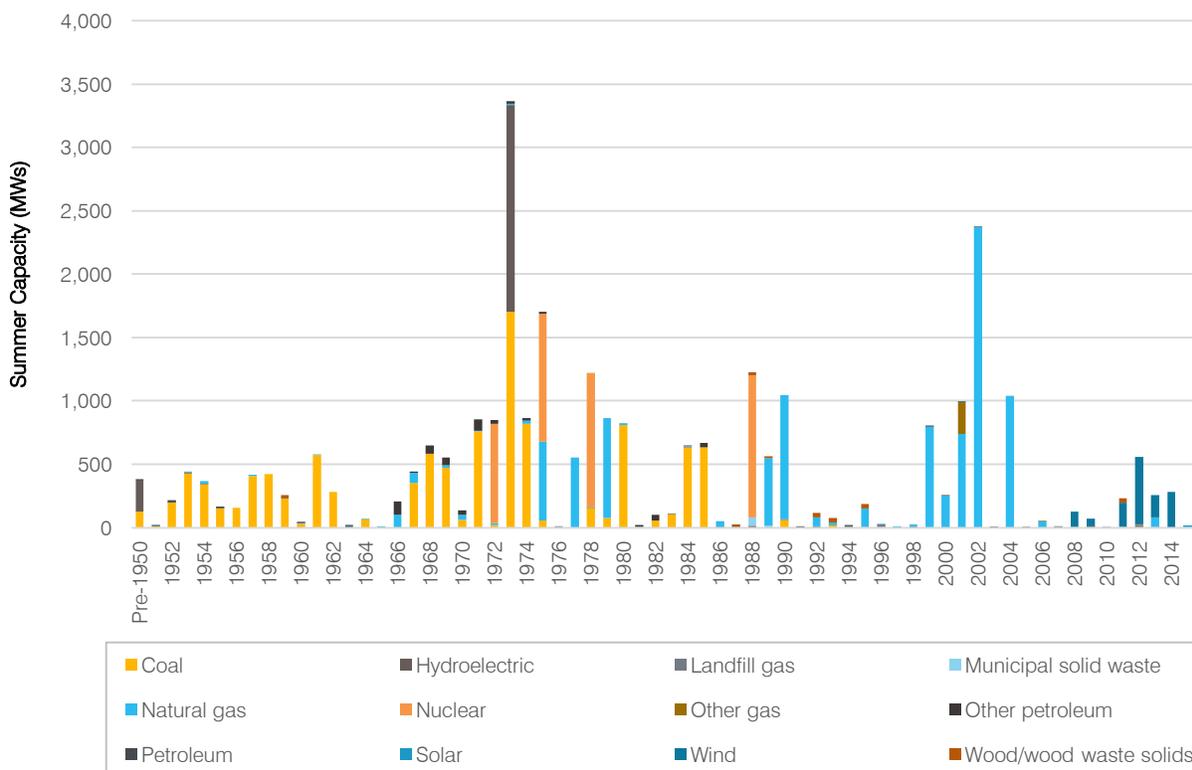
**EXHIBIT 4.3. Inventory of Operating Electric Generating Units, 2015**

Fuel Source	Summer Capacity (MWs)	Percentage of Capacity	Number of Units	Number of Facilities	Average Number of Years in Operation
Coal	10799.9	37.3%	57	25	51.07
Hydroelectric	1962.1	6.8%	234	57	73.34
Petroleum	47.2	0.2%	5	1	38.75
Natural gas	9504.5	32.9%	171	57	28.00
Nuclear	3976.5	13.8%	4	3	38.75
Wind	1360.1	4.7%	23	22	5.43
Solar	2	0.0%	2	2	2
Landfill gas	136.2	0.5%	102	23	16.05
Municipal solid waste	79.3	0.3%	2	2	28.50
Wood/wood waste solids	210	0.7%	8	8	27.75
Other gas	255.8	0.9%	4	3	10
Other petroleum	586.1	2.0%	105	34	46.09
<b>Total</b>	<b>28,919.7</b>		<b>717</b>	<b>214</b>	

NOTE: Age calculations based on average of initial operating year.  
(Average age = (sum of operating year for all units, by fuel source) / number of units, by fuel source)  
SOURCE: U.S. EIA. August 15, 2017. *Form EIA-860 detailed data*. Accessed September 6, 2017. <https://www.eia.gov/electricity/data/eia860/>

<sup>38</sup> Three smaller coal-fueled power plants were built between 1986 and 1990. These plants have a cumulative summer capacity of 111 MWs (U.S. EIA August 15, 2017).

#### EXHIBIT 4.4. Michigan Electric Generating Capacity Additions, Pre-1950–2015



SOURCE: U.S. EIA. August 15, 2017. *Form EIA-860 Detailed Data*. Accessed September 6, 2017. <https://www.eia.gov/electricity/data/eia860/>

The decision to maintain generating assets comes down to economics. When a plant’s expected costs exceed the expected lifetime revenue, then the plant will likely be retired. Environmental regulations are playing a major role in determining the future for some of Michigan’s aging generating assets—especially coal plants. Despite being under review, existing regulations have already played a major role in reshaping Michigan’s generation portfolio. Consumers Energy retired seven of its oldest coal fired units in 2016 due to age and new environmental requirements. DTE Energy has pledged to retire its remaining coal capacity by 2050. A recent survey of electric providers in MISO found eight to ten gigawatts of capacity is at risk of retirement because the costs of environmental compliance associated with MATS and CSAPR (Potomac 2014). As older facilities are retired either due to age or increased costs, there is the opportunity to transition to new, cleaner, more efficient sources of electricity.

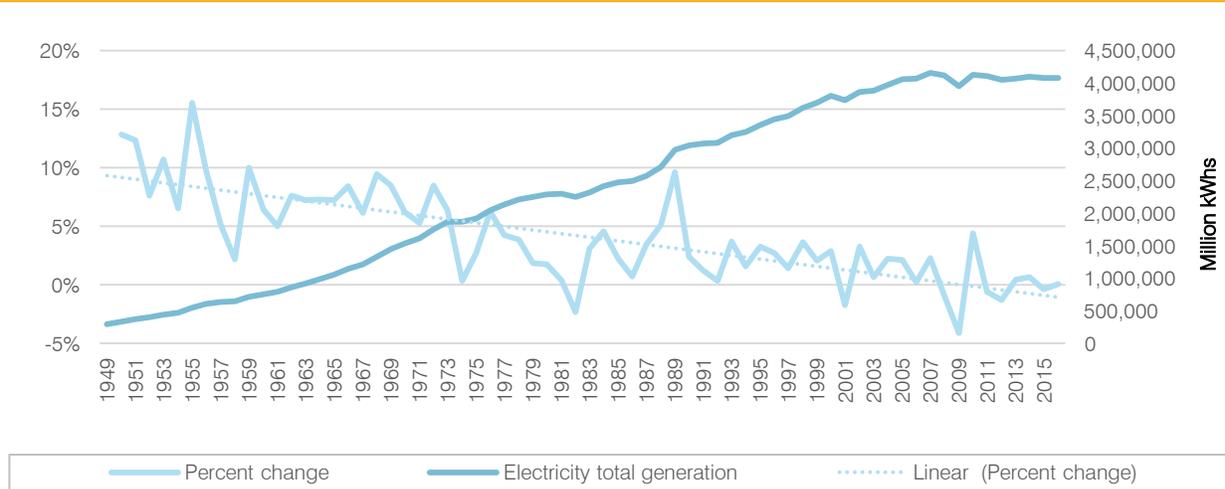
## REDUCED OR FLAT LOAD GROWTH

Demand for electricity increased significantly over the past 65 years, but the growth rate has gradually slowed over each decade during the same time period as shown in Exhibit 4.5. The growth rate peaked during the 1950s at 9.26 percent per year, but by 2010 it had fallen below 1 percent (U.S. EIA February 24, 2015). Part of the reason growth has slowed is energy consumption has become more efficient.<sup>39</sup> New

<sup>39</sup> 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.).

efficiency standards for appliances, better building codes, and technological innovations have helped lower electricity usage in homes and businesses. In addition to using energy more efficiently, demand has fallen in recent years due to steep economic downturn. Electricity use fell 5 percent during the Great Recession<sup>40</sup> and generation of electricity has yet to recover to prerecession levels (U.S. EIA February 24, 2015). Previously, increased revenue from load growth helped support the implementation of new technologies.

**EXHIBIT 4.5. U.S. Net Electric Generation Total, All Sectors and Percent Change in Electric Generation, 1949–2016**



SOURCE: U.S. EIA. August 2017. *Annual Energy Review*. “Electricity Net Generation: Total (All Sectors), 1949–2012” Accessed September 8, 2017. [https://www.eia.gov/totalenergy/data/monthly/pdf/sec7\\_5.pdf](https://www.eia.gov/totalenergy/data/monthly/pdf/sec7_5.pdf)

**EXHIBIT 4.6. Characteristics of Net Electric Generation for All Sectors, 1949–2013**

	1950s	1960s	1970s	1980s	1990s	2000s	2010–2016
Average growth rate per decade	9.26%	7.32%	4.55%	2.85%	2.22%	0.70%	-0.10%
Years with negative growth	0	0	0	1	0	3	3

SOURCE: U.S. EIA. August 2017. *Annual Energy Review*. “Electricity net generation: total (all sectors), 1949– 2012” Accessed September 8, 2017. [https://www.eia.gov/totalenergy/data/monthly/pdf/sec7\\_5.pdf](https://www.eia.gov/totalenergy/data/monthly/pdf/sec7_5.pdf)

## Projected Load

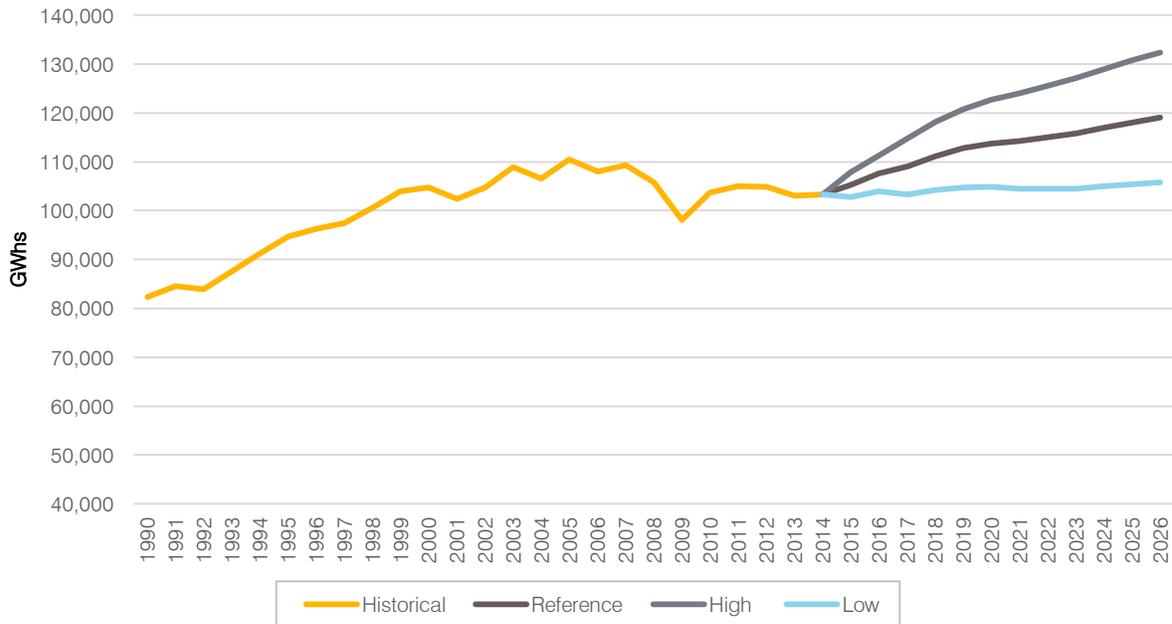
It is impossible to know what new technologies will affect the energy industry or how demand will change in the future. Building a large power plant can take years and, in some cases, cost billions of dollars. For energy providers to make wise investments, they must be able to accurately predict the growth in demand for electricity and target specific locations where such growth is located to economically size and locate generation. Forecasting energy demand is a complex task that relies on a series of computer models and statistical tools.

Recent electric load forecasts anticipate electric demand will grow slowly over coming years. The State Utility Forecasting Group recently published an electric load forecast for the MISO RTO. The forecast is

<sup>40</sup> The “Great Recession”—lasting from December 2007 through June 2009—was the longest and most severe economic downturn since the Great Depression (Isidore 2010).

broken down by state, covering a ten-year period from 2013 to 2024. It projects that demand for electricity will grow at a modest pace of 0.98 percent over the next decade. When accounting for Michigan’s goal to reduce energy consumption by 1 percent per year, the projected growth slows to 0.87 percent (Gotham et al. 2016). Various electric load forecasts are shown in Exhibit 4.7.

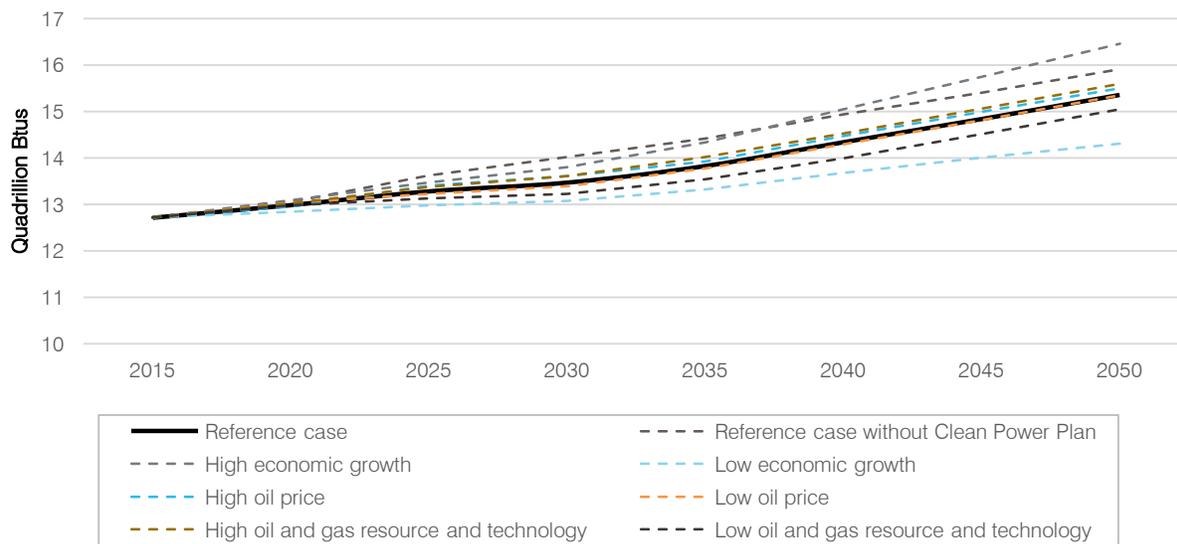
**EXHIBIT 4.7. Forecasted Electric Load in Michigan**



SOURCE: Douglas J. Gotham et al. November 2016. *2016 MISO Independent Load Forecast*. Accessed September 6, 2017. <https://www.misoenergy.org/Library/Repository/Study/Load Forecasting/2016 Independent Load Forecast.pdf>

National forecasts project similar low growth in electric demand in coming years. The EIA’s *Annual Energy Outlook* includes several electric demand projections for the period of 2012 to 2040. This forecast estimates that energy demand will increase by less than 1 percent per year. (U.S. EIA January 2017). Exhibit 4.8 shows the different national load forecasts presented in the *2016 Annual Energy Outlook*.

**EXHIBIT 4.8. Projections for Energy Use, All Sectors, Electricity, 2015–2050 (quads)**



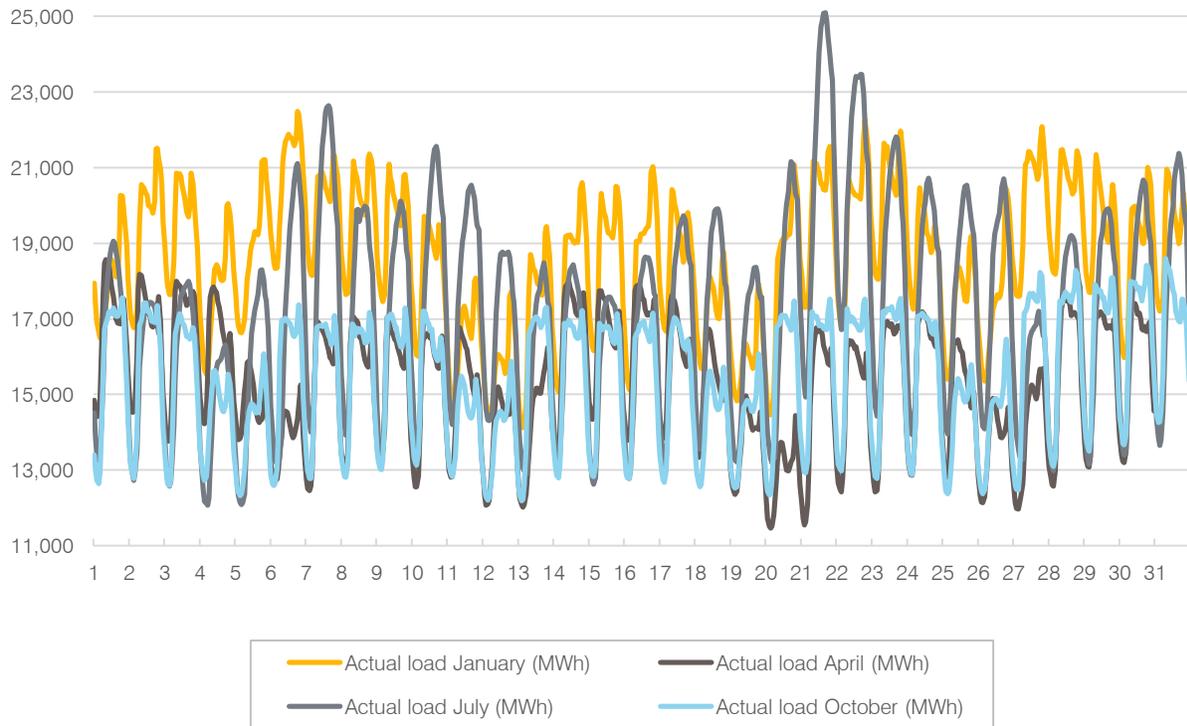
SOURCE: U.S. EIA. January 5, 2017. *Annual Energy Outlook 2017*. Accessed August 30, 2017. [https://www.eia.gov/outlooks/aeo/pdf/0383\(2017\).pdf](https://www.eia.gov/outlooks/aeo/pdf/0383(2017).pdf)

## CHANGING FUEL AND GENERATION ECONOMICS

Electricity use varies from hour to hour each day, and from month to month during the year. Demand is typically greater during the middle of the day than at night, and is highest during summer months when temperatures rise. Because of these variations in electric load, electric power producers rely on a diverse portfolio of generating assets to meet demand. Electric generators are dispatched to meet increased demand based on their variable operating costs. Generally, plants with the lowest variable costs will be dispatched first, with more costly plants only being called upon if demand continues to rise (U.S. EIA 2012).

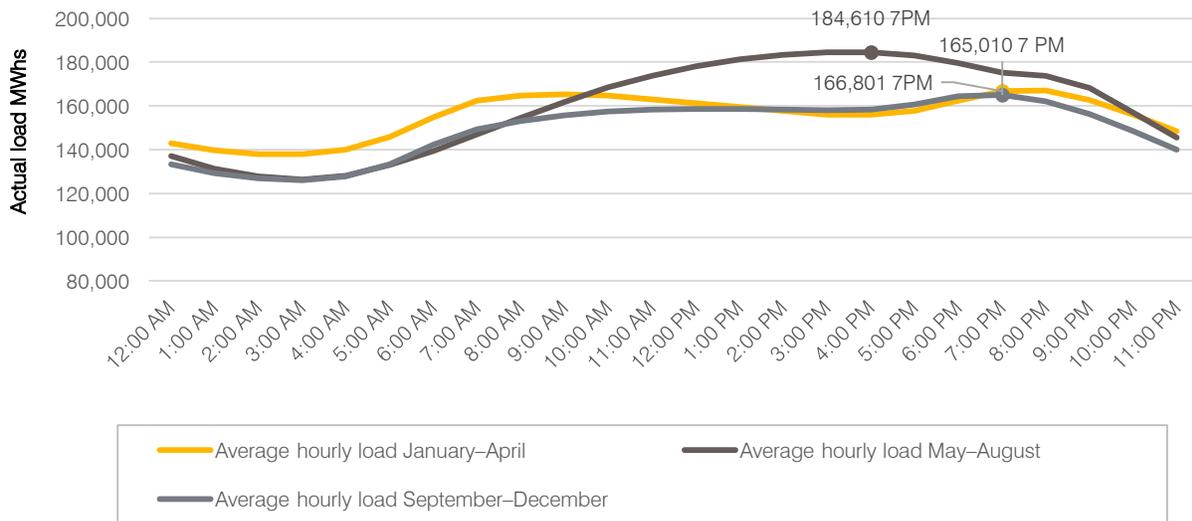
Some plants—predominately coal and nuclear—are used to supply baseload electricity because of their low variable operating costs. When demand rises, other generating capacity is brought online. These peaking plants generally have higher variable costs, but are able to respond quickly to increased demand. Generation dispatch in Michigan is managed by MISO or PJM. Exhibit 4.10 captures the variation in electric load over a one-month period and throughout different months in the year. Exhibit 4.11 illustrates that same variation seen hour by hour throughout an average day.

**EXHIBIT 4.9. MISO North Daily Variation in Electric Load, 2014 (MWhs)**



SOURCE: MISO. January 2, 2015. *Archived Historical Regional Forecast and Actual Load, 2012*. Accessed October 1, 2017. [https://www.misoenergy.org/MKTRPT\\_Archives/rfal\\_HIST/201412\\_rfal\\_HIST\\_xls.zip](https://www.misoenergy.org/MKTRPT_Archives/rfal_HIST/201412_rfal_HIST_xls.zip)

**EXHIBIT 4.10. MISO North Average Daily Electric Load, 2014**



SOURCE: MISO. January 2, 2015. *Archived Historical Regional Forecast and Actual Load, 2012*. Accessed October 1, 2017. [https://www.misoenergy.org/MKTRPT\\_Archives/rfal\\_HIST/201412\\_rfal\\_HIST.xls.zip](https://www.misoenergy.org/MKTRPT_Archives/rfal_HIST/201412_rfal_HIST.xls.zip)

In recent years, changing economic conditions have started to impact what resources are being dispatched to meet variable energy need. Fuel prices make up a significant portion of variable costs for power plants running on fossil fuels (Potomac Economics 2012). Coal has historically been the dominant fuel for electric supply in Michigan and for many parts of the country, but the average price of coal delivered to the electric power sector has increased approximately 4 percent annually from 2007 to 2011. During the same period, natural gas prices fell dramatically and have remained relatively stable, as shown in Exhibit 4.12. This was a result of abundant domestic resources and improved production technologies (U.S. EIA April 2014). Increased costs for coal-fired power plants and more competitive natural gas prices have led to greater utilization of natural gas-fired generation (U.S. EIA January 2017.).

**EXHIBIT 4.12. Weighted Average Price for Fossil Fuels in Electric Power Industry, 2005–2015**



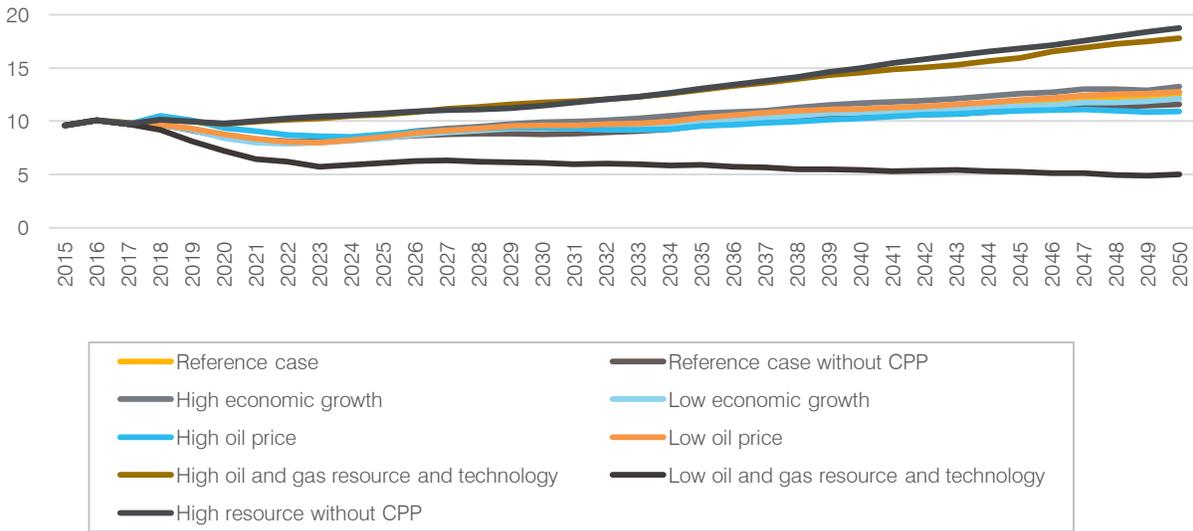
SOURCE: U.S. EIA. November 21, 2016. *Electric Power Annual*. "Receipts, Cost, and Quality of Coal, Petroleum, and Natural Gas." Accessed September 6, 2017. [https://www.eia.gov/electricity/annual/xls/epa\\_07\\_01.xlsx](https://www.eia.gov/electricity/annual/xls/epa_07_01.xlsx)

### Projections for Natural Gas

According to projections by IHS Research, natural gas generation will grow by 7 percent annually through 2020 (IHS 2015). As illustrated in Exhibit 4.13, the U.S. EIA projects that natural gas consumption for electricity will remain relatively static over the next decade, and the electric power industry's consumption of natural gas will increase by 0.6 percent annually growing by about two trillion cubic feet from 2016 to 2050 (U.S. EIA January 2017).

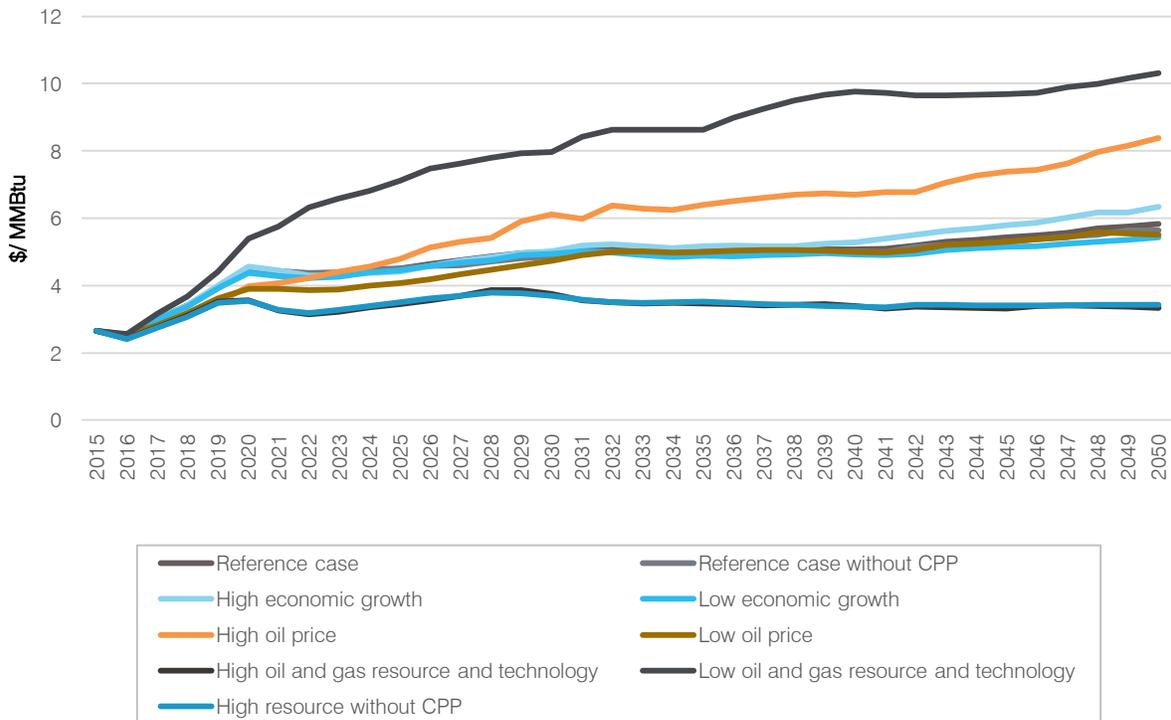
Production of natural gas is expected to outpace growing consumption in the United States through 2040. Expanded production is largely attributed to enhanced recovery technologies and the expansion of shale gas (U.S. EIA January 2017). Despite the expectation that production will grow more rapidly than consumption, natural gas prices are expected to rise in coming years. The U.S. EIA published a series of industry projections for natural gas prices in its *2016 Annual Energy Outlook*, these projections are shown in Exhibit 4.14.

**EXHIBIT 4.13. Projected Natural Gas Consumption for Electric Generation (trillion cubic feet)**



NOTE: Includes consumption of energy by electricity-only and CHP plants whose primary business is to sell electricity, or electricity and heat, to the public. Includes electric utilities, small power producers, and exempt wholesale generators.  
 SOURCE: U.S. EIA. January 5, 2017. *Annual Energy Outlook 2017*. Accessed September 6, 2017. <https://www.eia.gov/outlooks/aeo/data/browser/?/?id=13-AEO2017&region=0->

**EXHIBIT 4.14. Natural Gas Henry Hub Spot Market Price, 2016**



SOURCE: U.S. EIA. January 5, 2017. *Annual Energy Outlook 2017*. Accessed September 6, 2017. <https://www.eia.gov/outlooks/aeo/data/browser/?/?id=13-AEO2017&region=0->

The U.S. EIA’s forecast projects that, after 2030, new generation capacity will be split between natural gas and solar, with solar capacity representing more than 50 percent of new capacity additions in the reference case between 2030 and 2040. Natural gas will make up 73 percent of all new capacity from 2012 to 2040. The second largest source of new capacity during this period is expected to come from renewable energy technologies. The U.S. EIA projects that after 2030, 24 percent of new capacity will be from renewable generation (U.S. EIA January 2017). These projections are available in Appendix G. In many cases, the development of renewable generation has been brought on by state policies like RPSs or federal tax credits. As shown in Exhibit 4.15 the costs of many renewables have declined in recent years and have been developed in Michigan for less than the cost of a new coal plant.<sup>41</sup>

**EXHIBIT 4.15. Weighted Average Levelized Renewable Energy Contract Prices (dollars/MWh)**

Technology	Wind	Digester	Biomass	Landfill	Hydro	Solar
Consumers Energy weighted average	\$84.11	\$137.77	NA	\$106.21	\$121.31	\$160.00
DTE Energy weighted average	\$68.16	N/A	\$98.94	\$98.97	N/A	113.52
Combined weighted average	\$71.55	\$137.02	\$98.94	\$104.05	\$121.31	\$121.27

SOURCE: MPSC. February 15, 2017. *Renewable Energy Standard and the Cost-Effectiveness of the Energy Standards*. Accessed September 6, 2017. [http://www.michigan.gov/documents/mpsc/MPSC\\_PA295\\_Renewable\\_Energy\\_Report\\_Feb\\_2017\\_551772\\_7.pdf](http://www.michigan.gov/documents/mpsc/MPSC_PA295_Renewable_Energy_Report_Feb_2017_551772_7.pdf)

## TECHNOLOGY INNOVATION

The existing utility system model is shifting—from one based on centralized electric generation resources to a highly granular system more reliant on distributed, diverse energy resources. These resources include demand-side management capabilities and energy-efficiency measures. This new energy system requires management and coordination of energy system inputs and outputs and the deployment of intelligent communication and advanced control technologies necessary to interconnect, integrate, and harmonize the power system.

### Distributed Energy Resources

Businesses and consumers are beginning to see a variety of new energy products and services coming to market collectively referred to as distributed energy resources (DERs). DERs are defined by the Electric Power Research Institute as “smaller power sources that can be aggregated to provide power necessary to meet regular demand” (EPRI 2014). DERs includes power generation and energy management technologies and services that have the potential to provide reliable alternative power, reduce loads, reduce peak demand, improve power quality, and enhance grid resiliency. DERs can be categorized as follows:

- **Fossil fuel-based DG technologies:** These include CHP technologies that use natural gas, biomass, or petroleum; microturbines; fuel cells; reciprocating engines; and sterling engines.
- **Renewable energy DG technologies:** These include solar PV, small wind turbines, geothermal, and small hydroelectric facilities.

<sup>41</sup> Compared to \$133/MWh for a new coal plant (MPSC February 2017 p. 26).

- **Demand-side management technologies and energy services:** These technologies and services aggregate energy-efficiency measures, behavioral energy efficiency, dynamic pricing, load scheduling, automated energy management, and demand response into energy system resources.
- **Energy services and grid support:** Technologies that store energy—batteries, flywheels, compressed air, and thermal storage—can also provide grid services like frequency regulation and voltage support. Grid-connected electric vehicles can provide similar services.
- **Interconnection and grid integration technologies:** These include advanced controls and sensors, communication devices, inverters, synchrophasors, smart thermostats, and AMI that control and manage energy.

Unlike conventional power plants that generate electricity and use the transmission and distribution system to deliver power monodirectionally to end users, DERs are heterogeneous technologies operating bidirectionally—continuously adding, reducing, or modulating power flowing to the grid. By integrating DERs with the power grid, their service and value can be optimized (EPRI 2014). Effectively integrating DERs means greater operational complexity and requires a significant leap forward in grid design and engineering. Intelligent communication technologies, predictive analytics, and new networking, security, and interoperability protocols are necessary to optimize the power system and derive the full value from the technologies. Integrated operation of DERs can provide consistent power, reducing the need for baseload generators.

## Disruptive Forces

The successful reduction of energy use through energy efficiency, energy conservation, and demand management means that utilities can no longer rely on steady growth in electricity sales that have historically driven investment in central station electric infrastructure. New energy management technologies are coming to market with the potential further to reduce load. More than 65 million smart meters were deployed in the U.S. by 2015 (St. John 2016). With the integration of smart meters and other emerging technologies that increase connectivity, customers are finding new ways to monitor and manage energy consumption in real time. Google’s acquisition of Nest, Apple, and Samsung’s exploration of the home energy management sector suggests new areas of market competition for traditional utilities with a focus on achieving energy savings for customers.

DER growth is projected to be substantial. Innovation, improvements in energy technologies, and new materials will continue to sharpen the economics of DERs; the advent of new finance and business models will enable broader adoption of these technologies. Solar PV has the potential to reach retail or “socket” parity with utility service over time, in all areas including those with lower residential and commercial rates. In February 2015, the U.S. reached 1,000,000 solar systems installed on homes and businesses (Pyper 2016). Capital markets are responding to perceived new growth opportunities with tax equity financing, project finance lending, and residential PV leasing models (EEI 2013). Competition in energy markets will increase with new energy product and service offerings like yieldcos,<sup>42</sup> green bonds, and new financial models that enable procurement (BNEF 2015).

Another emerging trend is the growing demand from businesses, industries, and consumers for clean energy resources. General Motors, Switch, Google, Facebook, Microsoft, Amazon, Walmart, Intel, and many other businesses have zero-carbon energy procurement goals. Businesses, hospitals, military bases,

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<sup>42</sup> Publicly traded companies comprised mostly of operating renewable energy assets (BNEF 2015).

government agencies, and homeowners will increasingly self-generate their clean power. Microgrids, capable of operating independently in an “island” mode to support the grid during storm events and outages, are beginning to power critical infrastructure.

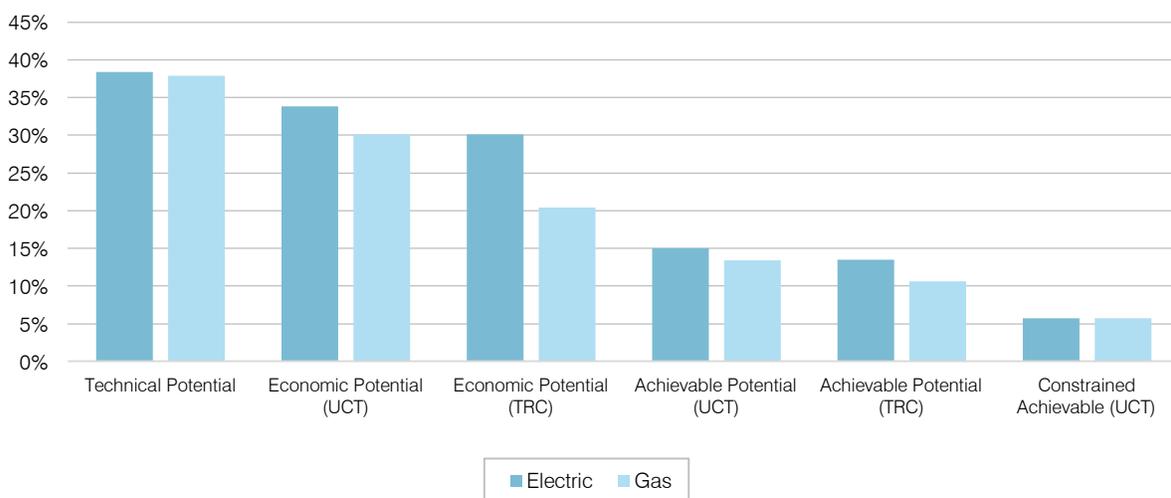
While the disruptive potential of DERs are substantial, so are the potential benefits. CHP plants can provide baseload power and heat energy, while other DERs can provide power to meet peak demand, supplemental power and remote power. They can also shape, balance and smooth loads while shaving peak demand. Because they are located close to load, DERs can help lower overall system cost by reducing transmission and distribution losses and deferring or avoiding new capital investment. DERs, are for the most part, low-carbon or zero carbon energy technologies, eliminating fuel costs or mitigating energy cost volatility. DERs are also capable of making the grid more reliable and resilient while improving power quality.

## POTENTIAL FOR SAVINGS THROUGH EO

The MPSC worked collaboratively with DTE and Consumers to complete a 2013 study of energy-efficiency potential in the state of Michigan. The study provided a roadmap for policymakers and identified the energy-efficiency measures having the greatest potential savings and most cost-effective measures. The study—conducted by the consulting firm GDS Associates—estimates the potential for energy-efficiency measures under several scenarios, including technical potential, economic potential, and achievable potential. See Exhibit 4.16 for additional information.

The study examined 1,417 electric energy-efficiency measures and 922 natural gas measures in the residential, commercial and industrial sectors combined. Overall, the achievable potential for electricity savings based on the utility cost test (UCT) is 15.0 percent of forecasted kWh sales for 2023. The potential for natural gas savings based on the UCT is 13.4 percent of forecasted million British thermal units (MMBTU) sales for 2023 (GDS 2013).

**EXHIBIT 4.16. Forecasted Electric and Gas Savings as a Percent of Statewide Sales in 2023**



SOURCE: GDS Associates, Inc. November 5, 2013. *Michigan Electric and Natural Gas Energy Efficiency Potential Study*. Accessed March 24, 2015. [http://www.dleg.state.mi.us/mpsc/electric/workgroups/mi\\_ee\\_potential\\_studyw\\_appendices.pdf](http://www.dleg.state.mi.us/mpsc/electric/workgroups/mi_ee_potential_studyw_appendices.pdf)

## POTENTIAL FOR RENEWABLE ENERGY DEVELOPMENT IN MICHIGAN

Renewable generation has increased at an average rate of 1 percent per year since Michigan’s RPS was implemented. The *Renewable Energy Report*, released as part of Governor Snyder’s Ready Michigan to Make Good Energy Decisions process, included an evaluation of the potential for expanding the state’s RPS. The report found Michigan could achieve a 30 percent RPS by 2035 without exceeding current surcharge caps. The report also noted that Wisconsin, Pennsylvania, Illinois, and Minnesota have RPSs with annual increases of 0.8 to 1.3 percent per year (Quackenbush 2013).

In April 2015, the Vermont Energy Investment Corporation (VEIC) released their final report—*Michigan Renewable Resource Assessment*—which estimates a bounded technical potential as well as projections for the cost and performance profiles expected over the next 15 years for utility scale onshore wind, solar PV, and central station biomass power (VEIC 2015). The bounded technical potential estimates the amount of renewable generation available by time period considering limitations on annual growth rates, renewable resource base, land use, and siting restrictions. Exhibit 4.18 shows the estimated bounded technical potential generation for each of the renewable energy resources included in the report.

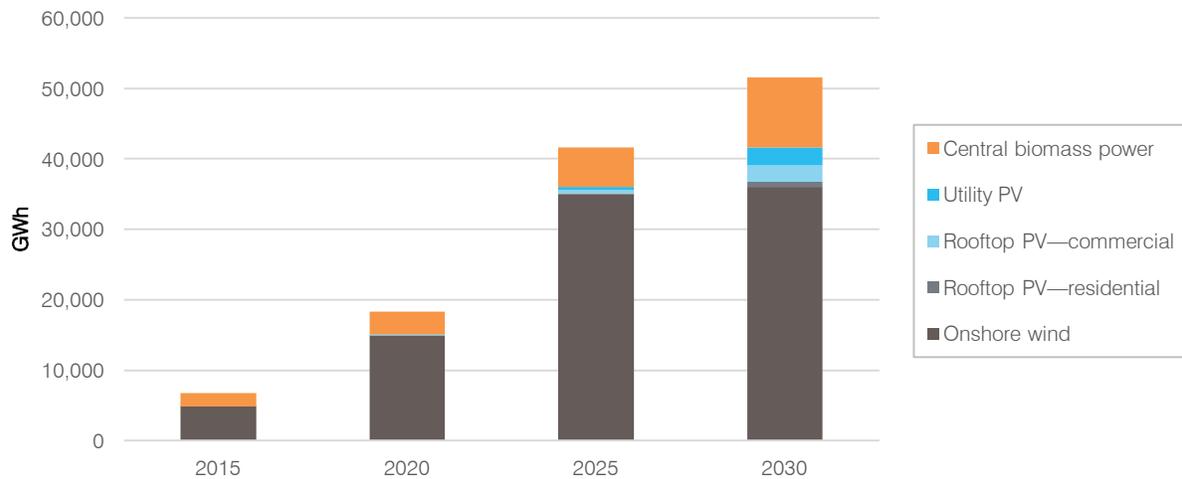
**EXHIBIT 4.18. Bounded Technical Potential Estimated Generation**

<b>Annual Generation (GWh)</b>	<b>2015</b>	<b>2020</b>	<b>2025</b>	<b>2030</b>
Onshore wind	4,882	14,897	34,971	36,000
Rooftop PV—residential	5	25	137	736
Rooftop PV—commercial	15	81	435	2,339
Utility PV	16	87	466	2,509
Central biomass power	1,814	3,198	5,635	9,931
<b>Total</b>	<b>6,732</b>	<b>18,288</b>	<b>41,645</b>	<b>51,514</b>

SOURCE: Vermont Energy Investment Corporation (VEIC). April 8, 2015. *Michigan Renewable Resource Assessment Final Report*. Accessed April 29, 2015. [https://www.michigan.gov/documents/mpsc/VEIC\\_Renewables\\_Assessment\\_487864\\_7.pdf](https://www.michigan.gov/documents/mpsc/VEIC_Renewables_Assessment_487864_7.pdf)

Exhibit 4.19 shows the amount of renewable energy required to achieve an expanded RPS that increases 1 percent per year starting at 10 percent in 2015.

**EXHIBIT 4.19. Onshore Wind, Biomass Power, and Solar Potential Contributions to Meeting Expanded RPS**



NOTE: Illustrates the bounded technical potential under expanded RPS. Standard starts at 10 percent in 2015 and increases 1 percent annually through 2030.

SOURCE: VEIC. April 8, 2015. *Michigan Renewable Resource Assessment Final Report*. Accessed April 29, 2015.

[https://www.michigan.gov/documents/mpsc/VEIC\\_Renewables\\_Assessment\\_487864\\_7.pdf](https://www.michigan.gov/documents/mpsc/VEIC_Renewables_Assessment_487864_7.pdf)

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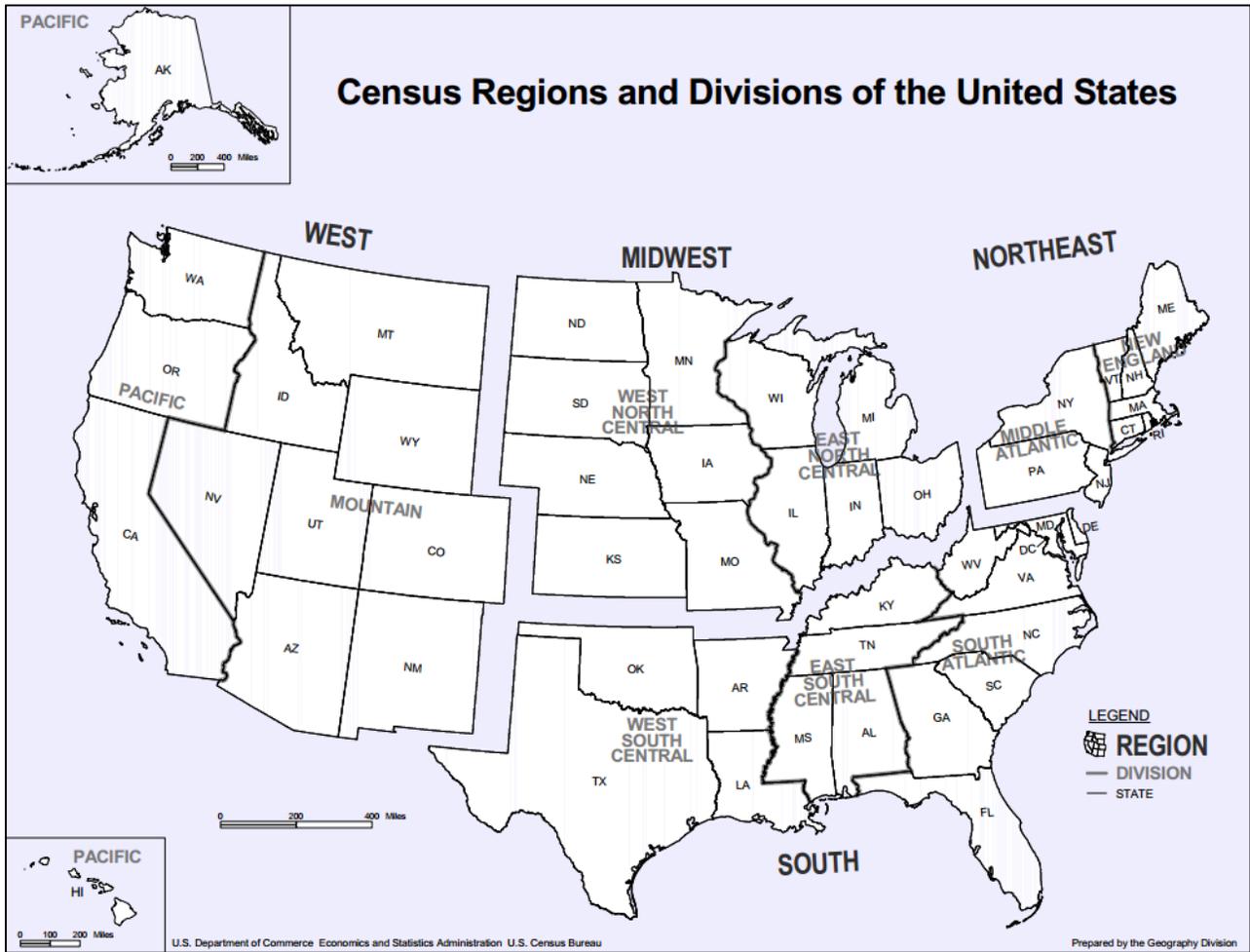
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# APPENDIX A. CENSUS REGIONS AND DIVISIONS OF THE UNITED STATES



SOURCE: U.S. Census Bureau. n.d. *Geographic Terms and Concepts - Census Divisions and Census Regions*. Accessed March 21, 2015. [http://www2.census.gov/geo/pdfs/maps-data/maps/reference/us\\_regdiv.pdf](http://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf)



## APPENDIX C. NATURAL GAS PIPELINE CAPACITY, MICHIGAN 2014

### 2016 Pipeline State-to-state Capacity, Delivered Out of Michigan

Pipeline	State From	County From	State To	County To	Capacity (MMcf/day)
Panhandle Eastern	Michigan	Wayne	Ontario	Ontario	100
Great Lakes Gas Transmission	Michigan	Chippewa	Ontario	Ontario	317
ANR Pipeline Co.	Michigan	Cass	Indiana	Elkhart	1,567
ANR Pipeline Co.	Michigan	Iron	Wisconsin	Florence	860
ANR Pipeline Co.	Michigan	Lenawee	Ohio	Fulton	100
ANR Pipeline Co.	Michigan	St. Clair	Ontario	Ontario	150
Vector Pipeline Co.	Michigan	St. Clair	Ontario	Lambton	1,350
Bluewater Pipeline Co.	Michigan	St. Clair	Ontario	Sarnia	250

SOURCE: U.S. EIA. May 11, 2017. *U.S. State-to-state Capacity*. Accessed September 6, 2017. <https://www.eia.gov/naturalgas/pipelines/EIA-StatetoStateCapacity.xlsx>

### 2016 Pipeline State-to-state Capacity, Delivered to Michigan

Pipeline	State From	County From	State To	County To	Capacity (MMcf/day)
Northern Natural Gas Co.	Wisconsin	Iron	Michigan	Gogebic	82
Panhandle Eastern	Ohio	Fulton	Michigan	Lenawee	960
Great Lakes Gas Transmission	Wisconsin	Iron	Michigan	Gogebic	2,226
ANR Pipeline Co.	Indiana	Elkhart	Michigan	Cass	1,520
ANR Pipeline Co.	Ohio	Fulton	Michigan	Lenawee	932
ANR Pipeline Co.	Wisconsin	Marinette	Michigan	Menominee	148
Trunkline Gas Co.	Indiana	Elkhart	Michigan	St. Joseph	739
Vector Pipeline Co.	Indiana	St. Joseph	Michigan	Berrien	1,350
Vector Pipeline Co.	Ontario	Lambton	Michigan	St. Clair	1,350
Bluewater Pipeline Co.	Ontario	Sarnia	Michigan	St. Clair	250

SOURCE: U.S. EIA. May 11, 2017. *U.S. State-to-state Capacity*. Accessed September 6, 2017. <https://www.eia.gov/naturalgas/pipelines/EIA-StatetoStateCapacity.xlsx>

## 2016 Natural Gas Pipeline Capacity State-to-state Flows

State Inflow Capacity			State Outflow Capacity			State Net Inflow Capacity	
State To	State From	MMcf/day	State From	State To	MMcf/day	States	MMcf/day
Michigan	Indiana	3609	Michigan	Indiana	1,567	Illinois	2,116
	Ohio	1892		Ohio	100	Indiana	2,070
	Ontario	1600		Ontario	2167	Ohio	2,969
	Wisconsin	2456		Wisconsin	860	Wisconsin	3,907
<b>Michigan Total</b>		<b>9,557</b>	<b>Michigan Total</b>		<b>4694</b>	Michigan	4,863

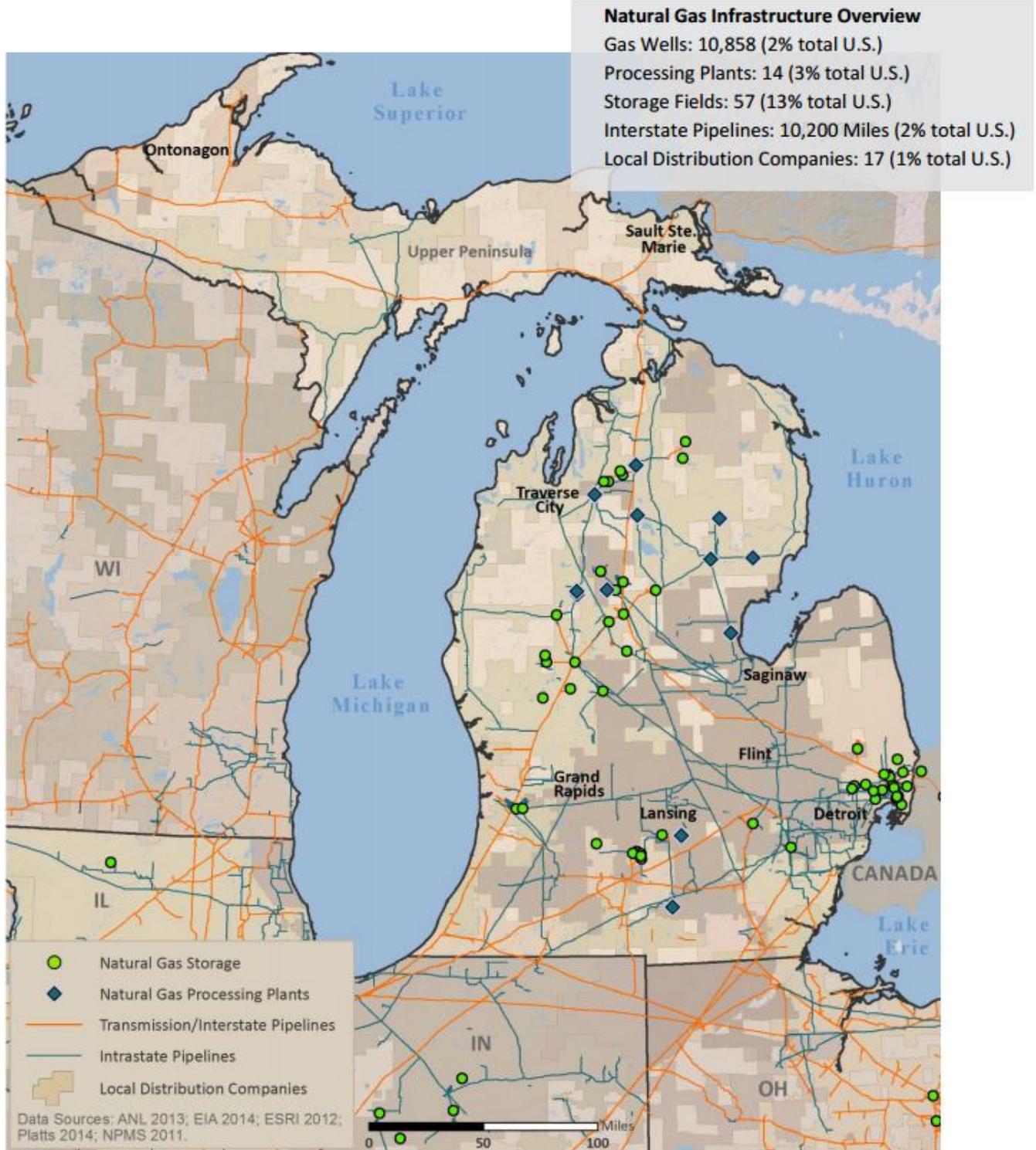
SOURCE: U.S. EIA. May 11, 2017. *U.S. State-to-state Capacity*. Accessed September 6, 2017. <https://www.eia.gov/naturalgas/pipelines/EIA-StatetoStateCapacity.xlsx>

## Natural Gas Pipeline Map



SOURCE: U.S. Energy Information Administration. March 2017. *Natural Gas Interstate and Intrastate Pipelines*. Accessed September 6, 2017. <http://www.eia.gov/state/?sid=MI>

## Natural Gas Infrastructure Map



SOURCE: U.S. DOE. May 2015. *State of Michigan Energy Sector Risk Profile*. Accessed October 17, 2017.  
[https://www.energy.gov/sites/prod/files/2015/05/f22/MI-Energy\\_Sector\\_Risk\\_Profile.pdf](https://www.energy.gov/sites/prod/files/2015/05/f22/MI-Energy_Sector_Risk_Profile.pdf)

# APPENDIX D. NATURAL GAS UNDERGROUND STORAGE

## Underground Storage Fields Map



SOURCE: U.S. Energy Information Administration. July 2016. *Natural Gas Underground Storage Facilities*. Accessed September 6, 2017. <https://www.eia.gov/state/?sid=MI>

## Underground Natural Gas Storage in Michigan, 2015

Underground storage capacity for natural gas	<b>1,071,630 (MMcf)</b>
Underground storage capacity, working capacity	685,726 (MMcf)
Total number of existing storage fields	44
Number of fields, salt caverns	2
Number of fields, depleted fields	42
Working capacity, salt caverns	2,159 (MMcf)
Working capacity, depleted fields	683,567 (MMcf)

SOURCE: U.S. EIA. July 2016. *Natural Gas Underground Storage Facilities*. Accessed September 6, 2017. <https://www.eia.gov/state/?sid=MI>

## APPENDIX E.

# 2017 FIVE-YEAR ELECTRIC RELIABILITY SUPPLY PLANS

Planning Year	2017–2018	2018–2019	2019–2020	2020–2021	2021–2022
<b>Consumers Energy</b>					
Total planning Reserve Margin (expected reserves), UCAP MW	7,926	7,843	7,807	7,774	7,756
Total Planning Resources, MW	8,015	7,876	8,395	8,594	8,639
Surplus/shortfall, MW	90	33	589	820	883
<b>DTE Energy</b>					
Total Planning Reserve Margin (expected reserves), UCAP MW	10,818	10,794	10,769	10,745	10,769
Total Planning Resources, MW	10,875	10,541	10,839	10,773	11,032
Surplus/(Shortfall), MW	56	-253	70	28	263
<b>Indiana Michigan Power Company</b>					
Total planning reserve margin (expected reserves), UCAP MW	4,673	4,551	4,594	4,208	4,212
Total planning resources, MW	4,686	4,723	4,722	4,534	4,656
Surplus/shortfall, MW	13	172	128	327	444
<b>Upper Peninsula Power Company</b>					
Total planning reserve margin (expected reserves), UCAP MW	121	120	120	120	120
Total planning resources, MW	135	138	138	108	108
Surplus/shortfall, MW	0	4	4	-26	-26
<b>Wolverine Power Supply Cooperative*</b>					
Total planning reserve margin expected reserves, UCAP MW	905	911	914	919	925
Total planning resources, MW	1,248	1,053	1,053	1,053	1,053
Surplus/shortfall, MW	343	142	139	134	128

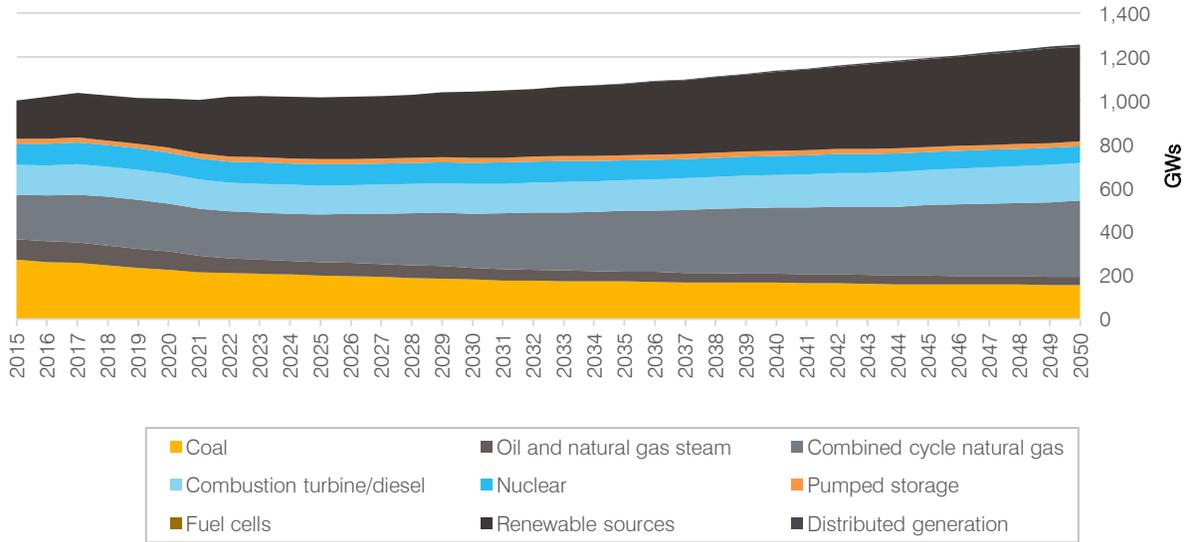
\*Includes Cherryland, Great Lakes, HomeWorks, Midwest Energy Cooperative (Midwest), Presque Isle, Wolverine Power Marketing Cooperative, Inc. (WPMC) and Spartan Renewable Energy, Inc. (Spartan)

SOURCE: MPSC. January 12, 2017. *Plans Filed in Case No. U-18197*. October 1, 2017.

<http://efile.mpsc.state.mi.us/efile/viewcase.php?casenum=18197+&submit.x=9&submit.y=16>

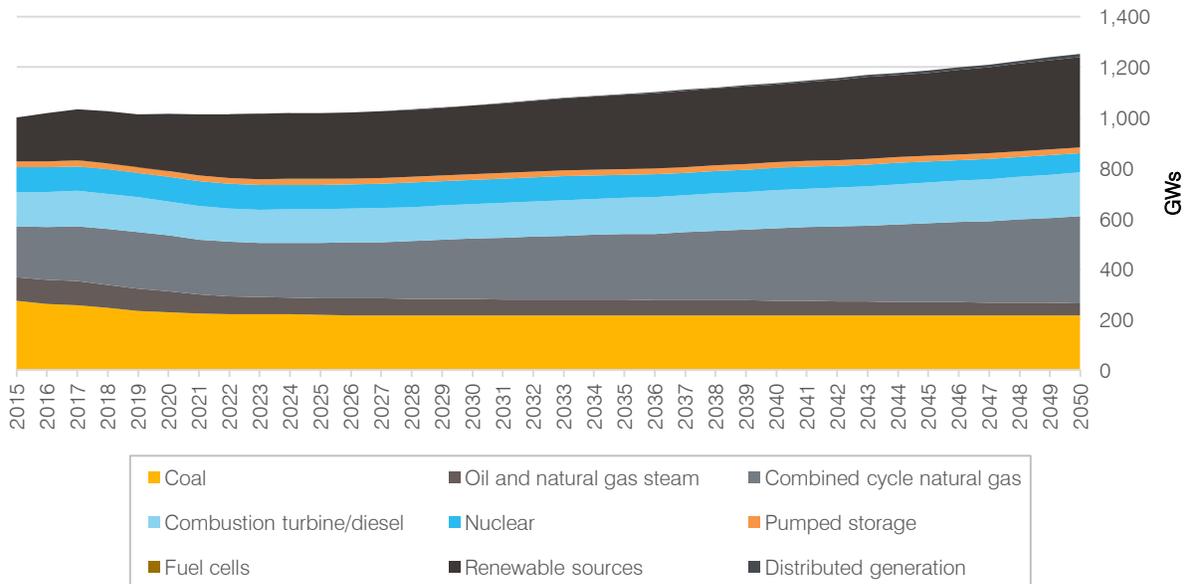
# APPENDIX F. U.S. EIA ANNUAL ENERGY OUTLOOK PROJECTIONS FOR ELECTRIC GENERATION FUEL MIX

Reference Case Projection for Electric Capacity, Electric Power Sector, 2015–2050



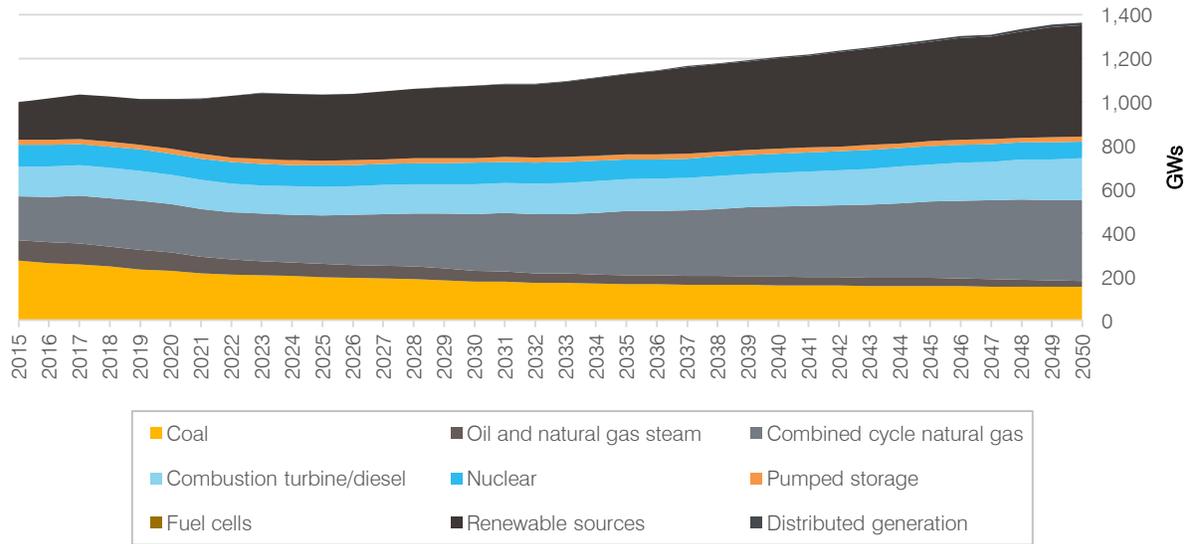
SOURCE: U.S. EIA. January 5, 2017. *Annual Energy Outlook 2017*. Accessed September 8, 2017. <https://www.eia.gov/outlooks/aeo/>

Reference Case Without CPP Projection for Electric Capacity, Electric Power Sector, 2015–2050



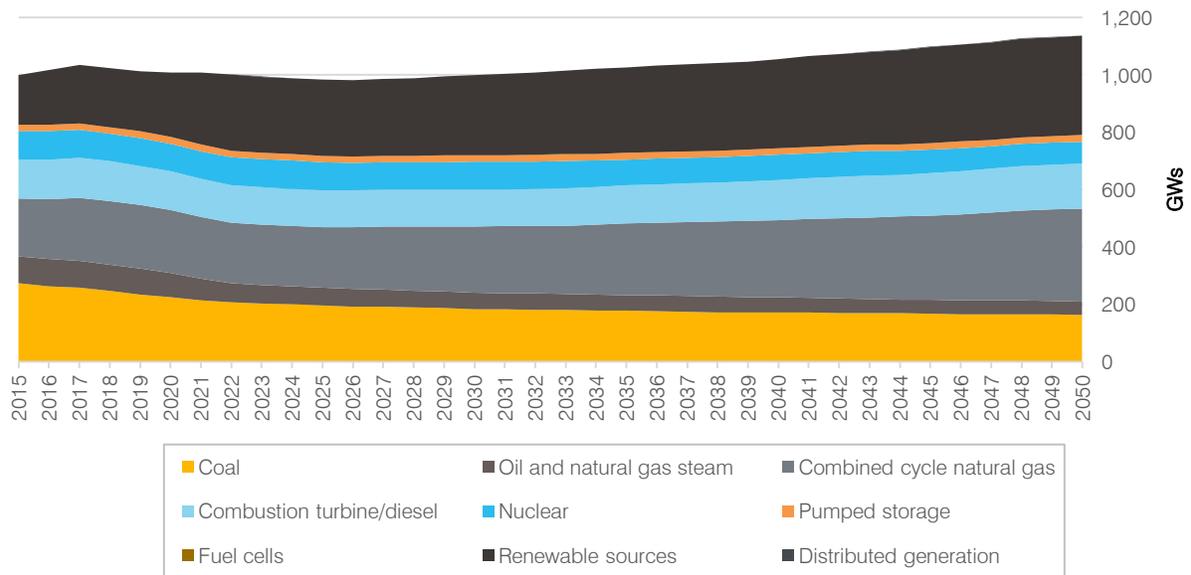
SOURCE: U.S. EIA. January 5, 2017. *Annual Energy Outlook 2017*. Accessed September 8, 2017. <https://www.eia.gov/outlooks/aeo/>

### High Economic Growth Projection for Electric Capacity, Electric Power Sector, 2015–2050



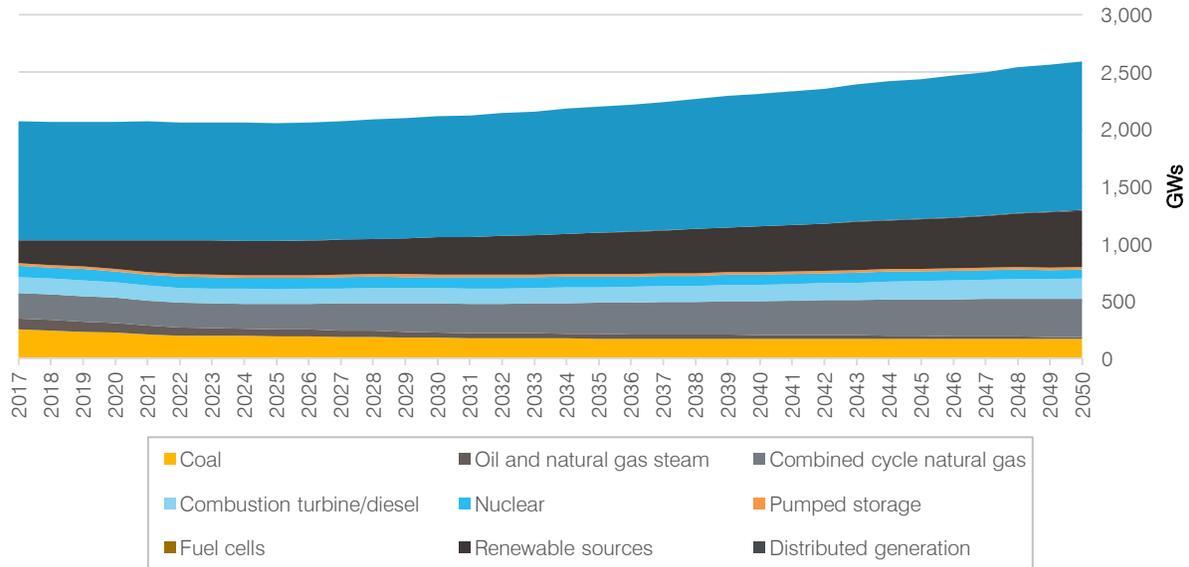
SOURCE: U.S. EIA. January 5, 2017. *Annual Energy Outlook 2017*. Accessed September 8, 2017. <https://www.eia.gov/outlooks/aeo>

### Low Economic Growth Projection for Electric Capacity, Electric Power Sector, 2015–2050



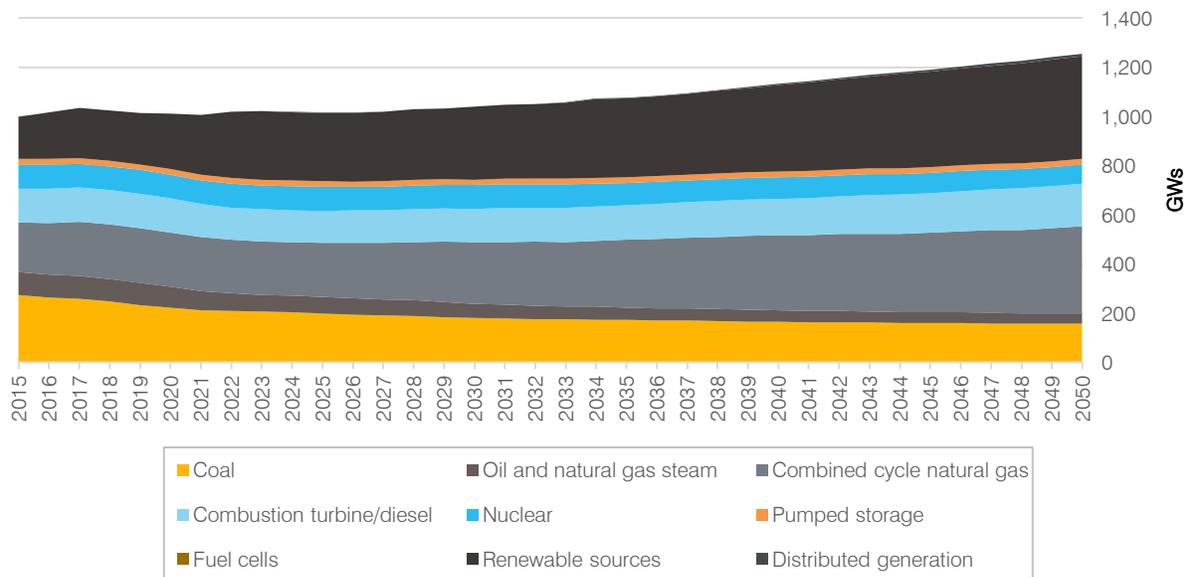
SOURCE: U.S. EIA. January 5, 2017. *Annual Energy Outlook 2017*. Accessed September 8, 2017. <https://www.eia.gov/outlooks/aeo>

### High Oil Price Projection for Electric Capacity, Electric Power Sector, 2015–2050



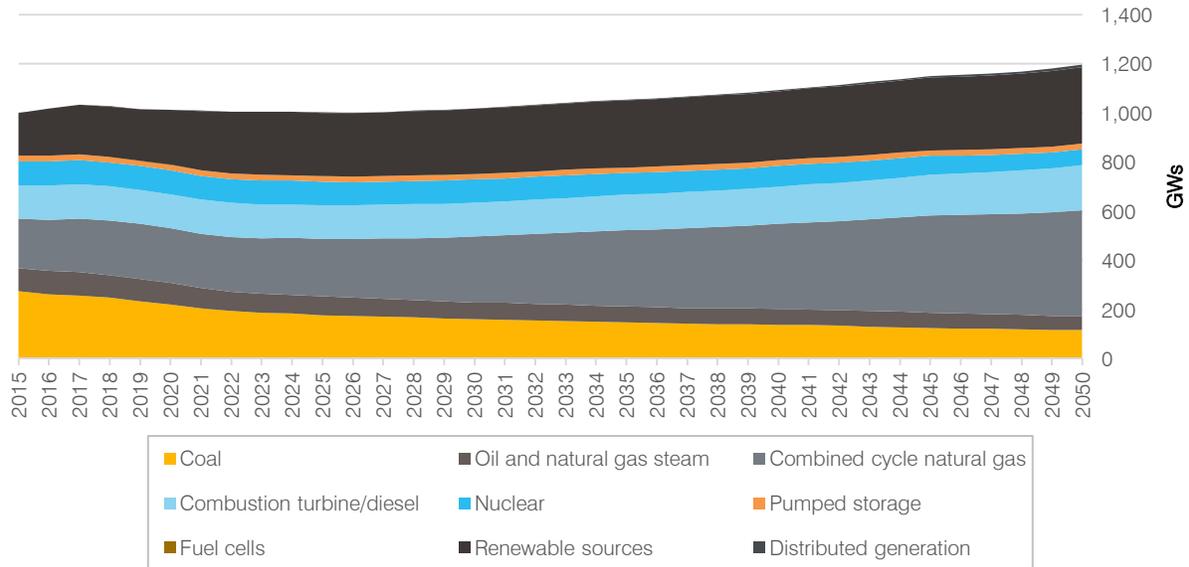
SOURCE: U.S. EIA. January 5, 2017. *Annual Energy Outlook 2017*. Accessed September 8, 2017. <https://www.eia.gov/outlooks/aeo>

### Low Oil Price Projection for Electric Capacity, Electric Power Sector, 2015–2050



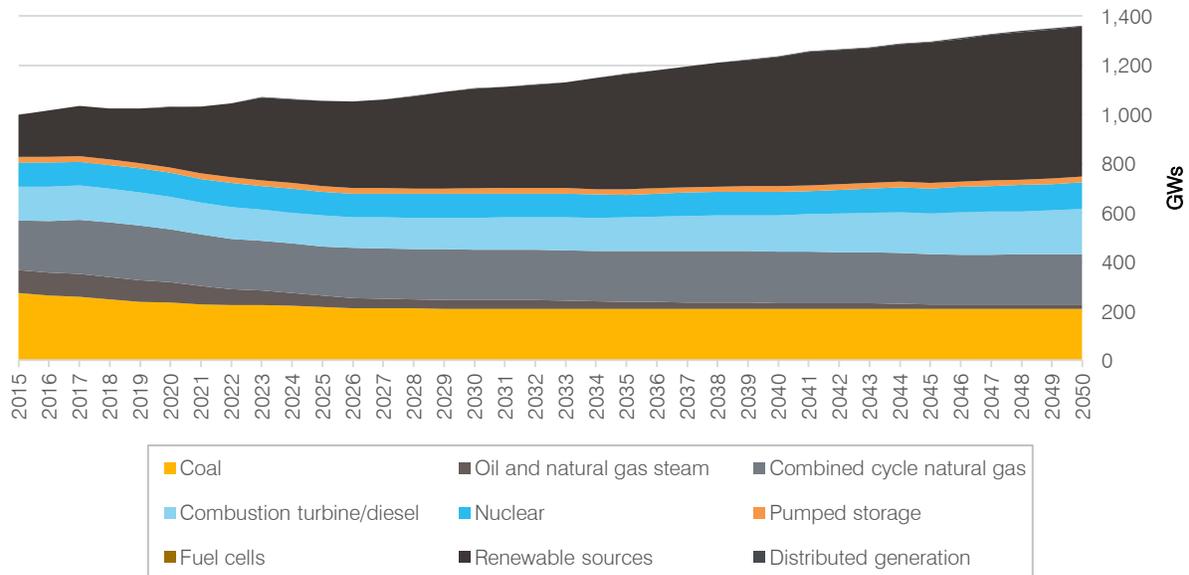
SOURCE: U.S. EIA. January 5, 2017. *Annual Energy Outlook 2017*. Accessed September 8, 2017. <https://www.eia.gov/outlooks/aeo>

High Oil and Gas Resource and Technology Projection for Electric Capacity, Electric Power Sector, 2015–2050



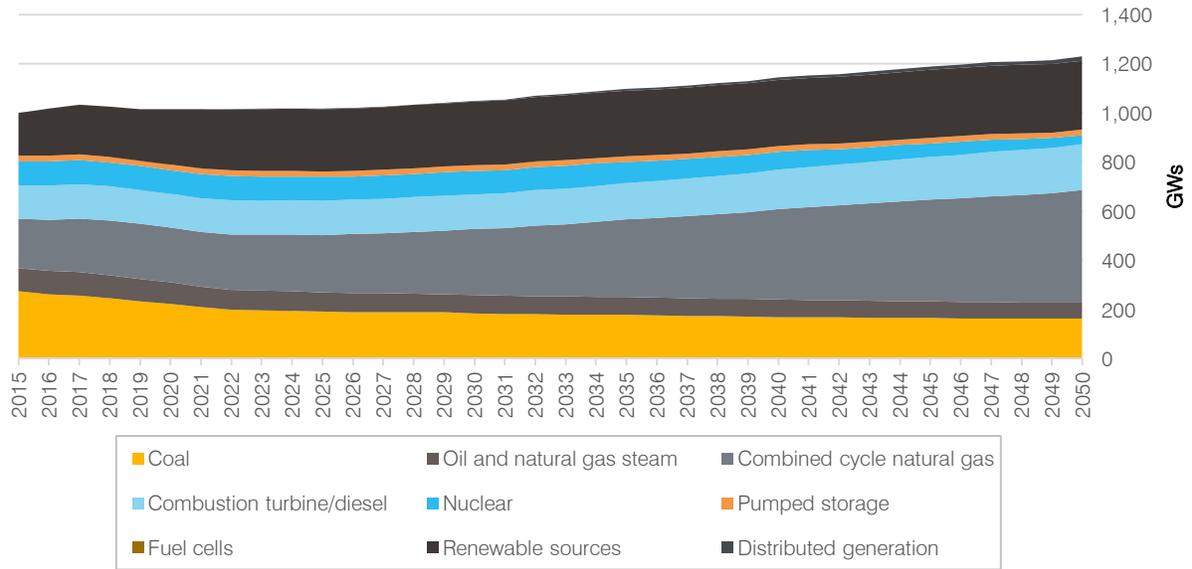
SOURCE: U.S. EIA. January 5, 2017. *Annual Energy Outlook 2017*. Accessed September 8, 2017. <https://www.eia.gov/outlooks/aeo>

Low Oil and Gas Resource and Technology Projection for Electric Capacity, Electric Power Sector, 2015–2050



SOURCE: U.S. EIA. January 5, 2017. *Annual Energy Outlook 2017*. Accessed September 8, 2017. <https://www.eia.gov/outlooks/aeo>

High Resource Without CPP Projection for Electric Capacity, Electric Power Sector, 2015–2050



SOURCE: U.S. EIA. January 5, 2017. *Annual Energy Outlook 2017*. Accessed September 8, 2017. <https://www.eia.gov/outlooks/aeo>



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