Michigan Jobs Project

A Guide to Creating Good-Paying Advanced Energy Jobs

JANUARY 2016

AMERICAN JOBS PROJECT

A Letter from the American Jobs Project

It's no secret that America's middle class is in crisis; indeed, "the hollowing out of the middle class" has become a well-worn phrase, causing politicians to rail, bloggers to rage, and citizens to reel. Polls consistently reveal that jobs and the economy are at or near the top of citizen concerns.[1] Over the last few decades, the loss of middle-income jobs in America has been due largely to the global shift in manufacturing ("tradable jobs") to emerging economies.[2] Of the millions of jobs lost during the recession, most were good paying, middle-class jobs.[3] Unfortunately, many of the jobs created during the recovery have been in low-skill, low-paying occupations.[4] These trends are not going to reverse themselves. Leadership is needed, but the gridlocked U.S. Congress has failed in recent years to adopt robust policies to stoke middle-class jobs in America.

In President George W. Bush's autobiography, Decision Points, the former president recounts a conversation he had with the then-President of China, Hu Jintao. "What keeps you up at night?" President Bush asked President Hu as an ice-breaker. As we can easily guess, what kept President Bush up at night was worry about terrorism. Hu Jintao's response was telling: what kept him up at night was, "creating 25 million new jobs a year" for his people.[5]

Is it possible to create good-paying American jobs in today's global economy? And what if the solutions did not involve Congress at all? What if there were creative middle-class job creation strategies being developed and tested in the laboratories of democracy -- the states and cities? The American Jobs Project seeks to answer these questions and provide a research-based roadmap for action for state and local leaders who are kept up at night trying to figure out how to create jobs for the people they serve.

Our quest starts with identifying the biggest market opportunity of our era: the global demand for advanced energy solutions. That demand -- whether borne out of a need for diverse, reliable and clean power or to achieve energy independence from unstable regimes -- creates "the mother of all markets" for local U.S. businesses to build and sell those solutions.[6] Strategically minded businesspeople looking at global growth projections in advanced energy demand are making major investments and reaping large revenues. In 2014, the private sector reported $1.3 trillion in global advanced energy revenues, the fastest growing year on record.[7] Advanced energy investments are now bigger than the global apparel sector and almost four times the size of the global semiconductor industry.[8] And jobs? Up to 16.7 million jobs are projected to be in the global advanced energy sector by 2030, almost tripling the 5.7 million people employed in the sector in 2012.[9] The question for the United States is: Where will those new jobs be created?

The American Jobs Project is about finding ways to make our states the answer to this question. If countries across the globe, including the U.S., are seeking technical products and solutions for our growing energy needs, how can U.S. businesses take advantage of this demand and build products locally that can be exported to the world? And how can we equip U.S. residents with the skills those businesses need to build their advanced energy products?

It is true that the U.S. will not likely be able to attract back the traditional manufacturing jobs of the past; those jobs are gone -- either to low-wage countries or to automation -- and we have to accept the fact that they are not coming back.[10] But our research shows that with innovative policies and a smart focus on industrial sectors, states can become hubs of innovation and job creation in specific advanced industries that soar with a state's strengths.

The American Jobs Project gives policymakers the tools to create good-paying jobs in their states. We propose innovative solutions built upon extensive research and tailored to each state. Many are best practices, some are new, and all are centered upon a state's business ecosystem. These solutions are written with an eye towards streamlining bureaucracy and are seasoned with the principles of competition, local control and fewer regulations.

If these recommendations are adopted, the beneficiaries will be those hard-working Americans looking for the dignity of a good-paying job.

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About us

American Jobs Project

The American Jobs Project is a national, interdisciplinary, research-based initiative. Our team has included nearly 100 student researchers with a broad range of expertise, including law, business, engineering, and public policy. We have ongoing relationships with hundreds of on-the-ground stakeholders and are actively collaborating with university partners and industry allies.

Peter Adriaens, Ph.D.

Dr. Adriaens is Professor of Civil and Environmental Engineering and Professor of Entrepreneurship and Strategy in the Ross School of Business, where he is affiliated with the Zell Lurie Institute for Entrepreneurial Studies. He is the past-President of the Association of Environmental Science and Engineering Professors, a member by eminence of the American Academy of Environmental Engineering, and a member of the Belgian Royal Academy of Applied Sciences, where he was recognized for bridging engineering and business entrepreneurship in academia and practice. Most recently, he was awarded a Finnish Distinguished Professorship for his work on cleantech portfolio financing models.

Following a 20-year career in technology development (environmental sensing, green buildings) and validation, his current work focuses on cleantech innovation and entrepreneurship. Specific interests include business water risk models focused on financial risk assessment, reverse innovation strategies for new mobility strategies, and development of indexes and investment portfolios in emerging cleantech clusters. He teaches courses on business models, entrepreneurial business fundamentals, cleantech venture assessment, and sustainability finance. He is the co-developer of the KeyStone Compact™, a data-driven analytical and strategic positioning tool that has been used by more than 1,000 global early- and later-stage companies in a wide range of investment domains (cleantech, biotech, ITC, space sciences) as well as economic development organizations in the United States, Europe, and Asia.

He is the co-founder and CEO of Water Risk Analytics, a large data and software analytics financial technology firm that addresses equity and portfolio risk and performance issues related to ESG investments. He is the CEO at the KeyStone Compact Group (www.keystonecompact.com), built around the KeyStone suite of tools addressing investment strategies across the business lifecycle. As the co-founder and Head Judge of the Global CleanTech Cluster Association (GCCA), he builds out value chains for industrial renewal by screening, repositioning, and connecting cleantech clusters and companies (www.globalcleantech.org). With 56 clusters in the Americas, Asia-Pacific, and Europe, representing nearly 10,000 companies, and $3.5 billion under management, the GCCA catalyzes global value system development. For more information, see www.linkedin.com/in/peteradriaens/.

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Dozens of hands were involved in the process of researching, writing, and designing the report. Nicole Danna and Daniel Curran co-led the research and writing. Jackie Kimble and Stephanie Smith were the lead editors and the lead analyst was Henry Love. Other contributors included Amariah Baker, Amanda Brief, Andrew Lewis, Matt Nguyen, Chukwubuikem Okoli, and Francisca Quense.

Executive Summary

The American Jobs Project was borne of two tough problems: loss of middle-class jobs in America and congressional paralysis. It seeks to address these problems by taking advantage of one of the biggest market opportunities of our era—the advanced energy sector—and to do so at the state, not the federal level. Policymakers who leverage the unique strategic advantages of their state to grow localized sectors of interconnected companies and institutions are poised to create quality jobs.

Michigan is well-positioned to benefit from the growing demand for advanced energy given the state's strength in advanced manufacturing and engineering, leading universities and research facilities, and skilled labor force. With investments totaling $2.9 billion, Michigan brought approximately 1,450 MW of new advanced energy projects online between 2008 and 2014.[11] Opportunities to leverage this momentum to further serve growing regional, national, and global markets offer real benefits for Michigan's economy and good-paying jobs for the state's residents.

Extensive research and more than 40 interviews with local stakeholders and experts in Michigan have resulted in identifying two economic sectors showing particular promise: smart buildings and solar.

There are several barriers hindering Michigan's advanced energy industries and preventing supply chains from reaching their full potential. Michigan must address these roadblocks to grow the state's advanced energy sectors and realize economic gains. In order to take full advantage of these opportunities, Michigan's policymakers can enact policies to increase demand for smart buildings and solar technology and to help the state's businesses grow, innovate, and outcompete regional, national, and global competitors. Indeed, with the right policies, Michigan can create as many as [XXXX] jobs through 2030. That is nearly [XXXX] jobs per year.

This project serves as a research-based roadmap for state and local leaders who seek to develop smart policies focused on leveraging Michigan's resources to create skilled, good-paying jobs.

Summary of Recommendations

The analysis presented in this report culminates in four thematic sets of recommendations for Michigan's policymakers. Each set of recommendations identifies opportunities for barrier removal and future growth in the advanced energy sector. Taken together, these recommendations chart a course for Michigan leaders to create and enhance jobs in the advanced energy sector.

Smart Building & Energy Efficiency

Allow On-Bill Financing for IOUs: Financing home energy improvements can be challenging because energy efficiency investments often involve high up-front capital investments. On-bill financing addresses this issue by allowing utilities (or financial institutions) to provide the upfront capital to finance energy efficiency improvements through a loan that is repaid on the customer's monthly utility bill. Michigan passed legislation in December 2014 that allows municipal utilities to offer on-bill financing programs to their customers. The Legislature could continue expanding access to this critical tool by repealing the on-bill financing ban for IOUs, which serve nearly 90 percent of electricity customers in Michigan.

Expand Dynamic Pricing to Promote Demand Response: Demand response is a pricing structure that allows utilities and grid operators to reduce costs by creating incentives for customers to adjust their demand for electricity in response to system conditions. Properly managed demand response can reduce the long-term cost of managing an electric grid by reducing the need to build expensive "peaking" power plants, and instead paying a lower cost for end-user demand reductions during peak hours. Michigan can capture the benefits of demand response by expanding dynamic pricing in two ways: (1) The Michigan Public Service Commission (MPSC) could make dynamic pricing the default electricity rate structure for all commercial and industrial customers in the state, expanding beyond existing pilot programs; and (2) residential customers could be allowed to opt-in to dynamic rates.

Allow for Decoupling of Electric Utility Revenues: Due to the way utilities are regulated, utility companies lack incentives encouraging investment in energy efficiency innovations that would serve their customers. To address this problem, almost half of U.S. states have adopted revenue decoupling mechanism programs for their utilities. Michigan can capitalize on the benefits of this type of regulatory structure by granting the MPSC the authority to implement decoupling for electric utilities.

Integrate Demand Reduction into the Capacity Planning

Process: Building new power plants is not the only way to meet a grid's capacity needs; permanent and "dispatchable" forms of demand reduction can also contribute electricity capacity to markets. For example, a supermarket may be able to automatically dim its lights in response to a "dispatch" signal from the grid operator. Similarly, a factory could permanently reduce its demand during peak hours through a project to eliminate energy waste in its HVAC system. Michigan policymakers could require utilities to investigate low-cost demand reduction alternatives before authorizing new generation be built under centralized planning processes. Alternatively, if Michigan moves towards a market-based approach for capacity planning, the MPSC could ensure that demand reduction proposals have the ability to bid directly into wholesale markets.

Remove the Spending Limits for Energy Waste Reduction by Utilities: Michigan utilities have exceeded target savings levels set by 2008 legislation (PA 295) aimed at driving smart investments in energy waste reduction. Current spending caps on utility waste reduction programs limit further increases in cost-effective savings. Given the long-term financial benefits of energy waste reduction investments, Michigan policymakers could eliminate these spending caps. Instead of a cap, the MPSC could require utilities to show an expected minimum return on investment for Michigan consumers on every dollar invested in energy waste reduction efforts.

Solar

Streamline Solar Permitting: Costly and inconsistent permitting processes currently burden solar expansion in Michigan. In fact, estimates suggest that up to 50 percent of the cost of a solar installation can be attributed to the time and money devoted to navigating the permitting process. The high cost of permitting contributes to Michigan having the tenth highest solar installation cost in the country. While proper permitting is both important and necessary, a confusing and burdensome web of permitting requirements that vary across the state is an unnecessary drag on Michigan's economic growth. Michigan could draw on recent successes in Colorado and Vermont where leaders have cut red tape and streamlined the solar permitting process across the entire state.

Remove Restrictions on Solar Net Metering: Michigan ranks in the bottom half of all states with respect to per capita solar capacity. Part of the reason for Michigan's low levels of solar power is its net metering policy, which is the primary mechanism for compensating residential and small-scale solar projects. Unfortunately, Michigan imposes individual and system-wide restrictions on solar projects to qualify for net metering. Michigan could alleviate these restrictions and increase the adoption of solar in the state by (1) raising the cap on individual solar projects to encourage larger distributed projects, and (2) raising the system-wide cap to send a signal to solar developers that the state is open for business.

Let Local Communities Develop Solar Projects: A straightforward way for Michigan leaders to support the state's emerging solar sector is to ensure that all consumers who wish to purchase renewable power have access to it. Currently, an estimated 49 percent of homes and 48 percent of businesses in the United States are locked out of the solar market due to the cost of financing a photovoltaic (PV) project, a lack of property rights (for renters), or because their land or buildings are not well suited for solar. Community-owned solar projects offer more local control for delivering solar power to customers who wish to purchase it.

Ease Taxes on Solar Projects: Solar installation tax assessments can have significant consequences on the economics of solar deployment within a state. Rulings by the Michigan State Tax Commission and Michigan Department of Treasury have effectively nullified intended legislative tax exemptions for commercial and industrial solar projects. Additionally, the state does not offer a tax exemption policy for residential solar. Michigan policymakers have the potential to grow the state's solar capacity by addressing related tax issues: (1) the legislature could extend tax exemptions to residential solar projects, putting them on an equal footing with commercial and industrial projects; and (2) the commercial and industrial tax exemption measure could be clarified to ensure that the Michigan State Tax Commission and Department of Treasury understand its intent.

Combine Solar and Electric Vehicle Charging Infrastructure: The transportation electrification process is underway. Under a scenario where vehicle fleets shift from dependence on gasoline and other liquid fuels to electric drive trains, demand for electricity will rise. Meeting a portion of this increased demand by combining solar with electric vehicle charging infrastructure provides distinct benefits for Michigan.

Innovation Ecosystem & Access to Capital

Facilitate Partnerships Within the Energy Innovation Ecosystem: Alignment between Michigan's leading research universities, private companies, nonprofits, and government can accelerate innovation and growth to stimulate a private market for energy innovation that will create jobs for Michiganders. The state could build on existing coordination efforts by allocating funding to jumpstart an energy innovation network.

Technology Investment Tax Credit: Investments in early-stage technology start-ups are essential for states to stay competitive and spur job creation. One policy that has seen success in multiple states is a Technology Investment Tax Credit. Michigan policymakers could offer this tax credit to grow the emerging hub of start-ups in Ann Arbor and Detroit, create a magnet for business investment, and boost economic activity.

Workforce Development

Capitalize on Digital Manufacturing to Drive Job Creation: Michigan leaders could build on existing strengths by facilitating public-private partnerships that increase the competitiveness and innovation capacity of small- and medium-sized manufacturers, promote advanced manufacturing technology, and develop corresponding workforce training. Without assistance, many companies cannot afford to invest in new technologies and the necessary workforce training, putting them at risk of losing out on major business opportunities.

Invest In and Retain Michigan STEM Talent: Michigan ranks last in the country in retention of young people, ages 25-34. This is a result of high numbers of young, skilled workers moving out of the state. STEM-educated students from Michigan's four-year universities could be incentivized to remain in-state after graduation through tax breaks.

Help Dislocated Veterans Transition to the Advanced Energy Sector: Many veterans have skills that can be retooled for advanced energy industries, making them an important population to consider in workforce development efforts. Michigan could establish a program for retooling veterans' skills for jobs in high-tech sectors, such as STEM and advanced energy industries

Chapter 1: Introduction

The American Jobs Project aims to spur job creation in the advanced energy sector by identifying innovative and state-specific policy and technology roadmaps. This national initiative takes advantage of the emerging global demand for advanced energy products and services. The American Jobs Project team analyzed the advanced energy economy in Michigan and designed recommendations specifically tailored to the state's strengths. These recommendations were informed by extensive research and over 40 interviews with local stakeholders and experts.

This report identifies opportunities to boost growth in two economic clusters in the advanced energy sector that leverage the state's legacy industries and current investment activities. State and local leaders who seek to leverage the state's resources to create skilled, good-paying jobs can use this report as a foundation for action.

Market Opportunity

Demand for advanced energy has soared in recent years and is poised for continued growth. Since 2004, new investment in the advanced energy sector has totaled $2.3 trillion worldwide.[12] In the United States alone, over $386 billion was invested in advanced energy between 2007 and 2014; $51.8 billion was invested in 2014.[13] In nationwide polls, Americans increasingly support renewables over other forms of energy[14] and demand for renewable energy is likely to continue to grow. By 2030, states will need to significantly reduce pollution from power plants.[15] The best way to meet those targets is from a combination of investing in advanced energy technology, utilizing renewable energy sources, and reducing demand through energy efficiency. Projections show that renewable energy will add the vast majority of generation (69-74 percent) between now and 2030.[16] These trends point to a clear market signal: demand for advanced energy will continue to grow over the next 15 years.[17]

Economic Clusters

Economic clusters encompass a variety of linked industries and institutions—including suppliers of specialized services, machinery, and infrastructure—which form a supply chain.[19] Clusters also extend to manufacturers of complementary products and to industries related in skills and technologies. By placing themselves in close proximity to industry allies, companies can benefit from each other's unique expertise and skilled workers.[20]

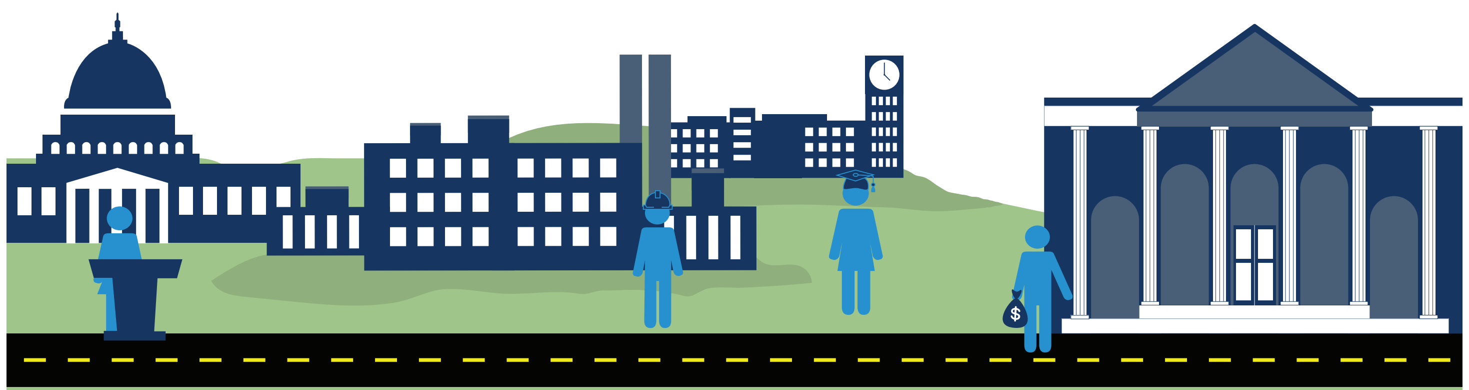
Companies in a cluster enjoy closer access to specialized skills and information, which helps increase productivity and efficiency.[21]

Geographic proximity and repeated exchanges of information help foster an environment of coordination and cooperation among these companies and institutions. Business clusters are shown to increase the productivity of companies in the cluster, drive innovation in the field, and facilitate the commercialization of this innovation by increasing communication, logistical support, and overall interaction between cluster entities.[22] Clusters also help build a strong foundation for creating and retaining employment opportunities.

> *"Clusters are geographic concentrations of interconnected companies and institutions in a particular field."*
>
> – Michael Porter, *Competitive Advantage of Nations*[18]

Economic Cluster

Economic Clusters are created when industries and institutions become linked with suppliers of specialized services, machinery and infrastucture that are within close proximity, forming a supply chain. Key elements to a successful cluster include Policy Certainty, Workforce Development, Innovation Ecosystem, and Access to Capital.



Policy Certainty
- Provides a clear market signal
- Reduces business risk
- Allows for long term planning

Workforce Development
- Invests resources in people
- Bridges skills gap
- Develops training programs and industry partnerships

Innovation Ecosystem
- Promotes research and development
- Facilitates new tech-nology to market
- Incubates early stage businesses

Access to Capital
- Provides funding for new and growing businesses
- Connects investors with market opportu-nities
- Attracts entrepreneurs

Michigan's Energy Profile

Current Energy Portfolio

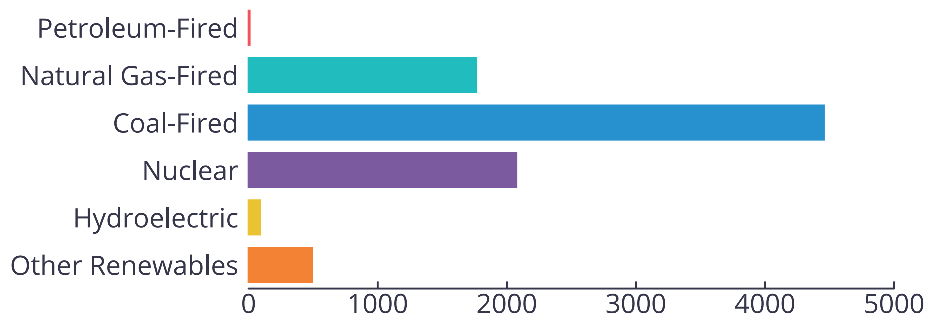


Figure 1: Michigan's Net Electricity Generation by Source (January 2015) (Source: U.S. Energy Information Administration http://www.eia.gov/state/?sid=MI#tabs-4)

Michigan's energy sector relies heavily on imported fuel. The state ranks thirteenth in electricity generated[23] due in part to the energy intensity of the state's manufacturing-based economy.[24] To meet these needs, Michigan imports 97 percent of its petroleum, 82 percent of its natural gas, and 100 percent of its coal and nuclear fuel.[25] In total, these imports account for about $0.72 of every dollar Michigan citizens and businesses spend on energy.[26]

Over half of Michigan's electricity production currently comes from coal imported primarily from Wyoming and Montana.[27] In 2012, the state spent approximately $1.2 billion on coal imports.[28] There are over 20 coal plants in Michigan, ranging in size from some of the largest in the country to small, single-unit plants operated by municipal electric entities. Michigan's three nuclear power plants account for nearly one-third of the state's total electricity production.[29] (Please refer to Appendix A for a discussion of Michigan's current utility structure and regulatory environment.)

Renewable Energy Development

There has been significant investment in Michigan's renewable energy sector since the passage of Public Act 295 in 2008, which is a combined Renewable Portfolio Standard (RPS) and Energy Optimization (EO) Standard. (Appendix B has additional details on Michigan's 2008 RPS and EO Standard.) Approximately $2.2 billion has been invested, bringing over 1,400 MW of new renewable energy projects into operation from 2008 through 2014, exceeding state goals.[30] Michigan's advanced energy cluster added nearly 1,500 jobs between 2005 and 2013 and now employs 8,375 people.[31] The Michigan Public Service Commission has concluded that it is possible for Michigan to increase renewable generation to 30 percent of the state's total energy generation (or perhaps higher) using local resources.[32]

The declining cost of renewable energy in Michigan has made renewables competitive with conventional electricity sources. In 2014, contracts for wind energy and solar energy were executed for $50 per MWh and $65 per MWh, respectively. Those prices compare favorably with the "all-in" cost of conventional sources (fossil fuel, natural gas, and purchased electric generation), which range from $68 to $74 per MWh.[33] Since 2009, all new electric generation capacity added in Michigan has been renewable energy.[34] Wind projects account for 95 percent of new capacity and solar projects account for 2 percent.[35]

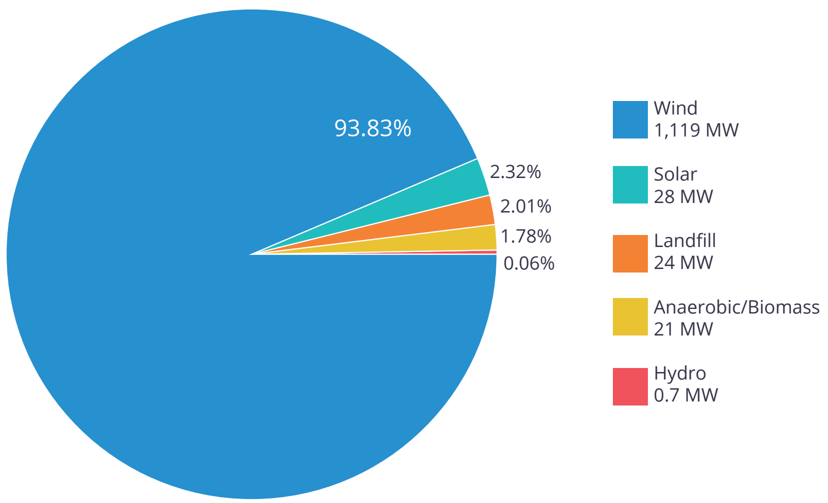


Figure 2: Michigan's Renewable Energy Capacity by Technology Type, 2013 (Source: Michigan Public Service Commission http://www.michigan.gov/documents/energy/renewable_final_438952_7.pdf)

Evolving Energy Needs

Michigan's energy mix will continue to change as half of the state's coal-fueled power plants are more than 40 years old and about a third began operation more than 50 years ago.[36] Nine coal power plants in Michigan are scheduled for decommission between 2015 and early 2016.[37] This trend is expected to continue, as nearly three-fourths of Michigan's coal power fleet will be more than 50 years old in the next 10 years. The retirement of older coal generation plants provides Michigan with an opportunity to invest in energy-saving technologies and renewable energy. If coal is replaced by natural gas, the state will need to continue spending billions on imported fuel every year. Rather than sending money out of the state, Michigan could replace coal with renewable sources and keep the money in-state. Meeting a portion of the state's energy needs with smart buildings and solar technologies manufactured within Michigan offers distinct economic benefits and creates good-paying, skilled jobs for local residents.

Jobs Potential

Maximizing job creation within Michigan is highly dependent on local action. An original equipment manufacturer (OEM) and its local suppliers employ workers from their community. Those employees spend much of their earnings at businesses in the local economy, such as grocery stores and restaurants. Local businesses also hire employees from within the community, who spend their earnings at other local establishments. This results in a multiplier effect, where a single dollar of spending in a community circulates through local businesses and their employees numerous times. Thus, recruiting advanced energy OEMs and their suppliers to a community can result in increases in local spending that are many times greater than the actual expenses of those companies. With the right policies, Michigan can create as many as [XXXX] jobs through 2030. That is nearly [XXXX] jobs per year.

Report Structure

The analysis presented in this report is divided into four complementary chapters, each covering key elements of growing advanced energy economic clusters in smart buildings and solar. Chapters 2 and 3 conduct a supply chain analysis for Michigan's emerging smart building and solar clusters. This analysis culminates in an assessment of Michigan's potential for advanced energy jobs within each cluster and specific policy recommendations tailored to the state's needs. Chapter 4 analyzes Michigan's innovation ecosystem and access to capital, both crucial elements of cluster development, and provides recommendations for further developing the state's innovation pipeline. Chapter 5 provides recommendations for programs and policies to prepare Michiganders for advanced energy jobs.

The conclusion of the report summarizes key themes. Primers covering Michigan's energy ecosystem, key state policies, and technology roadmaps for smart building and solar technology are provided in the extended learning sections at the end of the report.

Chapter 2: Smart and Efficient Building Technology

Introduction

This chapter provides a guide to the emerging smart and efficient building sector in Michigan through analysis of the existing supply chain, an overview of Michigan's potential for smart building jobs, and policy recommendations for further strengthening and developing the sector.

Michigan's policymakers will play a decisive role in the future of energy efficiency and smart building technology in the state. Targeting the emerging smart building cluster with strategic policy choices creates jobs, while helping the state's residents and businesses save money on energy costs. By emphasizing growth and technological innovation in the smart building sector, Michigan will be able to take advantage of opportunities not only in meeting the demand for smart building products from a strong in-state market, but also in exporting to regional, national, and international markets.

Michigan's Strengths, Weaknesses, Opportunities and Threats in the Smart Building Sector

Michigan is well-positioned to build a robust smart and efficient building sector. The state is home to several companies in this space, including businesses that specialize in environmental sensors, energy management systems, smart appliances, smart meters, smart building construction services, and smart grid development. Notably, the Siemens Building Technologies Centers in Plymouth, Wyoming and Midland, Michigan represent a significant nucleating opportunity for the emerging cluster. There is an opportunity for other businesses to work with this predominant anchor manufacturer as their supplier. Additionally, Michigan's base of chemical companies, such as Dow Chemical, BASF, and Akso Nobel, are well-positioned to leverage their know-how in new smart materials and gain access to distribution channels to scale the market.

Smart Building Technology & Energy Efficiency	
STRENGTHS	**WEAKNESSES**
• Legacy companies are well-positioned to leverage their know-how in new smart materials • Michigan has established utility and non-utility programs to reduce energy waste • Nationally recognized business accelerators in the advanced energy and efficiency space, such as Next Energy	• Utilities are barred from spending more than 2 percent of their budgets on waste reduction • Revenue decoupling is only allowed for gas utilities, not for electric utilities • Many consumers lack access to essential financing options, such as on-bill financing and PACE • Home and business owners lack adequate information regarding energy efficiency products and financing options
OPPORTUNITIES	**THREATS**
• Achievable potential for electricity savings over the next ten years (2014-2023) is 15 percent of forecasted kWh sales for 2023 • Above-average electricity prices produce a large market for cost-beneficial investment in energy conservation and efficiency measures • The large stock of aging buildings creates a vast need for energy efficiency upgrades • Revitalization efforts in Detroit offer the opportunity to pilot new energy efficiency technologies	• Michigan faces competition from states that have more developed energy efficiency clusters, including Illinois, North Carolina, and Colorado • All states must compete with emerging economies that are determined to win the fight to attract international manufacturers • Industry groups oppose energy efficient building standards

Furthermore, Michigan has nationally recognized business accelerators in the advanced energy and efficiency space, providing an innovation pipeline. For example, NextEnergy has accelerated investment and job creation in Michigan's advanced energy space, attracting more than $1.5 billion in new investment to the state since its inception in 2002. The University of Michigan is also a significant asset for the state. Specifically, its Energy Institute is a multidisciplinary research center comprised of more than 130 faculty working on critical energy issues, including building energy management system performance.

Energy efficiency has proved to be a lucrative investment for the state: the Michigan Public Service Commission (MPSC) estimates that for every dollar spent on energy efficiency programs in 2013, Michigan ratepayers received $3.75 in expected benefits. However, a number of barriers stand in the way of Michigan realizing the full economic benefit of energy efficiency investments. Although Michigan utilities have exceeded their target energy efficiency savings levels, delivering an average of 125 percent of their targets, further savings are limited due to caps on each utility's energy efficiency program spending. Additionally, revenue decoupling for electric utilities is not authorized under current Michigan law. Without revenue decoupling, utilities lack proper incentives to encourage investment in energy efficiency and the development of innovations that would serve their customers. Through policy leadership aimed at overcoming these barriers, Michigan stands to prosper by eliminating energy waste and boosting its smart building cluster.

Smart Building & Energy Efficiency Market Trends

Rising Demand

Buildings (commercial and residential) account for 41 percent of energy use in the United States. Transforming how buildings are designed, built, and operated can help reduce energy use and save money.

Demand for smart building and energy efficient technology is growing nationally and globally. The global market for smart homes and buildings is expected to grow from $4.8 billion of revenue in 2012 to more than $35 billion by 2020. This growth is attributed to government regulations, rising energy costs, and increasing environmental awareness. Significantly, $12.4 billion of this market is expected to be in North America and the sector is expected to grow at more than 25 percent per year. Furthermore, worldwide smart appliance sales will grow from $5 billion in 2015 to $34 billion by 2020. This represents a considerable opportunity for Michigan companies to position themselves on the cutting edge of smart building and energy efficiency technology, provided a position of strength can be identified for industry growth and export leverage.

Smart buildings are "smart" because they utilize integrated sensors and controls to provide two-way communication and automated control between lighting, appliances, plug-loads, heating, and cooling systems; distributed energy generation; and energy storage systems. Oftentimes, these smart components are connected together through a home energy management system (HEM) for residential buildings or a building energy management system (BEM) for commercial and industrial buildings. These connections allow the building components to work together to maintain comfort while attaining maximum efficiency.

Typically energy management systems include components which underpin the foundations of a smart building including sensors, controllers, actuators, and perhaps most importantly, management software. New BEM market entrants have attracted $1.4 billion in venture capital investment since 2000, which represents 26 percent of all investment in building energy technology arenas.

Market Share for Smart Buildings 2015-2020 (in Billions)

YEAR	NORTH AMERICA	GLOBAL
2015	$3,404,652,902.64	$9,692,278,021.21
2016	$4,409,025,508.91	$12,551,500,037.47
2017	$5,709,688,034.04	$16,254,192,548.52
2018	$7,394,046,004.08	$21,049,179,350.34
2019	$9,575,289,575.29	$27,258,687,258.69
2020	$12,400,000,000.00	$35,300,000,000.00

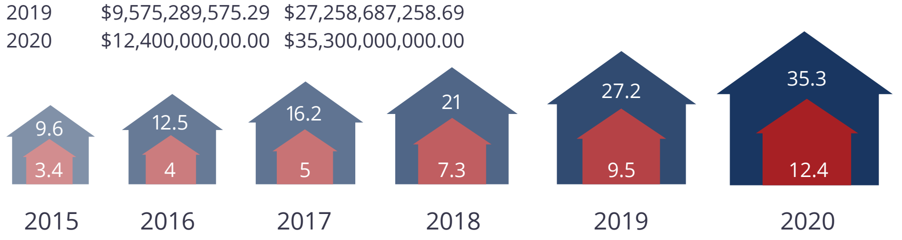


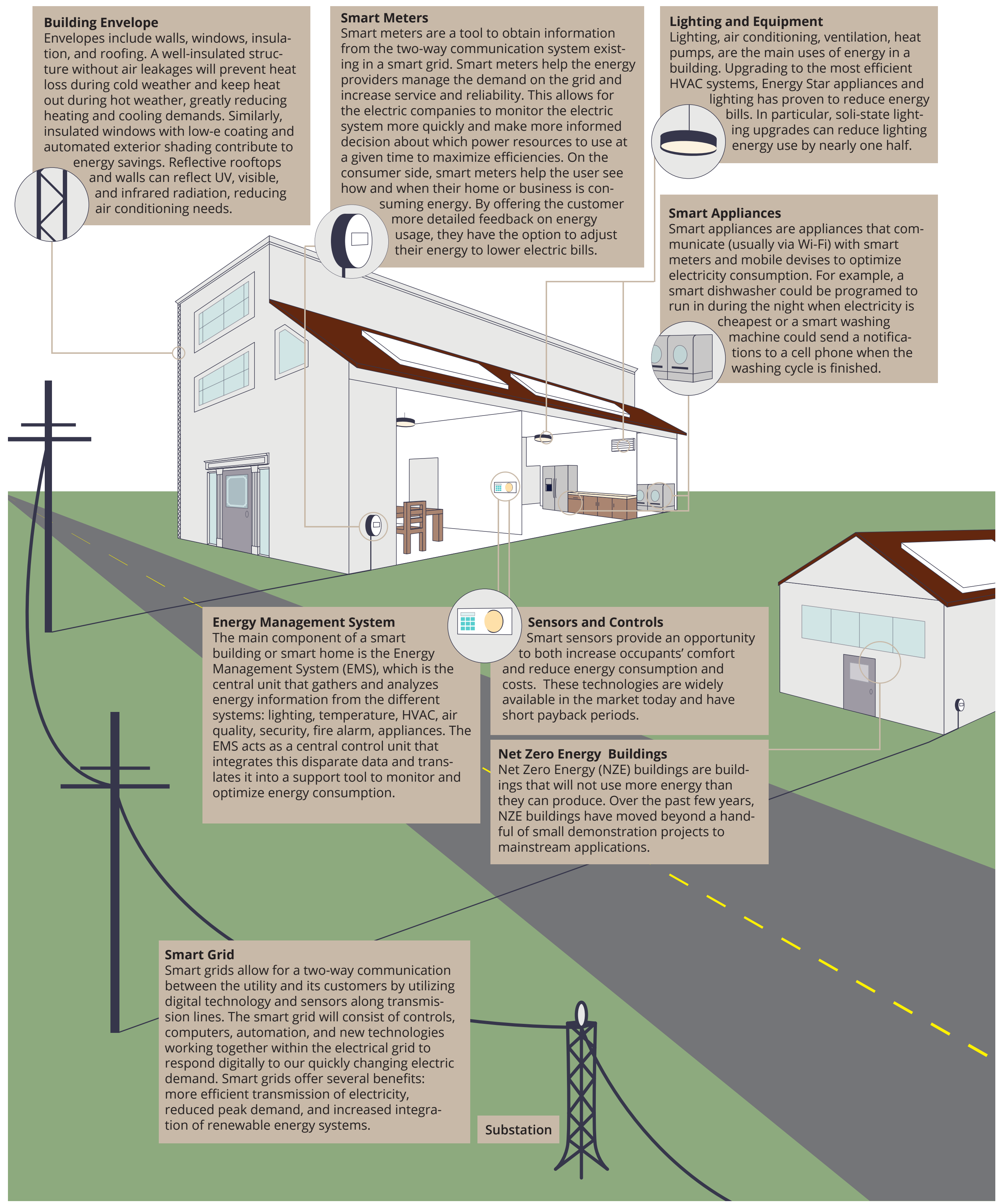
Figure 3. Source: Allied Market Research, "Global Smart Homes," January 2014

Falling Costs

The costs of sensors have dropped dramatically in recent years, making average return-on-investment payback periods on smart building upgrades very short—two years, in many cases. Significantly, the average cost per square foot of smart lighting systems has dropped by half or more in the past few years. The Department of Energy's Building Technologies Office (BTO) has a goal of driving the cost of sensors and controls for buildings down to $1 per node installed. BTO projects that by 2030, cost-effective technologies will exist to save buildings 35 percent of their energy usage.

Additionally, smart buildings allow constant commissioning of equipment, meaning building managers or owners can make proactive repairs as opposed to costly reactive emergency repairs. Innovations in automation and smart sensors can also drive efficiencies in water use, security systems, and emergency detection of fires and other dangerous situations.

Smart Building Technology



Smart Building Technology

In order for Michigan policymakers and leaders to craft forward-thinking policy that reflects the future of smart building technology, it is important to understand the different applications of smart building technology and advances in the space.

Smart Building and Energy Efficiency Supply Chain Analysis

The smart building supply chain consists of companies working across a variety of technology categories. For example, to achieve greater reliability and lower energy consumption, there must be a smart grid capable of communicating with the buildings. Additionally, smart meters are required to communicate between the grid and buildings. Energy management systems control the lighting, temperature, HVAC, air quality, security, and other energy consumption systems within the building. Smart appliances communicate with smart meters and mobile devices to optimize electricity consumption.. Behind all these elements, sensors detect changes in the environment and are used to control the building.

Table 1 below describes each of these technology categories, lists the number of in-state companies, and identifies areas where Michigan is especially strong (highlighted in blue), as well as areas where there are opportunities for growth (highlighted in yellow).

Table 1. Companies in Michigan's Smart Building Supply Chain

CATEGORY	NUMBER IN THE STATE	DESCRIPTION
Sensors	2	Any kind of device used to sense surrounding or operating conditions
Energy Management/Home Automation	13	Facilities that either manufacture components used in home automation or energy management or facilities that retrofit existing buildings
Smart Appliances	2	Washers, dryers, dishwashers that have connectivity capabilities
Lighting	3	Lighting devices that either have connectivity capability or react to surrounding light conditions
Smart Meters/Smart Grid Capabilities	3	Devices that would help buildings work in synergy with smart grid infrastucture
Advanced Materials	1	Materials that actively react to surrounding conditions
Total Companies	38	Key: Strength and Opportunity for recruitment[ii]

[ii] Strengths and opportunities for recruitment were based on the size and strength of companies. For example, several small start-up companies are not as advantageous as a large supplier that has the capital to produce at economies of scale.

Strengths and Opportunities for Growth

Michigan's smart building and energy efficiency supply chain is strong in the energy management, home automation, and smart appliance categories. Notably, the state is home to ABB Inc., Siemens Building Automation, and Honeywell facilities. Together, these industry leaders serve a major portion of the automation and energy management market nationwide. The presence of their facilities in Michigan is a significant strength for the state. Michigan is also home to companies in the system design and retrofitting space, including Home Automation Design and Entertainment and Intelligent Controls LLC. The sizable home appliance industry is transitioning to smart technology and while Michigan does not currently have a large number of companies in this category, the state is home to sizable Whirlpool and Bosch facilities. Whirlpool and Bosch are industry leaders in home appliances and provide Michigan with a strong foundation in the space.

Michigan's smart building and energy efficiency supply chain has ample opportunity for growth, specifically in the sensor manufacturing and advanced materials categories. Sensors are a key component to all smart building products, as this technology helps a building integrate with smart infrastructure. Michigan's supply chain currently does not include a significant number of facilities that manufacture sensors used in the smart building space. The presence of a strong sensor manufacturing infrastructure would strengthen the state's entire smart building sector. Additionally, Michigan lags in the manufacturing of products used to connect a building to the smart grid. Smart grids are rolling out across the state as smart meters are integrated into homes and businesses. The rollout of this technology significantly increases the market for smart grid connection devices, and Michigan stands to benefit from expanding the state's smart building supply chain in this area. Targeted Foreign Direct Investment (FDI) recruitment missions aimed at filling these key gaps in the supply chain provide opportunities for Michigan to grow its emerging smart building sector and capitalize on export demand.

Michigan also has an opportunity in the LED lighting industry. The LED industry is moving towards tunable LED light engines. Michigan currently does not have any companies working in this space, but the state's diverse array of additive manufacturing skills and the strong existing chemical industry make it an appealing place for this new LED industry to thrive. Additive manufacturing skills help innovation in the space by leading to greater product customization and decreased lead time for projects. The chemical and material industries will contribute to the ever-improving LED material composition. As with smart meters and sensor technology, Targeted Foreign Direct Investment (FDI) recruitment missions to fill supply chain gaps will allow Michigan to fully capitalize on its LED strengths.

Michigan's Emerging Smart Building Cluster

As shown in the map below, a smart building cluster is forming northwest of Detroit, near Novi and Farmington Hills. Companies in the cluster are producing both hardware and software for smart technologies, which translates to manufacturing and service jobs. Sensors and automation firms are most prominent in the state, followed by advanced lighting. The cluster encompasses large technology companies, such as Whirlpool, Siemens, ABB Inc., and Bosch.

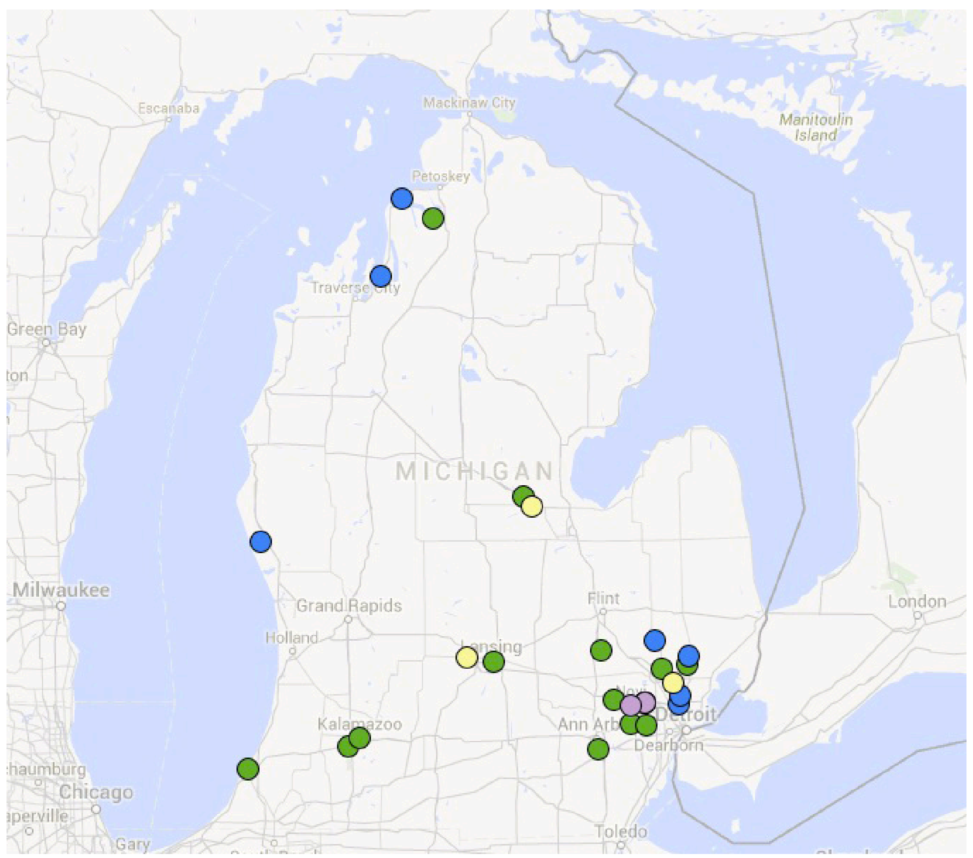


Figure 4. Map of Smart Building Supply Chain

What is a Job-Year?

A job-year is simply one full-time equivalent job for one year (2080 hours, or 40 hours/week for 52 weeks). This measure takes into account the length of a job. For example, if a new construction project is estimated to last 24 months, this would be measured as 2 job-years. Alternatively, if 10 people spend 208 hours on a retrofit project, this would be measured as 1 job year. In order to estimate the potential impact of Michigan's solar supply chain, total job-years are aggregated over the 2016-2030 time period.

Direct, Indirect, and Induced Job-Years

In order to estimate the potential economic impact of Michigan's smart building supply chain, direct, indirect, and induced job-years are measured:

- Direct job-years: reflect jobs resulting from initial changes in demand in Michigan's smart building industry
- Indirect job-years: reflect jobs resulting from changes in transactions between industries as supplying industries respond to increased demand from Michigan's smart building industry.
- Induced job-years: reflect jobs resulting from changes in local spending as a result of increased demand in Michigan's smart building and indirect industries.

Michigan's Potential for Smart Building Technology & Energy Efficiency Jobs

Michigan has the opportunity to create over 26,000 direct job-years from 2016-2030 throughout the smart building and energy efficiency supply chain (Figures 5).

Projections for job-years potential in the smart building and energy efficiency industry come from tools and analysis by the Green Jobs Labor Center and the Energy Information Administration. We utilized the [BETONY TOOL] to estimate job-years at different projections of energy efficiency savings and economic multipliers.

A multiplier effect of 2.0-3.0 percent of in-state supply chain purchases is used to analyze the impact of clustering on the smart building supply chain in Michigan. This results in an indirect and induced job-years potential between 26,732 and 77,915 over the 2016-2030 time frame. The lower bound for indirect and induced job-years potential is dependent on Michigan businesses meeting statewide demand for smart building products and services. The upper limit for indirect and induced job-years represents a theoretical upper bound if Michigan businesses were able to meet all of their purchase needs with in-state suppliers.

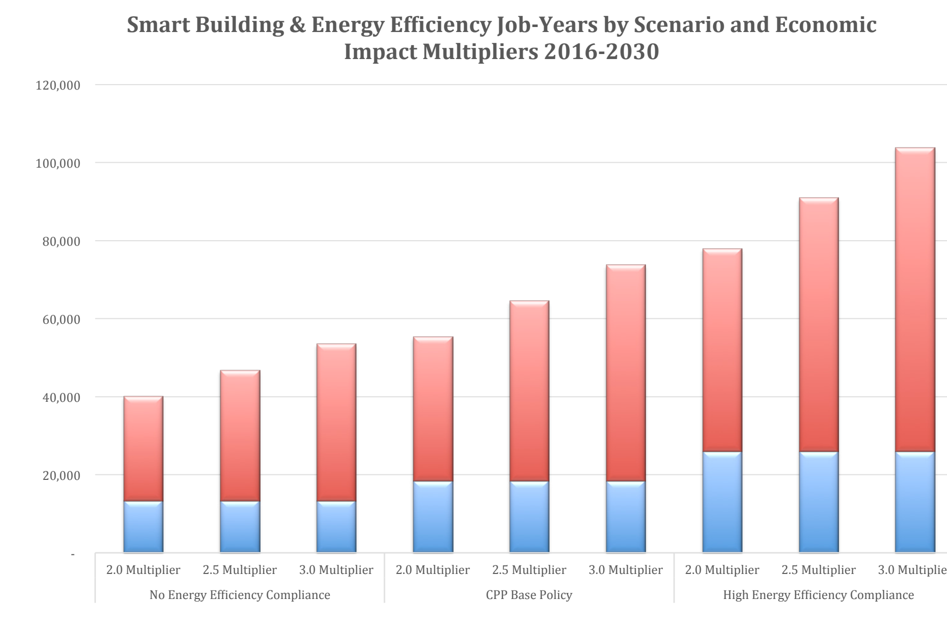


Figure 5.

Policy Recommendations

Michigan policymakers can bolster the state's smart and efficient building cluster by 1) removing financial and regulatory barriers to spur investment in energy efficiency and 2) exploring new and existing policies that stimulate demand within the state. Creating a robust in-state market will attract private investment, strengthen Michigan's economy, and create good paying jobs for residents. Furthermore, creating new value chains can accelerate the stimulation of new export markets.

Policy 1: Allow On-Bill Financing for Energy Efficiency Improvements

Financing home energy improvements can be challenging because energy efficiency investments often involve high upfront capital investments. This financial barrier can be prohibitive. Those seeking to make energy efficiency investments in the rental market face an additional barrier known as the "split-incentive problem": renters do not own the property and landlords do not see the economic benefit of the upgrades because they do not pay the utility bills. To overcome these barriers, Michigan should consider providing utility customers with on-bill financing, a simple and convenient tool for financing the upfront costs of efficiency improvements.

Michigan has already started providing access to this significant financing tool. In December 2014, the state passed legislation that allows municipal utilities to offer on-bill financing programs to their customers. While this is a promising first step, municipal utilities serve a small portion of the state's electricity customers. The Michigan Legislature could continue on this path and allow on-bill financing for Investor Owned Utilities (IOUs), which serve over 85 percent of retail electricity customers. Beyond helping Michiganders reduce energy waste and save money, expanding access to on-bill financing offers additional economic benefits. Many of the energy efficient technologies and materials purchased with on-bill financing will come from companies based in Michigan and will be installed by in-state contractors. Allowing on-bill financing for IOU customers will reduce energy costs, increase demand for products from Michigan businesses, and create jobs.

Policy 2: Demand Response through Dynamic Pricing

Michigan's existing demand response programs fall short of properly incentivizing customers. While the state's utilities have varying amounts of demand response, much of it is in the form of interruptible tariffs that have been in place for decades. These tariffs provide customers with a lower rate for power in exchange for agreeing to have service interrupted occasionally when demand is particularly high or supply is particularly low. Consumers Energy and DTE Energy also offer forms of time-of-use rates, in which customers are charged different rates throughout the day. , Interruptible tariffs and time-of-use rates help lower overall grid costs, but these are modest first steps. A more advanced form of demand response involves implementing prices that reflect the true cost of delivering electricity throughout the day, known as "dynamic pricing." Consumers Energy and DTE Energy both offer versions of dynamic pricing, but only in limited "experimental" or "pilot" programs. With Michigan's forecasted 3,000 MW shortfall of electricity capacity, the state is well-positioned to benefit from the potential cost savings of increased demand response.

Michigan can capture the benefits of demand response by expanding dynamic pricing in two ways. First, the Michigan Public Service Commission could expand beyond the existing limited "pilot" programs by making dynamic pricing the default electricity rate structure for all commercial and industrial customers in the state. Following the example of Michigan Power, utilities could be required to sell customers insurance to help minimize the volatility of their electric bills, without diminishing the incentives of real-time price signals. Second, residential customers could be allowed to opt into dynamic rates. To help inform customers in this decision, utility bills should be required to show the customer's monthly costs under both a standard rate and a dynamic rate. Additionally, to help residential customers who do opt into dynamic pricing, utilities can offer "level payment" services, allowing customers to spread the cost of an unusually high month over the following year's monthly payments. While consumer advocates may be concerned that customers who choose not to opt into dynamic rates will see a price increase, recent research suggests potential increases are modest and are not likely to impact low-income consumers disproportionately.

Michigan can position itself to capitalize on the smart and efficient building market by putting in place robust market signals, such as dynamic pricing, that compensate consumers for intelligently managing their electricity usage.

Policy 3: Allow for Decoupling of Electric Utility Revenues

Because of the way utilities are structured, utility companies lack incentives to encourage investment in energy efficiency and to explore innovations that would serve their customers. Under traditional regulation, utilities are authorized to recover their costs and provide a reasonable rate of return for their investors.

What is On-Bill Financing?

On-bill financing allows utilities (or financial institutions) to provide upfront capital to finance energy efficiency improvements through a loan, which is then repaid on the customer's monthly utility bill. Savings from energy efficiency upgrades are paired directly with monthly loan payments on the bill and regular payments are collected by the utility company until the loan is repaid.

What is Demand Response?

Demand response is a pricing structure that reduces utility and grid operator costs by creating incentives for customers to adjust their demand for electricity in response to system conditions. Properly managed demand response can greatly reduce the long-term cost of managing an electric grid by reducing the need to build expensive "peaking" power plants and replacing them with demand reductions from end-users during peak hours.

What is decoupling?

The name comes from the idea of decoupling a utility's revenue from the volumetric sale of energy, or energy as a commodity. Typically, utilities make money from selling power or gas. Under decoupling, regulators set a target revenue level for utilities. If electricity sales are reduced due to energy efficiency or distributed energy generation, electricity rates automatically adjust without a lengthy or expensive rate case process. This can keep utilities on track to meet their revenue requirement and reduce the volatility in their earnings. It also reduces the disincentive for utilities to implement energy waste reduction programs.

Based on the utility's estimated sales of electricity, regulators set a price on electricity for the next several years that allows a utility to recover their revenue requirement. This regulatory structure can create problems if energy waste reduction or distributed energy generation reduces a utility's sales. If electricity sales are below the utility's estimates from the rate case, the utility may be unable to recover their expected return on investment. This dynamic can create an understandable disincentive for utilities to reduce energy waste.

Close to half of the states have addressed this problem by adopting some form of decoupling for their utilities. In 2008, Michigan passed legislation that granted the MPSC the authority to allow decoupling of gas utilities. Two years later, the MPSC attempted to implement decoupling for both Consumers Energy and DTE Energy, but the Michigan Court of Appeals found that the MPSC lacked authority to decouple electricity utilities. As a result, no electric utilities in Michigan have a decoupled revenue structure.

Recent research highlights the success of revenue decoupling mechanism programs across the country. Efforts in Idaho and Wisconsin offer helpful examples of how decoupling can be implemented. By removing the utility disincentive for reducing energy waste, decoupling can open the door for increased energy savings. For example, energy efficiency savings increased in Idaho from 0.5 percent before decoupling was implemented in 2006 to 1.3 percent in 2010. Additionally, by adding more stability to utility earnings decoupling may lower the future cost of capital that utilities receive from investors. This could provide long-term savings if utilities can access low-cost financing for investing in grid infrastructure.

Michigan can capitalize on the benefits of a decoupled regulatory structure. The first step needed to make this a reality is to grant the MPSC the authority to implement decoupling for electric utilities. Michigan lawmakers could consider passing legislation that unequivocally grants the MPSC the authority to decouple revenues for electric utilities in the same manner that it can for gas utilities. The legislation does not need to go so far as to require the MPSC to implement decoupling—it only needs to grant MPSC the authority to do so. Once this authority is in place, the MPSC can work with electric utilities and other stakeholders to determine if implementing decoupling for electric utilities is a prudent decision. While decoupling may not make sense for all of Michigan's electric utilities, allowing the MPSC to have this alternative in its toolkit will benefit residents.

What are energy waste reduction programs?

Examples of energy waste reduction programs include rebates for purchasing efficient lighting, retrofitting water heating, or installing new home insulation. For industrial customers, rebates are provided for replacing equipment such as boilers, pumps, or compressors. These rebates should be viewed as investments, with the payback measured in future savings from the reduced need to build electricity generation and infrastructure, the cost of which would have been borne by customers.

Policy 4: Integrate Demand Reduction into the Capacity Planning Process

Recently, the Midcontinent Independent System Operator (MISO), which manages nearly all of Michigan's electric grid, announced that the state would be facing a capacity shortfall of 3,000 MW in the near future. Relying solely on building expensive new power generation in response to this concern could be a costly mistake for Michigan ratepayers.

State policymakers would be wise to look to the experience of the neighboring PJM grid, which includes a small portion of southwest Michigan. PJM has shown that building new power plants is not the only way to meet a grid's capacity needs. PJM allows permanent and dispatchable forms of demand reduction to participate in its market for electricity capacity. For example, a supermarket may be able to automatically dim its lights in response to a dispatch signal from the grid operator. Alternatively, a factory could permanently reduce its demand during peak hours through a project to eliminate energy waste in its HVAC system. A proposal to create a permanent or dispatchable form of demand reduction can bid into PJM's capacity market. Whenever it is cheaper to implement rather than build new power plants, the project is compensated and counted towards the region's capacity supply. Stiff financial penalties are in place to ensure the demand reductions are implemented and deliver the promised savings.

One option widely used across the country is a requirement for Michigan utilities to conduct integrated resource planning. Under integrated resource planning, utilities develop plants to meet the long-term peak demand and energy needs for their system using advanced cost-benefit analytical tools. If integrated resource planning is implemented in Michigan, policymakers could consider requiring utilities to investigate lower cost demand reduction alternatives before authorizing new generation build. In exchange for granting utilities a monopoly franchise, utilities and regulators must ensure that ratepayer money is not being spent on unnecessary power plants that could be avoided with demand reductions. Alternatively, if Michigan moves away from a centralized planning process towards a market-based approach for capacity planning, such as the capacity markets in MISO or PJM, the MPSC could ensure that demand reduction proposals have the ability to bid directly into wholesale markets, without having to go through their local utility as an intermediary. Under both options, allowing either permanent or dispatchable demand reductions to participate in the capacity planning process would be a huge win for Michigan ratepayers and businesses.

Policy 5: Remove the Spending Limits for Energy Waste Reduction Programs

Michigan's economy has seen tremendous benefits from investments in reducing energy waste. Legislation passed in 2008 created energy waste reduction programs aimed at driving smart investments that would reduce the long-run cost to consumers for electricity and gas services. Michigan utilities have not only met, but in fact exceeded, their target savings levels, delivering an average of 125 percent of their targets. However, further increases in cost-effective savings are limited due to caps placed on how much each utility can spend on energy waste reduction programs.

Michigan utilities have made substantial investments in reducing the state's energy waste, and consumers have shared the benefits. The MPSC recently analyzed the return on investment that Michigan consumers will receive from these programs. The benefits are clear: energy waste reduction investments in Michigan have produced superb financial results. One estimate shows that for every dollar spent on these programs in 2013, Michigan ratepayers received $3.75 in expected benefits. Over the lifetime of these programs, this amounts to over $900 million dollars in savings for Michigan consumers. Another estimate shows that on a levelized (or "all-in") basis, these investments have cost roughly one-third of the amount that would have been required by building new electricity generation. A separate analysis by the Michigan Conservative Energy Forum suggests that Michigan stands to gain even further if the state continues making smart investments in reducing energy waste. These benefits include reducing the state's dependence on imported energy sources and bolstering both Michigan's economy and industrial supply chain by creating new jobs in the energy waste reduction sector.

Given the financial benefits realized from these energy waste reduction investments, Michigan policymakers should consider eliminating the caps on utility spending in this area. Instead of a cap, the MPSC could require that utilities show that for every dollar they invest in proposed energy waste reduction efforts, Michigan consumers can expect to receive a minimum return of, for example, $2.00. As long as investments continue paying off for consumers, utilities could be free to expand their programs to reduce the state's energy waste.

Chapter Summary

Smart, strategic policy choices can help Michigan leverage the state's unique strengths and base of legacy companies in order to create a thriving smart building technology and energy efficiency sector. Michigan has a strong manufacturing base with many companies already building energy efficient products. As clusters coalesce around a nucleus of activity and relationships, Michigan's policymakers could remove barriers and stoke in-state demand. Enacting decoupling legislation, introducing financing options to level the playing field for energy efficiency investments, and expanding dynamic pricing are all ways Michigan could improve. Passing policies that spur demand and innovation and remove barriers to energy efficiency will reduce waste, increase consumer choice, and make Michigan a more energy efficient and economically competitive state.

Chapter 3: Solar Technology

Introduction

Michigan's policymakers will play a decisive role in the future of solar energy in the state. Over the last decade, solar energy deployment has grown rapidly in the United States due to falling PV prices, technological advancements, favorable government policies, available financing, and increased consumer demand for clean and renewable sources of energy. By targeting the state's emerging solar cluster with smart and strategic policy choices, Michigan's leaders can attract solar jobs, while helping the state meet a portion of its energy needs. With policies that encourage growth and technological innovation, Michigan can meet the demand for solar products from a strong in-state market and capitalize on export opportunities in regional, national, and international markets.

This chapter provides a guide to further strengthening and developing Michigan's emerging solar cluster. After analyzing Michigan's existing solar supply chain and discussing the state's potential for creating good-paying solar jobs, the chapter culminates in policy recommendations for future growth. These recommendations chart a course for Michigan policymakers to generate and enhance job clusters in the solar sector.

Strengths, Weaknesses, Opportunities and Threats for Solar Technology in Michigan

Michigan has leveraged its existing advanced materials supply chain and advanced manufacturing base to play a prominent role in solar manufacturing and technology development. With this foundation, Michigan is well-positioned to expand its existing solar cluster, spur business creation, and create job growth across the state.

Michigan companies have a particular advantage in supplying advanced materials due to the state's established base of legacy companies with national distribution channels. Significantly, Hemlock Semiconductor Corp. and other materials companies serve as an anchor for solar manufacturers. For example, California-based SolarBOS currently buys a portion of its

Solar

STRENGTHS	WEAKNESSES
• Michigan's legacy industries in materials innovation and advanced manufacturing • World-class university research centers and R&D facilities focusing on solar innovation and advanced manufacturing • Pioneering companies such as Dow Chemical and Hemlock Semiconductor are working on solar and advanced materials • Promising innovations in advanced materials and mounting solutions have received attention from venture capital firms and incubators • Strong consumer demand for solar power	• Slow solar uptake relative to states with a similar amount of sunshine, including Maryland, Pennsylvania, and New Jersey • Utilities have historically favored wind over solar • Inconsistent statewide policy hinders commercial and residential adoption
OPPORTUNITIES	**THREATS**
• Solar prices have dropped dramatically in the last decade, moving towards parity with the grid • Old-line manufacturing companies can re-tool to make renewable energy equipment • Strong growth in capturable segments of the solar value chain: lead generation, analytics, and power electronics (e.g., solar inverters)	• Other states are aggressively and successfully pursuing solar manufacturers • Out-of-state companies are winning bids for Michigan's energy contracts • Uncertainty over federal tax credits is hindering investments • Solar is a crowded industry, and Michigan leaders will have to make a unique value proposition in this space

materials from Belding and Saginaw, and intends to open a new manufacturing facility in Walker, Michigan.

Furthermore, Michigan's leading universities and industry research centers are actively engaged in cutting-edge solar research. For example, a lab at Michigan State recently developed a transparent window overlay that can concentrate and harvest solar energy. In the private sector, Midland-based Dow Chemical Co. is a leader in rooftop solar shingles, which offer consumers an alternative to traditional bolt-on panels.

Expanding Michigan's solar cluster will require overcoming several barriers. Solar deployment in Michigan has lagged far behind the

state's success with wind. The state has 28 MW of solar capacity, compared to more than 1,000 MW of wind capacity. If Michigan is going to achieve its goal of a reliable, affordable clean energy future, it is critical that the state reduce its dependence on any single energy source. Increasing solar power production is a critical component of diversifying Michigan's energy resource mix and reducing its dependence on imported fuel. Barriers such as high soft costs, an inconsistent permitting process, a lack of well-structured lead generation programs for installation opportunities, and low net metering caps have hindered residential and commercial adoption, standing in the way of Michigan realizing the full economic benefit of solar technology investments. Through policy leadership aimed at overcoming these barriers, Michigan can eliminate costly energy waste, jumpstart its solar cluster, and create thousands of good-paying solar jobs.

Solar Market Trends

Rising Demand

Global solar photovoltaic cells (solar) installed capacity has increased by a factor of nearly 70 over the last decade, from 2.6 GW in 2004 to 177 GW in 2014.

In the United States, solar PV cells are a primary source of new electricity generating capacity. Total solar installed capacity in the first quarter of 2015 represented 51 percent of all new electricity generating capacity. Strong demand for solar has made the United States the world's fifth largest solar market in terms of installed capacity. Forecasts show significant growth continuing through 2030.

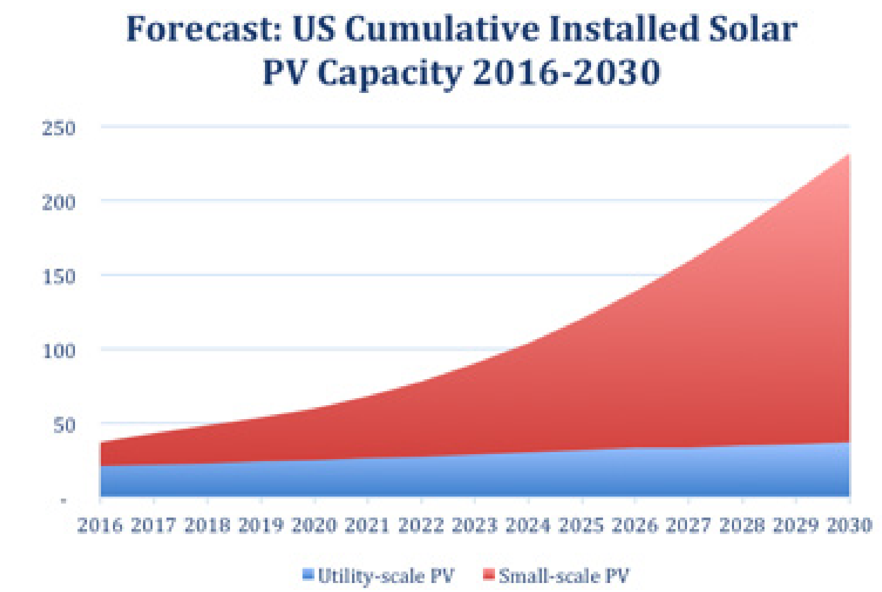


Figure 6: U.S. Cumulative Installed Solar PV Capacity, 2016-2030 (Forecast) Source: Bloomberg New Energy Finance. 2015 New Energy Outlook - Americas. June 23, 2015.

Given that on January 1, 2017, the 30-percent federal investment tax credit is scheduled to drop to 10 percent for non-residential solar projects and expire for residential projects, some analysts project a rush of installations in 2016 to capture the tax incentive and decreased growth in 2017. However, beginning in 2019, demand is projected to rise at similar (or higher) rates compared to 2015. This is primarily due to the declining cost of solar, which increases its competiveness.

Falling Costs and Increasing Efficiencies of Solar

In 1961, President Kennedy challenged the United States to land a man on the moon and return him safely to Earth by the end of the decade. In the same spirit, the Department of Energy's SunShot Initiative has challenged the nation to make solar energy cost-competitive with other forms of electricity. The program has made considerable progress towards achieving its goal of driving down the cost of solar energy to $0.06 per kilowatt-hour, without incentives, by the year 2020: the average cost of solar PV panels has decreased by more than 60 percent and the cost of a solar electric system has decreased by more than 70 percent since 2010. Today, solar is cost-competitive in 14 states where the solar levelized cost of electricity ranges between $0.10-$0.15 per kilowatt-hour and retail electricity price comes in at $0.12-$0.38 per kilowatt-hour.

What is Levelized Cost of Electricity?
The levelized cost of electricity (LCOE) is a summary measure of the cost of energy-generating technologies. The LCOE considers an assumed lifespan and utilization level in order to quantify the per-kilowatt-hour building and operating costs of a generating plant. To calculate the LCOE, a variety of factors and inputs are assessed including capital costs, fuel costs, operation and maintenance costs, and financing costs. The LCOE provides a way to compare the cost of installing a solar system to the rate for electricity charged by utilities. Due to nonexistent fuel costs for generation and very low variable operations and maintenance costs, LCOE for solar technology is mostly determined by capital and financing costs.

While the cost of solar energy has declined, the efficiency of solar technology has increased. In 2014, the average capacity factor of solar projects built in 2013 was 29.4 percent, compared to 24.5 percent for 2011 projects. This means that the same sized system can produce five percent more electricity.

What Does Rising Solar Demand and Falling Cost Mean for Michigan?

The offshoring of manufacturing jobs was not driven by intrinsic geographic, technological, or cultural factors; rather, aggressive policy and low wages in competitor nations shifted American jobs overseas. The International Energy Agency conducted a detailed analysis of the manufacturing shift to China, which "suggests that the historical price advantage of a China-based factory over a U.S.-based factory is not driven by country-specific factors, but by scale, supply chain development, and access to finance." State policy that helps build a market and develop the solar supply chain, promote access to capital, and invest in solar workforce development will attract solar companies. With the right combination of policies, solar resources, available land, and access to capital, Michigan can compete for market-driven solar manufacturing, generation, installation, and exports.

Michigan companies are leaders in supply chain integration and simulation-based manufacturing. Coupled with the state's active scientific community and high-tech workforce, this strong base enables Michigan companies to compete in the expanding solar market as major suppliers. Charting the growth of specific components within the value chain can help Michigan determine the best industries to leverage the state's strengths and capitalize on future growth. Specifically, the inverter and solar racking industries are projected to grow at an accelerated rate. The North American flat roof racking industry is projected to grow by an annual rate of 17.5 percent and the solar inverter industry will have an estimated 10-percent growth through 2018. Michigan-based companies, such as solar racking company AET, can capitalize on this growth.

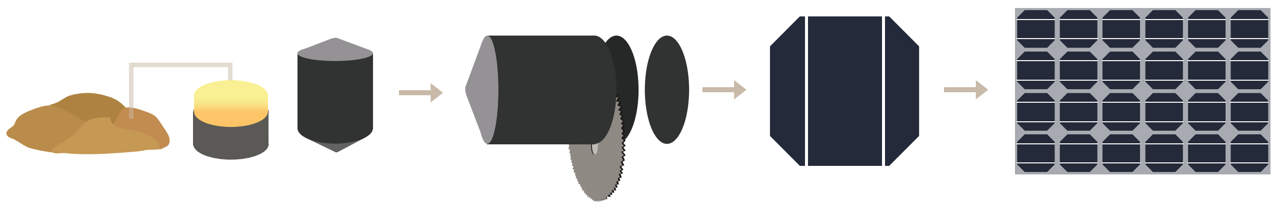
Increased manufacturing in Michigan will create the possibility for solar export to neighboring states. Many Michigan companies in the solar supply chain already export their products, including Hemlock Semiconductor, a leader in solar-grade polycrystalline silicon. Michigan is well-positioned to be a major player in solar exports, which will increase economic and job growth in the state.

Solar Manufacturing and Technology Roadmap

In order for Michigan policymakers and leaders to craft forward-thinking policy that reflects the future of solar technology, it is important to understand the solar manufacturing process and advances in the space.

The Solar Manufacturing Process

Crystaline silicon panel technology is the current standard for panels installed in the U.S. There are four main steps to assemble a crystaline silicon panel.



Extracting and Purifying Silicon

The production of a PV panel begins by deriving silica from sand. After the silica is extracted, it's purified to make a high purity silicon powder.

Manufacturing the Wafer

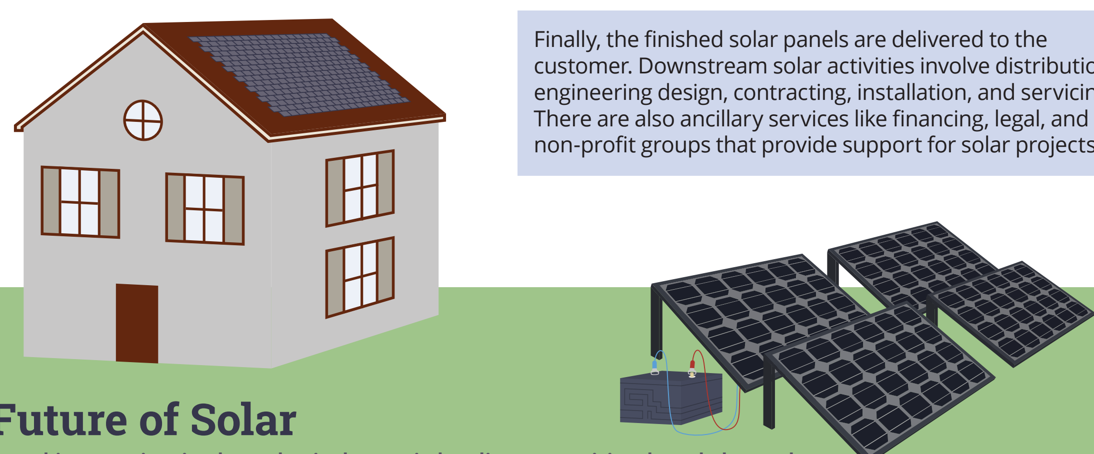
With the silicon powder, a wafer can be manufactured by doping the molten high-purity silicon with boron. Molten silicon is poured into a mold creating blocks of solid polysilicon. The block is then cut, polished, and cleaned.

Assembling the Modules

During cell manufacturing one side of the wafer is doped, usually with phosphorous. A conductive grid and anti-reflective coating are adhered to the top and a conductive back plate is assembled to the bottom of the cell. Cells are then combined electrically to form a module. A glass or film sheet is placed on the front and back. Finally, the module is covered by an outer frame, usually made of aluminum.

Assembling the Array

Finally, the finished solar panels are delivered to the customer. Downstream solar activities involve distribution, engineering design, contracting, installation, and servicing. There are also ancillary services like financing, legal, and non-profit groups that provide support for solar projects.



The Future of Solar

Research and innovation in the solar industry is leading to exciting breakthroughs

Building with Solar Cells

In the future, solar technology will be incorporated into the structure of a new building, rather than installed on a roof after construction is complete. For example, the near-medium term future could see walls, skylights, windows, and shingles manufactured with solar materials.

Organic Solar

Organic solar cells are a new type of solar cell that are carbon-based. This technology can be manufactured in innumerable applications, such as transparent paint. For example, windows could be coated in a transparent organic paint that provides electricity to the building.

Solar for the Home of the Future

"Smarter" solar panels will incorporate technology and sensors to provide real-time information about energy generation and demand. Unprecedented interconnectedness and energy management software will open the door for increased customization.

Ultra High Efficiency Solar Cells

The higher the efficiency of a solar panel, the more electricity it can create from the sun's rays. With ultra-high efficiency cells less area is needed to obtain the same amount electricity. Researchers project that solar cells will be up to 4 times more efficient in the near future.

Solar and Energy Storage

Renewables (wind and solar especially) are limited to the natural resource you available at a given moment. In the absence of these natural resources, for example at nighttime when there is no sunlight, they do not produce or dissipate energy. New battery storage technology allow solar energy to be stored and dissipated in the absence of sunlight, allowing solar panels to operate independently.

Solar Supply Chain Analysis

The solar supply chain is comprised of companies working across a variety of technology categories. Several businesses in Michigan are already working in the solar industry, in areas such as advanced materials, manufacturing, and installation. Table 2 below describes each of these technology categories, lists the number of in-state companies, and identifies areas where Michigan is especially strong (highlighted in blue) as well as areas where there is room for growth (highlighted in yellow).

Strengths and Areas for Growth

Michigan boasts major strengths throughout the solar supply chain. Especially significant is the presence of Hemlock Semiconductor Corp., a leading producer of polysilicon in the United States. Polysilicon is the main component in solar cells, making Hemlock an integral part of the in-state and worldwide

Table 2. Companies in Michigan's Solar Supply Chain

CATEGORY	NUMBER IN THE STATE	DESCRIPTION
Manufacturing		
Full System	5	Manufactures full PV solar systems
Advanced Materials	1	Manufactures materials used to develop solar cells
Mounting/Racking	5	Manufactures structural components to mount solar systems
Frames	4	Manufactures strucutral frames for solar cells
Tracking System	4	Manufactures components such as tracking systems, gears, and motors
Machine Manufacturing	9	Manufactures tools used in the process of manufacturing solar systems
Inverters	13	Manufactures inverters used in solar systems
Controllers	8	Manufactures solar cell controllers
Sealents and Protective Films	5	Creates structural sealants used to hold cells and strucutral frames together or manufactures films used to protect the surface of solar cells
Service		
Contractors/Installers	81	Installs rooftop or utility-scale solar systems
Project Developers	8	Assists with development of full-scale utility solar system projects; has a stake in the project
Distributors	10	Distributes finished solar systems from manufacturers
Consultants	10	Assist in stages of project development
Total Companies	163	Key: Strength and Opportunity for recruitment[ii]

solar cell supply chain. Michigan is also home to a number of major automated machine manufacturing facilities, such as FANUC Robotics America. The process of creating solar cells is incredibly intricate, increasing the importance of robotic manufacturing machines. Having strong in-state companies that produce solar cells is a major addition to the supply chain. Beyond manufacturing, Michigan has an extensive list of contractors and installers to facilitate the growth of statewide solar deployment and is home to a division of Fraunhofer CSE, a leading international solar research facility.

Michigan's solar supply chain has ample opportunity for growth, specifically in the full panel manufacturing and solar tracking spaces. One of the most significant gaps in the state's solar supply chain is the lack of a full panel manufacturing facility that has extensive reach outside the state. The long-term success of Michigan's solar cluster will depend on its ability to export. Another opportunity is solar tracking, which is among the most important components for utility-scale solar energy. Expanding this sector within the state is crucial if Michigan is to position itself as an industry leader. Targeted foreign direct investment recruitment missions aimed at filling these key gaps in the supply chain provide an opportunity for Michigan to grow its emerging solar cluster and capitalize on export demand.

Michigan's Solar Cluster

The map to the right shows that a natural cluster is forming around Detroit and manufacturing plants in Saginaw. Indeed, the two largest manufacturing plants—Hemlock Semiconductor and Suniva—are both located in Saginaw. As previously mentioned, Hemlock is an industry leader in high-purity polycrystalline and chlorosilane manufacturing. Suniva, a leading manufacturer of PV solar cells and modules, recently expanded their manufacturing in order to provide up to 200 MW of additional capacity. A notable addition to the state's solar manufacturing base is California-based solar company SolarBOS. In 2014, SolarBOS expanded operations with a new 40,000-square foot facility in Grand Rapids, Michigan.

Michigan's Potential for Solar Jobs

Michigan has the opportunity to create over 40,000 direct job-years from 2016-2030 throughout the solar supply chain (Figures 7-10).

Projections for job-years potential in Michigan's solar industry come from tools and analysis by the National Renewable Energy Laboratory (NREL), Department of Energy's Office of Energy Efficiency and Renewable Energy, the Energy Information

Michigan can leverage its extensive experience in precision manufacturing from the auto industry to grow the state's solar cluster. For example, AET, a Michigan-based company that manufactures solar racks, has demonstrated the ability to cross over between the two industries. AET was founded by auto industry veterans and creates solar frames and racking systems using similar manufacturing processes to those used on automobiles. This type of crossover ability represents both a strength and opportunity for Michigan as the state boasts a vast number of manufacturing facilities that already utilize precision manufacturing techniques, along with a skilled workforce trained in these processes.

What is a Job-Year?

A job-year is simply one full-time equivalent job for one year (2080 hours, or 40 hours/week for 52 weeks). This measure takes into account the length of a job. For example, if a utility solar construction job is estimated to last 24 months, this would be measured as 2 job-years. Alternatively, if 10 people spend 208 hours on a rooftop solar project, this would be measured as 1 job year. In order to estimate the potential impact of Michigan's solar supply chain, total job-years are aggregated over the 2016-2030 time period.

Direct, Indirect, and Induced Job-Years

In order to estimate the potential economic impact of Michigan's solar supply chain, direct, indirect, and induced job-years are measured:

- Direct job-years: reflect jobs resulting from initial changes in demand in Michigan's solar industry.
- Indirect job-years: reflect jobs resulting from changes in transactions between industries as supplying industries respond to increased demand from Michigan's solar industry.
- Induced job-years: reflect jobs resulting from changes in local spending as a result of increased demand in Michigan's solar and indirect industries.

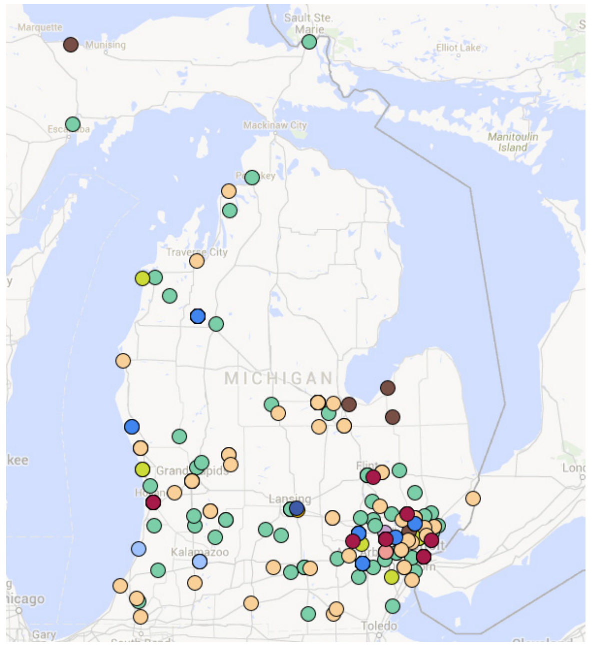
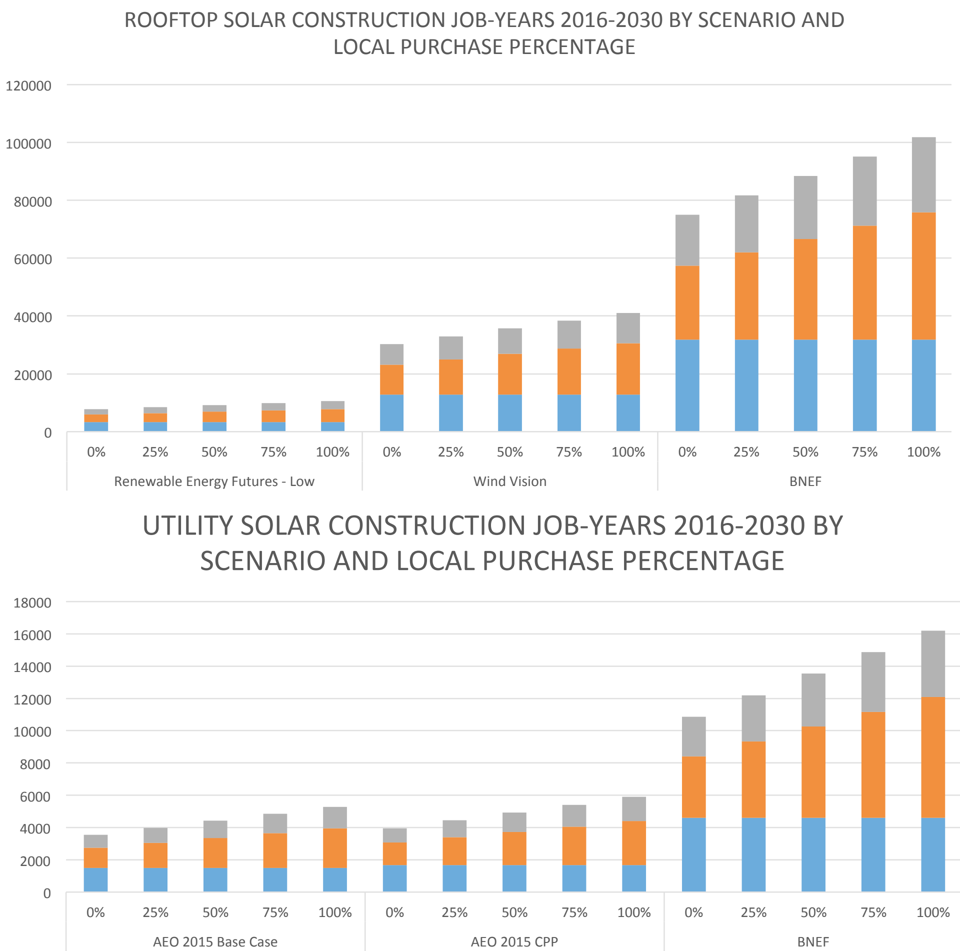


Figure 7: Michigan's Solar Supply Chain Companies



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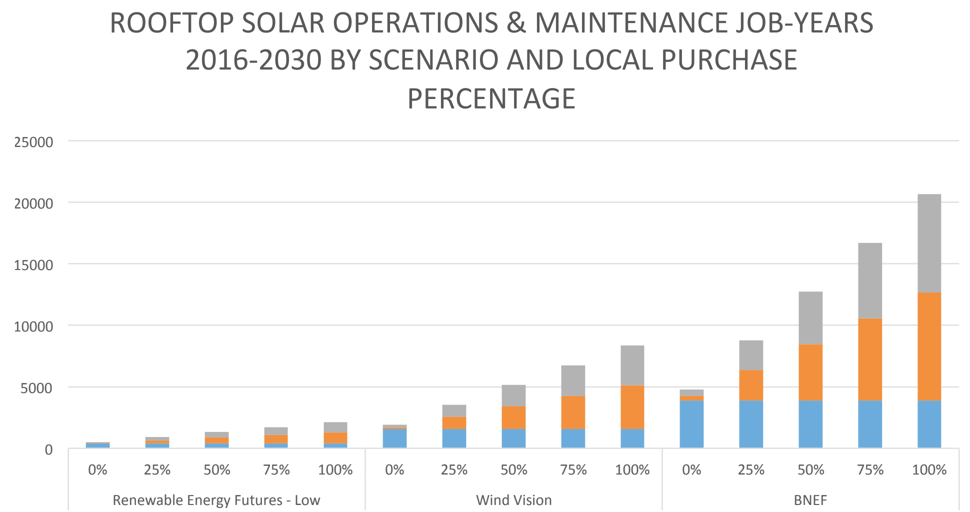

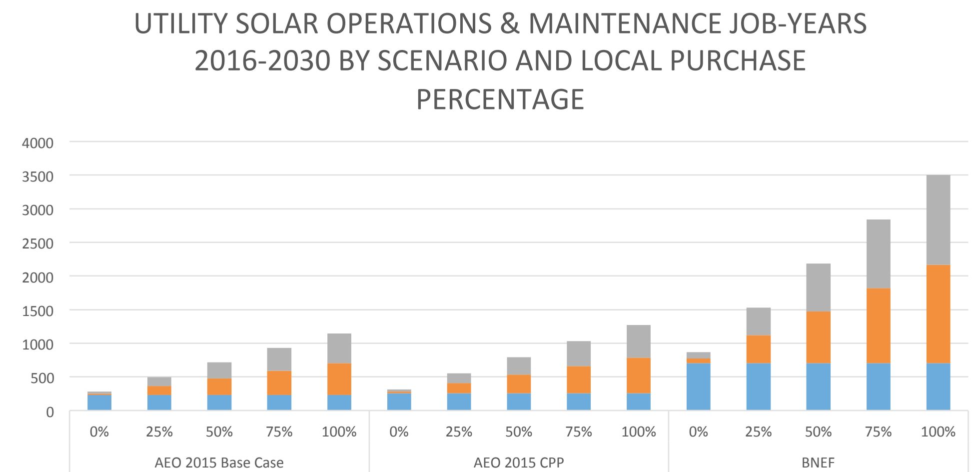

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Administration and Bloomberg New Energy Finance. The Jobs and Economic Development Impacts tool (JEDI) is utilized to estimate job-years at different levels of local supply chain concentration for rooftop solar (residential, small and large commercial buildings) and utility scale solar.

A range of 0-100 percent of in-state supply chain purchases is used to analyze the impact of clustering on the solar supply chain in Michigan. This results in an indirect job-years potential of 3,961- 53,786 over the 2016-2030 time frame depending on the percent of in-state supply chain purchases. Lastly, the induced job-years potential is between 2,705 and 34,733 over the 2016-2030 time frame, also depending on the percent of in-state supply chain purchases. The lower bound for indirect and induced job-years potential is dependent on Michigan businesses meeting statewide demand for new solar panel installations. The upper limit for indirect and induced job-years represents a theoretical upper bound if Michigan businesses were able to meet all of their purchase needs with in-state suppliers.

Policy Recommendations

Michigan can jumpstart the state's solar cluster by focusing on innovative policies that remove obstacles and boost demand within the state. Creating a robust in-state market will attract private investment, strengthen the economy, and create new value chains, which will subsequently stimulate and accelerate new export markets.

Policy 1: Streamline Solar Permitting

Costly and inconsistent permitting and approval processes burden the solar industry in Michigan. For example, installing a rooftop solar project typically requires a host of permits and approvals from a variety of state and local departments. Many localities require electrical and building permits while local utilities can require applications for interconnection and net metering. The lack of uniformity is a significant problem for residents and businesses seeking to deploy solar systems, as well as solar installers who have to navigate different requirements for multiple localities.

Navigating these inefficient permitting and approval processes can account for up to 50 percent of the time and cost of a solar installation. This high cost contributes to Michigan being the tenth most expensive state to install solar in. The confusing and burdensome web of permitting requirements is an unnecessary drag on Michigan's emerging solar industry.

Cutting bureaucracy and streamlining the solar permitting process across the entire state would benefit both consumers and regulators. One study suggests that permitting reform could increase solar growth rates in Michigan by up to 13 percent.

> Michigan can look to recent successes in reducing permitting time and costs in Vermont and Colorado. In 2011, Vermont passed legislation that simplified and standardized the permitting requirements across the entire state, as well as reduced the processing time for solar projects. In Vermont, local utilities have up to 10 days to review the standard application and raise any related issues. If no issues are raised within that timeframe, the project is automatically approved for construction. In Colorado, the Fair Permit Act of 2011 reduced permitting fees for solar projects, ensuring that customers were not charged more than was necessary to review their project. Colorado set the fee cap at $500 for residential systems and $1,000 for non-residential projects.

Michigan could draw from these recent state-level policy innovations in Colorado and Vermont by imposing similar solar permitting reforms. First, Michigan could impose statewide caps on the fees assessed by municipalities for permitting a solar project. Fees could be set at the lower end of either (1) each municipality's actual cost of permitting a solar project or (2) a statewide fee cap. Additionally, Michigan could consider simplifying and streamlining the permitting process across the state, particularly for small projects. A straightforward way to accomplish this is to set statewide uniform requirements for electrical and structural reviews of solar projects by local agencies. (The Solar America Board for Codes and Standards offers helpful examples.) Alternatively, the Michigan Bureau of Construction Codes could issue recommended standards for permitting review that could be voluntarily adopted by local communities. Lastly, steps could be taken to expedite the interconnection process. Any solar project less than 10 kW in size could be allowed to apply for interconnection using a standard, statewide application form. By eliminating unnecessary fees and reducing the variability in permitting requirements across the state, Michigan can help lower the overall soft costs of installing solar.

What is Net Metering?

Net metering is the primary mechanism for compensating residential and small-scale solar projects in Michigan. Under net metering, customers with renewable electric generators can reduce their electric bill by generating some or all of their power and receive a credit from their electric provider for any excess generation.

Policy 2: Remove Restrictions on Solar Net Metering

Michigan currently imposes several restrictions affiliated with qualifying solar projects for net metering. First, the size of an individual solar project is restricted by the customer's historical annual electricity usage as opposed to available rooftop space. This could limit customers to putting solar on only a small portion of their rooftop, which will substantially lower the energy generated but cost nearly the same as putting solar on the entire rooftop. Second, with few exceptions, solar projects greater than 150 kW are not eligible for net metering. Excluding moderate-sized projects slows the growth rate of solar in Michigan and hinders the development of the solar cluster. Last, within each utility's service territory, net metering projects are capped at one percent of the prior year's peak demand. Although the one-percent caps have not yet been reached, they will hinder future growth of distributed solar power.

Michigan's legislature could help increase the adoption of solar in the state by removing these barriers to solar freedom. Raising the cap on individual solar projects from 150 kW would encourage larger distributed projects. Raising the system-wide cap from one percent of peak load will send a positive signal to solar developers that Michigan is open to significant expansion in this space. Finally, the state could abolish the system-wide caps on net metering for subcategories of projects (e.g., projects smaller than 20 kW in size are capped at 0.5 percent of peak load). A system-wide limit on net metering is sufficient to assist utility resource planners. Removing these roadblocks will increase the demand for moderate-sized projects and bring good-paying solar jobs to Michigan.

Community Choice Aggregation

Under community choice aggregation, a city or county acquires power to be delivered to its citizens by the local utility. Some of that power could come from community solar. This model has been implemented in several states, including Illinois and Ohio.

Several other states, including Illinois and Massachusetts, have demonstrated that net metering can succeed when moderate-sized projects are allowed. Illinois recently reformed its initial net metering program launched in 2008. In 2011 and 2012, the state legislature updated several aspects of net metering in Illinois, allowing solar projects up to 2 MW in size to qualify for net metering and raising the system-wide cap to five percent of peak demand. Massachusetts has taken similar steps in recent years to raise the cap on individual project size (from 60 kW to 2 MW) and raise the system-wide limits (to nine percent of system peak load).

Policy 3: Let Local Communities Develop Solar Projects

With smart policies that encourage community development, all Michiganders who wish to purchase renewable power could have access to it. Currently, nearly half of all energy customers in the United States—49 percent of homes and 48 percent of businesses—are locked out of the solar market. Reasons for being unable to buy solar include the high cost of financing a PV project and a lack of property rights (for renters). Additionally, many property owners have land or buildings that are not suited for solar due to size, orientation, or shade from buildings and trees. In order to provide more local control, 25 states have offered a new option for delivering solar power to customers who wish to purchase it through community-owned solar projects.

There are different designs under which a local community could build a solar project to serve the needs of its citizens wishing to buy renewable power. One option would be for communities to build community solar projects and sell the power output directly to citizens who wish to purchase it. An arrangement that could facilitate establishing such a program is known as community choice aggregation (CCA).

If a community served by IOUs in Michigan were to establish a CCA today, it would technically be acting as an alternative energy supplier (AES). An AES is an entity that purchases power in wholesale energy markets on behalf of retail end-users. Michigan law limits alternative energy suppliers from providing more than 10 percent of the annual electricity sales within each utility's service territory. The 10-percent allocation is currently fully subscribed for both Consumers and DTE, meaning that communities would be unable to utilize this option for community solar projects.

By relaxing regulations on alternative energy suppliers, communities in Michigan could build community solar projects and sell the power output directly to citizens who wished to purchase it. To expand customer access to renewable energy sources, Michigan communities that are currently served by IOUs could be allowed to become alternative energy suppliers, and be exempt from the 10-percent cap on AES electricity sales.

Because operating as an AES requires resources and expertise that might be prohibitive for communities interested in adopting this option, an alternative strategy could be allowing municipalities to partner with an existing AES to serve their community's energy needs with renewable power. This approach would still require an exemption from the 10-percent AES cap.

To maintain individual choice, the legislature could stipulate that under no circumstances should customers be forced to buy power from a community AES or a partnership between a community and an existing AES. All customers could have the right to maintain their current arrangement with their local utility or AES. However, the local municipality could be given the authority to determine whether their residents will need to "opt in" or "opt out" of purchasing power from a community AES. Additionally, to ensure fair competition, every community AES could be required to purchase or generate at least as large of a percentage of power from renewable sources as does their local IOU.

Giving communities the freedom to purchase their own renewable energy increases customer choice, promotes local control, and diverts Michigan dollars away from imported fuels.

Policy 4: Ease Taxes on Solar Projects

Michigan's legislature has the opportunity to increase its solar deployment by altering the tax treatment of solar projects. In 2002, lawmakers exempted solar projects in the industrial and commercial sector from personal property taxes. However, rulings in 2008 by the Michigan State Tax Commission and Michigan Department of Treasury have effectively nullified this exemption by classifying some solar projects as subject to either real or personal property taxes. Additionally, Michigan does not offer a tax exemption for residential solar from property taxes, instead assessments include the cost of replacing the system. These high tax assessments of solar installations can have significant consequences on the economics of solar deployment within the state.

Electric Vehicles

Electric vehicles (EVs) offer a host of advantages, including increased energy security, improved air quality and public health, and a variety of economic benefits. Recognizing these benefits, 37 states and the District of Columbia have initiated programs to increase the number of EVs on their roads. In Michigan, EVs are exempt from emissions inspection requirements. In addition, Indiana Michigan Power, Consumers Energy, and DTE provide EV supply equipment rebates as well as special time-of-use rates for EV owners.

Recognizing this important policy lever, several states provide different types of property tax incentives for renewable energy systems. New Jersey, for example, has established policy to support solar deployment without creating financial burden on the state. New Jersey's policy offers local property tax exclusion for solar and other renewable energy systems for residential, commercial, industrial, and mixed-use buildings. Property owners must apply for a certificate from their local assessor to claim the exemption; the certificate reduces the assessed value of their property to exclude the renewable energy system.

Michigan's legislature could eliminate these costly barriers by passing legislation that restores and extends property tax exemptions for solar. First, the legislature could extend tax exemptions to residential solar projects, putting them on an equal footing with commercial and industrial projects. Second, the 2002 tax exemption measure could be clarified to ensure that the Michigan State Tax Commission and Department of Treasury understand its intent. Specifically, the legislature could specify the types of solar projects that are exempt from property tax in Michigan. This would eliminate current confusion and stimulate the solar market. Easing the burden of these taxes would make residential solar installments more attainable and increase the robustness of the sector throughout the state.

Policy 5: Combine Solar and Electric Vehicle Charging Infrastructure

With ownership of electric vehicles (EVs) growing, the need for an electrified transportation system is clear. Charging stations are needed in multifamily residences, commercial parking lots, and public spaces. Unless communities meet this demand for energy by strategically locating charging stations, vehicle range will be severely limited.

Supplying EVs with solar energy is a viable and promising option. Solar energy, which is most readily available during the day, offers a supply of energy for EV drivers who charge their vehicles at work. For utility companies, daytime EV charging with solar energy helps smooth the solar supply curve, minimize curtailment (where energy is produced but the grid cannot take it up), and enable more efficient use of transmission and distribution resources. EV owners and utilities will benefit from the increased availability of charging stations powered by the sun.

Michigan's leaders could promote the efficient co-location of solar and EV charging stations by implementing several smart, proactive policies. First, Michigan's legislature could provide rebates for co-location of EV charging and solar technologies in the residential and commercial sectors. Second, the legislature could provide tax exemptions for cities and counties that install solar-linked EV charging stations in public places. Third, the Michigan Public Service Commission (MPSC) could allow electric utilities to count EV charging loads that are offset by co-located distributed solar toward their energy efficiency requirements. Finally, the state legislature could direct the MPSC to identify grid locations where solar and EV charging can provide the greatest benefit and use targeted incentives in these locations. Promoting charging stations linked to solar panels increases demand for both EVs and solar panels, creating solar installation and maintenance jobs throughout Michigan.

Chapter Summary

Smart, strategic policy choices can help Michigan leverage the state's unique dual strengths in advanced materials and advanced manufacturing in order to create a thriving solar cluster. As clusters coalesce around a nucleus of activity and relationships, Michigan's policymakers could consider removing barriers and stoking in-state demand in order to create a diverse and robust cluster. Additionally, policy designs that de-risk corporate engagement with start-ups to build new value chains will be important to the success of the cluster. These types of policies are detailed in Chapter 4: The Innovation Ecosystem and Access to Capital.

Chapter 4: Innovation Ecosystem and Access to Capital

Today, businesses are most likely to thrive in cities and states that offer a rich innovative ecosystem and break down barriers to capital. A successful innovation ecosystem bridges the divide between the knowledge economy and the commercial economy to promote research and development, bring new technologies to market, and incubate early stage businesses.

Allowing ideas to be easily transferred from the lab to the marketplace accelerates further entrepreneurship and job creation. Essential elements of robust innovation ecosystems include efficient intellectual property protection mechanisms, mentoring for entrepreneurs, and engagement of business and venture capital.

"One of the reasons the innovation sector still creates plentiful jobs is that it continues to be a labor-intensive sector, since the main production input in scientific research is human capital — in other words, people and their ideas."

--Enrico Moretti, "The New Geography of Jobs"

Access to capital is critical for the success of advanced energy sectors, especially given the development costs associated with capital-intensive technologies. Financing is especially important in the early prototyping and commercialization stages as products are being pushed to market.

A robust innovation ecosystem with seamless connections among researchers, entrepreneurs, and funding is also vital for advanced energy sectors. Businesses and research institutions across the country are racing to build the advanced energy technologies of the future. The winners will be able to bring innovative ideas to the marketplace as quickly and efficiently as possible.

Innovation Ecosystem

- Promotes research and development
- Facilitates new technology to market
- Incubates early stage businesses

Access to Capital

- Provides funding for new and growing businesses
- Connects investors with market opportunities
- Attracts entrepreneurs

Michigan's Innovation Ecosystem

Michigan's innovation ecosystem is robust and well-established. Michigan consistently ranks as one of the top states in the country for higher education research spending[1] and is also home to a variety of innovative companies and industrial research facilities. The state is ranked number one in research and development (R&D) professionals, with 87,000 workers.[2] With forward-thinking government initiatives, long-established industrial partners, and a strong research base, Michigan is well-positioned to become an unrivaled Midwestern center of innovation. The state's innovation ecosystem is organized and diverse, and it benefits from energetic leadership.

Research Institutions

Michigan boasts an impressive collection of public research universities: the University of Michigan (UM), Michigan Technological University (Michigan Tech), Michigan State University (MSU), Wayne State University (WSU), and Western Michigan University. Collective R&D expenditures at just three of these schools—UM, MSU, and WSU—total $2.1 billion annually.[3]

UM has been a leader in technology transfer through a standardized revenue distribution policy. Their Technology Transfer Office allocates funding to inventors, each inventor's department (and school or college), and the central campus administration based on revenue tiers.[4] In 2014, the program generated 148 license/option agreements, issued 132 patents, launched 14 start-ups, and generated $18.5 million in revenue.[5] Since 2001, the program has generated $230 million in revenue and helped create over 2,000 jobs.[6]

Several Michigan universities house leading advanced energy research centers and labs. UM's Energy Institute plays an active role in collaborative research by bringing industry, government, and academia together to develop energy solutions.[7] Additionally, MSU is a partner in the Great Lakes Bioenergy Research Center[8] and the Institute of Public Utilities,[9] which contribute applied research to the regulatory policy community. Michigan Tech, WSU, Lawrence Technological University, and Grand Valley State University are also active in alternative energy and sustainability research.[10]

Local Business Accelerators and Incubators Relevant to Advanced Energy

Michigan is home to dozens of accelerators and incubators,[11] providing important resources to facilitate the commercialization of research emerging from universities and private companies. Several accelerators and incubators in the state specialize in advanced energy.

Ann Arbor SPARK. Ann Arbor SPARK is an economic development nonprofit that receives public support from the State of Michigan through the Local Development Financing Act.[12] State funding comes in the form of tax increment financing, a model that sets aside revenue from future taxes to pay for current investments.[13] Ann Arbor SPARK provides a variety of services to emerging businesses, such as loans, advising, and access to incubator space.[14] In addition, the organization sponsors collaborative events, including the monthly Michigan Energy Forum. Many communities in Michigan have similar economic development arms. Examples include The Right Place in Grand Rapids, Saginaw Futures, and the Traverse Bay Economic Development Corporation.[15]

Michigan SmartZones

Michigan's 15 SmartZones are technology clusters that facilitate the commercialization of technology emerging from university and private company research. Within SmartZones, businesses, entrepreneurs, and researchers locate near each other and community resources, such as technology business accelerators.[19]

Michigan Alternative & Renewable Energy Center Business Incubator Program. The Michigan Alternative & Renewable Energy Center at Grand Valley State University offers a business incubator program to assist alternative and renewable energy entrepreneurs. Services include business development training, business plan review, general business counsel, and press release preparation.[16]

Oakland University Incubator. The Oakland University Incubator (OU INC) is a SmartZone Business Accelerator and collaborative effort between Oakland University, the City of Rochester Hills, Michigan Economic Development Corporation (MEDC), and industry partners.[17] The university's Clean Energy Research Center provides technical support to OU INC projects.[18] OU INC also provides strategic resources necessary for developing businesses and bringing ideas to market.

Business Accelerator Fund. The Business Accelerator Fund pays for eligible start-up companies to receive services from participating Michigan accelerators.[20] Managed jointly by MEDC and the Michigan Small Business Development Center, the fund offers eligible companies up to $50,000 in accelerator services.[21]

Access to Capital for Advanced Energy Investment

Access to capital is essential for entrepreneurs to grow their businesses and bring their products to market. Many entrepreneurs are not able to find the necessary capital to sustain their companies long enough to reach the commercialization

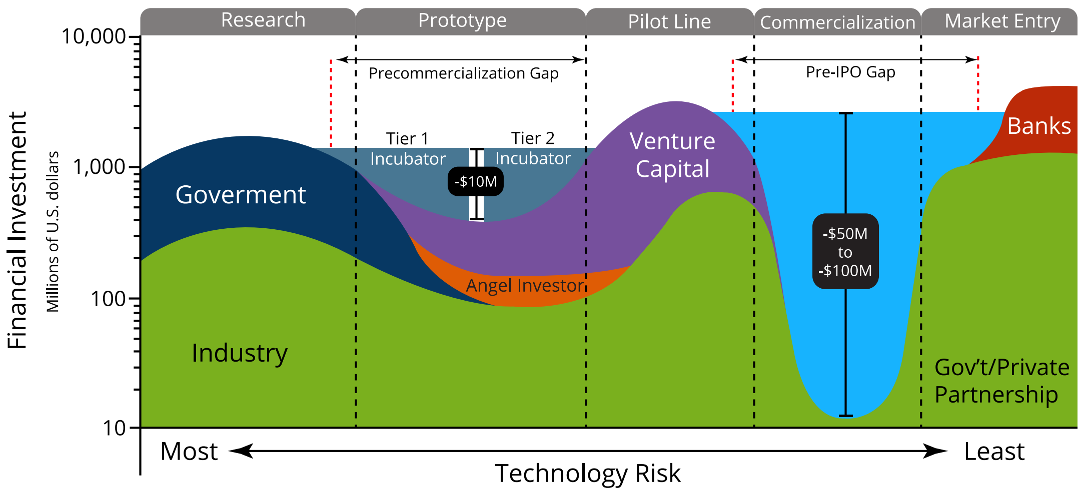

Figure 7. New technologies need help crossing the second "valley of death" during the commercialization process (Source: Department of Energy)

phase. As shown in Figure 7, companies nationwide often face funding shortages during the prototyping and commercialization phases, commonly known as the "valleys of death." Because 75 percent of venture capital funding goes to companies in California, New York, and Texas, companies in the other 47 states face even more funding difficulties.[22] Michigan has worked hard to secure early investment to help new companies survive the double "valleys of death" and bring their innovative technologies to market.

Venture Capital. Thirty-seven private venture firms operate in Michigan.[23] Twenty-six are headquartered in the state and the other 11 have a Michigan office.[24] The state is also home to four funds of funds (Renaissance Venture Capital Fund, 21st Century Investment Fund, Venture Michigan Fund I, and Venture Michigan Fund II), as well as two corporate venture funds (Dow Venture Capital and GM Ventures).[25] In addition, the Invest Michigan series of funds (Mezzanine Fund, Growth Capital Funds, and Michigan Opportunities Fund) and the Michigan Accelerator Fund 1 provide capital to early- and late-stage ventures.[26]

Venture capital funds headquartered or under management in Michigan totaled $4.8 billion in 2014, an 86 percent increase since 2009.[27] Venture capital available for new investments totaled $876 million in 2014, a 158 percent increase since 2009.[28] Michigan venture capital funds invest in a diverse range of sectors, including advanced energy. Investments in this sector currently account for 7 percent of total capital invested.[29]

The Renaissance Venture Capital Fund (RVCF) in Michigan is a great example of how business leaders, nonprofits, and the public sector can collaborate to boost venture capital and empower in-state entrepreneurs. Born in 2008 out of the nonprofit Business Leaders for Michigan's Road to Renaissance initiative, the RVCF aims to invest in the growth of innovative technologies and companies in the state.[32] The privately-run fund raised $45 million in Fund I, which was leveraged to attract total investments of nearly $500 million in 23 Michigan companies. That first round created hundreds of new jobs with an average salary of $85,000.[33] The fund was so popular with investors that RVCF decided to launch Fund II, which recently closed with a total of $79 million from private businesses, nonprofits, and state pension funds, all of which will be invested in Michigan.[34]

Michigan Translational Research Acceleration. Proof-of-concept funding is critical for emerging start-ups to advance out of the "valley of death." The Michigan Translational Research

Venture Capital Funds Investing in Advanced Energy

Michigan venture capital funds that focus on energy technologies include Huron River Ventures and Oakland Energy and Water Ventures. Huron River Ventures is an early-stage venture capital firm focused on agriculture, energy, and transportation technology companies in Michigan and across the Midwest.[30] Oakland Energy and Water Ventures is a second-stage fund that invests in and commercializes clean energy and water products and solutions.[31]

State Matching Funds

Since 2008, the Michigan Small Business Development Center and the Michigan Economic Development Corporation have dedicated $7.28 million to match federal Small Business Innovation Research and Technology Transfer funding opportunities. Funding is reserved for research and technical innovation generated within the state.[41]

and Commercialization (MTRAC) program provides this type of support by awarding grants to promising technologies at public universities and gives the universities a great deal of discretion in awarding the funds.[35] MTRAC grants only need to follow the statutory purpose of the fund: facilitate connections between Michigan's public universities and industry, develop new technologies for commercialization, and leverage sponsored research contracts for universities from industry.[36]

UM Student-Led Investment Funds. The Wolverine Venture Fund, Zell Lurie Commercialization Fund, and Social Venture Fund are UM student-led funds with targeted cleantech teams focused on evaluating emerging technologies. The $7-million Wolverine Venture Fund invests primarily in early-stage companies.[37] The Zell Lurie Commercialization Fund is a pre-seed investment fund focused on identifying and accelerating the commercialization of university research.[38] The Social Venture Fund is the first student-led impact investment fund.[39]

Michigan Emerging Technologies Fund. The Michigan Emerging Technology Fund expands funding opportunities for technology-based companies in the federal innovation R&D space. Funds may be used to bring projects to commercialization in four sectors, including alternative energy.[40]

Michigan Angel Fund. The Michigan Angel Fund is a for-profit angel fund established by Ann Arbor SPARK and funded by the MEDC. The fund helps finance early-stage companies in the state and attract additional angel investors to Michigan's entrepreneurial ecosystem.[42]

Tax Incentives Relevant to Advanced Energy Businesses. Michigan boasts an impressive array of tax incentives to attract and maintain businesses. The state is ranked as one of the top 10 states for corporate tax competiveness due to a 6 percent corporate income tax rate and $500 million in annual business savings through the elimination of the industrial personal property tax.[43] High-tech companies receive an additional 50 percent property tax abatement for up to 12 years.[44] Additionally, the High-Tech Michigan Economic Growth Authority (MEGA) grants employment tax credits to qualifying businesses that generate at least five new jobs by the time the tax credit is claimed and 25 jobs over the following five years.[45] Qualifying businesses can receive 200 percent of the sum of their payroll and health care benefits multiplied by the personal income tax rate per new job for three years.[46] Additionally, MEGA awards high-wage tax credits to businesses paying an average of 300 percent of the Federal Minimum Wage to all employees.[47]

Policy Recommendations

If Michigan wants to be a national leader in smart buildings and solar manufacturing, it needs to further build out its strong innovation ecosystem. Creative solutions will bring technologies to market faster and bring good-paying jobs to the state.

Policy 1: Facilitate Partnerships within the Energy Innovation Ecosystem

Given the complex nature of the advanced energy space, having effective partnerships across sectors is critical in making progress on energy innovation. Alignment between Michigan's leading research universities, private companies, nonprofits, and government can accelerate innovation and growth to stimulate a private market for energy innovation that will create jobs for Michiganders. Better cross-sector organization for energy innovation can take several forms, including the advancement of shared policy objectives, the enhancement of visibility around energy innovation issues, and the coordination of resources.

Michigan already has the infrastructure in place for forming these types of partnerships through the Michigan Corporate Relations Network and the University Research Corridor. Nonprofits such as NextEnergy and Ann Arbor SPARK also play an important coordinating role in Michigan's innovation ecosystem.

Michigan could build on existing coordinating efforts by allocating funding to jumpstart an energy innovation network. The MEDC, the Michigan Agency for Energy, or a similar state agency could provide seed funding for coordinating efforts focused on securing additional funding and commercialization. This type of collaboration is especially important given increased capital directed toward early-stage R&D—the U.S. government will double its current level of investment in advanced energy over the next five years.[54]

Aligning the energy innovation ecosystem can help attract capital, bring breakthrough research to market, and allow Michigan to have a greater impact in the advanced energy space.

Policy 2: Create a Technology Investment Tax Credit

Encouraging investments in early-stage technology start-ups is essential for states to remain competitive and spur job creation. One policy that has seen success in multiple states is a technology investment tax credit. A properly designed investment tax credit can boost funding for early-stage technology companies.

Michigan Corporate Relations Network

The Michigan Corporate Relations Network (MCRN) is a collaboration between six Michigan research universities with support from the Michigan Economic Development Corporation and the Michigan Strategic Fund Board.[48] As the first statewide university-to-business network in the United States, the MCRN is designed to support innovative research and business development, grow the state's economy, and enhance teaching and research at Michigan's universities.[49] This is accomplished through a variety of offerings, including business engagement offices, a small company innovation program, and a portal centralizing key data and faculty expertise.[50]

University Research Corridor

Michigan's University Research Corridor (URC) is an alliance between MSU, UM, and WSU. These three universities produced over $2.12 billion in R&D and contributed more than $16.8 billion to Michigan's economy in 2013.[51] The URC has also cultivated 173 start-ups since 2002.[52] In addition to coordinating across universities, the URC has engaged in strategic partnerships with the business, nonprofit, and government communities.[53]

Ohio Federal Research Network

Recognizing the importance of coordination within and across sectors, the state of Ohio funded the Ohio Federal Research Network in July 2015.[55] Wright State Applied Research Corp. will receive $20 million over the course of two years and Ohio State University will receive an additional $5 million to establish collaboration between the state's research universities, Wright-Patterson Air Force Base, NASA Glenn Research Center, and the private sector.[56] Approximately half of this funding will be used to create a model of how the research network will run.[57]

The goal of the Ohio Federal Research Network is to bring in $300 million in new federal research contracts to Ohio-based companies in the next five years. It is estimated that this funding will result in 2,500 new jobs, $250 million in private sector investment, and the creation or expansion of 100 companies.[58]

In 1996, Ohio pioneered a technology investment tax credit, a temporary tax credit with a $30 million cap.[59] Ohio's program allowed state taxpayers who invested in qualifying early-stage technology companies to claim a credit worth 25 percent of the investment, up to a maximum of $250,000 per company.[60] The program was so successful that venture capitalists are now calling for its return after reaching the cap in 2013.[61] Over the program's six-year lifespan, 3,500 Ohioans invested approximately $180 million in more than 665 companies.[62]

In 2014, Kentucky followed Ohio's lead and established a 40 percent credit for qualified investments in small start-ups.[63] Kentucky's credit increases to 50 percent for investments in businesses located in "enhanced incentive counties."[64] These are counties that have exceptionally high unemployment rates or are among the most distressed counties in the state.[65]

Michigan should consider offering a technology investment tax credit. By creating a significant incentive, the state can help funnel investment capital to early-stage technology companies. Such a program could help grow the emerging hub of start-ups in Ann Arbor and Detroit, create a magnet for business investment, and boost job creation and economic activity. Additionally, Michigan should consider providing an increased incentive for qualified businesses, similar to what occurs in Kentucky. Michigan could provide an enhanced credit—10 percent higher, for example—for advanced energy companies. A targeted credit for advanced energy would help jumpstart investment and facilitate cluster development.

Conclusion

Michigan has demonstrated a strong commitment to the state's innovation pipeline. The state provides significant support to emerging companies through its public university system, incentives and tax credits, venture capital funds, and strong partnerships with established innovative companies. However, Michigan can do more to bring new ideas to market, ensure increased investment in technology innovation, and capitalize on the strong research environment within the state's public university system. Michigan's innovation ecosystem has the capacity to develop and retain firms that will establish the state as a pioneering hub for advanced energy technology solutions.

Chapter 5: Workforce Development for Smart Buildings and Solar

Over the last several decades, Michigan has been disproportionately affected by the nationwide decline in the manufacturing industry given that manufacturing represents approximately 20 percent of the state's total GDP compared to 12.5 percent nationwide.[1] The bankruptcies in the auto sector in 2007-2009 were responsible for Michigan's high unemployment rate in those years, and the federal government's intervention to save GM and Chrysler proved to be a turning point. Michigan's economic recovery since 2009 has demonstrated encouraging progress: statewide unemployment has declined from a peak of 14.9 percent in June 2009 to 5.0 percent in late 2015.[2] Furthermore, in a reversal of 7 years of population loss since 2005, Michigan has registered steady population growth over the past 3 years.[3]

One indicator of Michigan's economic recovery is the growing rate of employment in the advanced energy sector. Over half of all jobs in Michigan's energy sector (46,000 out of 84,000 jobs) are in the energy efficiency subsector. The majority of jobs focus on construction activities and services that improve energy efficiency of buildings.[4] Employment in this field has displayed growth in Michigan since 2009 and is projected to continue to grow.[5] Additionally, the solar energy manufacturing sector in Michigan grew by an average of 15.8 percent annually between 2003 and 2010, and it currently employs 6,300 workers[6] in more than 100 companies across the state.[7]

Overall, the growing rate of advanced energy sector employment in Michigan is encouraging, and workforce development will be essential to maintaining this momentum. A skilled workforce is fundamental to the success of an industrial cluster. If firms in the same cluster are able to coordinate with the government, schools, and related nonprofits on policies and programs to train workers for their sector, they will be better equipped to identify their employment needs and find workers with needed skills to fill available jobs. A thoughtful, sector-based workforce development approach should include: industry best practices for recruiting, hiring, training, promotion, and compensation; education and training infrastructure (including community colleges, project-based learning experiences, and apprenticeship programs); and public policy, specifically rules, regulations, and funding streams related to workforce and education.[8]

Current Workforce Development Efforts Relevant to Advanced Energy

Michigan's robust public education system and existing workforce development efforts provide a strong base for professional and technical skill development. Each year, Michigan's extensive public higher education system educates approximately 300,000 students at 15 public universities.[9] The state is also home to 28 public community colleges, serving over 400,000 students.[10] The state's educational pipeline also encompasses K-12 education, Early/Middle College programs, apprenticeships, and other forms of certification outside the traditional academic environment.

STEM Education Partnerships and Initiatives. Student interest and achievement in STEM is a major focus throughout the state. The Michigan STEM Partnership facilitates communication between STEM employers, educators, students, parents, and legislators.[12] In addition to collaborative partnerships and education campaigns, STEM receives private financial support in Michigan, including a recent $5 million donation from The Herbert H. and Grace A. Dow Foundation to fund the e-STEM: Enhancing STEM Education and Practice initiative for K-12 teachers.[13]

Early/Middle College. Michigan's Early/Middle College Program provides high school students with the opportunity to participate in a five-year high school track to earn a Michigan Early/Middle College Association (MEMCA) certificate, an associate's degree, or up to 60 transferrable credits for a four-year degree.[14] To improve the integration of STEM education with existing Early/Middle College programs in other states, high-need school districts in Michigan participate in Columbia University's STEM Early College Expansion Partnership (SECEP).[15]

Community College Programs and Certificates. Michigan's community colleges offer highly specialized certificates or associate's degrees in green construction and remodeling; construction management; sustainable residential building practices; energy efficiency; environmental technology; and sustainable heating, ventilation, air conditioning, and refrigeration.[16] Community colleges throughout Michigan also provide certificate or degree programs related to solar energy, renewable energy technology, industrial electricity, alternative energy engineering, and wind and solar technician skills. Washtenaw Community College offers programs in industrial electronics technology and mechatronics,[17] both of which are relevant to solar panel manufacturing.

Professional Apprenticeships and Certifications. The Detroit JATC-Electrical Industry Training Center works with unions to sponsor three- to five-year technical apprenticeships for professional wiremen,[18] an essential high-skilled job in the solar supply chain. Regionally, the Midwest Renewable Energy Association (MREA) certifies solar energy workers in solar thermal design, sales, and site assessments. Additionally, MREA provides training for workers to become local instructors in PV installation, site assessment, and technology sales.[19] On the national level, the North American Board of Certified Energy Practitioners (NABCEP) offers an entry-level certification exam on PV and Solar Heating. The board also facilitates advanced certification exams for PV Installation Professionals and Solar Heating Installers.[20] The Midwest Energy Efficiency Alliance (MEEA) provides Building Operator Certification for smart building maintenance.[21] MEEA partners with the Michigan Economic Development Corporation to sponsor this program, which offers up to $350 in rebates to individuals who complete the training.[22]

Michigan: The Most Engineers Per Capita

Michigan's pool of highly advanced and technologically sophisticated professionals is a key differentiator for the state. Notably, Michigan is ranked first in the number of engineers per capita as nearly 10 percent of the state's population hold an engineering degree.[11] The state's community colleges and four-year universities play an integral role in furnishing this highly skilled workforce by providing the training necessary to grow the advanced energy industries. Michigan's existing degree programs include mechanical, industrial, electrical, and chemical engineering; computer science; alternative energy engineering; and programs in architecture and urban planning with specialties in green construction. These programs are drivers of innovation in the advanced energy industry.

Michigan Advanced Technician Training Program. This program provides training for workers in high technology, high-need industries through public-private partnerships. Trainees are linked with employers throughout the process to ensure a match between training and skill demand.[23]

Skilled Trades Training Fund (STTF). STTF finances workforce trainings through public-private partnerships with Michigan businesses. Trainings provide workers with a transferable industry-recognized credential. STTF allocates up to $1,500 per trainee, and up to $3,000 if the training program is a registered apprenticeship.[24] The Michigan Workforce Development Agency estimates that this program has created or saved 5,000 jobs while also providing employees with valuable technical certifications.[25] Private or nonprofit Michigan businesses that demonstrate a need for training are eligible to receive STTF funds.

Policy Recommendations

To ensure the success of the advanced energy sector in the state, Michigan must commit to workforce development efforts that target skill gaps in the smart building, energy efficiency, and solar clusters. Michigan could build upon existing job growth and education, training, and certification programs to capitalize on expansion opportunities in the state.

Policy 1: Capitalize on Digital Manufacturing and Innovation to Drive Future Job Creation

Michigan boasts a strong base of manufacturing firms that positively impact the state's economy and contribute to national and global energy efficiency markets.[26] To enhance the growth of advanced energy technology manufacturing within Michigan, state leaders could facilitate public-private partnerships that expand competition and innovation capacity of small and medium-sized manufacturers. This can be accomplished by promoting advances in manufacturing technology and the corresponding workforce trainings to ensure that workers can keep up with skill demand. High-performance computing technology and new modeling simulation and analysis can build competitive advantage through "innovative product design, production techniques, cost savings, improved time-to-market cycles, and overall quality."[27] However, without assistance, many companies cannot afford to invest in this type of technology, putting them at risk of missing significant business opportunities.[28]

Trends in Digital Manufacturing Training

To address rapidly evolving technologies, the Michigan Economic Development Corporation committed funding to the National Center for Manufacturing Sciences in November 2012. The purpose of this allocation of money was to help establish the Michigan Grid Cell (formerly named the Predictive Innovation Center), a facility that provides companies with equipment and workforce training to aid in virtual design and prototyping.[29] Additionally, North Central Michigan College has partnered with the Northern Lakes Economic Alliance, Charlevoix-Emmet Intermediate School District, Ferris State University, Little Traverse Band of Odawa Indians, Precision Edge, and numerous manufacturers to create a "self-contained mobile digital manufacturing lab," otherwise known as the "Fab Lab." The mobile lab can be set up near the workforce to improve the efficiency and accessibility of training programs. Students who complete the program receive a nationally recognized certificate in Computer Numerical Control (CNC).[30]

Michigan could expand these efforts by investing in digital manufacturing resources to drive future job creation. State policymakers could look to the success of the National Digital Engineering and Manufacturing Consortium's (NDEMC) public-private partnerships. NDEMC's Midwest pilot program in Ohio and Indiana matched $2.5 million in private sector investment with $2 million in federal grants and technical assistance from local universities. The funding was used to increase the accessibility of high-performance computing and training resources for small- and medium-sized firms. The 20 manufacturers that received NDEMC funding saw a combined $20 million increase in sales revenue each year, with exports accounting for half of total sales. These manufacturers also created 160 new jobs in 2012 and developed three new products.[31] Michigan could establish a similarly structured public-private partnership using state funding and leveraging the resources of the state's public university network. Additionally, Michigan's six Manufacturing Extension Partnership sites could also be supported to provide these digital tools and training to small manufacturers. Bolstering the state's workforce and innovation capacity within the manufacturing sector will set the stage for future growth and allow Michigan to effectively compete in the advanced energy global economy.

Policy 2: Invest In and Retain Michigan STEM-Educated Workers to Spur Job Growth

Michigan retains only half of the state's public university graduates.[32] This is a result of high numbers of young, skilled technical workers moving out of the state. Recognizing this challenge, Michigan established the Global Talent Retention Initiative to assist private employers in hiring skilled international students with university-level STEM education to work in the state.[33] While this program is encouraging, it is a modest first step. Michigan STEM-educated students could also be incentivized to remain in the state following graduation, which would reduce the "brain drain" following degree conferral.

Opportunity Maine

The Opportunity Maine program provides annual lump-sum tax credits to students who graduate from a Maine college and go on to live and work in the state. Individuals qualify if they maintained Maine residency while attending an accredited state higher education institution, obtained an associate's or bachelor's degree on or after January 1, 2008, and worked for an in-state employer after graduation.[34] STEM graduates are eligible for a refundable tax credit and non-STEM degrees are eligible for the nonrefundable tax credit (cannot exceed the Maine income tax amount).[35]

Michigan lawmakers have started to address this issue. Proposed House Bill 4118 (2015) would create a program similar to Opportunity Maine. The Michigan program would include an income tax credit equal to 50 percent of student loan payments made by individuals who received a degree from a state college or university after May 1, 2015 and are employed in Michigan. The bill has not gained sufficient traction and is currently stalled.[36] Revised legislation that specifically incentivizes STEM students to remain in-state after graduation may be more cost-effective and able to address a group of workers that are drivers of innovation and future job growth.

Policy 3: Help Dislocated Veterans Get Back to Work with Skill Retooling Programs

Michigan is home to over 630,000 veterans, accounting for 8.8 percent of the state's total adult population.[37] Many veterans have skills that can be retooled for advanced energy industries, making them an important population to consider in workforce development efforts.

The veteran population in Michigan is an untapped area of potential for the state's technical workforce. However, Michigan lacks targeted training programs to integrate veterans into the state's growing advanced energy industries. Recently, Michigan implemented a conceptually similar initiative for scientists, engineers, and executives called the Michigan Shifting Gears program.[38] Montcalm Community College and the Ionia Michigan Works! Service Center have implemented similar programs for dislocated technical workers following factory closure.[39]

The Michigan Shifting Gears Program

The Michigan Shifting Gears program is a career transition program that retools experienced professionals' skills to succeed in the state's high-tech industries. This is accomplished by career assessment, coaching, small business simulations, interview preparation, internships, and resume retooling to meet potential employers' needs.[40]

Michigan could establish a similar program targeted at veterans with a background in medium-skill maintenance, machinery, and electrical technician work. The workforce development program would need to determine on a case-by-case basis which of the veteran's existing technical skills could be connected with an in-demand job after being retooled. Such a program could be housed in the Michigan Department of Military and Veterans Affairs or the state's community college network.

Conclusion

With robust STEM education opportunities, existing workforce development programs, and a pool of skilled professionals, Michigan can build on these strengths to ensure the success of the state's industrial clusters. By building workforce conditions for rapid growth in the digital manufacturing sector, addressing the "brain drain" of STEM-educated students out of the state, and implementing veteran-specific programs, Michigan can prepare its workforce for the advanced energy economy.

Chapter 6: Conclusion

In order to build on Michigan's success in the advanced energy space and position the state for continued growth, policymakers will need to make advanced energy a priority. The purpose of The American Jobs Project: A Roadmap to Create Advanced Energy Jobs in Michigan has been to analyze Michigan's advanced energy economy in order to create recommendations specifically tailored to the state's needs. The policies recommended in this report are complementary and intended to help the state grow demand for advanced energy technologies, manufacture products within the state, enable entrepreneurship for technological advances, fund innovation with accessible capital, and equip workers with the skills required for the state's future economy.

Policy leadership in the advanced energy space can play an important role in promoting Michigan's advanced energy clusters and creating quality jobs for Michiganders. Advanced energy clusters focused on smart building and solar technology offer a great opportunity for Michigan to grow its economy, create jobs for the state's residents, and become a leader in the production and deployment of advanced energy technology.

If Michigan's policymakers take swift and purposeful action to grow the smart building and solar industries, the state can create up to XXXX jobs through 2030, or XXXX jobs per year.

Michigan has the right mix of strengths to leverage this opportunity. With smart, forward-thinking policies, the state can diversify its economy and create thousands of middle class jobs for hard-working Michiganders.

For more information about advanced energy technologies and best practice policies, visit http://americanjobsproject.us/.

Extended Learning Section

Appendix A: Michigan's Utilities and Regulatory Structure

Michigan has been described as having a "hybrid" structure with respect to its energy industry. Much of the state's energy industry still falls within the traditional regulated structure of a vertically integrated utility, meaning the utility takes responsibility for producing or purchasing wholesale electricity, maintaining the poles and wires of the transmission and distribution network, and handling customer metering and direct energy sales. However, some of the state's energy industry is based on a "restructured" model. This includes limited competition for retail electric sales, as well as the presence of an independent system operator managing the operations of the electric grid.

Utilities

Michigan's gas and electric utilities can be grouped into one of three categories: private investor-owned utilities (IOUs), rural electric distribution cooperatives (co-ops), and municipally owned electric utilities (munis).[1]

The state has eight private IOUs: four in the upper peninsula (Xcel Energy, Upper Peninsula Power Company, Wisconsin Electric Power Company, and Wisconsin Public Service Corporation) and four in the lower peninsula (Alpena Power Company, Indiana Michigan Power Company, Consumers Energy, and Detroit Edison Company).[2] Of these companies, Consumers Energy and Detroit Edison are by far the two largest, serving over 85 percent of Michigan's electricity sales[3] with a combined workforce of over 17,000 employees.[4]

In addition to IOUs, Michigan has nine co-op utilities: three in the upper peninsula (Alger Delta Cooperative, Cloverland Electric Cooperative, and Ontonagon County Rural Electrification Association) and six in the lower peninsula (Cherryland Electric Cooperative, Great Lakes Energy Cooperative, Midwest Energy Cooperative, Presque Isle Electric and Gas Co-op, Thumb Electric Cooperative, and Tri-County Electric Cooperative).[5] Of these co-ops, Great Lakes Energy Cooperative is the largest, ranking as the third largest utility in Michigan.[6]

There are also over 40 munis in Michigan, serving approximately 8 percent of the state's electricity needs.[7] Examples of munis include the Lansing Board of Water and Light[8] and Traverse City Light and Power.[9]

Alternative Suppliers

Most end-users in Michigan, both homeowners and businesses, buy their electricity directly from their local utility. However, in 2000, the state began to allow for competition in the retail sales of electricity from alternative electric suppliers (AES).[10] Opening the retail sector to alternative suppliers was part of a broader effort in Michigan to restructure the state's energy sector and allow for competition.[11] Today, the total number of customers purchasing electricity from an AES in Michigan is capped at 10 percent within each utility's service territory.[12]

Regulatory Framework

The primary regulator of energy in Michigan is the Michigan Public Service Commission (MPSC). All investor-owned and cooperative electric utilities are subject to regulatory oversight from the MPSC, though municipally-owned electric utilities are not (with some exceptions). The MPSC also provides regulatory oversight and licensing for alternative energy suppliers.[13]

Utilities need approval from the MPSC for the rates they charge their electric customers. Rates for utility electric services are established periodically in a process known as a "rate case," wherein a utility requests from the MPSC specific rate levels to charge its customers.[14] Additionally, under Michigan's Renewable Portfolio Standard and Energy Optimization legislation (Public Act 295 of 2008), the MPSC is responsible for determining utility compliance.[15]

While the MPSC has authority over retail sales of electricity and the operations of Michigan's electric utilities, the Midcontinent Independent System Operator (MISO) and the PJM Interconnection (PJM) conduct oversight of wholesale power transactions and the bulk transmission grid. These nonprofit entities were established in certain parts of the United States where utilities and regulators were looking to pool the management of the electric grid. MISO and PJM oversee the day-to-day operation and coordination of power plants on an electric grid as well as manage the long-term planning of the grid. In addition, they operate wholesale markets for the buying and selling of power between utilities and independent power producers.[16]

Nearly all of Michigan's utilities and their associated transmission lines and power plants are part of MISO.[17] MISO is responsible for managing the operations of the electric grid for much of the

Midwest, with a service territory stretching from the Canadian border of Minnesota down to the Gulf of Mexico in Louisiana.[18] The territory in southwest Michigan served by Indiana Michigan Power Company falls outside of MISO, and is instead a part of PJM.[19] Similar to MISO, PJM is responsible for managing the electric grid and wholesale power market for a large part of the Mid-Atlantic, with a footprint that includes northern Illinois, New Jersey, eastern North Carolina, and the thirteen states in between.[20] The authority granted to MISO and PJM is subject to oversight from the Federal Energy Regulatory Commission, which under federal law has jurisdiction over most interstate and wholesale electricity sales.[21] Additionally, MISO and PJM are responsible for maintaining the reliability of the electric grid.[22]

Appendix B: Public Act 295

Public Act 295 of 2008, known as the Clean, Renewable, and Efficient Energy Act, is a combined renewable portfolio standard (RPS) and energy optimization (EO) standard.

The RPS requires Michigan electric providers to attain a retail supply portfolio of at least 10 percent renewable energy by 2015, with interim steps for 2012, 2013, and 2014.[23] Electric providers meet these requirements through renewable energy credits. The standard also contains an incentive system that provides "Michigan incentive renewable energy credits" for solar power, renewable energy generation (excluding wind) during peak demand, renewable energy storage, and renewable energy produced by equipment manufactured within Michigan or constructed by a Michigan workforce.[24] Electricity providers are permitted to recover the incremental costs of compliance with the RPS requirements via a capped renewable energy surcharge on customer bills.[25] Michigan's electric providers achieved 7.8 percent renewable energy by the end of 2013 and 8.1 percent by the end of 2014, and the MPSC expects all providers will reach the 10 percent standard by the end of 2015.[26]

The EO standard requires all natural gas and electric utility providers in Michigan to implement programs to reduce overall energy usage by specific targets with the goal of reducing future costs to their customers.[27] Electric utilities are required to achieve an annual savings calculated as a percentage of the prior year's total electricity sales: 0.3 percent in 2009; 0.5 percent in 2010; 0.75 percent in 2011; and 1.0 percent in 2012 and each year thereafter. Similarly, natural gas utilities are required to achieve an annual savings calculated as a percentage of the prior year's total retail natural gas sales: 0.1 percent in 2009; 0.25 percent in 2010; 0.5 percent in 2011; and 0.75 percent in 2012 and each year thereafter. In 2013, Michigan utility providers successfully complied with the energy saving targets established in Public Act 295, meeting an average of 132 percent of their electric energy savings targets and 121 percent of their natural gas energy savings targets.[28]

Appendix C: Career Opportunites in Advanced Energy

Careers in the Green Construction Supply Chain

Job Title	Primary Responsibilities
Building Energy Auditor	Evaluates heat, electricity, water, and gas loss from commercial and residential buildings and recommends best strategies to increase energy efficiency and minimize costs.[29]
Urban and Regional Planner	Works with local authorities to develop zoning areas where buildings must achieve industry standards for energy efficiency.[30]
Architect (General and Landscape)	Designs improve building plans while working with engineers to maximize energy efficiency. Designs gardens and landscapes to minimize water waste and runoff.[31]
Software Developer and Technician	Develops operational software for smart sensors that track energy waste and for appliances with programs that minimize energy loss.
Electrical Engineer and Technician	Develops circuitry, electrical equipment, lighting, sensors, and building components to ensure minimal energy loss.[32]
Mechanical Engineer and Technician	Designs, manufactures, and assembles energy-efficient hardware such as HVACR appliances, and energy turbines/generators.[33]
Construction Manager	Assesses material needs, manages construction projects, and supervises contractors, carpenters, plumbers, and electricians.[34]
Construction Equipmet Operator	Operates heavy machinery to construct new green buildings and revamp existing buildings.[35]
Construction Laborer	Performs a variety of tasks to construct building parts or structures under manager supervision. Many engage in specialty trades like carpentry, roofing, plumbing, glazing, etc.[36]
Electrician	Performs installation and maintenance work on the energy systems of a building.[37]
HVACR Mechanic and Installer	Installs, diagnoses, and repairs heating/cooling, ventilation, air conditioning, and refrigeration systems to reduce energy waste.[38]
Insulation Worker	Manufactures and installs high-quality insulation material in buildings to prevent heat loss.[39]

Careers in the Solar Supply Chain

Job Title	Primary Responsibilities
Salesperson (Scientific, Manufacturing, and Technical)	Markets and sells photovoltaic technology to commercial and residential customers.[40]
Site Assessor	Determines expected energy production, best panel layout, and financial feasibility of solar energy projects for customers.[41]
Industrial Production Manager	Manages the factory and human processes for photovoltaic cell manufacturing.[42]
Materials Engineer	Works with metals, plastics, and composites to manufacture materials for solar panels.[43]
Research and Development Scientist	Conducts scientific research and development. Includes Physicists, Chemists, and Materials Scientists.[44]
Chemical Engineer and Technician	Designs and tests the effectiveness of solarcells, includingsupervising the production of semiconductors or organic materials.[45]
Electrical Engineer and Technician	Designs, manufactures, and assembles circuitry, separators, inverters, and other components for solar cell energy transmission.[46]
Industrial Engineer	Determines the most effective ways to increase the efficiency of solar panel production.[47]
Mechanical Engineer and Technician	Designs and manufactures the machines used to make solar panels as well as the electric generators used in solar power plants.[48]
Software Developer	Codes programs that control mechanical movements of sola panels to capture sunlight and conduct other smart processes.[49]
Electrical and Electronic Equipment Assembler	Produces and assembles individual components for solar panel manufacturing.[50]
Semiconductor Processor	Develops semiconductors that are then turned into photovoltaic cells.[51]
Metal Worker	Fulfills the welding, soldering, and brazing needs for manufacturing photovoltaic cells and their constituent components.[52]
Glaziers	Responsible for measuring and cutting glass or laminate to cover solar panels, securing it in place, and sealing it.[53]
Coating, Painting, and Spraying Machine Setters, Operators, and Tenders	Applies coating to solar panels through a complicated process requiring a high level of precision.[54]
Industrial Production Manager	Manages the factory floor, ensure quality, and keeps production on schedule.[55]
Solar Photovoltaic Installer and Repairer	Installs manufactured panels on roofs and buildings and conducts routine maintenance.[56]
Electrician	Connects solar panel electricity production to internal grid and local utility.[57]

Appendix D: Jobs Modeling Methodology

Economic Impact Methodology

The American Jobs Project combines existing tools, analysis, and projections from several reputable sources to estimate job creation. Rather than providing a specific estimate, we show jobs potential across a range of possible outcomes. All jobs are show in job-years that exist during the analysis timeline (2016-2030).

The key to job creation lies in local action. Our estimates are intended to start a conversation about how local stakeholders can work together to set their goals and utilize the same tools and data that we have used to estimate potential impacts.

Tools for Economic Impact Analysis

A number of modeling tools are available for estimating economic impacts from advanced energy industry growth. The most commonly use are: the Jobs and Economic Development Impact (JEDI), Impacts for Planning (IMPLAN) and the Regional Economic Models, Inc. (REMI) models. In this report, we employ the JEDI and IMPLAN models. Results from the JEDI model only show job gains and do not evaluate losses in other industries. They are based on approximations of industrial input-output relationships, and do not include intangible effects. The JEDI model is widely used because it estimates construction and other projects economic impacts at the local (usually state) levels. IMPLAN estimates the economic impact of a dollar invested into a sector and the resulting ripple, or multiplier, effects. Multipliers are used to generate the economic impacts of the project across three different categories namely: direct, indirect and induced. Not all advanced energy technologies can be modeled with JEDI. In these cases, BETONY INFO IS USED.

It is important to note the limitations of these modeling methods. As mentioned, the estimates shown are only gross job-year creation. Job losses in industries that compete with those in our analysis are not evaluated. Models do not dictate behavior, so indirect and induced jobs estimates could vary greatly based on the reality of what is actually purchased locally. Also, foreign and domestic competition can play a significant role in limiting the potential for job creation. The estimates presented in this report are highly dependent on sustained local action towards developing and maintaining these industries.

Estimates Used in the Michigan Report

Solar

JEDI was used to estimate jobs potential for the solar industry in Michigan. We show the jobs potential from several scenarios based on different percentages of local share, i.e., how much of the total industry supply chain and service expenditures could happen in the state to serve local and national demand. In the report, we show a range of 0%-100% of local share at 25% increments. In cases where there were only regional estimates, we assume that Michigan would maintain its current weighted average of solar capacity in the region over time. Where detailed information was not available for rooftop solar, estimates are based on "Tracking the Sun" weighted average distribution for residential, small commercial and large commercial buildings. This was also used for average capital costs per MW for analyses in JEDI. Job-years included in this analysis represent all job-years that exist during the timeframe of 2016-2030.

DOE Office of Energy Efficiency and Renewable Energy: Wind Vision

The Wind Vision Study Scenario was identified as a scenario that extends wind deployment trends, leverages the domestic wind industry manufacturing base, and complements the broader literature. The Study Scenario is represented by wind power penetration levels of 10% by 2020, 20% by 2030, and 35% by 2050 and includes projections for other renewable energy sources. Impacts from the Study Scenario are compared to a Baseline Scenario in which wind capacity is fixed at 2013 levels. This allowed the team to identify and quantify impacts for future wind deployment. The assessment was the work of more than 100 individuals from major stakeholder sectors (government, industry, electric utilities, and nongovernmental organizations), conducted over a two-year period from 2006–2008. The study analyzed wind energy's potential contributions to economic prosperity, environmental sustainability, and energy security.

National Renewable Energy Laboratory: Renewable Electricity Futures

The National Renewable Energy Laboratory's Renewable Electricity Futures Study (RE Futures) is an initial investigation of the extent to which renewable energy supply can meet the electricity demands of the continental United States over the next several decades. This study explores the implications and challenges of very high renewable electricity generation levels—from 30% up to 90%, focusing on 80%, of all U.S. electricity generation—in 2050.

RE Futures provides initial answers to important questions about the integration of high penetrations of renewable electricity technologies from a national perspective, focusing on key technical implications. The study explores electricity grid integration using models with unprecedented geographic and time resolution for the contiguous United States to assess whether the U.S. power system can supply electricity to meet customer demand on an hourly basis with high levels of renewable electricity, including variable wind and solar generation.

As the most comprehensive analysis of high-penetration renewable electricity of the continental United States to date, the study can inform broader discussion of the evolution of the electric system and electricity markets toward clean systems. RE Futures results indicate that renewable generation could play a more significant role in the U.S. electricity system than previously thought and that further work is warranted to investigate this clean generation pathway. The Incremental Technology Improvement scenario was used for our projections.

Energy Information Administration: Annual Energy Outlook 2015 Clean Power Plan

This report considers the proposed Clean Power Plan as modeled using EIA's National Energy Modeling System (NEMS). NEMS is a modular economic modeling system used by EIA to develop long-term projections of the U.S. energy sector, currently through the year 2040.

The level of regional disaggregation in NEMS varies across sectors. For example, Lower 48 states electricity markets are represented using 22 regions, coal production is represented by 14 regions, and oil and natural gas production is represented in 9 regions. In many but not all cases, regional boundaries follow state borders. To the extent possible, this analysis represents the Clean Power Plan using regional targets derived from the state-level targets in the EPA's proposal.

The Reference case projections developed in NEMS and published in the Annual Energy Outlook 2015 generally reflect federal laws and regulations and state renewable portfolio standards

(RPS) in effect at the time of the projection. The Reference case does not assume the extension of laws with sunset provisions. In keeping with the requirement that EIA remain policy-neutral, the Reference case does not include proposed regulations such as the Clean Power Plan.

The scenario used for solar projections was the base policy case, which assumes EPA's proposed carbon intensity targets during the interim and final compliance periods, enforced at the NEMS Electricity Market Module (EMM) region level.

By explicitly modeling the intensity targets, NEMS does not require or assume specific levels for individual compliance strategies. The discussion of EIA's analysis presents results in terms of the compliance options used to meet the regionalized Clean Power Plan targets.

Bloomberg New Energy Finance

Data from the Medium-term outlook for US power: 2015 = deepest de-carbonization ever report were provided by Bloomberg New Energy Finance (BNEF). BNEF projections build off an empirical process of research, based on market projections, EIA information and interviews with industry stakeholders. These projections are updated and published annually, though the back-end data is private and cannot be shared except by permission. BNEF graciously provided the data to us on the condition we would not publish it and only use it for our economic impact analyses.

Smart Building and Energy Efficiency

Estimates for smart building and energy efficiency jobs waiting on BETONY

Energy Information Administration: Annual Energy Outlook 2015 Clean Power Plan

The scenarios used for the smart building and energy efficiency analysis were: Base Policy, No Energy Efficiency Compliance and High Energy Efficiency Compliance. These projections represent the range of expected reductions in energy consumption due to smart building and energy efficiency. This was measured as the difference between the Base Case (business as usual) scenario's total energy consumption and the three Clean Power Plan scenarios for residential, commercial and industrial sectors. Jobs estimates from the BETONY TOOL used MWh of avoided energy consumption as the primary measure of expected job intensity.

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Front Material & Chapter 1: Introduction

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