BARRIERS TO ADVANCED ENERGY IN MICHIGAN

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INSTITUTE FOR ENERGY INNOVATION

CREDITS

The Institute for Energy Innovation is pleased to issue Barriers to Advanced Energy in Michigan, a new report that serves as the first comprehensive attempt to identify and catalog the many obstacles that impede the adoption of advanced energy technologies and business models in Michigan. By identifying these barriers, understanding why they exist, and determining how they interrelate, Barriers to Advanced Energy in Michigan is intended to help policymakers, communities, business leaders, and investors develop strategies to overcome these barriers and unlock the many benefits of advanced energy for the state.

ABOUT THE INSTITUTE FOR ENERGY INNOVATION

The Institute for Energy Innovation (IEI) is a Michigan not-for-profit organization. Its mission is to promote greater public understanding of advanced energy and its economic potential for Michigan, and to inform the public and policy discussion on Michigan's energy challenges and opportunities.

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EXECUTIVE SUMMARY

The global energy system is undergoing a dramatic transformation. Consumers, for the first time in history, have meaningful choices in how they power, heat and cool their homes and businesses, as well as a broader range of transportation options.

Energy efficiency measures and advanced energy management systems are reducing energy costs at homes and businesses while improved industrial processes are cutting energy intensity. A modernized grid, powered by renewable energy and electric storage and offering customers more control over where they get their energy and how it's used, can dramatically reduce outages, hold electricity prices in check, and offer greater adaptability to accommodate future energy developments. Electric transportation is nearing a market inflection point, and the total cost of ownership for electric vehicles is already below traditional vehicles using internal combustion engines.

In short, advanced energy systems, defined as the "broad range of products and services that constitute the best available technologies for meeting energy needs today and tomorrow,"[1] provide the opportunity to create not just a cleaner, lower carbon energy system, but a better one.

Despite these advantages, the path forward has many potential pitfalls. Utilities that have served society well for nearly a century delivering safe, reliable and affordable power are confronted with sudden and unanticipated challenges. Flat or declining electricity sales, escalating fossil-fuel costs, environmental regulations and aging infrastructure are reducing revenues and putting upward pressure on energy costs just as new energy products, services and business models are increasingly being integrated into wholesale and retail energy markets.

To effectively address these dynamic changes, Michigan market participants and policy leaders must overcome a number of barriers that stand in the way of unlocking the economic benefits of an advanced energy future. Identifying those barriers, understanding why they exist, and determining how they relate to one another will help policymakers, communities, business leaders, and investors develop strategies to surmount these barriers in order to take full advantage of the many benefits of advanced energy deployment.

Some of the most pressing barriers include:

TRANSACTIONAL BARRIERS, including a lack of uniformity in permitting and interconnection and limited use of business models that could accelerate deployment;

ORGANIZATIONAL BARRIERS, including the need to overcome corporate separation between energy managers and financial operations managers, as well as challenges in integrating advanced energy within organizational processes;

ECONOMIC BARRIERS, such as disincentives for new technologies and business models, differences in tax treatment between different technologies, access to capital, and lack of financing for improvements requiring significant up-front capital outlays;

UTILITY BARRIERS, including rate and tariff designs that incentivize the status quo and limit innovation

POLICY BARRIERS, such as statutory limitations on deployment, uncertainty about future requirements, and definitional issues that fail to consider emerging technologies;

TECHNOLOGY BARRIERS relating to the gap between the current state of technology and what's necessary to be cost competitive; and

NETWORK, COMMUNICATION, AND EDUCATIONAL BARRIERS, including a lack of data availability to assist in the development of new business models and limited awareness among the public around the benefits of advanced energy deployment.

Overcoming these barriers is critically important to encouraging advanced energy in three key areas:

- Reducing energy waste in Michigan, including maximizing energy efficiency and improving the energy intensity of Michigan's industrial sector, and the state economy as a whole;
- Modernizing electric generation and delivery, including moving to replace Michigan's aging fleet of coal-fired power plants with cleaner, more cost effective renewable energy and energy storage technologies while improving the reliability of electricity distribution grids; and
- Electrifying transportation, including much broader adoption of electric vehicles, as well as building out the infrastructure necessary to support this transition.

Such a future holds numerous advantages for Michigan. First, as Michigan struggles with electricity prices significantly above the national average and the highest in the Midwest, advanced energy technologies are now cheaper than conventional electricity generation technologies. Conserving energy remains the most economically efficient option available, and in Michigan, as well as many other states, wind energy is now the least expensive generation resource available. Long-term economic trends are shifting significantly in favor of these advanced energy technologies and the economics of "fuelless" renewable energy sources are likely to become even more favorable as innovation, scaling, new materials and advanced manufacturing processes continue to improve performance and reduce costs.

As a result, firms are increasingly investing in advanced energy projects to meet their operational needs. Large energy users are building utility scale wind and solar farms to power energy intensive facilities like data centers and server farms while retailers are finding solar PV systems increasingly cost competitive. In 2013, 60 percent of the Fortune 100 companies – and 43 percent of Fortune 500 firms – had set renewable energy, energy efficiency, and GHG reduction targets.[2] As of April 2014, more than 500 U.S. businesses derived 100 percent of their electricity from clean energy sources, including six based in Michigan.[3]

The combination of these rapid cost declines, advances in technology, growing consumer demand for advanced energy options, and innovations in energy business models, energy finance and policy has resulted in an explosion of renewable energy deployment. The amount of wind energy deployed in the United States tripled between 2008 and 2012, and as President Obama remarked in the 2015 State of the Union address, "every three weeks, we bring online as much solar power as we did in all of 2008". Innovative energy products and services are also being introduced into energy markets in ways that lower energy demand, shift energy loads, improve power quality, strengthen the grid, and store intermittent energy from wind turbines and solar energy.

At the same time, the disruptive effects of climate change from fossil fuels are lending urgency to the need to transition to energy sources with lower carbon profiles. Climate science is stating with greater certainty that unless we substantially reduce global greenhouse gas emissions in the coming decades, future temperatures will exceed 2°C. The recently released National Climate Assessment indicates that climate changes are already apparent in Michigan and that the Great Lakes Region is likely to experience temperature increases well in excess of 2°C by mid-century.

Add to these factors a growing concern over the economic risks of conventional fuels, the looming threat of large-scale stranded economic assets, and national security considerations tied to our current energy mix, and it's clear that the status quo in energy must be transformed.

Fortunately, Michigan is well placed to prosper in a world transitioning from the fossil-fuel based energy sources of the 20th century to the advanced energy technologies that will power the century ahead. Currently, Michigan imports 97 percent of our transportation fuels, 82 percent of our natural gas, and 100 percent of our coal and nuclear fuels,[5] and spends $22.6 billion each year on energy imports.[6]

A transition away from these imported fuels to an energy system built on manufacturing and innovation plays much more favorably to Michigan's strengths in advanced manufacturing, engineering, and materials science, the state's world class universities, colleges and research facilities, and its skilled labor force and training facilities. These strengths position Michigan to lead in producing and deploying the advanced energy technologies that global markets are demanding. Manufacturing related to biomass, energy storage, solar and wind contributes $4.9 billion each year to the Michigan economy,[7] while manufacturing of energy efficiency products adds an additional $2.3 billion in annual economic activity[8] – a total annual economic impact of $7.2 billion from advanced energy manufacturing alone. Opportunities to expand global markets for these Michigan manufactured goods provide real opportunities for the Michigan economy.

Finally, communities across the state are taking the lead in pioneering innovative approaches and developing solutions to unlock advanced energy in Michigan. These include:

- Wind development in Gratiot County, and how proactive zoning and community engagement has helped spur economic benefits for local residents
- The "Battle of the Buildings" competition organized by the West Michigan chapter of the U.S. Green Buildings Council, which has businesses compete to reduce the energy consumption of their buildings
- How the City of Battle Creek partnered with an energy services company to use performance contracting to reduce energy costs
- An innovative energy efficiency loan program organized and administered by the Traverse City Area Chamber of Commerce
- How district energy and combined heat and power are saving both energy and money for Grand Rapids Community College and Oakland University
- A community energy plan developed in the Keweenaw that aims to tackle high energy costs through energy efficiency and distributed electrical generation
- The Michigan Public Service Commission's use of Property Assessed Clean Energy to finance improvements to its new headquarters
- The City of Auburn Hills' Electric Vehicle Ready Project, which aims to use zoning and building codes to encourage EV ownership
- Smart Grid collaborations between the private sector, universities and the federal government, organized by Detroit-based NextEnergy

Learning from these best practices and understanding how local efforts are overcoming the various barriers to advanced energy are key elements in seizing the opportunities that advanced energy can deliver for the state.

Whether it's addressing high energy costs, hedging against long-term price risks, or working to address how global climate change will affect the state, Michigan has much to gain from a transition to advanced energy technologies and much to lose if it fails to take action. An energy system in transformation is latent with both opportunities and challenges.

Notably, while this report focuses primarily on barrier identification and does fully identify solutions, each of the three areas of focus - reducing energy waste, modernizing electric generation and distribution, and electrifying transportation - concludes with a series of recommendations for overcoming the various barriers identified. Some of these recommendations include:

REDUCING ENERGY WASTE It is estimated that 59 percent of primary energy consumed is wasted. Among the recommendations to reduce energy waste:

- Increase Michigan's natural gas and electric energy optimization standard and eliminate the cap on utility expenditures for energy optimization programs.
- Recognize demand response and energy efficiency as energy system resources, allowing full participation in energy markets.
- Expand financing options for energy upgrades, including Property Assessed Clean Energy (PACE), on-bill financing (OBF) and on-bill repayment (OBR) programs, revolving loan funds, credit enhancements, performance contracting, and other tools.

MODERNIZING ELECTRIC GENERATION AND DELIVERY Michigan spends $22.6 billion annually on energy imports. Recommendations to reduce this expenditure include:

- Increasing Michigan's renewable portfolio standard, setting new medium-term and long-term targets for advanced energy at levels equal to leading states.
- Establishing a comprehensive, adaptive process for forecasting Michigan's future electric demand and assessing electric generation technologies taking into account capital, operating and fuel costs, environmental concerns, anticipated regulations, and the adoption of distributed energy resources by utilities and end users.
- Allowing distributed energy resources to compete head-to-head with conventional resources; create a level playing field for all energy resources and energy services by limiting fees and charges associated with interconnection, standby services, load firming, and other administrative costs
- Enabling individuals, businesses and industries that want to obtain a greater share of their energy from renewable energy sources to be able to do so.

ADVANCED ENERGY IN THE TRANSPORTATION SECTOR Electrifying transportation would fortify U.S. national and energy security while taking advantage of Michigan's many strengths in the auto sector, providing opportunities for higher-skilled, better paying jobs in advanced manufacturing. Recommendations include:

- Policies and incentives that accelerate electric vehicle penetration and the availability of electric vehicle supply equipment (EVSE).
- Collaborations between Michigan automobile manufacturers, advanced energy storage companies, and universities and national laboratories to develop next generation energy storage technologies, control systems and power electronics for electric vehicles.
- Support for vehicle to grid (V2G) and vehicle to home (V2H) technologies to integrate electric vehicles into the smart-grid and to provide ancillary services and demand management capabilities.

The intent behind these recommendations - and indeed, behind the report as a whole - is to identify the areas where business innovation, policy intervention, education, and consensus building efforts should be directed.

Ultimately, deployment of advanced energy at scale is critical to Michigan's long-term prosperity and intergenerational equity - providing future generations with a livable, sustainable world. Transforming Michigan's energy system will yield a broad array of economic and other benefits. Optimizing Michigan's legacy strengths, catalyzing innovation, supporting new energy business and financial models, and building consensus on advancing the right policies, are imperatives to move Michigan forward. Removing the roadblocks is the first step.

CHAPTER 1
INTRODUCTION

The global energy system is undergoing a dramatic transformation. Advanced energy systems that produce zero or near-zero carbon are now cost competitive with conventional fossil-fuel based systems, with long-term economic trends shifting significantly in favor of these advanced energy technologies. Innovative energy products and services are being introduced into energy markets that lower energy demand, shift energy loads, improve power quality, strengthen the grid, and store intermittent energy from wind turbines and solar energy.

Energy efficiency measures and advanced energy management systems are reducing energy costs at homes and businesses while improved industrial processes are cutting energy intensity. Electric transportation is nearing a market inflection point. Consumers, for the first time in history, have choices in how they power, heat and cool their homes and businesses.

Despite this progress, the path forward has many potential pitfalls. Utilities that have served society well for nearly a century delivering safe, reliable and affordable power are confronted with sudden and unanticipated challenges. Flat or declining electricity sales, escalating fossil-fuel costs, environmental regulations and aging infrastructure are reducing revenues and putting upward pressure on energy costs just as new energy products, services and business models are competing in wholesale and retail energy markets.

Avoiding risks in energy markets undergoing dynamic changes and making the best decisions on investment and capital expenditures will test both industry executives and energy regulators. Investing in the most cost-effective energy resources for the long-term requires careful evaluation of the forces shaping future trends.

At the same time, the disruptive effects of climate change from fossil fuels are lending urgency to the need to transition to energy sources with lower carbon profiles. Climate science is stating with greater certainty that unless we decarbonize the global economy in the coming decades, future temperatures will exceed 2°C. The recently released National Climate Assessment indicates that climate changes are already apparent in Michigan and that the Great Lakes Region is likely to experience temperature increases well in excess of 2°C by mid-century.

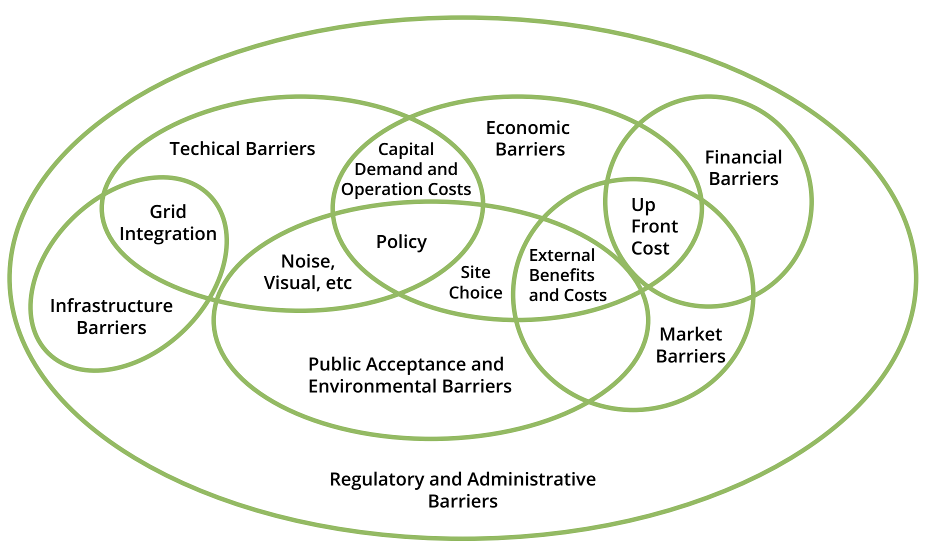
BARRIERS IMPEDING PROGRESS

This report attempts to identify the many barriers that impede the adoption of advanced energy technologies and business models in Michigan. Michigan has much to gain from a transition to advanced energy technologies and much to lose if it fails to take action. An energy system in transformation is latent with both opportunities and challenges.

Michigan's legacy strengths in advanced manufacturing, engineering, and materials science, its world class universities, colleges and research facilities, and its skilled labor force and M-Tech training facilities all position Michigan to lead in producing and deploying the advanced energy technologies that global markets are demanding. Failure to act means surrendering opportunities to other states and nations and slowing the pace of needed change.

As the path forward to an advanced energy economy becomes clearer, the interrelated barriers and impediments are becoming apparent. Identifying these barriers, understanding why they exist and determining how they interrelate will inform strategies to bring down the barriers and move Michigan forward. While technical, economic, and some financial barriers interpose challenges, they are in fact, being met and overcome through innovative policies and new business and financial models.

BARRIERS



Another mosaic of political, institutional and cognitive barriers are more intractable and difficult to overcome. Although this report focuses primarily on barrier identification and does not fully identify solutions, the intent is to help identify the areas where policy intervention, education, and consensus building efforts should be directed.

Ultimately, deployment of advanced energy at scale is critical to Michigan's long-term prosperity and intergenerational equity - providing future generations with a livable, sustainable world. Transforming Michigan's energy system will yield a broad array of economic, health and environmental benefits. Optimizing Michigan's strengths, catalyzing innovation, supporting new energy business and financial models, and building consensus on advancing the right policies are imperatives to move Michigan forward. Removing the roadblocks is the first step.

CHAPTER 2 MICHIGAN'S ENERGY PROFILE TODAY

Michigan is heavily dependent on the importation of fuel supplies to generate electricity, power industry and manufacturing, meet heating and cooling needs, and fuel transportation. Though richly endowed with abundant natural resources, fossil fuels are not among them. Michigan imports 97 percent of our transportation fuels, 82 percent of our natural gas, and 100 percent of our coal and nuclear fuels.[11] In 2009, expenditures for all forms of energy totaled $31.3 billion with $22.6 billion expended for the importation of fossil fuels and electricity from other states and Canada. [10]

According to the Energy Information Agency Michigan ranks 11th among states in total energy consumption and total expenditures for energy, and is 10th among states in the carbon dioxide emissions. [12] But despite it's high use of energy, Michigan ranks 35th in total energy consumed per capita [13] and 37th among states in per capita energy expenditures, averaging $4,000 per person in 2011. [14]

ELECTRICITY

Michigan is in the top quarter of states in electricity production because of the energy intensity of our manufacturing-based economy. With its relatively cool summers Michigan is less reliant on air conditioning, and with the availability of natural gas as a heating source, residential sales of electricity are below the national average. [13] In 2012, the most recent year for which data is available, Michigan ranked 12th among states in the total net production of electricity with a peak load capacity of over 30,000 MW. [16]

As of July 2014, Michigan derived 55.1 percent of its electricity from coal. [17] Michigan's three nuclear power plants (having a total of four reactors) produced 30.7 percent of our net electricity generation. [18] Natural gas provided 7.1 percent of Michigan's net generation, renewables accounted for 6.8 percent and petroleum 0.1 percent. [19]

Peak Generation Capacity
30,332 MW
Annual Net Generation
108.166.078 MWh

Michigan electricity prices are on average higher than other Great Lakes States and the national average, while prior to 2009, Michigan's rates were slightly lower.[20] The current higher rates are attributable to several factors including the loss of load due to recessionary business closures, customers migrating to alternative energy suppliers, and reduced energy usage - all of which have resulted in utility fixed costs having to be spread over fewer sales. [21]

> *From a ratepayer perspective, it is important to note a distinction between electricity and natural gas prices and costs, the latter representing the sum of price times energy usage. This distinction is important in Michigan as residential and commercial ratepayers generally use less electricity for cooling in the summer than Illinois, Indiana and Ohio. As a consequence, even with higher rates, Michigan commercial and residential ratepayers spend less money on electricity overall than ratepayers in these states. On the other hand, Michigan ratepayers use more natural gas for heating in the winter months.*

Consumers Energy and DTE Energy indicate that the total cost of coal has risen 96 percent between 2004 and 2012. Long-term utility contracts for coal were recently renegotiated resulting in higher costs.[22] Transportation costs for coal by rail have risen by 46 percent between 2001 and 2010 - an average annual increase of 4.3 percent.[23] In 2012, Michigan spent $1.918 billion on coal imports [24] with 82 percent of the coal coming from the Powder River Basin. [25]

Electricity Prices in Michigan - August 2014 [26]

Sector	Michigan	Midwest Average [27]	U.S. Average
Residential	14.88 cents/kWh	13.08 cents/kWh	13.01 cents/kWh
Commercial	11.33 cents/kWh	10.05 cents/kWh	11.07 cents/kWh
Industrial	8.04 cents/kWh	7.06 cents/kWh	7.38 cents/kWh

Where Electricity Comes From

Type	Percent of Michigan's Electricity	Percent of U.S. Electricity
Petroleum-Fired	0.10%	0.30%
Natural-Gas-Fired	7.10%	29.60%
Coal-Fired	55.10%	39.00%
Nuclear	30.70%	18.70%
Hydroelectric	1.20%	6.30%
Other Renewables	4.60%	5.40%

Together, DTE Energy and Consumers Power owned 17,522 MW of generating capacity in 2014. Both utilities rely on reserve capacity and purchased power from other generating sources to meet peak demand. [28]

Michigan is served by both the Midcontinent Independent Service Operation (MISO) and the PJM Interconnection that manage regional electric transmission and operate wholesale electricity markets. With Consumers Energy's anticipated retirement of seven coal units comprising 950 MW of generating capacity and the recent decision to switch the 1100 MW New Covert Generating natural gas plant, owned by Tenaska Capital Management, from MISO to PJM, MISO projects a capacity shortfall of 3,000 MW for lower Michigan by 2016. In making this announcement, however, a MISO executive noted that the capacity shortfall was not due to a lack of physical generation capacity, but rather a need for additional contracted capacity, such as a greater emphasis on demand side management.[29]

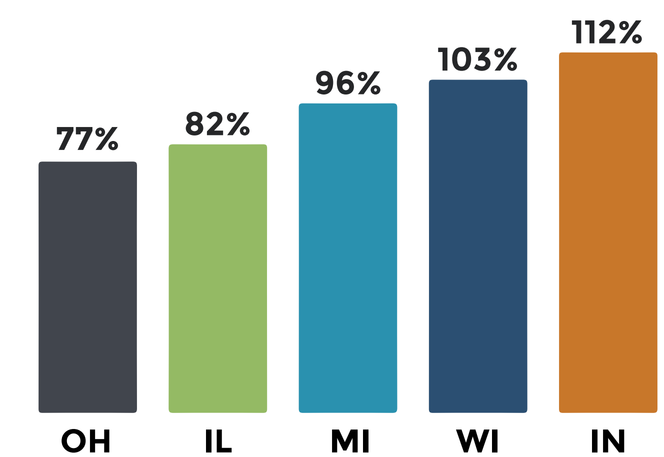
NATURAL GAS

Michigan ranks 17th among states in the production of natural gas at 130 billion cubic feet annually [30], but that represents less than 1 percent of U.S. annual production of 24,000 billion cubic feet. [31] Michigan natural gas production peaked in 1997 at 280 billion cubic feet per year, but declining well productivity reduced production to 141 billion cubic feet by 2010. [32] Michigan has 10,900 active natural gas wells and our natural gas storage fields can store 1.1 trillion cubic feet of natural gas - the highest storage capacity in the nation. [33]

The auction of oil and gas development rights in 2010 yielding $178 million in revenue suggested that natural gas developers believed Michigan's shale gas formations in the northern Lower Peninsula were very promising and would yield substantial economic quantities of natural gas. Exploratory wells appear not to have confirmed these expectations and oil and gas development since 2010 have been less than once anticipated. The Technical Report preliminary to the release of the University of Michigan's Hydraulic Fracturing Michigan Integrated Assessment, states that "it is unlikely that there will be significant growth of the oil and gas industry in Michigan in the near-term future."[34]

DELIVERED COAL COST INCREASES IN GREAT LAKES STATES [33]

2004-2012



Michigan pays less for natural gas than the national average, in part because our capacity to store natural gas allows utilities to purchase supplies in the summer when they are cheaper and balance demand throughout the heating season.

Nearly 80 percent of all homes in Michigan use natural gas for residential heating, ranking Michigan among the top five states in residential use of natural gas. Michigan ranks among the top ten in total overall use, consuming a total of 790 billion cubic feet in 2012 - more than six times Michigan's total annual production. [35] Michigan also consumes the greatest amount of liquefied petroleum gas (LPG) in the United States with 9 percent of Michigan homes heated with propane. [36]

Natural Gas Prices in Michigan – August 2014[37]

Sector	Michigan	Midwest Average[38]	U.S. Average
Residential	$14.57/MCF	$15.43/MCF	$17.39/MCF
Commercial	$10.09/MCF	$10.52/MCF	$9.65/MCF
Industrial	$7.91/MCF	$7.31/MCF	$4.88/MCF

PETROLEUM

In 2012, Michigan consumed 154.9 million barrels of petroleum at a cost of $22.22 billion. [39] Michigan produced approximately 7.7 million barrels of oil representing 0.3 percent of the U.S. annual oil production in 2013. [40] Michigan recently enacted a law that both provides new incentives for enhanced oil recovery through the use of carbon dioxide and provides the right of eminent domain to pipeline companies for the placement of necessary appurtenant infrastructure. [41]

The Marathon refinery in Detroit is Michigan's only oil refinery. It was recently expanded and refurbished to refine diluted bitumen from oil sands. The diluted bitumen is transported through Line 6b owned and operated by Enbridge Incorporated, which suffered a catastrophic failure on July 25, 2010. The Michigan Public Service Commission (MPSC), the state regulator charged with overseeing utilities and oil and gas companies, has since issued an order authorizing the replacement of line 6b with 160 miles of new pipe with capacity of 21 million gal/day.[42]

RENEWABLE ENERGY AND ENERGY OPTIMIZATION

Michigan's Clean, Renewable and Efficient Energy Act of 2008 has resulted in the rapid deployment of renewable energy resources and energy efficiency implementations. By the end of 2014, electric providers and project developers deployed over 1,400 MW of renewable energy, exceeding targeted goals.

The MPSC is required by law to annually evaluate Michigan's renewable energy and energy optimization programs and compare the cost to new conventional coal-fired electric generating facilities. [43] The MPSC reports that since the enactment of Michigan's Clean, Renewable and Efficient Energy Act in 2008, over $2.2 billion has been invested in new renewable energy projects. [44]

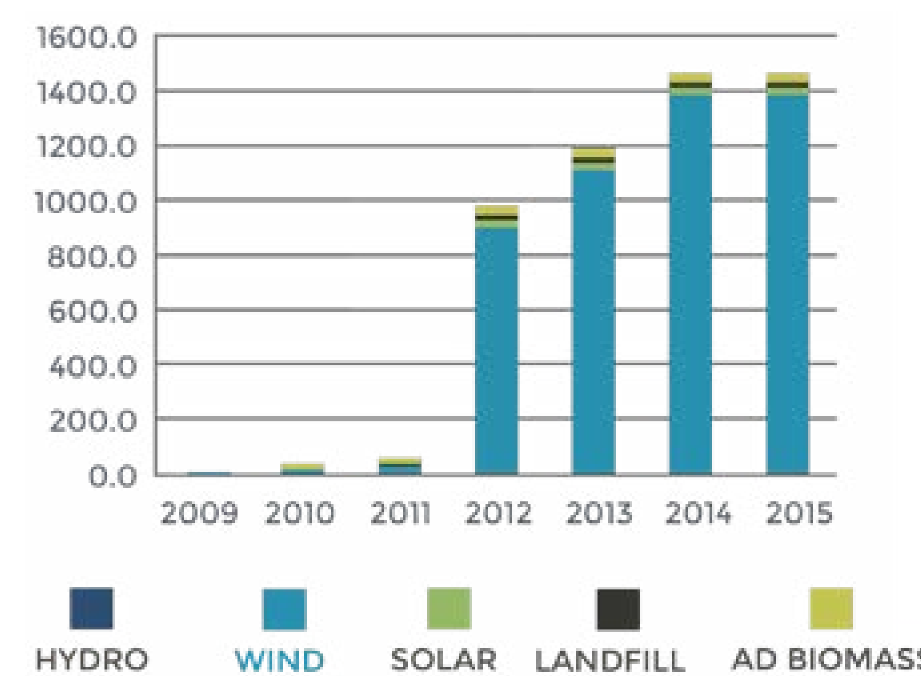
The price of renewable energy has declined rapidly in Michigan and has fallen below the cost of generation of both new coal and natural gas plants. Recently executed contracts for wind energy are less than $50 per MWh [45] and the Lansing Board of Water and Light was able to procure solar energy at $65 per MWh, comparing favorably with DTE and Consumers Energy reporting the "all-in" cost for the conventional mixed supply of fossil fuel, nuclear and purchased electric generation resources are $68 and $74 per MWh, respectively.[45]

The projected cost of electricity from a new coal plant is $133 per MWh according to the MPSC while Consumer's Energy's projected cost is $107 per MWh - both substantially more that the contractual price for renewable energy in Michigan. The recent cost of renewable energy is also at or below the anticipated cost of new combined-cycle natural gas plants. According to the U.S. Energy Information Administration (EIA), the estimated levelized cost of energy (LCOE) for a new combined-cycle natural gas plant entering service in 2019 is $66.30/ MWh, [46] while the MPSC estimates the LCOE at $70.40/ MWh. [47]

The low cost and long-term price stability of wind power also puts downward pressure on electricity prices. Department of Energy data show that for the eleven states having the most wind power electricity prices have come down slightly in the last five years while electricity prices in the remaining 39 states have increased an average of more than 7 percent. [48]

> *"The combined weighted average cost of the companies' energy optimization and renewable energy is $34.06 per MWh, significantly lower than the cost of all types of new fossil fuel generation plants."[54]*
> *- Michigan Public Service Commission*

Cumulative Michigan Renewable Energy Capacity by Commercial Operation Date [51]

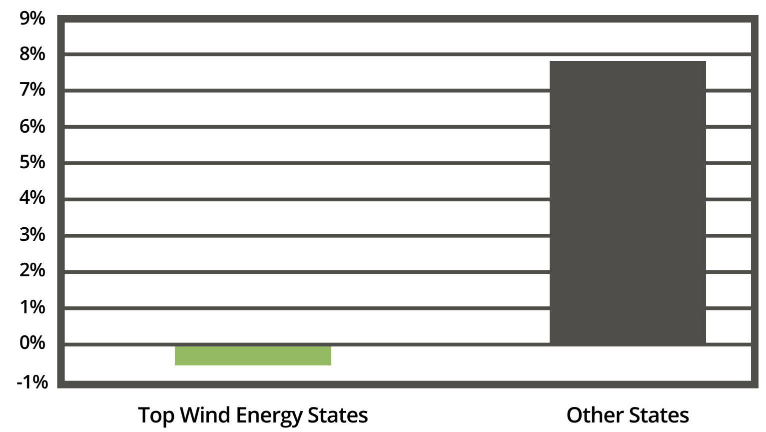


MICHIGAN'S ENERGY PROFILE TODAY

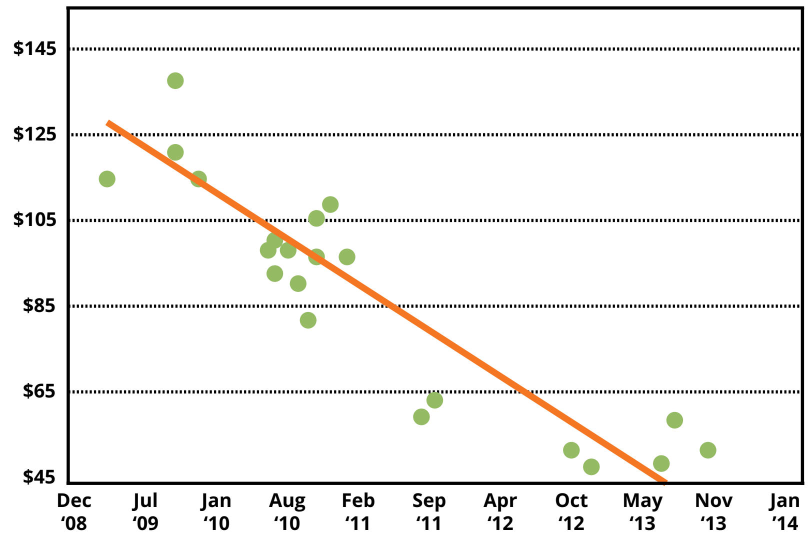
Renewable Energy - Downward Pressure on Wholesale Energy Prices

Numerous studies undertaken have documented the "price suppression effect" of renewable energy. In a nutshell, electric generation resources are bid into regional transmission grids such as the Midcontinent Independent System Operator at their operational marginal cost - mostly the cost of fuel and operational expenses. When fuelless energy sources like wind and solar are bid into the MISO market, these resources displace higher cost generating resources used to meet peak demand. As a result, ratepayers save millions of dollars annually in energy costs.

Price Changes, 2008 - 2013



Levelized Cost of MPSC Approved Renewable Energy Contracts - 2008 – 2013



GREENHOUSE GAS EMISSIONS

Michigan emitted 157.4 million tons of CO_2 from fossil fuel combustion in 2011, down from a high of 197 million tons in 1999. Michigan ranks 10th among states in the amount of CO_2 emissions from the production and use of energy. Michigan CO_2 emissions are higher than the national average in four of the five categories evaluated (electric generation residential, commercial, and transportation), but - interestingly - lower than the national average for the industrial sector.

CO_2 Emissions by Sector – 2011 (millions of tons)[49]

Sector	Michigan	Midwest Average [50]	U.S. Average
Electric Power Generation	69.4	83.6	42.8
Residential	19.5	15.8	6.5
Commercial	9.9	8.8	4.5
Industrial	16.9	27.8	18.2
Transportation	46.0	48.2	35.6
Total	157.4	183.6	107.7

CHAPTER 3

MICHIGAN'S ENERGY PROFILE 2050:

A PRACTICAL ROADMAP FOR EXPANDING ADVANCED ENERGY DEPLOYMENT

Advanced energy holds great potential for Michigan. The term "advanced energy" has been defined as "a broad range of products and services that constitute the best available technologies for meeting energy needs today and tomorrow." [51] These technologies span a range of applications, including energy efficiency, demand response, natural gas electric generation, solar, wind, hydroelectric, nuclear, electric vehicles, biofuels and smart grid. In short, "[i]t's all the innovations that make the energy we use more secure, clean, and affordable."

Advanced energy technologies and new business and financial models provide an opportunity to create not just a cleaner, lower carbon energy system, but a better one.

The feasibility of replacing global energy generation resources, and in some cases transportation fuels, with advanced energy technologies by 2050 has been the subject of numerous U.S. and international studies in recent years. These analyses largely conclude that the barriers to displacing fossil fuels and making moving to advanced energy resources are social and political and not technical or economic.

The Department of Energy (DOE) National Renewable Energy Laboratory's (NREL) four volume analysis of the feasibility of obtaining 80 percent of all electricity in the U.S. from renewable sources concluded that the goal was achievable even with today's technologies. NREL's key findings include:

- "Renewable electricity generation from technologies that are commercially available today, in combination with a more flexible electric system, is more than adequate to supply 80% of total U.S. electricity generation in 2050 while meeting electricity demand on an hourly basis in every region of the country.
- Increased electric system flexibility, needed to enable electricity supply and demand balance with high levels of renewable generation, can come from a portfolio of supply- and demand-side options, including flexible conventional generation, grid storage, new transmission, more responsive loads, and changes in power system operations.
- The abundance and diversity of U.S. renewable energy resources can support multiple combinations of renewable technologies that result in deep reductions in electric sector greenhouse gas emissions and water use." [52]

NREL estimates a range of costs for the energy transition is comparable to published cost estimates of other energy scenarios based upon renewable energy cost data available through 2010 and extrapolated through 2050. [53] The International Energy Agency estimates the cost of deploying advanced energy technologies sufficient to reduce GHG emissions by 50 percent in 2050 would result in savings of $71 trillion in avoided fuel costs over the same period. [54]

The conclusion is clear: the technology exists today to deliver energy that is more reliable, more sustainable, and more affordable than the replacement cost of existing fossil fuel energy infrastructure. In fact, Michigan is approaching a critical juncture: with all of the state's electric generating resources needing to be replaced between today and 2050, Michigan has no choice but to invest in new energy resources as the old technologies reach the end of their serviceable lifetimes. Moreover, near-term reserve capacity shortfalls threaten reliability and must be addressed. Identifying the energy infrastructure that will create the most reliable, resilient, affordable, and environmentally sustainable power system ought to be the consensus goal for policy-makers.

To that end, Governor Rick Snyder outlined a "No Regrets" energy policy for Michigan's future, setting four key objectives that energy policy should strive to attain by 2025. [55]

- Adaptability – energy policy should focus on efficient, achievable goals like reducing energy waste and replacing coal generation with natural gas and renewables.
- Reliability – Michigan's utilities should rank in the top quartile for outages, the top half for duration of outages, and never experience massive outages due to lack of supply.
- Affordability – residential customers should spend less than the national average on electricity and heating and Michigan's rates should be competitive to attract energy intensive industries.
- Protection of the Environment – Michigan's energy supply should reduce mercury, acid gases, and particulate matter by increasing renewable energy resources.

As Michigan replaces obsolete energy resources over the next 35 years, including its immediate efforts to address the projected capacity shortfall, advanced energy can transform the state's energy economy. Integration of advanced energy is inevitable - the only question is how soon Michigan makes the transition.

MICHIGAN'S ENERGY SYSTEM IN 2050: AN ACHIEVABLE VISION OF THE FUTURE

Picture, if you would, electricity from solar, wind, water and thermoelectric technologies powering everything without producing any GHG emissions. Transportation has been electrified for all but heavy trucks and aircraft, and even they are powered by hydrogen fuel made from electrolysis.

Homes and businesses, both old and new, are power plants generating and storing electricity. Building envelopes - exterior walls, roofs and fenestration - produce electricity and store it for later use in a household appliance smaller than today's refrigerator.

Energy management is intrinsic to every environment. An electric "internet of things" interconnects, optimizes and harmonizes living spaces, offices, appliances, vehicles and devices in a robust, environmentally benign, and inconspicuous energy ecosystem.

The utility of 2050 is to energy what Google today is to information: responsible for a portfolio of services that seamlessly integrate energy technologies with smartgrid architectures, ensuring that customers are provided efficient and cost-effective energy choices. Utilities have achieved failsafe system reliability, resiliency and security through automatic controls that diagnose and repair system faults and weaknesses without any service interruption or even the suggestion that anything is amiss.

Carbon dioxide and other greenhouse gases are stabilized with the international community focused on removing and sequestering GHGs from the biosphere.

FACTORS DRIVING ADVANCED ENERGY DEPLOYMENT

Making this vision a reality is an imperative, and requires integration of advanced energy at scale. Fortunately, the opportunity to construct a better energy delivery system is being aided by

- Rapid declines in the cost of advanced energy resources
- Growing demand for advanced energy
- Technology improvements
- Growing concern over global climate change
- National security considerations

Building a new energy delivery system can spur economic development, optimizing Michigan's participation in the large and growing global advanced energy markets, an opportunity that aligns exceptionally well with Michigan's traditional strengths in manufacturing and research and development of new technologies.

> "Renewable energy has more than tripled over the last ten years"

DECLINING COSTS OF ADVANCED ENERGY

The advanced energy sector has seen rapid cost declines, particularly over the past decade, making a number of generation technologies cost competitive with traditional energy sources.

In its recent report on the state of the global industry, Advanced Energy Economy found that the global advanced energy sectors were a $1.1 trillion industry – larger than pharmaceutical manufacturing or global trucking.

The share of the U.S. power mix being met with renewable energy has more than tripled over the last ten years, with the amount of wind energy deployed in the United States tripling between 2008 and 2012 alone. [56]

Reducing energy costs starts with energy efficiency, as a kilowatt of energy efficiency is always less expensive than generating a kilowatt of electricity. [57] The Michigan Public Service Commission has determined that the weighted average cost of energy conserved through Michigan's Energy Optimization Program is $10.97 per MWh. This compares with the cost of electricity from a new coal-fired power plant, which the MPSC estimates at $133/ MWh or the output of a new combined-cycle natural gas plant, which is projected to cost between $66-70/ MWh. If the cost of energy efficiency is combined with the cost of renewable energy, the average cost of energy saved from efficiency measures together with renewable energy is $34.06 MWh. [58]

In Michigan, as well as many other states, wind energy is now the least expensive energy resource available. The economics of "fuelless" renewable energy sources are likely to become more favorable as innovation, scaling, new materials and advanced manufacturing processes continue to improve performance and reduce costs.

The amount of solar energy installed in the U.S. increased by a factor of 10 between 2008 and 2012 – from 735 MW to over 7,200 MW. [59] and at the close of the 3rd quarter of 2014, the U.S. has deployed 16,100 MW of solar energy. During the same period, the cost of solar modules fell 80 percent. [60]

Michigan has cumulatively deployed approximately 25 MW of solar energy through the same period, representing less than ¼ of one percent of the amount of solar deployed nationally.

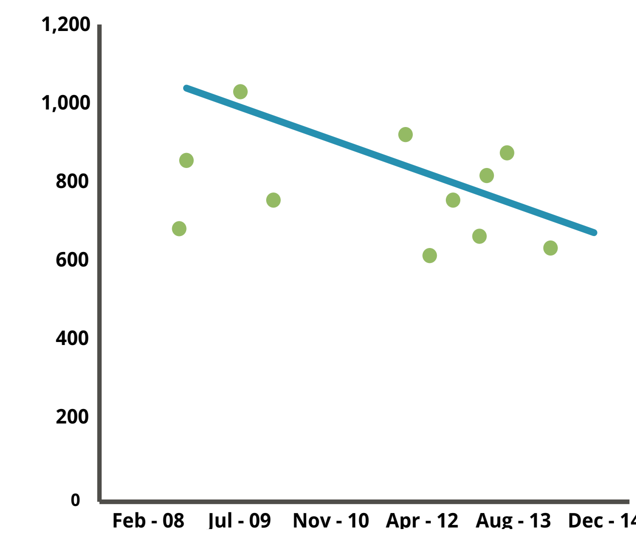
Over 600,000 U.S. homes and businesses have solar installations in 2014 with the number expected to reach 1 million in 2015. Distributed solar PV is already at retail grid parity for 16 percent of the U.S. electricity market [61] and unsubsidized solar is expected to be at grid parity in all but the least expensive retail markets by 2020. [62]

Costs for battery storage are also declining rapidly, and analysts predict further declines over the next several years. McKinsey & Company forecasts the cost of lithium-ion batteries will fall to $200 per kWh in 2020 and $160 per kWh by 2025. [63] A recent announcement from Ann Arbor-based Sakti3 suggests their solid state battery technology may soon be able to produce batteries with substantially higher energy density than today's lithium-ion chemistries, delivering battery storage at $100/ kWh. [64]

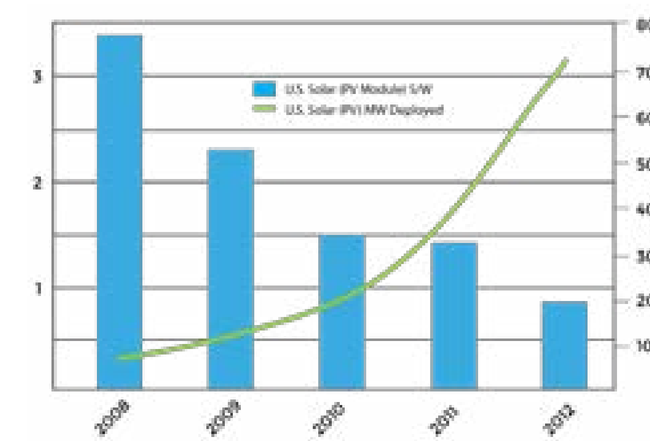
Cost Effectiveness of Energy Optimization and Renewable Energy Standards

Energy Optimization Cost of Conserved Energy Weighted Average ($/MWh)	$10.97
Renewable Energy Weighted Average Cost ($/MWh)	$78.39
Combined Weighted Average Cost of Energy Optimization and Renewable Energy (($/MWh)	$34.06

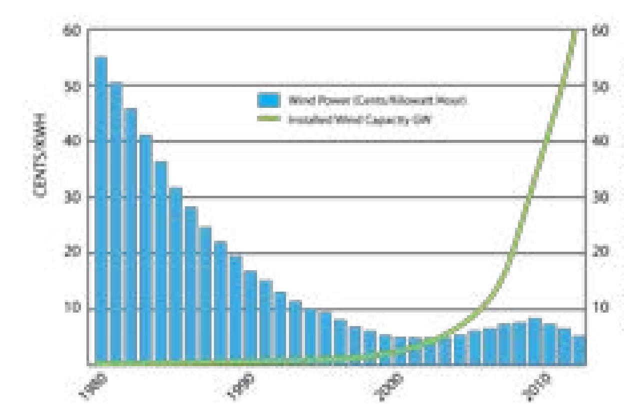
Industry Estimates for Battery Cost in 2013-14



US Deployment and Cost for Solar PV Modules
2008-2012



Deployment and Cost for U.S. Land-Based Wind
2008-2012

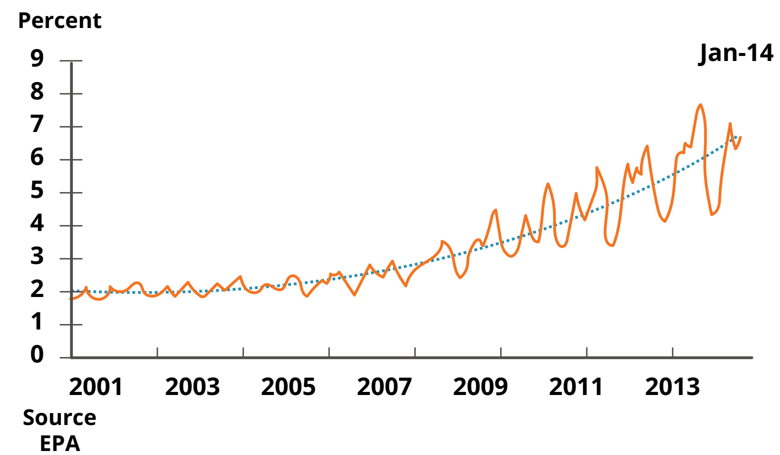


GROWING CUSTOMER DEMAND FOR ADVANCED ENERGY SOLUTIONS

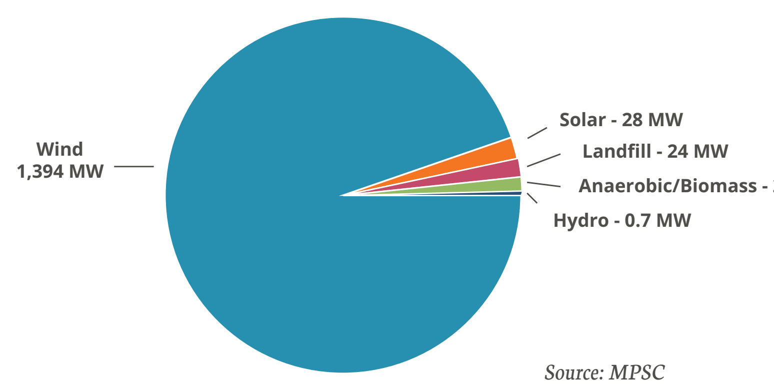
Deployment of advanced energy is growing rapidly. For the two-year period ending December 31, 2013, renewable energy sources accounted for more than 56 percent of all net additions to global power capacity [65] and 47.38% of all new generation capacity placed in-service (20,809 MW) in the United States.[82] Wind accounted for 41 percent of all new generating capacity in 2012 while solar energy accounted for 29 percent of all new generating capacity in 2013.[66] In 2012 - 2013, wind energy projects added 14,215 MW to the grid [68] while solar energy projects added 8,064 MW. [69]

In the last four years, all of the new electric generation capacity added in Michigan has been renewable energy. New wind projects comprised almost 95 percent of the added capacity while solar accounted for nearly 2 percent. The renewable energy has been integrated into Michigan's power grid without any impact on overall reliability of the power system.

Monthly Share of Non-Hydro Renewable Net Power Generation



New Electric Generation Capacity in Michigan Since 2009



Source: MPSC

Businesses are also increasingly investing in advanced energy projects to meet their operational needs. Large energy users are building utility scale wind and solar farms to power energy intensive facilities like data centers and server farms while retailers are finding solar PV systems increasingly cost competitive. In 2013, 60 percent of the Fortune 100 companies – and 43 percent of Fortune 500 firms – have set renewable energy, energy efficiency, and GHG reduction targets. In 2014, more than 500 U.S. businesses derived 100 percent of their electricity from clean energy sources, including six from Michigan. [70]

Twelve Fortune 500 companies recently issued the Corporate Renewable Energy Buyers' Principles: Increasing Access to Renewable Energy aimed at accessing greater quantities of renewable energy at more competitive prices than those offered under the current system. [71] The list of initial signatories to the Buyers' Principles includes Bloomberg, Facebook, General Motors, Hewlett-Packard, Intel, Johnson & Johnson, Mars, Novelis, Procter & Gamble, REI, Sprint and Walmart.

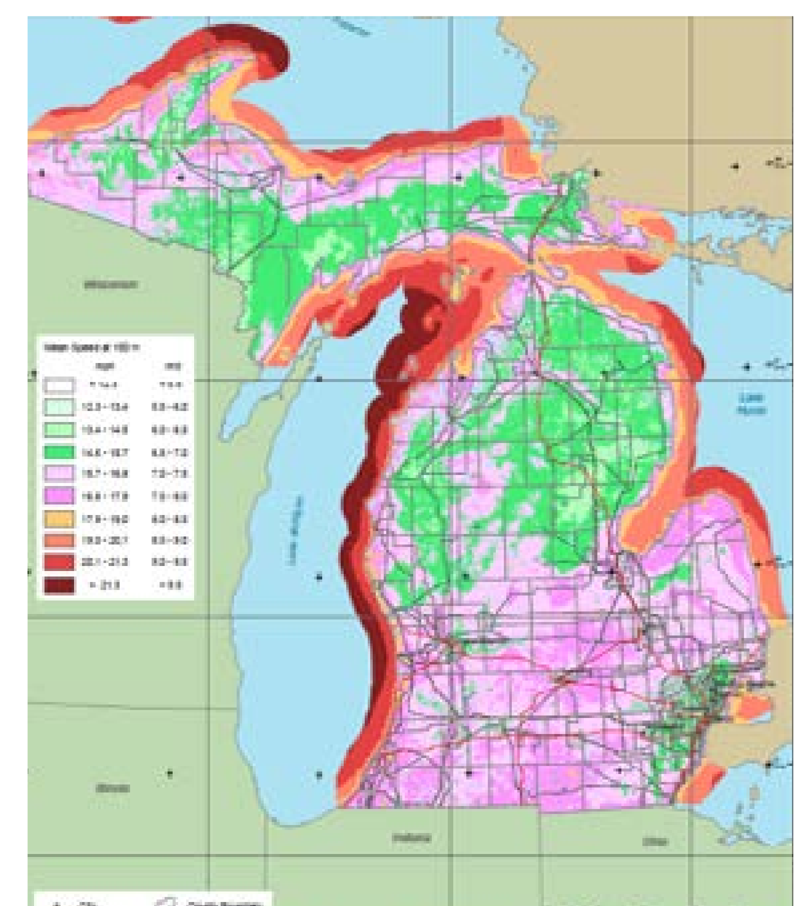
TECHNOLOGICAL PROGRESS IN ADVANCED ENERGY

Innovation and rapid advances in technology and new energy products and services are redefining energy markets. Technological advances in inverters, microinverters and power electronics are improving performance as well as power quality, facilitating the integration of variable energy resources like wind and solar into the power grid. Automated control systems, sensors and diagnostic systems, optimized by data analytics, can reliably and efficiently integrate distributed energy resources while enhancing grid resiliency and security. Demand management and load balancing technologies can more efficiently match supply and demand, reducing costs to ratepayers. Microgrids capable of supplying power in the face of natural disasters can power critical infrastructure like hospitals and emergency services as well as government and university campuses.

Improvements in turbine technology – larger rotors and taller towers - have dramatically increased the economic efficiency of wind energy projects. Since 1999, the average amount of wind energy produced per turbine has increased 260 percent.[72] The result is that most of the agricultural land in the central and southern Lower Peninsula can produce economical quantities of wind energy.

Innovation in materials and manufacturing processes are enhancing the efficiency of solar cells and solar modules. Racking systems and tracking technologies are boosting system performance while lowering the capital cost of producing energy. Breakthroughs like these – combined with innovations in business models like the third-party ownership of residential solar systems that is transforming the economics of solar energy – are spurring greater demand for and interest in advanced energy in Michigan.

Advancements in energy storage technologies have the potential of better integrating and harmonizing variable energy resources like wind and solar in to the grid, reducing peak demand, and smoothing loads while providing a host of other beneficial services. As a means of meeting peak demand, energy storage may soon be more economical than combustion turbines. Energy storage is also the key to electrifying transportation and reducing greenhouse gas emissions.



A Michigan-based solid state battery company, Sakti3, recently announced it could produce battery cells on a fully scalable manufacturing platform with over 1100 Watt hours per liter (Wh/l) in volumetric energy density, which would dramatically reduce the cost and increase the range of electric vehicles.

Other energy innovations promise fundamental changes to the energy system. Smart energy management technologies that save energy and building-integrated energy technologies that self-generate power are increasingly being incorporated into building designs. Building codes are becoming more rigorous and moving toward zero net energy (ZNE) design where structures essentially become power plants capable of meeting some or all of internal energy demand.

THE IMPERATIVE OF ADDRESSING CLIMATE CHANGE

Scientific evidence is mounting that human activities are causing systemic changes in the climate with the potential for profound social, economic, environmental and geopolitical consequences. Global warming is already affecting agriculture and food production, finance and insurance markets, transportation, infrastructure, health care and real estate. Because the alteration of the atmosphere has already been set in motion, the effects evident today will be amplified tomorrow, underscoring the need for both mitigation and adaptation strategies.

The Fifth Assessment Report (AR5) by the Intergovernmental Panel on Climate Change (IPCC) released in March 2014, states unequivocally that “[h]uman interference with the climate system is occurring, and climate change poses risks for human and natural systems.” [73] The IPCC identified the climate impacts that are already occurring, the further impacts that can be reasonably drawn from climate science, and the mitigation and adaptation measures that must be undertaken to avoid the most catastrophic long-term effects. The IPCC makes a clear distinction between climate variability, which may be attributable to natural causes, and human induced changes to the composition of the atmosphere:

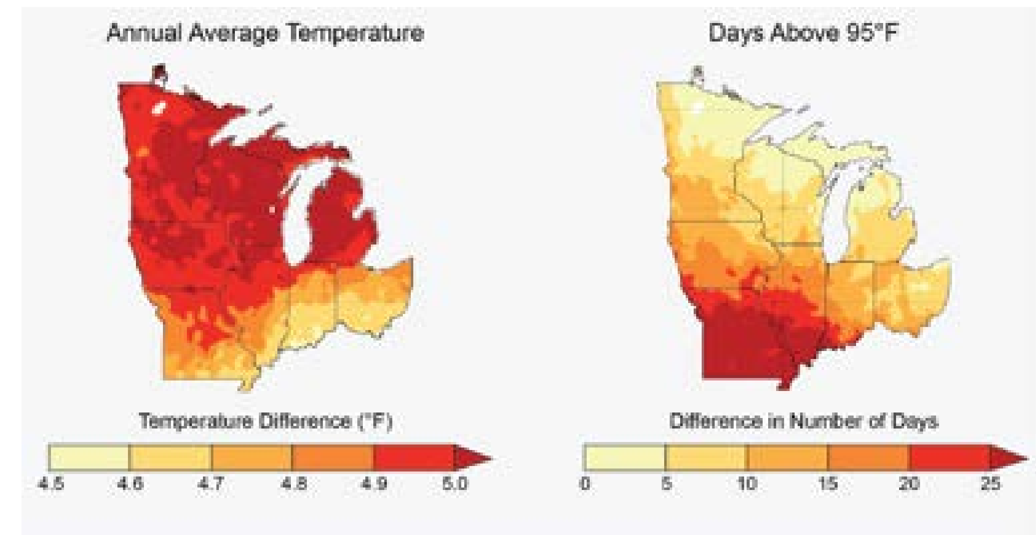
> *Continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system. Limiting climate change will require substantial and sustained reductions of greenhouse gas emissions. - Intergovernmental Panel on Climate Change* [74]

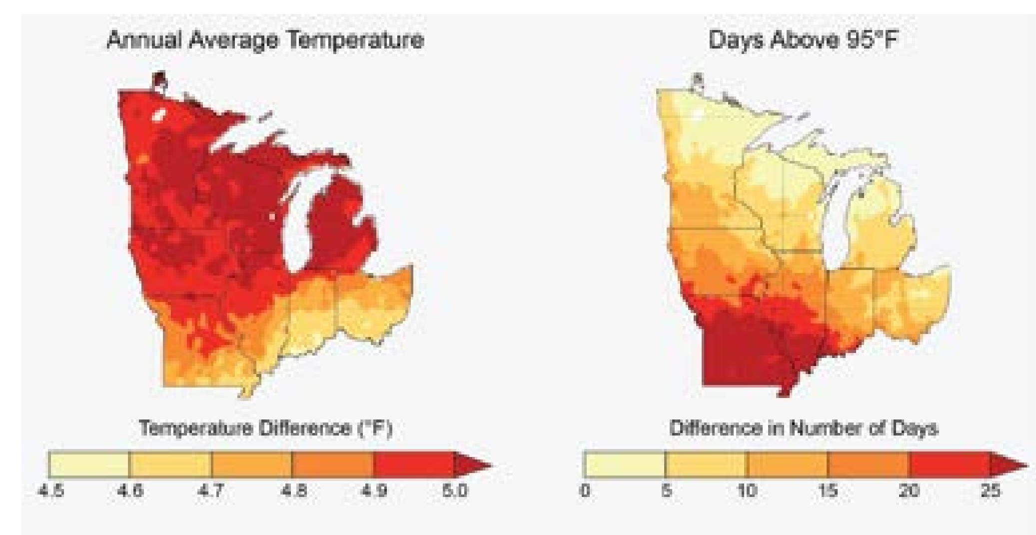
PROJECTED CLIMATE IMPACTS TO MICHIGAN

With a similar mission as the IPCC, the United States Global Change Research Program issues periodic National Climate Assessments (NCA) as required by the federal Global Change Research Act. [75] The forecast for the Midwest indicates that by mid-century, expected temperatures increases will range from approximately 3.8˚F for a scenario with substantial emissions reductions to 4.9˚F for the current business-as-usual (BAU) high emissions case. The projections for the end of the century are approximately 5.6˚F for the low emission scenario and 8.5˚F for the BAU case. [75]

MICHIGAN'S ENERGY PROFILE 2050

INCREASING TEMPERATURES BY MID-CENTURY (2041 - 2070) AS COMPARED TO 1971-2000





> *As a result, scientists predict that by the end of the century Michigan’s climate may look more like Oklahoma’s. Further, the effects of global warming are not necessarily linear; temperature increases can trigger feedback mechanisms that can accelerate and intensify impacts as we have seen in the arctic with recent summer ice minimums.*

Global warming is already affecting the Midwest Region and the Great Lakes. Between 1980 and 2010,[76] temperatures have increased three times as fast as they did during the overall period spanning from 1900 to 2010. Summer average surface water temperatures have increased 5.2°F in Lake Huron, 4.5°F in Lake Superior, and 2.7°F in Lake Ontario between 1968 and 2002. [77]

> *"Higher temperatures, increases in precipitation, and lengthened growing seasons favor production of blue-green and toxic algae that can harm fish, impair water quality, affect habitats and aesthetics, and could heighten the impact of invasive species already present." NCA*

The NCA projects that Michigan and other areas of the Midwest can expect a significant array of future impacts from climate changes. While some changes - like a prolonged growing season - may be beneficial, the predicted impacts are overwhelmingly negative. Yields for corn and soybean crops are expected to decline. Indigenous tree species will be lost as they shift to northern latitudes. Higher temperatures will bring negative health impacts with heat related stress, the potential for degraded air quality, and the amplification of allergenic pollens and disease vectors attributable to vermin and insects.[78]

Precipitation is expected to increase regionally but with greater potential for extreme weather events. The NCA projects that 40 percent of annual precipitation would occur, on average, during 10 days of the year, with flooding damaging infrastructure, increasing combined sewer overflow events, and more erosion and nutrient loadings to lakes and streams.[79]

Although less ice in the Great Lakes will extend the commercial shipping season, there may be a concomitant increase in the potential for accelerating the introduction of invasive species, declining beach health and harmful algae blooms. The NCA finds that the net effect of increased rainfall and evaporation is uncertain as to the long-term impacts of climate change on Great Lakes water levels.[80]

Reducing the risks presented by these predicted impacts requires mitigation and adaptation strategies that reduce the amount of carbon into the atmosphere. The NCA states:

> *Achieving the [low emission scenario] path would require substantial decarbonization of the global economy by century's end, implying a fundamental transformation of the global energy system.* [81]

The essential agreement of the NCA, the IPCC and the abundant multi-disciplinary science is that future global warming should be limited to below 2.0 °C (3.6 °F) relative to the pre-industrial level in order to prevent destabilizing and potentially catastrophic consequences. [82] A minimum 80 percent reduction in GHGs in developed countries by 2050 is widely recognized as the level that must be achieved to meaningfully mitigate the risks of global warming. [83]

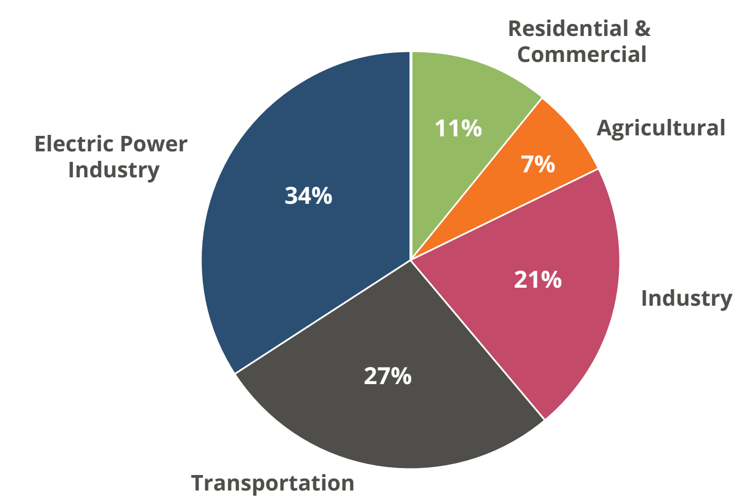
THE PATH FORWARD

The Copenhagen Accord, negotiated by the United States in 2009, states that "climate change is one of the greatest challenges of our time." [84] Following Copenhagen, President Obama affirmed the commitment of the United States by announcing a target goal of reducing greenhouse gas emissions (GHG) 83 percent by 2050. Many states have adopted similar targets. Of the 20 states that have GHG emission standards or goals, 15 have reduction targets of at least 75 percent by 2050.[85] Michigan's Climate Action Plan, released in 2009, also set a goal of reducing Michigan's GHG emissions to 80 percent below 2005 levels by 2050.[86] In July 2009, Governor Jennifer Granholm issued Executive Directive 2009-4 to effectuate the plan. [87]

More recently, President Obama announced a national Climate Action Plan calling for strict carbon reductions from the power generation sectors and accelerated adoption of advanced energy technologies.[88] Most recently, the US EPA proposed new regulations for new and existing power that would reduce carbon pollution by 30 percent by 2030.[89] The new climate accord reached by the United States and China may drive GHG reduction targets further.

These ambitious global, federal, and state emission reduction goals are rendered more challenging in light of future energy needs. If current trends continue, global energy consumption is expected to almost double from 2009 levels by 2050.[90] In developing economies, 1.4 billion people await the delivery of the energy systems that will provide basic electric service—the key to addressing endemic poverty and advancing nation building efforts.[91] While energy consumption is stabilizing in the United States and other developed countries, energy demand will continue to grow in the developing world. The BAU forecast from the IEA projects global energy demand growing 70 percent by 2050 with temperatures increasing 6°C.[92]

U.S. Greenhouse Gas Emissions by Sector 2010



Michigan is, therefore, faced with a most formidable challenge: On one hand, it must reduce GHG emissions 80 percent by 2050 to achieve climate stabilization goals. On the other hand, energy demand will double by 2050 as developing countries are electrified and underserved countries experience significant demand growth. Adequate resources must also be available to ensure affordable, reliable energy supplies to accommodate future population and economic growth within the United States.

Scaling deployment of advanced energy technologies and business models in Michigan is essential to meeting its goals in the electric power sector. Deployment of zero-carbon energy systems must largely replace fossil fuel-based generation as the existing infrastructure reaches retirement or is no longer compliant with existing or foreseeable regulations. In order to meet long-term greenhouse gas emission targets, Michigan must dramatically reduce emissions from its transportation and industrial sectors as well.

NATIONAL SECURITY CONSIDERATIONS

Advanced energy technologies also provide opportunities to improve the United States' national security by reducing energy-related geopolitical tensions and, by providing other energy options and thereby lowering the global oil price, depriving hostile regimes of much-needed financial resources to wreak havoc. In addition, in a 2008 report entitled More Fight-Less Fuel the Department of Defense's Defense Science Board called on the military to address energy challenges including the supply chains necessary to provide fuel in U.S. combat operations and the need to insulate U.S. military bases from the nation's aging commercial electrical grid. [93]

The national security advantages of greater deployment of advanced energy are numerous: reducing the source of conflicts; depriving bad actors, rogue actors, and hostile nations from financial resources tied to traditional energy sources; protecting troops in combat operations by shortening supply chains and distributed generation; and enhancing the military readiness of troops being trained on U.S. bases through more resilient energy options.

Camp Grayling is on track to be first net-zero military base in the U.S. "It sounds like we're hugging trees, but everything we're doing makes good business sense," said Brig. Gen. Stone, an attorney who served as military police in Iraq. "It makes good business sense to be energy independent." [94]

AVOIDANCE AND MITIGATION OF ENERGY RISK FACTORS

The emerging structural changes in the energy related sectors of our economy were not anticipated. Very few, if any, experts foresaw the shale gas revolution and the impact low cost natural gas would have on wholesale markets. EIA projections regarding energy resources have changed dramatically over time: in 2006, the EIA projected that the United States would need 174 GW of new electric generation capacity from coal-powered plants by 2030; [95] presently EIA forecasts only 10 GW of new coal-powered generation capacity through 2040. [96]

Forecasting future trends for energy resources have proved difficult. Fresh Energy's examination of EIA's and IEA's past predictions of future growth of energy sectors indicates that the amount of renewable energy has been consistently underestimated while future amounts of some fossil fuel based energy supplies have been overestimated. [97]

- In 2000, the International Energy Agency (IEA) published its World Energy Outlook, predicting that non-hydro renewable energy would comprise 2.3 percent of global energy by 2020. That benchmark was reached in 2008.
- In 2000, IEA projected that there would be 30 gigawatts of wind power worldwide by 2010, but the estimate was off by a factor of 7. Wind power produced 200 gigawatts in 2010, an investment of approximately $400 billion.
- In 1999, the U.S. Department of Energy estimated that total U.S. wind power capacity could reach 10 gigawatts by 2010. The country reached that amount in 2006 and quadrupled between 2006 and 2010.
- In 2000, the European Wind Energy Association predicted Europe would have 50 gigawatts of wind by 2010 and boosted that estimate to 75 two years later. Actually, 84 gigawatts of wind power were feeding into the European electric grid by 2012.
- In 2000, IEA estimated that China would have 2 gigawatts of wind power installed by 2010. China reached 45 gigawatts by the end of 2010. The IEA projected that China wind power in 2020 would be 3.7 gigawatts, but most projections now exceed 150 gigawatts, or 40 times more.

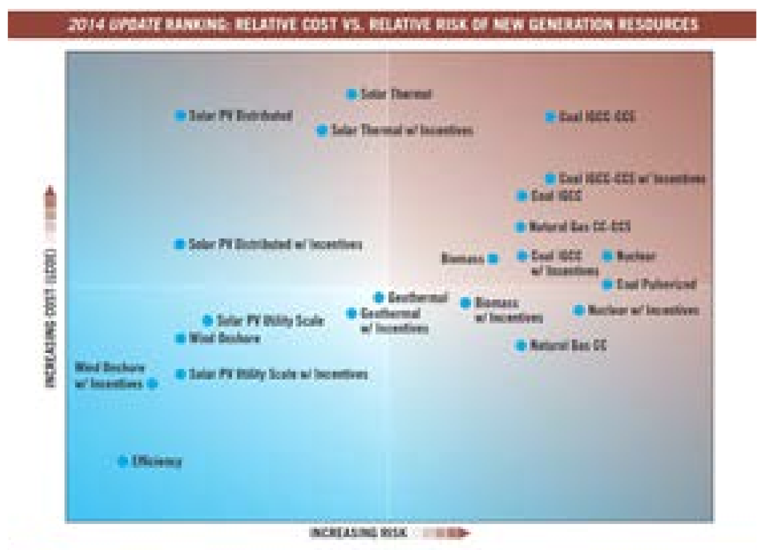
UTILITIES FACING MULTIPLE CHALLENGES

The sea changes evident in energy markets make it difficult for utilities to plan for long-term investments in new energy infrastructure. Never before have energy providers had to navigate so many variables in planning to meet their customers' future energy needs and the expectations of shareholders. Today, prudency requires a careful assessment of a number of risk factors, including:

- Flat or reduced load growth from energy efficiency and conservation
- Market trends toward more distributed generation and self-generation further reducing sales
- Increasing carbon sensitivity by business and industry
- Reserve capacity shortfalls projected by the Midcontinent Independent Service Operator
- Penetration of new energy technologies, new energy services and demand management technologies that smooth and shift loads
- Competition from third-party energy service providers
- Shifting relative cost of energy resources as renewable energy resources become cheaper while fossil fuel plants are increasingly expensive
- Revenue erosion as peak generation assets run less as peak demand is reduced
- Stricter environmental controls and new regulations for fossil fuel generation facilities
- The potential for future price volatility for fossil fuels and fuel transport
- Engineering, deploying and managing smart-grid technologies to integrate distributed energy resources
- Costs associated with maintaining grid security as thousands of new interconnection points to integrate distributed generation sources provide new openings for hackers and spies
- Better accounting of negative health and environmental externalities of fossil fuels
- Maintaining investor confidence in light of a thirty-year, industry-wide decline in the credit worthiness of the utility sector
- Urgency to address GHG emissions and climate destabilization

Balancing these considerations to make smart decisions in allocating capital and minimizing investment risk will test utility executives, regulators and policy-makers. Responding appropriately to these forces while maintaining reliable and affordable energy supplies is the critical challenge facing our energy providers.

As utilities make long-term investments in energy resources like power plants and other infrastructure that transport, store or process fossil fuels, their customers as well as regulators, shareholders and market analysts will expect that such investments are both reasonable and prudent. Anticipating and assessing the risk that fossil fuel-based investments may be affected by the need to respond to stricter regulatory schemes, carbon taxes, or the exigencies of climate change, must be part of the calculus for both energy providers and regulators. In the worst case, investments in fossil fuel plants may be stranded if they cannot operate for their full expected lifecycles.



The reserve capacity shortfall presents a near-term opportunity for new approaches. Rather than investing in fossil fuel peak generation plants that will be expensive to operate on a limited basis (in many cases, less than 400 hours per year), utilities could choose to pursue demand management strategies and integrate distributed energy resources to provide more elastic capacity and other quantitative benefits including load shaping, load shifting, reactive power control and other energy services while integrating variable renewable energy resources.

Utilities and energy companies face increasing scrutiny from shareholders and market analysts concerned with risk energy providers face from new technologies, future regulatory constraints and other forces shaping energy markets. Barclays recently downgraded the entire U.S. investor-owned utility sector, citing near-term risks from "utilities falling behind the solar plus storage adoption curve." [98]

The Securities and Exchange Commission requires disclosure of material risks and has recently issued interpretive guidance to aid in the disclosure of climate related risks. [99] Energy companies are being compelled to assess and disclose the risks of having to abandon fossil fuel reserves due to the urgency of climate disruption.

Meanwhile, pension funds and university endowments are under growing pressure to divest stock in fossil fuel-based companies, and this divesture movement is now the fastest growing divestiture movement in history. [100] Market strategies aimed at combating climate change are gaining ground. The Ceres Investor Network on Climate Risk (INCR), a network of 100 institutional investors representing more than $11 trillion in assets, is focused on managing the future risks to investor portfolios posed by climate change and identifying market opportunities to benefit from the mitigation of climate threats. [101]

HARNESSING NEW ECONOMIC DEVELOPMENT OPPORTUNITIES FOR MICHIGAN BUSINESSES

The pace of change - the speed of adoption of advanced energy is critically important. Much is at stake, particularly for a state like Michigan, where strengths and unique capacities in advanced manufacturing provide it with a disproportionate opportunity to participate in expanding global advanced energy markets. Michigan's automobile industry has provided a legacy of more than 300 research and development laboratories, superb engineering prowess, and leadership in materials science that translate well to the design, manufacturing and production of advanced energy technologies. Emerging from the recent recession with innovative products and renewed strengths, the industries and technology companies supporting the automobile industry have adaptive capabilities that provide advantages in penetrating the advanced energy sectors.

Advanced energy also supports Michigan manufacturing. Advanced energy manufacturing in Michigan is already a $4.9 billion industry. [102] Energy efficiency manufacturing adds another $2.3 billion annually, for a total annual economic impact to the state of $7.2 billion. [103]

The current emphasis by business, government and academia on advanced manufacturing, nanomaterials, and next-generation industrial processes could catalyze Michigan's innate strengths, providing opportunities for Michigan's energy technology companies to thrive. Significant benefits could be realized if the state made a serious, strategic effort at aligning our latent strengths in manufacturing and engineering with the evolving opportunities in advanced energy technology sectors.

> *"There is a clear and durable imperative for clean energy in the U.S., driven by advancing technology, federal air quality rules and the lower cost and risk profile of renewable and demand-side energy resources." - Ceres*

Michigan is already benefiting from the nexus of traditional economic strengths and forward looking policy. In a $1.1 trillion (and growing) global market, the economic opportunity for the state is immense. Michigan has not only the opportunity to create a modern energy ecosystem at home, it has to capacity to collar global energy markets as well.

INTEGRATING ADVANCED ENERGY IN MICHIGAN

Whether driven by cost declines, economic opportunities, or concerns over climate change, Michigan is well placed to take advantage of the transition to an advanced energy future.

Making the most of this opportunity, however, requires a strategy to harness the economic and other benefits connected with changing the way Michigan generates, uses, manages, and conserves energy. Such a strategy should focus on three key areas:

REDUCING ENERGY WASTE IN MICHIGAN, including maximizing energy efficiency and improving the energy intensity of Michigan's industrial sector, and the state economy as a whole;

MODERNIZING ELECTRIC GENERATION AND DELIVERY, including moving to replace Michigan's aging fleet of coal-fired power plants with cleaner, more cost effective renewable energy and energy storage technologies while improving the reliability of electricity distribution grids; and

ELECTRIFYING TRANSPORTATION, including much broader adoption of electric vehicles, as well as building out the infrastructure necessary to support this transition.

REDUCING ENERGY WASTE

Integrating advanced energy technologies, processes, and business models to reduce energy waste is the most cost-effective, least expensive and most readily available means to reduce energy usage and the cost of energy. Many energy efficiency measures like efficient lighting or insulation can be implemented simply, quickly, and - at the residential level- by homeowners themselves.

In addition to reducing energy costs, energy efficiency and energy conservation reduce energy demand, lowering the overall amount of energy needed. The National Academy of Sciences has determined that cost-effective energy efficiency measures alone could reduce energy demand in the United States by 22.6 % by 2020 and 35.8% by 2030.

Unlocking the potential associated with reduced energy waste, however, requires overcoming a number of barriers that frustrate efforts to improve the energy efficiency of Michigan homes and businesses. Some of these barriers are economic: many energy efficiency measures require high up-front expenditures, making it difficult to finance even the most cost-effective energy improvements. Others are organizational, such as the disconnect that too often occurs between the energy managers and facility operators responsible for managing a business's energy consumption and those corporate executives responsible for overseeing the overall financial health of the enterprise. This disconnect can serve to delay and even stop cost-effective energy efficiency measures from being implemented. In addition, the current state policy framework could be more aggressive, and existing barriers that serve to cap utility expenditures in energy efficiency measures - and that link utility profits with energy consumption, providing a powerful disincentive for reducing energy waste - need to be addressed as well. Overcoming these economic, corporate, policy and utility barriers can help reduce energy waste in Michigan.

MODERNIZING ELECTRICITY GENERATION AND DELIVERY

An economy powered by a highly distributed mixture of both simple and sophisticated energy technologies is within our reach, and offers multiple economic and reliability benefits. Utility scale projects like wind farms and solar parks can supplant central power stations, and distributed energy resources (DERs) located near the "load" or point of energy use are enabling a transformative paradigm shift where customers become active participants and contributors to the power system. Greater penetration of DERs would afford an array of benefits including improved power quality, enhanced reliability, deferred or avoided distribution and transmission infrastructure, increased grid resiliency and greater overall energy security.

MICHIGAN'S ENERGY PROFILE 2050

Full integration of advanced energy requires overcoming multiple market, institutional, communication and policy barriers. Despite the cost-effectiveness of wind and even solar energy, Michigan utilities currently face a statutory disincentive from owning renewable energy assets vis-a-vis traditional fossil fuel units. The current net metering framework also unnecessarily limits penetration of DERs and allows for excessive stand-by and other charges that reduce the economic benefits of DER ownership. There are also challenges that frustrate forward-thinking companies from purchasing the renewable energy needed to meet corporate economic and sustainability goals. Each of these barriers must be addressed to effectively encourage broad-based renewable energy generation in Michigan.

ELECTRIFYING TRANSPORTATION

With higher vehicle fuel efficiency requirements, national goals to reduce imports of petroleum, and new powertrain technologies coming to market, the transportation sector is making significant progress in improving transportation efficiency.

Yet more must be – and can be – done.

Electrifying transportation within the next 35 years is a "moonshot" – but is technically feasible. The effort entails rapid market transformation, robust public transit systems, and reductions in individual vehicle miles traveled (VMT). It also requires greater vehicle efficiency through new materials for lightweighting, "situationally aware" vehicle technologies, ubiquitous charging infrastructure, and, most importantly, attaining expected progress in battery and fuel cell chemistries.

Unlike the efficiency and renewable generation categories, advances in technology are necessary to fully electrify transportation as cost. Transitioning the transportation sector to electricity requires continuous progress in improving battery chemistry and cost reduction efforts. Increasing the energy density in battery systems increases vehicle range, reduces vehicle weight and improves vehicle mileage by requiring less energy per unit of distance travelled. The U.S. Department of Energy (DOE) and many other sector analysts predict increasing energy density for energy storage systems and significantly reduced cost of production.

McKinsey & Company forecasts the cost of lithium-ion batteries will fall to $200 per kWh in 2020 and $160 per kWh by 2025. And an analysis by the Electric Power Research Institute (EPRI) found that the total cost of ownership (TCO) of the Chevrolet Volt and the Nissan Leaf is already equal to or below the TCO for similar conventional vehicles.

Importantly, even with the (likely temporary) drop in gasoline prices, electricity for vehicles is still less expensive than gasoline, with the Department of Energy estimating that an "eGallon" – the electric equivalent of a gallon of gasoline – is $1.46 for Michigan, [104] compared with approximately $2/ gallon for traditional gasoline. [105]

Conversion of the transportation sector to electricity will significantly reduce primary energy consumption overall. Electric vehicles provide up to five times more work in distance traveled per unit of input energy than vehicles with internal combustion engines, primary due to the efficiency of electric motors.

Transportation innovation is where Michigan excels. Michigan's established leadership in vehicle technology development, engineering, robotics and materials science not only provides advantages in improving the performance of electric vehicles, it also gives Michigan manufacturers an edge in participating in a transformed global transportation market.

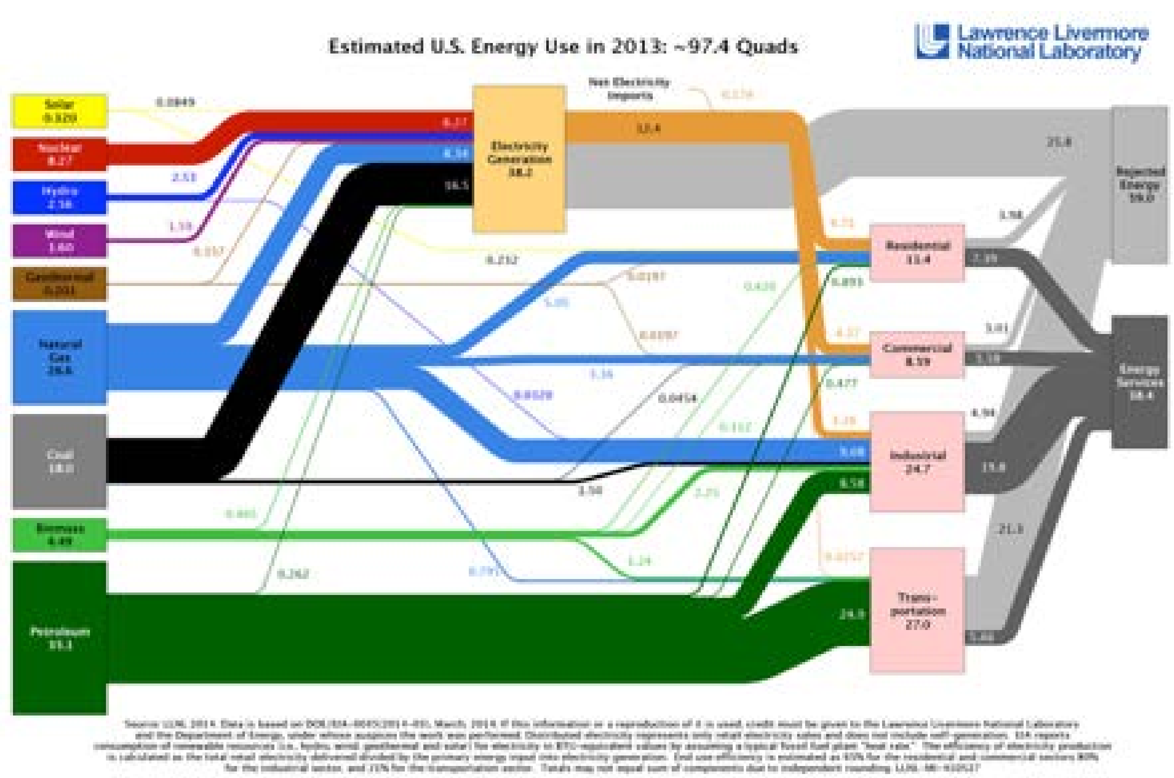
Electric vehicles are about three times more efficient than vehicles with internal combustion engines in converting energy to power at the wheels. Conventional ICEs convert only 17 – 21% of the energy stored in gasoline to power the vehicles at the wheels while EVs convert 59-62% of electrical energy from the grid to power vehicles at the wheels. - Source: US Department of Energy

CHAPTER 4
BARRIERS TO REDUCING ENERGY WASTE

Wasted energy is endemic to our economy. The Lawrence Livermore National Laboratory's (LLNL) annual calculation of energy wasted in the U.S. economy found that 59 percent of all primary energy consumed in the U.S. was wasted. [106]

Examples of energy inefficiency abound: Only 15 percent of the energy in gasoline is actually used by a vehicle for transportation; 85 percent of the energy in fuels is lost to the conversion inefficiency of internal combustion engines, drivetrains and idling. [107] The thermal efficiency of U.S. coal plants is only 32.5 percent. [108] Incandescent light bulbs, now functionally obsolete, waste 90 percent of energy consumed through heat loss. [109]

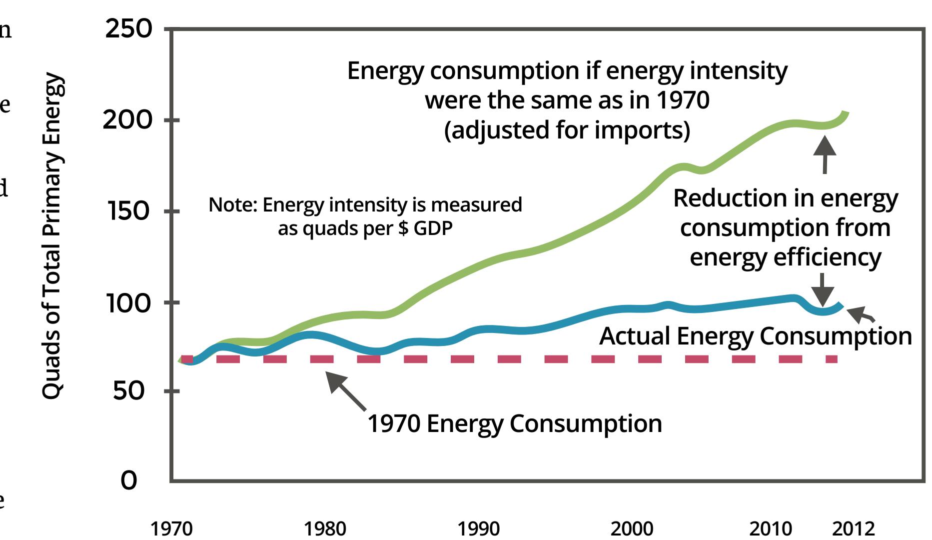
Residential and commercial buildings, which comprise 40 percent of U.S. energy consumption, offer another opportunity to improve energy performance. [110] The National Renewable Energy Laboratory (NREL) estimates that if available energy savings measures for residential homes - insulation, Energy Star appliances, efficient lighting, highly efficient HVAC - were implemented, household energy consumption would be reduced by 50 percent. [111] Michigan recently adopted a revised building code, [112] effective October 2014, that will result in energy savings up to 25 percent for newly constructed homes. [113]



A special opportunity exists to utilize energy efficiency to reduce the energy intensity of Michigan manufacturing. According to the Alliance to Save Energy, energy efficiency improvements are responsible for at least 50 percent of reductions in energy intensity over the last several decades. [114]

Expanding opportunities to reduce the energy intensity of the industrial sector can help reduce costs and boost the competitive position of Michigan companies competing in global markets. This is especially important given the importance of manufacturing to the Michigan economy.

In 2013, the manufacturing sector generated $82.3 billion in gross state product, [115] a 4.97 percent increase over 2012. [116] Michigan manufacturing in 2013 accounted for more than 19 percent of the state's total gross state product, up from 14.6 percent in 2009 [117] and more than six percentage points higher than 14.5 percent share of the U.S. GDP that is attributable to manufacturing, [118] which is still more than any other sector. [119] While the last decade has presented many challenges to Michigan's manufacturing sector and to the state economy as a whole, the gross state product attributable to the manufacturing sector is higher than it has been at any time since 2003. [120]



Source ACEEE analysis of data

Industry uses more energy than other sectors, and uses it in different ways. The U.S. industrial sector uses approximately one-third of all energy consumed in the country [121] - a figure that rises to more than 40 percent if transportation of manufactured goods is included. [122] And while industrial firms have significantly decreased their energy consumption over the last several decades while increasing the gross industrial product, opportunities for further savings exist.

Estimates suggest "only 43% of all energy inputted into the industrial sector is actually applied to 'process work' - the work that actually yields a good. The remaining energy is lost or wasted in other ways, costing the firm and the economy a tremendous amount that cannot be recovered as a value-added end product." [123] Furthermore, "a typical industrial facility can achieve energy savings of 10 to 20% considering currently available energy efficiency technologies within existing plants." [124] With this low-hanging fruit still on the tree, it is clear that energy efficiency can help Michigan's manufacturing sector to improve further its financial performance in a globally competitive marketplace. [125]

> *"A country that uses less energy to achieve the same or better results reduces its costs and pollution, creating a stronger, more competitive economy. While energy efficiency has played a role in the economies of developed nations for decades, cost-effective energy efficiency remains a massively underutilized energy resource." ACEEE*

While energy waste is ubiquitous, the economy is rich with ready opportunities to abate energy waste and reduce GHG emissions through aggressive energy efficiency implementation. Energy efficiency is the most cost-effective, practical and most immediately available energy resource for end users. In 2012, electric efficiency programs saved 126 TWh of electricity in the United States, enough to power 12.2 million homes for one year, and avoided the generation of 89 million metric tons of carbon dioxide. [126] In 2013 alone, the MPSC calculates the energy efficiency measures implemented under Michigan's energy optimization program will save Michigan ratepayers $945 million over the lifetime of the measures installed. [127] – a savings of $3.75 for every dollar expended.

ENERGY EFFICIENCY IN MICHIGAN

Michigan's Clean, Renewable and Efficient Energy Act provides for an energy efficiency resource standard (EERS) requiring all electric and natural utilities to establish and administer "energy optimization" (EO) programs. The EERS required that all electric utilities achieve 0.3% savings in 2009; 0.5% in 2010; 0.75% in 2011; and 1.0% in each year thereafter based upon the prior year's annual sales. Natural gas utilities must achieve 0.1% savings in 2009; 0.25% in 2010; 0.5% in 2011, and 0.75% in each following year. These statutory targets have largely been met by Michigan's investor owned utilities, municipal utilities and cooperatives.

In its 2014 report, the American Council for an Energy Efficient Economy (ACEEE), which ranks state energy efficiency programs and policies including state efficiency standards, building codes, combined heat and power (CHP) and state government initiatives, ranked Michigan's EO programs twelfth among states. [128] In terms of comparative energy saving requirements among states having an EERS, Michigan's annualized electric savings standard ranked 18th among the 26 states that have legally mandated or voluntary EERS standards. [129]

Michigan's efforts to reduce energy consumption through its utility administered EO programs have clearly been successful, yet many opportunities exists to capture even greater benefits from more aggressive efficiency programs and policies.

The ACEEE ranks Michigan's energy optimization programs twelfth among states.

However, a number of barriers prevent Michigan from realizing even greater energy savings. They include policy barriers regarding program administration, statutory limitations, and limitations on MPSC authority; transactional barriers including inadequate access to capital; and other financial limitations including suboptimal rate and tariff designs, shortcomings in education and communication, and economic disincentives.

POLICY BARRIERS

LIMITS ON ENERGY OPTIMIZATION FOR ELECTRIC AND NATURAL GAS UTILITIES

Ambiguity exists under Michigan law as to whether utilities are limited in the amount of energy optimization that they are authorized to achieve. There may be, in effect, a cap on the MPSC authority to set more ambitious requirements. The Clean, Renewable and Efficient Energy Act calls for all electric and natural gas utilities in Michigan to achieve annual customer energy efficiency savings equivalent to 1% of total annual electric sales (0.75% for natural gas) by 2012, and each year thereafter, by implementing energy optimization programs.

The ambiguity concerns whether the prescribed savings requirements constitute a "floor" or a "ceiling." Utilities are required to obtain MPSC approval of their "energy optimization plans." It is unclear whether utilities could propose to achieve higher energy optimization savings that the statutorily prescribed targets or whether the MPSC could authorize or require higher savings.

CAP ON UTILITY EXPENDITURES FOR ENERGY OPTIMIZATION PROGRAMS

A related impediment to increasing implementation of cost saving energy efficiency measures is the uncertainty regarding whether the MPSC has the authority to permit utilities to spend more on energy optimization programs. The Clean, Renewable and Efficient Energy Act includes specific caps limiting program spending. The ambiguity arises from apparent conflict within the language of the statute that appears to authorize additional expenditures with the approval of the MPSC and another statutory provision that imposes a cap on spending. [129]

The apparent categorical limitation on spending specified in the Act conflicts with the statutory provisions that seem to empower the MPSC to approve greater spending. Statutory clarification would help Michigan in persuing more aggressive energy efficiency standards.

REVENUE DECOUPLING FOR ELECTRIC UTILITIES IS NOT AUTHORIZED UNDER MICHIGAN LAW

Revenue decoupling is a regulatory approach that removes the traditional linkage between energy sales and utility revenues and profits. Under traditional regulation, utility revenues and profits are based upon sales - the more electricity sold the higher the revenues and profits. Under revenue decoupling, revenue targets are set for utilities taking into account the reduction in sales that result from implementing energy efficiency programs. Revenue differences are then "trued-up" on a periodic basis either as a surcharge or credit to the customers' bills so that the utility's revenues match the allowed revenue target as established in the utility's last general rate case.

Revenue decoupling reduces the utility's disincentive to promote energy efficiency by eliminating the negative financial impact on a utility's earnings resulting from the reduction of energy sales due to the implementation of energy efficiency programs.

In 2010, the MPSC ordered the establishment of RDMs and revenue targets for both Consumers Energy and DTE Energy. The Department of the Attorney General and the Association of Businesses Advocating Tariff Equity (ABATE) appealed the MPSC's orders approving the RDMs to the Michigan Court of Appeals. The court found that while the Clean, Renewable and Efficient Energy Act specifically provides natural gas providers with a "symmetrical revenue decoupling true-up mechanism that adjusts for sales volumes that are above or below the projected levels," the statute is silent regarding electric providers. [130] On that basis the Court of Appeals held that the MPSC was without authority to approve RDMs for electric providers. [131]

Without revenue decoupling, Michigan's electric utilities are without the best accounting mechanism to encourage investment in energy efficiency and to motivate utilities to explore efficiency program innovations that would serve their customers.

ENERGY SAVINGS ACCOUNTING

Michigan's energy optimization standard separates those improvements that reduce electricity consumption from those that result in lower natural gas usage. Dividing between fuels may make sense from the perspective of separate electricity and natural gas utilities; however, such a division makes little sense from the perspective of an end-user who uses both natural gas and electricity.

In addition, technologies and applications such as combined heat and power (CHP), waste heat to power (WHP) and geothermal heat pumps can actually serve to increase a customer's electricity and/ or natural gas use while decreasing their overall energy consumption (and thereby reducing the ultimate energy intensity of the business). As currently structured, however, Michigan's energy optimization program impedes the ability of customers to make use of these technologies and applications, and removes the incentive for utilities to investigate opportunities that bridge electricity and natural gas consumption.

ECONOMIC BARRIERS

FINANCING OPTIONS

The cost of energy efficiency measures can be substantial, particularly when retrofitting older building stock. Across the country, states are exploring a range of innovative mechanisms to assist in the financing of energy efficiency projects - some (but not all) of which are available in Michigan.

Michigan's current finance offerings include the successful "Michigan Saves" program, which offers homeowners loans up to $30,000 and businesses up to $250,000 for energy efficiency measures. In addition, the state's property assessed clean energy (PACE) statute allows for loans for energy improvements in participating communities to be secured by the borrower's property taxes, helping to increase the availability and lower the cost of capital. Thus far, nine Michigan counties and three cities have enrolled in Lean & Green Michigan, a statewide PACE program, and the City of Ann Arbor has also established its own PACE district. While PACE loans are available for commercial and industrial properties, the statute does not allow for PACE funding for residential efficiency upgrades, based on concerns raised by Fannie Mae and Freddie Mac during the recent housing crisis. The State of California, however, has recently found a way around these objections by establishing a $10 million loan-loss reserve fund to cover any losses from the program. This type of innovation has unlocked residential PACE in California, and could provide a blueprint for Michigan and other states to follow.

In addition, the state also enacted the Michigan Invests Locally Exemption (MILE) Act in 2013, and there has been some discussion about how to leverage this new crowdfunding tool to attract capital for energy efficiency and other energy upgrades.

Finally, Public Act 408 of 2014, signed by the Governor on December 27, 2014, allows municipal utilities to offer "on-bill" financing to their customers to finance energy efficiency upgrades, as well as distributed energy systems and electric vehicle charging infrastructure.

On-bill financing (OBF) is a tool where the utility provides the upfront capital and finances the energy measures under a long-term contract. The additional charge is added to the monthly bill, spreading the cost of the energy efficiency measures to reduce the payments. Under an alternate design for utilities that do not want to lend capital, utilities facilitate third-party financing for energy projects through on-bill repayment (OBR), where the utility does only billing and collection. In either case, the loan obligation may "run with the meter" so as to not interfere with the sale of the property.

Other states have gone further than Michigan in allowing for - or even requiring - on-bill financing. To date, 23 other states have on-bill financing programs. California, New York and Illinois have made utility programs mandatory, and California, Connecticut, Georgia and Kansas have established revolving loans or loan loss reserves to support their programs. It is unclear whether Michigan utilities could initiate OBF or OBR without statutory authorization and/or approval of the MPSC. As a starting point, the MPSC could initiate an exploratory proceeding creating the groundwork for OBF programs. Ultimately, however, additional legislation may be needed.

IMPEDIMENTS TO COMBINED HEAT AND POWER/WASTE HEAT RECOVERY

Combined heat and power (CHP), also referred to as cogeneration, is the most efficient way to produce and utilize energy. Using one power system to generate both electricity and heat from a single fuel source greatly increases the overall efficiency of the system. CHP power systems may reach energy efficiencies of 80 percent or more while the average efficiency of power generation has remained at 34 percent since the 1960's. [132] Similarly, waste heat recovery (WHR) utilizes energy that would otherwise be lost to produce electricity or heating or cooling capacity.

CHP and WHR systems lower the cost of energy, allowing energy savings to be invested for other purposes and boost the productivity and competitiveness of Michigan businesses. Because of their greater efficiency, CHP and WHR systems use fossil fuels more efficiently and have fewer greenhouse gas emissions per unit of energy produced. The potential benefits of CHP are so pronounced that President Obama issued an Executive Order setting a goal of obtaining 40 GW of additional CHP capacity by 2020. [133]

CHP and WHR systems are eligible for Output Based Regulation (OBR), a process-based system of determining allowable emissions levels based on the amount of emissions per unit of energy output. [134] Because of this regulatory flexibility, CHP and WHR can afford industrial facilities more flexibility in meeting air quality emission standards. CHP and WHR can also facilitate compliance with U.S. EPA's proposed Emission Guidelines for Existing Stationary Sources under section 111 of the federal Clean Air Act.

For utilities, CHP can provide valuable system benefits like improving system reliability and grid resiliency and lowering operating costs. Because CHP systems are typically installed within a facility, campus or complex, they operate proximate to the point of energy demand, avoiding distribution and transmission costs and line losses. CHP systems are also a ready source of electric capacity that reduces the amount of excess capacity utilities must have as a reserve. CHP systems can also participate in demand response markets and provide an array of ancillary services that improve power quality.

CHP and WHR systems face a number of disincentives in Michigan that include lack of access to capital, structural economic barriers and regulatory barriers.

COLLEGES TURNING TO COMBINED HEAT AND POWER, DISTRICT ENERGY SYSTEMS

A public university in southeast Michigan and a community college in West Michigan have both turned to innovative approaches in an attempt to reduce energy costs. Oakland University, located in Rochester Hills, recently partnered with Chevron Energy Services to construct a combined heat and power (CHP) plant that provides the university with both electricity and heat. Chevron Energy Services financed the $12 million project under a 15-year capital lease, with savings beyond 15 years going back to the university.

On the other side of the state, Grand Rapids Community College (GRCC) recently opted to connect with the Grand Rapids district energy system operated by Veolia Energy to have steam delivered to nine campus buildings for heating, hot water, and air conditioning instead of replacing the college's aging and inefficient boiler plant. As a result, GRCC will save $850,000 during the 15-year service agreement while reducing its carbon footprint.

Source: Veolia Energy, Oakland University

ACCESS TO CAPITAL

CHP and WHR systems can be capital intensive, requiring substantial investment with longer payback periods. Even when the long-term energy savings and other benefits are evident, CHP and WHR systems may face internal competition within capital budgets for investments that promise greater returns on investment and shorter periods of recovery. Access to low-interest capital is limited. This is particularly a problem in Michigan as the state lacks public benefit funds or other long-term sources of funding.

Under existing law, owners of CHP systems can only receive a 10 percent investment tax credit (ITC) while other energy technologies like wind, solar and geothermal are eligible for more robust tax incentives. Owners of WHR systems do not qualify for the ITC at all. Furthermore, some of the largest users of CHP systems, including non-profit organizations like colleges, universities and hospitals, cannot utilize tax incentives like the ITC or the production tax credit (PTC) because they do not have tax liability.

Another limitation is that CHP and WHR projects cannot yet take advantage of Master Limited Partnerships (MLPs) or Real Estate Investment Trusts (REITs). MLPs are financial structures that have the tax advantages of limited partnerships and can be traded on security exchanges. REITs are financial structures that own and operate real estate. Both MLPs and REITs are available to those making investments in oil and gas but not to CHP and WHR projects unless the IRS promulgates a new rule or until Congress passes legislation that would put advanced energy investments on a level playing field with the oil and gas sectors.

The Department of Treasury proposed a rule in May 2014 that would allow solar projects powering real estate to be included in a REIT under very limited circumstances. [135] Investors are also concerned that if solar projects are defined as "real estate" they may not be eligible for the investment tax credit (ITC) or accelerated depreciation.

BARRIERS TO REDUCING ENERGY WASTE

SPLIT FACILITIES MANAGEMENT RESPONSIBILITIES

CHP systems are particularly well suited for college and university campuses, hospitals, and industrial complexes and anywhere buildings and facilities are centrally located. A common barrier is that responsibility for the operation and maintenance of power and HVAC facilities are entirely separated from management and budget responsibilities. Facility managers lack incentives for energy efficiency when they are without responsibility for expenditures and accounting. On the flip side, those with budgetary responsibility lack the information and understanding regarding the potential of more efficient energy infrastructure.

MICHIGAN SPECIFIC HURDLES

In addition to the conventional barriers to increased penetration of CHP – cost, access to capital, long pay back periods and split responsibilities, Michigan has four significant state-specific barriers:

- Excessive standby charges – These are charges by utilities for backup, supplemental and replacement power that may be assessed if a customer-owned advanced energy system is not operating or is operating on a limited basis. Utilities have taken the position that CHP facilities must have 100 percent back-up capacity and charge the full incremental cost of peak generation costs.
- Interconnection costs – if CHP systems require enhancement of transmission or distribution infrastructure, utilities require the party deploying CHP to provide an open-ended commitment for full payment of the cost of the enhancement
- Underpayment for energy – utilities will not pay the wholesale market rate for CHP systems that generate power in excess of load
- Uncompensated system benefits - CHP can provide a number of positive system benefits to the power grid that are largely unrecognized and undercompensated.

A number of states have grants, rebates or other financial incentives for CHP systems or separate clean energy standards establishing targets for CHP systems.[136] The Michigan Clean, Renewable and Efficient Energy Act authorizes the creation and use of "advanced cleaner energy credits" (ACEC), that can be converted into renewable energy credits and utilized by utilities to meet RPS requirements. Although Michigan utilities can use ACECs, they thus far have proved insufficient in motivating utilities to own, operate or lease CHP systems for the benefit of their commercial and industrial ratepayers.

ORGANIZATIONAL BARRIERS

SPLIT INCENTIVES; PRINCIPAL/AGENT PROBLEMS

Owners and tenants of commercial properties and rental housing face economic disincentives that result in energy waste and prevent implementation of measures that reduce energy costs. The "split incentives" problem refers to situations where a building owner has little incentive to implement energy savings measures because the tenant pays the energy bill. Conversely, tenants have little incentive to conserve energy or install energy efficiency measures when the landlord is paying the energy bill. This problem is particularly acute in urban areas with lots of rental housing and in areas proximate to college and university campuses.

Some states and municipalities have come up with solutions. For example, New York City is deploying a pilot project in which both tenant and landlord share the costs and benefits of energy retrofits by agreeing on a predicted amount of annual savings and having the tenant pay the owner recovery costs based on the predicted savings. [137]

TRANSACTIONAL BARRIERS

PERFORMANCE CONTRACTING

Performance contracting is a specialty service offered by energy efficiency service companies "ESCOs" that provide comprehensive energy efficiency services from planning through implementation of energy efficiency measures. [138] ESCOs are especially well suited to provide services to public and institutional customers. As project developers, ESCOs assess and audit facilities to establish baseline energy usage and design, develop and install a comprehensive set of energy efficiency measures. Because ESCOs guarantee the performance of the energy efficiency measures and assume the risk of performance, they also ensure that the measures are maintained and are actively managed.

ESCOs sometimes arrange for financing of the installed measures. In some cases, the entire capital cost of the energy efficiency installation measures are paid from the savings accruing from reduction in energy use under long-term contracts extending 10 -20 years. This requires exact accounting, measurement and verification of energy consumption and savings. ESCOs include some of the nation's largest corporations with many having a presence in Michigan, including Johnson Controls, Honeywell, Siemens, IBM and Schneider Electric.

Advantages of performance contracting include:

- Simultaneous implementation of comprehensive energy efficiency measures (rather than incremental implementations which become progressively less economically efficient)
- Accelerated completion of large scale implementations on government, public and institutional buildings
- Capital savings and reallocating budget dollars for other needed projects
- Increased productivity from improved indoor air quality and building comfort conditions
- Optimal building performance and maintenance
- One contract with single source of accountability

Some states have instituted large-scale performance contracting programs targeting public buildings and have achieved significant savings while reducing energy usage and greenhouse gas emissions. In 2012 Michigan enacted new laws authorizing performance contracting and establishing criteria for projects. [139] A second statutory change was signed into law earlier this year. [140] Despite the legislation, however, Michigan has invested only a small fraction of the amount our sister states have expended on performance contracting. Lack of focus, internal consensus and skepticism as to the amount of energy savings that can be attained may be limiting performance contracting within state and local governments.

Several state governors have issued executive orders requiring performance contracting or specifying its consideration. [141] Other states have enacted legislation that requires energy audits and energy efficiency implementations if the capital cost of the energy efficiency measures can be paid back from energy savings. Texas has enacted critical infrastructure legislation mandating that any new or extensively renovated public facilities like police and fire stations, hospitals, drinking water and wastewater treatment plants, datacenters and other critical facilities undergo an evaluation to determine the cost of equipping the facilities with combined heat and power and advanced heating and cooling equipment. If the cost savings from such implementations over a 20-year period exceed the capital cost, the energy saving implementation is "preferred." [142]

Michigan Saves provides secured and unsecured loans to homeowners and businesses for energy efficiency improvements and renewable energy systems. Funded by the MPSC and the DOE, Michigan Saves has recently expanded its offerings to schools, universities and local units of government.

BARRIERS TO REDUCING ENERGY WASTE

Energy Services Coalition - Race to the Top

State	Population	Performance Controlling	Dollar per Capita	Job Years Created	Source Energy Saved (MMBtu)	Tons Carbon Avoided
Hawaii	1,360,301	$320,678,850.00	$235.74	3,486	2,660,993	45,708
Delaware	897,934	$138,707,463.00	$154.47	1,508	1,150,994	19,771
Ohio	11,536,504	$1,252,683,627.00	$108.58	13,616	10,394,769	178,551
Kansas	2,853,118	$278,951,861.00	$97.77	3,032	2,314,742	39,760
Colorado	5,029,196	$447,377,551.00	$88.96	4,863	3,712,338	63,767
Mississippi	2,967,297	$260,725,503.00	$87.87	2,834	2,163,500	37,162
Idaho	1,567,582	$129,000,000.00	$82.29	1,402	1,070,442	18,387
Massachusetts	6,547,629	$457,696,106.00	$69.90	4,975	3,797,962	65,238
Utah	2,763,885	$165,195,000.00	$59.77	1,796	1,370,788	23,546
Arizona	6,392,017	$323,732,433.00	$50.65	3,519	2,686,331	46,143
Rhode Island	1,052,567	$53,000,000.00	$50.35	576	439,794	7,554
Maryland	5,773,552	$243,409,541.00	$42.16	2,646	2,019,812	34,694
Nevada	2,700,551	$100,656,000.00	$37.27	1,094	835,243	14,347
Pennsylvania	12,702,379	$438,000,000.00	$34.48	4,761	3,634,524	62,430
North Dakota	672,591	$21,651,878.00	$32.19	235	179,667	3,086
Virginia	8,001,024	$228,537,402.00	$28.56	2,484	1,896,403	32,575
Washington	6,724,540	$185,197,377.00	$27.54	2,013	1,536,767	26,397
North Carolina	9,535,483	$252,640,978.00	$26.49	2,746	2,096,414	36,010
Wyoming	563,626	$13,000,000.00	$23.06	141	107,874	1,853
New Mexico	2,059,179	$43,248,261.00	$21.00	470	358,874	6,164
Alabama	4,779,736	$96,760,817.00	$20.24	1,052	802,921	13,792
Alaska	710,231	$13,000,000.00	$18.30	141	107,874	1,853
Tennessee	6,346,105	$112,417,888.00	$17.71	1,222	932,843	16,023
Kentucky	4,339,367	$75,000,000.00	$17.28	815	622,350	10,690
Missouri	5,988,927	$87,700,000.00	$14.64	953	727,735	12,500
Illinois	12,830,632	$178,000,000.00	$13.87	1,935	1,477,044	25,371
Minnesota	5,303,925	$59,076,958.00	$11.14	642	490,220	8,421
Louisiana	4,533,372	$37,675,830.00	$8.31	410	312,634	5,370
Texas	25,145,561	$200,000,000.00	$7.95	2,174	1,659,600	28,507
Florida	18,801,310	$121,982,058.00	$6.49	1,326	1,012,207	17,387
Montana	989,415	$5,700,000.00	$5.76	62	47,299	812
Oregon	3,831,074	$13,000,000.00	$3.39	141	107,874	1,853
Iowa	3,046,355	$8,000,000.00	$2.63	87	66,384	1,140
Michigan	9,883,640	$11,286,359.00	$1.14	123	93,654	1,609

Source: Institute for Energy Innovation, using data from the Energy Services Coalition

BUILDING RATING SYSTEM

The U.S. EPA as well as a number of cities and states have established building rating systems that assess and evaluate the energy efficiency of buildings including the comparative operational efficiency of the heating, ventilation and air conditioning (HVAC) systems and appliances the building contains. The EPA's Energy Star program certifies buildings and plants that meet energy performance standards. [143] Energy Star buildings use less energy, reduce GHG emissions and are less expensive to operate. Energy Star buildings also enjoy higher real estate values and rent at a premium. These advantages can motivate homeowners and businesses to deploy energy efficiency measures, reducing energy consumption and lowering monthly energy bills.

The biggest impediment to further adoption of building rating systems is lack of communication. Efforts to educate community leaders, real estate brokers, local chambers of commerce and policy-makers on the advantages of adopting building ratings need to be stepped up.

BATTLE OF THE BUILDINGS SPARKS COMPETITION TO REDUCE ENERGY USE

The West Michigan Chapter of the U.S. Green Building Council is sponsoring a "Battle of the Buildings" – what they call "an energy reduction war, a crusade against kilowatts, a barrage against btu's." Patterned after the television show "The Biggest Loser," Battle of the Buildings has building owners and managers compete to reduce their energy consumption, with contestants measuring, tracking, and reporting their monthly energy consumption using an online energy tracking tool. The buildings that demonstrate the greatest percentage-based reduction in energy use intensity over the course of 2014 will be recognized at an awards ceremony to take place in April.

In its first year, Batttle of the Buildings enrolled 67 buildings totaling more than 11.5 million square feet of real estate across West Michigan. For its second year, Battle of the Buildings plans to expand statewide through partnerships with Consumers Energy and DTE Energy, the state's largest utilities.

Source: USGBC-WM

NETWORKING AND COMMUNICATION BARRIERS

INADEQUATE INFORMATION

Many homeowners and businesses have a limited understanding of the opportunities, availability and benefits of energy efficiency. They often lack adequate information regarding the variety and application of available measures, the potential for reducing energy consumption through energy management and conservation practices, and the amount of energy savings that can be realized.

Information barriers are difficult to overcome. Energy savings potential varies based upon building features and uses, appliances and devices, as well as variables concerning building usage and energy consumption. Measurement of energy use is difficult to breakdown, and attributing energy savings to any measure or behavioral change is difficult to verify.

The volatility of natural gas prices and annual increases in electricity rates have further complicated the measurement of energy savings when reviewing monthly utility bills. Determining the avoided cost of future energy price increases renders energy savings accounting extremely challenging to most consumers.

However, the increasing availability of advanced energy measures including building energy management systems, smart meters and smart appliances promise homeowners and businesses the ability to monitor, measure and control energy use from every appliance, system and device in the home or business over the internet and through mobile applications. Demand management through automated controls connected to building energy systems will result in the capacity to reduce peak demand by remotely dialing down energy usage while yielding additional energy savings for the consumer. Providing access to energy data while protecting personal information can enable the development of new advanced energy business models that assist ratepayers in reducing their energy use.

Adding to the challenge in this regard are the growing threats to grid security, placing additional pressures and imposing additional costs on utilities to protect their grid infrastructure. Energy is already the sixth most targeted sector for hackers globally – and the most targeted sector in the U.S. [144] As deployment of advanced energy and utilization of smart meter technologies continues to increase, it will be critical that utilities and others are able to ensure grid security and protect the integrity of their networks.

PROGRAM AVAILABILITY AND PROGRAM OFFERINGS

Many homeowners and businesses are unaware of energy efficiency program benefits offered by their electric and gas utilities. A number of Michigan's electric and gas energy providers have developed their own independent energy optimization programs with their own system of incentives and rebates. While offering certain advantages, these numerous independent programs lack the administrative efficiency and the economy of scale that a centralized program could provide, making improvement in how different offerings are communicated that much more important.

Confusion regarding the geography of utility service territories, eligibility requirements, and the differences in program offerings between utilities further limit the reach and effectiveness of Michigan's energy optimization programs. The fact that Michigan's natural gas providers are deregulated and the electric providers are partially deregulated increases the potential for confusion when changing providers also means changing energy optimization programs.

Efficiency UNITED consists of 18 Michigan energy providers that have joined together to provide a portfolio of uniform energy efficiency programs and services including a standardized multilevel online energy audit. [145]

The lack of centralized information regarding utility offerings also sows customer confusion and program inefficiencies. A few states offer "one stop shopping" for utility energy efficiency programs that provide helpful clarity and assistance to consumers interested in determining what incentives and programs are available by each utility operating within the state. [1466]

MPSC BECOMES FIRST ENERGY AGENCY IN NATION TO FINANCE ENERGY IMPROVEMENTS THROUGH PACE

The Michigan Public Service Commission (MPSC) recently announced that it will be the first energy agency in the country to upgrade its office facilities through financing under the Property Assessed Clean Energy (PACE) model. Under PACE, a building owner is able to obtain low-cost financing for authorized energy upgrades, with the loans guaranteed by the building's property taxes, providing lenders with greater certainty of payback and thus a reduction in interest rates. In addition, because the loans are guaranteed by the property taxes, loan terms can extend well beyond the typical 5 year window for energy efficiency loans. While only available for private buildings, because the MPSC leases its office space from a private building owner, it was able to use PACE financing to make the expected energy improvements.

The MPSC project was done through Lean & Green Michigan, a statewide PACE program that leverages Michigan's 2010 PACE law to attract private capital to finance building improvements. The MPSC project includes adding LED lighting, installing solar panels to offset energy purchases, and putting in solar powered electric vehicle charging stations.

Source: Lean & Green Michigan, MPSC

SPECIFIC BARRIERS TO IMPROVING INDUSTRIAL ENERGY EFFICIENCY

ORGANIZATIONAL BARRIERS

Modern manufacturing companies are often complex organizations, and decisions relating to energy use are deeply rooted in individual plant operations. As a result, if an opportunity to improve a plant's energy efficiency requires a change in operations, such a decision "can represent significant risk to a firm, or may be perceived as such by decision-makers unfamiliar with the long-term benefits such an investment may provide. For these reasons, energy efficiency investments are made carefully, with much consideration. If the investment will require a change to an existing product line or production process, the cost of the investment is likely to be higher than it would be had no such change been required. In some cases this can even make a cost-effective efficiency investment too costly and too risky to be a good business decision." [147]

In addition, there is often a separation between those responsible for plant operations and those responsible for controlling energy costs, meaning that "substantial capital investment in more energy efficiency technologies may not occur despite the fact that a factory or shop manager understands its usefulness." [148]

Developing strategies to overcome these barriers requires the same disciplined decision-making that manufacturing executives use in making other business decisions to reduce costs and improve plant operations. As the National Association of Manufacturers has noted, "[a]t least 30 percent of industry's overall energy savings potential can be obtained without capital expense, by simply making changes to procedures and behavior. Obtaining these results by making energy management standard operating procedure – and not just a one-time project – is a process that bears a striking resemblance to financial planning." [149]

DuPont applied SixSigma to more than 75 procedure-based energy improvement projects – each required no capital investment and on average saved $250,000 per year. [150]

Tackling these organizational issues can only be done by fully integrating energy consumption decisions within the institutional decision-making process; "[t]he leading plants in energy efficiency are incorporating energy into their continuous improvement and quality control systems as a part of everyday business operations." [151] Such an approach requires the same development of human skills to manage energy use that manufacturers routinely use for technology research and development. After all, "[c]ompanies are always partnering to achieve economies in distribution and inventory, so why not in energy management? The information technology exists, and it can be done." [152]

ECONOMIC BARRIERS

Aside from corporate organizational barriers, a number of financial barriers frustrate greater industrial adoption of energy efficiency measures. These barriers include:

- High upfront capital costs;
- High development costs;
- Long payback periods;
- Uncertainty of savings and perceptions of risk;
- Split incentives; and
- Limited capital availability. [153]

BARRIERS TO REDUCING ENERGY WASTE

In addition, "internal competition for capital often favors investments directly related to the company's business model." [154] As a result, "energy efficiency investments are often pushed to the side when drafting annual budgets (internal financing) or pursuing outside investor interest (external financing) in favor of other investments that are deemed more essential to the institution's core business activities and operations, such as improving customer satisfaction, gaining market share, or expanding production." [155]

Though related to the availability of capital for energy efficiency in other sectors, this challenge is rooted in organizational decision-making, making it especially difficult to overcome. Simply providing access to capital, for example, is not necessarily sufficient to overcome understandable biases towards investments in core business lines. As a result, "[d]espite the emergence of innovative financing mechanisms, their use—like that of traditional sources of capital—is still limited in the commercial and industrial sectors. This may be due partly to the extra costs building owners must incur to pay the companies arranging the financing, installing retrofits, and taking on risk of underperformance." [158]

Rules relating to the accounting treatment of energy investments create additional barriers for expanding industrial energy efficiency. Even if using the capital for cost-effective energy efficiency investments that improve the long-term of a manufacturing operation, issuing debt to finance these investments "can negatively impact an organization's credit score and impact its ability to secure additional financing." [156] To address this, companies have sought to use "off-balance sheet" financing structures to fund energy efficiency improvements, though efforts to harmonize international accounting standards may limit the ability of firms to use these types of structures in the future.

Finally, inconsistencies and uncertainty surrounding the federal tax code add additional barriers to financing energy efficiency in the industrial context, including the failure by the U.S. Congress to extend a number of expired federal tax credits that have successfully encouraged efficiency upgrades. At the same time, the Investment Tax Credit (ITC) currently provides a federal tax credit for some combined heat and power (CHP) projects that capture the heat produced during electricity generation and use it to provide mechanical power or thermal heating or recycle it back into additional electricity generation. However, the credit is limited to 10 percent of the cost for the first 15 MW of a CHP project that is up to 50 MW in total size, and is not available for waste heat to power (WHP) projects that use the heat produced as a result of manufacturing operations to generate electricity. [158] A bipartisan group in Congress last term introduced the Power Efficiency and Resiliency (POWER) Act,[159] which would increase the ITC for CHP projects to 30 percent, add WHP as a qualifying technology for the ITC, and remove size and capacity restrictions on new installations eligible for the credit, though there is no indication that this legislation will ultimately receive Congressional approval.

LOCAL CHAMBER OF COMMERCE PROVIDES CAPITAL FOR ENERGY UPGRADES

In the Fall of 2012, the Traverse City Area Chamber of Commerce took $50,000 in its own cash reserves and did something a bit out of the ordinary for a regional business group, pledging the money as a low-interest revolving loan fund for energy efficiency improvements undertaken by its member businesses. In the first year, they loaned out this full amount, and then partnering with Traverse City Light & Power, added another $100,000 to the loan pool.

So far, using an expedited approval process that relies on an energy audit, a current tax return and two years of financial statements (and, most importantly, the personal relationship with Chamber leadership), the Chamber has financed nine energy efficiency projects totaling $157,528, with an average loan size of approximately $15,000. The businesses participating in the program have saved over $75,000 in reduced energy expenditures, amounting to 700,000 kilawatt hours annually.

Source: Traverse City Area Chamber of Commerce

RECOMMENDATIONS FOR REDUCING ENERGY WASTE

- Increase Michigan's energy optimization standard and eliminate the cap on utility expenditures for energy optimization programs.
- Recognize demand response and energy efficiency as energy system resources, allowing full participation in energy and capacity markets.
- Promote smart metering, time of use rates, and behavioral energy conservation strategies combined with ratepayer education programs to optimize system benefits.
- Reinstitute revenue decoupling to eliminate the linkage between energy sales and utility revenue and profit.
- Establish MPSC goals and objectives for demand side management programs and peak reduction targets within all ratepayer classes – industrial, commercial and residential; work with demand-side aggregators and home energy management system providers to enable load shifting and peak shaving.
- Promote adoption of building energy management systems, continuous commissioning, smart sensors and automated controls.
- Strengthen and improve building codes to encourage energy efficiency, adoption of advanced energy systems, and grid integration of distributed generation and electric vehicles.
- Significantly increase performance contracting for governmental and institutional buildings.
- Expand financing options for energy upgrades, including Property Assessed Clean Energy (PACE), on-bill financing (OBF) and on-bill repayment (OBR) programs, revolving loan funds, credit enhancements, performance contracting, and other tools.
- Remove accounting barriers that "silo" electricity and natural gas savings by allowing for alternate credits based on overall energy intensity/ energy consumption.
- Encourage the adoption of combined heat and power and waste heat to power systems in Michigan.
- Allow energy efficiency and other advanced energy companies to make use of Master Limited Partnerships, Real Estate Investment Trusts, and other corporate structures. Establish an Energy Efficiency Program Clearinghouse to help educate ratepayers on available energy efficiency programs and rebates.
- Apply process improvements such as SixSigma to industrial energy use to identify the best opportunities to save energy.
- Allow for off-balance sheet financial structures to finance energy efficiency improvements to avoid internal competition for capital.

CHAPTER 5
BARRIERS TO ADVANCED ENERGY IN ELECTRIC GENERATION

Conceptually, integrating advanced electric generation sources at scale may seem simple; Michigan needs only to substitute advanced electric generation resources for the existing resources as the latter retire at the end of their serviceable lives or when they no longer compete economically. The reality is that conversion of the existing power system to one that relies on advanced energy is a monumental task, one that will fundamentally transfer how energy is generated and delivered in Michigan.

Nevertheless, the transition is already underway. Existing advanced energy technologies are fully capable of being deployed economically and efficiently – and future innovations and scaling will further reduce costs. Innovative financial tools and business models are also coming into play, enabling new opportunities and accelerating growth. Homeowners, small businesses and Fortune 500 companies are embracing advanced energy and stimulating demand. Government is responding with new regulatory paradigms.

Yet much must be done to optimize these trends. Fully integrating advanced energy electric generation technologies entails overcoming deeply embedded policy barriers and institutional impediments.

POLICY BARRIERS

ABSENCE OF STATE POLICY DRIVERS

Michigan's utilities and cooperatives will meet the requirements of Michigan's Renewable Portfolio Standard (RPS) – which requires that 10 percent of the electricity generated by utilities comes from renewable resources by the end of this year – early and at significantly less cost than was anticipated at the time the legislation was enacted in 2008. Once the RPS is fulfilled, however, Michigan will lack policy that would drive further renewable energy deployment. Although the compelling economics of wind energy and the declining cost of solar energy will lead to further penetration of these resources, the absence of a policy or legal mandate will likely slow down the pace of deployment, resulting in Michigan falling further behind other states with more aggressive policies.

Of the twenty-nine renewable energy standards mandated by law and the seven voluntary state standards, Michigan's RPS ranks among the weakest. The absence of supportive policy in Michigan creates a substantial barrier to entrepreneurs and innovators working to design, engineer and manufacture advanced energy generation technologies, and frustrates the development of stable markets.

With the exception of net metering, Michigan also lacks other incentives available in other states to encourage advanced energy development. Leading states have a portfolio of programs, policies, incentives, tax treatments and public/private partnerships that create an attractive ecosystem where entrepreneurs and innovators thrive. These include:

- Financial structures like green banks, public benefit funds, revolving loan funds, grants and credit enhancements
- Portfolio standards for solar energy, combined heat and power, and advanced energy storage
- Pilot projects for microgrids and smart-grids
- Public/private partnerships and collaboratives integrating distributed energy resources
- Comprehensive State Energy Plans
- Participation in regional, multi-state energy initiatives
- Programs to accelerate adoption of electric vehicles
- State or regional carbon reduction markets

The lack of a robust suite of tools and policies puts Michigan at a competitive disadvantage in comparison to leading states, and creates barriers to advanced energy deployment.

INTEGRATED RESOURCE PLANNING

Integrated resource planning (IRP) is a process by which utilities analyze options for meeting future energy demand and reserve capacity. The process is intended to ensure that benefits and costs of various options are carefully weighed and compared so that the best decisions are made for the long-term, taking into consideration the magnitude of the investment and the serviceable life of the energy asset.

All but 13 states have laws requiring some form of IRP, though they vary considerably in what factors must be taken into account. [160] Common factors include forecasted load, fuel prices, technology choices (e.g. coal, natural gas, nuclear, renewable energy), construction, capital and operating costs, purchased power, energy efficiency, demand response, and environmental factors such as air emissions and waste handling and disposal. Some IRP's also require utilities to justify the methodology used as well as the assumptions that are made in the planning process.

Most state IRPs specify how often planning must occur and/or the frequency of updates. [161] IRP programs that require periodic reevaluation and identification of optimal energy resources establish solid analytical frameworks that serve both utilities and regulators well. "Best practices" in integrated resource planning take into account capacity planning, the integration of emerging technologies, risks associated with potentially stranded assets, economic trends involving technology and fuel costs, water consumption, new environmental standards, and future anticipated limits on GHG emissions. Many IRPs also include processes for public engagement and stakeholder collaboration.

In Michigan, integrated resource planning is not required. IRPs are only mandated when a utility seeks a "Certificate of Necessity" (CON) for a power project. CONs may be sought when a utility seeks to add capacity to its system by construction, renovation, or long-term power purchase. But whether a utility seeks a CON is a matter of discretion for the utility. [162] The MPSC has prescribed guidelines for IRPs that are reasonably comprehensive in the event a regulated utility chooses to develop an IRP. [163]

Michigan previously mandated broad integrated planning but repealed the requirements when Michigan deregulated utilities in 2000. Michigan utilities, the MPSC, and ratepayers would benefit from reinstituting integrated resource planning practices and modeling efforts. Without IRP requirements, the MPSC and policy-makers have less information to develop energy policy, and there is a higher potential that improvident investments may not be fully evaluated. In short, absent a more robust planning process, Michigan is less likely to obtain the full value and benefits an optimally integrated power system can provide.

NATIONAL PRIZE COMPETITION SPARKS DEVELOPMENT OF COMMUNITY ENERGY PLAN IN THE UP

With electricity rates among the highest in the nation, a group of Upper Peninsula communities are banding together to reduce energy usage in Houghton County, Michigan. The small-town character of this community, centered around the twin cities of Houghton (population 7650) and Hancock (population 4596), is very different than that of large, metropolitan areas, and the area has unique challenges in terms of reducing energy use. To address these challenges, a group of committed volunteers formed the Houghton Energy Efficiency Team (HEET) to develop the plan as part of an application for the Georgetown University Energy Prize, a national, multi-year competition where communities across the country compete for a $5 million prize to be awarded in 2017. The Houghton County Energy Plan builds on core elements of reducing energy consumption, increasing renewable energy, and increasing local generation to meet its goal of making Houghton County "a model for rural communities in creating an affordable, sustainable, and community-driven energy landscape to support a vibrant regional economy and a high quality of life for all its members."

Source: Houghton Energy Efficiency Team

INTEGRATED DISTRIBUTION PLANNING

The anticipated growth of distributed energy technologies has brought the need for a systems approach – integrated distribution planning – in order to achieve the most advantageous benefits to the electrical system. Rather than being reactive to interconnection needs as they arise, integrated distribution planning is anticipatory and proactive, and aims to locate grid resources where they are most useful. States experiencing significant growth of solar energy, combined heat and power, energy storage, electric vehicles, and other advanced energy services are focused on integrating these distributed energy resources so they maximize the value and benefits to the electrical grid.

New York has a "Smartgrid Consortium" comprised of experts from the state's energy programs, representitives from energy technology companies, utilities and engineering experts to identify the best way to integrate and deploy advanced energy technologies. [164] It has also launched a new initiative to redesign New York's entire power system. Reforming the Energy Vision focuses on managing demand and integrating distributed energy resources rather than relying on excess reserve capacity. The Electric Power Research Institute (EPRI), the research arm of the country's investor owned utilities, is focusing efforts on increasing the reliability and resiliency of the grid by strategically integrating distributed energy resources. [165] Other states are initiating similar efforts in anticipation of the introduction and dramatic growth of distributed energy resources, but Michigan has no similar process to plan for the future deployment of the distributed energy resources that are coming to energy markets.

TECHNOLOGY BARRIERS

The vision of highly granular distributed energy resources interconnected, modulated and harmonized by a super-intelligent, autonomous, bi-directional smart-grid is within reach, but success is contingent on further progress in key areas.

ENERGY STORAGE

Variable resources like wind and solar can be integrated into the power system while meeting demand and maintaining grid reliability. NREL's Renewable Electricity Futures Study demonstrates that 80 percent of electricity can come from renewable energy sources and meet hourly demand in every region of the country. [166] Achieving cost reductions for advanced energy storage technologies can only accelerate the transition to a modern power grid. Economically efficient energy storage systems for the home, business and utility sector will transform the power system into highly decentralized, resilient and decarbonized energy ecosystem. Economical energy storage systems would fully mediate the challenge of intermittent resources like wind and solar energy. Energy storage would also enable systemic energy management, providing backup and emergency power, frequency regulation, voltage support, and grid stabilization services. [167] Integrated into the distribution system to optimize its load balancing services, energy storage can displace expensive combustion turbines that operate only infrequently to provide reserve capacity. Energy storage is already more economical than combustion turbines when taking into account the grid support services storage provides, and the inevitable trend toward improved technology and lower storage costs in the future suggests that long-term investments in new combustion turbines may be improvident.

The market for lithium ion batteries is expected to reach $43 billion by 2020. [168] Michigan is uniquely positioned to lead in energy storage development with Michigan-based companies receiving $1.3 billion of $2.4 billion made available for battery manufacturing under the American Recovery and Reinvestment Act of 2009. [169] The highly competitive global market will be fueled not only by the need for commercial and utility-scale energy storage systems, but also by the proliferation of electric vehicles.

BARRIERS TO ADVANCED ENERGY IN ELECTRIC GENERATION

GRID MODERNIZATION

The transformation of the power grid is a complex process of integrating automated controls, sensors to monitor grid performance, diagnostic tools and security measures. It demands a grid architecture capable of managing millions of stochastic energy inputs and outputs and requires new standards and communication and interoperability protocols. Grid 2.0 will continuously analyze millions of data points, diagnose weaknesses, anticipate failures and automate repairs, ultimately reducing the number of outages and shortening their duration.

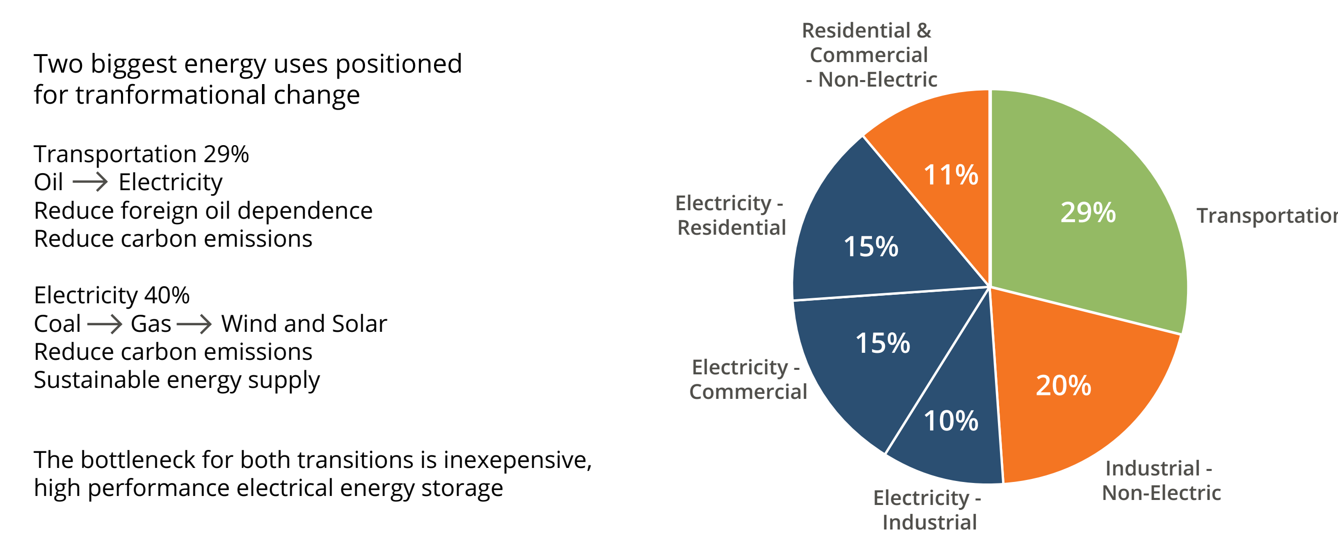
For the most part, utilities and regulators have not yet fully focused on grid modernization. Leading states are assembling collaboratives and stakeholder groups to determine the best pathway forward. Michigan utilities are deploying advanced metering infrastructure as an important first step.

In December 2013, the Massachusetts Department of Public Utilities issued an order requiring each electric distribution company to develop and submit a ten-year grid modernization plan. [170] *The Order establishes four grid modernization objectives:*

- *Reduce the effects of outages*
- *Optimize demand, which includes reducing system and customer costs*
- *Integrate distributed resources*
- *Improve workforce and asset management*

MICROGRIDS

The Department of Energy defines a microgrid as "a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode." A microgrid is essentially smaller version of the "macrogrid" but designed to provide energy services within the defined electrical boundaries of a university campus, hospital complex, governmental center or potentially any unified area of service.



Interest in establishing microgrids is growing with the availability of improved technologies, the lower costs of solar energy, advanced storage capabilities, smart-grid technologies and low natural gas prices. As a result of Hurricane Sandy and other severe storm events, the ability of microgrids to continue to operate as energy "islands" and provide power to critical infrastructure is increasingly attractive to institutions, businesses and policy-makers. A $10 billion market today, microgrid investment is expected to quadruple to $40 billion annually by 2020. [171]

Microgrids have many other potential benefits beyond increased energy resiliency and security: they can operate at high levels of efficiency by utilizing combined heat and power; participate in capacity markets and derive revenue from energy arbitrage; provide support to the central grid; and store energy from variable resources.

NextEnergy has been a national leader in developing microgrid enabling technologies and has helped launch numerous high tech startups.

Microgrids face many of the barriers confronting new technologies. Microgrids require significant investment and securing financing may be problematic. The ability to operate continuously and maintain power in the face of widespread outages has great value but is difficult to measure and monetize. Interconnection standards and interoperability protocols are still being developed. The separation and lack of communication between executive management who determine funding priorities for capital projects and facility managers who operate power plants can make change difficult and slow innovation.

The interrelationship with existing utilities services can be complicated as microgrids can result in lost revenue to utilities while utility standby and demand charges can undermine the economic case for microgrids. Regulatory barriers to utilities offering microgrids as either a premium, value-added service or as a way of enhancing the resiliency of designated critical facilities also serve as a roadblock to greater microgrid development, and should be addressed. [172]

Designing, building, interconnecting, operating, and maintaining microgrids are clear potential areas of opportunity for 21st Century utilities, but are outside the boundaries of our existing regulatory architecture. Regulatory innovation must parallel technology innovation and both must be enabled and directed by business leaders and policy-makers who grasp the many advantages microgrids and other distributed energy resources can provide.

TRANSMISSION CONSTRAINTS

In its 2013 quadrennial review, the American Society of Civil Engineers (ASCE) gave U.S. energy infrastructure a near failing grade - D+. The ASCE found that although the introduction of smartgrid technologies has boosted needed spending on infrastructure, the U.S. faces a spending gap for transmission and distribution infrastructure in the coming decades. [173]

Transmission in Michigan is constrained by geography. Our two peninsulas limit cross border transmission and make it difficult to expand load balancing areas. Michigan's transmission network is limited in the amount of high voltage power that can be imported from other regions. Michigan cannot, for example, benefit from the inexpensive wind power generated in the Great Plains states for lack of transmission capacity. With limited transmission capabilities, further retirements of aging generation infrastructure will challenge Michigan's ability to maintain adequate reserve margins.

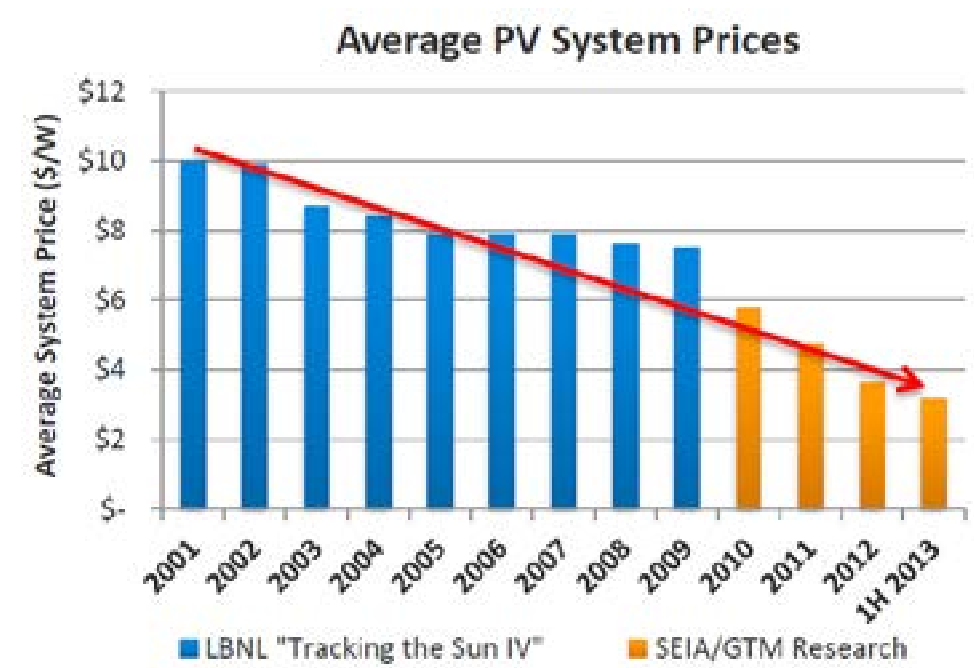
Consumers Energy and DTE Energy estimate that the cost of new transmission infrastructure attributable to meeting Michigan's RPS requirements at $570 million. [174] Interconnecting additional wind and solar farms will require additional capital expenditures for building out and upgrading Michigan's transmission system.

Renewable energy, energy storage, demand management and distributed energy resources could fill the void and meet future anticipated loads.

TRANSACTIONAL BARRIERS

LACK OF UNIFORMITY IN PERMITTING

The cost of solar photovoltaic panels has dropped precipitously, with prices falling 80 percent in the last five years and fifty percent in the last two years. Modules are now below $1 per watt and no longer represent the larger share of the cost of a solar PV system. The largest cost component of solar systems are the "balance of system" (BOS) costs that include all costs other than the modules - wiring, inverters, mounting systems, and permitting and permit fees. BOS costs also include the costs of logistics and the time spent securing permits and authorizations to interconnect the system to the grid. At the close of 2012, BOS costs represented 64 percent of the total residential system cost. [175]



In Michigan, electrical permits are issued by an approved jurisdictional authority that, depending on location, can be the Electrical Division of the Michigan Bureau of Construction Codes, a county or a local unit of government within the county. There are 1,740 state, county and local permitting authorities in Michigan. [176] Although each permitting authority follows the same electrical code requirements, the jurisdictions may have different procedures, policies, fee schedules and inspection requirements.

The installation of solar systems also require building permits that are issued by differing jurisdictional authorities with varying requirements. The lack of state-wide uniformity is a significant problem for both homeowners and businesses seeking to deploy solar systems and the installers who must deal with differing requirements from multiple jurisdictions.

Other states have addressed this problem by streamlining the permitting process and, ideally, attaining uniformity among jurisdictions. With support from DOE, the Solar America Board for Codes and Standards has developed a uniform permitting template that should meet the safety and engineering requirements of most states for systems up to 15 kW. [177] NREL has also published case studies from other states that have successfully streamlined the permitting process. [178] Michigan has yet to make effective use of these available resources to simplify the permitting process.

PROJECT RESISTANCE

As Michigan continues to accelerate the adoption of renewable energy, thoughtful and robust interaction with communities that host the wind, solar and other renewable energy projects will become increasingly important. More renewable energy projects will mean greater future project density. The propagation of utility-scale wind and solar parks will engender public responses ranging from greater enthusiasm from advanced energy proponents to deep concern from others who feel that the burdens associated with the impacts of local projects outweigh the benefits.

The increasing likelihood that community leaders and members of the public will directly encounter and interact with large-scale renewable energy projects as well as smaller, distributed energy systems creates a need to convey comprehensive, accurate and useful information to the general public.

The rapid evolution of advanced energy and the complexity of the technologies coming to market also make it difficult to remain current and well informed. Effective engagement of policy-makers and the public at large requires new approaches and better communication methods.

Garnering public acceptance of renewable energy projects is challenged by a number of barriers that existing means of communication fail to overcome.

- Many projects are planned, designed and advanced before there is any public communication beyond the initial effort to secure land leases. Projects developers then face the challenge of persuading the affected public to accept a "done deal."
- Failing to address community questions and concerns prior to advancing projects exacerbates suspicion and fear that projects will negatively affect community health, environmental and economic concerns.
- Traditional means of public communication do not directly engage the community in a manner that invests them in a process that promotes meaningful, fully transparent participation in a community dialogue.
- Public communication campaigns funded by project developers to support their own energy projects have limited credibility and effectiveness.

Michigan's largest wind project in Gratiot County received unanimous support from all county and township governmental bodies as a result of the community engagement efforts by the project developers long before ground was broken. Improved communications and direct engagement with community leaders and their constituents in interactive, intimate, bi-directional conversations that ensure that community concerns are articulated and heard are essential in establishing a relationship of trust and respect that is the basis of achieving community consensus.

COUNTY MASTER PLAN SPURS WIND-RELATED ECONOMIC DEVELOPMENT

Shortly after the State of Michigan enacted its energy law in 2008, interest in developing wind projects began to grow in a number of communities around the state, including Gratiot County, a mostly agricultural county located approximately 45 miles north of Lansing. In response, local elected leaders and economic development officials began the process of developing a master plan that eventually resulted in a seamless wind energy ordinance that covered the entire county (minus one southern township) with one set of rules, avoiding the patchwork of regulations that can hamper wind development. And because the process engaged the community and proactively addressed local concerns, Gratiot County is now home to Michigan's largest wind farm, has seen the largest increase in property values of any county in Michigan, and has captured hundreds of millions in direct economic impact as a result of wind development – all with broad local community support.

Source: Midwest Energy News; Greater Gratiot Development, Inc.

BARRIERS TO ADVANCED ENERGY IN ELECTRIC GENERATION

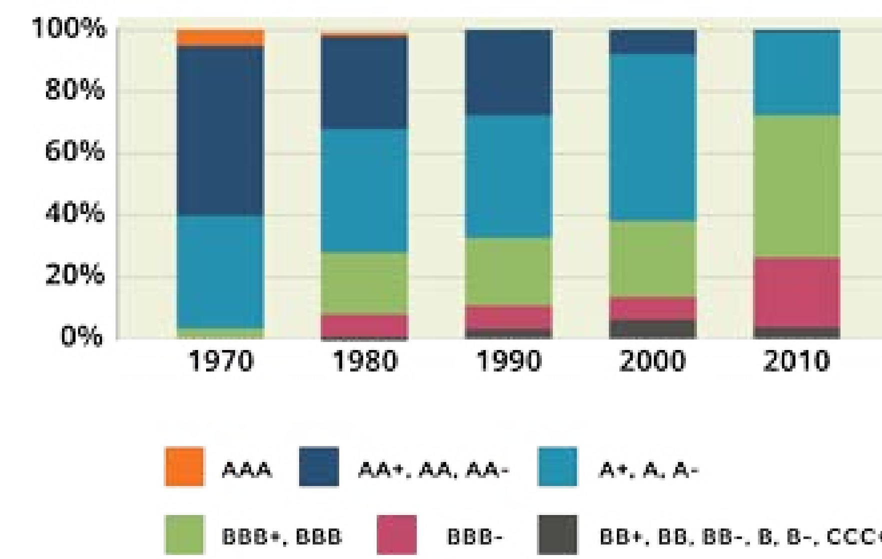
UTILITY BARRIERS

DISRUPTIVE CHALLENGES

Utilities face a multitude of challenges to their business models that were not clearly evident even a short time ago. Utilities face reduced or negative load growth from energy efficiency and conservation, customers self-generating their own power with solar PV, CHP and microgrids, and third-parties providing energy storage and energy management services, demand response and frequency regulation. Utilities are also being hit with increased capital and operating costs from escalating fuel and fuel transportation costs and environmental regulations, and now are challenged to reduce GHG emissions as well.

U.S. Electric IOUs Credit Rating History, 1970 – 2010

S&P Credit Ratings Distribution, U.S. Shareholder-Owned Electric Utilities



Source: Ceres

The forces transforming the nation's energy system are so apparent, the potential disruption of new technologies so acute and latent with so many radical changes to the traditional utility business model that all of the nation's investor owned utilities were downgraded in May 2014. These emerging disruptive challenges implicate utilities' fiduciary responsibility to shareholders and should motivate appropriate action on a number of fronts.

INVESTMENT RISK AND CAPITAL NEEDS

The risk of investing in new technologies during period of rapid technologic evolution makes utility investment choices more complicated and risky. Utilities are experiencing demands for increased reliability (fewer outages, of less duration and reduced scope), as climate disruption increases the potential for weather related outages. At the same time utilities are being charged with integrating variable output, distributed, non-dispatchable renewable energy. Reliability must be maintained while transitioning to a new energy system for which experience is lacking and expertise and competencies have not matured.

Between 2003 and 2012, Michigan experienced the most major weather-related power outages of any state with 71 outages affecting 50,000 or more customers. This was almost 25 percent higher than Texas, the next highest state with fifty-seven. [179]

In Michigan, the Snyder administration, legislators, and industry leaders continue to express concerns regarding the need for regionally competitive electric rates. Yet an influx of new capital demands for maintaining and decommissioning existing infrastructure, environmental controls for compliance with new environmental regulations, and smartgrid and distribution energy infrastructure will create upward pressure on rates, and both DTE and Consumers recently filed cases with the MPSC seeking to increase rates to deal with capacity shortfalls. Adding further future complexity is the possibility that conventional energy assets may be stranded further accelerates the transition to advanced energy generation options.

BUSINESS MODEL ADAPTATION

These factors underscore the difficulty utilities face in transitioning to new business models. The long-established, vertically integrated utility business model will be tested by the inexorable waves of change affecting utilities everywhere. Yet this environment is latent with opportunity for those utilities that successfully adapt to these changes.

The centrality of utilities in the new energy paradigm is not likely to change. Utilities will inevitably become energy managers in addition to energy providers. A new utility role, that of "distribution platform managers" coordinating and integrating millions of multidirectional energy inputs and outputs promises to be a powerful, transformational business model. Interconnecting, measuring, dispatching and harmonizing diverse energy resources to deliver reliable, resilient power is both a significant undertaking and a prodigious opportunity for Michigan's utilities.

The 21st Century utility can also deliver a suite of other new services and choices to their customers; providing renewable energy and energy storage, reducing energy demand for customers through energy efficiency, managing smart buildings with integrated renewable energy systems, aggregating energy savings through demand response, and managing demand and smoothing loads.

REGULATORY REFORM

As utilities develop the capacity to integrate and manage distributed energy resources, there is a corresponding need for regulatory and market innovation. Energy policies should enable and reward innovation. Utilities lack the resources and flexibility under existing regulatory oversight to invest in innovative, valued-added services or explore new business models.

The existing rate-of-return regulatory model providing utilities with a defined return based upon the value of the central station assets and unidirectional distribution networks is too inelastic, and does not fit the emerging energy products and services utilities will provide in the future. Utility regulation will need to transition, at least in part, from a rate-of-return, cost of service model to a performance based or "results-based" model where utilities are incentivized and rewarded for achieving desirable outcomes or penalized for not meeting prescribed targets.

For nearly a century utilities have operated without the need to innovate in designing new services or compete in the marketplace. The MPSC's regulatory architecture was not designed to encourage innovation, new energy services, or new utility business models. Distributed energy resources are transforming customers from passive ratepayers to active participants in the power system, providing new opportunities for both utilities and their customers.

Fostering innovation in energy services demands reform and modernity in regulatory structures. Under existing law it is questionable whether the MPSC has the authority to adopt a "results-based" program. On one hand, the MPSC is charged with establishing "rates, terms, and conditions of electric service that promote and enhance the development of new generation, transmission, and distribution technologies." [180] On the other hand, existing law examines utility expenditures through a traditional regulatory lens and requires that they be "reasonable and prudent."

ECONOMIC BARRIERS

CHRONIC UNCERTAINTY OF FEDERAL TAX POLICY

One of the largest financial challenges facing renewable energy developers is the chronic uncertainty over federal tax credits for renewable energy projects. Over the last decade, the perennial debate over the federal production tax credit (PTC), the investment tax credit (ITC), and other energy tax provisions has created a boom-bust cycle of investment and project development. The most recent Congress enacted legislation in December that extends the PTC, the 179D Commercial Building Energy Efficiency Tax Deduction and a number of other provisions, but only through the end of 2014 (retroactive to January 1, 2014), meaning that projects developed in 2014 ultimately qualified for the credits, but developers will again face uncertainty as to whether the Congress will approve the same credits for projects developed in 2015 and beyond. In addition, the current 30% ITC for solar and other projects expires at the end of 2016, at which point it will fall back to a 10% credit. This looming deadline is already impacting investment decisions for larger solar installations, and will increasingly chill solar deployment if Congress fails to act.

STATE TAX TREATMENT OF SOLAR PROJECTS

Solar energy systems in Michigan have encountered disparate tax treatments that have undermined the economics of solar projects. For taxation purposes, property is commonly classified as "real property" or "personal property." Commercial and industrial installations are regarded as personal property. In 2013, Michigan legislation abolished personal property taxes for the commercial and industrial sectors subject to a replacement tax that was approved by voters in August 2014.

Solar PV installed on residential premises in Michigan, however, is considered an improvement to real property and is subject to property taxes. While some tax assessors take the position that there is an indeterminate effect on value of solar improvements on residential premises and therefore do not impact the residential tax burden, other assesors increase the state equalized value (SEV) of property, thus taxing the solar system and reducing the financial benefit of the system.

The lack of uniformity in tax treatment could be resolved through clarifying legislation. Stakeholder collaboration with the Michigan Department of Treasury, the Michigan Tax Commission, and the Michigan Assessors Association could be a pathway to achievement both clarity and greater uniformity among assessor and governmental taxing authorities.

Eliminating the sales tax on solar PV systems could also marginally accelerate penetration of solar power by improving the economics of system costs. Twenty states have some form of sales tax exemption that apply to either residential or commercial sectors.

STATE TAX TREATMENT OF WIND PROJECTS

Utility-scale wind energy projects have their own set of taxation problems that make large-scale development projects less attractive. Wind projects require large tracts of land and often cross multiple governmental jurisdictions that often have different tax structures and millages. Project developers in Michigan, therefore, must understand the requirements of local taxing authorities and local procedures for filing and paying taxes.

Adding to this complexity is the fact that local millage rates and tax initiatives are not necessarily fixed; government may change the taxation rate for projects, affecting the return on investment and undermining the economics of a project. Finally, Michigan jurisdictions require separate personal property tax filings for every wind turbine within a project area, adding to the administrative burden of developing projects in Michigan.

Potential solutions exist for these problems facing wind projects. The telecommunications industry managed to garner support for similar problems associated with building "lines and poles." A change in law could render taxation uniform and provide greater certainty.

RECOMMENDATIONS TO ACCELERATE ADVANCED ENERGY IN ELECTRIC GENERATION

- Increase Michigan's renewable portfolio standard, setting new medium-term and long-term targets for advanced energy at levels equal to leading states.
- Establish a comprehensive, adaptive process for forecasting Michigan's future electric demand and assessing electric generation technologies taking into account capital, operating and fuel costs, environmental concerns, anticipated regulations, and the adoption of distributed energy resources by utilities and end users.
- Improve system reliability by deploying grid monitoring and diagnostic tools, automated controls, and communication systems having the capacity for instantaneous identification, isolation, repair or circumvention of system failures.
- Improve system resiliency by incenting microgrids and interconnecting distributed energy resources with the capacity to operate in an "island" mode; allow the sale of excess power.
- Explore new finance and business models that enable broad adoption of distributed energy resources.
- Identify, assess and deploy smart grid technologies through MPSC sponsored collaborations with utilities, system operators, advanced energy technology companies; optimize the integration of distributed energy resources to aid smart-grid design, engineering and new grid architecture.
- Allow distributed energy resources to compete head-to-head with conventional resources; create a level playing field for all energy resources and energy services by limiting fees and charges associated with interconnection, standby services, load firming, and other administrative costs.
- Improve the terms of net metering offerings including higher system caps, better offtake terms, and the removal of aggregate caps on net metered installations.
- Build capacity for use of big data and data analytics to improve energy services and optimize system performance.
- Integrate fast ramping technologies with improved forecasting capabilities to optimize utility-scale wind and solar systems.
- Utilize time-varying and dynamic rates to shift demand, shave peaks and smooth loads.
- Streamline the permitting and interconnection process for distributed generation systems and energy storage by standardizing the application, inspection and approval processes across Michigan's regulatory jurisdictions.
- Pursue proactive community engagement strategies to educate potential host communities on the various economic and other benefits of renewable energy development.
- Allow and encourage utilities to provide a range of value-added services to customers seeking more than "basic" electric service.
- Clarify the tax treatment of renewable energy projects, including both distributed- and utility-scale installations.
- Allow for those individuals and firms seeking to obtain a greater share of their energy from renewable energy sources to be able to do so.
- Promote greater certainty in federal tax policy for advanced energy projects.

CHAPTER 6 BARRIERS TO ADVANCED ENERGY IN THE TRANSPORTATION SECTOR

The pace of energy innovation in the transportation sector is accelerating, and advanced energy offers multiple opportunities to increase fuel economies, reduce overall transportation costs, and lower greenhouse gas emissions. One of the largest opportunities is to power our transportation fleets with electricity. This move would provide a number of significant benefits. Electrification would fortify U.S. national and energy security by first reducing, then eliminating, dependence on imported petroleum.

Electrifying transportation would also accelerate research and commercialization of innovative technologies and catalyze next-generation industrial processes while taking advantage of Michigan's many strengths in the automotive sector. It would enhance Michigan's leadership in auto-related technology development and engineering, while providing opportunities for Michigan to create new higher-skilled, better paying jobs in advanced manufacturing and the electric vehicle supply chain.

Transportation accounts for 33 percent of GHG emissions and 71 percent of all petroleum use in the U.S. [181] As with all other energy sectors, the transformation begins with efficiency; more efficient vehicle technologies and reduction in vehicle miles traveled (VMT) by using personal vehicles less and other modes of public transportation more. But at its core, the transformation requires reducing the fuel carbon intensity (FCI) from petroleum-based transportation fuels as well as ensuring that electricity for plug-in electric vehicles (PEVs) and hydrogen for fuel cell electric vehicles (FCEVs) are derived from low-carbon or zero-carbon sources.

There are a number of studies examining the technical and economic feasibility of transitioning to a low-carbon transportation system in the next several decades. They range from relying exclusively on electrification of all transportation systems to those that include significant reliance on the production of low-carbon biofuels for at least some of the transportation sectors.

The DOE Transportation Energy Futures (TEF) project has identified pathways to achieve a minimum 80 percent reduction in the use of petroleum based transportation fuels and a corresponding decrease in GHG emissions. NREL analyzed three low-carbon scenarios (Portfolio, Combustion and Electrification) that would each achieve both goals of reducing petroleum use and GHG emissions by relying on increasing the efficiency of vehicles, reducing vehicle miles traveled (VMT), and substituting biofuels for petroleum. The NREL scenarios assume that electrification dominates the light-duty vehicle (LDV) sector and biofuels are prevalent in the nonLDV sectors (truck, rail, aircraft, military).

Under the DOE model, vehicle efficiency (reflecting the efficiency of electric motors) accounts for approximately 55 percent of the reductions, reductions in VMT account for 10 percent, with low-carbon fuels accounting for 35 percent. The combination of a 40%-50% reduction in fuel use and a 60%-65% reduction in FCI, brings each of the low-carbon scenarios to the 2050 GHG goal for this analysis of 80% below 2005 GHG levels.

The IEA's Energy Technology Perspectives (ETP) 2014 examines the combination of policy and technologies that would result in global warming scenarios of 6°C, 4°C and 2°C by 2050. The ETP's Low-Carbon Electric Transportation Maximisation Index (LETMIX) shows that electrification of LDV and nonLDV sectors could significantly reduce GHG emissions. Under the most aggressive 2°C scenario, LDVs, public transport and freight rail are electrified as well as some nonLDVs.

The Solutions Project, a project led by Stanford University professor Mark Jacobsen, proposes to supplant all petroleum-based fuels for all transportation modalities with electric motors or hydrolytic hydrogen. Because of the high efficiency of electric motors, electrification of the transportation system is calculated to reduce end-use power demand by 37 percent. [183] The analysis shows that Michigan can obtain 100% of its energy needs from wind, water, and sunlight, including all necessary electricity for transportation, [181] at less cost that the existing conventional power system. [185]

TECHNOLOGY BARRIERS

Unlike the electric utility sector, where today's advanced energy technologies can adequately supplant conventional technologies, electrifying the transportation sector by 2050 will require improvements in technology. Even though the total cost of ownership (TCO) may be less than conventional vehicles with internal combustion engines (ICEs), the higher upfront cost of PEVs is a significant deterrent to consumers. To accelerate PEV uptake, battery energy density must increase and vehicle weight must decrease.

Accomplishing both will remove the most significant barriers to greater PEV market penetration: vehicle cost and "range anxiety" - the fear that an electric vehicle will exhaust its batteries, stranding driver and passengers. Both of these issues are being addressed by rapid improvements in battery and power electronic technologies that are reducing cost and extending range.

As previously indicated, McKinsey & Company forecasts the cost of lithium-ion batteries will fall to $200 per kWh in 2020 with the result that PEVs will have a lower cost of ownership than vehicles with internal combustion engines. [186] The near term ambition of the DOE goes well beyond these targets. DOE's Joint Center for Energy Storage Research expects to develop battery technologies that provide five times the energy storage at one-fifth the cost within five years. [187] Should that goal be even partially achieved, market conversion of ICE's to electric drivetrains would occur rapidly, enabling attainment of GHG emission reductions for the transportation sector.

Today's rate of PEV sales growth is sufficient to largely displace ICE vehicles by 2050 despite the fact that vehicle fleets turnover slowly. [188] Navigant Research projects 2.3 million PEVs on U.S. roads by 2023 with a compound annual growth rate (CAGR) for LDV PEVs at 24.6 percent through the end of the decade (compared to total LDV sales, which are expected to have a CAGR of 2.6 percent). [189] According to Research and Markets, electric vehicle sales are projected to reach 7.5 million vehicles by 2020 with a CAGR of 19 percent. [190]

While these numbers sound ambitious, in a recent speech at the Detroit Economic Club, former DTE Energy CEO Tony Earley - now CEO of Pacific Gas and Electric - noted that in 2010, just 0.8 percent of all vehicle sales were electrified vehicles, including hybrids. Three years later, that percentage had increased nearly five-fold, to 3.8 percent of total vehicle sales, and that globally, the number of plug-in vehicles has doubled every year for the past several years. The number of electric vehicle charging stations has grown as well, from 6000 in 2012 to more than 20,000 at the end of 2014.

Better batteries with higher energy density and lighter weight promise to improve PEV performance and lower operating costs by requiring less energy per unit of distance travelled. Research to improve battery design using new materials and chemistries is moving along on many fronts, including strategic collaborations by the Department of Energy, the Department of Defense and the private sector.

Other applications for grid-integrated PEV battery systems have the potential to further enhance the value proposition for PEVs, improving the economics and accelerating market penetration.

Technology collaboratives between government, academia and the private sector are focused on developing other valuable energy services that could be provided by PEVs, including:

- Vehicle-to-Grid (V2G) power - PEVs are becoming an energy resource for storing energy and delivering it back to the grid. V2G capabilities promise to fortify the reliability and resiliency of our national electric power system by enhancing grid stability and providing energy services like demand response and frequency regulation. [191] Enabled by advanced smart-grid power electronics and sensor and communications technologies, tens of thousands of PEVs could provide power to the grid. PEVs charging during periods of lower electricity usage could provide "carbitrage" opportunities for PEV owners to sell stored power during periods of peak demand. V2G is already advancing Department of Defense efforts to reduce dependence on fossil fuels, operationalize energy storage capabilities, and provide microgrid capabilities for forward operations.

In 2014, DOD acquired V2G technologies from Michigan-based Coritech Services to enable bi-directional electric vehicle charging capabilities. Detroit-based NextEnergy has facilitated numerous smart-grid technology collaborations with Michigan businesses and the U.S. DOE and Michigan's universities.

- Vehicle-to-Home (V2H) power– Back-up home and business generators that rely on gasoline or diesel fuel would face obsolescence with vehicle electrification. V2H systems are able to provide limited power to a typical home in the event of a blackout. Nissan, Mitsubishi and Toyota are equipping their PEVs in home markets to serve as an electric power supply for the home and business. [192] Already available in Japan, the Nissan Leaf to Home and Toyota V2H systems use inverters built into the charging station to convert stored energy from the battery into AC power for home use. Since home and business backup generators can cost more than $5,000 plus installation costs, this innovation will further improve the economics of PEV ownership.

Ford Motor Company is working on a fully-integrated advanced energy platform it calls MyEnergi Lifestyle, which would combine Ford's Energi PEV with smart meters from Eaton Corporation, smart appliances from Benton Harbor-based Whirlpool, smart thermostats from Nest, solar panels from SunPower, and invertors from Infineon to fully connect and automate on-site electric generation, smarter energy use in the home, and an electric vehicle for transportation and to provide V2H capabilities.

- Secondary Uses of Batteries for Energy Storage – The economics of PEV ownership could be improved by reusing automotive batteries in other applications after the batteries are partially degraded and no longer conform to vehicle specifications. Lithium ion batteries may retain as much as 70 percent of their original storage capacity after 10 years of service and may still have years of serviceable life in other applications, particularly, in commercial or utility scale energy storage systems. This additional capability adds value to the battery system, potentially creating a viable aftermarket, adding value to PEVs, and extending the energy storage technology supply chain. An analysis by NREL concludes that repurposed automotive batteries should be valued at $38/kWh to $132/kWh. [193] The secondary beneficial uses of automotive batteries also include frequency and voltage regulation, peak shaving, demand management and deferral of generation, distribution and transmission upgrades. [194] Similar to the state's efforts in leading the development of a regulatory framework for automated and connected vehicles, Michigan is well placed to lead in standardizing the regulatory and legal treatment of vehicle batteries for aftermarket grid applications.

LIGHTWEIGHTING VEHICLES

As home of the U.S. automobile industry with related automotive research and development capacities, a mature, sophisticated supply chain, and recent federal investment in advanced energy storage technology manufacturing, Michigan has clear advantages over other states in establishing a vibrant industrial cluster for electric vehicle manufacturing.

Despite these strengths, Michigan has not used these advantages to establish leadership in vehicle electrification. Unlike leading states, Michigan has not established electric vehicle program incentives or state-led planning efforts to promote electric vehicles.

Michigan has the capability to produce advanced manufacturing and advanced materials innovations that have potential cross-sector applications. New carbon fiber composites promise to outperform many existing materials. Carbon fiber composite materials are ten times stronger and 75 percent lighter than steel parts, 40 percent lighter than aluminum, and have higher tensile strength and durability. [195]

For automobile manufacturers, carbon fiber can displace heavier steel components, reducing weight and increasing the range of PEVs and traditional vehicles by requiring less energy per unit of distance travelled. Cutting the cost of carbon fiber and resins and improving the manufacturing process are the key innovations necessary for broader use of the carbon fiber to displace steel in hoods, fenders, roofs and truck lids.

Public/private partnerships and collaborative undertakings to develop and commercialize these new materials are underway. Fifty-eight companies and organizations have joined with Oak Ridge National Laboratory to establish the Oak Ridge Carbon Fiber Composites Consortium. [196] These companies, including Ford Motor Company, Dow Chemical Company, BASF, Steelcase as well as Michigan State University, aim to produce high volumes of low-cost carbon fiber. The collaboration holds promise to accelerate the use of advanced ultra-light materials in transportation vehicles, improving the performance and reducing energy consumption of both PEVs and ICEs.

DEPLOYMENT OF CHARGING INFRASTRUCTURE

The availability and location of charging infrastructure is a critical planning challenge requiring the cooperation of government, utilities, businesses and electric vehicle supply equipment (EVSE) manufacturers. Deploying charging infrastructure and facilitating "market readiness" by laying the ground work to accommodate electric vehicles are essential steps in the electrification of transportation.

"Michigan has clear advantages over other states in establishing a vibrant industrial cluster for electric vehicle manufacturing."

BARRIERS TO ADVANCED ENERGY IN THE TRANSPORTATION SECTOR

As of April 2014, Michigan has deployed 657 charging outlets, about 3 percent of the outlets in the U.S. [197] These are mostly "Level 2" charging systems that run on 240 volts and can recharge a PEV in 3-6 hours. Level 3 "fast-charging" technology can reduce charging times to 20-30 minutes, though Tesla operates the only publically available fast-charging station in Michigan.[198] As with other advanced energy technologies, costs are coming down rapidly with Level 2 charging stations costing as little as $400 while Level 3 fast charging stations cost $50,000 - $150,000 per station. [199]

Although industry surveys show that 81 percent of PEV charging is done at home, locating charging stations at multifamily housing units, high density urban areas, retail outlets, and at the workplace is a significant impediment that must be overcome. Ultimately, electric charging stations must be readily available and widely distributed if Michigan is to take meaningful steps towards electrifying transportation.

The deployment of charging infrastructure, however, presents a "chicken and egg" problem: the time, effort and cost of selecting suitable locations for charging stations and obtaining permitting and zoning approvals must reasonably align with the pace of PEV adoption. Building too much charging infrastructure too soon is costly and could result in poor locational choices and even obsolescence as EVSE technologies improve; building too little can dramatically frustrate electric vehicle adoption.

Michigan needs to accommodate electric vehicles while simultaneously launching strategies to boost consumer interest and customer satisfaction in using electric vehicles. Deploying charging stations to accommodate PEVs provides essential infrastructure to PEV owners while spurring new market opportunities, jobs and investment. In turn, parallel strategies to catalyze interest and spark demand for PEVs increase PEV penetration and complement the deployment of new infrastructure.

Urban centers present the greatest concentration of potential PEV customers. Many large cities share some key demographics that profile prospective EV purchasers – higher income, better educated, younger population that are attracted to sustainable, innovative technologies. But urban centers lack other characteristics that facilitate EV adoption – large cities have fewer single family homes with driveways and private parking that can accommodate charging stations. Instead, there are a higher percentage of urban dwellers who reside in apartments or condominiums. Multi-dwelling housing, condominiums and lessees presents special challenges for the deployment of EVSEs due to the lack of places to locate charging stations. Moreover, the periodic turnover of residents further complicates the issue of ownership and control of charging stations.

ANTICIPATING TECHNOLOGICAL CHANGE

Induction charging has the potential to displace cords and plugs by use of wireless technology that automatically charges the vehicles battery when a PEV equipped with a receiver parks over an induction pad producing an electromagnetic field.

Induction charging could not only make electric vehicles more convenient generally, it could also help to facilitate the conversion of vehicle fleets and public transportation to electric drives by charging taxis and public transportation vehicles each time they are parked at taxi stands, bus stops or other locations where induction charging units are deployed.

EDUCATIONAL BARRIERS

There is a significant need for public education and public engagement in order to familiarize consumers with the pros and cons of electric vehicle ownership and, at a broader community level, initiate planning efforts so that communities are prepared for the transition to electrified transportation.

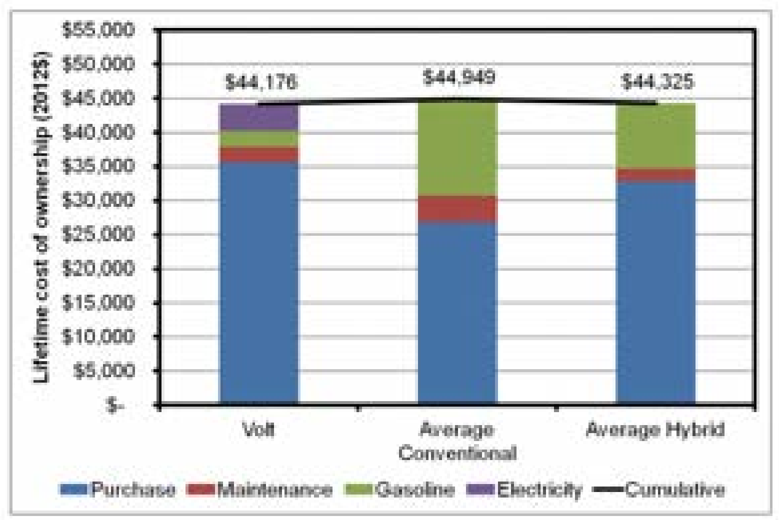
ELECTRIC VEHICLES: TOTAL COST OF OWNERSHIP

With EVs being new to the market and ownership experience being limited, the public remains largely unaware of the benefits and costs of EVs. EVs are generally perceived as being expensive and long-term performance of battery packs is at yet unmeasured in the real world. Consumers lack data and information concerning the performance, resale value, maintenance, and the total cost of ownership (TCO) of EVs.

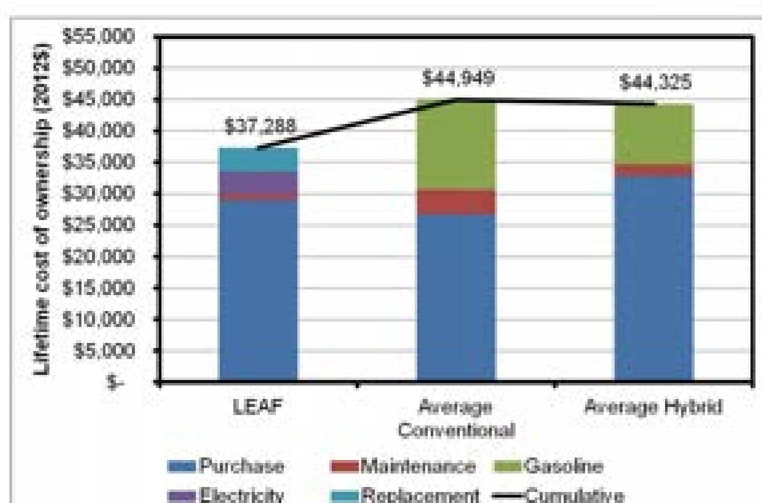
Notably, on a TCO basis, EVs and PHEVs are already at or below cost parity with conventional ICE vehicles. EVs and PHEVs have comparatively low maintenance costs, have high torque for faster acceleration, and even at today's gasoline and diesel fuel prices, compete economically with ICE vehicles. EPRI's recent analysis of the Chevrolet Volt and the Nissan Leaf found both vehicles TCO below the TCO for similar conventional vehicles. [200]

Despite the favorable TCO, the higher upfront costs of PEVs likely discourage potential purchasers from accurately assessing the long-term economic benefits of EV ownership.[201] As in the case with LED and CFL light bulbs, consumers eschew the higher upfront cost even when the long-term savings are considerable. Similarly, many consumers will not choose to purchase PEVs with higher initial cost unless the long-term savings are substantial or the consumer is motivated by the other external factors like concern for the environment.

COMPARATIVE TOTAL COST OF OWNERSHIP FOR VOLT AND OTHER SIMILAR VEHICLES



COMPARATIVE TOTAL COST OF OWNERSHIP FOR LEAF AND OTHER SIMILAR VEHICLES



BARRIERS TO ADVANCED ENERGY IN THE TRANSPORTATION SECTOR

Building successful partnerships brings diverse resources and expertise to common purpose, creating and sustaining relationships

ELECTRIC VEHICLE COMMUNITY COLLABORATIVES

Collaborative efforts that foster and galvanize broad groups of stakeholders to engage in planning activities are an essential step in the process of enabling and accelerating the pace of EV adoption. Around the country, early-adopter communities have formed voluntary collaborative bodies to research and prepare for EV deployment.

All effective collaborations share a common characteristic: they coalesce participants who represent key community interests, bringing credibility, knowledge, expertise and consensus building skills to a well-organized and structured forum with shared goals and objectives. Building successful partnerships brings diverse resources and expertise to common purpose, creating and sustaining relationships that aggregate and leverage private, governmental, academic, philanthropic and community assets.

In 2008, the MPSC convened a voluntary group of stakeholders including utilities, automobile manufacturers, government agencies, electrical workers, environmental groups, and associations representing Michigan cities, counties and townships. Together they formed the Plug In Michigan collaborative to overcome barriers limiting PEV penetration. The initiative addressed incentives, special EV rates and tariffs, charging infrastructure, and educational outreach. Despite good progress, the initiative ended in 2011.

Meanwhile, many states have redoubled their efforts to galvanize consumer interest in PEVs, plan EVSE infrastructure improvements and provide incentives.

Governors from California, Connecticut, Maryland, Massachusetts, New York, Oregon, Rhode Island and Vermont signed an agreement on May 29, 2014 outlining a strategy for putting more electric vehicles on the roads. The 11-point plan has a goal of adding 3.3 million zero-emission vehicles by 2025.

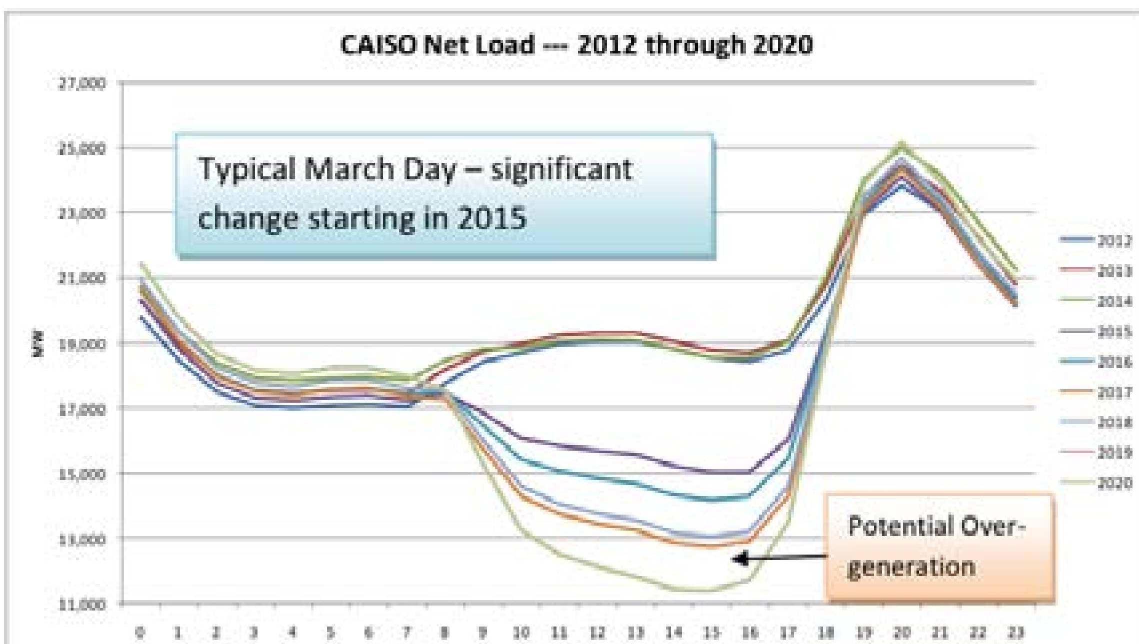
UTILITY BARRIERS

GRID INFRASTRUCTURE IMPROVEMENTS

The U.S. already has present capacity to fuel electric vehicles. The national grid has the present capacity to provide power to 84% of the nation's cars, pickup trucks, and SUVs (198 million) or 73% of the light duty fleet (about 217 million vehicles). [202] NREL's review of related studies show that replacing 50 percent of all vehicles with PEVs would require only an 8% increase in electricity generation and a 4% increase in generation capacity. [203]

Navigant Research estimates that PEVs increase residential household loads by 33 to 37 percent. [204] Because most charging will occur at home, it is important to minimize the spike in energy demand that will occur if most charging occurs when PEV owners return home at the end of the work day.

If homes are self-generating electricity and are equipped with energy storage capacity, then charging PEVs late in the day may not pose a problem. But if a high concentration of PEVs were to be charged by conventional generation resources, the time of day PEVs are charged, the rate at which they are charged and the charging location may become significant factors in the management of electricity demand and the generation resources needed to meet load.



Source: California Independent System Operator

Finding ways of redistributing and smoothing the energy load so that vehicle charging does not result in large peak demand will become increasingly important as PEV penetration increases. A number of states, including Michigan, are already examining ways of integrating PEVs using rate designs that encourage off-peak charging, yet more can be done to scale these programs.

Grid modernization efforts that accompany the transformation of the electric power sector will facilitate greater penetration of electric vehicles and, at the same time, use the energy storage capacity of PEVs to enhance grid stability, reliability and resiliency.

ECONOMIC BARRIERS

Although the United States has a national commitment to support research, development and commercialization of electric vehicles, Michigan lacks a corresponding state commitment to spur electric vehicle adoption. Michigan lacks financial incentives for vehicle purchasing and does not have a robust system to support and guide community planning efforts for PEV adoption. Nor are there state-led efforts to incentivize or otherwise support the deployment of EVSE and charging infrastructure. Michigan ranks 9th among states in car registrations but ranks 20th for electric vehicle registrations in 2012. [205] Michigan needs policies supportive of PEV deployment to create market synergizes, induce investment and catalyze growth.

ABSENCE OF FINANCIAL INCENTIVES

Well-designed policies can accelerate EV uptake and improve consumer satisfaction by providing attractive benefits and economic incentives to EV owners. Yet Michigan has no effective statewide policies or programs that are directed at accelerating PEV adoption and growth. Michigan's only incentives for PEVs are exemptions from personal property taxes and vehicle emissions testing, combined with limited utility pilot programs for charging infrastructure and off-peak charging rates..

Unlike Michigan, many states have incentives for purchasing PEVs that complement the federal incentives of $2,500 - $7,500 tax credits per vehicle. [206] Harvard's Michael Porter and others have shown that incentivizing purchases of sophisticated products are the most effective means of spurring innovation and growth because it motivates manufacturers to be attentive to consumer trends. [207]

Electrifying transportation also requires investment in, and deployment of, charging infrastructure. Leading states have a portfolio of inducements and incentives for PEV ownership, including purchase rebates, tax credits for charging systems, and use of high-occupancy vehicle (HOV) lanes. Michigan lacks this suite of financial and non-financial incentives, though some Michigan utilities have a reimbursement program for charging stations and special rate structures for PEVs:

- Consumers Energy has an incentive program that will reimburse its customers up to $2,500 to offset the cost of installing a Level II charging system. DTE Energy and Indiana Michigan Power (I&M) had similar programs that are now fully subscribed.
- Consumers Energy offers a time-of-day rate for PEVs ranging from 9 – 22 cents per kWh. [208] DTE offers several different rate options for PEVs including a time-of-use-rate for off peak hours and a PEV rate available for using Level 2 charging systems, [209] and I&M offers a similar experimental tariff. The Lansing Board of Water and Light also offers a discounted off-peak rate for its customers that install Level 2 charging systems. [210]

PUBLIC AND PRIVATE SECTOR FLEETS

The fastest way to increase penetration of EVs is to enlist the cooperation of public and private partners who can aggregate purchases of electric vehicles. Federal, state and local government as well as private companies manage millions of fleet vehicles. Large volume car and truck purchases occur regularly as commercial and industrial enterprises and government meet their transportation needs through the scheduled, large-scale acquisitions of new vehicles.

Fleet purchases offer an opportunity to significantly accelerate the rate of PEV deployment by displacing vehicles ICEVs with substantial numbers of PEVs. In 2012, there were 8,604,000 fleet vehicles operating in the United States: 4,376,000 cars and 4,228,000 trucks. [211]

One recent effort toward this goal is the November 2014 announcement from the White House and the Edison Electric Institute that more than 70 electric utility companies, including DTE Electric, Consumers Energy, Indiana Michigan Power and We Energies in Michigan, were committing to devote at least 5 percent of their annual fleet acquisition budgets to purchasing plug-in electric vehicles and technologies.

Competition for Capital - Despite long-term savings opportunities, higher vehicle cost means increased upfront capital expenditures, making it difficult for businesses to invest in electric vehicles. The promise of long-term savings over a vehicle's service life often competes poorly with other capital demands that promise higher returns or shorter periods of return on investment. Correspondingly, with limited demand, major OEMs have not entered the market for medium and heavy-duty electric trucks.

Learning Curve for Fleet Managers - Public and private fleet managers may not be aware of the operational advantages and economies of electric vehicles. The higher cost of PEVs can be offset by avoided fuel costs, reducing operation and maintenance costs, and "right-sizing" batteries to match battery size for those companies with predictable, uniform daily driving routes. Most PEV fleets would also benefit from the lower electricity rates utilities charge to commercial and industrial customers.

Recent studies suggest that PEVs offer the most economical total cost of ownership (TCO) solution for some fleet operators. A study by Navigant Research determined that the low charging cost of EVs and PHEVs result in a lower TCO than for similar conventional vehicles in fleet operations. [212] Staples, for instance, has calculated that PEVs could save $66,000 in fuel costs alone over the 10 year service life of each vehicle, off-setting the higher initial vehicle cost. [213]

Electric vehicle fleets also have the potential to produce revenue streams that are unavailable to conventional vehicles, making investments more attractive. When fleets of electric vehicles are integrated into the grid they can provide an array of grid services that can be sold into energy markets. Electric vehicles in fleets are ideal for V2G applications and can take advantage of lower electricity rates at night for arbitrage and provide valuable grid services like energy storage, demand management, and frequency and voltage regulation. A MIT study found that the energy services fleet trucks could provide would be valued between $900 and $1,400 per vehicle per year. [214] The Institute of Electrical and Electronics Engineers (IEEE) found that fleet managers could offset 5-11 percent of TCO with revenue from V2G services. [215]

But the additional economic potential of electric vehicle fleets are not yet being realized or recognized by fleet managers. Monetizing these benefits and apprising fleet managers of the added value of electric fleets could be an effective strategy in boosting electric vehicle penetration.

Photo by: GGT Electric - www.flickr.com/photos/ggtelectric/

TRANSACTIONAL BARRIERS

The installation and operation of electric vehicle charging stations and appurtenant infrastructure require governmental approvals, permits, and inspections as well as compliance with ordinances, codes, and technical standards. Securing these approvals can be time consuming and expensive. As is the case with distributed energy resources, the lack of uniformity in codes and standards for electric vehicles across jurisdictions can result in confusion, delays and increased costs. Technical requirements, codes and specifications must keep pace with the innovations in technology. Interoperability and connectivity requirements must also keep pace with technological advances.

MASTER PLANS AND ZONING

PEV charging infrastructure deployed in communities must be readily available, visible, and convenient. Ideally, the pace of the EVSE deployment would parallel the expansion of the PEV market. It requires government, businesses, retailers, colleges and universities, hospitals, chambers of commerce, and other organizations to anticipate and accommodate the charging needs of a growing number of PEV owners. Local units of government must have the capacity to provide guidance and assistance to the public and the private sector to help in locating EVSE at government offices, retail stores, multi-family housing, city centers, campuses and parking structures. An understanding of EVSE technology, infrastructure needs, PEV usage patterns, permitting, codes, MPSC regulations, model ordinances and signage is essential to optimize the integration of charging stations as PEV usage increases.

The Clean Energy Coalition reports that as of 2012, only 15 percent of Michigan communities had master plans that facilitate EVSE planning, although over 70 percent of communities surveyed expressed interest in incorporating EVRE into their planning efforts if guidance was provided to them.

A number of states have initiated comprehensive planning efforts aimed at accelerating PEV market penetration. Examples:

- *The Clean Energy Coalition has created Plug-In Ready Michigan An Electric Vehicle Preparedness Plan, a toolkit providing communities with several options for integrating EVSE into community master plans and addressing zoning, permitting, parking and signage.* [216]
- *The Washington Department of Commerce created an Electric Vehicle Infrastructure Guide for Local Governments that includes model ordinances for electric vehicle infrastructure (EVI) including codes, installation requirements, signage and zoning requirements.*
- *Oregon has developed Scenario Planning Guidelines, to inform the Oregon Sustainable Transportation Planning Initiative as a means of not having to rely on past trends and assumptions in preparing for a low-carbon transportation future.* [217]

As a step beyond municipal planning efforts, regional planning that informs and connects local planning efforts to create a regional landscape of charging stations would facilitate efficient and cost-effective charging system networks.

AUBURN HILLS'S "ELECTRIC VEHICLE READY PROJECT" WINS NATIONAL RECOGNITION

As the home of one of the "Big Three" Detroit automakers, the City of Auburn Hills would seem a natural place to lead in preparing for the adoption of a new generation of electric vehicles. And in 2011, Auburn Hills started doing just that, beginning with the adoption of a comprehensive Electric Vehicle Infrastructure Ordinance that enourages new construction projects to "rough in" home garages and parking lots for future installations of EV charging stations. The ordinance, which is modeled after similar ordinances in Oregon, California, and Washington, makes planning for EV growth standard practice, helping to raise awareness and reduce red tape. Under the program, 68 charging station locations have been prepared as part of 16 separate development projects, with 18 charging stations already installed. Auburn Hills has also installed eight public charging stations at three locations across the city, and led the national development of standardized signage for EV charging.

These efforts have not gone unnoticed. In 2013, Auburn Hills was awarded the Planning Excellence Award for Best Practices by the Michigan Chapter of the American Planning Association. That same year the City was named a partner in the U.S. Department of Energy's Workplace Charging Challenge, with DOE Assistant Secretary David Danielson singling out Auburn Hills as a success story and model for other cities across the country to emulate.

Source: City of Auburn Hills

PERMITTING, INSPECTIONS & ZONING

Streamlining the permitting and inspection processes and having uniform standards across jurisdictions save time and money and increase consumer satisfaction and support for PEVs. While the Michigan Bureau of Construction Codes (BCC) promulgates standards and code requirements that have statewide application, the state has delegated permitting and inspection authority to qualified local units of government [218] who have differing permit application processes, fees and inspection requirements.

The Clean Energy Coalition reports that as of 2012, there were 774 jurisdictions within Michigan that use their own electrical permit forms that do not include specific EVSE information. [219] Other states have improved the planning and permitting process by standardizing forms and procedures and streamlining administrative processes, approvals and inspections to simplify and speed up EVSE installations.

CODES AND STANDARDS

Codes and technical standards applicable to PEV charging stations have been promulgated by the state Bureau of Construction Codes (BCC), the Society of Automotive Engineers (SAE), the Institute of Electrical and Electronics Engineers (IEEE), the National Electric Code (NEC) and Underwriters Laboratory (UL). The codes and standards govern design, engineering and safety requirements for homes and buildings, construction requirements for EVSEs and charging station plugs and connectors.

- Buildings - Retrofitting buildings and parking infrastructure is more expensive than integrating EVSE equipment into the design of new construction. Michigan's residential construction code recommends, but does not mandate, installation of dedicated circuits for charging stations for new construction. As the percentage of PEVs in the vehicle fleet increases, adoption of more prescriptive code requirements for EVSE would be in order.
- Charging Stations - As more automobile manufactures launch new PEV models, lack of uniformity in basic charging technology is an obvious market barrier that limits customer choice and results in economic inefficiencies. The SAE has created standards for Level 2 plug-in connectors (J1772) used by most PEVs today. Superfast DC charging stations, however, that are capable of substantially charging a PEV battery in less than 30 minutes, do not have uniform technologies or protocols. Tesla's DC fast charging units use a Combined Charging Standard (CCS) for the plug connector and software that communicates between the vehicle and the charging infrastructure. Nissan, Toyota and Mitsubishi have adopted the CHAdeMO standard and General Motors and Ford Motor use the SAE J1772 Combo system. Inevitably, EVSE uniformity or compatibility must provide PEV charging the same level of convenience as fueling for ICEs today. Tesla's recent decision to release its patents and open source its battery and EVSE technology could speed the adoption of uniform technical standards. [220]
- Energy Services – Improving the economics of PEV ownership is the most important barrier to overcome. Smart-grid development and grid modernization will include integration of PEVs to leverage their capabilities for providing grid support and energy services like energy storage and demand management. The SAE has promulgated protocols and specifications for communication and interoperability between PEVs and the electric power grid. [221] Protocols for integrating charging systems with solar arrays and energy storage are also under development. [222]

RECOMMENDATIONS TO ACCELERATE ADVANCED ENERGY IN THE TRANSPORTATION SECTOR

- Promote policies and incentives that accelerate electric vehicle penetration and the availability of electric vehicle supply equipment (EVSE).
- Encourage a robust build-out of electric vehicle charging infrastructure, with a particular focus on workplace charging.
- Catalyze collaborations between Michigan automobile manufacturers, advanced energy storage companies, and universities and national laboratories to develop next generation energy storage technologies, control systems and power electronics for electric vehicles.
- Capitalize on Michigan's strengths in advanced manufacturing, engineering and materials science to accelerate the lightweighting of vehicles and to create an industrial cluster for electric vehicle development and manufacturing.
- Support vehicle to grid (V2G) and vehicle to home (V2H) technologies to integrate electric vehicles into the smart-grid and to provide ancillary services and demand management capabilities.
- Encourage secondary use of electric vehicle batteries by developing model standards for warranting batteries for aftermarket use.
- Encourage electrification of truck fleets and pursue grid support opportunities for electric vehicle fleets.
- Provide educational opportunities and incentives to communities, including urban centers, to deploy electric vehicle charging infrastructure.
- Support efforts to standardize charging technologies, interconnection protocols and interoperability specifications.
- Continue and improve differential rates for electric vehicle charging.
- Support electric vehicle adoption, charging stations and dedicated parking through master planning and zoning that accommodates electric vehicles.
- Streamline the permitting and inspection of electric vehicle charging stations through adoption of standardized procedures.

CONCLUSION

The transformation of Michigan's power system is inevitable; the only variables are the rate at which the transformation takes place and the extent to which Michigan participates in the opportunities that the global energy transformation brings. Michigan's legacy strengths in advanced manufacturing, engineering and materials science as well as our research and academic capacities position Michigan well to capture emerging energy markets and supply the new energy technologies and services that will power the next century. Michigan's future success is a function of our ability to overcome the transactional, economic, policy, communication and other barriers blocking the path forward. Michigan's future opportunities are less dependent on breakthroughs in technology and more dependent on innovation in business, financial and regulatory models. Leveraging its strengths and using market forces, Michigan can transform its power system with advanced energy resources, and participate in global energy technology markets, while creating a more resilient, more responsive energy platform.

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A natural gas provider or an electric provider shall not spend more than the following percentage of total utility retail sales revenues, including electricity or natural gas commodity costs, in any year to comply with the energy optimization performance standard without specific approval from the commission:

(a) In 2009, 0.75% of total retail sales revenues for 2007.

(b) In 2010, 1.0% of total retail sales revenues for 2008.

(c) In 2011, 1.5% of total retail sales revenues for 2009.

(d) In 2012 and each year thereafter, 2.0% of total retail sales revenues for the 2 years preceding.

The statute, by its terms, appears to permit EO spending above the prescribed EO plans. In addition, Section 89(1) of the Clean, Renewable and Efficient Energy Act provides:

The commission shall allow a provider whose rates are regulated by the commission to recover the actual costs of implementing its approved energy optimization plan. However, costs exceeding the overall funding levels specified in the energy optimization plan are not recoverable unless those costs are reasonable and prudent and meet the utility system resource cost test.

Based on these provisions, spending beyond the amounts prescribed under the Act may be authorized if such costs are: 1) specifically approved by the MPSC; 2) reasonable and prudent; and, 3) meet the utility system resource cost test on a life cycle basis.

However, uncertainty is introduced by an additional statutory limit on cost recovery for the actual costs of an approved EO plan set forth in section 89(3) of the Act:

For the electric primary customer rate class customers of electric providers and customers of natural gas providers with an aggregate annual natural gas billing demand of more than 100,000 decatherms or equivalent MCFs for all sites in the natural gas utility's service territory, the cost recovery under subsection (1) shall not exceed 1.7% of total retail sales revenue for that customer class. For electric secondary customers and for residential customers, the cost recovery shall not exceed 2.2% of total retail sales revenue for those customer classes.

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