Michigan's Energy Future: Expert and Public Opinion on Energy Transitions in Michigan

September 2018

INFORMING THE DEBATE

MAPPR Policy Research Brief

Institute for Public Policy
and Social Research
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When developing the paper series initiative in 1992, the topics of the papers were submitted following a two-day meeting with leaders from the business sector, nonprofit agencies, foundations, and university faculty and staff. That group evolved into the Urban Research Interest Group.

The Urban Research Interest Group recognized the pressure on urban core leaders to make critical decisions that continue to impact people long into the future. A commitment to generating background research to add to the core of debate on possible solutions to complex, urban problems was made. The dynamic connection between urban, suburban, and rural communities was quickly noted and the research support was extended to all communities.

The expected outcomes of the paper series include discussion that fosters and strengthens multidimensional connections among policy, academic, and practicing professionals. Throughout the years, the series has continued to cultivate research interest in policy-relevant issues among university faculty for consideration of decision makers across Michigan communities, and has often been reviewed by other states.

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Michigan's Energy Future: Expert and Public Opinion on Energy Transitions in Michigan

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EXECUTIVE SUMMARY

This study explores expert and public opinion on energy transitions in Michigan and finds that:

- There are high levels of public support for a transition away from coal in Michigan.
- There are very high levels of public support for solar and wind power in Michigan.
- There is higher public support for solar power than wind power, which may be because siting issues related to wind power have been more widely discussed in Michigan than solar siting issues.
- A large majority (80%) of the Michigan public is interested in leasing solar panels for their homes if it were affordable and available to them and if they owned their rooftop.
- There is mixed public support for natural gas.
- The majority of the public is opposed to nuclear power, although this research suggests that there could be higher support of more advanced nuclear technologies that are currently in the R&D stage. Nuclear power has not played a role in the discussion of energy transitions in Michigan.
- The scale of energy generation (centralized versus distributed) and who owns renewable energy generation are more contentious issues than a transition to more renewable energy use.

POLICY RECOMMENDATIONS

Members of the public identified barriers in access to solar power for low-income and middle-income populations that cannot afford the capital costs, renters, and people who do not have access to the necessary rooftop space. Solar leasing programs and community solar installations could make solar power accessible to these populations.

- *Solar leasing:* In order for solar leasing programs to be expanded, the tax burden for solar leasing would need to be addressed. Michigan charges industrial personal property tax on solar equipment used to "produce electricity for sale," which would result in taxation in the case of a solar lease in which the customer pays a third-party company for electricity. A bill has passed the House to treat residential solar systems as a home improvement, rather than treating solar systems as new property to be taxed. This bill is expected to pass the Senate. However, solar leasing programs in which a third-party entity installs a solar panel system on a consumer's roof and the consumer then pays that company for the electricity would still result in taxation. The property tax provisions in the current bill could be extended to solar leasing programs.
- *Community solar power:* Another way to increase access to residential solar power is for utility companies to offer community solar programs, in which utility companies build a solar power installation and utility customers then pay the utility company for this clean energy. Only three community solar installations exist in the State of Michigan, and barriers need to be removed to advance this type of solar development.

Finally, this study finds that Michigan needs to develop better policies to promote innovation in renewables and to take advantage of opportunities for economic growth, innovation, and competitiveness in the area of renewable energy.

I. SIGNIFICANCE: POLICY FOR ENERGY TRANSITIONS IN MICHIGAN

Energy is an important and dynamic topic in Michigan, and energy systems are currently undergoing important changes that have significant economic and societal effects. Energy is not only a technical challenge but also a public policy challenge, with important and extensive implications for security, public health, social equity, and climate change. Because energy infrastructure is long lasting and often difficult to change, the energy policy decisions made over the next two years will continue to have effects for decades to come. This policy briefing summarizes the findings of research conducted on expert and public opinions on energy transitions in the state of Michigan. It focuses on issues of electricity policy rather than transportation fuels. Given the importance of electricity as a policy, social equity, and environmental issue, and the plurality of interests related to energy policy in the state of Michigan, it is important for policymakers to understand opinions and perceptions of energy transitions in Michigan.

Michigan is facing numerous challenges in its electricity sector. Its existing infrastructure is aging. The state received a C- grade on energy infrastructure on the American Society of Civil Engineers (ASCE) 2018 Infrastructure Report Card because of high levels of dependency on external nuclear energy and fossil fuels, as well as aging infrastructure (ASCE, 2018). The state of Michigan also has the 15th highest average retail price for electricity in the country, at 15.17 cents per kWh ("Michigan - Rankings," 2017). Energy policy issues under debate in Michigan relate to the percentage of electricity required to be sourced from renewable energy, electricity choice programs that allow a certain number of consumers to purchase electricity from particular sources, integrated resource planning to select what energy resources will be developed and utilized in the future, and the reliability and affordability of electricity. Michigan has implemented a Renewable Energy Standard, which the legislature increased in December of 2016 to 15% of generation capacity from renewable energy by 2021 (Michigan Public Service Commission, n.d.) Consumers Energy and DTE made a non-binding commitment to the NextGen America super PAC to achieve 25% renewable generation by 2030 in return for cancelling a ballot initiative to increase the renewable portfolio standard to 30% by 2030 (Tomich, 2018).

Three years ago, around half of Michigan's electricity generation portfolio came from coal, but changes are quickly being made to the portfolio. All coal-fired plants in the state are scheduled to retire by 2040 at the latest, except for coal generation serving Wyandotte's municipal utility company. Wisconsin Electric's 430 MW Presque Isle plant and Lansing Board of Water and Light's (LBWL) Eckert plant are scheduled to close in 2020, and LBWL's Erickson plant is scheduled to close by 2025. Consumers Energy plans to close Karn 1 and 2 in 2023, Campbell 1 and 2 in 2031, and Campbell 3 by 2040. DTE plans to close Trenton Channel, River Rouge, and St. Clair by 2023; Belle River by 2030; and the Monroe plants by 2040 (S&P Global, 2018). In December 2017, Michigan's electricity generation came from 32% coal, 32% nuclear,

27% natural gas, 8% renewables, 1% hydro, and far less than 1% petroleum ("Michigan - State Energy Profile Overview," 2017). Additionally, Michigan's nuclear power plants are set to retire, beginning with Consumer's 805 MW Palisades nuclear plant in 2022 (Adams, 2017). Until recently, much of this retiring capacity was scheduled to be replaced by natural gas - which has potential benefits but also serious drawbacks - as well as renewable energy, which is environmentally friendly and has high levels of public support. However, the costs of solar and wind power have dramatically declined in recent years. Consumers Energy's 2018 integrated resource plan focuses on reducing electricity demand by improving energy efficiency and developing programs to shift users' electricity usage to different times of the day (or "demand response" programs). It also intends to develop 500 MW of wind and 5,000 MW of utility-scale solar, along with use of existing natural gas power plants (Consumers Energy, 2018). In contrast, DTE plans to build a 1,100 MW natural gas-fired power plant in 2019 (Laitner, 2017).

The Michigan Public Service Commission (MPSC) must approve all integrated resource planning decisions made by regulated utility companies in Michigan. The MPSC sets the rates that independent power producers should be paid for selling electricity to utility companies. The rate is based on the avoided cost of the utility adding its own generation capacity. The MPSC based the rate on the cost of electricity from a new natural gas combined cycle power plant. Since then, developers have proposed almost 3,000 MW of utility-scale solar projects to DTE and Consumers. This private sector interest in utility-scale solar power suggests that it will soon be cheaper to build solar and wind generation than to operate existing natural gas plants, which will markedly influence the energy transition. In addition, the MPSC is in the process of determining a new rate structure for how owners of rooftop solar are compensated for the surplus electricity they feed into the grid at certain times of day. Specific values in this rate structure will be determined for each utility in their respective rate cases, but these will likely reduce the economic value of rooftop solar systems, especially compared to utility-scale solar power. This is occurring even as strong commitments to utility-scale solar are being made, which suggests that distributed, rooftop generation will be debated in terms of "energy freedom" and the "democratization of energy" rather than in terms of reducing fossil fuel generation overall.

II. OVERVIEW OF RESEARCH

In order to understand expert and public perceptions of energy transitions in Michigan we took three steps.

First, we conducted 17 interviews with 20 experts in energy policy in the Lansing area. These interviews were conducted in the summer and early fall of 2016 (prior to the presidential election). The interviewees included 5 regulatory experts, 4 employees of nonprofit organizations, 5 utility companies and grid operators, 5 consulting firms/ lobbyists, and one legislative staff member. In order to protect interviewees' privacy and to encourage candor, we agreed to identify interviewees only by sector, rather than using their name and/or place of employment. We also use the gender-neutral "they" to further anonymize the interviews.

Second, we conducted a focus group on energy transitions with 12 members of the general public, which was held at Michigan State University in the fall of 2016 (prior to the presidential election). Focus groups are too small to be statistically representative. Instead, this methodology prioritizes diversity of perspectives and examination of in-depth qualitative data. We chose the focus group participants based on level of income, educational background, age, gender, race, and type of housing unit (renter versus owner). We also included an owner of a backyard solar photovoltaic (PV) system. By prioritizing diversity, researchers can observe points of potential conflict and agreement among constituencies. This portion of the research was based on a research project to study energy transitions in Michigan, with focus placed on solar photovoltaics and advanced nuclear power plants. The idea to study advanced nuclear power was made on the basis of a class held at Michigan State University in fall 2015 that explored new nuclear power plant designs that are under development. We also chose to focus on solar photovoltaic panels because they provide clean electricity, especially during peak hours of electricity demand during the hot summer months. Additionally, the panels can be placed on rooftops to generate electricity where it is used, or larger systems of panels can be placed in empty urban lots or open fields. Solar is an intermittent energy source because the sun does not always shine. Thus, we combined our focus on solar power with a focus on emerging nuclear power technologies because they are a potentially clean source of power that is almost always available 24 hours a day, 7 days a week. Depending upon whether the designs currently being studied can be feasibly developed, advanced nuclear power plants offer potential advantages over natural gas plants and coal-fired power plants, but this issue is very complex.

Third, we developed a set of 25 questions on the public opinion of energy transitions on the basis of our findings from the interviews and focus group. These questions were included in the fall 2017 State of the State Survey (SOSS), which is a randomly sampled landline and cellphone survey of the English-speaking adult population in Michigan age 18 and older. More detailed information on how the SOSS survey is conducted can be found on the IPPSR website (http://ippsr.msu.edu/survey-research/state-state-survey-soss). Our combination of in-depth qualitative responses from the focus group combined with quantitative data from a large, representative sample of the Michigan public offers a unique lens for understanding public opinion on energy transitions.

III. CHARACTERIZING MICHIGAN'S ELECTRICITY STRENGTHS AND WEAKNESSES

Both experts and members of the public see developing reliable, clean, safe, and affordable electricity infrastructure in the state as an important and urgent issue. Focus group participants thought that even 10 years would be too long to wait for a large-scale energy transition. In order to better understand the priorities for Michigan energy policy, we asked experts to address Michigan's greatest strengths and weaknesses in energy infrastructure and policy.

Infrastructure

Michigan has strong natural gas storage and has natural gas reserves, such as the Antrim Shale Play in the Lower Peninsula, which can be accessed through hydraulic fracturing ("Michigan - State Energy Profile Overview," 2017). Several interviewees also saw the Ludington pumped storage facility as an infrastructural strength. This facility allows for energy storage by pumping water uphill during periods of low electricity consumption and later releasing it to generate electricity during peak hours of electricity demand. Another infrastructural strength is Michigan's electricity interconnection with Canada and the Midwest. That said, other interviewees emphasized that Michigan's lack of maintenance of its infrastructure is a weakness. As one interviewee put it, "Michigan is notorious for not really updating our infrastructure." Michigan's electricity infrastructure is aging, with fossil fuel power plants that are an average of 49 years old, which represents the second oldest fleet in the country (ASCE, 2018).

Upper and Lower Peninsula

Many interviewees saw Michigan's geography as a weakness. Transmission interconnectivity between the upper and lower peninsulas is limited. In the Upper Peninsula (UP), there are challenges associated with low population density and with transmitting power over long distances through geographic features such as woods and rocky hills. Residential electricity prices vary widely in the UP from 11 to 24 cents per kWh (Kantamneni, Winkler, Gauchia, & Pearce, 2016) (compared to a national average of 12 cents per kWh) (EIA, 2018).

Renewable Energy

Many interviewees saw Michigan's renewable energy capacity and its recent increases in renewable energy as strengths. Michigan has strong wind energy resources, especially on the Great Lakes (EERE, n.d.). Michigan has additional rooftops and brownfields on which it could site solar panels. One interviewee stated, "We've seen $2.9 million investment in jobs from the renewable industry. We've seen the efficiency savings, for every $2 spent there's about $4 worth of savings of your residential bill."

Social Capital

Some interviewees emphasized that Michigan already has the expertise to enact an energy transition. Michigan has good universities and experts and a strong Public Service Commission. One interviewee stated, **"**There are a lot of smart people. I have confidence that the knowledge base exists to solve these problems" of energy transitions. Michigan is part of the Midcontinent Independent System Operator, Inc. (MISO), which is a transmission system operator that provides access to high voltage transmission lines that cross state lines and allows Michigan to access electricity generation capacity in other states. One interviewee saw the technical and regulatory experts involved in MISO as a strength for Michigan. Another interviewee identified the strength of the MISO region as a whole as "the diversity of the stakeholders and stakeholder process, including the [15] different states," as well as Manitoba, Canada, in which MISO

operates. However, they said that this strength is also a weakness because the stakeholder process can be slow-moving and inefficient.

Utility Companies

Several interviewees saw Michigan's strong and well-functioning utility companies as a strength. These interviewees perceived the utility companies as caring about customers, social value, and the place in which they are embedded. One stated, "I personally get the sense from the management from both companies DTE and Consumers they are 'of place,' and I think that's a really powerful determinant for creating innovation and opportunity." Other interviewees argued that Michigan's large utility companies are not innovative, calling them "slow moving beasts in a market that's moving faster and faster." Some interviewees expressed concern that while utility companies are responsible for social services related to reliability, affordability, safety, and environmental responsibility, they have a strong lobbying presence with the Michigan Legislature, which is responsible for overseeing utilities' commitment to the public interest. This presents a potential conflict of interest.

Policy and Regulatory Environment

Some interviewees saw the importance of energy economics—most crucially natural gas prices—as the determining factor for changes in Michigan's electricity mix, while other interviewees saw the Michigan Legislature's actions as the most important determining factor. Some interviewees argued that Michigan has not been sufficiently proactive in making energy legislation. One interviewee argued that regulatory and policy roles for energy have been conflated, stating that the regulators have been making social policy and economic development decisions on their own because of a lack of sufficient legislative guidance. This interviewee said that every agency in Michigan has a mandate to spur economic development; however, a clear separation ought to be maintained between policy and regulation to ensure checks and balances. If the regulators set policy, this is problematic because they are a "non-democratic body" that is not elected. Another interviewee said that the biggest problem is that the people who know how to solve problems at the energy-systems-level are often not involved in the process of integrated resource planning. Instead, they receive a budget, and they have to figure out how to spend that limited budget in order to fix the most urgent problems; thus, they are essentially doing "triage," and the system is not optimized. This interviewee went on to explain that the planning process should be more publicly transparent and should involve all stakeholders. Often, opportunities for public engagement on energy policy issues are difficult to access, occurring through technocratic forums such as the MPSC's call for comments on issues that the public would find difficult to understand.

Economic Competitiveness

Michigan has a strong manufacturing sector, and skilled workers in need of employment. Some interviewees argued that jobs could be created in clean energy manufacturing, including manufacturing of solar PV panels, wind components, and batteries. Michigan has 249 automotive technological development centers (Michigan Economic Development Corporation,

n.d.). While interviewees saw the automotive manufacturing and R&D sector as a strength, they criticized Michigan for its consistently late adoption of new technologies. For example, one interviewee explained that the state is not taking advantage of its universities and manufacturing expertise to develop a clean energy sector. Another interviewee argued that Michigan could choose to be at the forefront of battery manufacturing by developing a research cluster analogous to the Boston technology corridor, which includes a clean energy cluster (see, Callen, Eliseeva, Sharkey, & Tyler, 2017). They stated, "We need to continue to decarbonize… not just decarbonization as the goal, but innovation as the goal, and the deployment of a thoughtful set of technologies that are going to continue to keep Michigan at the forefront economically and creatively." Another interviewee discussed how "the most robust, dynamic multinational corporations are setting 100% zero carbon standards for their energy supply." They said that this includes Google, Apple, Facebook, Microsoft, Samsung, and other companies that are unlikely to establish branches in Michigan without access to clean energy. They said that the governor and legislature received a letter from Google and 12 other signatories saying that if the state cannot provide clean power then they will not invest in Michigan (Michigan EIBC a, b, 2015). This interviewee argued that the state government has not demonstrated leadership in energy policy, implementing fewer legislative initiatives than much of the rest of the United States, which negatively affects the economy.

Energy Dependence versus Independence in Michigan and Homegrown Energy

Many interviewees emphasized the importance of producing homegrown Michigan energy and perceived energy dependence as a problem. For instance, several interviewees emphasized that Michigan's coal-fired power plants use coal that is 100% imported from other states. "We're exporting dollars that could be spent in other ways, so I think that is not necessarily a strength of ours." Some interviewees emphasized that they did not want to turn more decision-making authority over to the federal government or MISO through continued grid integration: "There's this fight between the states and the feds about losing control of energy policy." Another interviewee emphasized the importance of locally-embedded organizations making decisions for Michigan.

Renewable energy could provide an avenue for bolstering homegrown energy. One interviewee discussed a study on how Michigan could provide most of the components for wind turbines at a lower cost than importing them from abroad (see, ELPC, 2011). Focus group participants saw solar panels as advantageous because they could be domestically purchased, including from Michigan. Many participants saw solar panels being manufactured in Michigan, rather than in China, as a significant benefit. The public also values energy independence, with 56% of SOSS respondents saying it is very important for Michigan to remain independent of other states and countries and 33% saying it is somewhat important. Only 10% said that it was not very important or not important at all. Thus, implementing policies that incentivize the development of a supply chain industry for renewable energy technologies in Michigan likely would garner high public and stakeholder support.

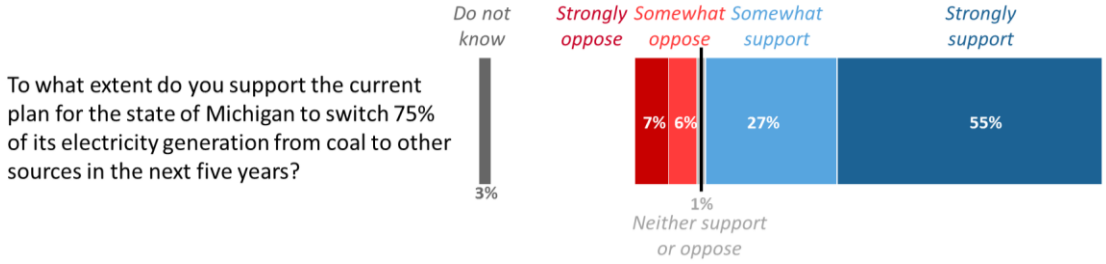
IV. PUBLIC AND EXPERT OPINION ON ENERGY OPTIONS

Energy transitions relate partly to the substitution of individual technologies within a system and partly to the optimization of the overall power system. The remainder of this report discusses expert and public opinion on the different primary fuel options for generating electricity (i.e., coal, natural gas, sun, wind, and uranium) and also the broader challenges and opportunities associated with the management of the electricity system that have arisen during the energy transition.

IVa. Expert and Public perceptions of Coal and Natural Gas

Over the next 10 years, most interviewees thought that coal-fired power generation will continue to decrease and renewable energy will increase somewhat. As one interviewee put it, "The war on coal is over, and coal has lost." Only one interviewee saw coal as an important fuel for the future, saying that by 2050 coal would make a comeback as a baseload power source using technologies that reduce the environmental effects of coal to make it more "socially acceptable."

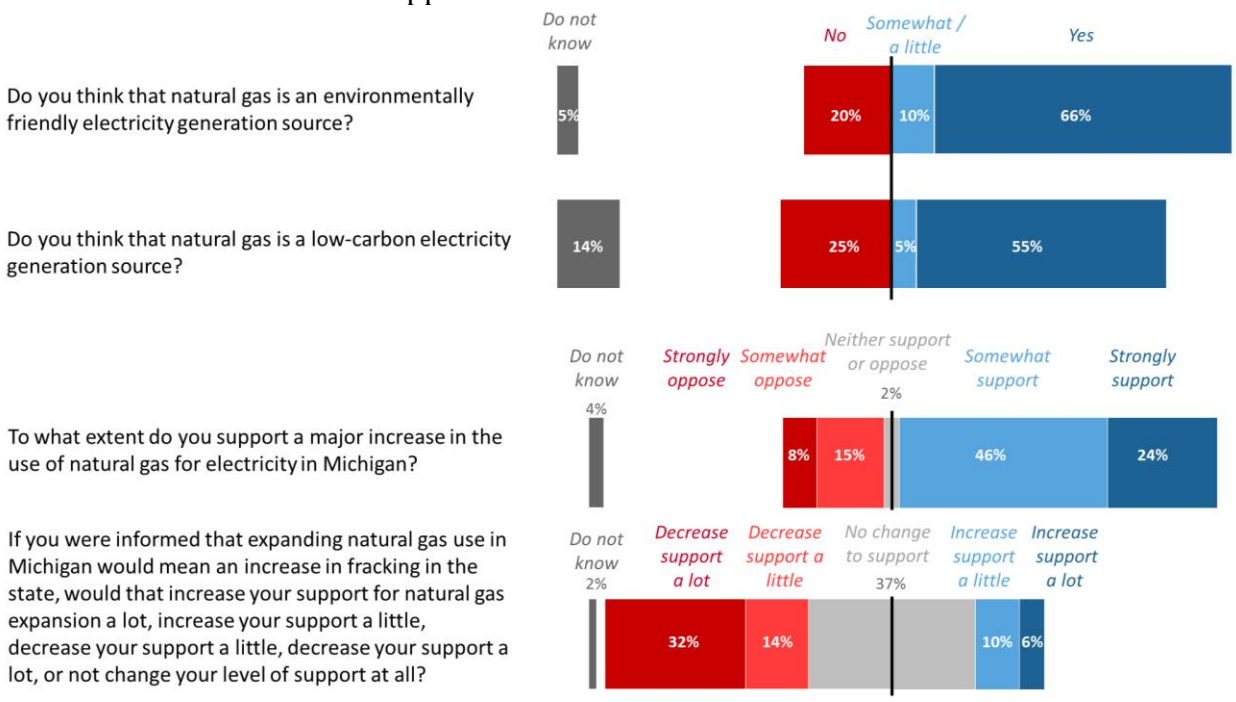
The SOSS survey found that the Michigan public supports a move away from coal. We asked, "To what extent do you support the current plan for the state of Michigan to switch 75% of its electricity generation from coal to other sources in the next five years?" Eight-two percent of the public supports this (55% strongly support and 27% somewhat support), and only 13% opposes this (6% somewhat and 7% strongly.)



Many interviewees thought that Michigan's coal capacity will be replaced partly by natural gas for baseload power by 2025, with one to three natural gas plants built in Michigan over the next two decades, although the cost of solar PV panels has dropped since we conducted the interviews. The Lansing Board of Water and Light announced the construction of a new natural gas plant in March 2018, although it will also reach 40% renewable energy capacity by 2030 (Gordan, 2018). Additionally, DTE plans to build a 1,100 MW natural gas plant, but this will not make up for a coal-fired power plant retirements; the rest will be met with a combination of renewable energy, energy efficiency, and demand response programs (Balaskovitz, 2018). Some interviewees supported this switch to natural gas, while others argued that natural gas emits too much carbon dioxide, at around 1/3 of the carbon dioxide emissions of coal. An interviewee from an NGO was concerned about investing in natural gas to provide baseload power because of potential price volatility. They said, "We're really hesitant. We don't think it's

a great long-term decision for Michigan." One interviewee referenced the argument of former Federal Energy Regulatory Commission Chair Jon Wellinghoff that investment in natural gas power plants and pipelines will become stranded assets as prices for battery storage and renewable energy technologies fall (Walton, 2015).

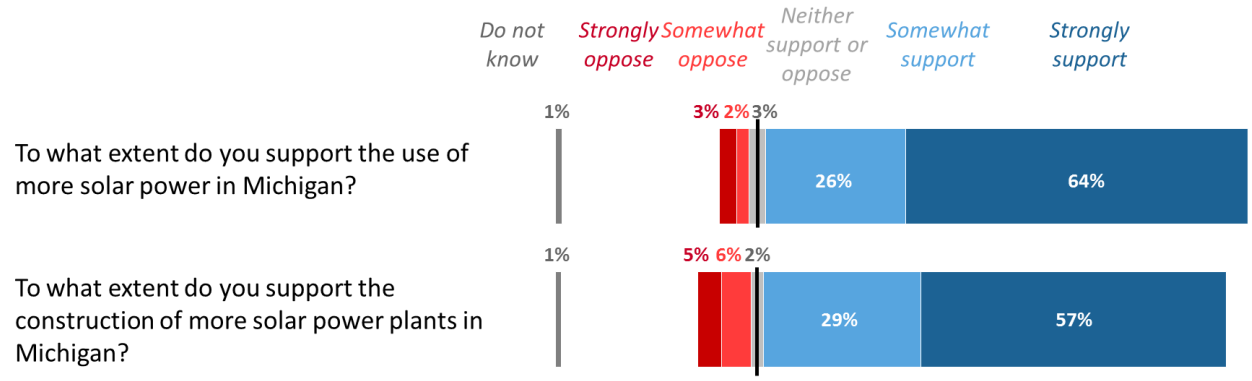
The SOSS survey found that the majority of the Michigan public supports a "major increase in the use of natural gas for electricity in Michigan," with 70% in support (24% strongly support and 46% somewhat support), with a sizeable minority in opposition at 23%. The majority of the Michigan public largely perceives (or perhaps misperceives) that natural gas is an environmentally-friendly electricity generation source, with 66% saying that they think it is an environmentally friendly source, 10% saying it is somewhat or a little environmentally friendly and a sizeable minority, 20%, saying it is not environmentally friendly. Fifty-five percent of the Michigan public perceives that natural gas is a low-carbon energy source, while 25% perceives it is not and 14% said that they do not know. Fracking in Michigan could affect public support somewhat. Researchers from University of Michigan conducted a survey that found that a slim majority of the Michigan public supports the extraction of shale resources in Michigan, with 54% in support (32% strongly supporting and 22% somewhat supporting) and 35% in opposition (19% somewhat opposing and 16% strongly opposing) (Brown et al., 2013). The SOSS results were mixed. We asked the public whether it would increase or decrease their support if an expansion of natural gas in Michigan meant an increase of fracking in the state. Many people said this would not change their opinion (37%), while about half, (46%) said it would decrease their support (14% a little and 32% a lot). A minority (16%) of respondents said it would increase their support.[1]



[1] Readers should note that the question from Brown et al. (2013) asks the public about the extraction of shale, whereas our survey question used the more politicized term "fracking." Brown et al. found that 45% of the Michigan public sees fracking as a negative term.

IVb. Expert and Public Perceptions of Solar PV Panels

The Michigan public is highly supportive of increasing solar power; 90% of the public supports more solar use in Michigan (64% strongly support and 26% somewhat support). Only 5% of the public opposes more solar use in Michigan (2% somewhat oppose and 3% strongly oppose), while only 3% of the public is neutral. In other cases, support for solar power has gone down among some constituents when siting issues and land consumption issues become visible; this opposition often comes from specific populations, such as from people living near proposed solar facilities or from environmental preservation organizations, rather than from the general public (Devine-Wright, 2011). In the SOSS survey, support for solar power decreased only marginally when the *construction* of a solar *power plant* in the state was emphasized in the question wording, to 86% supporting (57% strongly support, 29% somewhat support) and 11% opposed (6% somewhat and 5% strongly.) Focus group participants generally viewed solar power as cleaner, more environmentally friendly, and cheaper than other types of electricity. They saw little wrong with solar power, although they did express concerns about houses that did not have sufficient or appropriately oriented roof space, renters who do not own rooftop or backyard space, people who could not afford solar panels, and the disposal of solar panels. Focus group participants mentioned lack of storage a few times, but they assumed that battery storage would soon be available.



Generally, expert interviewees were highly supportive of the deployment of more solar PV panels in Michigan. An interviewee working in the regulatory sector said that solar power has "the ability to contribute tremendously to the resource mix." Experts emphasized the ability of solar PV panels to shave, or reduce, peak load in Michigan (at least in the spring and summer when peak is during the day, roughly April through September (MPSC Staff, 2018)). Researchers found that switching to solar power, with backup from small combined heat and power plants, was already economically competitive in 2016 in the UP (Kantamneni et al., 2016). Several interviewees emphasized the importance of combining efforts for further developing solar in Michigan with efforts to reduce energy consumption by improving energy efficiency.

Centralized versus Distributed Solar

The most contentious issue associated with solar power scale-up relates to whether it should be centralized— utility-scale— or distributed and who should own it. An interviewee stated, "the real debate in Lansing has to do *not* with renewables— because the utilities are really into renewables if they own [them]— the battle really has to do with distributed generation and rooftop solar." Some community groups argue for distributed generation because of issues of household independence and self-reliability. Many interviewees who supported distributed solar associated it with a "high tech" and "state-of-the-art" future. Those interviewees also thought that battery storage would soon become feasible, using words such as "breakthrough," "revolution," and "disruptive technology." Other interviewees were agnostic about centralized versus distributed energy and saw both as necessary as part of an "all of the above" energy strategy. They mentioned DTE Energy's recent solar installations as evidence that utility-scale solar is feasible. (These include the 48 MW DeMille and Turrill Solar Parks in Lapper County and 2 MW O'Shea Solar Park.) These interviewees also discussed community solar as more affordable and accessible to low-income communities than residentially-owned rooftop solar.

Solar rooftop system in Boston, *Source: Wikimedia Commons*

Komekurayama solar power plant in Japan. *Source: Wikimedia Commons*

Other interviewees believed that solar in Michigan would be largely centralized and owned by utility companies. An interviewee from a utility company argued that it is too expensive and difficult to scale up solar on rooftops. "There's a lot of homes where you don't have the right orientation—too many trees—if you think in terms of megawatts, it will be mostly utility-scale and owned by utilities. I think it's inevitable for a number of reasons." A power plant operator agreed, saying that, because of economies of scale, "utility-scale solar is the better option from a big picture standpoint than individual homes." Another interviewee from the utility sector said "I've never been terribly encouraged by highly distributed individualized solar on personal rooftops. I think that's an interesting hobby and kind of a unique market niche, but I don't think that's going to be our play." He argued that well-planned wind and solar plants that are mid-sized and geographically distributed could even out intermittency of power generation. Even with large-scale, centralized solar power, there will be debates over whether this solar generation will be owned by Michigan utility companies or by independent power producers.

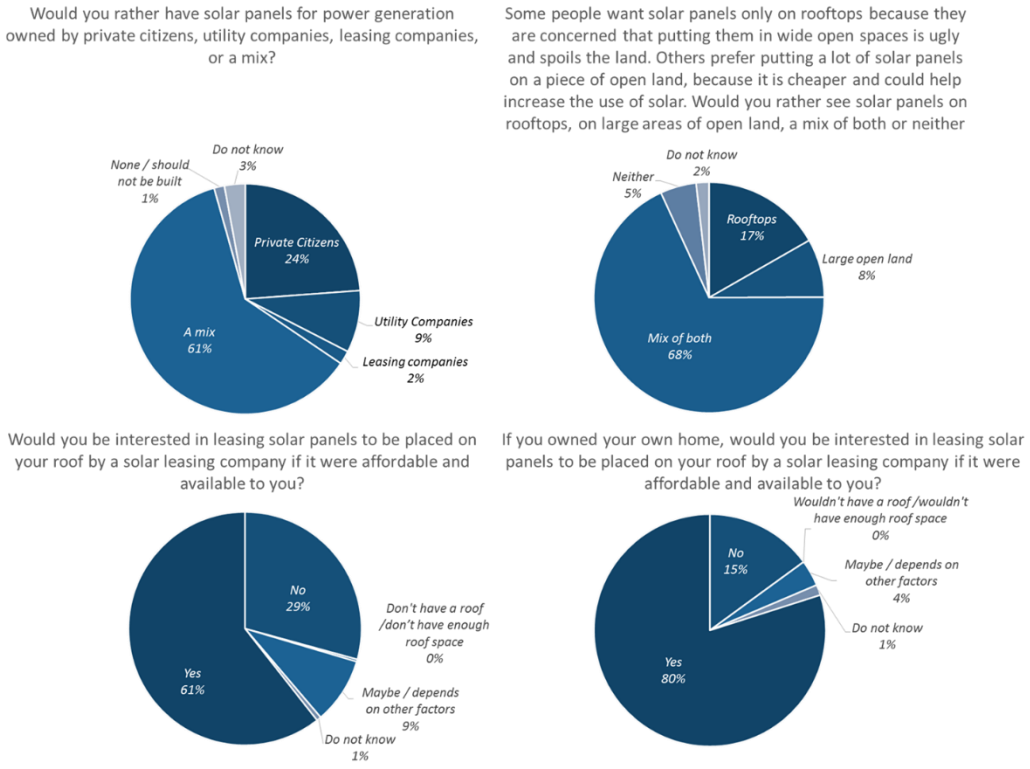
The interviewees in favor of centralized solar and wind plants argued that the centralized grid provides an important public service. One stated, "Imagine an industry where it's perfectly renewable and there's storage. I just described the water industry. Getting on the grid— it's more reliable, it's safer, and it gives you fire protection and positive externalities … at some point you have to see the relationship to social value." This interviewee wondered how many customers actually want to be in the energy business versus paying the utility company to provide clean energy for them. An interviewee from a utility company also said, "I think too right now there's a lot of customers that just don't really want to fuss with that." Another interviewee emphasized that they did not know whether centralized or distributed solar was

better, but they speculated that "there might be some sort of pride that people take in installing [solar panels] on their own roofs…and then being more conscious of what [energy] they're using."

In fact, the SOSS survey data showed that the public is very interested in rooftop solar PV panels. We found that 61% of the Michigan public would be interested in leasing solar panels "if it were affordable and available" to them. The sample included 70% home owners and 30% people who do not own their residence. We also asked if people would be interested in leasing solar panels for their roofs if they owned their own home *and* it was affordable and available to them. Under these circumstances, 80% of people would want solar panels on their rooftop, 4% maybe would want them, 1% did not know, and only 15% would not want solar on the rooftop. We do not have data on what citizens would consider to be "affordable and available," and a number of respondents answered "not applicable" even though we asked them to imagine a scenario in which they owned their home. However, this does indicate a high degree of willingness among Michiganders to have solar power in their rooftops. These is a large potential market for solar leasing in the Michigan, and the Michigan Legislature should work to remove tax burdens for solar leasing companies to operate in the state, as solar leasing gives people access to solar generation without shouldering the upfront costs in one lump sum. Michigan currently charges industrial personal property tax on solar equipment used to "produce electricity for sale," which would tax solar leasing arrangements in which the customer pays the leasing company for electricity. It would not tax solar leasing systems in which the customer pays to lease the solar system itself, but this scenario is a less feasible arrangement for solar leasing.

The public is largely open to mixed ownership of solar generation, but a number of people do want to see some citizen ownership of solar generation. We found that 61% of the public thinks that a mix of private citizens, utility companies, and leasing companies should own solar panels. A large minority (24%) thinks that private citizens alone should own solar generation. Only 9% of the public thinks that utility companies alone should own solar generation, and only 2% said leasing companies alone should own solar generation. We suspect that because a large number of citizens are interested in leasing solar and are interested in having it on their rooftop, that citizens value citizen-owned rooftop solar panels. It is not entirely clear whether citizens would be committed to owning rooftop solar panels because they associate rooftop solar with democratic values and freedom. Research outside of the state has suggested that activist groups value solar power because they see it as putting power generation back in the hands of the people and reducing the power of large energy corporations and encouraging consumers to be more in touch with their energy use (Moore & Hackett, 2016).[2] We did find that 17% of the public thinks that solar power should be sited on rooftops only, while the majority of the public thinks that a mix of both open spaces and rooftops would be most preferable.

[2] In some cases, this has cut across partisan party lines, with support from liberal environmental groups and from members of the Tea Party. See, for example, (See, for example, Solar Done Right http://solardoneright.org/index.php/site/about/ and https://e360.yale.edu/features/debbie_dooley_interview_why_this_tea_party_leader_is_seeing_green_on_solar_energy)



Net Metering for Solar

One interviewee from the regulatory sector thought that solar PV panel adoption rates will increase as financial mechanisms, such as net metering, for compensating people for the surplus energy they produce are better developed. Net metering refers to the rate at which solar PV owners are compensated for the surplus electricity they feed back into the grid during the day, typically the retail rate. This is a contentious issue because a low rate of compensation for surplus electricity generated will lengthen the payoff time for solar panels and make it less economically advantageous, which equates to a disincentive for citizens to purchase clean energy generation. Another concern is that solar PV panel owners rely on the grid for reliability, feeding energy in at some times of day, and purchasing it at night and on cloudy days. Most solar panel owners only partly defect from the grid, as full defection would require a large number of panels and home batteries and/or large amounts of conservation (Hanser, Lueken, Gorman, & Mashal, 2017; Hittinger & Siddiqui, 2017). There has been concern expressed that at high rates of homeowner solar panel adoption, the maintenance of the grid could be left to the poorest people in society who cannot afford to purchase rooftop solar and/or batteries (Federal Trade Commission, 2016). According to the 2016 US Census, Lansing's median household income in from 2012 to 2016 was $35,851, and 29.5% of people live in poverty (US Census, 2016). For the state, the median household income from 2012 to 2016 was $50,803, with 15% of people living in poverty (US Census, 2016). A 5.4 kW solar PV system without battery storage costs around $15,000 (with the panels costing $2.80 per watt), including the balance of system

costs (inverter, hardware, installation) (Fu, Feldman, Margolis, Woodhouse, Ardani, 2017). Costs have fallen substantially in the past three years, as the same system in 2010 would have cost $39,000 (ibid). However, the upfront capital investment of $15,000 is still too expensive for the average Lansing family. Some interviewees were concerned about the social equity issues associated with a large number of customers partially defecting from the grid. The argument is that subsidizing the reimbursement rate for surplus electricity from rooftop solar fed into the grid is a regressive way of financing clean energy, which could be disproportionately paid by low-income citizens.

The public utility commissions in Arizona and Nevada were the first in the United States to change net metering programs, in 2015 and 2016. There were utility concerns that compensating solar owners with the retail rate was too high and did not require owners of solar panels to sufficiently pay for the fixed costs of the grid, on which they still rely. In 2015, Nevada ended its net metering program and did not grandfather in existing solar panel owners (FTC, 2016), but in 2017 Nevada reinstituted net metering at a lower rate of compensation than before and at a cap of 80 MW of installed rooftop solar capacity (Pyper, 2017). In 2016, Arizona did away with its net metering program, although the Arizona Corporation Commission did grandfather in existing rooftop solar system owners, and it replaced the program with a net billing system in which customers are credited at less than the retail rate. The non-regulated public utility company SRP added a demand charge that was predicted to increase solar customers' bills by $50 per month (Fairley, 2015.) In 2017, Governor Snyder required the Michigan Public Service Commission to investigate this issue and to develop a fair and equitable compensation scheme (MPSC Staff, 2018). The MPSC has rejected charging rooftop solar owners a flat fee, because they found that it would be very difficult to determine what a fair fee would be and recommended using an avoided cost based on natural gas generation (ibid.).

While it would be difficult to survey the public on these issues, the focus group allowed us to broach the issue of an appropriate rate for compensating solar PV owners for electricity fed back into the grid, which one expert interviewee described as "*the* rate-making issue" in utility regulation today. We simplified the possible net metering rates, describing them as the wholesale rate, the retail rate, and above the retail rate.[3] Customers enrolled in net metering in Michigan have received the retail rate for electricity, or the same rate that customers pay per kWh for electricity on their bill. We explained that some people argue that solar panel owners should be paid the same amount that power plant owners receive for selling electricity to the grid, or the wholesale rate. We described this as the rate you would pay if you purchased a product directly from a manufacturer without a middleman. A second argument is that solar owners should be paid the same rate that we all pay on our bill to purchase electricity from the grid. This is called the retail rate, and it is higher than the wholesale rate because it includes fees for the maintenance of the grid. This is like the rate you would pay if you purchased a product from a retail store instead of directly from a company. This higher rate is helpful for owners of solar panels to recoup their capital investment. A third argument is that solar panel owners should receive a higher rate than the retail rate. This would be like purchasing a

[3] This is a simplification because rather than the wholesale rate, the MPSC has recommended using the "avoided costs," or the costs that the utility company does not have to invest in natural gas generation because of added generation from rooftop solar panels (MPSC, 2018).

product from a store, not from the manufacturer, plus paying extra for purchasing a green product. People who think this rate would be best argue that it would provide a financial incentive to encourage more people to purchase solar panels. They argue that we all indirectly benefit from solar panels on other people's roofs because the panels reduce the demand for polluting sources of energy. In contrast, others argue that anything more than the wholesale rate is unfair because it means that people who own solar panels do not invest in maintaining the grid, even though they benefit from using the transmission and distribution lines. We asked the members of the focus group what rate they saw as the fairest.

There was no clear consensus on this issue, which people unsurprisingly had difficulty grasping. What we did learn is that people wanted both to provide financial incentives for people to purchase solar panels *and* to protect people who could not afford solar panels. Participants expressed that utility companies should not use this ratemaking issue as a political mechanism to protect their business model and to stop citizens from purchasing solar panels. Most participants expressed concern about the importance of lower income-people being able to afford electricity. They discussed how some people in the Lansing area do not own their place of residence and therefore cannot purchase solar PV for their rooftop, or simply cannot afford it. People thought community solar projects should be available for renters and that the grid should still be maintained to provide the public good of electricity. They saw tax-based incentives for purchasing solar power as advantageous, but even a focus group participant who owns a solar PV system expressed that it was important that homeowners should not see solar panels as a way to make a profit.

Similarly, many focus group participants thought that the collective provision of electricity was important, especially for those who could not afford to purchase solar or wind generation for their residence. One person even saw the individual provision of electricity as potentially wasteful stating, "My nephew wanted to [buy] a wind generator for my farm, and I just didn't feel it was right to generate electricity at that level and use all those resources for one person. It should be a collective, or it should be a utility…" One participant expressed that if people saw the grid as a collective protection of the public interest, they would be more involved in energy policymaking. They stated,

> *But all of that is connected to our own safety and not just the safety of all of us as a whole, but your mom who's hooked up to a machine somewhere, her safety as well. But people don't see it that way. They see it as oh, I'm going to put solar panels on my house and then I'm not going to have to pay the [Lansing] Board of Water and Light anymore.*

In summary, members of the public saw net metering as an important issue relating to fairness and affordability. They viewed access to the grid as a social right, but they argued that utilities should not use grid maintenance as an excuse for blocking clean energy development. There are likely to be concerns that a two-tiered system for electricity access will emerge, with wealthy people having access to solar PV panels and low-income people relying on an aging and poorly maintained electricity grid. An analogy could be drawn to wealthy people being able to afford organic food while poor people cannot. However, this may not be an appropriate analogy since there are positive externalities for the public from solar PV adoption, including reduced

pollution and carbon dioxide emissions. Based on our research, we believe that the Michigan public would support further incentives for the purchase of residential solar panels, but that financial incentives should not be regressive, meaning that lower income populations should not be asked to shoulder a disproportionate share of the costs of rooftop clean energy adoption or of grid maintenance. Since we conducted the focus group, the MPSC has suggested that the rate be reduced to a rate close to the wholesale price (MPSC, 2018). In future rate cases, the rates for the inflow and outflow of electricity for households with solar PV panels will be determined for regulated utility companies.

Solar Siting

Many interviewees thought that there are plenty of places available to site solar PV panels. One interviewee who works for an NGO indicated that Michigan has a lot more available areas to site solar PV panels on marginal lands, rooftops, and brownfields. However, they said that moving to 20-30% solar capacity to decarbonize the energy system could become a significant land use challenge. Interviewees thought that the siting challenges for wind power are currently greater than for solar power, but they thought that this could change as more solar generation is built.

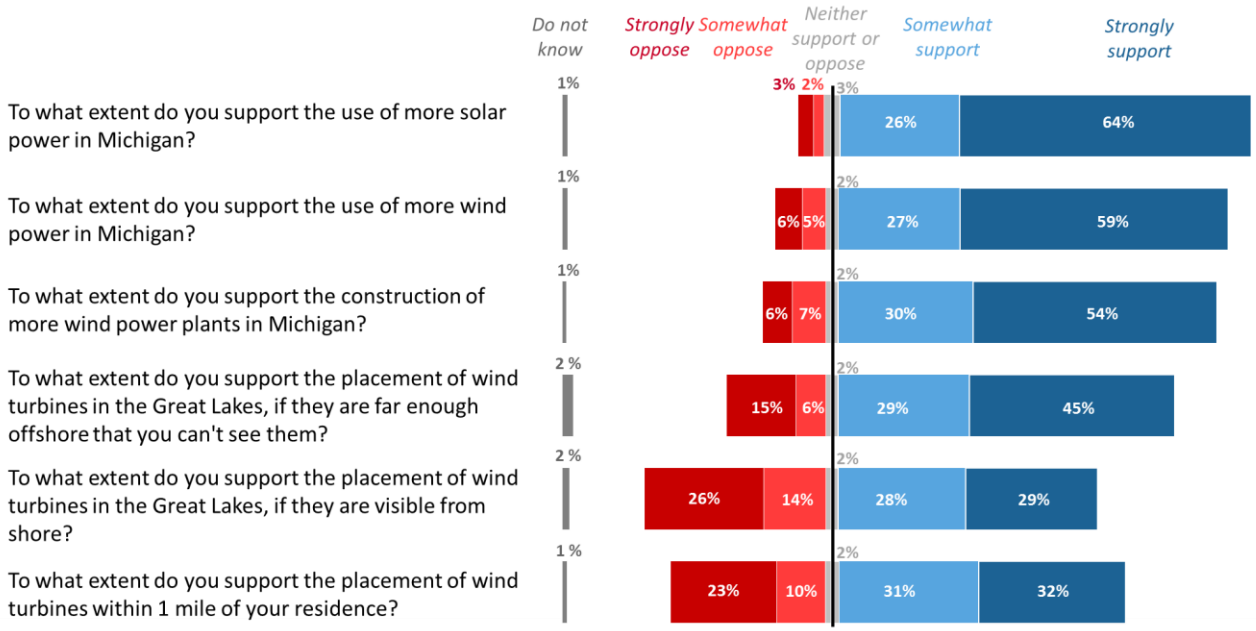
The public is open to mixed solar siting options, with 68% of SOSS survey respondents saying that solar PV panels should be built on a mix of rooftops and "large open land," although a substantial minority said rooftops only, at 17%. A small minority (8%) said that solar panels should be sited on large open land only while 5% said neither. Focus group participants were somewhat divided on this issue. Some participants perceived solar panels to be beautiful on rooftops. Others though rooftop solar panels were ugly and suggested that solar panels should be sited in deserts or other spaces that they perceived as useless land.[4] Some people were concerned about using large areas of "valuable urban land" for solar power, such as the 160 kW Lansing Board of Water and Light Cedar Street solar array, while others perceived this as an efficient use of space. This suggests that good public communication and stakeholder participation and buy-in early and often on solar siting decisions will be essential to the achieving the social acceptance of solar siting decisions made in Michigan as adoption rates increase.

IVc. Expert and Public Perceptions of Wind

A number of expert interviewees said that wind would play a more significant role in Michigan than solar since the state's wind resources are much stronger. As of December 2017, Michigan had 1,860 MW of installed wind capacity, which represents less than 2% of the state's total potential capacity (81,311 MW) (Oteri, Barnowski, Baring-Gould, & Tengen, 2018). The general public supports solar slightly more strongly than wind, with 90% of the public supporting more use of solar (64% strongly support and 26% somewhat support) and 86% of the public supporting more use of wind (59% strongly support and 27% somewhat support). Five percent of the public strongly opposes the use of more wind, whereas 3% strongly opposes solar.

[4] However, the perception of worthless or open land is subjective. See Moore & Hackett, 2016.

Twenty-one percent of the public opposes siting wind turbines on the Great Lakes that are *not* visible from shore (with 15% strongly opposed and 6% somewhat opposed). However, about two-thirds (74%) of the public supports wind on the Great Lakes not visible from shore (45% strongly support and 29% somewhat support). There are much higher levels of opposition to wind on the Great Lakes that is visible from shore with 40% opposed (14% somewhat opposed and 26% strongly opposed), although the majority of the public (57%) somewhat or strongly supports this option (29% strongly and 28% somewhat). While 80% of the public would want to lease rooftop solar if they owned their home and it were affordable and available, fewer people, or 63%, support the siting of wind turbines within 1-mile of their home (32% strongly support, 31% somewhat support, 1% do not know, 10% somewhat oppose and 23% strongly oppose). However, it is possible that this lower support of wind siting than solar siting is due to the greater attention given so far in the state to wind siting. Six communities in the state have moratoriums on wind energy development: Owosso Township, Ellington, Almer, Elmwood, Shiawassee County, and Huron County (Oteri et al., 2018). A number of townships are restricting wind siting, with more decisions to be made on the ballot in fall of 2018.[5]



IVd. Expert and Public Perceptions of Nuclear Power

Michigan's nuclear power plants are aging. Some interviewees thought the current plants should remain part of the mix for as long as they can safely operate. While license extensions are being requested for a total of 60 to 80 years, most interviewees thought that nuclear in Michigan would be shut down by 2050. This will do away with a large portion of low-carbon baseload power in the grid. The Fermi III, Cook, and Palisades nuclear power plants provide

[5] See http://www.windworksmichigan.com/resources/ and http://closup.umich.edu/files/Mills-Greenwood-Township.pdf

about 4 GW of capacity in the state, providing 32% of electricity in Michigan in December of 2017. Palisades is now scheduled to close in 2022. In 2015, utility company DTE received a license for Fermi III, a nuclear power plant in Monroe, from the MPSC and the federal Nuclear Regulatory Commission (Greene, 2017). However, most interviewees thought that DTE will never use this license. Additionally, construction was halted in the fall of 2017 on the VC Summer nuclear power plant in South Carolina after $9 billion was already spent (Moore, 2017), which is likely to have a chilling effect on new nuclear power construction in the United States.

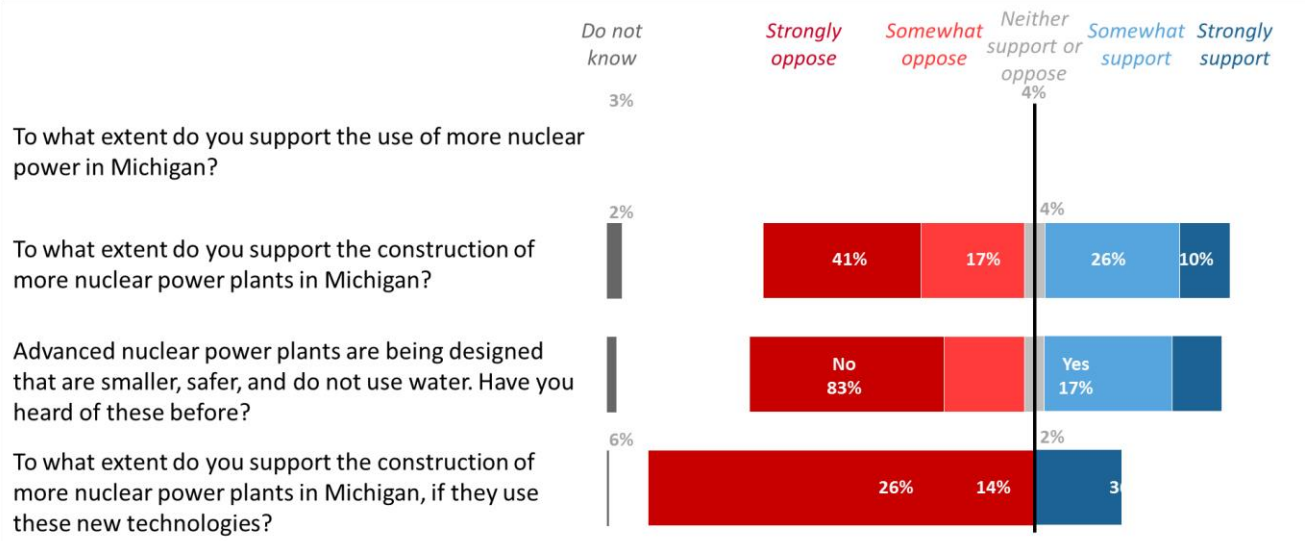
Nuclear has received little attention in the Michigan energy transitions discussion. As one interviewee put it: "I don't think nuclear is a part of the discussion at all. And it's interesting at this point in time when we're talking about the state's energy future, does anyone talk about nuclear?" Another interviewee said nuclear is not being discussed "because 1) there's no public support 2) it's too expensive 3) we haven't been able to deal with the waste management." Most interviewees thought that Michigan should not increase its nuclear capacity. In spite of the Fukushima nuclear power accident in Japan in 2011, nuclear power was contentious among interviewees because of its high cost more so than its safety record. While two interviewees thought that nuclear power was important for baseload power, many interviewees viewed natural gas as more feasible because natural gas power plants and fuel are both currently cheap. An interviewee from a utility company stated that "natural gas is so competitive that it doesn't make any sense to sink the capital cost into the nuclear component—it's just too expensive now."

If Michigan's retiring nuclear capacity is replaced by natural gas, this likely will increase greenhouse gas emissions in the state, since nuclear is zero carbon in the generation phase. Some interviewees thought that climate change may "resurrect" nuclear power, or thought that climate change presented in dilemma in relationship to nuclear power. One interviewee who supported nuclear power said, "There are downsides and risks to nuclear energy, but under the current state of affairs, as we are attempting to combat greenhouse gases and climate change issues, nuclear energy is easily the largest source of non-emitting generation in the country. And we will not meet any of the climate goals that have been established by the EPA if we are shutting down nuclear power plants." Another person from the regulatory sector said that "people treat natural gas combined cycle generation like it was zero carbon. It's not— nuclear is zero carbon generation, and I think there's a place for it." An interviewee from the regulatory sector said that nuclear power is important for energy diversification. Only one focus group participant thought that nuclear power had a role to play in climate change mitigation, and most focus group participants did not view nuclear power as environmentally friendly because of problems associated with storing nuclear waste.

Many interviewees argued that the public would not support new nuclear construction in Michigan, particularly due to the proximity to the Great Lakes. Opposition in Michigan to a proposed low- and medium-level nuclear waste repository on Lake Huron in Canada (Carmody, 2017) came up as evidence that the public in Michigan does not support nuclear power. Generally, nuclear power was not favored among focus group members, although it was seen by a few participants as advantageous for its long and robust lifespan. The allure of low-risk solar

power also made nuclear power less attractive to focus group participants. In the focus group, comparing nuclear power to natural gas for baseload power improved favorability only a little.

The SOSS survey found that general public support of nuclear in Michigan is somewhat divided but that the major of the Michigan public opposes nuclear power. A total of 56% of the public opposes more use of nuclear power (22% somewhat oppose and 34% strongly oppose). Thirty-seven percent of the Michigan public supports nuclear, with 27% somewhat in support and 10% strongly in support (compared to 64% strong support for solar and 59% strong support for wind). Opposition to nuclear power in Michigan is roughly in line with the national average. A 2016 Gallup poll found that 54% of Americans oppose nuclear and 44% favor it (Gallup, 2016). This was the first time that the majority of Americans in the Gallup poll opposed nuclear power, and Gallup speculates this increase in opposition was because of low gasoline prices (ibid). Additionally, the SOSS survey was is the field shortly after the construction of VC Summer nuclear plant in South Carolina was canceled, which might have increased opposition to nuclear power. When the question wording emphasized the *construction* of nuclear power plants, more respondents moved from the somewhat oppose category to the strongly oppose category, with 17% somewhat opposed and 41% strongly opposed. For solar, when we emphasized *construction* more people in the strongly support category moved to the somewhat support category. In other words, an emphasis on "construction" moved the bottom end of the spectrum for nuclear power, while it moved the top end of the spectrum for solar power.



Advanced Nuclear Power

We also asked expert interviewees, focus group participants, and the public about their perceptions of emerging nuclear power plant designs, called Generation IV nuclear power plants. (Note that although the canceled AP-1000 reactor type in South Carolina is sometimes called "advanced nuclear," we refer here to much more advanced designs that are still in the R&D stage.) In the focus group and expert interviews, we focused on molten salt reactors, which are arguably among the most advantageous Generation IV designs from a sustainability

standpoint (Taebi & Kloosterman, 2015). We also discussed small and modular reactors (SMRs) (see, Ingersoll, 2016). Molten salt reactors could theoretically use nuclear waste or stored civilian plutonium as a fuel source, but the feasibility of this remains uncertain. These reactors cannot melt down because they use liquid fuel, and they do not use water as a coolant. They yield less volume of waste, and the waste that these reactors yield, in theory, would require storage for 500 years rather than 200,000 years (Taebi & Kloosterman, 2015). The opportunity to use nuclear waste as a fuel to reduce the number of years it would need to be stored improved the favorability of nuclear power only a little among focus group participants. However, many thought that developing a better means of disposing of nuclear waste would be more important than building another generation of nuclear power plants to use the waste as fuel. Most expert interviewees were not at all familiar with Generation IV nuclear power plants, although some had heard of SMRs. SMRs are further along in the development process; for example, the NuScale SMR is undergoing the Nuclear Regulatory Commission's licensing process. One interviewee from the regulatory sector said, "I'm very much in favor of doing the research, coming up with designs that are small-modular-safe, and do not create bomb-grade material." However, most interviewees thought that Generation IV nuclear power plants were too far away from being commercialized to play a role in the energy transition in Michigan and thought that they were not yet a state-government concern.

The data from the focus group suggests that existing negative perceptions of nuclear power will affect public opinion of Generation IV nuclear power plants. The public is likely to see Generation IV reactors not as a new technology, or as a grouping of novel nuclear power plant designs, but as a continuation of existing nuclear power technology. While expert interviewees' who opposed nuclear power plants opposed them because of concern about high costs, focus group participants opposed nuclear power because of safety concerns. Some focus group participants still remembered the 1966 accident at Fermi 1, a liquid sodium cooled fast breeder reactor, and they used Fermi I as an example of the risks associated with nuclear power. Three or four participants remembered the song "We Almost Lost Detroit" by Gil Scott Heron. Younger participants became curious about Fermi I and asked for additional information. Those participants who remembered the Fermi I accident remembered there was a problem that, while resolved, had catastrophic potential. They did not recall the details, but they remembered being emotionally affected by the accident. This experience with nuclear power is likely to shape public opinions of Generation IV nuclear power plants, even if the designs are very different from the current generation of reactors.

The SOSS survey found that the vast majority of the Michigan public (83%) had not heard of advanced nuclear power plants. Since Generation IV nuclear power designs did not increase support for nuclear power much among the focus group, we wondered how it might affect general public opinion. Thus, we included an intentionally-leading question in the SOSS survey, asking the public if they knew of nuclear power plants that were "smaller, safer, and do not use water" and whether they would support construction of such nuclear power plants in Michigan. A slim majority of the public supported the construction of these hypothetical power plants, with 52% in support (16% strongly support, 36% somewhat support), 2.6% neutral and 6% don't know, and 40% opposed (14% somewhat and 26% strongly oppose). Public support for the *construction* of Generation IV power plants is 15% greater than support for the increased *construction* of traditional nuclear power plants and 16% greater than support for the

increased *use* of nuclear power. These findings only apply to the Michigan public, and the benefits we presented were somewhat random, as we proposed three possible benefits of Generation IV reactors and SMRs, rather than asking about a specific design. Therefore, these results are preliminary and further state- and national-research and public engagement would be required to better understand public opinion on advanced nuclear power plants.

IVe. Energy Efficiency

While we did not ask the public about energy efficiency, it did come up as an important issue in a number of expert interviews. There are still a number of areas in which energy efficiency can be improved in the state. One interviewee expressed that efficiency is particularly important for low-income populations because houses that lack insulation and weather-stripping are very expensive to heat. They said that low-income populations have more to gain from energy efficiency than clean energy.

V. SYSTEMS MANAGEMENT: BASELOAD VERSUS PEAK LOAD

Our results demonstrate very high levels of support for renewable energy in the state of Michigan. However, as renewables increase, questions are being asked about the reliability of the electrical power system since solar and wind are intermittent energy sources (i.e., the sun does not always shine, and the wind does not always blow). Baseload power refers to power plants that provide a steady flow of power 24 hours a day and seven days a week. According to interviewees, until recently, Michigan had overbuilt generation capacity and could always easily meet the federal regulatory requirements of 'a loss of load of only one instance every ten years' (see Pfeifenberger & Spees, 2013). Today, baseload power is decreasing in the state, leading to a discussion in the energy regulatory arena that the state could "go dark" if it does not meet reserve requirements. This discussion about baseload power and reserve power is a critical one for energy transitions in Michigan and elsewhere. The options for baseload power include coal, natural gas, nuclear, and hydropower plants. Alternatively, new ways of balancing supply and demand could be developed that would eliminate the need for baseload power.

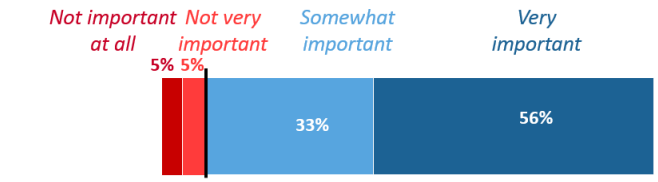
Among interviewees involved in utility regulation and utility policy, perceptions of the importance of baseload power were mixed. Some interviewees saw baseload power as essential. One regulator expressed that "I think in an industrialized society with an industrial base, it's always going to be a requirement" for baseload power. "As a homeowner, you might be able to get along with a delay in washing your clothes, but if you're manufacturing steel or something you have to be able to turn that motor on: The assembly line has got to go." One interviewee questioned, "What world are you in which you would believe that we could get by without baseload power, that any company would move to Michigan to manufacture products 24/7 without some assurance that their power is going to be there 24/7/365 and that it's going to be good power?" A former utility company employee also said that baseload power is needed for industry. He stated, "Industries like Hemlock Semiconductor Group…if they have a

disruption in their power source…you lose about a 12 million dollar batch of, ironically, polysilicon for solar." That said, he was skeptical of predictions that 5-10% intermittent energy would challenge system reliability, and he assumed that the number is closer to 30-40%. A utility company employee reported that "municipal utilities in Michigan are getting out of the baseload sort of generation" because it is too expensive to maintain old coal-fired power plants. Yet he also said that baseload is important for three reasons: 1) constant supply for reliability 2) meeting an unanticipated surge in demand or loss of power from a malfunction in the system and 3) providing ancillary services such as voltage support.

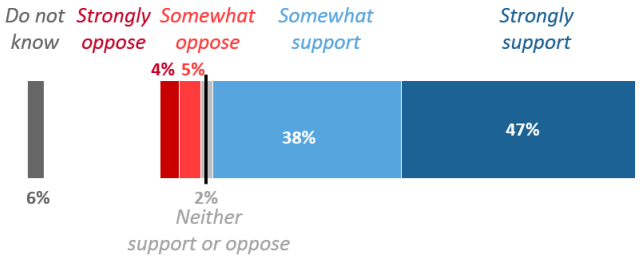
Other interviewees saw baseload power as previously useful but incapable of addressing the challenges of climate change and local environmental pollution. A smarter and more sophisticated grid will be needed instead. Several interviewees used the example of distributed computing to illustrate this point. They explained that we currently have an individualistic system of computing, with individually-owned smartphones and computers, rather than a centralized system of computing. A grid that can accommodate more distributed energy will be needed in the future. Another interviewee said planning a grid system around baseload power is planning around "a false metric." A number of interviewees discussed increased grid intelligence to allow for load shifting (shifting demand to off-peak hours of usage). One interviewee stated that it ultimately would be cheaper to build a set of nested micro grids with "very sophisticated energy management systems" rather than to build new baseload power plants. There are opportunities for scaling up battery storage and pumped hydro storage (such as at the Ludington pumped storage facility). An interviewee from an environmental NGO discussed the potential benefits of increased regional electricity systems integration, since "the wind is typically blowing somewhere….It may not be blowing wind today here in Lansing, but [it may be] in Iowa and South Dakota….Wind can be a pretty good baseload." With smarter grids "you can figure out ways to balance and provide power and needs that don't necessarily require you to be running [power plants] 24-7-365."

We wondered whether the public would support greater electricity integration within the Midwest region to help with balancing intermittent power. We found that 87% of the general public thinks that energy independence is important, but when we emphasized that greater electricity integration could help to increase the use of renewable electricity, the public was more open to integration with other states, with 85% in support (47% strongly supporting electricity integration and 38% somewhat supporting), and only 9% somewhat or strongly opposed.

How important is it to you that Michigan remains mostly energy independent from surrounding states and other countries?



Greater electricity integration with surrounding states in the Midwest and with Canada could help increase the use of renewable energy in Michigan. Given this, to what extent do you support greater electricity integration in the region?



Given the lack of stakeholder support for nuclear power in Michigan, the phase out of coal and existing nuclear plants, and the carbon dioxide emissions associated with natural gas, Michigan could benefit from increased grid integration, battery and other types of storage. Programs that encourage energy efficiency and consumer load shifting to ensure clean, reliable and affordable electricity for the future could also be beneficial.

VI. POLICY RECOMMENDATIONS

Members of the public identified barriers in access to solar power for: low-income and middle-income populations that cannot afford the capital costs, renters, and people who do not have access to the necessary rooftop space. Solar leasing programs and community solar installations could make solar power accessible to these populations.

- *Solar leasing:* In order for solar leasing programs to expand, the tax burden for solar leasing would need to be addressed. Michigan charges industrial personal property tax on solar equipment used to "produce electricity for sale," which would result in taxation in the case of a solar lease in which the customer pays a third-party company for electricity. A bill has passed the House to treat residential solar systems as a home improvement, rather than treating solar systems as new property to be taxed. This bill is expected to pass the Senate. However, solar leasing programs in which a third-party entity installs a solar panel system on a consumer's roof and the consumer then pays that company for the electricity would still result in taxation. The property tax provisions in the current bill could be extended to solar leasing programs.
- *Community solar power:* Another way to increase access to residential solar power is for utility companies to offer community solar programs, in which utility companies build a solar power installation and utility customers then pay the utility company for this clean energy. Only three community solar installations exist in the State of Michigan, and barriers need to be removed to advance this type of development.

Finally, this study finds that Michigan needs to develop better policies to promote innovation in renewables and to take advantage of opportunities for economic growth, innovation, and competitiveness in the area of renewable energy.

Acknowledgements

The authors thank Michigan State's Institute for Public Policy and Social Research MAPPR grant program and the Science and Society at State grant program for funding this research. We also want to thank Prof. Tom Bieler and students Jacob Claes, Emily Linden, and Jordan Stomps at Michigan State University for their assistance with this research. Thanks to Graham Pierce for his help designing the SOSS survey questions and for his coordination of the survey.

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