MI POWER GRID

Making the Most of Michigan's Energy Future

Draft Staff Report

Michigan Public Service Commission Staff Report

U-20898 MI Power Grid: New Technologies and Business Models Workgroup

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MPSC

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Michigan Public Service Commission
MI Power Grid: New Technologies and Business Models

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A list of organizations that participated in the stakeholder process or shared their expertise with Michigan Public Service Commission staff is below. The list may not be comprehensive as not all participants shared their organizations.

Participating Organizations

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City of Grand Rapids
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Clark Hill
Clarke Energy
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Executive Summary

On October 17, 2019 the Michigan Public Service Commission (MPSC) launched MI Power Grid in collaboration with Governor Whitmer. MI Power Grid is a customer-focused, multi-year stakeholder initiative intended to ensure safe, reliable, affordable, and accessible energy resources for the state's clean energy future. The initiative is designed to maximize the benefits of the transition to clean, distributed energy resources for Michigan residents and businesses. MI Power Grid encompasses outreach, education, and changes to utility regulation by focusing on three core areas: customer engagement; integrating new technologies; and optimizing grid performance and investments. The MPSC maintains a dedicated website for the initiative at www.michigan.gov/mipowergrid.

This report highlights the efforts of the New Technologies and Business Models workgroup (Case No. U-20898), its stakeholder process, and its learnings. It also includes MPSC staff (Staff) recommendations. This workgroup explored new business and ownership models and focused on understanding the opportunities and deployment barriers for the following technologies:

- Behind the meter and community solar,
- Combined heat and power,
- Electric vehicles,
- Energy storage,
- Heat pumps for space and water heating, and
- Microgrids.

Staff conducted nine stakeholder meetings and one meeting with Michigan Tribes to explore new technologies and business models. Outside of surveys conducted after each meeting to obtain feedback, Staff also developed and conducted four surveys regarding meeting content and timing, behind the meter and community solar, and Michigan Tribes' experience and needs. Staff synthesized the information from workgroup activities and literature reviews to make its recommendations.

First, Staff recommends the Commission provide guidance on what "just" rates entail when evaluating new technologies and alternative business and ownership models, especially if Staff should consider the following when evaluating "just" rates:

- Safety,
- Reliability,
- Resiliency,
- Environmental sustainability,
- Equity, including intergenerational equity,
- Environmental justice,
- Disproportionate impacts to vulnerable populations, and
- Economic impacts of utility investments.

Second, Staff recommends the Commission provide guidance on how utilities and Staff should consider non-energy benefits and costs. Specifically, Staff recommends the Commission require:

- Benefit cost analysis, as detailed by the National Standard Practice Manual for Distributed Energy Resources, be required from the utilities when proposing and evaluating future pilots for new technologies and alternative business/ownership model pilots, and
- Cost and benefits related to facets of "just" rates the Commission details be included in any benefit cost analysis.

Third, Staff recommends the Commission support data-driven decision making by:

- Establishing baselines to support development of future regulatory innovations and the quantification of their impacts,
- Ensuring 3rd party access to utility data in a secure, timely, and ongoing manner,
- Recognizing the necessity of hardware, software, and communications investments necessary to support grid-edge innovations, visibility, and control, and
- Supporting analyses to ensure new technologies are included in integrated resource plans and distribution plans.

Fourth, Staff proposes an expedited pilot approval process intended to support the rapid transformation of the energy system needed to meet overarching state goals. This proposed pilot process allows eligible pilots to seek a 45 day Commission review of the pilot implementation plan. Commission approval must be received before the pilot starts. Approved pilots may seek a 30 day Commission review of any proposed changes to pilot scope, with automatic approval if the Commission does not respond within the 30-days. A combined total annual cap of $3 million per year for each utility is proposed for the expedited pilot process. Details on pilot eligibility, notice, reporting, and cost recovery are provided in Staff's proposal (See Section 11.4-4 for more details). Staff recommends the Commission request stakeholder comment be filed on Staff's proposed process for expedited pilot review in Michigan. After stakeholder comments are reviewed, Staff recommends the Commission modify the proposed expedited pilot process accordingly and adopt the revised process.

Fifth, Staff recommends the Commission support the development of alternative business and ownership models by:

- Establishing a comment proceeding to consider legal and regulatory barriers to utility ownership of behind the meter distributed energy resources,
- Supporting exploration of alternative business and ownership models by requesting utility pilots in this area, and
- Requesting the offering of comparable, parallel third-party pilot or tariff, either separately or within the same pilot or tariff, where feasible, in recognition of frequent third-party innovations that may result in cost savings, system benefits, and alternative business and ownership model learnings. Such third-party pilots or tariffs are envisioned to be facilitated by the utility, which selects the third-party through a competitive process, and

provides the necessary data and at the needed frequency for the third-party to conduct and evaluate the pilot.

Sixth, Staff recommends technology and fuel agnostic incentives be developed and that:

- Regulatory rates and incentives should be agnostic to technology or technology fuel types as implementation of new technologies advance,
- Outside of transitional relief for pilots, regulatory rates and incentives:
    - Should reflect cost-of-service,
    - Should incentivize efficient use of the grid and grid resources, and
    - May reflect social or policy goals.
- Though rates should be technology agnostic, studies may be required for new technologies or programs using alternative business or ownership models to determine the overall costs and benefits. This information may be needed to update or determine the cost-of-service, and
- The Commission consider technology-neutral rates and tariffs as the implementation of new technologies advances.

Seventh, Staff recommends the Commission support:

- Pilots of tariffed on-bill programs for implementation of residential and commercial energy technologies and energy efficiency to determine the efficacy of on-bill tariff programs for varied applications in Michigan, and
- Exploration of financial incentives that support beneficial uptake of distributed energy resources, especially ones that help overcome barriers experienced by low- and moderate-income customers.

Eighth, Staff recommends the Commission recognize the importance of education in the uptake of new technologies and business/ownership models by:

- Requiring all such pilots that interact or recruit customers provide customer education that provides, at a minimum:
    - Information on the technology and business/ownership model,
    - Possible benefits and costs,
    - Applicable rates or tariffs, and
    - Financing options.
- Requiring all such pilots that implement new technologies in Michigan to also include contractor education and training,
- Supporting efforts within the State of Michigan or elsewhere to promote and provide trainings to first responders on how to safely interact with new energy technologies during accidents, and
- Supporting efforts to provide clear regulatory and utility information needed by third parties to educate potential customers on energy products and services.

Lastly, Staff recommends the Commission chart a clear path supporting rapid new technology and business/ownership model learnings in Michigan by:

- Taking rapid action on items outlined by Staff recommendations throughout the MI Power Grid process,
- Avoiding near-term solutions that prevent or complicate longer-term transformative change, and
- Supporting uptake and safe integration of beneficial energy innovations and business models into the established practices of Michigan utilities and regulatory processes.

Though Staff's recommendations focus on largely regulatory barriers, as the Commission charged this workgroup to provide, a variety of barriers and solutions beyond the regulatory realm were also shared through presentations, panels, and discussions. All identified barriers, hurdles, and solutions are summarized in tables for each of the covered technologies. Staff hopes others who can address the identified non-regulatory barriers and hurdles may find the tables of interest and helpful in future endeavors. Staff looks forward to future Commission guidance, as well as the findings of ongoing and future MI Power Grid workgroups, that will likely shed more light on how to better support new energy technologies and alternative business and ownership models in Michigan.

1. Introduction

1.1 MI Power Grid Initiative

On October 17, 2019, the Michigan Public Service Commission (MPSC or Commission) launched MI Power Grid in collaboration with Governor Gretchen Whitmer. MI Power Grid is a customer-focused, multi-year stakeholder initiative intended to ensure safe, reliable, affordable, and accessible energy resources for the state's clean energy future. The initiative is designed to maximize the benefits of the transition to clean, distributed energy resources for Michigan residents and businesses. MI Power Grid encompasses outreach, education, and changes to utility regulation by focusing on three core areas: customer engagement; integrating new technologies; and optimizing grid performance and investments. The MPSC maintains a dedicated website for the initiative at www.michigan.gov/mipowergrid.

MI Power Grid seeks to engage a variety of stakeholders, including utilities, energy technology companies, customers, consumer advocates, state agencies, and others, in discussions about how Michigan should best adapt to the changing energy industry. This report highlights the efforts and findings of the New Technologies and Business Models workgroup within the Integrating Emerging Technologies core area of MI Power Grid.

1.2 New Technologies and Business Models Workgroup and Tasks

The MPSC recognized the opportunities for technological advancements present as well as the market and regulatory barriers that could hinder the pace and scale of their adoption. (2019, p. 3) In its October 17, 2019, order, the Commission outlined four work areas under the core area of Integrating New Technologies: Interconnection Standards and Worker Safety, Data Access and Privacy, Competitive Procurement, and New Technologies and Business Models. More specifically, the Commission stated the New Technologies and Business models workgroup would include (2019, p. 7):

> *preparing for the opportunities and challenges associated with the commercialization of new technologies and business models such as electric vehicles, electric storage, and other technologies still under development, both at customer and utility scale.*

The New Technologies and Business Models stakeholder workgroup was launched on October 29, 2020, as part of Phase II of MI Power Grid. In its order, the Commission provided guidance for stakeholders and Staff on the Commission's objectives and expectations. The problem statement for the workgroup was as follows (Michigan Public Service Commission, 2020)):

> *There are regulatory and business model barriers to the development and full utilization of clean, distributed energy and resources in Michigan. Stated differently, there is the need to adapt the regulatory framework to allow for different applications of DER [distributed energy resources] and to define the appropriate roles of utilities and other entities in supporting a more decentralized energy system that is clean, affordable, and accessible.*

The New Technologies and Business Models workgroup was designed to create a shared understanding of different technologies and their potential applications, to identify barriers to integration of new technologies, and to propose potential solutions for consideration by the Commission. The examination of barriers focused on issues and solutions that the Commission can address within its oversight of utilities under the current regulated market model established by the Michigan Legislature. Additionally, the workgroup aimed to identify and present market, policy, and legal impediments to certain technology applications that may be beyond the Commission's existing authority but could be cataloged as a part of the research process to be addressed in coordination with the Governor and/or Legislature (Michigan Public Service Commission, 2020, pp. 6-7 and 11).

As the Commission noted, MI Power Grid's emphasis is on "clean, distributed energy resources," thus, the workgroup was ordered to initially focus on (2020):

- Microgrids,
- Electric vehicles,
- Energy storage,
- Distributed energy generation, and
- Space and water heating using heat pumps.

Distributed energy generation was clarified to include technologies such as combined heat and power and behind the meter and community solar projects. In addition to technology-specific topics, the New Technologies and Business Models workgroup was to have a focused session on alternative business and ownership models (Michigan Public Service Commission, 2020, p. 11).

The workgroup was to "examine, as applicable, different configurations or ownership models, technical capabilities (e.g., resilience, voltage support, ramping), potential benefits or impacts, cost and adoption trends, and an inventory of barriers and potential solutions in the near and long term." (Michigan Public Service Commission, 2020, p. 11). The workgroup was to consider "a broad array of benefits in the context of Michigan's electric power system such as reliability, safety, affordability, accessibility, resilience, energy (energy capacity, ancillary services), environmental impacts, equity, and community." (Michigan Public Service Commission, 2020, p. 11).

2. Background

2.1 Current Regulatory Structure in Michigan

2.1.1 Powers and Jurisdiction

Public Act 3 of 1939 (Act 3) established the Michigan Public Service Commission. Under this act, the Commission regulates all public utilities in the state except a municipally owned utility, the owner of a renewable resource power production facility, and except as otherwise restricted by law. MCL 460.6(1). The MPSC is vested with the power and jurisdiction to regulate all rates, fares, fees, charges, services, rules, conditions of service, and all other matters pertaining to the formation, operation, or direction of public utilities. *Id*.

2.1.2 Regulatory Construct

The regulatory construct grants the utility a service territory, within which the utility has exclusive rights to provide a specific utility service. In return, the utility accepts regulation, which includes rate regulation and also operational rules, like shutoff rules. The utility must provide service to new customers. It cannot run credit checks or otherwise test who is allowed to be a utility customer.

In 2000, Public Act 141, the Customer Choice and Electricity Reliability Act, allowed for the provision of electric choice in Michigan. For electricity, this allows customers to select an alternate provider for the power supply portion of their bill, while maintaining their local utility as the billing and distribution provider. Under current legislation, the amount of alternative electric supplier choice allowed is capped at 10% of a utility's average adjusted retail sales. MCL 460.10a(b). Several utilities have reached this cap.

Some innovative technologies discussed seek to push the envelope on the service territory portion of the construct, others seek to push against current legislative rules or state regulations. Many of the barriers that have been identified are in contrast to some preexisting understanding or actual written agreement about the existing regulatory construct. Some changes to the construct may be possible and within the purview of the Commission, while others would require an amendment or additional legislation. This report will now turn its attention to specific rules and issues that have been highlighted by the New Technologies and Business Models workgroup.

2.1.3 Interconnection

The interaction between most appliances and the grid is limited to drawing power, or load. Other devices can energize or supply the grid with electricity, including storage and self-generation. An electric vehicle (EV) could be considered load or supply depending on whether it is charging or discharging its battery to the grid. An interconnection agreement with the utility is required if a device generates electricity or provides stored electricity and operates parallel to the grid. As an example, a backup generator is a form of self-generation; but it only operates when a home or business is physically disconnected from the grid. An interconnection agreement, sometimes called a parallel operating agreement, is not required for the use of a back-up generator. If this same generator were to function while the home or business is connected to the grid, an interconnection agreement is required. This is done in part to protect utility employees that may be working on the system from unexpected energy being present on the wires.

EVs require special consideration due to their portability. Interconnection agreements are typically tied to a location where an agreement allows an eligible device to operate in parallel to the grid in a certain location. An EV, even if it is capable of being discharged anywhere, would only be allowed to discharge at a location with an interconnection agreement. This would mean that it makes more sense to tie interconnection agreements to capable charging stations, rather than to the vehicles themselves. When a capable vehicle is at a capable charging station with a valid interconnection agreement, that vehicle could be permitted to discharge to the grid at that location if necessary.

As utilities experience increased numbers of interconnection requests, efforts to streamline and improve the interconnection process are continually explored. A revision to the interconnection rules is underway with input from the MI Power Grid Interconnection Standards and Worker Safety workgroup and will not be discussed at length here. The Commission's efforts in updating the Electric Interconnection and Net Metering Standards are in Case Nos. U-20344 and U-20890.

2.1.4 Rates

Under Public Act 304 of 1982, a gas utility, electric utility, or steam utility may not increase its rates and charges, or amend any rate or rate schedules, the effect of which will be to increase the cost of services to its customers, without first receiving Commission approval. MCL 460.6a(1). Rates are set through a procedure that includes revenue requirement, cost-of-service, and rate design. Revenue requirement looks at the accounting and finances of the utility and determines how much money needs to be collected from customers. Cost-of-service determines who, by customer class, the revenue should be collected from. Rate design then determines how the money will be collected from customers in the customer class. Cost of service and rate design are guided by a few main publications.[1] Every step of the process includes science, judgement, and art, resulting in a broadness to what could be considered an appropriate rate.

Rates do not usually change the utility's overall revenue requirement. A discount provided to a customer is usually paid for by another customer. Similarly, an incentive paid to a supplier also gets paid for by a customer. It is possible that an incentive will result in savings to all customers. This can be considered in the regulatory environment.

2.1.5 Meters

Rates are closely related to items that can be measured. Some measures, like total customers, use utility records. Other measures used for rates, such as the amount of energy being consumed by an individual customer, depend on a more technical measuring device. The most common of device is an electric utility meter. Utility meters have a certified level of accuracy that deems them to be "revenue grade". Other devices such as the inverter on a solar generation system, or the measurement of charging on an EV, may or may not be considered revenue grade. Imagine a residential home that has storage, a solar generation system, a heat pump, and an EV. If all of these had separate rates, they might all require separate revenue grade meters to determine charges or reimbursement. Some utilities are looking into submetering technologies that may be helpful. The Commission is exploring rate design options in the Distributed Energy Resources Rate Design workgroup (Case No. U-20960) and facilitated by the Regulatory Assistance Project.

[1] The National Association of Regulatory Utility Commissioners (NARUC) published the Electric Utility Cost Allocation Manual that includes methods and guidance for cost-of-service. Principles of Public Utility Rates by James C. Bonbright is another oft-quoted resource on the principals of rate design.

2.1.6 Regulatory Barriers to Implementation of New Technologies

Staff identified five reoccurring regulatory barriers to the implementation of new technologies and business models. These are: the capabilities of advanced metering infrastructure, the individualized billing of multi-family units, the market competitiveness of behind the meter solar, the ownership of distributed energy resources, and the location requirements and definition of microgrids. In this section of the report, Staff seeks to outline the existing regulations on the above topics and identify barriers or specific instances where each barrier has prevented new technologies from being added to the energy grid.

2.1.6-1 Advanced Metering Infrastructure Capabilities

Michigan does not currently have the metering infrastructure to measure the use and production of multiple technologies with one meter within a household or project. An illustrative example is that a household that has solar panels, geothermal electric generation, and an electric vehicle could have as many as three meters in the current regulatory environment. Additional meters are only required if customers wish to use the special rate schedules. Many customers elect to not go on the geothermal and EV rates to avoid the extra meters. Under Michigan's Technical Standards for Electric Service, all electricity that is sold by a utility must be sold by a metered measurement unless the consumption can otherwise be readily computed. Mich. Admin. Code R 460.3301.

Under the current regulations, only investor-owned, cooperative, or municipal electric utilities can own, construct, or operate electric distribution facilities or electric meter equipment used in the distribution of electricity in the state of Michigan. MCL 460.10q(4). There are no prohibitions on a self-service power provider constructing, owning, or operating electric metering equipment if the sole purpose is providing or utilizing self-service power. See MCL 460.10q(4). The Commission does not have the authority to prohibit an electric utility or electric cooperative from metering and billing its customers for electric services. *See* MCL 460.10q(5); MCL 460.10x(4).

In 2012, many Michigan utilities began deploying Advanced Metering Infrastructure (AMI) or smart meters. A traditional electric meter needs to be read each month to produce an accurate bill. Smart meters record energy usage and transmit the data through radio-frequency signals, giving utilities the ability to collect data and monitor usage in real-time. While bidirectional meters and smart meters can allow for remote reading of both the electricity inflows and outflows, they do not currently have the technical capability to provide readings of multiple technologies for one customer. Under the current technological limitations, each distinct inflow and outflow used within a project or household has a meter with its own individual rate. Customers who want to utilize specialized rate schedules for different technology types can lead to the necessity for multiple meters to calculate the inflow and outflow of different technologies. For example, a solar panel and an electric vehicle discharging its battery onto the grid would need separate meters. A third meter would possibly be necessary to measure the inflow kWh for the customer.

The distributed generation program is governed by Part 5 of MCL 460.1001 and each utility's distributed generation (DG) tariffs. The distributed generation program was established under the Clean and Renewable Energy and Waste Reduction Act. The metering requirements for the DG programs are governed by the Institute of Electrical and Electronics Engineers (IEEE) 1547.1 Standard Conformance Test Procedures for Equipment Interconnection Distributed Energy Resources with Electric Power Systems and Associated Interfaces and the Underwriters Laboratories, Inc. (UL) Standard for Inverters, Converters, and Controllers and Interconnection System Equipment for Use with Distributed Energy Resources. Utilities must install bidirectional meters, which can measure the flow of energy in both directions for customers with a generation system capable of generating more than 20 kilowatts. The DG program metering requirements are based on an inflow and outflow billing mechanism. Meter(s) must be used to measure utility kWh deliveries to the customer (inflow) and kWh exported to the grid (outflow).

As a part of the Distributed Energy Resources Rate Design workgroup, Staff is investigating the following metering and billing frameworks as alternatives to the current inflow/outflow billing framework: monthly netting, buy-all/credit-all, time-of-use netting, granular netting options using AMI. A final report is due to be filed by the workgroup on October 31, 2021.

2.1.6-2 Individualized Billing of Multi-family Units

Multi-family dwellings have limited access to on-site generation because Michigan does not currently have utility submetering policies or regulations in place for electricity. According to the National Conference of State Legislators, utility submetering is "the implementation of meter systems that allows the operator of a multi-unit property to bill each unit for individual utility usage through the installation of multiple meters behind a utility meter."[1] The critical role of submetering in implementing new technologies is that submetering can be managed by a third-party entity that does not produce electricity but resells utility services to the customer behind the utility meter. Utility submetering may also consist of the installation of an additional meter on the customer side of a utility meter to obtain data about a specific end us or uses inside a facility. Under the current regulations, a "customer" is defined as "the building or facilities served through a single existing electric billing meter and does not mean the person, corporation, partnership, association, governmental body, or other entity owning or having possession of the building or facilities." MCL 460.10a.

Submetering is distinct from master-metering implemented in current low-income master-meter waivers. Master-metering allows a landlord to purchase energy at a commercial customer rate and then sub-meters the electricity to tenants at a residential or smaller commercial scale. See NCSL. State approaches to utility submetering vary and may establish acceptable uses of submetering in properties, create a mechanism for determining customer charges, and determine if building owners may charge customers additional fees. According to the National Conference of State Legislators, some states require public service commission approval for submetering policy. Submetering policies can determine how pricing is calculated or require that pricing be equitable to customers. These policies may also address fees and service charges by utilities and building operators "including formula-based fees or service charges, device fees; flat service charges; and other 'reasonable' fees or charges." NCSL. A state statute may also address submetering versus master-metering policies in specific circumstances. Michigan has master-metering regulations in place for the distribution of natural gas from the 1974 order in Case No. U-4211.

The current distributed generation program and billing system complexity limit the participation of multi-family units in on-site generation. In 2016, Public Act 342 was ordered into law.[2] Act 342 required Michigan to implement a distributed generation program. The distributed generation and legacy net metering programs allow Michigan utilities and alternative electric supplier customers to install on-site renewable energy electric generation projects to meet some or all their electric energy needs and to reduce electric bills. Customers reduce electricity purchases from the utility by using behind the meter generation and receiving a credit for excess generation.

2.1.6-3 Market Competitiveness for Behind the Meter Solar

Historically, projects consisting of behind the meter solar generation combined with battery storage have been funded by non-utility investment. Allowing utilities to own behind the meter solar raises concerns about the competitiveness of the energy market.

Consumer's Energy has requested distributed generation pilots in two different cases. The first was in Case No. U-17875 of 2015, where the company requested approval of a Solar Distributed Generation Pilot program. This pilot program was designed to "promote solar distributed generation, gather information relating to customer interest in distributed generation, and provide interested customers an opportunity to obtain distributed solar generation for their homes or businesses." Consumers Energy was to serve as an advisor, marketer, and packager of solar distributed generation for interested customers. Consumers Energy would enter into agreements with solar vendors who would provide standardized solar equipment for lease or sale to interested customers and provide installation and service on the solar equipment. The Commission approved an amended version of the solar pilot on November 7, 2016.[3]

In Consumers Energy's most recent rate case (Case No. U-20963), the company proposed a Home Battery pilot designed to "test participating customers' interest in paying for resiliency as a service, grow the company's understanding of battery costs versus distribution and generation use cases, and explore the similarities and differences between customer owned and utility-owned battery fleets in managing supply and demand across the evolving energy grid."[4] The pilot consisted of 2,000 home battery units across 1,000 homes in Consumers Energy's territory with two battery units in each home. The primary goal was to test customer willingness to participate in a home battery back-up pilot.

Testimony and comments on both proposed pilot programs questioned utilities operating as monopolies and moving into a competitive market, as this may have adverse impacts on market competition. In the 2016 case, Great Lakes Renewable Energy Association, Zerwell Energy Corporation, West Michigan Solar LLC, CBS Solar, Celtic Acres LLC, The Alliance for Solar Choice, Solar Winds Power Systems, Environmental Law and Policy Center, Michigan Energy Innovation Business Council, Cedar Michigan, and Solar Winds Power Systems commented in the docket. The comments primarily outlined concerns regarding fair competition between solar vendors in

Michigan. The commenters were concerned that the pilot program as proposed would provide an unfair competitive advantage to solar vendors chosen by Consumers Energy to participate in the pilot program. Consumers Energy amended its original application to state that "entities which are not the Solar Vendor in the Solar DG Pilot will remain free to market and sell solar distributed generation systems regardless of Consumers activities as part of the Solar DG Pilot" and that "entities that are not the Solar Vendor will also be free to demonstrate their qualifications and experiences to install distributed solar systems and to apply to the Solar Vendor to be selected as an Installation Company under the Solar DG Pilot."

Testimony on the Home Battery Back-Up pilot proposed in Consumers most recent rate case (Case No. U-20963) raised similar concerns. Testimony filed on behalf of Michigan Environmental Council, Natural Resources Defense Council, Sierra Club, and Citizens Utility Board of Michigan stated that "the Commission should also address issues created by the fact that the Company is a monopoly subject to economic regulation, and its move into the competitive market may have adverse impacts disrupting such competition." Consumers Energy plans to contract with Michigan companies to address issues of competitiveness. However, intervenor testimony stated that the company's plan to contract with Michigan vendors and installers does not sufficiently address these issues because such contracts intrinsically distort competitive market dynamics.[5]

Additionally, testimony filed by Michigan Energy Innovation Business Council (MEIBC) and the Institute for Energy Innovation recommended that the Commission approve a bring-your-own device program in place of a Company-ownership model. The testimony argues that having utility-owned behind the meter battery storage has "a destructive impact on the competitive market's ability to provide energy storage products and grid services." The testimony states that while non-utility owned resources and other third-party service providers can compete on a cost and performance basis with many utility investments and services, their ability to do so is in large part dependent upon the existence of a market environment with a level playing field "under which an incumbent monopoly is not offered competitive advantages that derive from its monopoly status rather than innovation or other competitive factors."

2.1.6-4 Ownership of Behind the Meter Distributed Energy Resources

The implementation of community solar programs and pilots presents issues of ownership for the Commission to consider. In its August 20, 2020 order in Case No. U-20147, the Commission stated that "as behind-the-meter technologies such as DERs and energy efficient appliances evolve, the suite of grid solutions and services they are capable of providing to the distribution system will evolve as well" and "[a]s utilities move to advance distribution management systems to gain better transparency in the real-time operation of grid assets, the potential for ancillary services beyond load reduction, such as reliability improvement, volt/var reduction, and microgrids from DERs, will also expand."[6] In that case, the Commission stated that it would like to see pilot studies focusing on behind-the-meter technologies to better understand how customer-sited resources can improve the reliability, efficiency, and productivity of the distribution system.

In Case No. U-20649, Consumers Energy Company proposed a "Bring Your Own Bright Field Pilot Program" (BYOBF) as a voluntary green pricing program. The pilot would be a behind-the-meter option open to full-service customers with a minimum of 1 MW load. This allowed participants to have a solar energy system with optional battery storage owned by Consumers installed at the customer's facility to supply the customer's power needs. The proposed pilot program offered customers a behind-the-meter Voluntary Green Pricing option. In that case, intervenors contested the approval of the BYOBF pilot, claiming that the utility was "without legislative authority to participate in an unregulated market; the company would have an unfair advantage with access to customer and electricity load information and capital unavailable to third parties."[7] MEIBC argued that the Legislature previously acted explicitly when granting utilities the authority to participate in formerly unregulated markets. The Legislature allowed utilities to offer value-added programs to its customers in 2016 under MCL 260.10ee and approved customer-choice programs in 2000 under 260.10 *et seq*. MEIBC argued that the Commission did not have the statutory authority to allow utilities to participate in unregulated markets. Similarly, Energy Michigan also raised concerns in that case that approval of the BYOBF pilot would allow Consumers to put into rate base behind-the-meter "projects that would directly compete with third-party, non-utility developers—again with no legislative authorization for this regulatory action."[8] In reply brief, Consumers argued that the Commission has the authority to regulate a utility's behind-the-meter pilot evident by the following: (1) the Commission's broad authority to regulate rates and conditions of retail electric service; (2) the pilot was a provision of retail electric service; (3) the Bring Your Own Bright Field pilot was a voluntary green pricing program explicitly provided for by the legislature; and (4) the Commission has the authority to regulate and approve the program. In that case, the Commission found that additional information and deliberation was needed before the Commission considered approval of the Bring Your Own Bright Field pilot or a similarly structured program. The pilot was rejected.

The March 10, 2021, New Technologies and Business Models stakeholder meeting focused on behind-the-meter and community solar. As a part of the workgroup efforts, Staff surveyed stakeholders about utility ownership of behind the meter solar the related responses to the survey results are included in Appendix I-1 as Q6 through Q8.

2.1.6-5 Location and Definition of Microgrids

The final of the reoccurring regulatory barriers identified in the New Technology and Business Models stakeholder discussion was the location and definition of microgrids. The existing rules and regulations in Michigan are applicable to distributed generation as a broader category and do not address microgrids specifically.

Of concern is the unclear definition of what constitutes a microgrid and how microgrids could be counter-intuitive to current electric regulations. Part of this concern stems from questions about a microgrid's ability to fit the definition of "premises" under the Public Service Commission's Technical Standards for Electric Service in the Michigan Administrative Code. Rule 102 of the code defines a "premises" as "an undivided piece of land which is not separated by public roads, streets, or alleys." (Michigan Admin Code R 460.3102).

Discussion on the definition of "premises" in Rule 102 most frequently comes up in cases regarding Michigan Administrative Code Rule 411. Rule 411(1)(a) defines "customer" as the "buildings and facilities served rather than the individual, association, partnership, or corporation served" and states that "an existing customer shall not transfer from one utility to another." (Michigan Admin Code R 460.3411(2)).

The Michigan Supreme Court addressed Rule 411 in *Great Wolf Lodge of Traverse City, LLC, v. Michigan Public Service Commission and Cherryland Electric Cooperative* (Great Wolf Lodge, MSC 138544). When Rule 102 definitions were incorporated into Rule 411 in that case, it read as follows:

> *The first utility serving [buildings and facilities] pursuant to these rules is entitled to serve the entire electric load on the [undivided piece of land which is not separated by public roads, streets, or alleys] of [those buildings and facilities] even if another utility is closer to a portion of the [buildings and facilities'] load.*

These rules become problematic when applied to microgrids. A microgrid may generate energy in one location to serve customers at a remote location. The current definitions may limit microgrid siting and microgrid abilities to provide widely distributed energy to customers, and for multiple customers to own and benefit from a microgrid. A condominium complex serves as one example. A solar grid may be positioned on the roofs of one set of condominium units but serves customers in multiple units across streets or alleys. Under the current definition, this would not be defined as one premises, even though all units may be owned by one management company and be considered one "customer" for the purposes of Rule 411.

2.2 State Initiatives and Targets

On September 23, 2020, Governor Gretchen Whitmer signed Executive Order 2020-182 and Executive Directive 2020-10 which created the MI Healthy Climate Plan. Within this plan, "Michigan committed to pursue at least a 26-28% reduction below 2005 levels in greenhouse gases (GHG) such as carbon dioxide by 2025 and to accelerate new and existing policies to reduce carbon pollution and promote clean energy development at the state and federal level" (https://www.michigan.gov/climateandenergy/0,4580,7-364-98206---,00.html). These directives encourage the MPSC and Michigan Department of Environment, Great Lakes, and Energy (EGLE) to support energy policies and regulations that push toward the carbon neutrality goal. Part of ED 2020-10 directs EGLE to expand the environmental advisory opinion filed in the IRP process to evaluate potential impacts of proposed energy generation resources and include the consideration of environmental justice and health impacts pursuant to the Michigan Environmental Protection Act.

Due to these policies, EGLE, the Office of Environmental Justice Public Advocate, and MPSC staff have been coordinating on an ongoing basis to create presentations on the topic during MI Power

Grid stakeholder events, develop lists of additional environmental data requests to include in upcoming IRPs, and improve coordinating strategies of state agencies to address the above Executive Order and Executive Directive. At the point of this report, MPSC Staff and EGLE have worked with Consumers Energy, Upper Michigan Energy Resources Corporation (UMERC), and Indiana Michigan Power (I&M) on additional environmental considerations and analysis to conduct in their IRPs filed in 2021.

2.3 Community Initiatives, Interest, & Commitments

In addition to initiatives at the state level, several communities in Michigan have established their own climate action plans. Two hundred local governments in Michigan have renewable energy goals or requirements for their own municipality's energy use, and most would require deploying additional technologies. About 22% of local governments in Michigan responded to a survey saying they considered placing solar on a public facility in their community, which comes to roughly four hundred communities in Michigan (Davis, Miner, & Stults, 2021).

The energy and climate goals set out in community plans range in ambition and timeframe, as show in Table 1. Most energy goals are focused on government facilities' energy usage, but several set targets for the wider community.

Table 1. Michigan Community Climate Action Plans

Community	Plan Type	Plan Enacted†	Goal	Goal Date
City of Ann Arbor	Climate Action Plan	Apr 2020	100% Renewable*	2030
City of Dearborn	Initial Climate Action Plan	Aug 2012	10% GHG Reduction	2015
City of Detroit	Climate Action Plan	Jul 2019	80% GHG Reduction*	2050
City of Grand Rapids	Sustainability Plan and Report	Apr 2019	100% Renewables	2025
City of Hazel Park	Energy Action Plan	Sep 2012	50% GHG Reduction	2050
City of Kalamazoo	Climate Action Plan	Apr 2017	28% GHG Reduction	2025
			90% GHG Reduction	2050
City of Petoskey	Climate Action Plan	Jun 2019	100% Renewables	2035
City of Southgate	Climate Action Plan	Sep 2012	50% GHG Reduction	2050
City of Traverse City	Climate Action Plan	Feb 2011	25% GHG Reduction	2012
		Dec 2016	100% Renewables	2020
		Aug 2018	100% Renewables	2040
City of Ypsilanti	Climate Action Plan	Jul 2012	50% GHG Reduction	2050
Meridian Township	Climate Action Plan	Oct 2017	50% Renewables	2025
			100% Renewables	2035
Northport Village	UofM Feasibility Study	Apr 2016	100% Renewables	2025

† Most recent plan. Several communities have enacted iterations of their plan.

*Community-wide targets

Increasing renewables and reducing greenhouse gas (GHG) emissions are just one aspect of the comprehensive actions in above communities to address climate change impacts and the threat it poses to the wellbeing of their residents to create more sustainable and resilient communities. The City of Ann Arbor, in its 2020 Climate Action Plan, for example, laid out six core strategies to achieve a just transition to community-wide carbon neutrality:

- Power the electric grid with 100% renewables,
- Switch appliances and vehicles to electric,
- Significantly improve buildings' energy efficiency,
- Reduce vehicle usage by at least 50%,
- Change the way materials are used, reused, and disposed of, and
- Enhance the resilience of the people and place.

The City of Detroit has also laid out a similarly comprehensive plan for achieving a more sustainable city. Though large communities like Ann Arbor and Detroit have dedicated sustainability focused staff, not all communities have the resources and expertise to develop such ambitious plans. Some communities, like the City of Rockford, depend on the energy and sustainability expertise of volunteers (Davis et al., 2021). However, all communities are seeking to ensure the best outcomes for their communities. Eight Michigan colleges and universities plus one military base also currently have climate action plans. Emerging technologies and business models, like micro-grids, are essential for these communities to achieve their energy goals.

2.4 Utility Commitments & Initiatives

All three of Michigan's largest investor owned utilities have carbon emission reduction commitments, which will likely impact the types of new technologies and business models the utilities consider while pursuing and realizing these goals. DTE Electric and Gas committed to net zero carbon emissions by 2050 (DTE Energy, 2019, 2020). Consumers Energy's goal is to reach zero carbon emissions by 2040 (Consumers Energy, 2020). Lastly, American Electric Power, of which I&M is a subsidiary, committed to a 70% reduction in CO_2 emissions by 2030 (American Electric Power, 2019).

In addition to its net zero carbon emissions goal, Consumers Energy announced plans, which require regulatory approval, to end coal use by 2025. In addition, the utility plans to use 90% clean energy resources by 2040 and build almost 8,000 MWs of solar energy by 2040, while projecting customer savings to be about $650 million through 2040 (Consumers Energy, 2021).

With grid transformation, the importance of a holistic planning approach is recognized. American Electric Power, parent company to I&M, established the Grid Solutions business unit in January 2021, to combine integrated generation, transmission, and distribution planning together. The I&M/AEP Grid Solutions team will also develop new grid resources, including renewable energy, distributed generation, and energy storage (Indiana Michigan Power, 2021; Sistevaris, 2021).

Lastly, DTE Energy is committed to and supports the Low-Carbon Resources Initiative led by the Electric Power Research Institute and Gas Technology Institute (Willis, 2021). This initiative seeks to enable the pathway to economy-wide decarbonization and is focused on advancing low-carbon technologies for large-scale deployment across the energy economy (Electric Power Research Institute, 2021).

2.5 FERC Order 2222

FERC Order No. 2222 is a landmark order issued on September 17, 2020. Order 2222 requiring market operators to ensure DERs can participate alongside traditional resources in regional organized wholesale markets through aggregation (Tumilowicz, 2021). FERC found it necessary to improve competition and to ensure "just and reasonable" rates. The agency broadly defined DERS to include "any resource located on the distribution system, any subsystem thereof or behind a customer meter." This definition includes electric storage resources, distributed generation, demand response, energy efficiency, thermal storage, and electric vehicles and their supply equipment. All RTOs/ISOs must amend their existing participation models or create new ones to enable participation by DER aggregations (Dennis, 2021).

FERC determines who can participate, some rates for wholesale sales from DER, and rates, terms, and conditions of any transmission or wholesale services provided by DERS. State and local regulators retain significant authority to address reliability, safety, and costs impacts on distribution systems of DER participation in wholesale markets, and terms and conditions of retail DER programs (including who participates in those retail programs). However, they cannot regulate who can participate in wholesale markets or how. Order 2222 requires active coordination of wholesale and retail operations (Dennis, 2021).

Increased DER participation in wholesale markets will accelerate business model innovation and result in third-party and utility deployments (Tumilowicz, 2021). Local DERs may enhanced resilience to infrastructure threats. Ratepayers benefit from improved competition and lower wholesale rates. The additional supply of services will be vital for cost-effective decarbonization. Lastly, FERC Order 2222 unlocks new revenue streams which lowers costs for developers and customers. For example, barriers to integration of DERs impact the ability to maximize the value of electric school buses. By requiring market operators to ensure DER aggregations have one or more pathways, FERC Order 2222 allows technologies like electric school buses to provide all the wholesale services they are technically capable of providing (Dennis, 2021).

Grid operators and stakeholders need to work to remove barriers to ensure DER participation can create benefits for everyone in the electricity sector. Wholesale market operators gain the ability to utilize assets to meet the needs of the larger grid. Distribution utilities gain local resilience on the distribution grid. DER aggregators are provided a new revenue stream, helping them make DERs and new services available to more customers. Finally, ratepayers benefit from cost savings passed on by DER aggregators while also receiving desired service (Dennis, 2021).

3. Summary of Stakeholder Process

3.1 Stakeholder Meetings

3.1.1 Stakeholder Series

The stakeholder series kicked-off in January 2021 via teleconference. In total, nine stakeholder meetings were held from January to June 2020. See Appendix A for meeting summaries by date and links to meeting presentations and recordings. See Appendix B for meeting agendas. Specific details from stakeholder meetings are discussed in Sections 2 and 4, where applicable.

3.2.1 Tribal Forum

Staff held a meeting with Michigan Tribes to share MI Power Grid New Technologies and Business Models Workgroup goals and tasks. Lizana Pierce (U.S. Department of Energy Office of Indian Energy) provided an overview the Office of Indian Energy, its offerings, and experience. For energy development on Tribal lands, the most significant barriers are financing, funding, infrastructure, and leadership or staff knowledge. The Office of Indian Energy seeks to address some of these barriers by providing financial and technical assistance, as well as education and capacity building, to help Tribes achieve their energy vision (Dennis, 2021; Pierce, 2021).

Afterward, Commissioner Peretick and Staff shared results of the survey of Michigan Tribes and moderated a discussion of Tribal experiences and needs with energy technologies and business models. See Section 3.2.4 for information on the survey and Appendix C for the meeting agenda.

3.2 Stakeholder Surveys

3.2.1 Initial Stakeholder Survey on Workgroup Timing & Content

An initial survey was sent to stakeholders via the listserv on August 21, 2020, to solicit input regarding the timing and content of the workgroup. A total of 53 responses were collected before the survey closed on September 8, 2020. Stakeholders were most interested in the following technologies, in decreasing order of interest.

- Energy storage
- Demand response technologies
- Community solar energy
- Electric vehicles
- Energy efficiency advancements
- Heat pumps for space and water heating/cooling
- Microgrids
- Combined heat and power

Stakeholders also recommended additional technology and business model topics for the workgroup and business models of interest. Respondents indicated strong support for an October Commission order establishing the workgroup (93.2%; 41 respondents). The majority desired an October – December 2020 kickoff of the workgroup series (73.9%; 34 respondents), with 19.6% preferring a kickoff in January 2021 and only 6.5% preferring a kickoff in February or later. See

Appendix D for all collected stakeholder responses. Please see Appendix D for the pre-workgroup stakeholder survey and Appendix E for the summary of survey responses.

3.2.2 Stakeholder Recommendations for Speakers & Resources

After the Commission order on October 29, 2020, establishing the New Technologies and Business Models workgroup, Staff sent a survey to stakeholders via the listserv on December 7, 2020, to request any resources, projects, case-studies, and comments or recommendations regarding:

- Behind the meter & community solar
- Combined heat and power
- Electric vehicles
- Microgrids
- Space & water heating using heat pumps
- Storage
- Alternative business and ownership models
- General new technologies and business model topics

Fourteen survey responses provided recommendations regarding resources, speakers, projects, and more. Please see Appendices F and G for the stakeholder recommendation survey and summary of recommendations regarding resources, projects, and case studies, respectively.

3.2.3 Behind the Meter and Community Solar Survey

A behind the meter and community solar survey was sent out to stakeholders via the listserv on February 19, 2021. It was intended to gather information to guide the panel discussions during the March 10, 2021, stakeholder meeting. A total of 34 responses were received.

3.2.3-1 Behind the Meter Solar

Respondents found the top three most effective behind the meter solar processes in Michigan were: Interconnecting with distribution utility, ability to finance project, and access to customer usage data. One respondent pointed out that thousands of behind the meter solar projects have been connected in Michigan which indicates successful processes. However, some respondents said that all behind the meter solar processes are difficult and several commented that off-grid solar and battery combinations were attractive options. Other responses mentioned that the distributed generation program size (also referred to as "cap") should be increased and the restriction on charging customer batteries with grid electricity should be eliminated.

In response to the question asking about utility and regulatory challenges that may impact the development of behind the meter solar projects, the top answers were that the excess generation purchase price does not accurately reflect costs and benefits, difficulty calculating the impact of utility standby rate tariffs, lack of utility program options, lack of hosting capacity data, no publicly available solar project market cost data, and difficulties accessing customer usage data.

Eighteen respondents provided additional information about behind the meter solar development challenges. Many of the responses echoed information provided in response to the previous questions however some new concerns appeared: distributed generation (including solar, smart inverters, and storage) compensation rates do not reflect its true benefits, difficulties with developing projects larger than 150 kW (outside of the distributed generation program parameters), and regulatory restrictions on crossing parcel lines with solar.

Respondents were asked for descriptions of behind the meter solar business/regulatory models they would like to see in Michigan. Multiple respondents suggested that a value of solar and solar plus storage compensation rate should be developed. Other responses mentioned the pros and cons of utility involvement/ownership of behind the meter solar and storage, removal of distributed generation program size limits and allowing projects larger than 150 kW to participate, fair and simple standby rates, distributed energy resource (DER) aggregation, and virtual net metering for multi-occupant buildings.

Twenty-seven respondents replied to the questions asking about the advantages and disadvantages of regulated utilities owning customer behind the meter solar projects. More than half of the responses indicated that advantages of utility ownership include:

- Utilities understand utility rates and could more accurately model customer bill impacts,
- Lower costs to participating customers due to utility purchasing power,
- Better operation and maintenance, safety, reliability, and consumer protections, and
- Potential to provide solar and storage to low-income customers.

The remaining responses were unequivocal that utilities should not own behind the meter solar projects. Concerns about unfair competition with third-party solar companies include the utility's ability to leverage cheaper financing, unfair access to customers and customer data, and lack of innovation. Several responses indicated that utility ownership pilots could be an opportunity to further examine the benefits and drawbacks of utility ownership. Multiple respondents said the ability of private market competition to achieve lower prices and better innovation should not be compromised by the entrance of regulated utilities.

When asked if there was anything else about behind the meter solar that was not captured in the survey questions, twelve respondents provided information which is summarized below:

- Innovative tariffs that are simple to understand and fairly compensate customers for solar and storage,
- Ongoing analysis of on-site DERs impacts/benefits and continued enhancements of utility tariffs,
- Recover a significant portion of distribution system costs during peak times since it must be sized to meet peak loads,
- Consider economic development aspect of regulations that encourage behind the meter solar development,
- Rate forecasting and/or modeling tools from MPSC and utilities to enable customer bill impact calculations,

- Whether current statutes and regulations allow utilities to own behind the meter generation, and
- Develop a buy all-sell all rate that allows solar projects to be sized to fit the available installation area instead of being limited to a customer's usage,

3.2.3-2 Community Solar

In response to the question regarding community solar business models that should be offered by rate regulated utilities 26 respondents suggested that small-scale non-utility owned, located in the subscriber's community should be offered. Ten respondents offered other suggestions with many mentioning on-bill financing as an option and community solar for resiliency centers such as schools and churches.

Respondents were asked how a low-income community solar program should be funded. Most responses suggested that both voluntary donations and grants should be used, with a slight edge towards grants. Sixteen additional responses provided other options for funding which included ratepayer funded, and taxpayer funded. Several responses indicated that a state program should be made that allows for this type of program to be funded.

When asked if on-bill crediting was necessary, 60% of respondents said it was necessary for community solar to flourish.

Fifteen respondents offered consumer protection issues to be considered. The issues that were of concern centered around:

- Transparency in the billing and crediting methodologies,
- Allowing for customers to be in shorter contracts, and
- Price fluctuations based on performance of the solar.

Several respondents mention that if a utility operated the program, these consumer protection concerns are resolved, as there are already many consumer protections put in place though regulation of the investor owned utilities.

When asked about the barriers to community solar, many respondents identified legislative, regulatory, utility coordination, and cost barriers. Several respondents also identified interest and demand, project siting, customer education, and small credits as barriers.

When asked if there was anything else about community solar that was not captured in the survey questions, nine respondents provided information which is briefly summarized below:

- Consider more locally owned community solar as this allows pride of ownership with customers as well as the benefits of locally cited solar,
- More considerations about the impacts of storage and EVs should be included in future community solar programs, and
- Partnering with communities that have climate goals may help enable more buy-in from customers that may want to aid in the community's goal.

3.2.4 Survey of Michigan Tribes

A survey to Michigan Tribes was distributed on January 29, 2021, to better understand the needs and experiences of Tribes with new technologies and business models. A total of six responses were received from five Tribes. These Tribes were: Bay Mills Indian Community, Little Traverse Bay Bands of Odawa Indians, Pokagon Band of Potawatomi, Saginaw Chippewa Indian Tribe, and Sault Tribe of Chippewa Indians.

Four Tribes acknowledged experience with behind the meter and community solar, electric vehicles and charging infrastructure, microgrids, and heat pumps for space or water heating. Experience with geothermal and building a new substation interconnected with transmission were also acknowledged. While implementing energy technologies, 60% (3 out of 5 respondents) acknowledged that barriers to implementation and operation were experienced. Specific barriers included: project funding or capital, internal knowledge capacity, and information from the energy provider. Only 33% (2 respondents) pursued new business models when implementing energy technologies.

In terms of future energy projects, there is broad interest in all six energy technologies examined in the workgroup, as well as additional projects (bioreactor/biomass power generation and wind turbine). Technologies grouped by interest are listed below by interest expressed by respondents:

- 67% or 4 respondents
  - Community solar
  - Electric vehicles and charging infrastructure
  - Energy storage/batteries
- 50% or 3 respondents
  - Behind the meter solar
  - Microgrids
- 33% or 2 respondents
  - CHP
- 17% or 1 respondent
  - Space and water heating using heat pumps

Common barriers faced in implementing projects of interest include cost (83% or 5), utility cooperation and project siting (50% or 3), technology and regulatory barriers (33% or 2). Raising capital was also noted as a barrier. See Appendix K for additional survey responses.

3.2.5 After-Meeting Surveys

Surveys regarding stakeholder experiences and opinions regarding each stakeholder meeting were conducted. Response rates were relatively low, ranging from one response (where one out of three attendees of the Tribal Forum responded) to a maximum of 10 survey responses received for a particular meeting. Generally, most stakeholders who responded found the meetings to be very good or excellent. Though most found the length satisfactory, many stakeholders commented on the length of the meetings suggesting shorter meetings or longer breaks. Majority of respondents were likely or very likely to attend future meetings and to review the final staff report. See Appendix M for the responses to after meeting surveys.

4. Behind-the-Meter Solar and Community Solar

Solar technologies convert sunlight into electrical energy through the use of solar photovoltaic (PV) cells or through mirrors that concentrate solar radiation (U.S. Office of Energy Efficiency and Renewable Energy, nd-b). PV cells are connected together to form PV panels and arrays, that, when paired with mounting structures, inverters that convert direct current (DC) electricity to alternating current (AC) electricity, and often batteries for storage, form a complete photovoltaic system (U.S. Office of Energy Efficiency and Renewable Energy, nd-b). This report focuses on the application of solar generation as a form of distributed generation (DG) located on the distribution system (Cory, 2020). This report refers to solar PV projects as "solar" projects, community solar PV as "community solar," and behind the meter (BTM) solar PV as "BTM solar"

There has been steady growth in solar projects and customers each year in Michigan, reaching [update for final report after 2020 DG report is issued] customers and [update for final report after 2020 DG report is issued] MW by the end of 2020. Tremendous progress has been made is the interconnection process for projects less than 150 kW. Michigan is in the early stages of BTM solar deployment, which makes understanding the barriers and solutions facing solar PV development important in the MI Power Grid initiative to maximize the benefits of the transition to clean, DERs (Baldwin, 2021). By 2050, rooftop PV systems primarily on residential and commercial buildings, along with industrial and some commercial combined heat and power systems are projected to be more than 7% of total electricity generation. This is nearly doubled onsite power generators in 2020 (U.S. Energy Information Administration, 2021a).

New business models for solar projects should be proactive, not just reactive to potential problems from higher solar market penetration, but help anticipate, mitigate, or avoid potential problems altogether. Solar energy's value to offset generation, capacity, and transmission and distribution investment outweigh those from its potential ancillary services on the distribution grid (Frantzis, Graham, Katofsky, & Sawyer, 2008).

4.1 Behind the Meter Solar

4.1.1 Behind the Meter Solar PV Background

BTM solar projects are installed on a customer's premises and are designed to enable the customer to use the solar generated electricity on-site and reduce utility purchases. Because the electricity produced by these on-site projects does not pass through the electric utility's meter before it is consumed, it is referred to as "behind" rather than in "front" of the meter (California Senate Office of Research, 2021). BTM solar projects typically generate less than full load for a particular customer (Cory, 2020) and may or may not be configured to export excess generation to the utility distribution system.

Annual Midwest residential solar projects are projected to increase yearly through 2025. Growth in utility-scale solar is expected to decrease near 2025 (Gagne, 2021a). Sharp decreases in BTM solar cost per kW-DC generated is expected through 2030 before more moderate cost declines are expected through 2050 for both residential and commercial cost applications (Gagne, 2021a).

New advances in solar technologies may increase future applications of BTM solar. A University of Michigan led research team achieved 8.1% efficiency and 43.3% transparency with organic PV cells (Y. Li et al., 2020), setting a new efficiency record for color neutral, transparent solar cells (University of Michigan, 2020). The solar cells absorb near infrared light, a significant portion of the energy in sunlight, and is transparent in the visible range. The transparent solar cells can be placed between panes of double glazed windows. In the future, the use of such technologies may allow windows to generate electricity (University of Michigan, 2020). If used ubiquitously, BTM solar generation may occur in every building with windows.

4.1.2 Behind the Meter Solar Discussion

Several areas presenting hurdles to the development of behind the meter (BTM) solar projects were discussed. These areas are:

- BTM solar benefits are not fully recognized,
- BTM solar utility business models are underutilized by Michigan utilities,
- Barriers limit non-utility business models for BTM solar,
- Energy justice issues from skewed adoption may be exacerbated without changes,
- Distributed generation program and inflow/outflow makes modeling solar benefits difficult,
- Holistic cross-sector approaches may support future opportunities, and
- Leverage synergies with other energy technologies.

Each of these areas presenting hurdles to BTM solar will be discussed in the following sections.

4.1.2-1 BTM Solar Benefits are Not Fully Recognized

BTM solar currently provides benefits to the grid. ISO New England found the recorded peak on July 30 would have been almost 1,000 MW higher without the region's behind-the-meter PV (Heart, 2021).

Behind the meter technologies, like BTM solar, can help provide revenue streams and savings while grid connected. However, in the event of a grid outage, such technologies can also help increase resiliency and survival time when connected to a microgrid (Gagne, 2021a). However, resiliency benefits are not currently considered in regulatory processes.

Resiliency is not the only benefit provided by behind the meter solar that is not currently considered in regulatory processes. A meta-analysis of value-of-solar studies examined the utility system and societal impacts for distributed solar energy across fifteen studies. A total of 18 value categories were considered in two or more studies. See Table 2 for a summary. (Fine et al., 2018). Not all identified BTM solar benefits are considered in current regulatory processes.

Table 2: Summary of Value Categories found in Meta-Analysis of Value of Solar Studies ((Fine et al., 2018)

	Value Category	Benefit (+) or Cost (-)	Number of Studies Addressing this Category
Utility System Impacts			
G	Avoided Energy Generation	+	15
	Avoided Generation Capacity	+	15
	Avoided Environmental Compliance	+	10
	Fuel Hedging	+	9
	Market Price Response	+	6
	Ancillary Services	+/-	8
T	Avoided Transmission Capacity	+	15
	Avoided Line Losses	+	11
D	Avoided Distribution Capacity	+	14
	Avoided Resiliency & Reliability	+	5
	Distribution O&M	+/-	4
	Distribution Voltage and Power Quality	+/-	6
C	Integration Costs	-	13
	Lost Utility Revenues	-	7
	Program and Administrative Costs	-	7
Societal Impacts			
S	Avoided Cost of Carbon	+	8
	Other Avoided Environmental Costs	+	9
	Local Economic Benefit	+	3

There are resources to help quantify the benefits from DERs. For instance, REopt Lite is a free web tool to help determine economic and resilience benefits of DERs (Gagne, 2021a). However, the overall value provided by solar depends on the costs and benefits that are included and monetized. It also depends on how value categories are defined and quantified, perspective from which value is assessed (utility business perspective, ratepayer consumer perspective, grid operator technical perspective), and input assumptions (Fine et al., 2018).

4.2.1-2 BTM Solar Utility Business Models are Underutilized by Michigan Utilities

Michigan utility involvement in BTM solar has been limited to managing the interconnection process and billing apart from a Consumers Energy Solar Distributed Generation Pilot program in 2015.[2] The pilot was like the utility BTM facilitator model described below and concluded without becoming a permanent utility program.

Three utility-led BTM solar business models were presented in the workgroup stakeholder meeting: rooftop leasing, BTM facilitator model, and utility-led community solar (Gagne 2021). Some utilities in other states have developed a rooftop leasing business model where they own and operate BTM systems on customer rooftops. The benefits of this business model are that the utility can rate-base the assets, strategically locate PV for transmission and distribution upgrade deferral and local voltage support, and the resulting increased diversity that comes from more

[2] See MPSC e-docket U-17875 https://mi-psc.force.com/s/filing/a00t0000005pd10AAA/u178750020

distributed solar. However, BTM solar is generally more expensive than utility-scale solar, requires upfront capital investment, the utility faces competition from third-party solar developers, and the regulatory structure may limit progress (Gagne, 2021a).

The facilitation business model is where the utility creates a platform to connect distributed generation market participants. A utility taking on the facilitation role could serve as a consumer advocate by using their knowledge of the solar and energy industry on behalf of the customer who is typically less knowledgeable, aggregate customer interest and manage competitive procurement, potentially finance on behalf of customers, and offer both individual and community PV systems. The utility can monetize this facilitation business model through performance-based ratemaking. The ability for utilities to control and shift loads to when solar is producing could also attract further investment into funding larger scale projects (Gagne, 2021a). Utility-led community solar is discussed in the Community Solar section of this report.

4.1.2-3 Barriers Limit Non-Utility Business Models for BTM Solar

The most prevalent BTM solar business model in Michigan is a customer-owned solar project purchased from a solar installation company. This is consistent with general solar trends, where the most widespread PV business model is where the owner of the building where the PV system is located is the main energy user. This includes customer owned and customer sited solar (Horváth & Szabó, 2018).

Third-party owned solar is another BTM business model, which first emerged in the U.S. in 2005. In this model, a third-party offers Power Purchase Agreements (PPAs) or lease construction (Horváth & Szabó, 2018). In the lease model, a customer signs a contract with an installer/developer and pays for the use of a solar system over a specified period, rather than paying for the power generated. In the PPA model, the solar energy system offsets the customer's electric utility bill, and the developer sells the power generated to the customer at a fixed rate.[3] Anecdotally, Staff believes these business models are not common in Michigan. There is uncertainty about the legality of a BTM power purchase agreement under Michigan's regulatory structure. Authorization of third-party power purchase agreements for BTM solar is a factor in the regulatory landscape (Gagne 2021).

The expansion of power purchase agreements and changes to municipal, state, or federal level policies that provide mandates or frameworks for non-utility business models will likely impact BTM solar growth in Michigan (Gagne, 2021a). Likewise, cost declines in solar technologies and the growth of Michigan's solar industry will also impact growth of BTM solar in the state.

4.1.2-4 Energy Justice Issues from Skewed Adoption May Be Exacerbated without Changes

Though PV is increasingly affordable and financially beneficial for low- to moderate- income (LMI) households, high-income households remain more likely to adopt rooftop solar PV. Income-skewed PV adoption is an emerging energy justice issue. Not only may LMI household electricity

[3] See EPA Understanding Third-Party Ownership Financing Structures for Renewable Energy https://www.epa.gov/repowertoolbox/understanding-third-party-ownership-financing-structures-renewable-energy

bills increase under typical rate structures due to income-skewed deployment, inequitable PV adoption may also decelerate rooftop PV deployment. However, policy and business model interventions can increase PV adoption equity (O'Shaughnessy, Barbose, Wiser, Forrester, & Darghouth, 2021).

Five approaches can help increase LMI rooftop solar PV adoption. First, an incentive to lower adoption cost can be provided. Most states and local jurisdictions offer rebates or ongoing production based incentives, but these program offerings have declined recently. Second, LMI specific incentives can be provided to households under certain income thresholds. These incentives are usually small and about 1% of all distributed incentives. However, with LMI incentives, more incentives were provided to underserved than conventional markets, creating a shift that fully offset historic deployment patterns. Third, adopting households can lease, rather than buy the rooftop solar installation. This significantly reduces upfront adoption costs that impede most LMI households, but this approach is not offered by most solar installers. Fourth, Property Assessed Clean Energy Financing (PACE) allows homeowners to finance rooftop solar through property tax payments. PACE is more accessible to LMI customers than other loans due to more lenient qualification criteria and has little to no upfront cost (O'Shaughnessy et al., 2021).

Lastly, the Solarize business model is a community initiative that recruits a coalition of prospective rooftop solar adopters and negotiates bulk purchase from one or more installers. These campaigns can realize 20-30% discounts and may help overcome informational barriers associated with LMI adoption (O'Shaughnessy et al., 2021). The Solarize model, which has been used in Michigan, tackles three major market barriers: cost, complexity, and customer inertia (Irvine, Sawyer, & Grove, 2012). Ann Arbor Solarize program is a community bulk-buy solar program. The City gathers households, along with participating solar installers, to learn about residential solar, gets questions answered, and provides the option to come together to bulk purchase solar, allowing for significant savings (City of Ann Arbor, 2021). Solarize programs like Solarize Massachusetts, which aggregates homeowner buying power to lower installation prices for participants through a competitive solicitation process (Massachusetts Clean Energy Center, nd), may be a substitute for the utility facilitation business model (Gagne, 2021a).

There is evidence that solar adoption equity increases with LMI incentives, leasing, and PACE financing and helps shift deployment into underserved markets with lower income levels. These interventions may also serve as an indirect catalyst of LMI adoption in underserved areas through peer effects absent policy or business model interventions, historical patterns of high-income adoption of rooftop solar PV will continue (O'Shaughnessy et al., 2021).

4.1.2-5 Distributed Generation Program and Inflow/Outflow Makes Modeling Solar Benefits Difficult

Public Acts 341 and 342 of 2016 required the MPSC to phase out the net metering program and create a new distributed generation program to replace the net metering program. To do this, the MPSC Staff conducted a study on equitable cost of service for customers participating in the distributed generation program. The Commission next approved an inflow/outflow billing mechanism, where inflows represent the kWh delivered to the customer by the utility and outflows represent the kWh generated by the customer's generator and not used on site (MPSC, 2018).

The inflow/outflow billing mechanism complicates modeling the customer bill impacts of solar projects. The difficulty lies in estimating how much solar generation will be used behind the meter, resulting in a full retail rate offset, and how much of the solar generation will be exported to the grid as outflow, resulting in the distributed generation program outflow credit based on the power supply portion of the full retail rate.

There is a need for clear customer billing to identify on-site generation opportunities and savings from BTM solar projects. The regulatory agency, solar installer, and customer cannot easily model what customer bill savings will be with the inflow/outflow billing mechanism. Some stakeholders recommend incorporating daily, weekly, or monthly netting into utility billing mechanisms for the distributed generation program (Freeman, Heart, Toepfer, Wiste, & Zebarah, 2021).

The inability to predict solar project bill impacts may also present equity concerns. Lower income customers need more bill reduction certainty to justify a solar project. Without a way clear and effective way to model solar project impacts on utility bills, low-income customers may be driven away from implementing solar projects more so than other income brackets. The current inflow/outflow billing mechanism has made solar less affordable and that has resulted in only 60% of the solar in MI being owned by customers making $100,000 or less per year. Thus, a billing mechanism that regulators and solar installers can readily model will increase customer knowledge and support equity of BTM solar implementation (Freeman et al., 2021).

Lastly, the distributed generation program's cap on program size is also a barrier. Currently, a utility is only required to offer the distributed generation program until the program reaches 1% of its in-state peak load averaged over the past five years. Two utilities, Consumers Energy and Upper Peninsula Power Company, reached their minimum program size requirements. After their programs were closed, they voluntarily increased their program size (MPSC, 2019). Upper Peninsula Power Company voluntarily increased its program size a second time as part of a settlement agreement approved on May 26, 2021, in case No. U-20995. Given a cost based tariff like Michigan's inflow/outflow tariff billing mechanism, some believe the program size cap is no longer necessary. In addition, if utility programs reach full capacity, there are concerns that the solar industry will be impacted negatively and workers laid off (Freeman et al., 2021).

4.2.1-6 Holistic Cross-Sector Approaches May Support Future Opportunities

Factors that impact the development of BTM solar which are outside of the business model were also discussed by stakeholders. During a panel discussion on BTM solar, panelists noted that it would be beneficial for builders to plan for rooftop solar in new construction. There could be incentives provided by the legislature or even a mandate for new construction to incorporate rooftop solar as seen in other states (Freeman et al., 2021).

For instance, the State of California was the first in the nation to require all new single-family homes and multi-family buildings up to three stories must have solar panels. Exemptions are made for buildings that are often shaded. The rules were adopted in 2018 by the Building Standards Commission by unanimous vote and came into effect in 2020. At the time of its passage, the standard was expected to add an additional $10,000 to the cost of the home, while providing $19,000 of savings over a 30 year mortgage. In addition, incentives were provided for adding high-capacity batteries to homes to help store the generated solar energy. The new standards were expected to help buildings reduce costs, better withstanding impacts of climate change such as power outages caused by wildfires and reduce greenhouse gas (GHG) emissions. Strong support from environmental groups, utilities, and solar companies was received (Chappell, 2018).

Significant support and interest in solar energy further strengthens the need for holistic cross-sector approaches to support future solar opportunities. A 2019 poll found 70% of respondents supported a version of California's rooftop solar policy being mandated nationally (Anzilotti, 2019). A 2016 Pew Research Center survey found 89% of U.S. adults across the partisan divide support expansion of solar power. An average of 40% of all U.S. homeowners have given serious thought to installing solar panels at home. Another 4% of homeowners had already installed them. In the Midwest in 2016, 42% of homeowners were interested in installing solar panels on their homes, with less than 1% with them already installed (Brian Kennedy, 2016). By 2019, 46% of U.S. homeowners were seriously interested in installing solar panels at home and 6% had already installed them. In the Midwest, the percentage of homeowners interested in installing solar panels remained the same as 2016, but the percentage of homeowners with solar increased to 2% (Brian Kennedy & Thigpen, 2019). In 2019, homeowners were interested in reducing utility bills (96%), helping the environment (87%), receiving the solar investment tax credit (67%), and supporting their own or their family's health (60%). Given strong interest from homeowners in solar technologies, consideration of cross-sector approaches that allow holistic support of solar technologies may be warranted.

4.1.2-7 Leverage Synergies with Other Energy Technologies

The potential expansion of behind the meter solar projects largely is dependent on the impact of emerging technologies and new policy frameworks. The increased electric loads from uptake of technologies like air-to-air heat pumps and EVs can increase electricity use, making behind the meter solar projects more appealing to customers looking to offset higher electric bills. U.S. emissions can decrease 70-80% by 2035 if existing technologies are deployed at scale, including rooftop solar, batteries, EV, wind and solar, and heat pumps. To build a more resilient grid, dynamic DERs must be better integrated in the grid via market mechanisms (Heart, 2021).

Pairing BTM solar with energy storage can add new value streams to both the utility and customer. A battery storage system offers the utility, with a customer agreement, an effective demand response tool by lowering load at peak hours and helping defer transmission and distribution upgrades with these projects reducing the new for higher load carrying infrastructure. Customers are offered greater resiliency and backup power in the case of grid failure and reduce the utility's demand charge (Gagne, 2021a). Market-driven local solar and storage bring savings to all customers. A recent model developed by Vibrant Energy supports potential cost reductions of $473 billion (Freeman et al., 2021; Heart, 2021).

Regulatory issues, such as tariff structure, can impact the economic attractiveness of different energy projects incorporating solar. For instance, tariff structures affect the internal rate of return on behind the meter solar microgrid projects and should be considered when analyzing which customers to target for these projects. Due to solar prices dropping 6.6% per year and battery prices dropping 8.1% per year, later projects may see increased internal rate of returns due to the lower prices, with substantial IRR increases for midsized commercial class customers compared to residential time of use tariff customers (D. J. Wright et al., 2021).

Virtual power plants, which aggregate decentralized energy sources like solar PV, provide opportunities for solar and storage aggregations. Virtual power plants are being used in a project called the Oakland Power Plant, where Sunrun is installing rooftop solar/battery systems on more than 500 low-income housing units. From the project, community residents will gain bill savings, resilience, and lower pollution (Heart, 2021).

Spotlight: Sunrun California Solar-Storage Project

Three counties in Northern California have developed a plan to deploy thousands of solar-battery systems to combat grid resilience issues due to the threat of blackouts caused by wildfires. The counties have contracts with Sunrun to install up to 20 MWs of solar-battery systems for 6,000 homes. Incentives, like $1,000 discounts to customers on buying Sunrun's Brightbox battery-solar systems, will be paid for through the grid services like helping offset peak demand. Sunrun will provide 5 MW of capacity which will also help the local utility meet resource adequacy requirements set by the California Public Utilities Commission. Sunrun is tapping state programs to offer incentives for low-income multifamily housing, to reduce costs for low- and moderate-income customers. This project will be Sunrun's largest aggregation to date and will test if such systems can be a larger part of California's long-term resiliency goals (St. John, 2020).

Sunrun works with electric providers and independent system operators to provide grid services from single BTM solar projects and by aggregating multiple BTM solar projects together. This is being done by responding to time of use and peak pricing tariffs and using Bring Your Own Device (BYOD) programs. There is a BYOD model where the utility identifies the grid need, competitive companies finance, manage and assume all risk, and the participating customer receives backup power. In ISO New England, Sunrun has an aggregated solar and battery program that participates in the capacity market and at the retail level. This is the heart of FERC Order 2222 opportunities. MISO and PJM do not yet have these pathways, but as more solar and storage systems are deployed, opportunities will likely become available (Heart, 2021).

4.1.2-8 Summary Table of BTM Solar Barriers and Solutions

The table that follows summarizes the barriers/hurdles and solutions pertaining to BTM solar. This table collects all barriers and solutions mentioned in workgroup stakeholder meetings and discussions, which go beyond the regulatory realm. However, the table may not be comprehensive, as it only reflects the learnings and discussions in this workgroup. Inclusion of barriers, hurdles, and solutions in the tables does not imply endorsement by Staff.

Table 3. Behind the Meter Solar Identified Barrier/Hurdles and Possible Solutions

Identified Barriers/Hurdles	Possible Solutions
1. Distributed generation cap limits investment.	• Eliminate the distributed generation cap to provide market certainty through legislation.
2. Inflow/outflow billing mechanism complicates calculating future customer bill impacts due to uncertainty and causes inaccurate estimates.	• Figure out how to model inflow/outflow billing mechanism through additional research. • Learn more about DTE's Rider 18 customer bill impact model. • Incorporate daily, weekly, or monthly netting back into the distributed generation program billing mechanism to enable more accurate estimates of future customer bill impacts from installing a solar project. This may require a legislative or a ballot initiative solution.
3. Project size is limited by the distributed generation program.	• Remove project size limits for the distributed generation program through legislation. A standby charge may be required for larger projects.
4. Investor-owned utility business model discourages utility support of customer or third-party owned behind the meter solar.	• Develop business models that benefit the utilities, solar industry, and customers.
5. Unfair market impacts might occur if utilities are allowed to sell or own customer sited-solar located behind the meter.	• Find a business model that benefits the utilities, solar industry, and customers. • Possibly allow utility to own BTM for LMI customers. • Shared savings approaches • Performance mechanisms
6. Third-party leasing is not happening in Michigan.	• This model may be on the decline and may still reduce net present value to the customer. • Easier to execute with C&I customers.
7. Homeownership impacts BTM solar capability.	• Investigate the appropriateness of setting the community solar subscriber credit equal to the distributed generation program credit based on equity between customers who can install rooftop solar and those who cannot. • Develop a formal tariff to enable the anchor-tenant community solar model. This model allows the anchor tenant to offer fully or partially subsidized subscriptions to low-income customers. • Find ways to do BTM solar at rental homes and communities.
8. Houses are not oriented with south facing roofs.	• Encourage builders to design homes with south-facing roof orientations. This may need a legislative action.
9. Integration with electric vehicles is limited.	• Examine systems such as solar plus EV charging/home backup, such as the F150 Lightning model.

4.2 Community Solar

4.2.1 Community Solar Background

U.S. community solar projects were first completed in 2006. Consumers could access solar energy without installing PV systems individually by subscribing to PV systems in solar parks or gardens. The community solar model provided a cost-effective alternative for subscribers to access renewable energy through virtual net-metering.

In Michigan, there is currently no legislatively or Commission adopted definition of community solar. The U.S. Department of Energy defines community solar as "any solar project or purchasing program, within a geographic area, in which the benefits of a solar project flow to multiple customers such as individuals, businesses, non-profits, and other groups" (nd-c). It has also been defined as "shared solar", where the electricity generated by a jointly owned or third-party-owned system is used to offset multiple households or businesses' consumption (Feldman, Brockway, Ulrich, & Margolis, 2015). Community solar is usually facilitated by legislation or virtual net metering regulations (Gagne, 2021a). Alternative business models may also support growth of community solar deployment. Feldman et al notes (2015):

> *Emerging business models for solar deployment…such as offsite shared solar and arrays on multi-unit buildings can enable rapid, widespread market growth by increasing access to renewables on readily available sites, potentially lowering costs via economies of scale, pooling customer demand, and fostering business model and technical innovations. Fundamentally, these models remove the need for a spatial one-to-one mapping between distributed solar arrays and the energy consumers who receive their electricity or monetary benefits. The output of shared solar arrays can be divided among residential and commercial energy consumers lacking the necessary unshaded roof space to host a PV system of sufficient size, or divided among customers seeking more freedom, flexibility, and a potentially lower price.*

An estimated 49% of households are unable to host solar photovoltaic (PV) systems due to lack of home ownership, access to sufficient roof space, or suitable roof space. An estimated 48% of businesses are also unable to host a PV system due to lack of access to or existence of sufficient roof space for a PV system supplying enough of their energy needs (Feldman et al., 2015).

Multiple subscribers receive the energy output of a single community solar installation (Wochos, 2021), which many times is located away from the site of electricity consumption (U.S. Department of Energy, nd-c). Community solar participants often receive an electricity bill credit for their share of the electricity produced by the community solar installation (U.S. Department of Energy, nd-c). Community solar projects can be owned by the utility company, non-profits, third parties or even building owners. Project ownership can be related to the organization of subscribers, but this is not always the case (Heeter, 2021).

The average net present value (NPV) of projects developed in 2019 was $0.36/Watt. For projects developed in the beginning of 2020, the average NPV was $0.43/Watt. This is driven by project size, market maturity, and averaging. Project size is also increasing. In 2015, the median project size was 218 MW-AC. In the first half of 2020, the median project size was 2,018 MW-AC. Some states have a size limitation or cap on community solar projects which they consider as a DER so it must fit in the DER framework (Heeter).

Community solar projects are typically 2-5 megawatts (MW) in size and are connected to the distribution system (Wochos, 2021). Michigan is 22nd in the country for community solar deployment and has around 7 MW-AC installed as of mid-2020. The projects are small in size, usually under 2 MW (Heeter, 2021). In July 2020, there was an estimated 2,600 MW-AC of community solar capacity in 39 states and Washington D.C., spread across more than 1,200 projects (Heeter, 2021). This is far below the projected 5.5-11 GW of potential community solar in 2020 estimated by Feldman et al in 2015. As the authors noted, that potential was dependent on "states and utilities adopting enabling legislation and practices that support shared solar program" (Feldman et al., 2015). This highlights the importance of supporting legislation, regulations, utility programs, and business models to achieve the full potential of technologies like community solar.

4.2.2 Community Solar Discussion

For successful community solar programs, community involvement from the start about where to locate the solar in the community, how the project will work, and how the benefits are distributed are key issues to address (Brader, Fisher, Kinch, La Fave, & McDonnell, 2021). In the stakeholder process, several areas presenting hurdles to the development of community solar projects were discussed. These areas are:

- Community solar benefits are not fully recognized,
- Clear program structure and participation rules required,
- Clear bill credits process required,
- Utility coordination and clear interconnection process needed,
- Low- and moderate-income participation needs to be accessible,
- On-bill financing and funding support low to moderate income participation, and
- Regulatory and legislative barriers challenge community solar development.

These hurdles to community solar development will be discussed in the following sections.

4.2.2.-1 Community Solar Benefits Not Fully Recognized

The benefits of community solar projects are not fully recognized. In addition to providing renewable clean energy, community solar projects can provide other environmental benefits, local economy and workforce benefits, grid benefits, and improved reliability and resiliency (Koeppel & Gorjala, 2021).

Community solar projects, outside of producing clean renewable energy, also provide additional environmental benefits. By allowing the soil to sit fallow, the community solar project may help increase soil productivity, especially for temporary installation. By maintaining existing draining, reducing impervious areas, and planting with a native seed mix, such projects may also help decrease run off while also increasing ground water recharge. Additional pollinator habitat is provided through the native plantings, which also have deeper root systems to combat erosion. Since no pesticides and fertilizers are used, these streams of possible environmental pollutants are also reduced, which help improve public health and general welfare (Wochos, 2021).

Community solar development on brownfield sites can provide further environmental benefits. Brownfield sites can be good for community solar projects (Brader et al., 2021). Redevelopment of brownfields into community solar projects help environmentally remediate the site while also provide the other benefits of community solar. Grid connectivity at urban brownfield sites can help reduce interconnection costs. Since solar development on brown fields are usually more expensive than on "greenfields," programs and incentives can be designed to support the conversion of brownfield sites into solar developments (Schaap, Dodinval, Husak, & Sertic, 2019).

Community solar projects can generate local economic and workforce benefits. During construction phase, there can be the equivalent of 20-30 full time workers in the area that will temporarily live in the area and contribute to local spending. Many project materials, such as concrete, gravel, steel, and seed, and services can be locally sourced (Wochos, 2021). In addition to the economic benefits, community solar projects can be designed to support local workforce development and community engagement (Heeter, 2021). In the stakeholder series, there was a strong desire to increase benefits to the community through the implementation of community solar projects. Koeppel and Gorjala recommended community solar developers utilize the partnership flip model, local partnerships, and other programs to build community wealth (2021).

Through strategic siting, community solar projects can provide grid services (Heeter, 2021). Interconnection upgrades may result in improved reliability for area (Wochos, 2021). Resiliency may also be improved when solar is paired with storage to allow it to sustain critical loads during grid outages (Gagne, 2021a). The value of grid benefits provided by community solar should be considered when determining the community solar subscription credit (Brader et al., 2021).

4.2.2-1 Clear Program Structure and Participation Rules Required

There is a need for a clear program structure for community solar in Michigan. Currently, there is no legislative or regulatory definitions for community solar in Michigan. Similarly, a lack of guidance on what constitutes a community solar program, a subscriber, and eligible program administrators can also serve as barriers to community solar (Wochos, 2021). Legislation defining the rights of communities in implementing their own energy choice may also help address the current lack of clarity a community solar framework in Michigan (Koeppel & Gorjala, 2021).

Greater clarity on what constitutes a community solar facility is needed. Additional details, such as how big a community solar facility can be, where it can be located, and where it cannot be located are all important to clarify in a community solar framework (Wochos, 2021).

Details regarding community solar participation rules also help address barriers to community solar development. How individuals can subscribe or register for community solar programs, how access to utility bill credits are ensured, and how the community solar facilities interact with utilities are all important issues to address (Wochos, 2021).

In terms of how individual may participate in community solar projects, there are several different subscription structures that have been pursued. These are detailed in Table 4 below. The most common subscription payment structure is the upfront payment, followed by monthly payment, and hybrid contract (Heeter, 2021).

Table 4. Community Solar Subscription Payment Structures (Heeter, 2021)

Subscription Payment Structure	Description
Upfront Payment	Subscriber provides payment all at once at the beginning of the subscription period.
Hybrid Contract	Subscriber provides upfront payment followed by multiple payments.
Multiple Payments	Subscriber typically has a monthly bill.
Fixed Discount	Subscriber receives a fixed discount on the electricity rate instead of payment.

Michigan investor-owned utilities do not currently offer on-bill financing for customers to use for the purchase of their portion of the community solar project. Such programs would help reduce the cost burden of joining a community solar program (Solar Breakout Room, 2021).

Some community solar programs stipulate a certain percentage of the project must be allocated for specific entities, such as low-income participants, residential entities, or commercial businesses (Feldman et al., 2015). Under the anchor tenant model, Michigan law allows a non-profit or city to be the subscriber of last resort and own up to 100% of the subscriptions (Brader et al., 2021).

There are a variety of community solar ownership models. The utility-led community solar business model is also be known as solar gardens, shared solar, or roofless solar (Gagne, 2021a). About 25% of Americans own their electric utility through co-ops or city or county owned utilities and can direct their utility to pursue community solar projects. Publicly owned utilities generally have led in the deployment of community solar projects. "[U]tilities have the legal, financial, and program management infrastructure to handle organizing and implementing a community solar project" (Coughlin et al., 2010). They can also buy in bulk to further reduce costs (discussion in workgroup, likely from solar meeting). Investor owned utilities may be interested in expanding customer choice by providing community solar (Coughlin et al., 2010). The current investor-owned utility business model drives utilities toward community solar ownership.

A jointly-owned project or third party owned project is used to offset multiple individual businesses' or households' consumption (Gagne, 2021a). The third-party can either be a business focused on producing community solar power or a non-profit (Coughlin et al., 2010). In a third party led program, an entity develops and maintains the project. Electricity generated goes to the electric utility and community solar subscribers receive community solar bill credits (Wochos, 2021). During the community solar panel in this workgroup series, the overwhelming preference was for small-scale, non-utility owned community solar business model (Brader et al., 2021).

Customer protections need to be considered when enabling third-party owned community solar. However, there should be a balance to provide consumer protections and guardrails without overburdening subscriber organizations. For instance, a template or standard disclosure form can be developed for third-party subscriber organizations to use when presenting value propositions to potential subscribers. Bonding can be used to protect subscribers if a subscriber organizer leaves the state. Massachusetts, Minnesota, and Colorado are leading states with solid consumer protections (Brader et al., 2021). Anchor tenant sophistication should be considered, where additional protection may be required in certain cases. Lastly, it should be easy for customers to exit the program, like in the Lansing Board of Water and Light community solar program (Brader et al., 2021). Legislation may be required to allow the MPSC to require subscriber organization bonding in the event the subscriber organization ceases business in the state and to ensure transparency in cost information presented to potential customers (Solar Breakout Room, 2021).

4.2.2-3 Clear Bill Credits Process Required

Currently, the largest regulatory barrier is the bill crediting system (Heeter, 2021). Retail rate credits, or virtual net metering, has been the crediting mechanism with the most community solar traction. It is also a good starting point during nascent stages of community solar deployment (Brader et al., 2021). Currently, state public utility laws often prevent community solar projects from transferring electricity off site (Koeppel & Gorjala, 2021). Legislation could be amended to allow this transfer, which would allow renters and homes for which solar does not work to have access to solar. For small constrained geographic areas, a community solar project could be viewed as a microgrid. The billing mechanism is key in addressing this transfer. For instance, virtual net metering could be provided for a single organization (Solar Breakout Room, 2021).

Several bill credit barriers can exist for community solar. Authority must be given to provide bill credit to customers when the system is not behind the customer's meter. Details like how and when a credit is applied to a customer's bill and for how long should be provided. Allowing consolidated billing or net crediting helps simplify the customer's experience by providing one consolidated bill (Wochos, 2021). Lack of details regarding the amount of the bill credit received by the customer can also be barriers. Information regarding the amount the subscriber receives per kWh on the bill, whether the value of the renewable energy credit is included or not, and the clear statutory guidance all can help address this barrier (Wochos, 2021).

In the cases where the subscription fee for community solar exceeds the total program credits, a participation barrier may exist. If robust community solar participation is desired, the subscription credit may need to be as high or higher than the full retail rate. However, this may result in non-participating customers subsidizing the program, which is not allowed under Michigan law. A

MPSC proceeding to examine and assign an appropriate value to community solar may be required to determine suitable community solar credits (discussion from closing meeting).

It may also be unclear who should pay for the cost of utility billing system modifications to enable on-bill crediting of non-utility owned community solar projects (closing meeting discussion). This should be clearly determined and billed accordingly.

4.2.2-4 Utility Coordination and Clear Interconnection Process Needed

Effective coordination between the utility and those involved with the development of a community solar project is key to its success. The utility is an important partner in community solar projects. During the stakeholder process, Valerie Brader described a 24 MW landfill solar project in the City of Ann Arbor. The city aims to see the credit reflected on the bill in the same way as if the customer were part of net metering or distributed generation. To do this, the utility must be involved. In addition, there can be no subsidization under Michigan law meaning the community solar credit must be based on market pricing (Brader et al., 2021).

A safe and efficient interconnection enables a community solar project to begin generating clean energy for participants and revenue for the developer. The Commission initiated a process to update its Electric Interconnection and Net Metering Standards in November 2018. The update is intended to improve the interconnection process by identifying each step and its timing for the utility and the community solar developer, adding a new fast track process for projects up to 1 MW in size, and enabling better grid integration by incorporating the new technical standards in IEEE 1547-2018. Another feature of the updated rules is the addition of a pre-application report. This report provides community solar developers information about the utility's distribution system at the expected interconnection location.

Hosting capacity maps are beneficial because they provide community solar developers the information needed to place community solar in an area with the most available capacity so it can be more useful and interconnection costs are less (Heeter, 2021). In response to the MI Power Grid Electric Distribution Planning workgroup findings, the Commission issued an order directing Consumers Energy and DTE Electric to develop initial base-level zonal go/no go maps published and refined with updated analyses over a two-year period with detailed updates in 2021 distribution plans (MPSC, 2020a). These initial base-level zonal go/no go maps represent progress on the path to full hosting capacity maps. Consumers Energy's first iteration of an online hosting capacity analysis tool is available on its generator interconnection webpage.

4.2.2.-5 Low- and Moderate-Income Participation Needs to be Accessible

Community solar is an emerging method to include low-income customers in solar projects (Gagne, 2021a). Likewise, methods to streamline or eliminate barriers and costs for LMI participation is also an emerging issue (Heeter, 2021). Table 5 shares some common approaches to low- and moderate-income participation in community solar.

Table 5. Common Low and Moderate Income Participation Approaches (Heeter, 2021)

Approach	Description
Percentage Carveout	Require certain LMI participation
Incentives	Usually provided through RFP process prioritizing LMI subscription
Voluntary	Utility voluntarily creates program targeting LMI customers

In addition to grid benefits, there are local benefits that arise form community solar. Community owned solar models can offer financial advantages including reduced energy burdens, price stability, tax credit availability, and diversity of possible funding streams. It allows low-income customers to have greater control over their energy sources, reduce fossil fuel dependence, and environmental improvements. It also mobilizes community resources, builds community relationships, and increases community wealth. Lastly, it reduces the perceived credit risks of serving low-income customers (Koeppel & Gorjala, 2021).

An anchor tenant, such as a city or municipality, under the anchor tenant model, may offer partially or fully subsidized subscriptions to low- and moderate-income customers (Brader et al., 2021). However, stakeholders in this workgroup series were interested in ways to make community solar accessible to low-income customers without subsidies from non-participating customers.

Identifying low to moderate-income customers may be problematic. Utilities are best positioned to identify these customers. Zip code designations or coordination with community action agencies can also help identify these customers (Brader et al., 2021). Simplified income verification processes is necessary and can be implemented (Thomas, 2021).

Spotlight: Michigan Solar Communities & Consumers Energy Sunrise Program

Michigan Solar Communities program began via the U.S. Department of Energy Clean Energy for Low Income Communities Accelerator. The accelerator sought to provide renewable energy access and demonstrate locally designed solutions for low-income households (Thomas, 2021).

The Michigan Solar Communities Program aims to address low-income energy burden and provide renewable energy access. Low-income participants receive home weatherization and a community solar subscription, which provides monthly bill credits for the generated electricity. The program phases focused on different utility types: cooperative (Cherryland Electric), municipal owned (Village of L'Anse), and investor owned (Consumers Energy) (Thomas, 2021).

In Consumers Energy's Sunrise program, income qualified customers can participate in the Solar Gardens program at no cost. Costs are paid by a non-profit agency subscribed to the program. The agency then assigns its subscriptions to selected income qualified customers. The program, approved by the Commission in Case No. U-20649 on September 24, 2020, launched on February 1, 2021.

Both program and project level approaches need to be used to increase low-income and black, Indigenous, and people of color access. Barriers to equitable and accessible community solar programs that exist within the MPSC, utility positions, and statutory law should be addressed (Koeppel & Gorjala, 2021).

4.2.2-3 On-Bill Financing & Funding Support Low to Moderate Income Participation

On-bill financing may help make community solar available more broadly, by reducing the initial upfront cost to participants. The Village of L'Anse municipal utility offers on-bill financing to help make the community solar program available to all. The project was informed by holding community meetings, partnering with Michigan Tech, and receiving technical assistance from Michigan Energy Options (Brader et al., 2021).

In retrospect, on-bill financing may have enabled more low- and moderate-income participation in the Lansing Board of Water and Light (LBWL) community solar project. In this project, which is owned and operated by Michigan Energy Options, subscribers pay an up-front cost and LBWL provides monthly credits on the customer bills. The investment payback is estimated to be about 9 years. The low- and moderate-income piece was not established at the program's start. Though 90% of the subscribers for the LBWL project are residential, half of the panels are subscribed by non-residential customers who tend to have larger subscriptions (Brader et al., 2021).

Lastly, the availability of funding sources for community solar projects helps lower the overall cost and further accessibility to low- and moderate-income participation. This was true for the Village of L'Anse, where the municipal utility received grants from the MI Department of Agriculture and Rural Development and partnered with the Michigan Department of Environment, Great Lakes, and Energy to offer a weatherization component for low-income customers (Brader et al., 2021).

Spotlight: DTE Electric Low-Income Community Solar Pilot

DTE Electric is implementing a low-income community solar pilot for participants who are at or below 200% of the federal poverty level. This program was included in the settlement agreement approved by the Commission in Case No. U-20713, et al on June 9, 2021. From 2022 through 2024, the company will build three community solar projects, with one each in Detroit, River Rouge, and Highland Park. DTE Electric will provide up to 30% of the upfront capital for each community solar project for a total of $900,000. Other funding will be sourced from voluntary contributions and donations. Participating low-income customers will receive an anticipated monthly bill credit of $25 to $30.

A Low-Income Solar Council will interface with the three pilot cities, solicit proposed project locations, review potential projects, rank the projects for DTE Electric's consideration, and work with DTE Electric to determine the number of participants and selection process.

4.2.2-3 Regulatory and Legislative Barriers Challenge Community Solar Development

Current regulatory and legislative barriers challenge entities interested in community solar projects. HOPE Village's efforts to develop a community solar project encountered initial setbacks. It first explored building the community solar project on vacant land. However, under Michigan law, the project would be required to become a utility because the project would be located off the property of the subscribing customers. Next, HOPE Village considered installing solar on large rooftops, where generated power would be used by the buildings and surplus generation sent to the community. This also ran into regulatory and legislative barriers. The final model developed seems like it will be successful. Under this model, three low-income apartment buildings undergoing renovations will have rooftop solar. They will receive low-income tax credits in addition to the solar tax credit. The rooftop solar will be used behind the meter by the people living in the building through a power purchase agreement. This is possible due to a waiver that allows low-income multi-family apartment buildings to take service through a single utility master meter. Though HOPE Village worked around current regulatory and legislative barriers, addressing the barriers would ease future community solar developments (Brader et al., 2021).

4.2.2-4 Summary Table of Community Solar and Joint Barriers and Solutions

The table that follows summarizes the barriers/hurdles and solutions pertaining to community solar and those that affect both community solar and BTM solar. This table collects all barriers and solutions mentioned in workgroup stakeholder meetings and discussions, which go beyond the regulatory realm. However, the table may not be comprehensive, as it only reflects the learnings and discussions in this workgroup. Inclusion of barriers, hurdles, and solutions in the tables does not imply endorsement by Staff.

Table 6. Community Solar Identified Barriers/Hurdles and Possible Solutions

Identified Barriers/Hurdles	Possible Solutions
1. Lack of clarity on what constitutes a community solar program, subscribers, and eligible program administrators.	• Define community solar facility, size, eligible locations, and ineligible locations. • Define community solar subscriber, minimum subscriber requirements, and participating customer types. • Define eligible entities to administer community solar facilities. • Detail how community solar subscribers register and fully participate in the program, ensure access to utility bill credit tariffs, and subscriber interactions with utility. • Legislation to define the rights of communities in implementing their own energy choice
2. Current investor-owned utility business model drives utilities to community solar ownership.	• Legislation needed to expand-non-utility ownership • MPSC be more proactive in leading the way for alternative community solar model.
3. Lack of clarity on customer acquisition.	• Detail any restrictions/mandates on customer acquisition and management, requirements for low- or moderate-income participation, and requirements for residential or commercial participation.
4. Subscription may cost more than the program credit, resulting in a net cost for participants. Further, participants cannot access the solar tax credit.	• Conduct a MPSC proceeding to examine and assign appropriate value to community solar. • Subscription credit may need to be as high or higher than the full retail rate, but this could result in non-participating customers subsidizing the program which is not allowed under Michigan law.
5. Lack of understanding of community benefits.	• Developer could provide worker training options during construction. • Support ways to increase benefits to local community from community solar. • Developer can use partnership flip model, local partnerships, and other programs to build community wealth.
6. Low income and diverse access to community solar programs limited.	• Developers can set aside certain percentages of electricity to be provided to low-income communities. • Support financial flexibility through on-bill financing or flexible relationships with subscribers. • Implement net crediting to streamline payment and remove wealth barriers for low-income customers. • Programs can ensure transportability to allow access for renters.
7. There may be barriers associated with low- or moderate-income customer recruitment to community solar projects, such as qualification barriers and costs and perception of credit-risk.	• Utilize the anchor tenant model as a fiduciary failsafe and assist in offering pay-as-you-go structures. • Simplify income verification. • Streamline or eliminate qualification barriers and costs. • Establish pay-as-you-go subscriptions to enable participation by low-income customers.
8. State public utility laws often prevent community solar projects from transferring electricity offsite.	• Amend legislation to allow offsite transfer to support solar access for renters and homes unsuitable for solar. • Allow virtual net metering/distributed generation for service of a single organization.
9. There are bill credit barriers, such as a lack of statutory guidance as well as clarity on who should pay for billing system modifications.	• Clarify statutory guidance and give authority to provide consolidated billing or net crediting, where a bill credit is provided to a community solar customer when system is not behind the customer's meter. • Detail how, when, and how much of a credit is applied to a customer's bill and for how long. Also clarify whether the value of renewable energy credits is included or not in the customer's bill credit.
10. Consumer protection concerns arise with third-party owned community solar	• Allow the MPSC to require subscriber organization bonding in the event subscriber organization leaves the state and to ensure transparency in cost information presented to potential customers. • For consumer protection, include a standard disclosure form.
11. Land availability for project siting may be limited.	• Utilize brownfields to site community solar projects within communities.

Table 7. Joint Behind the Meter and Community Solar Identified Barriers/Hurdles and Possible Solutions

Identified Barriers/Hurdles	Possible Solutions
1. No method to value resiliency.	• More studies on how to value resiliency in regulatory processes. • Utilize community solar projects to provide resilience in emergency situations like powering emergency shelters and charging devices.
2. Lack of available and accurate grid information to optimize project locations.	• Provide access to hosting capacity information. • Provide accurate hosting capacity information to help solar projects locate where there is most capacity and potential to provide a non-wires alternative to distribution grid issue(s).
3. Distribution system benefits are unclear and unquantified.	• Conduct pilots using the solar projects to determine/identify distribution system benefits.
4. The full array and value of grid services undetermined currently.	• Develop grid services programs and tariffs for behind the meter solar and storage.
5. In addition to grid services, solar can provide an array of ancillary benefits, but the values of these ancillary services are not clearly identified.	• Develop methodology to consistently value ancillary services such as resiliency, workforce development, and community engagement.
6. Current utility tariffs require separate meters for each residential housing unit in multi-family residential buildings.	• New waiver process may be used to provide a single meter option for certain low-income multi-family residential buildings. It can enable one solar project to serve all residential units behind the meter.[4] • Pursuant to Case No. U-20646, DTE Electric Company was authorized to amend the Standard Contract Rider No. 4 tariff within the Electric Rate Book to assist the housing needs of low-income residents. Applicable Owners or its authorized agents of a newly constructed or rehabilitated multifamily dwelling, shall have the opportunity to avoid the requirement of metering each residential housing unit separately. • Potentially extend to all residents of multi-family residences regardless of income.
7. Low- or moderate-income subscribers may be hard to attract due to ill designed programs.	• Understand low and moderate customer and subscriber needs when developing the program.
8. Lack of interconnection process clarity can be an issue.	• Provide clear interconnection rules that detail how projects are studied as well as management of the queue.

[4] HOPE Village is using this waiver option to build community solar projects on three rehabilitated low-income apartment buildings.

5. Combined Heat and Power

5.1 Combined Heat & Power Background

Also known as cogeneration (U.S. Office of Energy Efficiency and Renewable Energy, nd-a), Combined Heat and Power (CHP) refers to any technology using a fuel source to generate both thermal energy and electricity. Benefits of CHP include (Hampson & Rackley, 2013; Hampson, Tidball, Fucci, & Weston, 2016; Leidel, O'Connell, & Bixby, 2021):

- Increased energy efficiency,
- Low-cost new electricity generation capacity,
- Reduced energy and operational cost while providing electricity price stability,
- Enhanced system resiliency and reliability,
- Improved fuel flexibility and decreased dependence on fossil fuel,
- Reduced GHG emissions via improved efficiency or use of onsite produced fuel like biogas,
- Use of clean domestic energy sources like biomass and biogas, and
- Reduced need for new transmission and distribution infrastructure.

CHP is a key component for microgrids. They provide the option to disconnect during disasters and outages. CHP systems provide 37% of power for existing microgrids and are a less expensive backbone resource than storage (Kirshbaum, 2021). As a form of distributed generation (Naik-Dhungel, 2012), CHP is typically located on the same site or close to the point of energy consumption. It can range in scale to supply the energy needs of one or more buildings.

When paired with a system of underground pipes for distribution of the thermal energy, this application of CHP is often called district energy (Environmental and Energy Study Insititute, 2011). Areas that have multiple thermal hosts, like a university campus or urban downtown with commercial office buildings, hospitals, museums, and other buildings, are most viable candidates for district energy (Hampson et al., 2016). In urban settings, the most cost-effective and energy-efficient scenarios have a mix of technology, including CHP plants of appropriate size. For cities with less than 200,000 people, urban planning policies preventing CHP use may cause total system cost penalties of 2% and energy efficiency penalties of up to 24% when compared to business-as-usual case using boilers only (Keirstead, Samsatli, Shah, & Weber, 2012).

5.1.1 Topping Cycle CHP

Combined heat and power systems can be configured as *topping cycle* (the most common) or *bottoming cycle*. In a topping cycle CHP process, fuel is first used in a heat engine to generate electricity. The waste heat from the electricity generation process is then recovered to provide useful thermal energy, often in the form of hot water or steam, that can be used for space heating (Naik-Dhungel, 2012), cooling, hot/chilled water, or an industrial process.

There are two common topping cycle CHP configurations. In the first method, a combustion turbine or reciprocating engine burns fuel (natural gas, oil, or biogas) to turn generators to produce electricity. Heat recovery units capture the waste heat and repurposes it. In the second method, a steam boiler produces steam using fuels like natural gas, oil, biomass, and coal to turns a steam turbine. Next, a generator produces electricity. Steam exiting the turbine can provide useful thermal energy (U.S. Environmental Protection Agency, 2021c).

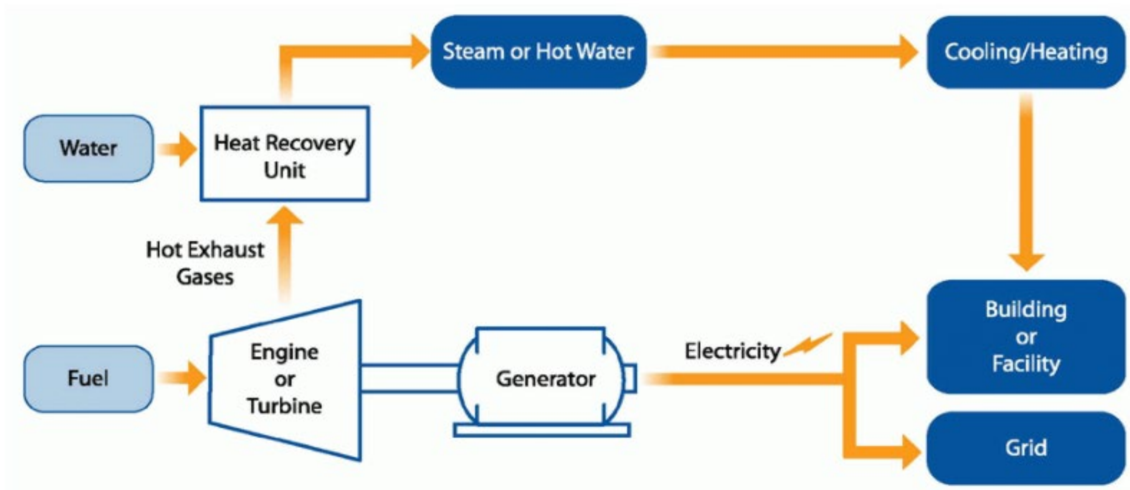

Figure 1. Combustion Turbine, or Reciprocating Engine, with Heat Recovery Unit (U.S. Environmental Protection Agency, 2021c)

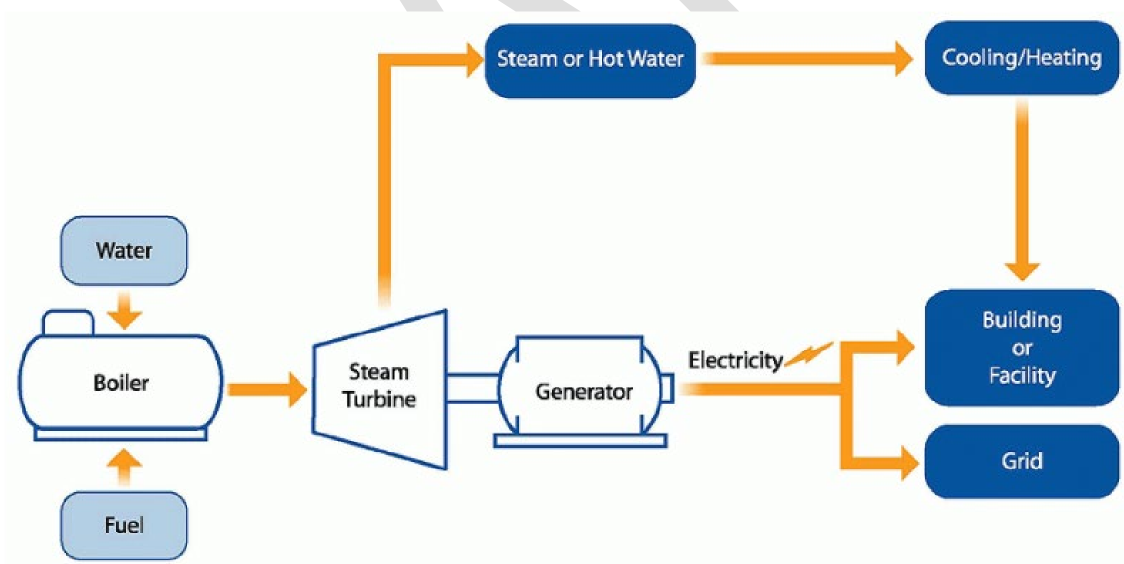

Figure 2. Steam Boiler with Steam Turbine (U.S. Environmental Protection Agency, 2021c)

5.1.2 Bottoming Cycle CHP

In the bottoming cycle CHP, also called Waste Heat to Power (WHP), fuel is first used to power an industrial process or commercial building heating system. Next, waste heat from the process is used to generate electricity or mechanical power (Sharkey, 2021). WHP uses thermal energy from existing processes, whereas topping cycle CHP requires direct fuel consumption to generate electricity (Naik-Dhungel, 2012). WHP is viewed as "emission free" as the waste heat will be generated regardless of whether the wasted portion is captured or not (Sharkey, 2021).

The most common WHP system uses waste heat to generate steam in a boiler that drives a steam turbine. WHP processes often operate as a *Rankine cycle*, where a working fluid—in the case of a steam turbine, water—is pumped to an elevated pressure before entering the waste heat boiler and then recycled after powering a turbine generator using a condenser (Naik-Dhungel, 2012).

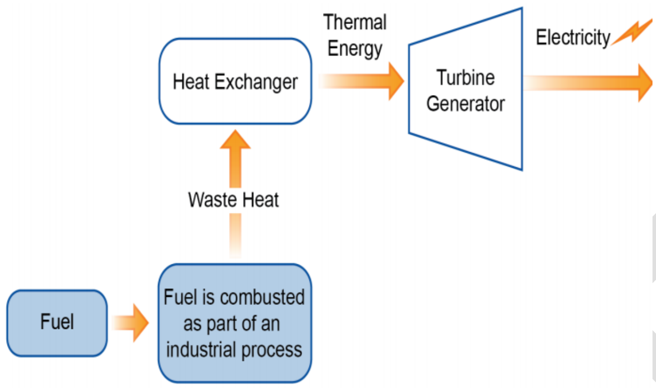

Figure 3. Waste Heat to Power Diagram (Naik-Dhungel, 2012)

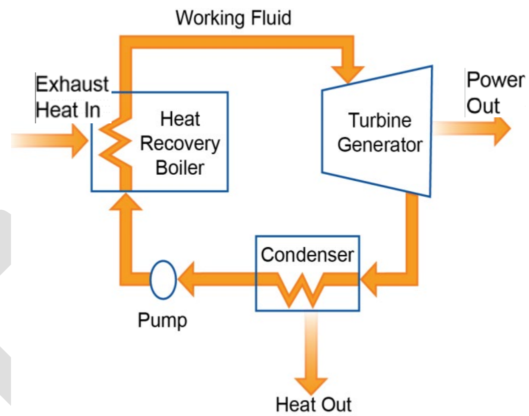

Figure 4. Rankine Cycle Heat Engine (Naik-Dhungel, 2012)

5.1.3 CHP Market and Michigan Trends

Adding 1 GW of CHP capacity in Michigan would produce and estimated $109 million in incremental business profit and would save the economy $94 million per year in fuel costs, at the cost of $850 million direct investment and annual O&M costs of roughly $67 million. In addition, it would provide an annual emissions reductions of 662 tons CO_2, 379 tons nitrous oxide, 39 tons sulfur oxide (Baker et al., 2018).

Currently, there is 3,579 MW of installed CHP capacity in Michigan with 87% of the CHP capacity fueled by natural gas. Over 50% of Michigan's total CHP capacity is installed in the chemicals sector. In addition to the installed capacity, there is 4,987 MW of CHP technical potential in the state. About 86% of this technical potential arises from the industrial sector. About 68% or over 1500 MW of the industrial sector CHP potential is from the transportation equipment sector, chemical sector, and primary metal sector (G. Miller, 2021). Organizations that install CHP systems in Michigan have done so to (Lynch, Means, & Richards, 2021):

- Reduce operating and energy costs,
- Seek fuel flexibility and not be solely dependent on fossil fuel,
- Use fuel produced onsite for energy production instead of being flared off,
- Increase resiliency and reliability of the system, and
- Reduce greenhouse gas emissions.

Facilities that produce biogas onsite, like the Benton Harbor St. Joseph Wastewater Treatment Plant, may be further incentivized to install CHP system. These installations support greater sustainability through effective use of the produced biogas (Lynch et al., 2021).

Though commercial buildings have seasonality of onsite power and thermal demand, they are the strongest potential growth market for CHP. Building types like retail stores, commercial and multifamily buildings, hotels, and colleges and universities have more CHP potential than existing CHP installations. Commercial buildings with high and consistent space cooling demand may benefit from CHP paired with absorption chillers. Refrigerated warehouses, supermarkets, and data centers are some potential commercial buildings with such needs (G. Miller, 2021). Since CHPs are best used in continuous operation, universities, hospitals, 24-hour manufacturing plants, and other end uses with continuous operation are well suited for CHP use (Leidel et al., 2021).

Commercial buildings represent the strongest potential growth market for CHP. From 2015 to 2019, though most capacity was installed for industrial applications (61%), the overall number of installations were concentrated among non-traditional CHP markets (light industrial, commercial, institutional, and multi-family: 88%). Most installations were smaller (77% of installs were reciprocating engines or microturbines) and natural gas fueled (77% of new capacity). There is increasing interest in hybrid systems integrating renewables and energy storage with CHP, as well as CHP for critical infrastructure and microgrids. Standardized packaged CHP systems may be especially suitable for commercial building applications, where the same installation can be used in multiple facilities owned by an organization (G. Miller, 2021).

Standardized packaged CHP systems eliminates many site-specific engineering requirements, which help reduce cost and ease installation when compared to site specific customized designs that are constructed on-site. Most packaged CHP systems range from 10 kW to 3 MW. Modular pre-engineered systems can be available in larger sizes. These factors increase likelihood of commercial sector uptake of CHP (G. Miller, 2021).

5.2 Combined Heat & Power Discussion

In the stakeholder process, several areas presenting hurdles to the development of CHP projects were discussed. These areas are:

- High initial cost and needed operational expertise can be problematic,
- Significant GHG reductions are not fully considered,
- Resiliency benefits are not fully recognized,
- Waste heat to power has distinct unrecognized characteristics in Michigan,
- Interconnection to the grid may be difficult,
- Rate structure and complexity pose challenges, and
- No applicable utility rebates limit attraction.

Each hurdle to CHP project development is discussed in the following sections.

5.2.6 High Initial Cost and Needed Operational Expertise can be Problematic

Lack of knowledge surrounding CHP is a primary obstacle to its installation, as is the reluctance to extend beyond one's area of expertise to run a CHP system. Financing can also be difficult to secure (Leidel et al., 2021). The use of CHP in district energy systems reduces the need for users of CHP to have operational knowledge of CHP systems (Swinson, 2021). Aggregating thermal loads also decreases costs in ways not feasible for a single building and creates a "market" for the thermal energy (Thornton, 2021).

Even though CHP systems provide net savings over the project life, the high initial cost is a significant barrier (Leidel et al., 2021; G. Miller, 2021). CHP capital costs almost always will exceed that of a stand-alone boiler. However, cost savings from electricity generation from the CHP system decrease energy costs and make the investment cost beneficial (G. Miller, 2021).

This is clear in a comparative example of a CHP and a natural gas boiler system for a medium to large-sized institutional facility. The new natural gas boiler system has an initial capital cost of $4.2 million, while the CHP system has an initial capital cost of $21 million (Hampson & Rackley, 2013). This initial "sticker shock" prevents many from looking further at CHP systems (Leidel et al., 2021).

Table 8: Comparison of CHP and Natural Gas Boiler System Economics (Hampson & Rackley, 2013)

	New Natural Gas Boilers	New Natural Gas CHP	Comparison
Peak Boiler Capacity, MMBtu/hr input	120	120	
Peak Steam Capacity, MMBtu/hr	96	96	
Avg Steam Demand, MMBtu/hr	76.8	76.8	
Boiler Efficiency	80%	NA	
CHP Capacity, MW	NA	14	
CHP Electric Efficiency	NA	31%	
CHP Total Efficiency	NA	74%	
Annual Steam Use, MMBtu	614,400	614,400	0
Annual Steam Use, MMlbs	558.6	558.6	0
Annual Power Generation, kWh	NA	106,400,000	106,400,000
Fuel Use, MMBtu/year	768,000	1,317,786	549,786
Annual Fuel Cost	$4,608,000	$7,906,719	$3,298,719
Annual O&M Cost	$729,600	$1,687,200	$957,600
Annual Electric Savings	0	($6,703,200)	($6,703,200)
Net Annual Operating Costs	$5,337,600	$2,890,269	($2,447,331)
Steam Costs, $/MMBtu	$9.56	$5.18	($4.38)
Capital Costs	$4,200,000	$21,000,000	$16,800,000
10 Year Net Cash Flow (output)	**$65,389,602**	**$54,138,850**	($11,250,752)
Incremental CHP Payback			6.9 years
10 Year IRR - CHP vs. Gas Boiler			10%
10 Year NPV – CHP vs. Gas Boiler			$2,411,765

Source: ICF International

Notes: Based on 8,000 hours of operation, 7 cents per kWh electricity price, and $6/MMBtu natural gas price. CHP system cost of $1,500/kWh, O&M costs of $0.009/kWh and 31 percent electrical efficiency. CHP availability of 95 percent and portion of electric price avoided by on-site generation of 90 percent are assumed values. Natural gas boiler estimated cost of $35/MBtu input was provided by Worley Parsons. Net cash flow is based on a sum of 10-year operating costs, escalated at 3 percent annually, including capital cost as a Year 1 cost. All efficiency values and natural gas prices are expressed as higher heating values.

However, the CHP system has lower annual operating costs due to over $6.7 million of electricity it generates per year. This causes the CHP system to pay back in 6.9 years (Hampson & Rackley, 2013). Though the CHP system has higher fuel costs and operations and maintenance costs per year, the savings from the electricity produced by the system yields a net savings of $2.4 million per year (G. Miller, 2021). See Table 8 for comparative analysis for this example.

5.2.1 Significant Greenhouse Gas Reductions are not Fully Considered

There is no current method to quantify and value the GHG reductions from CHP in Michigan. Similarly, there is not a method to quantify and value the site versus source GHG reductions. Given that about 4.5% of Michigan's generated electricity was lost in transmission and distribution in 2019 (U.S. Energy Information Administration, 2021f), the same GHG emissions reduction at a centralized generator and at the site of consumption is not equivalent (T. Miller, 2021).

Michigan energy policies tilt economics of clean energy in favor of renewable energy, regardless of CO_2 emissions reductions by providing only renewable energy credits for renewable resources and EWR credits for energy conservation. No credits are provided for CO_2 emissions reduction, which discourages private investment in CHP and WHP. It ignores the large CO_2 emission reductions that can be achieved immediately in C&I sectors with these technologies and available fuel, while also missing an opportunity to make Michigan's industry more competitive (Sharkey, 2021). As carbon intensity metrics are adopted, CHP and district energy systems using them may be valued over traditional energy sources (Thornton, 2021).

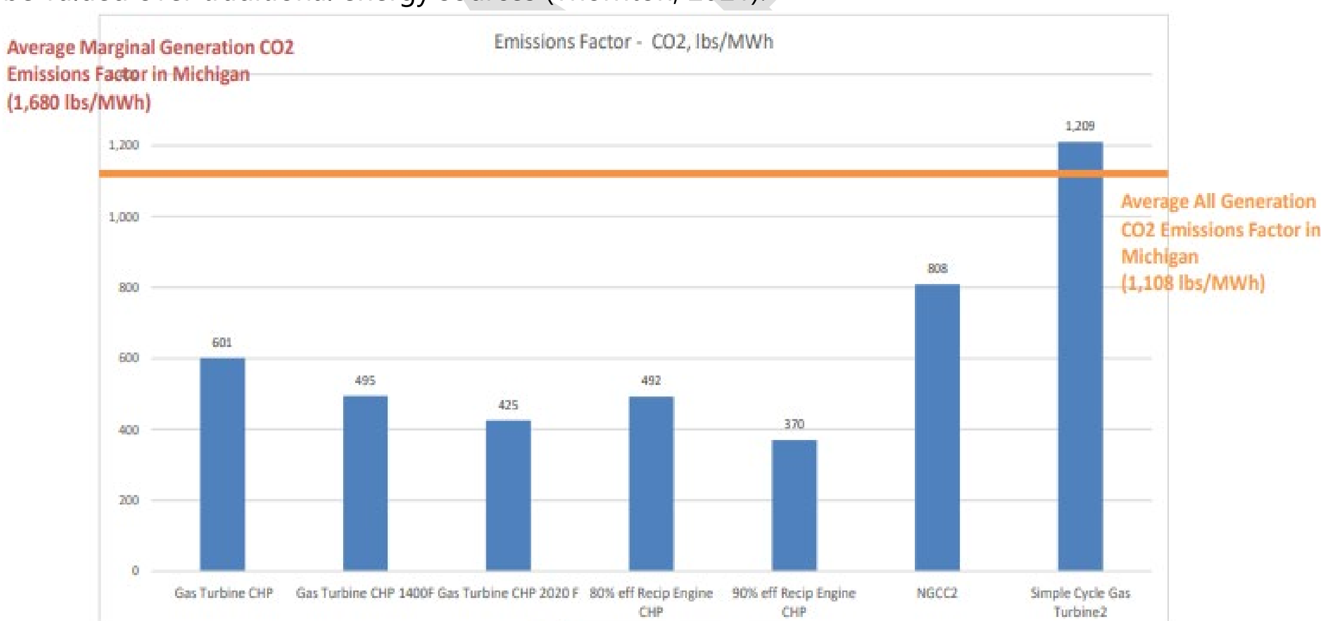

Figure 5. Carbon Dioxide Emissions of CHP compared to Michigan Grid (G. Miller, 2021)

CHP's higher efficiency results in energy and emissions savings compared to Michigan's grid. By recapturing heat of generation, CHP increases energy efficiency and reduces GHGs (Kirshbaum, 2021), yielding 30-55% reduction in GHG emissions (G. Miller, 2021). Further, CHP helps offset generation from marginal units, which are non-baseload sources, often fueled by fossil fuels, used to meet intermediate and peak loads (Kirshbaum, 2021; G. Miller, 2021). CHP configurations produce less emissions than nearly any combined cycle generation option. The GHG emissions reductions from CHP in six years exceeds that from the same capacity of solar PV achieved in 35 years (G. Miller, 2021).

Though there are some headwinds for natural gas use, natural gas fueled CHP is still a useful carbon mitigation strategy (Leidel et al., 2021; Thornton, 2021), as demonstrated from the information above. However, CHP and district energy systems can be retrofitted to run on renewable sources such as renewable natural gas, hydrogen, or combined cycle steam (Thornton, 2021). These efforts will further help reduce emissions from CHP use in the future, making CHP both a short-term and long-term emission reduction investment (Kirshbaum, 2021).

5.2.1-1 Renewable Natural Gas and Other Low Carbon Fuels Can Reduce CHP Emissions

CHP can be fueled by lower carbon or renewable fuels, like biogas, renewable natural gas (RNG), and hydrogen. These fuels can further reduce emissions. The use of existing gas pipeline infrastructure to deliver low carbon or renewable fuels can provide low cost fuel delivery and "green" the overall gas system (Kirshbaum, 2021). Biogas, produced from anerobic digestion of landfill waste, wastewater, and agricultural waste, can be captured and cleaned for onsite use (Kirshbaum, 2021). When further cleaned, it becomes RNG or biomethane, which is fully interchangeable with conventional natural gas and can be transported in natural gas pipelines (ICF, 2019; Kirshbaum, 2021). Hydrogen can be produced using renewable electricity is called "green hydrogen." Though still under development, there is increased interest in green hydrogen around the world. Research is being conducted on increasing the percentage of hydrogen fuel that can be used in CHP systems, as well as how to transport hydrogen fuel in existing gas pipelines (Kirshbaum, 2021).

Renewable natural gas (RNG) is a promising method to help CHP reduce emissions in the future (Kirshbaum, 2021; G. Miller, 2021). By 2040, projected RNG annual production for pipeline injection is expected to range from 1,660 – 4,510 trillion Btu (TBtu) and realize 101-235 million metric tons of GHG emission reductions (ICF, 2019). The high potential estimate is about 93% of the ten-year average for residential natural gas use and nearly 95% of residential CO_2 emissions in the U.S. from 2019-2018. However, without technical or economic constraints, nearly 13,960 TBtu of RNG can be produced. RNG production is projected to increase over time while costs are projected to decrease. In 2040, RNG is expected to cost $55-300/ton of GHG emission reductions (ICF, 2019), making it cost competitive with other emission reduction strategies (G. Miller, 2021).

Of the 2,200 US sites producing biogas, 860 or about 39% use the biogas onsite. Michigan has five landfill gas RNG production facilities. One such site, Bell's Brewery, produces biogas from anerobic digestion of its wastewater bioproduct, which contains malt husk and unfermented sugar. The biogas is cleaned and used onsite by the CHP system to power the wastewater treatment process, generate electricity for plant operations, and capture heat to support the anerobic digestion process and steam for cleaning the plant (Kirshbaum, 2021).

As biogas can be generated from agricultural waste, Michigan has the potential to generate much more biogas due to its robust agricultural industry. Michigan is the nation's 6th largest milk producer, producing about 5.6% of the nation's milk from 24 top states in July 2021. It produces the most milk per cow and has a total of 445,000 dairy cows as of July 2021 (U.S. Department of Agriculture, 2021). Milk production is Michigan's largest agricultural commodity, valued at nearly $1.92 billion in 2020 (National Agricultural Statistics Service, 2021). GHG emissions reduced by anerobic digestion of dairy manure to be 2.94 metric tons of CO_2 equivalents ($MTCO_2e$) per cow annually in New York. This assumes replacement of electricity through on-site generation using biogas (P. Wright & Gooch, 2017). Though New York is not directly comparable to Michigan, this metric yields an estimated 1.3 million $MTCO_2e$ per year. This demonstrates the estimated carbon reduction potential from anerobic digestion of Michigan's dairy manure, which may generate biogas and RNG to fuel CHP installations in the state. However, similar to CHP, anerobic digestion faces challenges from the GHG reductions not being fully valued (P. Wright & Gooch, 2017).

5.2.2 Resiliency Benefits are not Fully Recognized

The lack of methods to quantify the value of resiliency undercounts the benefits CHP provides in maintaining reliable systems, even in the event of extreme storms (Kirshbaum, 2021). CHP enhances energy resilience by maintaining power and heating/cooling during outages (G. Miller, 2021). During extreme weather, CHP can support the local grid and "mission critical" customers by islanding. In systems with renewables, CHP also adds balancing capacity to further enhance grid and energy security (Thornton, 2021). Natural gas CHP is one of the most reliable DERs during disaster events. To increase resiliency, CHP should have black start capability (synchronous generation), ample carrying capacity, and all parallel utility interconnection and switchgear control (G. Miller, 2021). Currently, CHP systems provide 37% of the power for existing microgrids at a lower cost than storage (Kirshbaum, 2021).

The current incentives in Michigan for renewable energy and energy waste reduction exclude CHP and WHP. This ignores their value as baseload resources that can supplement utility owned generation, stabilize grid resources, and complement RE resources (Sharkey, 2021).

CHP served as the backbone for some Texas microgrids during the February 2021 polar vortex. The Texas Medical Center in Houston was supplied by a district energy system operated by Thermal Energy Corp. that kept it online during the polar vortex event in Texas in February. The system has realized projected cost savings of $200 million over 15 years, and 302,000 tons of $CO_{2\ \text{emissions}}$ displaced annually. The district energy system at the University of Texas at Austin saved 22 MW during the February storm. Increasing efficiency over time: Amount of space served by district energy has increased by 10 million square feet since 2000 while the amount of fuel consumed has remained the same. Recovering water from air handlers has allowed recovery of an average of 60 million gallons, helping to mitigate drought conditions that often occur in Texas (Thornton, 2021).

During Hurricane Sandy in 2012, CHP systems supported continued operations of critical infrastructure. South Oaks Hospital in Amityville, NY, provided critical services to 245 hospital beds for two weeks by relying solely on its 1,250 kW CHP system. Smaller systems at St. Joachims and Anne Nursing and Rehab (300 kW) as well as the Christian Health Care center (260 kW) supported continued healthcare services. Bergen County Utilities Wastewater Plant in Little Ferry, NJ, operated for 24 hours without utility support using their 2,800 kW CHP system to provide treated cooling water throughout the storm event to 47 communities. Lastly, CHP systems supported university operations and sustained power and heating to residents in multifamily buildings (Hampson & Rackley, 2013). As the value of resiliency increases, the value of district energy systems that can help lower costs while providing adaptive efficiency with renewable fuel sources will also grow (Thornton, 2021).

5.2.2-1 CHP Helps Stabilize Transitional Grid

The grid is evolving from a traditional power grid with centralized generation, long-distance transmission, one way power flow, and separation of generation and load. It is transitioning to distributed generation, from a variety of DERs with variable production, bi-directional power flows, and close coordination of generation and load to optimize system performance and reduce costs (G. Miller, 2021).

Since current renewables cannot respond quickly to load changes at peak demand, CHP can be a stabilizing factor in the transitional electric grid. Long-duration, on-site energy, and high resiliency can be provided with a combination of solar, storage, and CHP. In such a system, the CHP provides base load power and thermal energy. The solar PV system reduces grid demand and emissions during peak hours. Storage provides additional flexibility to help meet peak loads. Since the CHP is sited with PV and storage, the required unit size is also reduced (G. Miller, 2021).

5.2.4 Waste Heat to Power has Distinct Unrecognized Characteristics in MI

Waste heat to power (WHP) systems capture heat generated as a by-product of a man-made activity, such as an industrial process or power generation, and convert it to electricity. This is distinct from CHP, which generates electricity first and then captures waste heat from electric generation for useful thermal purposes. WHP has zero emissions since it uses the waste heat generated by existing processes that would occur regardless of whether the waste heat was captured or not. This allows WHP to reduce the carbon intensity of manufactured goods and process heating and fuel costs (Sharkey, 2021). Industries most suitable for WHP systems are those with large waste heat streams, like refining, chemicals, and metals manufacturing (Hampson et al., 2016).

Waste heat is an abundant resource with a total opportunity of about 15 GW (Sharkey, 2021). Energy consumption lost is the process of use or conversion is called rejected energy and most often arises as waste heat. Though rejected energy decreased by 7% from 2019 in 2020, about 67% of estimated U.S. energy consumption was rejected energy (Lawrence Livermore National Laboratory, 2021). The amount of energy loss by sector varies. See Table 9 on the next page.

Though capturing high temperature waste heat is more technically and economically feasible currently, a variety of low-temperature WHP technologies, like thermoacoustic, shape memory alloys, and pressurized hydrogen, are emerging (Sharkey, 2021). Roughly 60% of U.S. waste heat is generated at lower temperatures (<230℃) (U.S. Department of Energy Industrial Technologies

Program, 2008). Capturing the low-grade waste heat could provide billions of dollars in energy savings per year (Sharkey, 2021).

Table 9: U.S. Total Energy Consumed and Rejected Energy by Sector in 2020

Sector	Total Energy Consumed (Quads)	Rejected Energy (Quads)	% Rejected Energy of Sector Energy Total
Electricity Generation	35.6	23.2	65.2%
Residential	11.5	4.01	34.9%
Commercial	8.66	3.03	35.0%
Industrial	25.3	12.9	51.0%
Transportation	24.3	19.2	79.0%

Data from Lawrence Livermore National Laboratory (2021).

5.2.4 Interconnection to the Grid may be Difficult

Utility interconnection of CHP systems may present challenges. In the case of a micro CHP (mCHP) installation in Oakland County, Michigan, the customer contacted both the Governor and MPSC due to interconnection issues. In the end, DTE approved the project's interconnection after nine months (T. Miller, 2021). A CHP project at the Veteran's Affairs Hospital in Ann Arbor also experienced interconnection issues with DTE. After the hospital contacted the Governor's office, the utility approved the interconnection agreement after a six-month delay (Lynch et al., 2021).

As part of the MI Power Grid efforts, the MPSC is working to update the interconnection and distributed generation standards. The rule making process has now scheduled a Notice of Public Hearing for October 20, 2021 (MPSC, 2021d). As stakeholders provide input during the revision of these standards, hopefully future issues with interconnection of DERs like CHP will be ameliorated.

5.2.5 Rates Structure and Complexity Pose Challenges

Complex rates make understanding the applicability of each rate difficult (Leidel et al., 2021). Since distributed generation is not incentivized in the traditional utility business model (Leidel et al., 2021), customers may not have incentive to install CHP and WHP systems or to use the systems to full capacity to help support the grid (T. Miller, 2021).

Utility rates can significantly impact CHP systems, as the assumed rates and prices impact the design and study phase. These assumptions can impact the size and payback of the system. In the case of the CHP system installed at Northern Michigan University, utility costs changed significant from when the study and plant design occurred and when the system came online in 2013. This significantly impacted the operating costs to run the system and project financials, causing the university to move from wood fuel to natural gas in 2019. Though utility rate fluctuations impact the CHP project savings, the Veterans Affairs Hospital in Ann Arbor has seen positive financial performance in recent years (Lynch et al., 2021).

Because regulatory policies and practices discourage exporting power generated by customer-owned CHP systems, the systems are usually undersized to ensure electricity generation is less than onsite electricity demand (Chittum, 2013). This leaves the systems generating less than they could, like the spotlighted mCHP below (T. Miller, 2021), and leave efficiency savings on the table (Chittum, 2013).

Spotlight: Aisin Technical Center of America Micro CHP Project

Aisin Technical Center of America has a 1.5 kWh mCHP unit installed in a typical, suburban, single-family home in Oakland County, Michigan. The project tests the CHP system, which provides onsite power generation to cover the baseload, and identifies energy storage for residential and blackout applications. The Aisin mCHP reduces the need and dependency on electricity from the grid, lowers total energy costs and CO_2 emissions, and provides blackout power protection and support to areas where the grid is over-stressed. It also provides design flexibility for the home builders (T. Miller, 2021).

The project uses solar and storage to provide backup power and black start capabilities. The overall cost was approximately $40,000. Despite experiencing delayed interconnection and confusion regarding applicable utility rates, the project sees a financial return with a 44% reduction in electricity purchases with the system at 47.8% of its potential (T. Miller, 2021). Interconnection was approved 9 months after initial application and after both the Governor and the MPSC were involved. Though the project was designed for and submitted originally under Rider 18 DG due to the solar PV installation, it was approved under Rider 14DG, which is not limited to renewable energy projects and has a lower buy back rate. With a $0.022608/kWh buy back rate on Rider 14 DG, the customer is not incentivized to sell excess power to the grid (T. Miller, 2021).

5.2.7 No Applicable Utility Rebates Limit Attraction

No incentives exist for CHP and WHP in Michigan's current energy policy and regulatory environment. Though WHP is zero emissions, fuel neutral, baseload energy resource displacing fuels on the margin, Michigan energy policies disincentivizes WHP and CHP by providing renewable energy credits for renewable resources and EWR credits. WHP and CHP are excluded from these incentives (Sharkey, 2021).

The current regulatory framework also understates the value CHP and WHP provide. Regulatory limitations on EWR credits and fuel switching pose a challenge, as CHP cannot be considered under EWR measures (Leidel et al., 2021).

5.2.8 Summary Table of Barriers and Solutions

The table that follows summarizes the barriers/hurdles and solutions pertaining to CHP. This table collects all barriers and solutions mentioned in workgroup stakeholder meetings and discussions, which go beyond the regulatory realm. However, the table may not be comprehensive, as it only reflects the learnings and discussions in this workgroup. Inclusion of barriers, hurdles, and solutions in the tables does not imply endorsement by Staff.

Table 10. Combined Heat and Power Identified Barriers/Hurdles and Possible Solutions

Identified Barriers/Hurdles	Possible Solutions
1. Lack of regulatory path, business models, and incentives for utility use of CHP and WHP.	• Create incentives and regulatory path/programs that support utilities to use or build CHP and WHP. • WHP systems are also needed to achieve the environmental goals of the state and they need to be reviewed for use.
2. No regulatory support or recognition for the resiliency, reliability, and energy cost reductions CHP and WHP technologies provide.	• Regulations supporting easier installation of CHP and WHP technologies. • Recognize the economic, reliability, and resiliency benefits of a diversified generation portfolio. • Examine and value future fuel flexibility. Review future fuel sources, like hydrogen, and determine carbon reduction impacts. Renewables alone cannot meet the carbon reduction goals.
3. IRPs do not consider CHP and WHP adequately.	• Update economics of CHP and WHP included in IRPs.
4. Complex and confusing electric rates.	• Provide interactive templates and tools for easy customer calculations of bill impacts and economic benefits of CHP and WHP. Raise awareness of availability.
5. There are high standby rates.	• Continue review of standby rates in the rate case process.
6. Utility interconnection can be long, unclear, and frustrating.	• Offer streamlined checklist to customer. Highlight process steps and who is responsible for each step.
7. Not all electric companies allow net metering of natural gas and propane systems, even if they reduce emissions compared to the energy mix.	• Allow net metering for all technologies (agnostic of fuel source) that provide an overall reduction in greenhouse gases, according to standardized procedures. • FERC 2222 will provide solutions to have customers work with aggregators.
8. There are high capital costS.	• Provide incentive programs to reduce initial cost and reduce return on investment period. Areas most suitable for CHP/WHP, such as hospitals, universities, industrial facilities, can be identified and supported through incentives. • Educate the public education on CHP and WHP benefits, like that they are cheaper than storage in microgrids. • Be clear about the assumptions used to calculate project payback, such as variable utility rates. Build in flexibility. • Capitalize on utility investment, public private partnerships, and private capital to reduce costs. • Expanded opportunities with FERC 2222, will bring additional value streams for CHP and help address cost issues.
9. Michigan has credits for renewables and energy conservation. There are no incentives for other technologies reducing CO_2 emissions. There are also legislative fuel switching barriers. Michigan economics of clean energy favor of renewables, regardless of CO_2 emissions reductions.	• Create technology agnostic incentives based on actual CO_2 emissions reductions. Clarify value of decarbonization and monetize it. • Remove legislative barriers to fuel switching, clarify that CHP and WHP use is not fuel switching, or revise MI energy policies to incentivize CHP and WHP with renewables or add WHP to MI RPS and CHP to Advanced Clean Energy Portfolio Standard. • Provide robust industrial energy efficiency incentives.
10. Negative view of environmental impact due to use of natural gas or other fossil fuels in net zero carbon goal environment.	• Provide education on CHP and WHP's significant emissions reduction, high efficiency, reliability, resiliency, and security. • Support fueling systems with renewable and low carbon fuels like biogas, renewable natural gas, and hydrogen. • Recognize WHP is emissions free, as it uses waste heat that will be wasted if not captured, at the state level.
11. Lack of standardization in the site versus source calculation for greenhouse gas reductions.	• Develop a standardized procedures for calculating site versus source greenhouse gas reductions. • Allow net metering for all technologies (agnostic of fuel source) that provide an overall reduction in greenhouse gases, according to standardized procedures.
12. Legislative barrier to selling electricity of a third party, which causes issues like underutilization of industrial parks.	• Create ability to sell electricity generated to multiple parties on the land, regardless of land ownership. • Third party market investment can be leveraged to build CHP for industrial park to bring new opportunities for CHP systems to serve load.
13. Decision makers are hesitant to go beyond the core business.	• District scale solutions allows a third party to run the CHP and WHP systems so the entities can focus on core business
14. There is lacking customer knowledge of CHP and WHP systems.	• Educate the public on CHP and WHP systems and their benefits. • Provide contractor trainings.

6. Electric Vehicles and Charging Infrastructure

Since the beginning of the American automotive industry, Michigan has been a hub for mobility and a home for the companies that pursue it. The fortunes of Michigan businesses, communities, and families have long been intertwined with the automotive industry ("Executive Directive 2020-1.,"). Though the transportation sector is transforming with more electrified, connected, and intelligent options, Michigan remains a mobility leader. With nearly nine billion of announced investments since 2014, Michigan leads nationally in corporate investments in medium and heavy duty (MHD) zero emissions vehicle (ZEV) supply chain. It is second to California with about 86 companies involved in MHD ZEV supply chain, but leads nationally in the number of workers employed by these companies with over 60,000 workers (Environmental Defense Fund, 2021).

Michigan is well positioned to extend its global mobility leadership. It has created the Michigan Office of Future Mobility and Electrification (Office of Governor Gretchen Whitmer, 2020), which seeks to enhance Michigan’s mobility ecosystem. Though the Office focuses on bolstering Michigan’s mobility manufacturing, workforce, investment, and startups, it also focuses on expanding smart infrastructure and accelerating electric vehicle adoption in Michigan ("Office of Future Mobility and Electrification," 2021). The electric charging infrastructure in the state will need to grow to support the increasing current and future demand for electrified transport.

6.1 Electric Vehicles and Charging Infrastructure Background

6.2.1 Electric Vehicles Background

Electric vehicles (EV) are transportation methods self-propelled with internal electricity systems rather than traditional fossil fuels like petroleum. Electric vehicles generally have lower fuel and maintenance costs than traditional vehicles (Preston, 2020). Although EVs can refer to public transportation methods such as electric trains, planes, or personal mobility devices, the term “EV” in this report and stakeholder process focuses on electric automobiles such as cars, trucks, and buses. Typical electric vehicle technology includes the following (U.S. Environmental Protection Agency, nd):

- **Hybrid EVs**: Also known as Plug-In Hybrid EVs (PHEV). Automobiles which combined a conventional powertrain with an electric engine. Most hybrids use fossil fuels for generation, with the notable exception of hydrogen power.
- **Plug-In EVs**: Also known simply as EVs. Vehicles that contain rechargeable batteries supplied by an external electricity source. This technology has no tailpipe emissions.
- **Commercial EVs**: A vehicle class that includes busses, semi-trucks, or specialized vehicles such as commercial or industrial equipment. This technology has different operating conditions than typical EVs and can be either PHEVs or EVs.

Most personal vehicles on the road today are powered by fossil fuels. Worldwide EV adoption has reached a record high of 2.9% in 2019 and it is estimated that EVs are at the start of an exponential increase in adoption (Muratori, 2021). Currently the levelized savings of electric vehicles over gas powered vehicles can save the average consumer roughly $7,700 over a vehicle’s lifetime. As more consumers adopt electric vehicles and infrastructure increases, greater savings are expected to occur (Borlaug, Salisbury, Gerdes, & Muratori, 2020). NREL's Electrification Futures Study projects significant transportation electrification with electrified transport growing from 0.2% in 2018 to 23% of electricity consumption in 2050. Nearly 76% of vehicle miles traveled in 2020 is projected to be powered by electricity (Zhou & Mai, 2021).

Michigan EV sales have grown 11% since 2019, and are predicted to be 8% of the vehicle market by 2025 (Ghamami et al., 2019). Predicted EV penetration for Michigan is shown in Figure 6 (Ghamami et al., 2019).

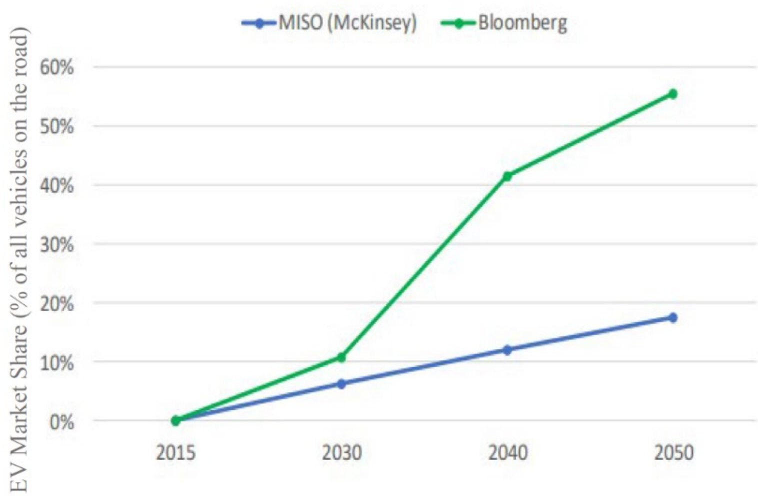

Figure 6. Predicted EV Penetration for Michigan (Ghamami et al., 2019)

The International Council on Clean Transportation estimates EV uptake by state and major metropolitan areas through 2030 (Bauer, Hsu, Nicholas, & Lutsey). See Table 11 for historical and projected EV stock.

Table 11. Michigan and Detroit EV stock for 2020-2030 (Bauer et al.)

Location	Electric Vehicle Stock		
	2020	2025	2030
Michigan	35,154	119,641	424,974
Detroit	24,050	67,847	195,629

Though EVs do not currently represent most vehicles on roadways, their uptake may be rapid and extensive. Historical diffusion of many new energy technologies has followed S-shaped adoption curves. Slow initial growth is followed by difficult to predict, but rapid and extensive adoption (Adil & Ko, 2016; Mai et al., 2018). See Figure 7.

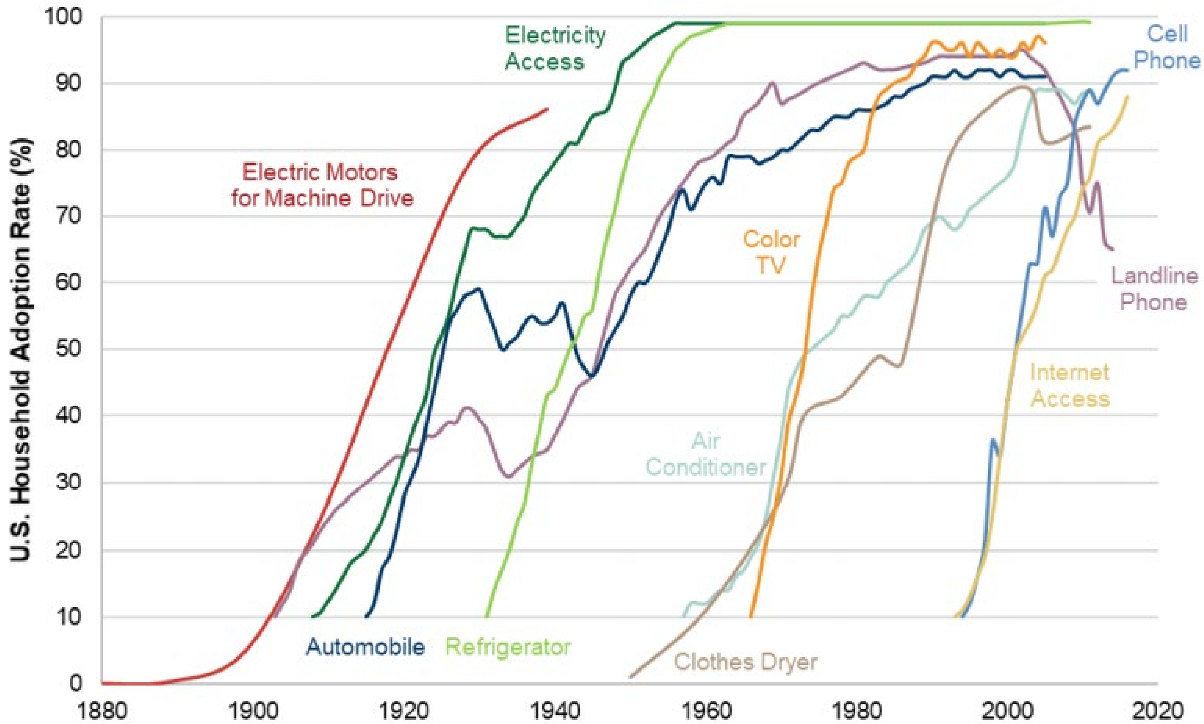

Figure 7. Examples of Technology Diffusion in U.S. Households (Mai et al., 2018)

Manufacturing commitments suggest that EV models and production will increase dramatically. By 2030 year end, the following are expected (White (2021) unless otherwise noted):

- 2022: Ford plans production of the electric F-150 Lightning in spring.
  Mercedes plans to introduce ten new EVs.
- 2023: Nissan plans to launch eight new EVs and sell one million PHEVs or EVs per year.
  Honda plans production of an EV, likely a crossover, in partnership with GM.
  Mazda plans at least two PHEVs by year end.
- 2024: Acura and Land Rover both expect production of one EV.
  Volvo plans to begin XC60's all electric successor using more sustainable battery technology (Cenizo, 2021) by 2024.
- 2025: Audi plans to have 20 EVs and 10 PHEVs by 2025.
  BMW expects 15-25% of global sales to be composed of PHEVs and EVs.
  Ford plans $29 billion of EV investment by 2025.
  GM plans to have 30 EVs available globally by 2025, with 20 in North America. It also plans $27 billion of EV investment through 2025.
  Production plans of 23 Hyundai EVs globally and six Land Rover EVs.
  Toyota plans launch of 60 new PHEVs, EVs, and fuel cell vehicles by year end and 5.5 million sales of electrified models per year.
  Volkswagen plans production of 1.5 million EVs by year end.
  Volvo pledges one million PHEV and EVs on road by year end and 50% of global sales composed of EVs.

Michigan may see high EV adoption in rapidly due to S-shaped adoption of new technologies and extensive car manufacturing commitments. Michigan's utility infrastructure must be ready for the many EVs that car manufacturers have committed to producing and selling (Baumhefner, Daniel Bowermaster, Dick, Gilleo, & Jones, 2021). The demand, challenges, and opportunities that EVs present to the electric grid will require near term learnings for infrastructure readiness.

6.2.2 Electric Vehicle Charging Infrastructure Background

Typical electric vehicle charging infrastructure includes the following (Slusser, 2020):

- **Level 1 Charging Station**: Analogous to a typical residential wall socket, these chargers provide up to 3kW, resulting in around 5 miles of range per hour of charge. It uses alternating current.
- **Level 2 Charging Station**: Provides up to 7.2kW on residential circuits or 19.2kW on commercial circuits, resulting in around 20-50 miles of range per hour of charge. Technology is used for long-term charging of municipal or commercial fleets. It uses alternating current.
- **Direct Current Fast Charging (DCFC) Station**: Provides up to 350kW, resulting in around 200 miles of range per hour of charge. These chargers include proprietary Tesla chargers, which cannot charge all EVs.
- **Induction Charging**: Also known as wireless charging, this charging technology is in development and has not achieved full deployment. It allows charging of various levels without need for a wired connection or plug-in.

Large investor-owned utilities in Michigan are studying EV charging and demand structures in pilot programs – Consumers Energy with its *PowerMIDrive* program,[5] DTE with its *Charging Forward* program,[6] and Indiana Michigan with its *IM Plugged In* program.[7] All give annual progress updates in their respective dockets. All pilot programs focus on customer education, incentivizing charging station installations, and investigating time of use rates impacts to EV charging.

In addition to utility rebates, the Charge Up Michigan Program, from the Michigan Department of Environment, Great Lakes, and Energy (EGLE), provides funding to deploy DCFCs to ensure feasibility of long distance electric vehicle trips within Michigan and to neighboring states and Canada (Office of Climate and Energy, 2021). It supports DCFC installations at sites identified by the optimized DCFC charger placement map identified by an Michigan State University led research team (Ghamami et al., 2019; Office of Climate and Energy, 2021). EGLE has also provided millions in grants for large-scale EV charging (EGLE, 2020a, 2020b). The Upper Peninsula (UP) Michigan EV Readiness Workshop, hosted by NextEnergy and funded by EGLE, in December of 2020 focused on EV programing in the northernmost regions of the state with emphasis on rural areas and environmental equity (NextEnergy, 2020).

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[5] MPSC Case No. U-20134. See docket for updates.
[6] MPSC Case No. U-20162 and No. U-20561. See dockets for updates.
[7] MPSC Case No. U-20359. See docket for updates.

The International Council on Clean Transportation estimates non-home charger numbers and non-home charging infrastructure costs by state and major metropolitan areas through 2030 (Bauer et al.). See Table 12 for information regarding number of non-residential chargers and infrastructure costs for Michigan and Detroit.

Table 12. Michigan and Detroit Non-Home Chargers and Charging Infrastructure Costs for 2020-2030 (Bauer et al.)

Location	Total Non-Home Chargers			Associated Charger Costs from 2021 on ($ million)	
	2020	2025	2030	2025	2030
Michigan	5,626	20,813	52,880	206	625
Detroit	2,278	10,950	24,324	95	272

6.2 Electric Vehicles and Charging Infrastructure Discussion

In the stakeholder process, several areas presenting hurdles to the development of electric vehicles (EVs) and charging infrastructure projects were discussed. These areas are:

- Transportation decarbonization matters,
- Grid integration impacts must be considered,
- Opportunities for strategic generation capacity and T&D benefits exist,
- Equity and affordability concerns arise from inclusion in rates,
- High cost of EVs and charging infrastructure slows adoption,
- Cohesive standards are required, and
- Collaboration and holistic infrastructure development are needed.

Each hurdle is discussed in the following sections.

6.2.1 Transportation Decarbonization Matters

Electric vehicles are an important step for Michigan's move towards full decarbonization. In 2020, the transportation sector was the largest source of CO_2 emissions in the U.S., responsible for 36% of all CO_2 emissions that year (U.S. Energy Information Administration, 2021c). Governor Whitmer's Executive Directive 2020-10 lays out a path for economy-wide carbon neutrality for Michigan by 2050 and maintenance of net negative greenhouse gas emissions thereafter. To achieve these goals, it will be critical to increase the pace of transportation electrification (Baumhefner et al., 2021).

Moving towards carbon free transportation requires coordination with the utility sector. Though the electric power sector was the second largest contributor to U.S. CO_2 emissions in 2020 at 32% (U.S. Energy Information Administration, 2021c), utilities in Michigan and elsewhere have carbon reduction commitments. This suggests transportation electrification will likely reduce transportation sector emissions over time as utilities seek cleaner sources of electricity generation to reach their carbon reduction goals. If transportation is fully electrified, the utility sector could reduce emissions for both the electric power and transportation sectors, which together caused

68% of total U.S. CO_2 emissions in 2020. Utility EV programs will need to move beyond pilots to achieve carbon neutrality goals (Baumhefner et al., 2021).

Transportation electrification will yield significant health and climate benefits. The resulting cleaner air from a shift to zero-emissions transportation technologies are estimated to avoid 6,300 premature deaths, 93,000 asthma attacks, and 416,000 lost workdays in 2050. Annual benefits in 2050 are projected to be over $72 billion in avoided U.S. health costs and over $113 billion in avoided climate change impacts (American Lung Association, nd-b). The total estimated health benefits to Michigan in 2050 from transportation electrification are estimated to be $1.7 billion, with an estimated $1.1 billion of health benefit to Detroit alone. Michigan's estimated health benefit from transportation electrification is third in the Midwest, following Illinois ($3.2 billion) and Ohio ($2.4 billion) (American Lung Association, nd-a).

Communities that face disproportionate exposure to pollution, such as low-income communities, communities of color, and communities most impacted by fossil-fueled power plant emissions, will benefit from transportation electrification and a move towards renewable energy generation. In addition, individuals susceptible to poor air quality, like children, the elderly, and those with respiratory, cardiovascular, and other chronic health conditions will also benefit. Lastly, all those that are impacted by roadway emissions, such as daily commuters, transit riders, delivery drivers, residents near major roads, and school children will also benefit from towards net zero transportation electrification (American Lung Association, nd-b).

The emissions reduction achieved from EVs will be impacted by the fuel mix of the generated electricity, which may fluctuate throughout the day. The percentage of fossil fuels providing energy in the grid highly impacts emission from EVs (McLaren, Miller, O'Shaughnessy, Wood, & Shapiro, 2016). For example, overnight EV charging in California and New York were found to have about 70% more and 20% fewer emissions than daytime charging, respectively (Miller, Arbabzadeh, & Gençer, 2020). In a study using 2018 data of the PJM grid, controlled EV charging reduced associated generation costs by 23-34%. Though costs were lower by shifting loads to coal plants, emissions were higher and net social benefits were negative. However, a future grid with coal retirements and increased renewable generation, like wind, may realize positive net social benefits from controlled EV charging (Weis, Michalek, Jaramillo, & Lueken, 2015). Thus, electricity generation sources and EV charging times can significantly impact the emissions reduction realized from EVs.

Spotlight: Michigan's First Electric School Buses Deployed in 2019

Michigan's first electric school buses went on the road September 2019, supported by a $4.2 million grant from the Department of Environment, Great Lakes, and Energy's (EGLE's) Fuel Transformation Program. They replaced 17 older diesel school buses and will operate in Zeeland, Kalamazoo, Three Rivers, Oxford, Gaylord, Roseville, and Ann Arbor (EGLE, 2019).

The effort was led by led by the Michigan Association for Pupil Transportation, which convened stakeholders for the effort to support cleaner air, alternative fuel options, and safer environments for children. The electric buses will eliminate student exposure to harmful exhaust fumes and particles when driving or idling (EGLE, 2019).

Emissions from electrified transportation may also depend on the EV charging used. Extreme fast charging (XFC) can fully charge an EV with a compatible battery in a few minutes. Using real world EV charging data, researchers modeling XFC (350 kW) in 2030 found it increased GHGs and local air pollutants (Jenn, Clark-Sutton, Gallaher, & Petrusa, 2020). This suggests that how EVs are charged may also impact the overall emissions from the vehicles.

Emissions optimized EV charging can realize significant emissions reductions. In studying smart charging to optimize emissions reductions, WattTime found it reduced annual emissions by up to an additional 18% and daily emissions by up to an additional 90%. Areas with electric grids with both fossil and renewable generation, like in Michigan, have the largest opportunities. By managing EV charging to match the local generation mix through tools like time-based marginal emissions signals, emissions reductions can be maximized (Lewis, Bronski, McCormick, & Amuchastegui, 2019).

6.2.2 Grid Integration Impacts Must be Considered

With new EV load, care must be taken with grid integration impacts. EV charging stations largely impact the electric distribution system, when they are connected at home, office, and public charging sites (Kintner-Meyer et al., 2020). Grid impacts largely stem from where charging may exceed the maximum power that can be supported by the distribution system in a given area (Muratori, 2021). Large-scale EV adoption may cause radical increases in electricity demand peaks that can critically strain electricity grids (Valogianni, Ketter, Collins, & Zhdanov, 2020). However, using historical trends of vehicle purchases and expected generation, sufficient energy generation is expected to be available to support a growing EV fleet (Muratori, 2021). EV charging should be considered in all new distribution system upgrades, as significant vehicle electrification is expected, especially in medium and high electrification scenarios (Mai et al., 2018). See Figure 8.

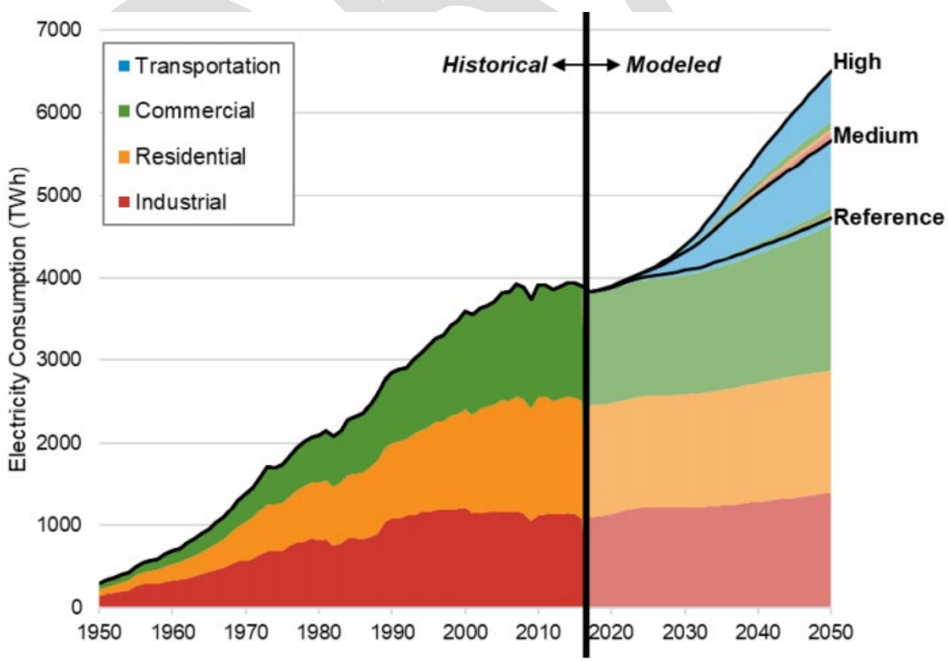

Figure 8. Vehicle Electrification Growth Dominates Electrification Futures (Mai et al., 2018)

Public charging or fleet charging will also greatly affect the grid. Commercial trucks (long-haul semi-trucks) present the most promising electrification potential of all vehicles on the road today, but would likely need level 3 fast chargers for efficient movement These chargers have the greatest electricity draw, and would need to be place strategically to avoid overloading parts of the distribution grid (Muratori, 2021).

Specific distribution level challenges to the grid from transportation electrification that warrant additional study are (U.S. Drive, 2019):

- Extremely fast charging (at 150kW and above) for light, medium, and heavy-duty vehicles,
- Dense urban areas with legacy infrastructure constraints, and
- Distribution capacity expansion and cost impacts.

Managed charging, which uses smart communications to coordinate EV charging (U.S. Drive, 2019), may help better integrate EV demand. It offers flexibility to reduce peak demand impacts from EVs and will be important in integrating EVs at scale (U.S. Drive, 2019). Many opportunities for managed charging exist, as a typical personal EV is used for transportation only about 5% of its life (Muratori, 2021). Successful managed charging is easy, reliable, and scalable. Several pilots have successfully managed EV load during peak demand events (Dunckley, Alexander, Bowermaster, & Duvall, 2018; Electric Power Research Institute, 2016). Managed charging requires real-time, effective communication between load managers and customers to allow EV loads the flexibility needed to make charging a grid resource.

6.2.3 Opportunities for Strategic Generation Capacity and T&D Benefits Exist

At scale, aggregated new load from high EV deployment can affect the bulk power system (Kintner-Meyer et al., 2020). From 1990-2017, annual net generation capacity additions ranged from zero to over 50 GW, even when excluding renewable energy generation. At low, medium, and high EV scenarios, additional generation capacity of 0.7, 4.5, and 14 GW, respectively, to meet this demand is forecasted (U.S. Drive, 2019). See Figure 9 for context of how this EV load compares to historical annual net generation capacity additions.

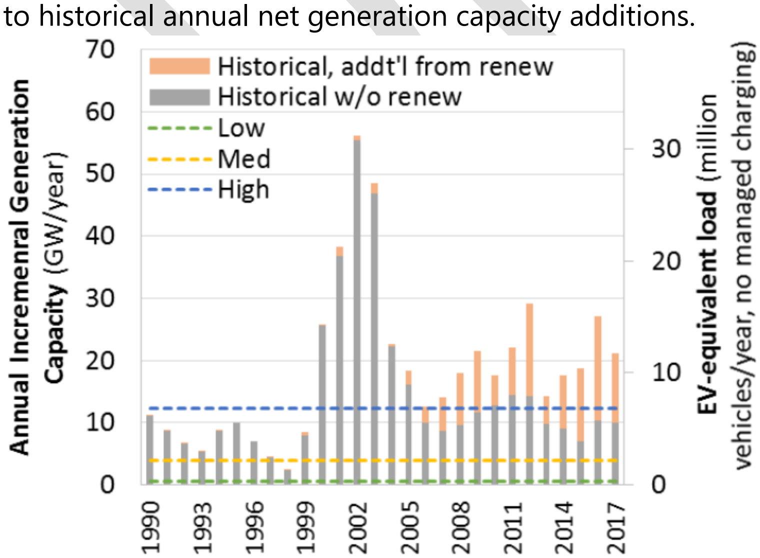

Figure 9. Annual Expected Generation Capacity vs. Forecasted EV Equivalent Load (U.S. Drive, 2019)

Though EV demand may be significant, even at high EV market growth, there is expected to be to be enough energy generation and generation capacity to support transportation electrification. Proper planning for EVs and the resulting charging demand will help manage their impact (U.S. Drive, 2019). EVs have a high potential to be used in various DER functions, including in storage, dispatch and as a resilience measure in extreme events. By balancing power quality and supporting end-use customers, EVs can also provide strategic generation capacity and/or transmission and distribution benefits.

How EV charging is managed can impact system costs and emissions associated with EVs. A study examined transformer capacity and EV charging optimization in the Netherlands. Compared to uncontrolled EV charging, emission-based charging optimization was found to potentially reduce marginal emissions from charging by 23.6% and associated costs by 13.2%. In a scenario with vehicle to grid (V2G), marginal emissions reductions of up to 67.3% were possible with cost reductions of 32.4%. The study also found differences in V2G and unidirectional EV charging when considering transformer upgrade costs and emissions. With unidirectional EV charging, a transformer upgrade was never cost beneficial or reduced emissions, even with the additional freedom provided to EV charging by the larger transformer capacity. However, transformer upgrades were found to be cost beneficial and reduce emissions when V2G charging optimization was used (Brinkel, Schram, AlSkaif, Lampropoulos, & van Sark, 2020).

Other solutions also exist to integrate EV load into the current grid structure. ITC submitted a pilot proposal to FERC to allow DC fast charging to occur at the transmission level. Should the pilot be approved and be successful, it will allow for more make-ready solutions in places where distribution architecture is unable to support high EV charging load (Burns, Morris, Myrom, & Stephanoff, 2021). Organizing EV fleets into virtual power plants (VPPs), which aggregate decentralized energy sources like EVs and solar PV, can help integration of renewables into the grid by charging and discharging when needed. In a study of 1500 EVs in Northern Europe, VPPs generated profits for fleet owners, reduced wind power curtailment, and reduced customer energy costs (Kahlen, Ketter, & van Dalen, 2018).

Additional analysis may be help address additional challenges. Assessment of transmission constraints can ensure transmission expansion, which can be expensive and time consuming, are deliberate. Likewise, bulk power system spinning reserve requirements and ramping capabilities of the generating fleet can be analyzed to support planning to meet grid needs (U.S. Drive, 2019).

6.2.4 Equity and Affordability Concerns Arise from Inclusion in Rates

Transportation electrification has equity and affordability implications. Immediate air quality benefits are realized with EV deployment, which addresses equity and environmental justice issues. Many current EV programs nationally have equity targets. However, equity in EV deployment is an area of learning. The Alliance for Transportation Electrification is actively engaging member utilities in equity issues and formed a committee focused on black, indigenous, and other people of color. These communities need early listening and stakeholder engagement to develop tailored programs (Baumhefner et al., 2021).

Caution should be taken to ensure the needs of disadvantaged communities are met in transportation electrification efforts (Baumhefner et al., 2021). Low and middle-income households, with an estimated demand elasticity of -3.3, are more price elastic than high-income adopters of EVs (Muehlegger & Rapson, 2018). This suggests that low and middle-income households are more sensitive to EV purchase costs and may own less EVs in comparison to high-income households. Even if low-income households owned EVs, EV charging access may be problematic. Provision of EV charging at multi-unit dwellings, like apartments, where a larger percentage of low-income communities reside, can be challenging. Older homes and buildings in low-income communities may have inadequate electrical service capacity and require infrastructure investments before EV charging loads can be supported. These challenges may limit low-income access to EV charging at home and they may need to rely more on public EV charging instead (Advanced Energy Economy, 2018). Greater incentives may need to be offered to multi-family dwellings (Burns et al., 2021). Care should be taken to ensure that transportation electrification benefits are equitably distributed, especially if utility rates help cover EV infrastructure implementation.

Energy affordability is a significant issue. The cost burden of the bulk transportation system has never fallen on electric utilities. To add that cost would unduly burden electric ratepayers. Electric vehicle transportation system implementation can be kept out of electric rates and funded elsewhere: either from public funding such as the EGLE programs, demand charges on the station, or other avenues (NextEnergy, 2020). The Infrastructure Investment and Jobs Act, passed by the U.S. Senate on August 10, 2021, included $7.5 billion to support EV charging station deployment across the U.S. and $7.5 billion to transition buses and public transportation to zero emission options (Szymkowski, 2021). If passed by the House of Representatives, it may be a substantial funding source for EV infrastructure and deployment. More communication and coordination between vehicle manufacturers, electric utilities, and others are essential to allow this change to occur equitably, especially as utility programs move out of the pilot stages (NextEnergy, 2020).

Currently, personal electric vehicle charging occurs mostly in residential homes, usually in areas with a high socioeconomic status given the current expense and distribution of EVs. Unless standardized and controlled, this will create unequal impacts on the entire distribution system and introduce inequity in the EV charging process (Baumhefner et al., 2021). In California, race and income disparities were found in the deployment of public EV chargers. Neighborhoods with predominantly Black and Hispanic residents were found to have lower access to public EV chargers (about 0.7 times as the reference group) and even lower access to publicly funded chargers (half as likely as the reference group). Locations with more multi-unit dwellings also experienced a larger EV charger access gap (Hsu & Fingerman, 2021). Care should be taken to ensure that inequitable distribution of ratepayer funded EV chargers has not and will not occur in Michigan.

Electric school buses may help empower communities wanting DERs and the associated benefits, especially low-income and environmental justice focused communities. School buses are a large community asset, and one of the most visible things in a community. Wisconsin set a goal to electrify all school buses by 2030. The school bus can be turned into a public-private partnership. In Michigan, DTE recently partnered with school districts to purchase electric buses to test and prove this on a small scale (Delaney, Foley, Melanson, Myers, & Wong, 2021b).

6.2.5 High Cost of EVs and Charging Infrastructure Slows Adoption

EV adoption is slowed by high costs of both vehicles and the charging infrastructure needed to support them (Madina, Zamora, & Zabala, 2016). In a study of U.S. EV adoption, researchers found EV purchase rebates, early investment in charging infrastructure especially along highways, and reflection of the environmental cost of gasoline vehicles likely will increase EV adoption (Narassimhan & Johnson, 2018). Business models must be developed to allow charging service operators to recover costs while offering EV users a sensible charging price. Fast charging likely requires intensive infrastructure usage for it to be profitable business case (Madina et al., 2016).

However, high cost of EVs and infrastructure is not necessarily a barrier that regulators must address. Utility regulators must ensure utility EV infrastructure investments are just, reasonable, and prudent. They consider whether the investments are equitable to ratepayers, result in fair returns on utility investments, and align with policy goals in deciding whether ratepayer funds should be used to enable EV utility programs and infrastructure deployment (Allen, Van Horn, Goetz, Bradbury, & Zyla, 2017). Ensuring that the electric system is ready to meet future EV demand in a safe, reliable, and prudent fashion that generates benefits for all ratepayers is distinct from advocating for and promoting the growth of the EV market and charging infrastructure.

6.2.6 Cohesive Standards are Required

Efficient and available EV charging infrastructure is vital to the efficacy of EVs (Kumar, Usman, & Rajpurohit, 2021). EV charging infrastructure with wide acceptability and utility coordination is key to successful implementation of EVs (Masoum, Moses, & Hajforoosh, 2012), while also decreasing power grid impacts (Kumar et al., 2021). Unified standards for EVs and charging infrastructure is necessary for greater EV uptake (Das, Rahman, Li, & Tan, 2020). The two most widely used standards for EV charging by the International Electrotechnical Commission (IEC), used widely in Europe, and Society of Automotive Engineers (SAE), used widely in the U.S. (Kumar et al., 2021), are critical (Rajendran, Vaithilingam, Misron, Naidu, & Ahmed, 2021).

The presence of technical and payment standards may help improve customer experience, minimize stranded EV charging infrastructure, and ensure public access (Advanced Energy Economy, 2018). Lastly, the standards clarifying operations and maintenance expectations for charging stations to ensure continued safe operation after initial installation will further EV driver confidence and improve customer experience.

6.2.7 Collaboration and Holistic Infrastructure Development are Needed

In planning EV infrastructure deployment, a holistic and consistent state-wide approach helps address barriers (Burns et al., 2021). An optimized placement map for DCFC along highways was developed by Michigan State University researchers with funding from the Michigan Energy Office. Map details placement of 150 kW DCFCs, which actually help reduce system costs even though individual charger costs are higher (Ghamami et al., 2019). EGLE uses the map when awarding grant awards for EV chargers, which cover up to 33.3% of total charger costs. Eligible organizations must also be enrolled in a utility EV program (EGLE, 2021b). Both Consumers Energy and DTE Electric use the map in the deployment of DCFC chargers in their EV pilot programs. Though this map provides a strong foundation for continuity in Michigan's deployment of EV DCFC infrastructure in the state, it is not enough to ensure it.

Additional work in Michigan is needed if a holistic and consistent state-wide approach to EV charging is desired. Efforts should be taken to ensure that rural areas of Michigan also benefit from charging infrastructure (Burns et al., 2021). Ensuring a seamless regional EV experience may support tourism benefits to reach rural Michigan communities (Asgeirsson, Gawron, Hall, Krackovic, & Pawl, 2021). Currently, there are no Commission approved utility EV programs in the UP. As such, organizations there are not eligible for the EGLE grant opportunities. Given that the high cost of charging infrastructure is a barrier to EV charging deployment, these grants and utility rebates offer substantial assistance in overcoming the cost barrier. If UP organizations are ineligible for available funding opportunities supporting EV charger deployment, broad deployment of EV chargers in the UP are unlikely to occur.

The MPSC can support Michigan utilities in learning how to best adapt to meet future EV charging needs in their service territory through utility pilot programs and work to ensure that ratepayer funded EV programs benefit all ratepayers, not just those with EVs. Though the Commission can work to support utilities in ensuring the grid's safety and reliability in future with high transportation electrification, this will not be enough.

Dynamic programming and responsible policy is also needed (Asgeirsson et al., 2021). The Michigan Office of Future Mobility and Electrification can help join efforts across State agencies like EGLE, the Michigan Department of Transportation, and the Michigan Economic Development Corporation, to seed EV and mobility innovation. In the energy space, greater collaboration between electric distribution and transmission organizations will likely be needed in the future (Burns et al., 2021). Michigan increase its EV ranking through government policy, industry participation, and investment (Asgeirsson et al., 2021).

The MPSC, other state agencies, and organizations like local governments, auto manufacturers, and EV charging companies will need to coordinate and collaborate to ensure Michigan's transportation electrification efforts are holistic, consistent, and effective in achieving state and local government goals.

6.2.8 Summary Table of Barriers and Solutions

The table that follows summarizes the barriers/hurdles and solutions pertaining to EVs. This table collects all barriers and solutions mentioned from workgroup stakeholder meetings and discussions, which go beyond the regulatory realm. However, the table may not be comprehensive, as it only reflects the learnings and discussions in this workgroup. Inclusion of barriers, hurdles, and solutions in the tables does not imply endorsement by Staff.

Table 13. Electric Vehicles Identified Barriers/Hurdles and Possible Solutions

Identified Barriers/Hurdles	Possible Solutions
1. Lack of long-term sustainable utility business model for EV infrastructure.	• Encourage innovative business models, like battery leases, bus leasing, utility capitalization of charging equipment and/or on-board storage, and on-bill financing, to help overcome upfront costs. • Combine mobility/transportation as a service with energy as a service. • Include all EV make ready in a plant asset and allow a broader line extension policy • Performance incentive mechanisms to encourage better use of metrics and program success. • Scale EV programs to keep up with the market with a more permanent funding approach.
2. Rate designs, tariffs, and requirement to have a separate meter for charging stations pose barriers.	• Create standardized treatment of EV charging infrastructure across different utility service territories. • Broader examination of rate design and tariffs beyond residential charging, including public charging and commercial charging stations, to result in the best environment for EV and electrification programs. • Examine demand charges and short-term rates to support long-term sustainability and increased adoption. • Use batteries to help reduce costs for small, underutilized stations negatively impacted by demand charges. • Increase the availability of alternate rates like those for DCFCs • Explore ways to meter EV charging without requiring a separate meter be installed
3. FERC Order 2222 requires MISO to create a tariff to allow aggregators to participate in its market. FERC wants monitoring costs low.	• Encourage all parties to keep infrastructure at a low cost, using AMI if possible. • Need to help monetize the process and make it easier for EV owners to participate as with an aggregator in marketplace.
4. Smart charging is not easy and uses only time of use rates.	• Facilitate vehicle-to-grid and vehicle-to-building, in addition to demand response programs, to maximize use of growing number and capacity of vehicle batteries as a resource when vehicles are parked or idle. • Communicate when to charge based on system needs. • Ensure real-time, effective communication, which is critical for smart charging and EV flexibility. • Educate customers on charging at off-peak hours.
5. Coordination between transmission & distribution is required.	• Method of service should stay with distribution to determine the most suitable connection point to the system. • Share information about system capacity and expected demand between transmission and distribution entities.
6. There is a lack of financial resources provided through policy.	• Funding from outside of utility rates would help as electricity customers should not be responsible for the bulk of the costs to rebuild the vehicle transportation system. • Link and co-market with other energy waste reduction and renewable energy programs. • Inclusive financing to capitalize on grid edge solutions, like EVs, through tariffed on-bill financing. • Create structure to support long term stability of investments. • Increase amount of public charging stations.
7. EV pilots are not yet full programs.	• Move out of pilot phase, incorporate lessons learned, and start full programs. • Provide regulatory flexibility to better utilize the grid, support vibrant third-party partnerships, and provide incentives to implement supporting technologies like batteries. • Recognize EV infrastructure is not a short-term investment and is critical to being carbon neutral by 2050.
8. EVs are sometimes viewed as a burden to the grid.	• Pursue flexible EV charging that supports the grid and is enabled by charging infrastructure. • Recognize EV benefits, including to non-EV owners, through resilience to extreme events, balancing and power quality, seasonal planning, generation capacity & transmission/distribution planning and Commitment and dispatch decisions. • Implement technologies that help lower cost and increase grid benefits like EVs with home energy backup and self-generation.
9. Substation upgrades may be required to accommodate charging demand.	• Though majority of substations examined could supply 100 EVs at 100kW without upgrades, some substations will require upgrades unless alternative on-site solutions like storage are pursued. • Develop a system where costs are shared by customers instead of being borne by last customer that necessitates new substation.

Table 13. Electric Vehicles Identified Barriers/Hurdles and Possible Solutions, cont.

Identified Barriers/Hurdles	Possible Solutions
10. EV charging infrastructure is not developing at the same speed as vehicles are reaching the marketplace.	• Include EV charging in new distribution system upgrades to help inform decisions. • State regulators should consider charging infrastructure and enabling managed charging. • Charging infrastructure can focus on single-family and multi-family homes, workplaces, entertainment industries, and corridors.
11. There is a high cost for implementing charging infrastructure, especially in rural locales, along with a lack of financial resources provided through policy.	• For small, underutilized stations, seek solutions like distributed batteries to help reduce costs. • Support the creation of mobility hubs • Allow leasing and new ownership models. • Move electrification beyond pace of incentives. • Offer funding from outside utility rates and make sure investments remain stable in the long term.
12. There exist socioeconomic barriers in adoption and needs in some communities are unmet.	• Examine EVs paths and needs in underserved communities through early listening and engagement to come up with tailored programs that make sense for underserved communities. • Offer greater incentives to multi-family housing building owners. • Ensure low-income customers have access to electrification opportunities through efforts like exploring innovative approaches like on-bill financing, community EV charging hubs, etc.
13. Electrification of Class 4-8 trucking operations may stress the electricity distribution system	• Encouraging the right charging schedule may significantly reduce peak demand. • Charging at lowest possible power level reduces peak power demand by ~40-90% • Charging at higher power levels results in increased flexibility to schedule charging
14. Residential EV charging significantly increases household electricity use. Clustering effects in EV adoption and higher power charging exacerbate it.	• Consider EVs in systems upgrades and distribution planning standards • Seek effective planning, smart EV charging, and distributed energy storage systems. • Update standards so EVs to integrate into the grid as both a resource and load. • Implement larger transformers and three-phase wiring
15. Utilities with many distributed energy resources (DERs), like EVs, will have many more controllable nodes connected to it than traditionally seen.	• Support utility engagement of a third party, who can control the DERs using substation level constraints communicated by the utility. • Clarify interoperability while allowing multiple standards.
16. Effectively communicating to customers to encourage movement to off-peak charging can be challenging.	• Create communications on when to charge based on the customer's systems. • Create real-time effective communications to allow EV load to be flexible.
17. DCFC interoperability has challenges.	• Invest intelligently in chargers and open standards for EVs to ensure interoperability. • Commission can mandate independent 3rd party testing for chargers supported by ratepayer funds. • Require operations and maintenance on DCFCs to ensure continued operability.
18. There is a lack of updated standards.	• Update standards. Electrification will allow EVs to integrate into the grid as both a resource and load. There are significant storage implications as well.
19. There is a lack of holistic, common statewide approach to EVs and electrification	• Create a holistic, common statewide approach to EVs and electrification—not a patchwork by different state agencies.

7. Heat Pumps for Space & Water Heating

7.1 Heat Pumps Background

Heat pumps serve as an alternative to traditional space heating and cooling. Heat pumps efficiently transfer heat from warm to cool spaces by creating a thermal differential between two parts of the system. Unlike a furnace, a heat pump does not generate heat; it transfers heat from one space to another (U.S. Department of Energy, nd-f). Most heat pumps consist of a compressor, an expansion valve, and at least two coils, an interior and exterior, which often contain a refrigerant used to transport the heat. Common heat pump technologies include the following types:

- **Air-Source**: Heat pumps with exterior coils surrounded by air to create the thermal differential over which it operates. It transfers heat between the building and the exterior air (U.S. Department of Energy, nd-b).
- **Ground-Source**: Heat pumps with buried or submerged exterior coils to create the thermal differential over which it operates, also commonly known as geothermal heat pumps (U.S. Department of Energy, nd-e).
- **Absorption**: A typical heat pump, but instead of a compressor run by electricity, absorption heat pumps are driven by a generated heat source. Common heat sources are natural gas, propane, or heated water. Unlike traditional heat pumps, absorption heat pumps cannot be reversed to provide cooling (U.S. Department of Energy, nd-a).
- **Ductless Mini-Split**: Small, individual space heat pumps that do not require typical ductwork. Mini-splits avoid heat loss typical of central air systems (U.S. Department of Energy, nd-d).

Heat pump's primary advantage over traditional heating methods is its superior energy efficiency. Heat pump efficiency is measured by SCOP (Seasonal Coefficient of Performance), which accounts for variations between seasons and is a more realistic measure than COP, which is only for a specific set of conditions. SCOP is a measure of how much heat is delivered for a given amount of energy input. If a heat pump has an efficiency of 4 SCOP, that means the system will, on average, transfer 4 watts of heat for every watt of electricity used to power the heat pump (Mayernik, 2021).

Due to the limitations of thermodynamics, furnaces have essentially reached their maximum level of efficiency, with the highest being around 97%. Furnaces and electric heaters cannot reach above 100% efficiency, but heat pumps can achieve 400% efficiency. This is because they do not generate the heat, they merely transfer it from one space to another. While heat pumps are significantly more efficient than furnaces, their efficiency is dependent on outdoor air or ground temperature and can only transfer pre-existing heat. The efficiency is determined by the difference between the outside and inside temperature. The smaller the difference, the more efficient the heat transfer. The primary reason ground-source heat pumps are more efficient than air-source is because the ground stays warmer than the air in winter and cooler than the air in summer and is thus closer to the indoor temperature (Mayernik, 2021).

Compared to the US average, Michigan requires more heating, about 85 to 90% more. This means that Michigan residents would get more use out of a heat pump and the increased efficiency. But as the temperatures fall, that efficiency diminishes. Unless properly designed or coupled with a secondary heating source, the heat pump may not be able to keep up with heat losses on the coldest days. Performance is also dependent on adequately sealing the building envelope and sufficient insulation to improve heat retention (Mayernik, 2021).

Modern heat pumps can maintain a comfortable indoor temperature with outdoor temperatures as low as -14° F. Heat pumps capable of operation in even lower temperatures are currently being developed. The northern parts of the state can reach temperatures below -14° F, but many modern systems have backup heating options. These are less efficient options but are critical for maintaining indoor temperature during deep cold snaps (Mayernik, 2021).

Since heat pumps are 2.5 to 7.5 times more efficient than traditional furnaces, the emissions from energy consumption are significantly lower. However, the exact impact on emissions is difficult to calculate because heat pumps have a different demand profile than traditional systems. Furnaces switch on and off regularly whereas heat pumps run almost constantly, keeping the building or water tank at a near constant temperature. Another complicating factor is that heat pumps rely on refrigerants that have significant global warming potential if they leak into the atmosphere due to damage or degradation over time. Natural gas-powered heat pumps also exist, commonly referred to as absorption heat pumps, that rely on natural refrigerants like ammonia.

Cold climate heat pumps can provide efficient heating, even at very cold temperatures as low as -14 degrees F. Many heat pump systems have back up heating to maintain thermal comfort on days that are even colder than that. The value proposition for heat pumps in Michigan is likely going to improve with time given the further technological improvements to performance and efficiency (Mayernik, 2021).

The price of heat pumps varies significantly, but it has been shown that in general, cold climate heat pumps are economical in Michigan. With proper design, heat pumps should almost always be a cost-effective option. Higher energy costs and a longer heating season mean that the value of annual energy savings will be greater. For retrofits, additional envelope upgrades, such as additional air sealing or insulation, contribute to both the upfront cost and the operational savings. When considering the operational costs, electricity prices are projected to remain stable, while natural gas prices are expected to increase and may increase considerably by the year 2050.

In NREL's Electrification Futures Study, researchers found residential and commercial electrification in buildings impacted space heating, water heating, and cooking end uses the most. In the reference scenario, 18% and 15% of 2050 space heating in residential and commercial buildings, respectively, were provided by electric technologies with air source heat pumps (ASHPs) representing 40% and 54% of this in residential and commercial buildings, respectively. Under the medium electrification scenario, ASHPs grow to 40% and 35% of space heating needs for residential and commercial buildings, respectively, while electric water heating grows to 47% and

20%, respectively. The high electrification scenario assumes R&D advancements that make cold climate heat pumps cost competitive with conventional technologies. Under this scenario, 35% of end-use service demand in cold climate residential and commercial buildings are from heat pumps (Mai et al., 2018).

7.2 Heat Pumps Discussion

In the stakeholder process, several areas presenting hurdles to the development of heat pumps for space and water heating were discussed. These areas are:

- Lack of customer awareness and education impedes implementation,
- High cost of implementation poses barriers,
- Site specific limitations may pose barriers for geothermal heat pumps,
- Heat pumps provide opportunities for grid integration and management,
- Heat pump emissions reduction impact is not fully recognized,
- Limits on fuel switching complicate utility rebates for heat pumps,
- Winter peaking fears are reduced with weatherization and demand response, and
- Holistic regional strategy supports implementation of heat pumps.

Each hurdle is discussed in the following sections.

7.2.1 Lack of Customer Awareness and Education Impedes Implementation

Heat pump availability, demand, and education impede implementation. Most people do not know the benefits a heat pump can provide. The lack of customer education or awareness of heat pumps and few contractors promoting them drives the cost up, which all discourages adoption (Goncalves, Holladay, Jackson, McNeally, & Neme, 2021). HVAC Installers need to be trained not only on heat pump capabilities, but also on how to properly size and install them (Murchy, 2020). Most furnace replacements occur after a failure, so there is little customer forethought as they defer to the contractor. If the contractor is not comfortable with heat pumps, they will not recommend them.

Spotlight: Ontonagon Village Housing

Michigan's Upper Peninsula Power Company (UPPCO) and Efficiency United installed high efficiency, cold climate mini-split heat pumps in Ontonagon Village Housing units. The heat pumps provide heat even when outside temperatures reach -10 degrees Fahrenheit, reduce reliance on electric baseboard heaters, and lower overall consumption. The Ontonagon Village Housing's weatherization efforts in its sixty units in preparation for the heat pump installations saved approximately 10% of its energy bill in the winter of 2018-2019 (TV 6, 2019). Though residents have been pleased with the heating performance, as well as the additional dehumidification and cooling from the heat pump units, Ontonagon Village Housing did not originally know heat pumps were an option when replacing its aging electric baseboard heaters until its utility, UPPCO, reached out to educate them about the option (Goncalves et al., 2021).

Air source heat pumps have been around for some time and have experienced technology renovations. They can deliver heat at lower temperatures and do it more efficiently than in the past. Consumer views of heat pumps may be negatively impacted by experiences with past, older heat pump systems (Lis, 2021).

7.2.2 High Cost for Implementation Poses Barriers

Heat pumps are expensive. Incentive programs can help make them more affordable (Billimoria, 2021; Gold, Kushler, & Perry, 2021). Since stranded costs of gas infrastructure disproportionately affect low-income customers, there should be specific allocations in any funding programs for low-income customers (Billimoria, 2021).

Incentives can change the payback period substantially. Cost effectiveness for commercial space heating electrification, even in cold climates, were cost effective with incentives, which changed a 50-year payback to 20 years. However, heat pumps applications in new construction and retrofits of fuel oil, propone, or electric baseboard heating systems already have low payback periods (Billimoria, 2021; Gold et al., 2021; Mayernik, 2021). Even without incentives, residential retrofits and new construction were found to be cost effective (Gold et al., 2021). Currently in Michigan, there are an estimated 336,000 households depending on propane and 42,000 households depending on fuel oil for heating fuel. Therefore, an estimated 378,000 households in Michigan could cost effectively switch to heat pumps for home heating now. If these households install geothermal heat pump systems, they will realize potential annual savings of more than $1,500 and carbon savings of up to 65% and 80% for propane and fuel oil retrofits, respectively (Tang, Banai, & Rinehart, 2021).

Michigan has about three million households with natural gas heat (Tang et al., 2021). Conversion of natural gas heated homes to heat pumps is not currently cost effective as an individual investment (Gold et al., 2021; Mayernik, 2021; Tang et al., 2021). However, if the retrofit of natural gas heating systems to heat pumps is viewed in the context of broader decarbonization efforts, including those in the electricity and transportation sectors, total consumer energy costs may be similar to those currently (Murphy & Weiss, 2020).

7.2.3 Site Specific Limitations May Pose Barriers for Geothermal Heat Pumps

Geothermal heat pumps, especially, are limited by individual sites. In residential applications, the site may lack the area needed for a traditional rig suites to install the geothermal heat pump system (Tang et al., 2021). There is also a high initial cost for installing the external portion of the geothermal heat pump system, so it may only be economically feasible if it is located to served concentrated load, such as in commercial buildings or complexes. Lastly, most buildings in the US are distant from economical sources of geo-heat (Hughes, 2008).

However, with advances in geothermal heat pumps, smaller rig suites allow access to suburban homes with smaller footprints. Other innovations, like standardized installation and integrated software and hardware help further reduce costs (Tang et al., 2021).

7.2.4 Heat Pumps Provide Opportunities for Grid Integration and Management

From a utility's perspective, there are cost savings from the energy efficiency of the heat pumps alone, when compared to other electric heating technologies. However, heat pumps can contribute in more meaningful ways. In the future, these devices may be useful in providing ancillary services to the grid, especially when aggregated. Like other heating and cooling technologies, they can be utilized to lower peak demand through demand response. They also have the potential to be used in a smart grid to provide services like voltage reduction, congestion management, renewables integration, and residential load smoothing (Fischer & Madani, 2017).

7.2.5 Heat Pump Emissions Reduction Impact is not Fully Recognized

Governor Whitmer's Executive Directive 2020-10 has a goal of carbon neutrality by 2050. Heat pumps can help in realizing this goal. They can reduce carbon emissions compared to the gas alternative over the lifetime of the heat pump in 99% of U.S. households, as heat pumps deliver two to four times more heating energy than the electric energy they consume. Heat pumps can help significantly reduce building carbon emissions. Beyond adding carbon to the atmosphere, burning natural gas for building use also presents human health concerns. The increase in natural gas infrastructure combined with its long payback periods pose a significant barrier to Michigan's timeline for reaching carbon-neutrality (Billimoria, 2021).

Outside of carbon reductions, heat pump water heaters can allow utilities to shift and shed loads due to their grid connectivity. Given that heat pump water heaters use about half as much energy as electric resistance water heaters, they can support substantial energy and greenhouse gas emissions reductions, while also providing flexible control for the utility (Gold et al., 2021).

Supportive policies can significantly improve the economics of space heating electrification, even in colder climates. They can help achieve beneficial electrification, which can be a form of energy efficiency when it reduces total energy consumed in source Btus, saves consumers money, and reduces emissions. Through policy goal setting, fuel switching restriction reform, cost-effectiveness guidelines, business model reform, and program design updates, states have brought beneficial electrification into energy efficiency programs. Many states have energy efficiency resource standards (EERS), which hinge on load reduction. However, many states are starting to adopt a more holistic approach of fuel-neutral "Btu" goals that consider site and source savings and includes a portfolio of targets to ensure electricity efficiency. To encourage decarbonization and energy efficiency in utility programs, decoupling and incentives need to be in place. Targeting upstream incentives to contractors will also help to encourage weatherization, or pre-electrification programs, along with new heat pumps (Gold et al., 2021).

Cost-effectiveness tests have been adjusted to better value electrification benefits. The National Standard Practice Manual shares guidelines for benefit-cost analysis of DERs. Though electrification will largely require increased generation and net electric utility system costs, it will also reduce costs from fuels that it replaces. The greenhouse gas emissions reductions should also be included in the analysis. Electrification usually leads to increased electric utility revenues, which may lead to reduced electricity rates (Gold et al., 2021).

7.2.6 Limits on Fuel Switching Complicate Utility Rebates for Heat Pumps

Public Act 342 creates limits on fuel switching, which complicates utility rebates for heat pumps. It defines energy waste reduction, (EWR) as a "decrease in customer consumption of electricity or natural gas, achieved through measures or programs…" [Sec. 59d)]. The Act states the overall goal of EWR is to reduce the future costs of utility service to customers, and that EWR plans shall be designed to delay the need for constructing new electric generating facilities and protect consumers from incurring the costs of such construction. Additionally, the Act specifically ties both the EERS and the potential for incentive payments for utility performance to a reduction in the percentage of sales in MWh for electric providers and a percentage of sales in dekatherms for natural gas providers. The Act is silent on the effects of these programs targeting climate, GHG reduction or carbon reduction. This means potentially the only heat pumps that could qualify as an EWR measure is electric heat pumps replacing inefficient electric heat, or gas heat pumps replacing inefficient gas heat (Gold et al., 2021).

The Commission has stressed the importance of adherence to the legislative language. The Commission stated, "Notwithstanding, the Commission cautions that measures that increase overall electricity consumption–regardless of a reduction in total million British thermal units of energy usage or other benefits–are not suitable for full-scale electric EWR program implementation. The Commission stresses the importance of maintaining the integrity of electric EWR programs with respect to the clear statutory charge in 2008 PA 295 as amended–that is, to save kilowatt-hours and defer investment in new power plants. The Commission also added in those orders, "Moreover, the Commission is concerned, particularly for low-income customers, that heat pump applications may increase overall energy costs relative to propane or other fuel sources, at least based on current prices." Although the Governor has expressed great interest in combating climate change, absent explicit statutory authority, the Michigan utility programs should maximize building energy efficiency while continuing to research and pilot projects to prepare for future larger scale heat pump electrification (Gold et al., 2021).

7.2.7 Winter Peaking Fears are Reduced with Weatherization and Demand Response

There are concerns that high heat pump use will cause winter electricity peaks in Michigan. The use of weatherization and demand response solutions will help mitigate winter peaking concerns (Billimoria, 2021). In addition, the impact on winter peak demand is not uniform across ground source and air source heat pumps. In a study of electrification in New England, researchers found the addition of ground source heat pumps increased demand by 17% while ASHPs increased demand by 94%. Due the higher electricity needs of ASHPs and its impacts on peak demand, high ASHPs adoption may increase electric heating costs (Murphy & Weiss, 2020). The reduced impact of ground source heat pumps on winter demand peaks is likely due to the greater capacity and discharge temperatures at cold temperatures of ground source heat pumps in comparison to ASHPs (Tang et al., 2021). See Figure 10 and Figure 11 for examples.

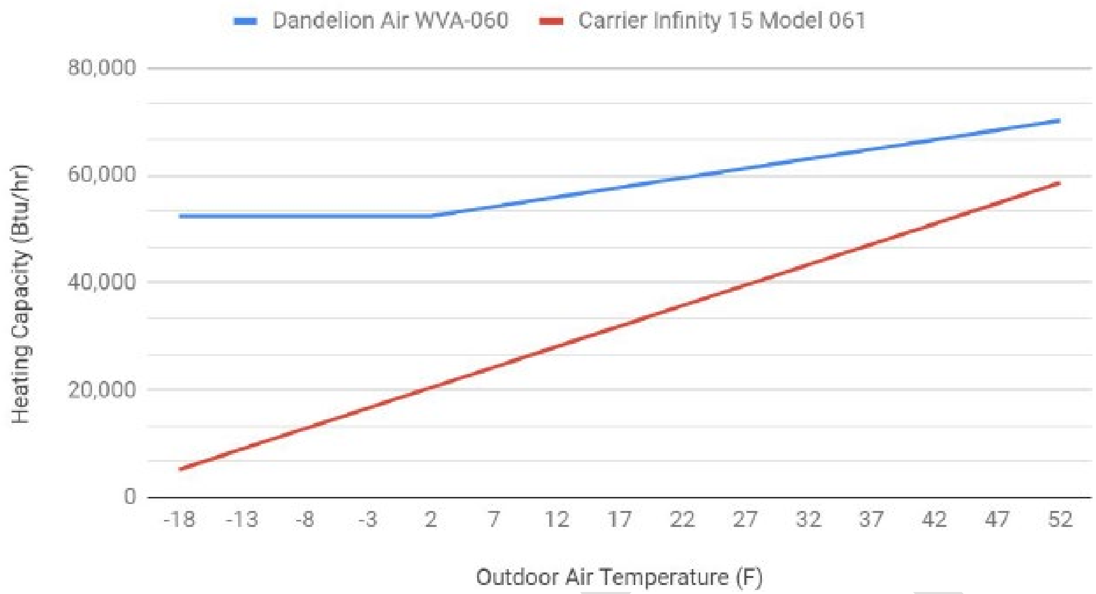

Figure 10. Heating Capacity vs. Outdoor Air Temperature Comparison of Ground Source vs Air Source Heat Pump Example (Tang et al., 2021)

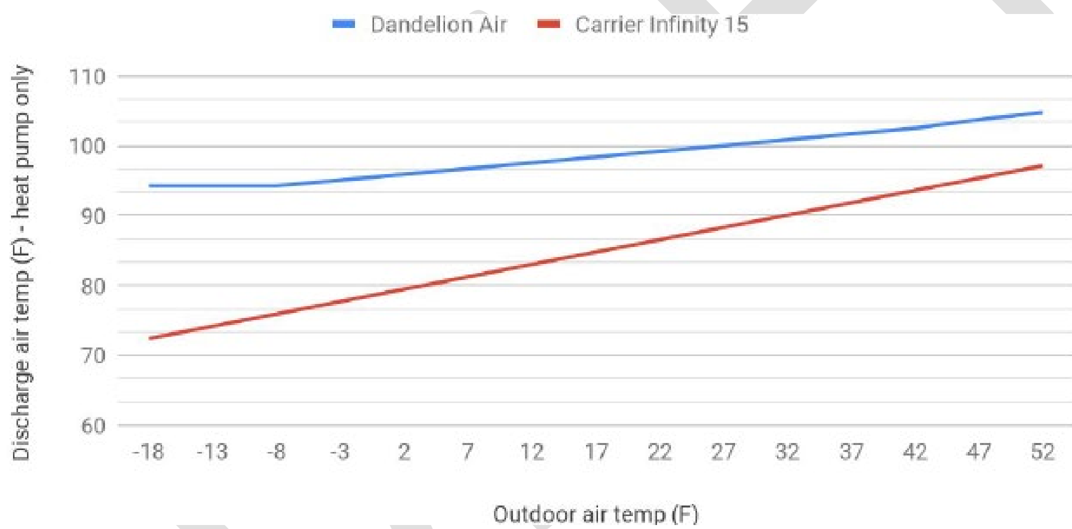

Figure 11. Discharge vs. Outdoor Air Temperature of Ground Source and Air Source Heat Pump Example (Tang et al., 2021)

7.2.8 Holistic Regional Strategy Supports Implementation of Heat Pumps

Michigan lacks a holistic strategy supporting implementation of heat pumps, unlike other states and regions. Air source heat pumps sales in the Northeast is rising and dominated by ductless systems. Variables accounting for the increase in market share: market forces, consumer demand, robust programs, supporting policies, and regional coordination. Some states are re-examining positions on beneficial electrification to allow heat pumps to have a market share (Lis, 2021).

The Northeast Energy Efficiency Partnerships (NEEP) works to implement a regional strategy by working with policy makers, industry players & business interests and program administrators and advocating for the adoption of heat pumps. NEEP engages in a number of market transformation strategies and has a long-term adoption target of 40% primary heat pump systems installed by

2030 (Lis, 2021). It balances the urgency of changing market penetration immediately and quality of making sure the right infrastructure is in place to support market changes. It also offers a suite of consumer and installer resources (Lis, 2021).

Spotlight: The Maine Example

Maine uniquely mostly uses delivered fuels for heating. It is aiming for electric heating due to high heating costs. Efficiency Maine, an independent quasi-state agency, focuses on scalable market-based electrification which requires extreme customer satisfaction, attractive business opportunity for vendors and installers, and supportive public policies. To promote positive consumer experiences, it provides heat pump customer education, assists with finding a contractor, and provides online home heating cost comparison tools. Customer peace of mind is supported through quality assurance, vendor training and registration, and inspections (Burnes, 2021).

To create an attractive business opportunity, Efficiency Maine provides heat pump rebates with no weatherization or energy audit prerequisite. For participating distributors that mark down heat pump prices, it reimburses them $850. Trade allies have access to rebates, home energy financing, marketing funds, training scholarships, e-newsletters, sales tools, and listing on the registered vendor locator. Instead of "training up" contractors, Efficiency Maine creates a market. For instance, with heat pump water heaters, program implementers make sure they are the least expensive option, as many water heaters are replaced in emergencies with customers seeking the cheapest model (Burnes, 2021).

Maine public policy sets it apart from other states in the heat pump market. Maine law requires Efficiency Maine to harvest "all cost-effective" electric efficiency and that such efforts will be paid through utility rates. It also requires Efficiency Maine to install 100,000 high efficiency heat pumps in the next five years. High performance standards have also translated to high customer satisfaction. These efforts are effective. Maine has the highest market penetration for heat pumps in the country. Support from policy makers and regulators help heat pump uptake substantially (Burnes, 2021).

Gas and electric regulation can either support or hinder building decarbonization. To support decarbonization, regulation should include 1) a focus on equity and inclusion from the beginning, 2) holistic approaches to decarbonization including coordination of legislation, public service commission, and other state agency efforts as well as workforce development plans to address technology deployment, near-term market opportunities like how to get heat pumps into homes cost effectively and at scale and 4) managing the transition. Policy regulatory efforts like electricity rate designs and reconsidering fuel switching prohibitions are necessary. In shifting towards electrification, attention must be given to not leave stranded gas assets. Therefore, gas and electric planning should no longer be siloed, but considered together (Billimoria, 2021).

7.2.9 Summary Table of Barriers and Solutions

The table that follows summarizes the barriers/hurdles and solutions pertaining to heat pumps. This table collects all barriers and solutions mentioned from workgroup stakeholder meetings and discussions, which go beyond the regulatory realm. However, the table may not be comprehensive, as it only reflects the learnings and discussions in this workgroup. Inclusion of barriers, hurdles, and solutions in the tables does not imply endorsement by Staff.

Table 14. Heat Pumps for Space and Water Heating Identified Barriers/Hurdles and Possible Solutions

Identified Barriers/Hurdles	Possible Solutions
1. There is a lack of consideration of HPs in energy system planning.	• Expand energy system planning to include electric heat pumps. • Manage infrastructure and stranded asset risk.
2. There is a lack of standardized per ton (BTU ton) incentives.	• Provide meaningful per-ton incentives that applies to all utilities in the state, like in NY, CT, and MA. • Create incentives that consider the size of the unit installed
3. There are legislative barriers regarding fuel switching. Michigan utility EE statute (PA 342 of 2016) essentially precludes electrification and use of heat pumps.	• Expand EWR legislation to look at fuel neutral energy waste reduction. • Encourage fuel switching or substitution through guidelines or fuel-neutral goals that decarbonize in a cost-effective way. • Utilities can provide more fuels sources, as delivered fuel market is volatile and expensive. • Customers can make the choice to change without EWR marketing. • Change building codes to eliminate natural gas furnaces/hookups and to be HP ready. Also provide incentives to install HPs in new construction.
4. There are perverse price signals and an unlevel playing field.	• Mobilize state and local policymakers to expand support for ASHPs • Enable promotion of climate appropriate ASHPs through improved performance metrics. • Update electricity rate designs and create a rate specifically for ASHPs. • Very good calculation that is trusted to show the economics. Well understood by the broader population.
5. There is a lack of consumer knowledge. There may also be misinformation from incumbent supply chain installers and fuel dealers, causing impression of customer satisfaction to be low due to past heat pump experiences.	• Provide customer education and outreach opportunities regarding heat pump benefits and promoting positive consumer experiences. • Clearly calculate the economics so that it is trusted and well understood by the broader population. • Provide heat pump technical information and a registry of vendors. • Develop more accurate tools to predict energy, cost, and GHG savings associated with ASHPs using analysis of real-world performance data. • Michigan has certain use cases (such as all electric systems in new construction, residential propane to HP retrofits, and residential fuel oil to HP retrofits) that are likely cost effective now. Gather data, analyze it, and provide education regarding the benefits and economical use cases. • Provide quality assurance through registration, training, and inspections.
6. There is a lack of contractor availability in Michigan due to lack of demand and education.	• Provide customer education on heat pumps and optimize customer and market offerings. • Provide contractor training on cold climate heat pump performance, maintenance, etc. and address the aging and retiring HVAC workforce. • Target upstream incentives for contractors or distributors
7. Heating electrification economics are difficult due to high cost of heat pumps, especially in Michigan due to lack of scale.	• The right policies greatly improve economics. Policies such as utility incentives with energy efficiency upgrades, financing options, carbon price, or a statewide incentive rather than individual utility rebate programs help develop HP demand to create economies of scale. • Customer education regarding which heating fuels or systems are more economical to have supplemental heat pumps. • Enable long term view. Electricity prices are expected to decrease/increase moderately. Natural gas prices are expected to increase up to 125%. • Customer affordability is the priority and understanding the impact on their bills will help develop further solutions. • Transition AC to heat pumps to help drive the market, in turn driving down cost.
8. Cold climate limits potential HP usage.	• Provide education on modern HPs' cold climate performance to help build trust in the technology. Be truthful of limitations. • Install dual fuel systems, like natural gas backup, for comfort in the Midwest. • Cold climate HPs should be standard in MI. Look to NEEEP standards for examples such as 15 SEER, 10 heating seasonal performance factor (HSPF) for single zone mini split system and 15 SEER for multi zone and 9 HSPF. • Treat the home as a system and include weatherization measures. Update energy efficiency standards when electrifying homes.
9. Site space limits ground source HPs.	• Use new product innovations that that reduce required footprints, standardize installation, and drive down costs. • Use horizontal GSHP which require a smaller footprint.
10. Many heating system replacements are for emergencies with no research.	• Education and pre-planning for heat pump retrofits for consumers and dealers/installers. • Provide incentives that make heat pumps the lowest cost system so when these cases occur, heat pumps are installed.
11. Use of HPs can cause winter peaking in a highly electrified future.	• Building envelope efficiency cannot be ignored especially in cold climates. Provide corresponding efficiency education. • Encourage development of mitigating strategies such as weatherization and demand response programs.
12. There is no holistic decarbonization approach.	• Alight efficiency policies with decarbonization and align decarbonization regulatory work across state and local agencies. • Establish clear guidelines for alternatives fuels and plan for workforce development

8. Microgrids

8.1 Microgrids Background

A microgrid is a series of interconnected loads and distributed energy resources (DERs) within clearly defined electrical boundaries. Microgrids can act as a single controllable entity with respect to the grid and can operate in both grid-connected mode or island mode. Microgrids are comprised of the following (Gagne, 2021b):

- One or more generation assets,
    - This can be traditional fuel-powered generation, wind turbines, solar PV, or CHP.
- Energy storage (optional),
- Control hardware/software,
    - This is an often overlooked component that is many times a significant driver of overall microgrid costs, especially for smaller systems.
- Conductors,
- Protection devices, and
- Power factor correction (optional),

Microgrids vary in their size and application according to end-user needs. In recent years, U.S. microgrid installations have been driven by resiliency needs in response to extreme weather events. Between now and 2025, microgrid deployment is expected to the highest growth in Florida and Texas to provide resiliency from hurricanes, Alaska as a remote fuel supply cost mitigation measure, California for wildfire resiliency and high time of use rate mitigation, and the Northeast, especially in New York and Massachusetts where policy encourages microgrid implementation (Gagne, 2021b).

There can be a phased approach to microgrids. In the basic phase, grid-level generators can island groups of loads from the grid through manual operation of all switching and generation. In the intermediate phase, grid-level generators can remotely island loads from the grid. Though the system is half-automated, it still requires manual load shedding. Once loads are shed, generators can be remotely controlled. Lastly, in the advanced phase, the microgrid is fully automated. The entire installation can be islanded through central control of both load shedding and generator output (Gagne, 2021b).

A microgrid can be community based, campus based, building based, or home based. Common system elements include controllable loads, DERs, and intelligent controls. Costs for microgrid projects are driven by size, complexity, and system requirements. Examples of complex microgrids include government, municipal, utility large industrial, university hospital, and data center. Basic microgrids are commercial buildings, distribution centers, and small-scale processing. Finally, simple microgrids are small office buildings, light commercial, or residential projects. Complex, basic, and simple microgrids have different resiliency, efficiency, and sustainability goals (Connors, Vernacchia, & Ruckpaul, 2021).

8.2 Microgrids Discussion

In the stakeholder process, several areas presenting hurdles to the development of microgrids were discussed. These areas are:

- Microgrid resilience and sustainability benefits are not fully recognized,
- Microgrid funding mechanisms are needed,
- Variety of interconnection processes increase complexity,
- Need for experimentation and large scale exploration,
- Include microgrids in planning processes,
- Empower flexibility to allow benefits to be broadly shared, and
- Barriers make translating community interest into reality daunting.

Each hurdle is discussed in the following sections.

8.2.1 Microgrid Resilience and Sustainability Benefits are not Fully Recognized

Microgrids provide resiliency, sustainability, and efficiency. Resiliency results from addressing grid instability, providing backup power for operations, and the ability to operate autonomously from the grid. Sustainability results from the ability to achieve Net Zero through renewable power generation, and the reduction of environmental pollutants such as GHG and carbon dioxide. Efficiency means that grid energy spending is reduced with on-site generation, peak shaving, demand response, and more. Efficiency also comes from the ability to participate in energy markets and to benefit from economic incentives such as renewable energy credits, tax credits, and government funding (Connors et al., 2021).

Resilience, however, is more subjective that reliability, which is an objective concept that can defined by standards. Resilience is difficult to monetize. It is also difficult to develop planning objectives for it. A resilient grid framework begins by recognizing resilience as a locational value and identifying specific risks and optimal means of addressing them. Specifically, a resilient grid framework involves: site selection, risk identification, definition of critical loads, and engagement in iterative planning between project and grid levels (Twitchell, 2021a).

A decision to pursue a microgrid is based on a site's need for increased resilience. An increased need for resilience can be identified by critical site functions that could result in loss of life or equipment if disrupted. Some examples include hospitals, flight operations, laboratory tests, and emergency shelters. A site with unreliable power is also ripe for a microgrid project (Gagne, 2021b).

The cost and economic benefits also impact the decision to pursue a microgrid (Gagne, 2021b). A potential microgrid project must weigh if improved resilience is worth the added costs. Though microgrids are generally expensive due to the tailored analysis, engineering, and equipment, they also provide financial benefits. This includes peak shaving, energy price arbitrage, demand response, renewable energy credits, ancillary services like volage regulation and capacity market payments, avoided distribution system upgrade costs, and many others (Gagne, 2021b). In some cases, microgrids can provide essential grid support in emergencies, as in the case of Texas Medical Center microgrid operated by Thermal Energy Corporation (TECO) during Winter Storm Uri in February 2020 described in the spotlight below.

Cost considerations may not be central to the installation of a microgrid. In the case of the TECO microgrid, the critical load and the magnitude of the $25 billion business that TECO serves made the cost of the microgrid a small price to pay to ensure continuity of business operations, functional service to 9,200 hospital beds, and preservation of the medical research conducted at the facilities. Though no financial benefit was assumed in the decision to install the TECO microgrid, the investment has paid for itself by 150% in the eleven years the microgrid has operated (Swinson, 2021).

Spotlight: Texas Medical Center Microgrid Operated by Thermal Energy Corporation

The Texas Medical Center in Houston is the largest medical center in the world, serving 17 institutions, including eight hospitals, with over $25 billion in revenue and over $2.5 billion per year of funded medical research. As such, energy reliability and resiliency are paramount. It is served by a district energy system and microgrid run by the non-profit TECO. The district energy system, the largest CHP district chilled water system in North America, was commissioned in 1969 and the microgrid was installed in 2010. The microgrid has 64 MW of power generation and can serve all TECO's summer peak power needs (Swinson, 2021).

Winter Storm Uri in February 2021 caused record cold temperatures throughout Texas. Of the 107,514 MW of installed capacity in the state, there were 52,277 MW of outages. Since the TECO system is designed to provide 100% of peak power requirements in the summer, and this was a winter event, the Texas Medical Center load was only 5 MW. This allowed TECO to export 50MW/hour for 6 days. This was enough power to support 10,000 homes while the Texas Medical Center operated without interruption. The Texas grid frequency dropped to 59.302 Hz during the storm event. At 59.300 Hz, a total blackout across the entire state would have occurred. Had TECO experienced an outage of its own, the frequency would have dipped below the crucial threshold. The microgrid not only provided the Texas Medical Center with reliable and resilient utility services, it also provided essential power grid support to the larger electric system (Swinson, 2021).

8.2.2 Microgrid Funding Mechanisms are Needed

Though microgrids may be installed for more than cost considerations, they can be expensive to implement, making funding mechanisms beneficial. Microgrids can be funded in different ways. In a direct purchase, a site owner purchases a system that has been designed and built. There is often a contract for ongoing operations and maintenance support. In a benefit share option, a battery energy storage system is used to create shared revenue streams between an owner and a provider. A power purchase agreement is an energy as a service model where the owner pays a single rate to a provider (and/or financer) based on the output and performance of the microgrid system (Connors et al., 2021).

A key aspect of whether a microgrid can take off is the ability to pay for it. Revenue streams must be opened for more market access. FERC Order 841 will be delayed in its response to whether batteries have access to the market. FERC Order 2222-A is another avenue by which DERs can participate in markets. As time-based elements are added to tariffs, flexibility is incentivized. Commercial and industrial customers may be able to pay more for microgrid systems depending on the outcomes they can achieve. Businesses must be mindful of regulations and tariffs, and this is where a developer can help. Utilities and energy-as-a-service companies can be valuable assets. Grid services can stretch across equipment and is not concentrated just at the microgrid location. Private companies operating microgrids can provide benefits to the consumer and to the grid. (Barnes, Feasel, & Rafson, 2021).

Federal microgrids can be government or privately owned. Government owned microgrids have procurement options of utility energy service contracts or energy savings performance contracts (ESPC). Privately owned entities have procurement options of ESPC energy sales agreements, power purchase agreements, and enhanced use lease/real property arrangements (Gagne, 2021b).

Spotlight: University of Texas Microgrid

University of Texas at Austin campus microgrid serves the entire campus electric, cooling, and heating needs for 20 million ft^2 in 160 buildings. There is an estimated $3 billion worth of infrastructure investment since the 1976, built with intentional redundancy, to support campus needs, especially the research conducted, which is worth about $500 million and cannot afford to be interrupted. Lab buildings consume almost 40% of the energy on campus. The single largest load on the system is cooling which makes up 25-50% of total load depending on time of year (Ontiveros, 2021b).

For its microgrid system, the University purchases 3.9 MMBTU of natural gas and generates 339 million kWh per year. There are 2 combustion turbines, rated for 45 MW and 32 MW, respectively, that produces power. Exhaust make steam that goes to four steam turbines (two 25 MWs and two 6 MWs turbines). One combustion turbine and one steam turbine are run as a pair at any given time. One is sized for summer loads and one for winter loads. If the system trips, there is 25 MW on standby. There are four boilers to produce steam can for the steam turbines in the event of a system trip, as steam cannot be purchased. For cooling loads, there are 18 electric chillers ranging from 2,000 to 5,000 tons. Two thermal storage tanks with 10 MW of stored capacity are used to shift load as backup for the cooling. Though campus square footage has increased over time, the fuel used and carbon emissions are at 1976 levels due to the high system efficiency (at 88.5% in 2019) (Ontiveros, 2021b).

In operating its microgrid, the University has learned the importance of building partnerships with the natural gas state agency as well as vendors, engineers, and contractors. Technology investments, like an intuitive data historian, instrumentation, and metering to measure performance, and forecasting support optimization of the system (Ontiveros, 2021b). Beyond technology investment, investment in people and culture is also needed. During the extreme conditions during Winter Storm Uri in February 2021, some university plant operating staff worked 70 hours straight, sleeping on the plant floor, to ensure continuity of service to the university (Ontiveros, 2021a).

8.2.3 Variety of Interconnection Processes Increase Complexity

The right regulatory structure can make interconnection easier. Currently, there are many different interconnection processes which make it difficult for developers to navigate each one (Barnes et al., 2021). Interconnection requests for microgrids can be treated like any other DER interconnection request. A standardized process is valuable, and a microgrid can follow that process easily (Barnes et al., 2021).

Recognition of the value microgrids provide may support interconnection of such devices. There is value to a microgrid being able to island during an outage. A utility can also request that a microgrid system island during peak usage to alleviate system demands. In a similar vein, Consumers Energy has a program that will pay customers to run generators during demand response events (Barnes et al., 2021).

Utilities are in the beginning stages of microgrids, storage, and using renewables for resiliency. Utilities try to take as many variables into account as possible when applying solutions to the grid. Microgrids can be designed for a specific location with different components and different outcomes. Currently, there is a "toolbox" of solutions that utilities can use to determine needs and design for resiliency. Developing a matrix could be the next step (Casablanca, Singh, & Washburn, 2021).

8.2.4 Need for Experimentation and Large Scale Exploration

To move the microgrid market forward in Michigan in the short term, utilities should be allowed to experiment and study microgrids on a large scale. Customers need to be able to see the opportunity from their end. The MPSC needs to examine how the regulations and rules they are implementing will affect the ability to develop microgrids which will add stability to the grid and benefit external customers as well. Investing in digitization is a much smaller investment that benefits customers (Gagne, 2021b).

As local needs grow, understanding how microgrids can benefit the local and larger grid is necessary. Microgrid adoption has been impacted by electrical demand, decentralized electric supply, and growing infrastructure needs (Connors et al., 2021). Successful microgrid projects have resilience benefits that are hyperlocal. Projects are limited to a single facility and may be as small as a single residence. Energy storage is a key enabling technology for microgrids (Twitchell, 2021a). Understanding how local and grid needs can be met by microgrids requires experimentation, exploration, and continued learning. Engagement with stakeholders and customers is valuable to determine their needs and wants (Casablanca et al., 2021).

Allowing experimentation and large-scale microgrid learnings may help utilities operationalize the learnings for consistent implementation. The technology around microgrids is constantly evolving, making it hard for utilities to keep up. Utilities focus on keeping up with industry and technology changes. One of the challenges is coming up with a standard menu of options and maintaining a catalog of options (Casablanca et al., 2021).

8.2.5 Include Microgrids in Planning Processes

Microgrids are not currently included in all grid planning processes. Adding microgrids, individual systems, and DERs takes much planning. The protection aspect of microgrids must be considered. Islanding requires studies and planning by grid engineers. Response to the ever-changing technology is important. Utilities need to adapt to new technology while balancing risks (Barnes et al., 2021).

Microgrids involve internal considerations, like outages and power quality, as well as external issues, like rate structure and equipment operations. The internal and external considerations shape the financial aspects of grid design. During the planning process, it is important that positive outcomes are not only created just for the wealthy. Grid benefits must be incentivized, as well as digitizing energy so the ability to impact how and when consumers use energy is possible (Barnes et al., 2021).

8.2.5 Empower Flexibility to Allow Benefits to be Broadly Shared

Empowering flexibility will allow benefits to flow to all energy consumers. Technology is evolving Work to figure out the blockchain mechanics is necessary so consumers can reap some of these benefits. Michigan's current structure of regulated utilities does not allow an individual to sell power to a neighbor. Other states, such as Illinois, have this capability. From the utility's perspective, the future involves how best to manage DERs. They will need to decide whether to incentivize through rate design, or to manage individual assets (Barnes et al., 2021).

Spotlight: Veridian @ County Farm – Living Community Microgrid

Veridian at County Farm is a neighborhood in development in Ann Arbor, Michigan, that is intended to meet sustainable energy goals. A site plan has been approved for the neighborhood, which will be all 100% electric, 100% solar powered, and net zero energy. At completion, one third will be affordable housing and the remaining homes will vary in price point from under $200,000 to $765,000. Over 1.4 MW of solar will be installed over unit rooftops to produce 1.6 MWh per year. The system would be all privatized at the homeowner level (Grocoff, 2021).

The development faces many barriers: regulatory, code, logistical, financial, and others. Though it will provide clean energy benefits, the development also presents potential grid complications. THRIVE Collaborative, which is developing the neighborhood, is brainstorming ideas with DTE Electric on how to execute the project components. THRIVE Collaborative recognizes the opportunity the development presents and is eager to partner with DTE Electric to assemble, test, and manage the technologies for the all-electric community (Grocoff, 2021).

THRIVE Collaboration has partnered with University of Michigan, DTE Energy, Ann Arbor 2030 District, A^2 Zero, and NextEnergy to apply for a U.S. Department of Energy grant. If awarded, DTE Electric will be put storage, demand response, solar, and efficiency onto the grid. The utility will also control the DERs in response to community and system needs (Grocoff, 2021).

In Michigan, the self-service language in Act 3 states that self-generation can provide power to adjacent properties as long as it is behind-the-meter. This could prevent microgrids from benefitting a larger area. There is opportunity to utilize the behind-the-meter aspect to participate in self-generation and sub-meter the energy to smaller facilities. Virtual net metering in other states has allowed microgrid systems to benefit a larger footprint. Michigan does not currently have virtual net metering. It can be beneficial to not use the word "microgrid." A developer can say they are utilizing on-site generation and storage (Barnes et al., 2021).

8.2.6 Barriers Make Translating Community Interest into Reality Daunting

The existing barriers that face microgrids makes the development of microgrid communities difficult, even for well versed developers like THRIVE Collaborative in the Veridian example. For communities with strong interest in microgrids, but no prior development experience, it can be daunting translating that interest into reality. One such example is Parker Village in Detroit.

Parker Village is an organization and future Smart Neighborhood in the City of Detroit. It is being built with the intention of revitalizing Highland Park from within by creating a model of sustainability (Shannon, 2021). The process for Parker Village started in 2015 with the purchase of a 43,000 ft^2 property with a former school (Roff, 2020). At completion, it will consist of single and multi-family homes, each with solar panels that connect to a central battery storage system. Homes will be owned by Parker Village and leased by tenants to ensure the neighborhood can remain off-grid. In addition to solar panels planned for the homes, there is also a solar pergola on the main campus. The neighborhood currently has 7.7 kW of solar power installed on the campus with another 4.8 kW coming soon. The goal is to have between 1-2 MW of solar power over the entire village. The development will also have greenhouses, an aquaponics facility, farmer's market, café, and retail (Shannon, 2021).

Greater stakeholder education and the creating clear and accessible tools to support calculations regarding microgrid developments may be helpful to interested communities. In his workgroup meeting presentation, Juan Shannon, the founder of Parker village, shared not only his enthusiasm and vision for the development, but also how daunted he felt after the development process began (2021). Clarifying the microgrid development process, benefits, and costs may support future communities interested in microgrids.

8.2.7 Summary Table of Barriers and Solutions

The table that follows summarizes the barriers/hurdles and solutions pertaining to microgrids. This table collects all barriers and solutions mentioned from workgroup stakeholder meetings and discussions, which go beyond the regulatory realm. However, the table may not be comprehensive, as it only reflects the learnings and discussions in this workgroup. Inclusion of barriers, hurdles, and solutions in the tables does not imply endorsement by Staff.

Table 15. Microgrids Identified Barriers/Hurdles and Possible Solutions

Identified Barriers/Hurdles	Possible Solutions
1. There are varying definitions of microgrid.	• Adopt a consistent definition of microgrid. The definition could vary based on the various types of microgrids and categorized accordingly. Examples of a classification system can be seen in Puerto Rico.
2. There is no rate design or planning from the MPSC to move microgrids forward, such as time of use and demand charges.	• Support pilots, which allow utilities and customers to experiment and learn about microgrids, and digitization to allow utilities to be more situationally aware. • Incentivize early adopters and develop regulations that follow a legal, rule-based definition of a microgrid.
3. Lack of interconnection rule coverage.	• Examine whether current practice of treating microgrid interconnection as a DER interconnection request is sufficient. • Develop interconnection rules and standards for connecting microgrids.
4. Self-service language in Act 3 presents geographical constraints that can prevent a microgrid from being realized.	• Modify language in Act 3 to allow microgrid implementation regardless of geographical constraints. • Have utilities allow some work arounds. • Do not call it a microgrid. Call it storage and onsite generation.
5. There are financial challenges and high costs from tailored analysis, engineering, and equipment.	• Allow grid services, which help make projects economically feasible. • Provide market access detailed by FERC. • Incentivize flexibility through time-based tariffs, other regulatory incentives, and rebates.
6. Resiliency currently not clearly valued. It also lacks standards, unlike reliability.	• Create legislation clarifying resiliency value, vision for Michigan, and requiring microgrids for facilities like emergency services. • Define what resilient outcomes planning should pursue. • Develop microgrid to support critical infrastructure like hospitals, communications, and water/sewage treatment systems. • Analyze critical infrastructure needs and how microgrids might support them. • Explore and clarify different aspects of resiliency. Resiliency can be for assets/equipment or for the grid. • Establish resiliency practices for operations and standards for development of new systems.
7. Resilience is a locational value that varies based on the site.	• Conduct locational studies that examine local grid conditions and specific project needs when designing microgrid projects. • Identify critical circuits and use microgrids for critical circuits.
8. Locational challenges arise (e.g., limitations from infrastructure and grid conditions).	• Include planning practices, islanding protection. • Provide hosting capacity analysis and maps to assist with locational challenges.
9. There is a gap between the utility and customers. Microgrid project can be viewed negatively by utility due to reduction in demand from the site.	• Encourage greater collaboration between utilities and developers • Ensure customer benefits of resiliency and sustainability are equitably distributed through regulatory rate designs that allow the stability and resiliency of microgrids to be realized. • Figure out how to best partner to provide customers solutions, meet demand, and educate regarding safety, control, communication, and cybersecurity standards. • Find ways to build partnerships with utilities, vendors, and others to avoid adversarial relationship.
10. There is interest in developing microgrids, but there is a lack of knowledge of the processes. Those that do try to develop such projects can find it overwhelming.	• Develop and use virtual modeling to “de-risk” microgrid projects to support customer education and implementation.
11. Technology is rapidly evolving faster than the utility can keep up with.	• Utility engagement with stakeholders to identify needs/wants and conduct pilots to understand new, rapidly evolving technologies. • Explore planning processes and necessary studies, like fault studies, to evolve current practices.
12. Low-income housing tax credits complicate solar and microgrid development for affordable housing.	• Extend multi metering tariffs to microgrid.
13. Most commercial and industrial customers want to focus on their core business, not operate microgrids.	• Allow developers or third parties to operate the microgrid for customers interested and willing to pay for full backup but wanting to focus on their core business.

9. Energy Storage

9.1 Energy Storage Background

Energy storage is the capture of energy produced at one time for use later to reduce imbalances between energy demand and energy production. A device that stores energy is generally called an accumulator or battery. Common energy storage technologies include the following (U.S. Environmental Protection Agency, 2020a):

There are two main categories storage: short-term and long-term. Short-term storage, like flywheels, has low capital cost per capacity. Long-term storage, like pumped hydro, has low capital cost per energy. Some have large initial capital costs to install, but additions are relatively cheap (Blair, 2021).

- **Pumped Hydroelectric**: Electricity is used to pump water up to a reservoir. When water is released from the reservoir, it flows down through a turbine to generate electricity.
- **Compressed Air**: Electricity is used to compress air at up to 1,000 pounds per square inch and store it, often in underground caverns. When electricity demand is high, the pressurized air is released to generate electricity through an expansion turbine generator.
- **Flywheels**: Electricity is used to accelerate a flywheel (a type of rotor) through which the energy is conserved as kinetic rotational energy. When the energy is needed, the spinning force of the flywheel is used to turn a generator. Some flywheels use magnetic bearings, operate in a vacuum to reduce drag, and can attain rotational speeds up to 60,000 revolutions per minute.
- **Batteries**: Like common rechargeable batteries, very large batteries can store electricity until it is needed. These systems can use lithium ion, lead acid, lithium iron or other battery technologies.
- **Thermal Energy Storage**: Electricity can be used to produce thermal energy, which can be stored until it is needed. For example, electricity can be used to produce chilled water or ice during times of low demand and later used for cooling during periods of peak electricity consumption.

On August, 11, 2021, the Commission issued an order in U-21032 encouraging Michigan investor-owned electric utilities to propose pilot programs in upcoming rate cases that meet the criteria outlined in the order and the Proposed Definition and Objective Criteria for Utility Pilots set forth in Exhibit A of the February 8, 2021 order in Case No. U-20645 (MPSC, 2021a).

9.1.1 Drivers of Energy Storage

Storage is on the rise as part of the energy mix as a resource to support different generation types. It is also an infrastructure resource to defer investment to support different distribution and transmission system needs. Storage is increasing exponentially (Paslawski, 2021). The key opportunity for storage is the vast need for capacity to meet peak demand periods. With solar PV deployment, there is the potential for more than 200 GW of diurnal storage in the US (Blair, 2021).

Trends and drivers tend to be more important in the long-term. Grid services is the next largest market for storage, followed by peaking capacity replacement. Proliferation of solar PV creates a sharper peak period due to the duck curve. Storage is well equipped to fulfill the capacity need during that short window of time (Blair, 2021). Other storage drivers include (Paslawski, 2021):

- Increase in renewables and the need to balance intermittent resources,
- Decrease in storage cost and the expected increase in its capabilities. Prices are forecasted to continue rapidly decreasing until 2030 with smaller reductions in costs expected until 2050 (NREL),
- Policies that continue to evolve related to distributed energy resources. There is more distributed generation on the system and exploration of how storage can support it as a resource. There are also FERC Orders 841 and 2222, as well as MPG initiative, which provide further context and motivation,
- Carbon reduction goals coming from several places. The MI Healthy Climate announced by Governor Whitmer detailed plans to have Michigan carbon neutral by 2050. Michigan's major utilities have carbon reduction goals, as do other Michigan companies, such as GM, and
- The focus on resilience and what it looks like in the grid of the future.

9.1.2 Applications of Storage

Energy storage has two defining characteristics that make it unique. First, it is flexible. Generation and load can be increased or decreased as needed. Second, it is scalable. Since storage is flexible and scalable, it can provide services throughout the grid: generation, transmission, and distribution (Twitchell, 2021b).

Thermal storage is not a battery. It uses excess electricity for heating or cooling and is the lowest cost option to store energy. There is new technology that allows thermal storage to be used for grid purposes, which include water heaters, cold storage, pre-heating with solar, and pumped hydro. Water heating is a substantial load, and it is the second largest in residential load. It is non-invasive, controllable load, and has a quick response time, usually within milliseconds. Water heating can be used to demonstrate time-of-use peak avoidance windows and can be combined with DR events if needed. Fleets of water heaters can be used as grid resources. There are many energy products that can be deployed from this: reliability improvements, renewables, hedging against fuel costs, and the wholesale market. The emphasis is that there are hybrid uses for the technology (Rehberg, 2021).

Due to the power grid changing substantially and the lowest renewable costs, there is an excess need for storage and taking advantage of the space to create it. Storage should manage the supply of energy and the demand. It is possible to maximize thermal storage along with electrochemical batteries, which create hybrid benefits. Technology and business and regulatory innovation is needed to support different regulatory models (Rehberg, 2021).

The next few years are important to build the regulatory processes, business models, and the experience needed to optimize the value streams of energy storage. Only fundamental changes that allow markets to recognize the full value of storage will lead to it being able to fairly compete evenly with the resources it will need to replace (Baur, 2020).

9.2 Energy Storage Discussion

In the stakeholder process, several areas presenting hurdles to the development of energy storage were discussed. These areas are:

- Benefits of storage must be valued properly,
- Coordinated and guided state policy is needed for storage,
- Lack of customer awareness and education impedes implementation,
- Integration systems and standards is needed for efficient use of storage,
- Clear interconnection standards and rate expectations are needed,
- Include storage in all grid planning and procurements,
- Business and ownership model innovation support storage uptake,
- Piloting refines program efficacy, and
- Flexibility in eligible storage technologies in beneficial.

Each hurdle is discussed in the following sections.

9.2.1 Benefits of Storage Must be Valued Properly

The benefits of storage need to be properly considered and valued. Currently, not all the benefits of storage are considered in regulatory policies; sub-hourly values (due to modeling constraints), option value (i.e., how storage use changes over time), flexibility over time, locationality (best resources in best locations), and availability to distribution system operations. Appropriately valuing all the benefits that storage can provide will help drive investment (Eisert, Feingold, & Hatcher, 2021).

However, due to the ability of storage to provide multiple services, it can be difficult to appropriately value all the benefits. Valuing the benefits in a way that the primary and secondary functions of a storage device are not conflicting will be important (X. Li et al., 2019). NARUC, in a 2020 report on battery energy storage, recommended that states consider policy and market modifications that encourage value stacking of behind the meter storage and grid services (NARUC, 2020). These modifications could help drive adoption of energy storage.

9.2.2 Coordinated and Guided State Policy is Needed for Storage

A policy position should be developed for state-level energy storage goals. Current legislation often fails to adequately classify and define the role of energy storage devices (Fong, Moreira, & Strbac, 2017). The lack of a coordinated state policy could hinder the investment and deployment of storage technologies. Michigan currently does not have a statewide policy position on storage technologies. A more coordinated and guided effort across the state on deploying and investing in energy storage will be more effective than disparate actions. Rules and regulations should be technology agnostic, based on benefits and hazards, and encourage innovation (Goldwasser, Houck, Mulder, O'Connell, & Shick, 2021). Policies like deployment targets and incentive programs help value and compensate storage flexibility (Boggs, 2021).

A holistic statewide approach to storage will help coordinate currently disparate storage efforts and interest in the state. Customers (large commercial and industrial, utilities, BTM, military) are increasingly asking for storage solutions and come to companies for storage for clean energy goals and reliability concerns. These customers use storage to meet reliability concerns and best utilize the transmission system. Utilities, in particular, are able to capture the portfolio optimization benefits of storage. BTM customers often combine storage with solar arrays and use batteries to charge energy in off-hours to control their energy costs (Goldwasser et al., 2021).

9.2.3 Lack of Customer Awareness and Education Impedes Implementation

There is hesitancy of storage adoption. Even though costs are decreasing, the valuation of all the services storage can provide is still difficult. Education regarding the costs, values, and services storage can provide will be critical to implementation. Customers do not understand all the benefits yet and are not sure what a storage resource might provide so it can be hard sell for them to adopt the technology without additional education. Customers prefer to invest in something they understand better (Goldwasser et al., 2021).

9.2.4 Integration Systems and Standards is Needed for Efficient Use of Storage

Storage requires systems, like information controls and monitoring systems, to be in place to integrate with other generation resources and to allow grid managers to see what is happening on the system in real-time. Technical standards help implement these systems (Eisert et al., 2021). IEEE released two technical standards recently: IEEE 1547-2018 and IEEE 1547.1-2020. IEEE 1547-2018 updated a prior standard on technical rules for interconnection of DERs and IEEE 1547.1-2020 established test procedures for devices with smart inverters (i.e. storage, solar PV) (Lydic, 2020). These standards help establish technical standards to give project developers certainty that their projects would be compliant with the requirements that states could adopt. This gives both states and utilities a better timeline for when they can expect these projects will come to market. Since IEEE issued IEEE-1547, Hawaii, Minnesota, Maryland, and California have adopted the standards or adjusted their requirements to be in line with it (Lydic, 2020).

Standards or rules on cybersecurity countermeasures and data quality for measurement and verification support effective storage programs. In addition, good thermal storage programs are supported by algorithms and sensors to preserve customer comfort, utility grade hardware with long life components, utility control of alternative storage, and review of whether fast responding thermal storage can be used to augment batteries and extend battery life (Rehberg, 2021).

9.2.5 Clear Interconnection Standards and Rate Expectations are Needed

Interconnection standards and rate expectations can help provide certainty for storage developers to ensure that interconnection can happen at scale. Getting this right will be important because it will drive investment (Goldwasser et al., 2021). State and federal policies have established diverse expectations for energy storage: resource adequacy, peak reduction, ancillary services, renewables integration, customer rate management, transmission/distribution system services, transmission/distribution investment deferral, resilience, and decarbonization. The ability of energy storage to provide these services is shaped by its point of interconnection and the needs of the owner. In some cases, additional infrastructure or mechanisms may be necessary to facilitate a particular use. Tariff and rate design can help value and compensate storage for flexibility, while interconnection processes can enable storage access to the grid and markets (Boggs, 2021).

9.2.6 Include Storage in All Grid Planning and Procurements

Storage is a single bidirectional entity, where it can serve as generation and load. Effectively modeling energy storage capabilities in long-term resource, distribution, and transmission planning will help enable energy storage to compete. In addition, renewables/clean energy standards, wholesale market rules, and resource adequacy rules further help enable storage to compete in procurements (Boggs, 2021).

9.2.7 Business and Ownership Model Innovation Supports Storage Uptake

The unique characteristics and technical aspects of storage technologies can make it more beneficial for these technologies to be used in a multi-use business model rather than just a single service business model. Single service business models can still provide high value for storage resources. For example, economic analyses of battery energy storage (BES) providing a single service such as load leveling and primary frequency regulation showed that primary frequency regulation was profitable for storage resources (Fong et al., 2017). Storage resource could also utilize the multi-service business model where the storage resource provides multiple services rather than a single service. Analysis has shown that the multi-service business model can provide as much as 1.5 times more revenue than the single service business model (Fong et al., 2017). Investment and technology costs will also factor into the economics of storage projects.

There are several energy storage business models. Storage may be deployed in front of the meter (FTM) or behind the meter (BTM). Both have strengths and weaknesses. Storage may also be owned by utilities, customers, third parties, or some mix thereof. Regulatory structures may prohibit some ownership models (Twitchell, 2021b). Utilities can also use utility-owned or subscribed software to aggregate customer-owned storage. A direct-to-consumer product will be released later this year for customers who want to manage outputs (Rehberg, 2021).

For FTM, utility owned assets can provide every service except customer management. Third-party owned assets can readily provide most services but may need specific contracting provisions to provide transmission service or to provide ancillary services in a vertically integrated region. Decarbonization through storage is not guaranteed. Deliberate polices and strategies must be in place to meet that policy outcome (Twitchell, 2021a, 2021b).

For BTM, every identified service may be provided by storage systems. However, many of those services are conditional on enabling communications infrastructure and tariff structures. Tariff design is particularly important for achieving desired policy outcomes for customer-owned storage (Twitchell, 2021b).

Energy storage can be an enabling technology in support of multiple state energy policies. However, how storage is used varies by where it is installed and who is using it. To ensure that storage investments support policy objectives, policymakers may consider addressing ownership.

There are tradeoffs associated with the different ownership models. First, utilities have greater visibility into grid needs and can more readily site and dispatch storage to meet them, but they also pass all costs onto customers. Third party ownership may reduce costs and provide some grid visibility; however, third parties may struggle to achieve the same level of visibility. Customer ownership can reduce the costs that are assigned to all customers and enable customers to control energy usage but requires additional mechanisms to enable/incent grid benefits. Lastly, hybrid models may combine strengths of different models while minimizing weakness.

9.2.6 Piloting Refines Program Efficacy

Green Mountain Power (GMP) has two programs, a Bring Your Own Device program, and a grid transformation pilot. Eligible devices for the Bring Your Own Device Pilot included batteries, vehicle chargers, and water heaters. Both customer and third-party ownership of batteries was allowed. Compatible battery storage devices are Sonnen, Tesla, Generac, and SolarEdge. GMP used a software platform called Virtual Peaker to manage the devices. Participants chose between an upfront incentive of $850 per KW and a monthly bill credit of $11 per kW per month. For the pilot, the ratio of energy to power was 3:1. This ratio was used to determine the amount of kW of program participation. For example, a 15 kWh battery divided by 3 hours received compensation under the pilot based on 5 kW. GMP discharges the battery for 3 hours to peak shave. The incentive was calculated based on GMP's estimate of 10 years of avoided peak costs with a 10-year expected value stream for the customer. GMP had 5 – 10 peak events per month where the batteries were discharged for 3 hours (Ferreira, 2021).

The Bring Your Own Device Pilot is now a tariffed program. Changes incorporated into the tariffed program include limiting the eligible devices to batteries and providing an up-front incentive only. Pilot findings that only a few water heaters were enrolled and GMP's program for electric vehicles were the basis for limiting the tariffed program to batteries. The monthly incentive was dropped because the up-front incentive was selected by nearly all pilot participants. The tariffed program includes an $850 per kW incentive plus an $100 per kW adder for solar constrained areas for 3-hour resources and a $950 per kW incentive plus a $100 per kW adder for solar constrained areas for 4-hour resources. The tariff allows GMP to add 5 MW each year for 3 years. As of the date of the presentation, GMP reported about 200 customers participating in the program. GMP does not expect the program to reach 5 MW in any year (Ferreira, 2021).

A regulatory framework that encourages innovation, allows quick deployment, and is repeatable helps facilitate the use and adoption of energy storage. A framework supporting utilities to quickly introduce a pilot program or system, start it quickly, gain lessons learned, and bring it to scale would be beneficial in Michigan. As the storage industry evolves, new storage technologies will emerge that can apply to wider ranges of use cases, which will require utility exploration and testing. Facilitating the use of pilots will help utilities and customer gain experience with using energy storage and drive adoption (Eisert et al., 2021).

Spotlight: Green Mountain Power Powerwall Pilot and Energy Storage Program

The original GMP Grid Transformation Pilot is more commonly known as the Powerwall Pilot. All batteries used were Tesla Powerwall batteries owned and rate based by GMP and leased to customers. There were no up-front customer costs. Customers paid for emergency back-up service. Cost recovery for GMP is based on avoided power supply costs and customer payments. Customers could pay an up-front cost of $1,500 or $15 monthly for 10 years. During the pilot, GMP limited the offering to include two-battery systems based on learning customers preferred two batteries and that, in some cases, two batteries were necessary to power water well pumps. Having two batteries allowed for whole-home backup service instead of having to break out critical loads for backup service when only one battery was deployed (Ferreira, 2021).

The Powerwall Pilot became the tariffed Energy Storage Program, which provides two Tesla Powerwalls for whole-home backup. Customers receive a 27 kWh/10 kW system and pay $55 per month for 10 years or $5,500 up-front. The tariff allows GMP to add 5 MW each year for three years. For the first two years, the program was fully subscribed. GMP expects the third year to also be fully subscribed. There were about 2,700 customers with Powerwalls at the time of the presentation. On average, customers received 13.4 hours of backup service under the Energy Storage Program. Tesla built an algorithm that predicts GMP system peaks which is used to monitor and discharge the batteries. GMP notifies Tesla when inclement weather that could cause an outage is expected to ensure batteries are fully charged and prepared to provide backup service if needed. Customer backup service is prioritized over peak-shaving (Ferreira, 2021).

9.2.6 Flexibility in Eligible Storage Technologies is Beneficial

Flexibility in eligible storage technologies when crafting rules, regulations, and incentives is beneficial. A technology agnostic approach, especially one that also allows retrofit of existing equipment or technologies to become energy storage resources, that instead focuses on desired benefits encourages innovation (Goldwasser et al., 2021; Rehberg, 2021).

9.2.7 Summary Table of Barriers and Solutions

The table that follows summarizes the barriers/hurdles and solutions pertaining to energy storage. This table collects all barriers and solutions mentioned from workgroup stakeholder meetings and discussions, which go beyond the regulatory realm. However, the table may not be comprehensive, as it only reflects the learnings and discussions in this workgroup. Inclusion of barriers, hurdles, and solutions in the tables does not imply endorsement by Staff.

Table 16. Energy Storage Identified Barriers/Hurdles and Possible Solutions

Identified Barriers/Hurdles	Possible Solutions
1. There is a lack of utility and customer knowledge about how to properly use and value storage. Additional analysis is required for utilities and stakeholders to consider optimal least-cost portfolios.	• Provide public education regarding storage benefits and value. • Analyze the true value of energy storage technologies. • Create a pilot framework facilitating learnings about energy storage with repeatable pilots • Improve the deployment process and increase speed of introducing a pilot to quickly gather information. • Allow pilots in controlled environment to test use cases.
2. Rate design for demand and standby charges are very complex, making it difficult to calculate payback of a storage investment.	• Create clear demand and standby charge structures. • Treat storage differently in rate design due to its unique characteristics.
3. Storage is not incorporated well into current planning processes (IRP, reliability, etc.).	• Pursue more studies. Identify the information needed or lacking to design and implement needed studies. • Explore storage by starting with use cases and going backwards to reflect the problems needed to be solved. • Optimize storage across value streams by including it in planning processes, such as long-term resource planning, distribution planning, and transmission planning.
4. Storage is not enabled to compete in all grid procurements.	• Include storage in renewable and clean energy standards. • Detail rules for storage in wholesale market rules and resource adequacy rules.
5. There is a lack of utility options to use utility owned or subscribed software to aggregate customer owned storage.	• The MPSC can approve a software solution with a customer enrollment program where the customer gives the utility the device control. • Support and allow third party ownership of aggregation. • Implement shared savings opportunities between utility or third-party owner and the customer. • Explore relevance to FERC Order 841 and Order 2222.
6. Current utility pilots are focused only on lithium-ion storage solutions and not the full array of storage technologies.	• Properly value the benefits and characteristics of storage from a technology-agnostic standpoint. • Educate on the value of other forms of energy storage, like thermal energy storage.
7. Storage is not integrated with EV DCFC charging stations.	• Encourage utility pilots to explore new business models and technology solutions for EV and storage.
8. Storage is unable to access grid and markets	• Include storage in interconnection processes, codes, and standards. • Create multiple use frameworks and ownership rules.
9. Storage is not valued or compensated for flexibility	• Conduct thorough, clear, and transparent cost benefit studies to determine the value of storage. • Change tariff/rate design to compensate storage for provided flexibility. • Wholesale market products.
10. Energy arbitrage value is needed to realize optimal deployment.	• Develop framework for accounting for the full value stack.
11. Balance customer and grid needs for customer sited solutions.	• Gather quality data and create algorithms to help manage both.
12. Cybersecurity concerns arise with highly connected grid and devices.	• Create strong cybersecurity countermeasures
13. Lack of statewide target and vision for storage, as well as incentives.	• Statewide target broken out by user or storage type. • Set storage deployment targets and create incentive programs. • Create more incentives at the state level.
14. Thermal storage is undefined.	• Define thermal storage under FERC Distribution Plant, Distribution Station Equipment or Software definitions for accounting purposes.
15. Storage functionality is not separated from energy efficiency.	• Recognize thermal storage uses of HVAC, water heaters, etc. are different from energy efficiency.
16. Use of rare minerals may not be sustainable.	• Support “green” storage that’s 100% reusable/recyclable, domestically sourced, safe in and around communities.

11. Discussion and Staff Recommendations

In this section, Staff discusses and shares its recommendations based on workgroup learnings. As noted earlier in the background section, this workgroup was asked to focus on barriers, issues, and solutions that the Commission can address within its oversight of utilities under the current regulated market model established by the Michigan Legislature (MPSC, 2020c, pp. 6-7 and 11).

11.1 Commission Guidance on "Just" Rates

Many of the examined technologies are limited by a lack of consideration of non-energy benefits. These benefits, as discussed below, frequently include carbon dioxide and greenhouse gas emissions reduction, flexibility, resiliency, and sustainability and are variables that are not currently quantified and considered in Michigan's regulatory process. These non-quantified benefits may have sustainability, resiliency, equity, and economic impacts that are not currently included when making regulatory decisions regarding utility cost approvals for energy projects and programs and may impact the safety, reliability, and accessibility of energy in the state of Michigan

11.1-1 Environmental Sustainability and Resiliency

GHG emissions from human activities, such as CO_2 and methane from energy production and use, can impact the weather, climate, and economy. The frequency of large weather and climate disasters is increasing over time. From 1980 to 2021 year to date, Michigan has experienced 39 weather and climate disasters with losses exceeding $1 billion each. These were composed of severe storms (25), winter storms (5), drought (5), flooding (3), and freeze events (1). From 1980 to 2020, the United States experienced on average 7 billion dollar weather events annually. From 2016 to 2020, the annual average was 16 events (NOAA National Centers for Environmental Information, 2021). With climate change unaddressed, these severe weather and climatic events causing significant economic losses have and will continue to increase in frequency.

Climate system changes such as frequency and intensity of hot temperature extremes, heavy precipitation, and droughts are expected to become larger as global climate change effects increase. At the same time, land and ocean carbon sinks will likely be less effective in slowing atmospheric accumulation of CO_2 as CO_2 levels increase (IPCC, 2021). Past and future greenhouse gas emissions cause irreversible and long-lasting changes, especially in the ocean, ice sheets, and global sea levels. Some changes may last for centuries to millennia (IPCC, 2021).

June 2021 was the hottest June on record in North America. Though sweltering daily temperature records received much coverage, more nighttime temperature records were also broken than in any previous June on record. In the last week of June alone, 1,503 nighttime temperature records were broken in comparison to the 1,238 daily temperature records. Extreme higher nighttime temperatures reduce people's ability to cool down from daytime heat. Failure to dissipate body heat can lead to organ failure and death. People are especially vulnerable to heat stroke in the first three days of a heat wave, before their bodies can acclimate (Bhatia & Choi-Schagrin, 2021).

These weather impacts are not new to Michigan and have been observed for years. In the last week of June 2021, Michigan had one daily maximum record temperature and six daily minimum record temperatures broken (Bhatia & Choi-Schagrin, 2021). A snapshot of the temperature and precipitation observations averaged for April-June show deviations from normal temperatures and median precipitation levels in all of the last three years (See Figure 12 and Figure 13).

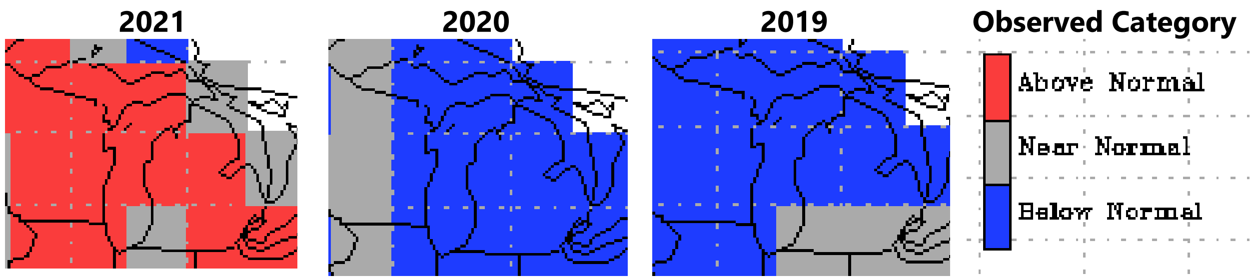

Figure 12. Categorical Temperature Observations for Michigan for April – June, 2019-2021 (NOAA/National Weather Service Climate Prediction Center, 2021)

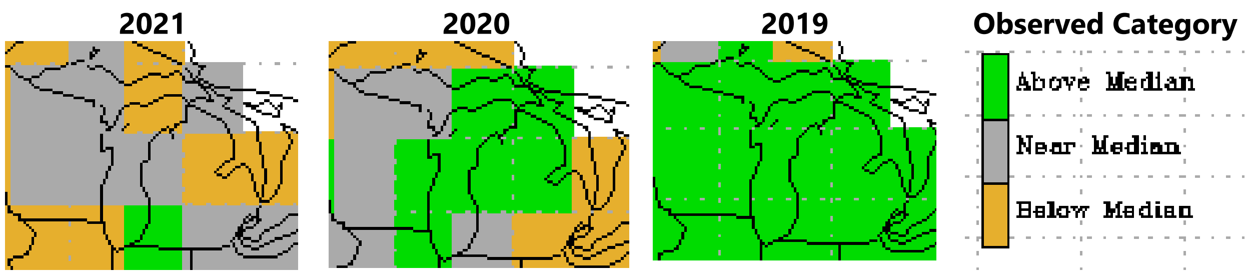

Figure 13. Categorical Precipitation Observations for Michigan for April – June, 2019-2021 (NOAA/National Weather Service Climate Prediction Center, 2021)

Unsurprisingly, high heat can impact electricity demand due to increased demand for cooling equipment like air conditioners, dehumidifiers, and fans. On August 12, 2021, daily high temperature of above 90F was experienced by most of the country. The hourly electricity demand for the contiguous 48 states to reach 720 GWh for 4 - 5 p.m. Eastern. This is the highest reported value for a single hour since hourly reporting of hourly electricity demand to the U.S. EIA began in July 2015 (U.S. Energy Information Administration, 2021b).

Although April through June of 2021 saw, on average, near or below median precipitation for much of the state, there were still instances of extreme precipitation events. On the weekend of June 25, the Detroit area received five to seven inches of rainfall over a short period and experienced flooding (Johncox, 2021). Two pumping stations on Detroit's east side, which experienced some of the worst flooding in the area, had operational issues due to power outages (Cwiek, 2021). One of the pumping stations, Conner Creek, had similar issues in 2014 and 2016 that caused widespread basement flooding in the nearby community (Cwiek, 2021). On Saturday, June 26, 2021, Governor Whitmer declared a state of emergency for Wayne County to protect the public health, safety, and property, and to lessen or avert the threat of more severe and persisting impacts on the community (State of Michigan, 2021). A need for greater resiliency of the city's infrastructure to combat global warming impacts was recognized by Detroit's Water and Sewerage Department director, Gary Brown (Rahal & Grzelewski, 2021).

Despite the significant negative human and economic impacts from severe weather and climate effects of GHG emissions, it may be challenging to reduce and eliminate fossil fuel energy generation. As electricity demand rebounds from the COVID-19 pandemic, countries around the world have seen increased coal generation. Despite goals to reduce carbon emissions worldwide, coal prices have risen to multiyear highs due to high demand for electricity as economies reopen after pandemic challenges. Renewable energy generation has increased, but its intermittency poses challenges during surges in electricity demand. This is expected to be status quo until additional renewable capacity and storage, such as batteries, are added (McFarlane & Blunt, 2021).

Community ability to adapt to environmental challenges may be impacted by not only its financial resources, but also planning and infrastructure development over time. Amid California's most recent drought, rainfall was not the only determinant of water access. Money and infrastructure, developed through years of planning, have allowed communities in the more arid Southern California to have nearly full water reservoirs. Smaller northern California communities, with historically wetter climates and more plentiful water supply, are not well prepared for drought challenges. In the summer 2021, Northern California reservoirs are critically low. A hydroelectric power plant at Oroville Dam stopped generating electricity due to low water levels. Many residents voiced concerns that only those with money will have access to water (Fuller, 2021).

Accessibility to water and electricity are interlinked. In Michigan, hydroelectric power, generally run-of-river hydro, provides 2% of annual energy to the state, not including the large pumped hydro storage facility in Ludington, MI (U.S. Energy Information Administration, 2021d). In May 2020 in Midland, Michigan, massive flooding occurred due to the failure of hydroelectric dams (Cappucci & Freedmana, 2020). Lake Michigan water levels also have the potential to affect the operation of the Ludington Pumped storage plant in the event of a severe drought. Though water is a different utility than electricity, these examples demonstrate the importance of long-term planning in adapting to climate change, as well as some of the challenges facing smaller and poorer communities that may not have the resources to plan and invest in such infrastructure.

The Commission has highlighted the more frequent and extreme weather events on the utility system. Power outages impacted many in 2021. In Governor Whitmer's letter to Chair Dan Scripps of the MPSC, dated August 20, 2021, she noted that "[o]ver the past several weeks, more than 750,000 Michiganders lost power – with many outages lasting for several days on some of the hottest days of the year" (Whitmer, 2021). Nearly one million Michigan utility customers lost power, with some outages lasting for more than one week (MPSC, 2021b). In response, the Commission opened Case No. U-21122 to "expand the data it receives from utilities about their efforts to boost reliability, support more transparency around planning, and encourage more engagement in how best to prepare and harden Michigan's electric distribution system to better withstand the state's increasingly recurrent extreme weather" (MPSC, 2021e).

11.1-2 Equity and Environmental Justice

The June 2020 killings of George Floyd, Rayshard Brooks, Ahmaud Arbery, and Breonna Taylor led the Commission to address diversity, equity, and inclusion at the MPSC. On a global level, a survey of the chief human resources officers of nearly 400 of the world's largest global employers showed that strategizing for DEI was a larger concern than cultural transformation in anticipation of the post-COVID work environment (82% vs. 71%) (Colletta, 2021). DEI issues within the energy industry include access (Kowalski, 2021), engagement in program design (Catchpole, 2020), and employment in clean energy jobs (Merchant, 2020). Equity and diversity have impacts on the energy industry of Michigan which have previously gone unaddressed by the MPSC.

The importance of equity and environmental justice was recognized by the State of Michigan through the establishment of the Environmental Justice Response Team. Chair Dan Scripps serves as a member of the response team. This team was created to ensure "all Michigan residents benefit equitably from the protections and policies of state government" (EGLE, 2021a). In addition, the team is developing an Environmental Justice screening tool to help identify areas of concern using environmental data and health impacts (EGLE, 2021a). Without active work pursuing equity, the energy transition will be inequitable (Delaney, Foley, Melanson, Myers, & Wong, 2021a).

Historically, there have been inequities in how energy projects have been sited. Black and Hispanic minority communities bear a disproportionate level of exposure to fine particulate matter ($PM_{2.5}$) from electricity production relative to the amount of energy they consume, as shown in Figure 1 below (Tessum et al., 2019). This exposure to air pollutants has consequences on human health and economic activity along with other socio-economic externalities. About 20% of observed neighborhood segregation can be linked to past pollution, persisting even over forty years after closure of pollution sources (Heblich, Trew, & Zylberberg, 2021). Higher historic exposure to atmospheric particulate matter was found to be associated with higher county-level COVD-19 mortality rates, even after considering other confounding issues (Wu, Nethery, Sabath, Braun, & Dominici, 2020). Consideration of DEI issues in the development and implementation of utility and energy programs and investments will likely be an increasing and ongoing focus.

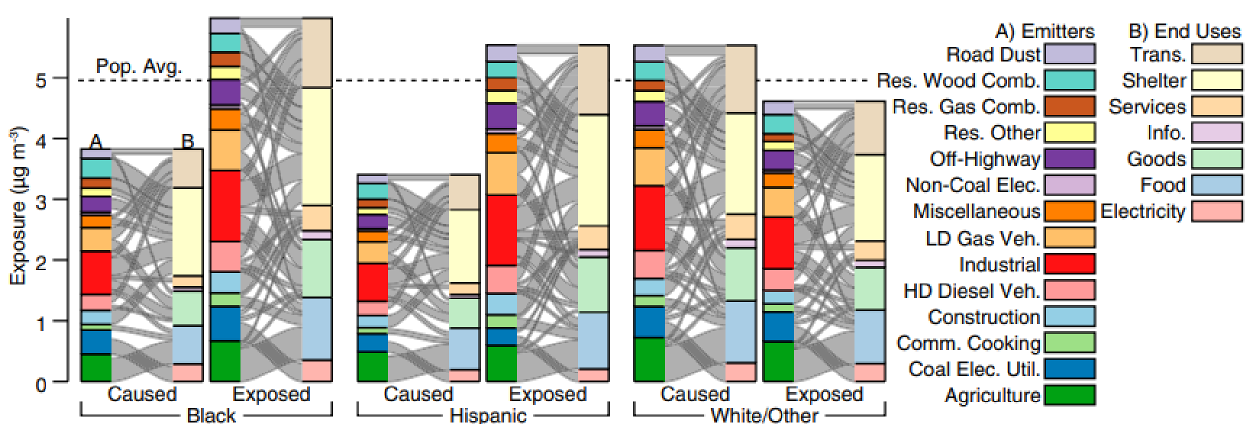

Figure 14. Average PM2.5 Exposure Experienced and Caused by Racial Ethic Groups (Tessum et al., 2019)

Seemingly non-energy policies can have energy implications. "Intra-urban" heat islands, or areas of cities that are hotter than others due to the uneven distribution of heat-absorbing buildings and pavement, and cooler spaces with trees and greenery (U.S. Environmental Protection Agency, 2020b), have been impacted by inequitable policies. Redlining is the practice of denying or limiting financial services to certain neighborhoods based on race or ethnicity without regard to the resident's qualification of creditworthiness (Fair Housing Center of Greater Boston, nd). In a study of 108 urban areas in the U.S., researchers found formerly redlined areas in 94% of the studied areas had elevated land surface temperatures about 2.6°C higher than non-redlined areas. A maximum difference of 7°C was reported (Hoffman, Shandas, & Pendleton, 2020). Annual changes in residential energy use are most related to changes in temperature (U.S. Energy Information Administration, 2021e). Thus, higher local surface temperatures likely increase the energy needed by these communities to stay comfortable and safe, especially in cases of extreme heat.

11.1-2.1 Intergenerational Equity

The equity issues associated with climate change are not constrained to the present. Climate change raises (Weiss, 2008):

> *…serious problems of justice between our generation and future generations, and among communities within these future generations…Only by addressing issues of intergenerational equity now can we ensure that we are passing a planetary legacy to future generations which is no worse than we received it.*

Questions of intergenerational equity are critically important when selecting mitigation efforts, as it impacts when current generations should pay and how much (Caney, 2014).

Many times, the rights of future generations are overlooked. Even participatory decision processes, like this one, have inherent inequities as they favor current users over future generations. These processes "also provide a forum for powerful or influential 'constituents' to manipulate environmental decisions to their advantage" (Treves et al., 2018). Thus, decisions are many times made only with input from current users and no representative for future generations (Treves et al., 2018).

Though 144 countries have constitutions containing protections for the biosphere, the U.S. does not. However, the U.S. respects ancient sovereign public trust principles protecting nature and other public resources (Treves et al., 2018). Public trust doctrine is rooted in the Institutes of Justinian, part of Roman law that underlies modern civil law systems.

Michigan has specifically recognized public trust principles in its actions. In November 2020, the State of Michigan referred to the public trust doctrine when revoking the easement for Line 5 (Totten, 2020). In doing so, the State recognized its legal obligations to protect the public's rights in the Great Lakes from any impairment. It also recognized the rights Michigan Tribes retained to hunt, fish, and gather in the lands and waters ceded to the U.S. under the 1836 Treat of Washington (State of Michigan, 2020).

In *Juliana v. United States*, 21 youth and organizational plaintiff Earth Guardians, filed a lawsuit asserting that the government, through actions causing climate change, failed to protect public trust resources and violated constitutional rights to life, liberty, and property for younger generations (Our Children's Trust, 2021). The Court concluded (*Juliana v. United States*, 217 F. Supp. 3d 1223, 1240, 1250 (D. Or. 2016)):

> *Exercising my 'reasoned judgement', I have no doubt that the right to a climate system capable of sustaining human life is fundamental to a free and ordered society…a stable climate system is quite literally the foundation 'of society, without which there would be neither civilization nor progress.'…without 'a balanced and healthful ecology,' future generations 'stand to inherit nothing but parched earth incapable of sustaining life.'*

The electric power sector has a significant impact on U.S. CO_2 emissions, which is a major contributor to climate change. In 2020, the electric power sector was the second largest contributor to U.S. CO_2 emissions at 32%. The transportation sector, responsible for 36%, was the largest contributor. Given the movement towards transportation electrification, the utility sector could have the ability to reduce emissions for both sectors, which represented 68% of 2020 U.S. CO_2 emissions (U.S. Energy Information Administration, 2021c). As such, Commission decisions can significantly impact the trajectory of CO_2 emissions reductions in Michigan, as well as the utility infrastructure and environment current and future youth of the state experience and inherit.

11.1-3 Energy Services and the Vulnerable

Extreme weather can impact energy needs such as the cooling needs during extreme heat or heating needs during extreme cold. During high heat events, the elderly, young, pregnant women, and those outdoors, like agricultural and construction workers and the homeless, are especially vulnerable (Bhatia & Choi-Schagrin, 2021).

Extreme weather can also cause power outages that are especially challenging to vulnerable populations. Holding the duration of the outage the same, the impact of power outages is not uniform on households. They are especially challenging to those that depend on reliable power for life-saving therapies and medicines, as well as low-income households. On August 12, 2021, a storm hit Michigan with high wind and tornado-like conditions. It was one of the 10 most severe storms in Consumers Energy company history, leading to 370,000 customers without power. In DTE Electric territory, more than 600,000 customers lost power (Dodge, 2021), and it was the second worst storm in DTE Electric's 135 year history (MPSC, 2021b).

Given that electricity is vital to modern life, especially with the increase in remote schooling and work in response to the pandemic, disruptions in electricity provision impact many areas. In a literature review of power outages, extreme events, and health, researchers found twelve areas across the literature that were impacted by power loss. These range from temperature control to sewage disposal to life support devices and medical technologies. See Figure 15 for the full list.

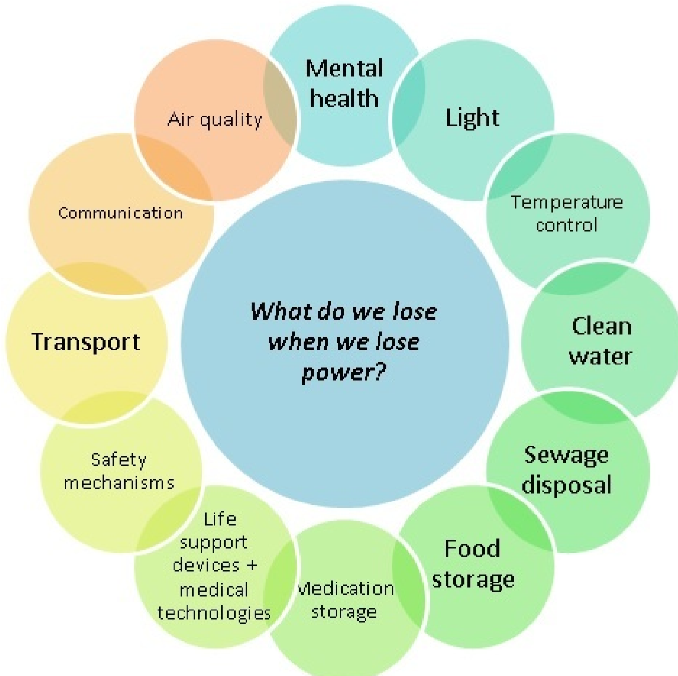

Figure 15. What Do We Lose When We Lose Power? (Klinger, Landeg, & Murray, 2014)

Power outages can significantly impact public health. Electricity is vital to functioning hospital systems, as well as patients with functional needs, like those with respiratory illnesses requiring oxygen, that are cared for in their homes and communities. Those with adequate resources may purchase a generator to support necessary medical equipment or devices at home. However, incorrect generator use leads to increases in carbon monoxide poisoning during disasters (Klinger et al., 2014). In a study of carbon monoxide poisoning from 1991-2009, 94% of carbon monoxide poisoning deaths occurred at home. Of these, 54% of nonfatal cases and 83% of fatal cases were due to generators. The majority of cases occurred within three days of a disaster's start (89% of fatal and 53% of nonfatal case) (Iqbal, Clower, Hernandez, Damon, & Yip, 2012).

Though power outages and the consequences, such as food spoilage, are inconvenient to many, they may harm health or kill for some customer populations. For financially constrained families, replenishment of spoiled foods or medicines may not be possible. For those that depend on power for life saving therapies and medical services, it can be deadly. In Michigan, as of July 2021, there were a total of 94,232 electricity dependent Medicare beneficiaries in the state. Of these, 3,630 live in the Upper Peninsula and 90,602 live in the Lower Peninsula of Michigan (U.S. Department of Health and Human Services, 2021). Each additional day of an outage increases the challenges for these populations. Problems with medical therapies like dialysis, ventilation, and oxygen generation arise once outages near a week. Desperate family members may also take risks during disaster events to obtain needed items, like oxygen tanks, as seen in Louisiana after extended power outages from Hurricane Ida in August 2021 (Morris, 2021).

The elderly, homebound, and small children, may be especially vulnerable in some disasters. Researchers found these populations, especially those in low-income housing projects, experienced dangerous conditions due to prolonged lack of power and heat in the aftermath of Hurricane Sandy (Redlener & Reilly, 2012). The elderly are more vulnerable to disasters due to (Fernandez, Byard, Lin, Benson, & Barbera, 2002):

> *…impaired physical mobility, diminished sensory awareness, chronic health conditions, and social and economic limitations that prevent adequate preparation for disasters and hinder their adaptability during disasters. Frail elderly, those with serious physical, cognitive, economic, and psycho-social problems, are at especially high risk.*

Low-income housing residents, specifically, bear a disproportionate energy burden when compared to what they use. While middle- to upper-class housing energy bills are typically 5% of the household income, low-income and the very poor can spend upwards of 20% on energy purchases (Hernández & Bird, 2010). Low-income and vulnerable housing is also disproportionately less energy efficient than that of higher-income counterparts, contributing to this divide (Nevin, 2010). People with disabilities are twice as likely to live in poverty than people without disabilities (National Council on Disability, 2017) and often need more stable temperature control, refrigeration, and electricity to manage health conditions and mobility needs, as discussed above (Hernández & Bird, 2010).

11.1-4 Economic Impacts of Utility Investments

Coal plants are heavy polluters and expensive to run. There are 203 U.S. coal power plants operating in federally regulated transmission markets. When considering fixed and variable operating costs, more than 90% provide power at a higher price per megawatt hour than the average competitive market price in 2020. The percentage of coal-generated electricity is expected to decline from about 25% current to 15% by 2026 (Patterson, 2021). However, the closing of a coal plant can not only impact customers rates, but also the local communities in terms of tax revenue and job opportunities.

Even after power plants are decommissioned, they play an outsized role in affecting local tax revenues and employment. Bay, Wayne, and St. Clair counties in Michigan were found to be vulnerable to power plant closure. For example, the City of River Rouge stands to lose $5 million, or a third of its tax revenue, from DTE’s River Rouge power plant closing (Gignac, 2021; Richardson & Anderson, 2021).

Governor Whitmer and the Michigan Department of Treasury recognized the challenges communities face in the transition to a cleaner energy future as energy generation facilities reduce operations or close entirely by creating the Energy Transition Impact Project. This project provides “analysis, assistance, expertise, and planning to assist in developing an energy transition strategy for areas affected by environmental action” (Michigan Department of Treasury, 2021).

11.1-5 Staff Recommendations

According to *Detroit Edison Company v. Michigan Public Service Commission*, 127 Mich. App. 499, “[t]he legislature has delegated to the Commission full discretionary authority to set just and reasonable rates." However, the Commission has not clearly directed Staff in how to evaluate and examine "just" rates. As such, Staff recommends the Commission provide guidance on what "just" rates entail when evaluating new technologies and alternative business and ownership models, especially if Staff should consider the following when evaluating "just" rates:

- Safety,
- Reliability,
- Resiliency,
- Environmental sustainability,
- Equity, including intergenerational equity,
- Environmental justice,
- Disproportionate impacts to vulnerable populations, and
- Economic impacts of utility investments.

11.2 Commission Benefit Cost Analysis Guidance is Needed

11.2-1 Quantification of Externalities

Current models for analyzing the economic impacts of electric generation leave out potential hidden costs or negative externalities, like impacts to public health and the environment, that are disproportionately borne by historically marginalized communities (Mohai, Lantz, Morenoff, House, & Mero, 2009; Tessum et al., 2019).

Calculating these negative externalities is critical to understanding the total costs behind each form of generation. Though quantifying non-energy impacts may seem difficult, quantifiable values can and have been placed on these externalities and used for analysis. Currently the EPA has designed a "Public Health Benefits per-kWh Values" tool which can be used together with the "CO-Benefits Risk Assessment Health Impacts Screening Tool (COBRA)" tool to calculate the health benefits of energy efficiency and renewable energy projects compared to fossil fuel generation (U.S. Environmental Protection Agency, 2021a, 2021b). As an example, carbon pricing—a negative externality which estimates real cost of carbon emissions—is currently being debated on a national level. Ten bills have been proposed in Congress since 2019 to put a price on carbon spanning from $15-$54 per metric ton of carbon, with half of those being bipartisan efforts (Hafstead, 2021). These examples are likely imperfect estimates of the actual costs, but allow the inclusion of externalities in the decision-making process. However, quantifying externalities allows closer estimation of the true costs and benefits of proposed changes or programs. If analyses include non-energy benefits and costs, newer technologies with lower externalities will likely be more competitive because the cost benefit analysis reflects benefits which are currently left out of analysis (Parry, 2016).

The externalities associated with generation touch many aspects of human health and economic activity. Many of these externalities have been clarified and quantified. Crop productivity in corn and soybeans saw roughly an average of a 5% yield loss due to air pollution over the last two decades. Significant improvements in air quality since 1999 are estimated to have increased yields by 20% (Lobell & Burney, 2021). Air pollution can impair adult cognitive function and effects on memory ability. This poses a risk of productivity loss to sectors of the economy that are rely on memory-oriented abilities (La Nauze & Severnini, 2021). There are significant links between exposure to particulate matter in ambient air and diseases like Alzheimer's, dementia, and diabetes. Signs of Alzheimer's disease impacts from air pollution were found in infants as young as 11 months old in Mexico City, with the disease presenting in 24.8% of 30-40 year old adults (Calderón-Garcidueñas et al., 2018). In parts of the U.S. with heavy particulate matter pollution, older women's risk of dementia nearly doubles (Cacciottolo et al., 2017). One of the largest studies of its kind attributed that air pollution was linked to 14% of the world's diabetes cases in 2016. In the U.S., this translates to 150,000 cases (Bowe et al., 2018).

Evidence of air pollution's effects on life expectancy has been found following China's Huai River policy, where those north of the Huai river received free coal-fueled winter heating, while those south of the river did not. The policy is estimated to have resulted in the loss of more than 2.5 billion life years of life expectancy due to increased levels of suspended particulates air pollution. The findings suggest an additional 110 $\mu g/m^3$ of total suspended particulates in air pollution is associated with a three year reduction in life expectancy at birth (Chen, Ebenstein, Greenstone, & Li, 2013). In 2019, 6.67 million deaths globally were due to air pollution with 4.14 million deaths due to long-terms exposures to ambient particulate matter in particular (Health Effects Institute, 2020), and is expected to increase to 6.6 million deaths in 2050 (Landrigan et al., 2018). Air pollution is estimated to account for 20% of newborn deaths worldwide, especially due to complications arising from low birth weight and preterm birth (Health Effects Institute, 2020). The evidence is clear that the externalities that may arise from the energy industry have sweeping impacts on people's lives. Consideration must be given in determining how such externalities might impact analyses in decisions on future energy generation.

New technologies may have fiscal and environmental benefits that have already been quantified. For example, electric vehicles produce up to four to seven times less emissions than new gas powered vehicles (Reichmuth, 2020), have less emissions from production a majority of the time (Knobloch et al., 2020), and can save consumers thousands of dollars over the vehicle's lifetime under typical charging (Borlaug et al., 2020). However, stakeholders have voiced growing concerns with the production of EV batteries using rare earth metals and fears that offsets in emissions from this technology could be coming at a cost of environmental damage and health implications for production locations (Manzanaro & Rodriguez, 20219). Examples like this demonstrate the need for incorporating both positive and negative externalities in the Commission's analysis for current and future proposals regarding new technologies.

11.2-2 Transparency Matters

Transparency and accountability are important in ensuring grid modernization benefits help enable new technologies and business models to stimulate innovation and creativity. New York and Connecticut use benefits implementation plans, which require utilities to map out the delivered benefits, the sequence, and timeline. This can be linked to performance-based regulation (Jung, 2021). The MPSC recognized the importance of transparency and information sharing through the Commission's order to develop an online Michigan Pilot Directory (MPSC, 2020b). Though many companies may be wary of greater transparency, investments in providing transparent, accessible, and objective information can benefit them through greater customer trust and willingness to pay a premium to interact with transparent businesses (Merlo, Eisingerich, Auh, & Levstek, 2018). Transparency benefits not only customers, third parties, and regulators, but also the companies themselves.

11.2-3 Benefit Cost Analysis

Even if quantitative values are assigned to non-energy benefits and costs, a systematic approach for assessing the overall cost-effectiveness of an investment compared to alternatives is helpful. This approach is called benefit cost analysis (BCA) and has been widely used by businesses and utilities in assessing the best investment decisions. Documentation of the BCA process and calculations also provides transparency regarding the decision making process (Woolf et al., 2020). The National Standard Practice Manual provides resources regarding how to conduct BCA for distributed energy resources and energy efficiency resources specifically for utility and regulatory decisions (National Energy Screening Project, 2021).

In Case No. U-20147, the Commission directed Staff to work with utilities and other stakeholders to further explore the appropriate framework for evaluating BCA to inform and be integrated into future utility distribution plans. However, the Commission did not adopt any particular BCA framework or criteria (MPSC, 2020a). Staff and stakeholders from the MI Power Grid Electric Distribution Planning workgroup will meet in fall or winter of 2021 for an extended BCA conversation. In addition to the National Standards Practice Manual for Distributed Energy Resources, they will also look at other state BCA methodologies.

11.2-4 Staff Recommendations

For future explorations of new technologies and alternative business and ownership models, Staff recommends the Commission provide guidance on how utilities and Staff should consider non-energy benefits and costs. Specifically, Staff recommends the Commission require:

- Benefit cost analysis, as detailed by the National Standard Practice Manual for Distributed Energy Resources, be required from the utilities when proposing and evaluating future pilots for new technologies and business/ownership model pilots, and
- Costs and benefits related to facets of "just" rates the Commission details be included in any benefit cost analysis.

This ensures consistency and transparency when evaluating and comparing different technologies and business/ownership models in future utility pilots. By supporting a consistent quantification process, the value provided by various energy market opportunities will be clearer. A clean signal for the value stream also helps support the buildout of market opportunities (Bolino, 2021).

11.3 Require Data Driven Decision Making

11.3-1 Interest and Need for Data Driven Decisions

The Commission has already shown its interest in data-driven decision-making regarding energy programs and technology pilots. In its February 4, 2021, order in U-20645, the Commission adopted a definition for pilot and a list of objective criteria with which to evaluate them (MPSC, 2021c). The adopted definition and criteria, informed by best practices and stakeholder input, establish a foundation for future utility pilots and their evaluation in Michigan. It also establishes clear guidance to Michigan utilities on the data that should drive pilot development, deployment, and evaluation. The Commission's goal is to provide more analytical rigor when reviewing utility pilots (MPSC, 2020b).

As Michigan moves forward in examining and integrating new technologies and alternative business and ownership models, efforts and decisions should be driven by data to ensure highest likelihood of success. The edge of the distribution grid, or grid edge, refers to the last mile of wire. It has traditionally been treated as the last stop. Utility returns on distribution have also been less attractive and focused more on compliance than performance. Visibility and control regarding the grid edge are necessary to unleash the full potential of clean energy and enable demand response, FERC 2222, dynamic pricing, smart charging, and other opportunities. However, there is little data and information regarding the grid edge. Utilities many times rely on outdated and incomplete physical models when operating the grid edge. Leveraging data from every investment will help clarify what is occurring at the grid edge and where it is occurring (Jung, 2021).

To ensure safe and reliable operation of the grid, visibility, and close coordination of grid participants, safety considerations such as technology standards, forecasting, and monitoring and direct control are necessary, especially due to the less predictable nature of distributed energy resources. Forward looking analytical software may support these data needs (Delaney et al., 2021a), as well as foundational systems like automation technologies (Mathew, 2021). These will help support utilities to build resilient, reliable, and flexible grids that can accommodate DERs and be agnostic to customer technology choices (Mathew, 2021).

11.3-2 Establish Baselines to Better Quantify Regulatory Innovation Impacts

The baseline effectiveness of current regulatory business and ownership models, as well as incentives, should be established. There may be many methods to establish such a baseline. One method is a management audit, which can prove beneficial by allowing an objective macro view of a utility's overall structure and operations more holistically and comprehensively than possible during normal rate case review (Munro Tulloch, 2020). Instead of focusing on individual line items, the management audit takes a broader view. In Hawaii, the Commission ordered a management review to include governance and executive leadership; capital and operations & maintenance planning, budgeting, and investment strategy; and program and project management. It hired a third party, Munro Tulloch, to conduct the review. Identified structural and process improvements could deliver potential annual customer benefits of up to $35.7 million. However, a realistic target of annual benefits and savings of $25-$26.2 million was recommended (Munro Tulloch, 2020).

Audits are a common regulatory tool used by regulatory commissions in most states and federal agencies. Traditionally, audits were connected with rate cases. In the early 1980s, Commission supplemented financial audits with management audits after discoveries of large cost overruns in nuclear power plants. Audits primarily reduce information risk for regulators, where the Commission may make an incorrect decision by relying on faulty information. As the magnitude of the decisions to be made increases, the relative level of information risk also increases (Wirick, Lawton, Burns, & Lee, 1996). There is interest and initial efforts to innovate current utility incentives or business models in Michigan. As noted by Wirick et al. (1996),

> *[p]erformance-based and other types of incentive regulation…require intensive use of utility data to discover and construct appropriate indices that might be used to reward or penalize utility performance in a variety of areas, such as power and fuel procurement, quality-of-service, reliability, customer satisfaction, universal service, demand-side management deployment, as well as to pursue other social goals.*

Innovations in utility incentive structures and business models, if approved, may cause monumental changes and should be based on reliable data. Establishing the effectiveness of current regulatory models and incentives allows future changes to be better informed by data by identifying areas where regulatory innovations are needed. It also allows quantification of the impacts of future regulatory changes regarding utility business models and ownership models.

11.3-3 Encourage Data Driven Decision Making for All

Encouraging utility and regulatory decisions and improvements to be informed by data is not enough. Other stakeholders like third-party energy service providers and contractors, should also be encouraged to make data-driven decisions. However, this requires data access. Efforts to ensure third parties have access to needed data in a timely and secure manner should be taken.

Standard weights and measures for energy programs and solutions serve as the foundation of market-based solutions. There are various third-party tools that support performance quantification. Not only does this help customers know what they are buying, it also helps utilities and regulators have a common understanding of performance and drive toward flexible market solutions (Best, 2021b).

Third parties are also making efforts to digitize the grid edge. These efforts are intended to help utilities, regulators, and customers better understand what is occurring at the grid edge. There must be the right incentives to encourage investment in the necessary hardware, software, and communications to provide greater visibility and control of the grid edge. Software will be especially important in solving the complexity of the grid edge (Jung, 2021). The MI Power Grid Customer Education and Participation workgroup addressed relevant data accessibility issues with third parties at its May 25, 2021, session and its June 22, 2021, session. Summaries and Staff recommendations regarding third party data accessibility will be included in the Customer Education and Participation workgroup Staff report to the Commissioners in February 2022.

As technologies advance and control nodes increase, utilities will face increasing complications. Third parties can help by providing aggregation services. In the case of electric vehicles, third parties can also help provide mobility hubs, which decrease unit cost of connection, move electrification beyond pace incentives, allow leasing and new ownership, and change the utility relationship (Piero, 2021). In addition, data and communications will be required to support coordination between transmission and distribution, in addition to considering the impacts of transmission-connected resources and loads with distribution rates and rules (Piero, 2021).

Technological advancement also impacts the data available that can be used to inform utility and regulatory decisions. For instance, with EV charging, the vehicles, hardware, and software are continually evolving and adapting to market needs. Rate designs can be increasingly sophisticated to leverage the technological capabilities. This also enables more benefits to be realized from the rate design (Alliance for Transportation Electrification, 2021). As the Alliance for Transportation Electrification notes, "State commissions should encourage utilities to adopt a data driven approach that allows for flexibility in designing rates and programs that reflect the experience [gained]…through …pilots and programs" (2021). Poor data transparency increases difficulty in identifying optimal points of interconnection (Peterson, 2021).

DERs may offer many challenges to planning, operating, regulating, and conceptualizing the power system, however, they also offer opportunities. DERs are a key disruptive force shaping power system transformation worldwide. For instance, for distributed PV integration, there are concerns about the effects of distributed PV on the grid, including voltage regulation, reverse power flow, unintentional islanding, and load masking. Current and emerging practices are aiding with the integration of DERs to the grid. Advanced power electronics can address some of the challenges to the integration of high levels of distributed PV. Flexible interconnection utilizes controls to dynamically curtail DER systems in response to grid needs with failsafe mechanisms to ensure reliability. This solution applies to dynamic hosting capacity concepts and may lead to faster and cheaper interconnections in certain areas (Peterson, 2021). Some technologies like CHP and storage, face hurdles in terms of inclusion in integrated resource, distribution, and transmission plans. For utilities to effectively include energy technologies effectively in these studies, they and regulators much better understand the attributes and value propositions of these technologies (Boggs, 2021; Chittum, 2013). Additional benefit-cost studies may be helpful (Boggs, 2021). Better grid integration and coordination is required to support grid decarbonization. If achieved, demand response event coordination will help provide capacity services to the grid and customer benefits (Tumilowicz, 2021).

11.3-4 Staff Recommendations

Staff recommends the Commission support data-driven decision making in the energy sector in Michigan. Though the Commission's adoption of objective criteria of utility pilots establishes expectations of the types of data that should inform pilot development, implementation, and quantification, Staff recommends the Commission also support data-driven regulatory and third-party decisions. Specially, Staff recommends the Commission:

- Establish baselines to support development of future regulatory innovations and the quantification of their impacts,
- Ensure 3rd party access to utility data in a secure, timely, and ongoing manner,
- Recognize the necessity of hardware, software, and communications investments necessary to support grid-edge innovations, visibility, and control, and
- Support analyses to ensure new technologies are included in integrated resource plans and distribution plans.

11.4 Support Agility and Flexibility in Testing & Finding Energy Solutions

The energy sector is rapidly transforming due to technological innovation, improved communications, and the goals of utilities, communities, and policymakers. The use of a combination of technologies may also create breakthrough innovations that can initiate substantial changes in the energy sector (Bolino, 2021). In this dynamic setting, it is vital for utilities to have the ability to rapidly test new technologies to understand how they integrate into existing systems, customer demand, and how such technologies may be best utilized to meet utility, customer, and policy goals. New business models may better support the adoption of new and emerging technologies (Leslie, 2021). Pilots may be necessary to determine which business models effectively support the adoption of technologies realizing regulatory and policy goals.

However, in Michigan's current regulatory structure, significant lag can occur from when a pilot is conceived and its final approval in one of the existing regulatory processes (Armstrong-Cusack et al., 2020). This lag may be a barrier to implementing new energy technologies, as Michigan utilities, regardless of interest or need, will experience a lag of nearly a year or more from pilot conception due to the regulatory process alone. Agility and flexibility in testing new technologies will be important for utilities to learn how to best utilize and integrate them into their existing systems, especially as they aim to meet their own carbon emissions reduction goals, as well as the Governor's goal to make Michigan carbon neutral by 2050. Other jurisdictions have implemented expedited pilot review and approval processes.

11.4-1 Innovation Platforms

Expedited pilot framework is one of three innovation platforms. The other two platforms are test beds and regulatory sandboxes. Test beds are often utility-led and explore impacts of increased deployment of a specific technology. Expedited pilot frameworks facilitate "fast track" regulatory approval for specific deployment and collaboration pathways. Regulatory sandbox mechanisms demonstrate new customer offerings and accelerate offerings to the market, which open opportunities for new business models (McDonnell, 2021). They may also be a great first step for Michigan to move forward to innovative and flexible programs (Best, 2021a).

Connecticut's innovation pilot framework was developed by the Public Utilities Regulatory Authority to support an equitable modern grid and to deploy high-value project solutions that would not have been possible in the current regulatory framework. The innovation pilot framework has four phases (McDonnell, 2021):

- Solicitation of ideas from innovators and screening out unsuitable projects,
- Evaluate potential projects based on framework criteria to select projects to test,
- Project development & implementation, and
- Project performance review and determining project scalability.

11.4-2 Vermont's Innovative Pilot Process

The Vermont Public Utility Commission approved an Innovative Pilots process for Green Mountain Power (GMP). To be eligible, the piloted products and services must comply with the state's Renewable Energy standard required resource category and help achieve goals of "meeting 90% of energy supply with renewable resources by 2050 and reducing fossil fuel consumption and…greenhouse gas emissions 75% below 1990 levels by 2050" (GMP, 2020). Eligible pilots must involve products or services beyond sale of basic electric service. Vermont's Innovative Pilots framework provides (GMP, 2020):

- Expedited pilot review and approval,
  - 15 days advance notice before commencing pilot programs
  - 7 days advance notice of changes to pilot pricing, terms, or conditions
- Pilot notice shall include the following information:
  - Narrative explanation of pilot and how it meets Innovative Pilots eligibility criteria,
  - Number of customers pilot will serve and how they were selected,
  - Expected costs and revenues,
  - Frequency of status reports (not less than six months), and
  - Certification of Efficiency Vermont collaboration and that work is not conflicting.
- Rate recovery clarity[8],
- Reporting criteria,
  - Semi-annual pilot status reports, and
  - Final report criteria.
- Customer satisfaction survey after one year, and
- Required offering of comparable, parallel third-party pilot or tariff, either separately or within the same pilot or tariff, where feasible.

[8] "Any Annual Rate Base filing during the term of the Multi-Year Plan in which GMP seeks to reflect the costs and revenues of Innovative Pilots developed under this Plan that are not already included in rates at the start of the Plan shall include a schedule setting forth the costs and revenues of all Innovative Pilots offered as well as known and measurable information supporting the addition to rate base and shall be subject to Department review and Commission approval" (GMP, 2020).

11.4-3 Hawaii Expedited Pilot Review Process

On December 23, 2020, the Hawaii Commission approved an expedited pilot review process as part of its performance based ratemaking framework. The pilot process provides utilities greater freedom and flexibility in pursuing pilots, such as the flexibility to select pilot vendors without strict adherence to traditional contract bidding and selection processes. While it affords Hawaii utilities greater discretion in initiating pilots, the process still provides Commission oversight and requires Commission approval for pilot costs as well as required reporting of approved pilots.

There is a total annual cap of $10 million for the expedited pilot process. Requests in excess of this amount require Commission approval (Hawaii Public Utilities Commission, 2020). The annual cap is the combined total for all three Hawaiian utilities (Relf, 2021; Ruiz, 2021): Hawaiian Electric Company (HECO on Oahu), Hawaiian Electric Light Co. (HELCO on Hawaii Island), and Maui Electric Co. (MECO on Maui, Molokai and Lanai) (Ruiz, 2021). HECO, HELCO, and MECO are under one parent company, Hawaiian Electric Industries (Hawaiian Electric, 2021). The utilities often work together and offer programs across islands and jurisdictions (Relf, 2021).

To be eligible for the pilot process, pilots must (Hawaii Public Utilities Commission, 2020):

- Involve products or services beyond the sale of basic electric service and align with an established regulatory goal,
- Seek to leverage funding from alternative sources to minimize customer impact,
- Incorporate the requirement for pilots involving non-local vendors and larger sole-sourced vendors to participate in cost-sharing for the pilot (e.g., in-kind contributions),
- Incorporate preference for pilot partnerships with Hawaii-based vendors,
- Provide estimates of net present value with considerations like new revenue sources, cost savings, reduction in GHG, contributions to State policy goals, etc.,
- Provide Commission, consumer advocate, and key stakeholders with reasonable data access, and
- Incorporate participant customer surveys or measurement and verification evaluation to measure pilot progress against success criteria and metrics.

In Hawaii's process, there is a workplan development phase where utilities, the Commission, Consumer Advocate, and interested stakeholders identify 5-10 areas of collaboration. The collaborative workplan must be submitted to Commission for review and feedback prior to implementation phase, where the utilities must provide notice to the Commission of the pilot. The notice must include (Hawaii Public Utilities Commission, 2020):

- Narrative of pilot project and expected pilot outcomes,
- Alignment of pilot outcomes with State energy goals and Commission orders, and
- Areas of potential overlap with other existing project(s)/program(s) and how overlap will be addressed by pilot.

The expedited approval process details:

- Commission review and order issued approving, denying, or modifying proposed pilot within 45 days of receiving notice,
- Discontinuance or material changes to pilot filed 45 days in advance for Commission review, approval, modification, or denial. If the Commission does not respond in 45 days, the pilot changes are considered approved. Written notice must also be sent to pilot participants.

Eligible pilots in Hawaii's process must also provide an annual comprehensive report on all active pilots by March 31 each year. In addition, the report should include final reporting for completed pilots. For ongoing pilots, the report should provide information such as:

- implementation schedules,
- pilot progress relative to objectives and key performance metrics,
- impacts on underserved communities,
- costs and revenues,
- qualitative description of pilot and customer benefits, and
- any proposed changes.

Cost recovery is also addressed by Hawaii's process. If the Commission approves a pilot notice, the order will authorize certain amounts be applied towards the pilot. Companies will submit costs and revenues (if applicable) with the annual comprehensive pilot report. Cost recovery is allowed for the duration of the pilot according to the schedule approved by the Commission. However, should the pilot timeline change or should it move to a full-scale program, the Commission will re-visit the pilot cost recovery nature and details (Hawaii Public Utilities Commission, 2020).

11.4-4 Staff Recommendation

In the MI Power Grid Energy Programs and Technology Pilots workgroup (Case No. U-20645), Staff recommended the Commission adopt a streamlined pilot review process but did not have a specific recommended process. The Commission, in its October 19, 2020, order, rejected Staff's recommendation as it found there were numerous avenues for pilot program proposals and review. It also noted that it was "open to future proposals relating to potential new procedures for pilot program proposals and review" (MPSC, 2020b).

Through this workgroup's activities, there were continued calls for additional pilots to explore the applicability of energy technologies to Michigan, especially how technologies might work in concert and integrate into the existing utility infrastructure and operations. Given that alternative business and ownership models will also require testing and refinement before arriving at solutions that are effective for Michigan, pilots will also be necessary for areas beyond just technology implementation. In the time since the Michigan Commission's October 19, 2020, order, another regulatory example of expedited pilot review has been initiated in Hawaii.

Staff still finds an agile pilot approval process supportive of the rapid transformation the energy system required to meet overarching state goals. It recommends the Commission adopt a process supporting expedited pilot review for select pilots only, like Vermont and Hawaii. These pilots could focus on technology implementation or alternative ownership and business models. Staff recommends the Commission request stakeholder comment be filed on the proposed process below for expedited pilot review in Michigan. These comments should reference Case No. U-20898. After stakeholder comments are reviewed, Staff recommends the Commission modify the proposed expedited pilot process accordingly and adopt the revised process.

Expedited Pilot Review for Innovative Pilots

Eligibility: Governor Whitmer's Executive Directive 2020-10 lays out a path for economy-wide carbon neutrality for Michigan by 2050 and maintenance of net negative greenhouse gas emissions thereafter. For utilities to help meet these goals, rapid learning about technologies, business models, and ownership models supporting significant reductions in carbon dioxide and greenhouse gas emissions is needed. As such, eligible pilots are those seeking cost recovery that pilot products and services that help Michigan "achieve economy-wide carbon neutrality no later than 2050 and help maintain net negative greenhouse gas emissions thereafter" ("Executive Directive 2020-10," 2020). In addition, pilots must:

- Involve products or services beyond the sale of basic electric service,
- Seek to leverage funding from alternative sources to minimize customer impact,
- Incorporate requirement for pilots involving non-local vendors and larger sole-sourced vendors to participate in cost-sharing for the pilot (e.g., in-kind contributions),
- Provide estimates of net present value with considerations like new revenue sources, cost savings, reduction in GHG, contributions to State policy and regulatory goals, etc.,
- Provide information on pertinent areas of interest noted by the adopted Objective Criteria for Pilot Review, including equity and environmental justice,
- Provide Commission, consumer advocate, and key stakeholders with reasonable data access,
- Incorporate participant customer surveys or measurement and verification evaluation to measure pilot progress against success criteria and metrics, and
- Offer a comparable, parallel third-party pilot, either separately or within the same pilot, where feasible, in recognition of frequent third-party innovations that may result in cost savings, system benefits, and alternative business and ownership model learnings. Such third-party pilots or tariffs are envisioned to be facilitated by the utility, which selects the third-party through a competitive process, and provides the necessary data and at the needed frequency for the third-party to conduct and evaluate the pilot.

Eligible pilots at each utility have a combined total annual cap of $3 million and requests in excess require Commission approval. Pilots conducted across multiple utility service territories will be considered, especially if cost savings and broader learnings can be obtained.

Pilot Development: Utilities are encouraged to work with the Commission and interested stakeholders in developing a pilot workplan detailing pilot proposals and areas.

Pilot Notice: Notice will be provided to the Commission 45 days prior to the commencement of any eligible pilots. This notice shall include:

- Narrative of pilot project and how it meets eligibility criteria,
- Stakeholders involved in pilot development,
- Funding leveraged from alternative sources and any cost-sharing,
- Number of customers served and selection process,
- Estimated net present value with considerations like new revenue sources, cost savings, reduction in GHG, contributions to State policy and regulatory goals, etc.,
- Information on pertinent areas of interest noted by the adopted Objective Criteria for Pilot Review,
- Any areas of potential overlap with other existing project(s)/program(s) and how overlap will be addressed by pilot, and
- Comparable, parallel third-party pilot, either separately or within the same pilot, where feasible.

Expedited Review: Expedited pilot review will involve:

- 45 day Commission review of pilot implementation plan for pilot approval
- 30 day Commission review of any proposed changes to the pilot scope, such as pricing, terms, or conditions. Affected participating customers must also be informed of any such changes.

Commission approval must be received before the pilot may commence. However, in the case of proposed pilot changes, should the utility not hear back from the Commission by the end of the 30-day period to review of any proposed pilot changes, it may assume such changes are automatically approved.

Pilot Reporting: The utilities shall provide semi-annual pilot reporting on all ongoing pilots approved through the expedited pilot process as well as any final reporting for completed projects. For ongoing pilots, the report should provide information such as:

- implementation schedules,
- pilot progress relative to objectives and key performance metrics,
- impacts on underserved communities,
- costs and revenues,
- qualitative description of pilot and customer benefits,
- customer satisfaction, and
- any proposed changes.

Cost Recovery: Pilots costs will be authorized with the Pilot Notice. Companies will submit costs and revenues (if applicable) with the semi-annual comprehensive pilot report and its next rate case filing. Cost recovery is allowed for the duration of the pilot according to the schedule approved by the Commission and given rate case review of reasonableness and prudency.

However, should the pilot change in any way or should it move to a full-scale program, the Commission will re-visit the pilot cost recovery nature and details.

11.5 Support Development of Alternative Business and Ownership Models

A business model is a value chain, a role companies play, and a way companies make money. A utility business model may also be described as a regulatory construct, framework, or structure. Though alternative business models may look similar, the way to earn money may be quite different. With alternative business models, the core electrical infrastructure (wires, poles, substations, transformers, etc.) may be the same and continued investment will be required, but the rules for earning money will change. The fully centralized utility business model is unlikely to be the optimum mode in the future. At the same time, the fully decentralized model where parties are energy independent is likely insecure, impractical, and economically infeasible. The role of the utility as a platform orchestrator is likely the path forward (Bolino, 2021). As the grid transforms from centralized power plant to distributed grid edge resources (Best, 2021b), how to best utilize and incorporate energy technologies in the existing utility infrastructure must be learned, as well as what alternative ownership and business models prove effective.

Innovation platforms or regulatory sandboxes can help facilitate rapid development and scaling to test new ideas and pilots. Alternative regulatory mechanisms can enable new customers and third-party business models by helping better align utility financial incentives (McDonnell, 2021). Though rate-based models can be used when it makes sense, Consumers Energy believes the right incentive structures and business models are needed to make sure value creation and capture are well aligned and appropriate. This ensures that new technologies create multiple value streams and use their capabilities to solve customer problems in the right way. By limiting regulatory barriers, investment can move at the speed of technology development and utilities can implement programs based on customer preferences (Hartmann, 2021).

Experimentation may be needed, as there are many different model designs to promote DERs and no single program structure is best. When modernizing utility business models, thought must be given to the utility function, current service model, and scalability. When thinking about reducing barrier one must consider if the incentive structure encourages DER use and expansion, what conditions is it appropriate for the utilities versus third parties to own DERs, and if utilities should be allowed to facilitate customers' applications of behind the meter solar and own the equipment as a rate-based asset (Felder, 2021).

11.5-1 Provide Opportunities for Third Party Solutions and Innovations

There is great variety in new solutions and business models in the energy sector. Many of them arise from third parties. See Figure 16. Given the vibrant and rapidly developing energy market, it is possible that third parties may offer new products or services that benefit utilities and their customers more cost-effectively than utility developed solutions. Market driven approaches should be supported.

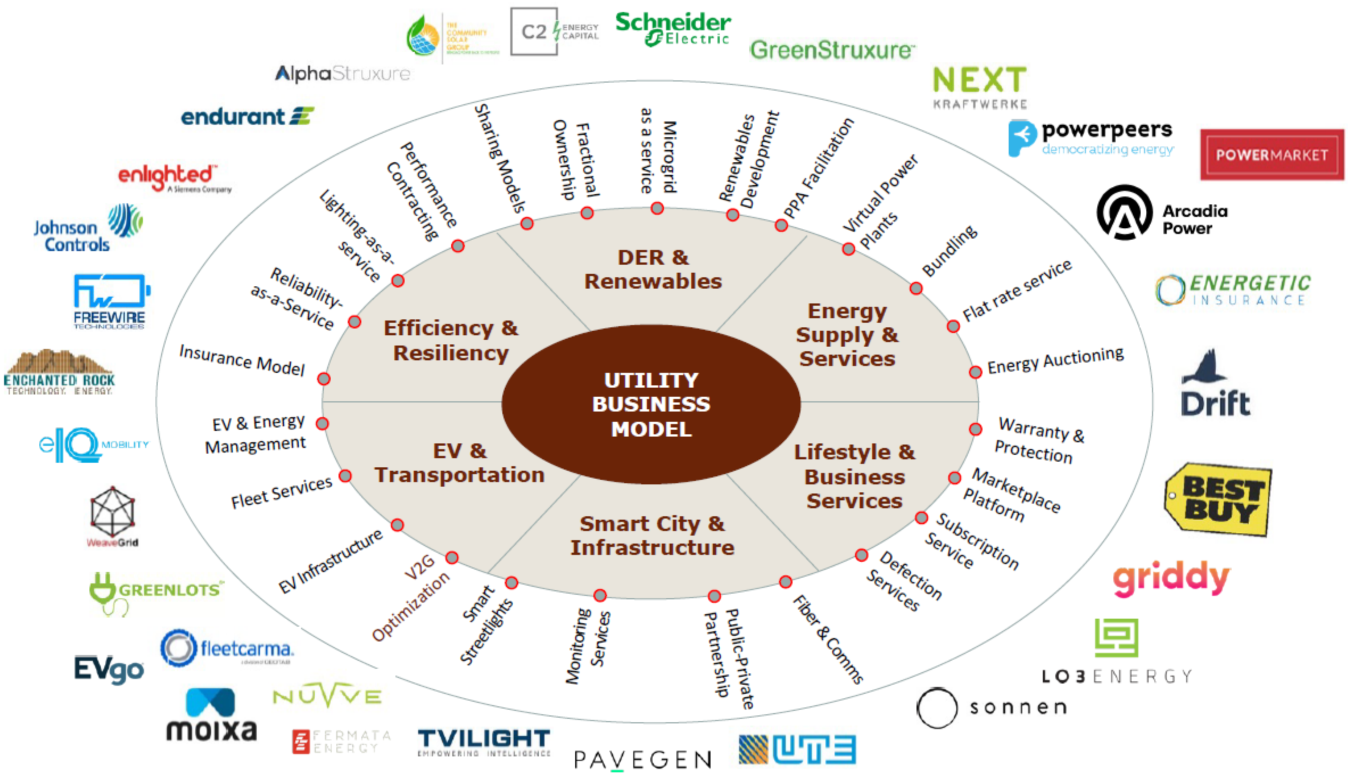

Figure 16. New Business Models in Energy (Bolino, 2021)

The importance of third-party solutions has been recognized in other states. In Vermont, Green Mountain Power agreed to provide "competitive market participants with transparent and nondiscriminatory access to CMP's DER platform, marketing, and billing services to allow customer and third-party ownership arrangements of DER products, and to facilitate efficient integration into the grid" (GMP and REV, 2019). To better understand the opportunities third-party solutions provide, "any new tariff or pilot program that focuses on an available consumer product, [Green Mountain Power] will offer a comparable, parallel third-party pilot or tariff…where feasible" (GMP, 2020). This in noted in the utility's multi-year regulation plan, which was approved by the Vermont Public Utility Commission in 2020[9] (Vermont Public Utility Commission, 2021).

11.5-2 Staff Recommendations

It is important that regulators be adequately prepared to navigate the transition to a cleaner, increasingly distributed energy future that is more equitable. There have been major technological advancements in the energy landscape. To understand how to best capture benefits cost-effectively, alternative business and ownership models must be considered in conjunction with technological innovations. It is important to think beyond the current utility business model to examine the full value that alternative business and ownership models and third-party innovations can bring to Michigan's energy future. Staff recommends the Commission:

[9] Approved by the Vermont Public Utilities Commission on August 27, 2020, in Case No. 20-1401-PET.

- Establish a comment proceeding to consider legal and regulatory barriers to utility ownership of behind the meter distributed energy resources, including the following questions/issues:
    - Whether or not third-party community solar fits in the current regulatory framework,
    - The legal and regulatory barriers for a third party to sign customers up, charge a per kWh subscription fee, pay a per kWh subscription credit outside of the utility framework,
    - The current legal and regulatory structure for utilities to own solar generation behind the customer's meter,
    - Legal prohibitions preventing a utility from owning and rate-basing technologies located behind the customer's meter, and
    - The risk or liability associated with putting batteries behind the customer meter.
- Support exploration of alternative business and ownership models by requesting utility pilots in this area, and
- Request the offering of comparable, parallel third-party pilot or tariff, either separately or within the same pilot or tariff, where feasible in recognition of frequent third-party innovations that may result in cost savings, system benefits, and alternative business and ownership model learnings. Such third-party pilots or tariffs are envisioned to be facilitated by the utility, which selects the third-party through a competitive process, and provides the necessary data and at the needed frequency for the third-party to conduct and evaluate the pilot.

11.6 Develop Technology and Fuel Agnostic Incentives

Some technologies discussed in the workgroup experienced deployment barriers due to technology or fuel-specific policies that excluded them from incentives or programs. Limitations on fuel switching in EWR incentives impacts heat pumps for space and water heating and CHP (Leidel et al., 2021). In Michigan, Public Act 342 of 2016 defines energy efficiency as a "decrease in customer consumption of electricity or natural gas, achieved through measures or programs…" [Sec. 5d)]. The Act states the overall goal of Energy Waste Reduction (EWR) as to reduce future utility service costs to customers, especially to delay the need for and construction of new electric generating facilities. The EWR standard is designed as a percentage of electric sales for electric utilities and a percentage of natural gas sales for natural gas utilities. The Act is silent on the effects of these programs in targeting climate, greenhouse gas reduction or carbon reduction. It limits the eligibility of heat pumps for EWR incentives. Only an electric heat pump replacing inefficient electric heat or a gas heat pump replacing inefficient gas heat would quality (Gold et al., 2021). This essentially bars EWR incentives from being provided in fuel switching scenarios, like instances where an electric heat pump might replace inefficient gas heat.

Cost remains a barrier to customers, communities, and Tribes interested in implementing energy technologies (Davis et al., 2021; Pierce, 2021). Additional funding sources, through grants, rebates, tax credits, or other incentives are welcome. However, technology agnostic incentives determined based on holistic policy goals allow the optimization and selection of technologies that best meet the identified goals.

The misconception that all technologies using natural gas is “dirty” impacts technologies like CHP (T. Miller, 2021), even though CHP provides substantial GHG emissions reductions in the short and long-term (ICF, 2019; Kirshbaum, 2021; G. Miller, 2021). This misconception impacts the willingness of electric utilities in allowing such resources to interconnect and the willingness of policymakers to craft supportive policies (T. Miller, 2021).

It is important for utilities to be technology agnostic. By being neutral, utilities can ensure fair treatment and recovery of investments supporting new tech business models through accurate cost allocation. Utilities need to ensure appropriate costs are being collected and customers are paying their fair share and compensated fairly (Delaney et al., 2021a).

In the transition to clean energy, understanding and quantifying the value and price paid for new technologies is necessary. To do this, foundational hardware and software is needed to provide the needed data. Efforts or frameworks to quantify the costs and benefits of distributed energy resources are necessary. Similarly, rate design and price signaling should reflect the quantified costs and benefits. This should be agnostic of technology or fuel so that regulators and utilities do not create winners and losers (Delaney et al., 2021a). By providing the correct signals, customers and the market can help arrive at the optimal solutions. It is necessary to have neutral market facilitation that is open, easy, and fair (Delaney et al., 2021a).

11.6-1 Adhere to Cost of Service Principles with Only Transitional Relief

U.S. public utility and service commissions largely focus on cost of service for rate design, which requires customers contribute in proportion to the fixed and variable costs they impose on the electric power system. The cost-of-service principles suggest rates (Alliance for Transportation Electrification, 2021):

- be designed for fair utility recovery of the costs for serving customers, including capital costs,
- be set to encourage customer management of demand to reduce bills and use the grid efficiently, and
- reflect social or policy goals.

However, for new technologies and early stages of market development, regulators may elect to provide transitional relief from cost-of-service principles through the provision of short-term subsidies for specific use cases. For example, elimination of or discounts for demand charges have occurred during the transitional period of EV market development (Alliance for Transportation Electrification, 2021). Though relief from cost-of-service principles may be provided during pilot phases, rates over the long-term should reflect cost-of-service principles.

11.6-2 Staff Recommendations

Staff recognizes the need for pilots to examine specific energy solutions, whether it be technology, business model, or ownership model focused. It recognizes that technology- or fuel-specific criteria or incentives may be explored to generate the desired learnings during pilots. However, outside this transitional relief, cost-of-service principles should apply.

Staff recognizes that a future MI Power Grid workgroup will focus on Financial Incentives and Disincentives. Though that workgroup will delve more deeply into financial incentives and disincentives, Staff from this workgroup recommend the following:

- Regulatory rates and incentives should be agnostic to technology or technology fuel types as implementation of new technologies advance. Not only does this support selection of the best technologies that resolve the examined issues, this solution may also avoid the necessity for installing multiple meters in a single residence to track the various electric load and generation.
- Outside of transitional relief for pilots, regulatory rates and incentives:
    - Should reflect cost-of-service,
    - Should incentivize efficient use of the grid and grid resources, and
    - May reflect social or policy goals.
- Though rates should be technology agnostic, studies may be required for new technologies or programs using new business or ownership models to determine the overall costs and benefits. This information may be needed to update or determine the cost-of-service.
- The Commission consider technology-neutral rates and tariffs as the implementation of new technologies advances.

11.7 Create Financing Methods for Customer Flexibility, Inclusion, & Ease

Grid edge solutions provide many opportunities. However, cost barriers prevent some customers from participating due to large up-front costs associated technologies like thermostats, EVs, home solar, home energy efficiency (Hummel, 2021), CHP (Leidel et al., 2021), and other energy technologies.

11.7-1 Financing Products Can Help Overcome Barriers and Increase Adoption

Low- and moderate-income households may be especially impacted by product financing, as they may have difficulties accessing traditional financing programs and incentives due to credit issues or limited liquid capital to provide upfront payment. Traditional financing programs and incentives are also many times inaccessible to renters, so low-income households living in rental units experience even greater barriers (U.S. Department of Energy, nd-g).

Financing products can help overcome barriers like affordability, underwriting approaches, and transfers. Specialized financing products are designed to address several barriers for low- and moderate-income consumers. These products include (U.S. Department of Energy, 2017):

- On bill products, where investments are repaid on the utility bill,

- Property Assessed Clean Energy (PACE) financing, where investment is secured through special property assessment, and
- Savings backed arrangements like energy savings performance contracts

Specialized financing products have been used extensively for energy efficiency upgrades. Over $76 million was invested in residential energy efficiency through on-bill programs in 2014 (U.S. Department of Energy, 2017). In 2020, PACE facilitated nearly $2.1 billion in cumulative investment in over 2,560 commercial properties and $7.3 billion in cumulative investment with over 306,000 residential upgrades (PACENation, 2021). In terms of on-bill programs, there are two main types (ACEEE, 2017; Southeast Energy Efficiency Alliance, 2020):

- On-bill financing, where the utility or third party is the lender and repayment occurs via the utility bill, and
- Tariffed on-bill, where the utility pays for upgrades and customer repayment occurs via a tariff with a cost recovery charge on the utility bill that is less than the estimated savings.

Tariffed on-bill address more barriers than on-bill loan payments. Though both do not require upfront participant costs and both recover costs through a utility bill charge, tariffed on-bill provides greater participant flexibility that can especially address low- and moderate-income barriers (Hummel, 2021). Pay As You Save® (PAYS®) provides a platform for tariffed on-bill investment programs and was developed by the Energy Efficiency Institute (Southeast Energy Efficiency Alliance, 2020). See Table 17 for a comparison of on-bill loan and PAYS® comparison.

Table 17. Comparison of On-Bill Loan and PAYS® Tariffed On-Bill Attributes (Hummel, 2021)

Attributes	On-Bill Loan	PAYS® Tariff
• No upfront participant cost for cost effective upgrades	✓	✓
• No credit or income qualification required		✓
• Renters are eligible		✓
• Estimated savings <u>must exceed</u> cost recovery charges		✓
• Participant accepts terms of a utility tariff <u>tied to the location</u>		✓
• Cost recovery is through a fixed charge on the utility bill	✓	✓
• Participant agrees to disconnection for not paying utility bills		✓
• Payments end if upgrade fails and is not repaired		✓
• Cost recovery runs with the location and remains in effect for subsequent customers at that site until cost recovery is complete		✓

Pay As You Save® and PAYS® are trademarks of the Energy Efficiency Institute, Inc.

Inclusive financing expands uptake of energy solutions and the subsequent economic opportunity. This is demonstrated by the uptake of building energy efficiency upgrades. The use of PAYS® doubled customers eligible for the program, increased the accepted offers by five times, doubled the deal size, and decreased the default rate by ten times. These benefits helped accelerate investment in building energy efficiency (Hummel, 2021). See Figure 17.

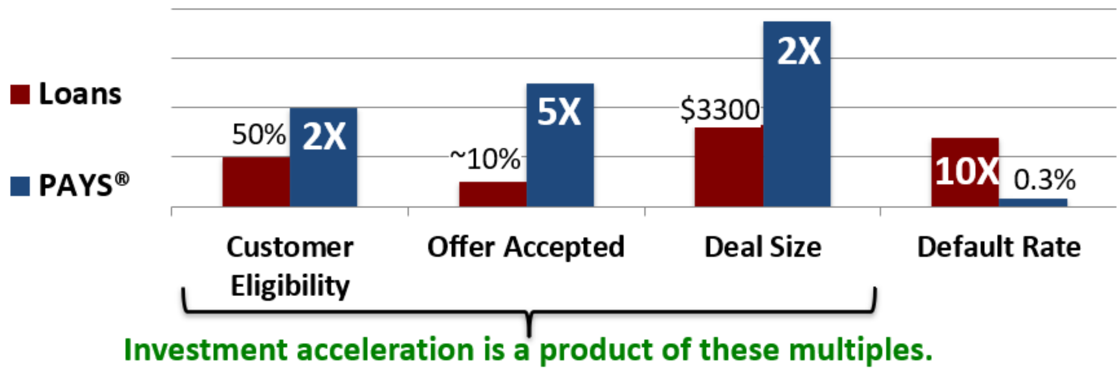

Figure 17. Comparison of Loans vs. Pay As You Save® Financing Models on Building Efficiency Upgrades (Hummel, 2021)

11.7-2 Staff Recommendations

Staff recognizes that a future MI Power Grid workgroup will focus on [Financial Incentives and Disincentives](). Though that workgroup will delve more deeply into financial incentives and disincentives, Staff from this workgroup recommend the Commission support:

- Pilots of tariffed on-bill programs for implementation of residential and commercial energy technologies and energy efficiency to determine the efficacy of on-bill tariff programs for varied applications in Michigan, and
- Exploration of financial incentives that support beneficial uptake of distributed energy resources, especially ones that help overcome barriers experienced by low- and moderate-income customers.

11.8 Education Should Remain a Focus

In the discussion of new technologies in this workgroup, the issue of knowledge was mentioned again and again as a barrier. Lack of knowledge about the technology, the available potential benefits, or the applicable rates or tariffs posed barriers. In addition, research and education in related or supportive technologies, such as green hydrogen which may further reduce CHP emissions, may also impact uptake of technologies (Kirshbaum, 2021). By educating the public, there will likely be increased demand from communities for technologies that support decarbonization (Davis et al., 2021).

The importance of education was especially clarified by Karen Jackson, Executive Director of Ontonagon Village Housing, where heat pumps were installed for space heating. Residents expressed high satisfaction with the heating provided by the heat pumps as well as the additional cooling and dehumidification the heat pumps provided. However, Ontonagon Village Housing did not consider heat pumps when it needed to replace the electric heating systems in the units.

It was only through outreach from its utility, the Upper Peninsula Power Company, that it learned of heat pumps and considered it as an option (Goncalves et al., 2021). This demonstrates the importance of utility education and outreach in providing customers with actionable information that may impact technology implementation.

Customer education supports better purchase decisions, increases customer satisfaction, increases positive word of mouth (Sun, Foscht, & Eisingerich, 2021), and increases customer participation (Huang, Huang, & Deng, 2013). All these characteristics help support uptake of new, beneficial energy technologies.

Lack of contractor education can limit the uptake of technology. Since few contractors in Michigan are familiar with heat pumps, they are not as comfortable with installing such technologies (Leidel et al., 2021). They also cannot educate customers on unfamiliar technologies and help them consider it as an option when replacing new equipment.

Lastly, education to first responders for some new energy technologies, such as electric vehicles and energy storage, may be necessary to ensure the safe deployment and use of these technologies. First responders must know how to safely interact with these technologies in event of accidents.

Regulated utilities may be especially suited to providing customer education. They are often a highly trusted source of information regarding energy resources and use. Utilities also know customers well and have multiple venues of providing customer education, such as bill inserts, websites, or emails (Alliance for Transportation Electrification, 2020).

11.8-1 Staff Recommendations

The Commission has recognized the importance of customer education and engagement in the transition to a clean energy future through the establishment of the MI Power Grid Customer Education and Participation workgroup, which will likely have distinct and more detailed recommendations.

Staff in this workgroup recommends the Commission recognize the importance of education in the uptake of new technologies and business/ownership models by:

- Requiring all such pilots that interact or recruit customers provide customer education that provides, at a minimum:
    - Information on the technology and business/ownership model,
    - possible benefits and costs,
    - applicable rates or tariffs, and
    - financing options.
- Requiring all such pilots that implement new technologies in Michigan to also include contractor education and training,

- Supporting efforts within the State of Michigan or elsewhere to promote and provide trainings to first responders on how to safely interact with new energy technologies during accidents, and
- Supporting efforts to provide clear regulatory and utility information needed by third parties to educate potential customers on energy products and services.

11.9 Rapid and Holistic Action is Required

Energy use and society change are inextricably tied. The COVID-19 pandemic significantly impacted human health and the economy. Residential energy use in 2020 increased noticeably due to an increased number of Michigan residents staying at home and an increase in remote working arrangements. Adaptations in daily life caused by the conditions of the pandemic are expected to result in long term adjustments to energy usage. Residential energy use is expected to continue at elevated levels due to continued remote working arrangements (U.S. Energy Information Administration, 2021e).

Traditional infrastructure adaptation has been techno-centric and can result in unwanted tradeoffs. Near term solutions can "lock-in" infrastructure that exacerbates ecological and social issues, while also creating barriers to longer-term transformative change (Brown et al., 2021; Markolf et al., 2018). However, there is strong interest in Michigan from utilities, communities, and stakeholders, to seek a path in the clean energy transition that is equitable and just, one that recognizes the highly complex interconnections of infrastructure with not only technological, but also social and ecological systems (Markolf et al., 2018).

Community and customer interest in and adoption of new technologies, along with proactive utility adaptions, are driving changes to the electric grid. Michigan utilities have made significant commitments to reducing carbon emissions and work tirelessly to modernize the grid while still supporting its safety, reliability, and resiliency. At the same time, there is a need to invest in communities impacted by coal plant closures to support recovery and diversification of their economies (Richardson & Anderson, 2021). Specifically, Michigan's "coal-dependent counties have a critical need for a more intentional vision to support communities in adjusting to lost tax re revenue and to repurpose former coal plant sites into economically diverse and beneficial uses" (Gignac, 2021).

Many new technologies have importance across different sectors. As the clean energy transition occurs, traditionally separate sectors like the energy and mobility may merge. This provides opportunities for a zero emissions mobility sector (Delaney et al., 2021a). Rapid technological innovation in energy and policy mandates has prompted many groups and governments to seek a holistic approach in examining economic impacts of electricity generation (Gies, 2017). Holistic policies and frameworks that recognize and account for cross-sector interactions are needed, especially as some interactions are synergistic while others are competitive (Brown et al., 2021). "Drawdown Georgia" presents a systematic approach to evaluating carbon reduction options for a U.S. states to identify impactful near-term solutions (Brown et al., 2021). Cooperation and action must be taken on a wide scale to achieve climate targets. There needs to standardization and harmonization to enable holistic integration to accomplish public policy decarbonization goals (Tumilowicz, 2021). Only holistic action and vision can address the wide-ranging social, ecological, and technological opportunities and impacts of the energy sector. As such, it is important for the Commission to work alongside other government agencies, businesses, and stakeholders to realize the opportunities presented by new technologies and business models and to ensure a just and equitable energy transition.

Holistic approaches and partnerships have brought effective change currently and in the past. In Iowa, Energy Districts leverage partnerships with local governments, economic development organizations, to farm groups to implement energy efficiency and locally owned clean energy. These Energy Districts were based on past Soil and Water Conservation Districts, which championed conservation farming after the 1930s Dust Bowl. These districts were locally formed and elected. Authorized by the states, they leveraged state and federal resources to implement solutions with ecological and economic impact (Winneshiek Energy District, 2019).

Rapid, decisive action is needed. UN Secretary-General António Guterres discussed the latest IPCC Climate Report, calling the report a "code red for humanity" and insisting that decisive action now is required to avoid global temperature increases that will put billions of people at risk. In addition, he said (Guterres, 2021):

> *The viability of our societies depends on leaders from government, business and civil society uniting behind policies, actions and investments that will limit temperature rise to 1.5℃…We need immediate action on energy…Climate impacts will undoubtedly worsen [but] [i]f we combine forces now, we can avert climate catastrophe…there is no time for delay and no room for excuses.*

11.9-1 Staff Recommendations

To maximize the benefits of the transition to clean, distributed energy resources for Michigan residents and businesses, Staff recommends the Commission chart a clear path supporting rapid new technology and business/ownership model learnings in Michigan by:

- Taking rapid action on items outlined by Staff recommendations throughout the MI Power Grid process,
- Avoiding near-term solutions that prevent or complicate longer-term transformative change, and
- Supporting uptake and safe integration of beneficial energy innovations and business models into the established practices of Michigan utilities and regulatory processes.

In this process, Staff received stakeholder feedback indicating fatigue with the extensive stakeholder workshops and requests for input. While stakeholders believe the work is worthwhile and important, the amount of input requested by the Commission in not just this workgroup, but through the many MI Power Grid workgroups, strained stakeholder resources. As such, Staff recommends the Commission acknowledge the resource and time strain faced by stakeholders and Staff by taking direct action on Staff recommendations throughout the MI Power Grid effort. The recommendations are informed by extensive stakeholder processes and Staff research.

Staff believes rapid action is necessary for the Commission to ensure that Michiganders have safe, reliable, and accessible energy at reasonable rates now and in the future. Staff appeals to the Commission to do everything in its allotted power to support a just and equitable energy transition, one that is rapid enough to help avert economic and climatic disaster. Such actions will not only be for the ratepayers of today, but also for those of the future that will inherit the energy system the Commission regulates and oversees.

12. Conclusions

It has been a great privilege engaging with stakeholders and experts, in Michigan, the U.S., and Canada, to learn and discuss the opportunities, barriers (or hurdles as one stakeholder noted), and solutions in this workgroup. Excitement for Michigan's energy future has been a constant thrumming thread connecting the topics examined. Likewise, there has been strong interest in thoughtfully deploying energy technologies, alone or in concert, to create solutions that meet the needs of Michigan residents, businesses, and communities.

Energy is a means to an end. Electricity is generated and natural gas is mined only because we use them to provide desired and much needed services. How we plan for, provide, and site energy technologies is integrally tied to the wants, needs, and goals of Michigan residents, businesses, and communities. These considerations should be vital when selecting and implementing energy technologies. The technologies, for the many years or decades they are in service, can either be long dark shadows or foundational supports. The needs and wants of Michigan residents, businesses, and communities, now and in the future, are key in determining which role energy technologies will play.

As Dr. Martin Luther King reminded us in 1963, there is "the fierce urgency of now. This is not time…to take the tranquilizing drug of gradualism" (King Jr., 1963). Energy technologies are being implemented through the everyday decisions of Michigan residents, businesses, and communities. However, these decisions are being made many times individually and in a disjointed fashion.

If we are to ensure an equitable and just energy transition, one that ensures a safe, affordable, reliable, and resilient energy system for all in Michigan, a cohesive vision, mandate, and plan is required. The needs of Michiganders now and in the future should be at its core. It should include mechanisms that empower and simplify their ability to contribute to joint goals through everyday energy decisions, while ensuring the safety, reliability, and resiliency of the energy system that serves them.

All hands on deck are required to develop and implement such a plan. The Michigan Public Service Commission has a crucial role, as do the utilities it regulates. The barriers and possible solutions identified in this workgroup extend beyond the regulatory arena. There are roles and responsibilities from many parties when addressing barriers to energy solutions, new technologies, and alternative business and ownership models. Change agents include the Commission, the Legislators, the business innovators, the community advocates, and many of the stakeholders who participated in this workgroup process. To successfully address Michigan's needs in the face of the great many changes afoot and in the future, we must all work together.

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Appendix A: Stakeholder Meeting Summaries by Date

A-1. January 27, 2021: Kickoff Meeting (Presentation Slides | Recording)

Commission Chair Dan Scripps and Kayla Gibbs, MPSC Customer Assistance Division representative, provided opening statements and introductions. Zachary Peterson from NREL and Nick Tumilowicz from EPRI presented an academic perspective on designing for distributed energy resources, new technologies, and innovative business practices. Three major Michigan utilities presented on utility approach to new technologies, followed by a panel on community experiences with evolving technology. Cory Felder of the Rocky Mountain Institute closed with innovative reforms to current utility DER modeling.

A-2. February 10, 2021: Electric Vehicles (Presentation Slides | Recording)

Commissioner Tremaine Phillips and Joy Wang gave opening statements and introductions at the second stakeholder meeting focused on electric vehicles. Matteo Muratori from the National Renewable Energy Laboratory (NREL) presented most recent EV data trends and a systems-level perspective on current EV implementation barriers. Afterward, moderated by Britta Gross at the Rocky Mountain Institute, a panel of experts discussed regulatory barriers and solutions to EV adoption. DTE, I&M, CE, and ITC presented their various EV pilot progress. The meeting closed with a general discussion on next steps and a wrap up from Joy Wang.

A-3. February 24, 2021: Heat Pumps for Space & Water Heating (Presentation Slides | Recording)

The fifth stakeholder meeting, focused on Heat Pump applications in Space and Water Heating, opened with statements from Karen Gould, manager of the Energy Waste Reduction section of the MPSC. Jack Mayernik of NREL and Sherri Billimoria from RMI shared current heat pump technology barriers and regulatory solutions, as well as the status of heat pump adoption in Michigan. A panel moderated by Dave Walker of the MPSC EWR group explored the different ways companies and the public have used heat pumps for space and water heating and elaborated on personal experiences with the technology. The American Council for an Energy-Efficient Economy (ACEEE) returned to Michigan contexts and various policy options, followed by Ian Burnes of Efficiency Maine and David Lis of Northeast Energy Partnerships with reflections of northeast states. Finally, Dandelion, a MI Heat Pump installer, discussed their experiences in both the northeast and in Michigan.

A-4. March 10, 2021: Behind the Meter & Community Solar (Presentation Slides | Recording)

The fourth stakeholder meeting was focused on behind the meter solar and community solar. Joy Wang and Julie Baldwin (MPSC Staff) provided the meeting welcome and opening remarks. Jenny Heeter (National Renewable Energy Laboratory) provided an overview of community solar markets, trends, and regulatory considerations. In her presentation on community solar market development, Sarah Wochos (Borrego Solar Systems) discussed typical third-party market structure, benefits, barriers, and typical projects. State agency successes in providing solar opportunities to low- and moderate-income customers was discussed by Lisa Thomas (EGLE). A panel discussion titled "It Takes a village…Raising Successful Community Solar" covered community solar business models and community solar examples. Douglas Gagne (National Renewable Energy Laboratory) gave an overview of behind the meter solar trends and discussed several ownership models. The panel "Looking Ahead at Behind the Meter Solar" discussed aspects of behind the meter solar that are working well and factors that are limiting its development.

A-5. March 24, 2021: Storage (Presentation Slides | Recording)

Joy Wang and Commissioner Katherine Peretick provided opening comments for the meeting. Julian Boggs (Energy Storage Association) presented on current storage opportunities, different use cases for energy storage in utility systems with integrated renewables, policy drivers, state targets, incentive programs and FERC and PJM activities.

Nate Blair (National Renewable Energy Laboratory) presented on NRELs current energy storage research and its Storage Futures Study. Mr. Blair explained that the decreasing costs of renewables, and load profile changes are resulting in a higher demand for energy storage. He discussed three reports: *The Four Phases of Storage Deployment*, *Storage Technology Modeling Input Data Report,* and *Grid Scale Diurnal Storage Scenarios*. His presentation concluded with an overview of current battery costs and a breakdown of cost by component.

A panel discussion entitled "Utility Storage Solutions – Experiences, Barriers, & Opportunities" followed. The panel was moderated by Ines Ribeiro (Canella Mosaic Environmental Consulting). Panelists included Kirk Eiset (Indiana Michigan Power Co.), Noah Feingold (DTE Energy), Teresa Hatcher (Consumers Energy). They discussed the different energy storage use cases.

Craig Ferreira (Green Mountain Power) presented on Green Mountain Powers Storage programs. His presentation focused on two programs that GMP offers, its Bring Your Own Device program, and its Tesla Powerwall program. He explained the BYOD programs incentive structure and the compatible battery systems. He then described the Powerwall program which includes two Powerwalls per home. The participants agree to a ten-year term at $55/month or $5500 up front. He concluded his presentation with different customer stories about the battery backup program. Tanya Paslawski (5 Lakes Energy) presented on the future roadmap for storage in Michigan and included a description of the drivers advancing storage in Michigan.

A second panel titles "Opportunities & Barriers for Energy Storage Deployment in Michigan" was held. The panelists for this panel included Rachel Goldwasser (Key Capture Energy), Jason Houck (Form Energy Inc.), Jon Mulder (Volta Power System), Kevin O'Connell (Michigan CAT & McAllister Machinery) and Reed Shick (Advanced Battery Concepts) and was moderated by Laura Sherman

(Michigan Energy Innovation Business Counsel). This panel discusses the current barriers being seen in Michigan for energy storage and gave examples of several opportunities for storage.

Eric Rehberg (Armada Power) presented on thermal storage. He provided an overview of what thermal storage is and how it could function in Michigan. He then gave examples of potential grid scale impacts of thermal storage and what considerations should be included when developing a thermal storage program.

A-6. April 7, 2021: Combined Heat & Power (Presentation Slides | Recording)

Chair Dan Scripps provided opening comments. Graeme Miller (Energy Resources Center University of Illinois at Chicago) presented on the CHP potential in Michigan. He highlighted the technical benefits of CHP and illustrated how Michigan's 5 GW CHP potential could aid the clean energy transition and emissions reduction.

Rob Thornton (International District Energy Association) presented CHP as a community-scale energy solution. He explained how CHP can be used to generate local heat and power in order to improve resiliency and sustainability. Mr. Thornton gave several examples of CHP systems that aided areas through disasters.

A panel discussion entitled "The Power of CHP – Roadblocks to Harnessing Its Opportunity" occurred. Panelists were James Leidel (DTE Gas), Kevin O'Connell (Michigan CAT), and Chris Bixby (Clarke Energy). Lynn Kirshbaum (Combined Heat and Power Alliance) moderated. The panelists discussed opportunities for CHP, as well as barriers holding back widespread development. Panelists also discussed solutions to the CHP hurdles that they felt would help CHP development in Michigan.

A second panel discussion was held, entitled "Speaking from Experience – CHP Motivations, Barriers, and Realities." Lynn Kirshbaum (Combined Heat and Power Alliance) again served as moderator. Timothy Lynch (Benton Harbor Saint Joseph Wastewater Treatment Plant) gave a brief overview of the CHP project in Benton Harbor. Jeff Means (Department of Veteran Affairs) gave his overview of how CHP is used at VA facilities in Ann Arbor. Finally, Kathy Richards (Northern Michigan University) presented the CHP system utilized at the university. The panelists agreed that the motivations for CHP projects are energy savings and reliability issues.

Patricia Sharkey (Heat is Power Association and Midwest Cogeneration Association) presented CHP as a solution for Michigan's industrial sector. She introduced waste heat power as an energy resource and discussed the opportunities for its use in Michigan. Ms. Sharkey briefly discussed Michigan energy policies and the need for CHP incentives.

Lynn Kirshbaum (Combined Heat and Power Alliance) discussed the future of CHP. She illustrated how CHP can help to reduce emissions while also improving resilience. While citing several case studies, Ms. Kirshbaum discussed how CHP can be used with lower carbon fuels, and also contribute to a microgrid system.

Finally, Tom Miller (Aisin Technical Center of America) presented a case study of mCHP installation in a single-family home in Michigan. He gave a detailed overview of the project, including equipment needs, interaction with the utility, and results from the system.

A-7. April 21, 2021: Microgrids (Presentation Slides | Recording)

Joy Wang and Commissioner Katherine Peretick provided opening comments for the meeting. Jeremy Twitchell (Pacific Northwest National Laboratory) presented on microgrid resilience. He discussed energy storage and planning considerations that pertain to a microgrid system. Several case studies were presented, including military installations and Green Mountain Power, that illustrated the resilience factor in microgrid planning.

Next, Douglas Gagne (National Renewable Energy Laboratory) discussed microgrid applications and business cases. He presented several locations in the US with microgrid deployment and highlighted some benefits of these systems. Mr. Gagne briefly discussed cost and financing, including some federal microgrid financing approaches.

Matt Grocoff (THRIVE Collaborative) presented a microgrid community named Veridian Living Community, a net zero, all electric development featuring both traditional and low-income affordable housing. It will use solar panels, EV chargers, and batteries.

Juan Shannon (Parker Village) presented a smart neighborhood microgrid that is being developed in Highland Park, Michigan. The proposed neighborhood will feature rooftop solar and EV chargers on homes leased to residents. Mr. Shannon explained that the smart neighborhood is in phase one of a seven-phase plan.

A panel entitled “Business Perspectives on Microgrid Development” was moderated by Cory Connolly (Michigan Energy Innovation Business Council). Panelists were Sam Barnes (Commonwealth), Mark Feasel (Schneider Electric), and Robert Rafson (Charthouse Energy). The panel discussed the benefits of microgrids, as well as barriers to widespread microgrid development.

Paul Connors, John Vernacchia, and Harold Ruckpaul (Eaton Corporation) presented microgrid applications and benefits and provided a video demonstration of a microgrid system in Pittsburgh, Pennsylvania. They discussed factors driving microgrid costs and key trends impacting microgrid adoption.

Juan Ontiveros (The University of Texas at Austin) discussed the “mature” microgrid at the university that has been operating since 1929. He gave an overview of the system and discussed the performance of this microgrid during the historic winter storm in Texas in February 2021. Steve Swinson (Thermal Energy Corporation) presented the Texas Medical Center microgrid as an example of a microgrid system providing critical load, He also illustrated how microgrid systems provide reliability and resiliency during weather disasters.

Finally, second panel entitled "Utility Microgrid Perspectives," moderated by Arindam Maitra (Electric Power Research Institute), consisted of Carlos Casablanca (AEP Service Corporation), Husaninder Singh (DTE Energy), and Nate Washburn (Consumers Energy). Panelists discussed how microgrids impact utility planning, grid resiliency and reliability, and the role of the utility in microgrid planning.

A-8. May 19, 2021: Alterative Business & Ownership Models (Presentation Slides | Recording)

Joy Want again welcomed participants and Mike Byrne (MPSC COO) provided opening remarks. Jeff Dennis (Advanced Energy Economy) presented on FERC 2222. Greg Bolino (DG Reimagined) spoke about partnerships and innovating the utility business model. Carmen Best (Recurve) spoke about demand flexibility. Michael Jung (Utilidata) was one of many speakers to discuss the grid edge in his presentation on connecting platforms and markets to benefit climate and customers.

After the first break, Greg Bolino moderated a utility panel on perspectives on alternative business and ownership models that included Michael Delany (Consumers Energy), Neal Foley (DTE Energy), Jess Melanson (Utilidata), Erika Myers (World Resource Institute), and Josh Wong (Opus One Solutions).

After the second break, Holmes Hummel (Clean Energy Works), spoke on business models for making building energy upgrades and vehicle grid integration accessible to all. Matthew McDonnell (Strategen) then presented on advanced regulatory frameworks to support energy innovation. Jack Piero (NUVVE) discussed EVs as distributed energy resources and then Jeremy Twitchell (Pacific Northwest National Laboratory) spoke on the nexus between energy storage ownership models and policy goals. Amy Heart (Sunrun) presented on building and efficient, resilient grid, and Jackson Koeppel (Soulardarity) capped off the day by presenting on alternative community solar models and community benefits. Brief statements were made by Joy Wang and the meeting was brought to a close.

A-9. June 16, 2021: Summary, Discussion, & Closing (Presentation Slides | Recording)

Joy Wang provided opening comments and a summary of the workgroup learnings from the prior stakeholder meetings. The first half of the meeting focused on breakout rooms: Combined Heat and Power, Electric Vehicles, Heat Pumps, Microgrids, Solar, and Storage. All participants could select the breakout room, which they were interested. The breakout rooms focused on barriers, solutions, and alternative business and ownership models of each technology listed above. The discussions were moderated by Staff. After the completion of the breakout rooms, Staff moderators of each technology provided an overview and debrief of the discussion. This included the focuses described above. Patrick Hudson and Joy Wang provided closing statements, timelines, and next steps for the workgroup and report.

Appendix B: Stakeholder Meeting Agendas

Appendix B-1. January 27, 2021: Kickoff Meeting

GRETCHEN WHITMER
GOVERNOR

STATE OF MICHIGAN
DEPARTMENT OF LICENSING AND REGULATORY AFFAIRS
PUBLIC SERVICE COMMISSION

ORLENE HAWKS
DIRECTOR

TREMAINE PHILLIPS
COMMISSIONER

DAN SCRIPPS
CHAIR

KATHERINE PERETICK
COMMISSIONER

MI Power Grid: New Technologies and Business Models
Workgroup Meeting #1: Kickoff Meeting

Wednesday, January 27, 2021
1:00 p.m. – 5:00 p.m. Eastern
Join Microsoft Teams Meeting
Join by phone: +1 248-509-0316; 694592013# (Dial-in Number)

Agenda Items		
1:00 pm	Welcome	Joy Wang, MPSC Staff
1:05 pm	Opening Statements	Katherine Peretick, Commissioner, MPSC
1:15 pm	MI Power Grid and Workgroup Introduction	Kayla Fox, MPSC Staff
1:25 pm	Emerging Practices for Integrating Distributed Energy Resources	Zachary Peterson, National Renewable Energy Laboratory
2:00 pm	Break	
2:10 pm	Solving for the Future State of the Grid: New Technologies and Business Models	Nick Tumilowicz, Electric Power Research Institute
2:45 pm	Utility Approach to New Technologies & Business Models	Brian Hartmann, Consumers Energy Joyce Leslie, DTE Energy Subin Mathew, Indiana Michigan Power
3:20 pm	Community Interest and Experience Panelists: Melissa Davis, New Power Tour, Inc. Mindy Miner, City of Rockford Sustainability Committee Missy Stults, City of Ann Arbor	Moderator: Dr. Sarah Mills, University of Michigan
4:15 pm	Break	
4:20 pm	Utility Business Model Reform: Incentive Alignment for Clean DER Expansion	Cory Felder, Rocky Mountain Institute
4:55 pm	Closing Statements	Joy Wang, MPSC Staff
5:00 pm	Adjourn	

Appendix B-2. February 10, 2021: Electric Vehicles

STATE OF MICHIGAN
DEPARTMENT OF LICENSING AND REGULATORY AFFAIRS
PUBLIC SERVICE COMMISSION

GRETCHEN WHITMER
GOVERNOR

ORLENE HAWKS
DIRECTOR

TREMAINE PHILLIPS
COMMISSIONER

DAN SCRIPPS
CHAIR

KATHERINE PERETICK
COMMISSIONER

MI Power Grid: New Technologies and Business Models Workgroup Meeting #2: Electric Vehicles

Wednesday, February 10, 2021
1:00 p.m. – 5:00 p.m. Eastern
Join Microsoft Teams Meeting
Join by phone: +1 248-509-0316; 678645732# (Dial-in Number)

Agenda Items		
1:00 pm	Welcome & Opening Remarks	Joy Wang, MPSC Staff, and Tremaine Phillips, Commissioner, MPSC
1:05 pm	Electric Vehicle Grid Integration: System Level Perspectives	Matteo Muratori, National Renewable Energy Laboratory
1:40 pm	Electric Vehicle Regulatory Barriers & Solutions: A National Perspective Panelists: Max Baumhefner, Natural Resource Defense Council Daniel Bowermaster, Electric Power Research Institute Andrew Dick, Electrify America Annie Gilleo, Greenlots Philip Jones, Alliance for Transportation Electrification	Moderator: Britta Gross, RMI
2:35 pm	Break	
2:45 pm	Utility EV Pilot Updates & Challenges in Michigan Panelists: Ben Burns, DTE Craig Morris, Indiana Michigan Power Co. Jeff Myrom, Consumers Energy Joseph Stephanoff, ITC	Moderator: Al Freeman, MPSC Staff
3:55 pm	Break	
4:00 pm	Transportation Electrification in Michigan & Opportunities for Vehicle-to-Grid Integration Panelists Hawk Asgeirsson, Pacific Northwest National Laboratory Jim Gawron, Ford Motor Company Jamie Hall, General Motors Tanya Krackovic, eCamion Trevor Pawl, Office of Future Mobility and Electrification	Moderator: Cory Connolly, Michigan Energy Innovation Business Council
4:55 pm	Closing Statements	Joy Wang, MPSC Staff
5:00 pm	Adjourn	

Appendix B-3. February 24, 2021: Heat Pumps for Space & Water Heating

STATE OF MICHIGAN
DEPARTMENT OF LICENSING AND REGULATORY AFFAIRS
PUBLIC SERVICE COMMISSION

GRETCHEN WHITMER
GOVERNOR

ORLENE HAWKS
DIRECTOR

TREMAINE PHILLIPS
COMMISSIONER

DAN SCRIPPS
CHAIR

KATHERINE PERETICK
COMMISSIONER

MI Power Grid: New Technologies and Business Models Workgroup Meeting #3: Space & Water Heating with Heat Pumps

Wednesday, February 24, 2021
1:00 p.m. – 5:00 p.m. Eastern
Join Microsoft Teams Meeting
Join by phone: +1 248-509-0316; 268 685 086# (Dial-in Number)

Agenda Items		
1:00 pm	Welcome and Opening Remarks	Joy Wang, MPSC Staff, and Karen Gould, Manager of Energy Waste Reduction section, MPSC
1:05 pm	Space & Water Heating with Heat Pumps – Energy Savings and GHG Reductions	John (Jack) Mayernik, National Renewable Energy Laboratory
1:40 pm	Regulatory Solutions for Heat Pump Deployment	Sherri Billimoria, RMI
2:15 pm	Break	
2:25 pm	Panel: Heat Pumps for Space & Water Heating – Learnings, Opportunities, and Barriers Jose Goncalves, DTE Energy Gregg Holladay, Bradford White Karen Jackson, Ontonagon Village Housing Andrew McNeally, Upper Peninsula Power Company Chris Neme, Energy Futures Group	Moderator: David Walker, MPSC Staff
3:20 pm	Break	
3:25 pm	Heat Pumps: Promising Use Cases, Policy Options, and Michigan Context	Rachel Gold, Marty Kushler, Christopher Perry, American Council for an Energy-Efficient Economy
4:00 pm	Beneficial Electrification of Space and Water Heating: A Perspective from Maine	Ian Burnes, Efficiency Maine
4:20 pm	Cold Climate Air-Source Heat Pumps: Hurry Up, Slowly	David Lis, Northeast Energy Efficiency Partnerships
4:40 pm	Ground Source Heat Pumps: New Opportunities and Barriers to Expansion in the Residential Market	Sinye Tang, Dandelion, & Ian Rinehart, the AdHoc Group
4:55 pm	Closing Statements	Joy Wang, MPSC Staff
5:00 pm	Adjourn	

Appendix B-4. March 10, 2021: Behind the Meter & Community Solar

STATE OF MICHIGAN
DEPARTMENT OF LICENSING AND REGULATORY AFFAIRS
PUBLIC SERVICE COMMISSION

GRETCHEN WHITMER
GOVERNOR

ORLENE HAWKS
DIRECTOR

TREMAINE PHILLIPS
COMMISSIONER

DAN SCRIPPS
CHAIR

KATHERINE PERETICK
COMMISSIONER

MI Power Grid: New Technologies and Business Models Workgroup Meeting #4: Behind the Meter and Community Solar

Wednesday, March 10, 2021

1:00 p.m. – 5:00 p.m. Eastern

Join Microsoft Teams Meeting

Join by phone: +1 248-509-0316; 197 646 018# (Dial-in Number)

Agenda Items		
1:00 pm	Welcome and Opening Remarks	Joy Wang, MPSC Staff, and Julie Baldwin, Renewable Energy Section Manager, MPSC
1:05 pm	Community Solar Markets, Trends, and Regulatory Considerations	Jenny Heeter, National Renewable Energy Laboratory
1:40 pm	Community Solar Market Development	Sarah Wochos, Borrego Solar Systems
2:05 pm	Michigan (MI) Solar Communities – Low to Moderate Income Access	Lisa Thomas, Energy Services, EGLE
2:15 pm	Break	
2:25 pm	*Panel: It Takes a Village… Raising Successful Community Solar* Valerie Brader, Rivenoak Consulting Inc. Debbie Fisher, HOPE Village Revitalization John Kinch, Michigan Energy Options Robert La Fave, Village of L'Anse Matthew McDonnell, Strategen	Moderator: Cody Matthews, MPSC Staff
3:20 pm	Break	
3:25 pm	BTM Solar Trends, Integration Challenges and Ownership Models	Douglas Gagne, National Renewable Energy Laboratory
4:00 pm	*Panel: Looking Ahead at Behind the Meter Solar* John Freeman, Great Lakes Renewable Energy Assoc. Amy Heart, Sunrun Craig Toepfer, Solar Homeowner Leah Wiste, Michigan Interfaith Power and Light Ken Zebarah, Harvest Solar	Moderator: Julie Baldwin, MPSC Staff
4:55 pm	Closing Statements	Joy Wang, MPSC Staff
5:00 pm	Adjourn	

Appendix B-5. March 24, 2021: Storage

STATE OF MICHIGAN
DEPARTMENT OF LICENSING AND REGULATORY AFFAIRS
PUBLIC SERVICE COMMISSION

GRETCHEN WHITMER
GOVERNOR

ORLENE HAWKS
DIRECTOR

TREMAINE PHILLIPS
COMMISSIONER

DAN SCRIPPS
CHAIR

KATHERINE PERETICK
COMMISSIONER

MI Power Grid: New Technologies and Business Models
Workgroup Meeting #5: Storage

Wednesday, March 24, 2021

1:00 p.m. – 5:00 p.m. Eastern

Join Microsoft Teams Meeting

Join by phone: +1 248-509-0316; 800 840 540# (Dial-in Number)

Agenda Items		
1:00 pm	Welcome & Opening Statements	Joy Wang, MPSC Staff, and Katherine Peretick, Commissioner, MPSC
1:05 pm	The State of Energy Storage – Opportunities and Barriers	Julian Boggs, Energy Storage Association
1:40 pm	NREL Energy Storage Research & the Storage Futures Study	Nate Blair, National Renewable Energy Laboratory
2:15 pm	Break	
2:20 pm	*Panel: Utility Storage Solutions – Experiences, Barriers, & Opportunities* Kirk Eisert, Indiana Michigan Power Co. Noah Feingold, DTE Energy Teresa Hatcher, Consumers Energy	Moderator: Inês Ribeiro Canella, Mosaic Environmental Consulting
3:10 pm	GMP Energy Storage Programs	Craig Ferreira, Green Mountain Power
3:30 pm	Break	
3:40 pm	The Future of Energy Storage: A Roadmap for Michigan	Tanya Paslawski, 5 Lakes Energy
3:50 pm	*Panel: Opportunities & Barriers for Energy Storage Deployment in Michigan* Rachel Goldwasser, Key Capture Energy Jason Houck, Form Energy, Inc. Jon Mulder, Volta Power Systems Kevin O'Connell, Michigan CAT & McAllister Machinery Reed Shick, Advanced Battery Concepts	Moderator: Laura Sherman, Michigan Energy Innovation Business Council
4:45 pm	Thermal Storage: Non-battery Storage	Eric Rehberg, Armada Power
4:55 pm	Closing Statements	Joy Wang, MPSC Staff
5:00 pm	Adjourn	

Appendix B-6. April 7, 2021: Combined Heat & Power

STATE OF MICHIGAN
DEPARTMENT OF LICENSING AND REGULATORY AFFAIRS
PUBLIC SERVICE COMMISSION

GRETCHEN WHITMER
GOVERNOR

ORLENE HAWKS
DIRECTOR

TREMAINE PHILLIPS
COMMISSIONER

DAN SCRIPPS
CHAIR

KATHERINE PERETICK
COMMISSIONER

MI Power Grid: New Technologies and Business Models Workgroup Meeting #6: Combined Heat & Power

Wednesday, April 7, 2021
1:00 p.m. – 5:00 p.m. Eastern
Join Microsoft Teams Meeting
Join by phone: +1 248-509-0316; 201 279 814# (Dial-in Number)

Agenda Items		
1:00 pm	Welcome & Opening Statements	Joy Wang, MPSC Staff, and Dan Scripps, Chair, MPSC
1:05 pm	The Potential for Combined Heat and Power in Michigan	Graeme Miller, Energy Resources Center/University of Illinois at Chicago
1:40 pm	District Energy/CHP Systems for Resiliency & Sustainability	Rob Thornton, International District Energy Association
2:05 pm	Break	
2:15 pm	*Panel: The Power of CHP – Roadblocks to Harnessing Its Opportunity* James Leidel, DTE Gas Kevin O'Connell, Michigan CAT Chris Bixby, Clarke Energy	Moderator: Lynn A. Kirshbaum, Combined Heat and Power Alliance
3:00 pm	*Panel: Speaking from Experience – CHP Motivations, Barriers, & Realities* Timothy Lynch, Benton Harbor Saint Joseph WWTP Jeff Means, Department of Veteran Affairs Kathy Richards, Northern Michigan University	Moderator: Lynn A. Kirshbaum, Combined Heat and Power Alliance
3:45 pm	Break	
3:50 pm	Waste Heat to Power: An Overlooked Zero Emission Energy Resource for Michigan's Industrial Sector	Patricia Sharkey, Heat is Power Association & Midwest Cogeneration Association
4:15 pm	The Future of CHP: Reducing Emissions and Improving Resilience	Lynn A. Kirshbaum, Combined Heat and Power Alliance
4:40 pm	Aisin mCHP Development	Tom Miller, Aisin Technical Center of America
4:55 pm	Closing Statements	Joy Wang, MPSC Staff
5:00 pm	Adjourn	

Appendix B-7. April 21, 2021: Microgrids

GRETCHEN WHITMER
GOVERNOR

STATE OF MICHIGAN
DEPARTMENT OF LICENSING AND REGULATORY AFFAIRS
PUBLIC SERVICE COMMISSION

ORLENE HAWKS
DIRECTOR

TREMAINE PHILLIPS
COMMISSIONER

DAN SCRIPPS
CHAIR

KATHERINE PERETICK
COMMISSIONER

MI Power Grid: New Technologies and Business Models Workgroup Meeting #7: Microgrids

Wednesday, April 21, 2021
1:00 p.m. – 5:00 p.m. Eastern
Join Microsoft Teams Meeting
Join by phone: +1 248-509-0316; 875 926 218# (Dial-in Number)

Agenda Items		
1:00 pm	Welcome & Opening Statements	Joy Wang, MPSC Staff, and Katherine Peretick, Commissioner, MPSC
1:05 pm	Microgrid Resilience: Case Study of Energy Storage Applications & Planning Considerations	Jeremy Twitchell, Pacific Northwest National Laboratory
1:30 pm	Microgrid Applications and Business Cases	Douglas Gagne, National Renewable Energy Laboratory
1:55 pm	Veridian Living Community Microgrid: How a Neighborhood Can Emulate a Forest	Matt Grocoff, THRIVE Collaborative
2:07 pm	Smart Neighborhood Microgrid	Juan Shannon, Parker Village
2:19 pm	Break	
2:30 pm	*Panel: Business Perspectives on Microgrid Development* Sam Barnes, Commonwealth Mark Feasel, Schneider Electric Robert Rafson, Charthouse Energy	Moderator: Cory Connolly, Michigan Energy Innovation Business Council
3:25 pm	Break	
3:30 pm	Microgrid Applications and Benefits	Paul Connors, John Vernacchia, and Harold Ruckpaul, Eaton Corp
4:00 pm	UT Austin's Microgrid	Juan Ontiveros, The University of Texas at Austin
4:15 pm	TECO and Real-Life Benefits of Microgrids	Steve Swinson, Thermal Energy Corporation
4:30 pm	*Panel: Utility Microgrid Perspectives* Carlos Casablanca, AEP Service Corporation Husaninder Singh, DTE Energy Nate Washburn, Consumers Energy	Moderator: Arindam Maitra, Electric Power Research Institute
5:00 pm	Closing Statements & Adjourn	Joy Wang, MPSC Staff

Appendix B-8. May 19, 2021: Alterative Business & Ownership Models

STATE OF MICHIGAN

GRETCHEN WHITMER
GOVERNOR

DEPARTMENT OF LICENSING AND REGULATORY AFFAIRS
PUBLIC SERVICE COMMISSION

ORLENE HAWKS
DIRECTOR

TREMAINE PHILLIPS
COMMISSIONER

DAN SCRIPPS
CHAIR

KATHERINE PERETICK
COMMISSIONER

MI Power Grid: New Technologies and Business Models Workgroup Meeting #8: Alternative Business and Ownership Models

Wednesday, May 19, 2021

1:00 p.m. – 5:00 p.m. Eastern

Join Microsoft Teams Meeting

Join by phone: +1 248-509-0316; 768 774 782# (Dial-in Number)

Agenda Items		
1:00 pm	Welcome & Opening Comments	Joy Wang, MPSC Staff, and Mike Byrne, Chief Operating Officer, MPSC
1:05 pm	FERC Order No. 2222 and Maximizing the Benefits of DERs to Consumers and the Grid	Jeff Dennis, Advanced Energy Economy
1:25 pm	Reimagining Energy: Innovating the Utility Business Model	Greg Bolino, DG Reimagined
1:45 pm	Introducing the Demand Flexibility Marketplace	Carmen Best, Recurve
2:00 pm	Looking to the Edge: Connecting Platforms and Markets to Benefit Climate and Customers	Michael Jung, Utilidata
2:15 pm	Break	
2:25 pm	*Perspectives on Alternative Business & Ownership Models* Michael Delaney, Consumers Energy Neal Foley, DTE Energy Jess Melanson, Utilidata Erika Myers, World Resource Institute Josh Wong, Opus One Solutions	Moderated: Greg Bolino, DG Reimagined
3:20 pm	Break	
3:25 pm	Inclusive utility investments at the grid edge: Business models for making building energy upgrades and vehicle-grid integration accessible to all	Holmes Hummel, Clean Energy Works
3:40 pm	Advanced Regulatory Frameworks to Support Energy Innovation	Matthew McDonnell, Strategen
3:55 pm	EVs as Distributed Energy Resources: New business models for a changing energy ecosystem	Jackie Piero, NUVVE
4:10 pm	The Nexus Between Energy Storage Ownership Models and Policy Goals	Jeremy Twitchell, Pacific Northwest National Laboratory
4:25 pm	Building an Efficient, Resilient Grid	Amy Heart, Sunrun
4:40 pm	Alternative Community Solar Models and Community Benefits	Jackson Koeppel, Soulardarity Meera Gorjala, Univ. of Chicago Law School
4:55 pm	Closing Statements	Joy Wang, MPSC Staff
5:00 pm	Adjourn	

Appendix B-9. June 16, 2021: Summary, Discussion, & Closing

STATE OF MICHIGAN
DEPARTMENT OF LICENSING AND REGULATORY AFFAIRS
PUBLIC SERVICE COMMISSION

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GOVERNOR

ORLENE HAWKS
DIRECTOR

TREMAINE PHILLIPS
COMMISSIONER

DAN SCRIPPS
CHAIR

KATHERINE PERETICK
COMMISSIONER

MI Power Grid: New Technologies and Business Models Workgroup Meeting #9: Summary, Discussion, & Closing

Wednesday, June 16, 2021
1:00 p.m. – 5:00 p.m. Eastern
Join Zoom Meeting
Meeting ID: 834 2383 4836; Password: 480949
Join by phone: 888-363-4735; Conf. code: 582366

Agenda Items		
1:00 pm	Welcome & Opening Comments	Joy Wang, MPSC Staff, and Katherine Peretick, Commissioner, MPSC
1:05 pm	Summary of Workgroup & Learnings	Joy Wang, MPSC Staff
1:25 pm	Breakout Rooms Discussions of Staff Outlines of Barriers, Solutions, and Alternative Business & Ownership Models by Technology Breakout Rooms: *Combined Heat and Power* *Electric Vehicles* *Heat Pumps* *Microgrids* *Solar* *Storage*	Moderated by MPSC Staff Participants can select their breakout room.
1:55 pm	Break	
2:10 pm	Breakout Debriefs & Discussion: *Combined Heat and Power* *Electric Vehicles* *Heat Pumps* *Microgrids* *Solar* *Storage*	Moderated by MPSC Staff
4:55 pm	Closing Statements, Timeline, & Next Steps	Pat Hudson, Manager, Smart Grid Section, MPSC Joy Wang, MPSC Staff
5:00 pm	Adjourn	

Appendix C: Tribal Forum Agenda

STATE OF MICHIGAN
DEPARTMENT OF LICENSING AND REGULATORY AFFAIRS
PUBLIC SERVICE COMMISSION

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GOVERNOR

ORLENE HAWKS
DIRECTOR

TREMAINE PHILLIPS
COMMISSIONER

DAN SCRIPPS
CHAIR

KATHERINE PERETICK
COMMISSIONER

Tribal Forum Part I:
MI Power Grid: New Technologies and Business Models

Wednesday, April 28, 2021
1:00 p.m. – 2:50 p.m. Eastern
Join Microsoft Teams Meeting
Join by phone: +1 248-509-0316; 671 703 541# (Dial-in Number)

Agenda Items		
1:00 pm	Welcome: Part I	Katherine Peretick, Commissioner Michigan Public Service Commission
1:05 pm	Introduction of Tribal Participants	Reka Holley Voelker, Tribal Liaison Michigan Public Service Commission
1:20 pm	MI Power Grid & Workgroup Introduction	Katherine Peretick, Commissioner, Michigan Public Service Commission
1:25 pm	New Technologies & Business Models Workgroup Goals and Tasks	Joy Wang, Staff, Michigan Public Service Commission
1:40 pm	DOE Office of Indian Energy Overview and Offerings	Lizana Pierce, DOE Office of Indian Energy
2:10 pm	New Technologies & Business Models Survey Results: Discussion of Experiences and Needs	Moderated by: Katherine Peretick, Commissioner Joy Wang, Staff Michigan Public Service Commission
2:50 pm	Part I Adjourn	

Appendix D: Pre-Workgroup Stakeholder Survey

New Technologies and Business Models Workgroup

Stakeholder Survey: Content

The New Technologies and Business Models workgroup is an upcoming MI Power Grid stakeholder workgroup. The Commission envisions this workgroup will be educational in nature to share information on technologies and their potential applications and to focus on regulatory, business model, economic, or other barriers. In preparation for the stakeholder series and the issuance of a Commission order to officially launch this workgroup, Staff seeks stakeholder input regarding the workgroup topics of interest and timing.

Please fill out the survey below to share your preferences on topics the New Technologies and Business Models workgroup may explore and its timing.

---

1. Please select and rank **five** of the topics below in order of your preference for inclusion in the workgroup, where 1 notes your highest preference. Do not include topics you find adequately covered in other Michigan Public Service Commission forums.

- Biofuels
- Combined Heat and Power
- Community Solar Energy
- Demand Response Technologies
- Energy Storage
- Energy Efficiency Advancements
- Electric Vehicles
- Heat Pumps for Space and Water Heating/Cooling
- Green Hydrogen
- Grid Interconnected Buildings

Appendix D: Pre-Workgroup Stakeholder Survey, cont.

- Hydroelectric Advancements
- Microgrids
- Novel Energy Technologies and Materials (e.g. electrocatalytic conversion of CO_2 to ethanol, radiative cooling for modular electricity generation, etc)
- Nuclear Microreactors and other Advanced Reactors
- Solar Energy Advancements
- Wind Energy Advancements

2. If you have recommended topics beyond those above that you want included in this workgroup, please share them below.

3. If you have any suggested topics focused on regulatory barriers or business models, please list them below.

Next

Appendix D: Pre-Workgroup Stakeholder Survey, cont.

New Technologies and Business Models Workgroup

Stakeholder Survey: Timing

Stakeholders have shared the significant time required to participate in multiple MI Power Grid workgroups. In the near term, the Commission expects to launch two new MI Power Grid workgroups (integrated resource, distribution and transmission planning and competitive procurement) and to move forward with the formal rule-making process for generation interconnections. The following questions pertain to the timing of the New Technologies and Business Models workgroup.

4. Are you agreeable with an October Commission launch of this workgroup?

◯ Yes

◯ No

5. What are your preferences for the kickoff meeting timing? Please select one.

◯ Kick-off meeting between October – December 2020

◯ Kick-off meeting in January 2021

◯ Kick-off meeting in February 2021 or later

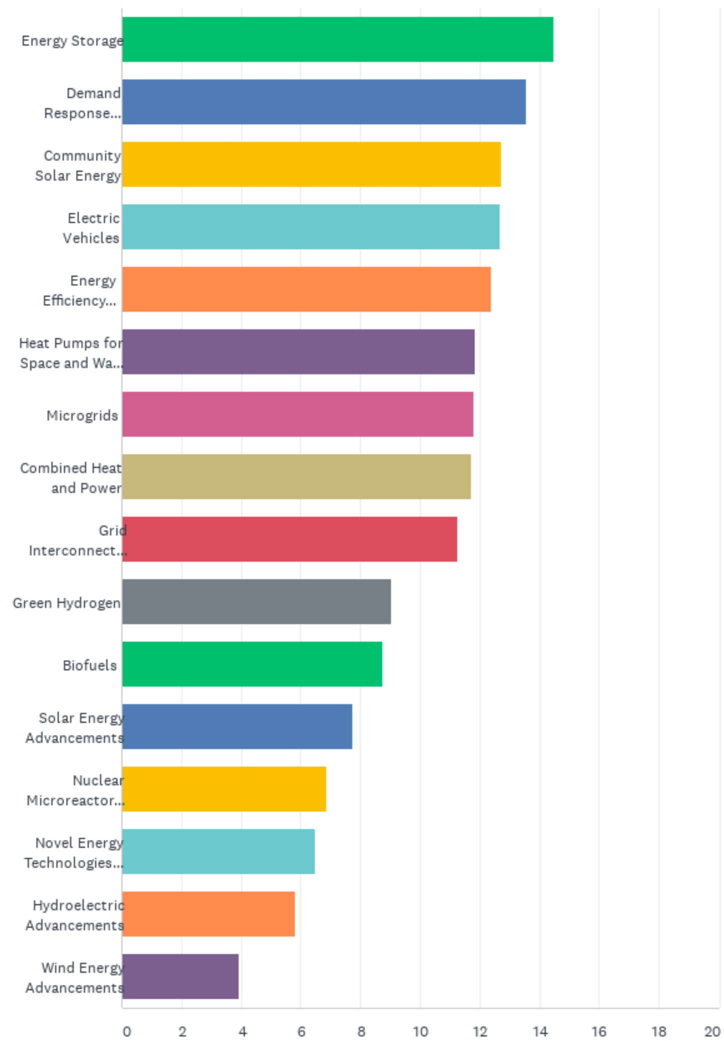
6. If you have specific concerns regarding the timing of the Commission launch of this workgroup and the kick-off meeting, please share them below.

Prev Done

Appendix E: Pre-Workgroup Survey – Summary of Results

A total of 53 survey responses were received. A summary of survey results is provided below. Text responses are provided in full.

Q1 Please select and rank five of the topics below in order of your preference for inclusion in the workgroup, where 1 notes your highest preference. Do not include topics you find adequately covered in other Michigan Public Service Commission forums.



Appendix E: Pre-Workgroup Survey – Summary of Results, cont.

Q2 If you have recommended topics beyond those above that you want included in this workgroup, please share them below.

Answered: 19 Skipped: 34

#	RESPONSES	DATE
1	Not at this time.	9/8/2020 4:12 PM
2	It may be beneficial to define a problem statement in the first workgroup around new technologies and business models, and then select specific topics to meet that objective. Consumers Energy's view of one problem statement might be: there are limitations within our regulatory construct and utility business model that prevent us from deploying solutions needed for cost-effective decarbonization. Our rankings from Question #1 reflect this problem statement. Additionally, other topics may come into scope depending on how the workgroup objectives are framed up. For example, carbon capture and sequestration may be a topic for discussion as we explore cost-effective pathways for decarbonization. Additionally, beyond just green hydrogen as a fuel replacement, we may consider examining hydrogen fuel cells, power to other clean gases (ammonia, synthetic gases and fuels), etc.	9/8/2020 11:04 AM
3	Gas and coal.	9/3/2020 1:28 PM
4	Accounting Treatment of Cloud Computing Arrangements	9/3/2020 12:24 PM
5	None ... the list above (Item 1) is very comprehensive.	9/3/2020 11:38 AM
6	Electric vehicle charging / transportation electrification infrastructure	9/3/2020 11:11 AM
7	Carbon capture and sequestration; in storage - it would be nice to look both and short and long-duration technologies	9/3/2020 10:52 AM
8	Net Metering and increasing the value of outflows ABOVE retail	9/3/2020 9:46 AM
9	VTG and Induction on the fly technologies	9/2/2020 11:58 AM
10	Grid modernization (transmission infrastructure).	8/30/2020 11:28 AM
11	Not appropriate for this workgroup, but the MPSC really needs a workgroup on CME (coronal mass ejection) hardening of the grid. One day such an event could cripple the entire midwest grid. Michigan should lead the effort to stockpile transformers for the region (nation) and harden the Michigan grid.	8/28/2020 11:15 PM
12	Clean Fuel Standards / Low Carbon Fuel Standards	8/28/2020 6:44 PM
13	Heat pump clothes dryers could be included with "Heat Pumps for Space and Water Heating / Cooling", and induction cooking in "Energy Efficiency Technologies"	8/24/2020 7:38 AM
14	environmental/social justice	8/23/2020 5:34 PM
15	Utility/Customer Partnerships	8/22/2020 11:53 AM
16	Bio-digester	8/22/2020 7:46 AM
17	smart sensors/inverters	8/21/2020 10:37 PM
18	Performance based utility business model reforms	8/21/2020 6:04 PM
19	Grid integration of renewable energy	8/21/2020 11:20 AM

Appendix E: Pre-Workgroup Survey – Summary of Results, cont.

Q3 If you have any suggested topics focused on regulatory barriers or business models, please list them below.

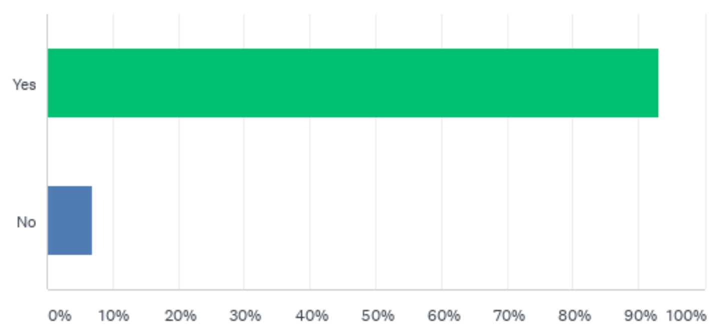
Answered: 26 Skipped: 27

#	RESPONSES	DATE
1	1. How can regulators and the regulatory process support innovation and technology development by regulated energy businesses. 2. Consider flexibility in how certain assets are classified to ensure the regulatory process is being supportive of those alternative technologies being viable solutions. For example a battery used on the distribution system or transmission system may need to be classified or treated as one of those assets respectively (instead of a generation asset) to support them being a viable option.	9/8/2020 4:12 PM
2	It may be appropriate to consider capital intensive vs. non-capital intensive technologies more broadly rather than individual technologies or use cases. The lack of incentives for utilities to deploy non-capital, emerging technologies are a barrier that should be considered in the workgroup.	9/8/2020 11:04 AM
3	transmission as a storage asset, recovery for batteries	9/4/2020 6:58 AM
4	Regulatory barrier - Need for increased space for open competitive markets and less utility gate keeping.	9/3/2020 4:34 PM
5	Michigan needs to focus careful attention on systematically listing all the regulatory barriers and considering potential resolutions for those. Also, business models need to be carefully articulated for both: (a) potential roles for utilities or utility affiliates; and (b) potential roles for competitive service providers.	9/3/2020 1:43 PM
6	To much time spent on workshops	9/3/2020 1:28 PM
7	cloud capitalization	9/3/2020 12:48 PM
8	Accounting Treatment of Cloud Computing Arrangements	9/3/2020 12:24 PM
9	In terms of specific barriers: a) I would like to see the workgroup address current limits on production from CHP systems. In terms of business models: b) I would like the workgroup address market-based incentives for renewable energy production .	9/3/2020 11:38 AM
10	* DER aggregation / virtual power plants * For energy storage: (1) enable business model innovation (i.e., one party owns, another party has dispatch control; two parties share dispatch control; etc); and (2) enable multiple-use of DER storage for retail service and wholesale markets	9/3/2020 11:11 AM
11	Utilities should not earn more for selling more energy. They need a new business model.	9/3/2020 9:46 AM
12	Siting & Permitting of renewable energy projects, local vs state authority - pros/cons.	8/30/2020 11:28 AM
13	Determining if/how electric vehicle charging can effectively participate in MISO markets.	8/28/2020 6:44 PM
14	- Changing utility performance incentives on program performance from overall kWh savings based to emissions savings based. - Adding utility performance incentives for customer experience and satisfaction and considering inclusion when determining return.	8/28/2020 5:56 PM
15	Regulatory structure to support the aggregation of investments in EE beyond focus on single buildings to larger scale, either geographically (e.g., neighborhood scale) or topically (e.g., single family houses of a certain type and vintage).	8/25/2020 11:58 AM
16	Energy as a service and whether it contributes to electric choice Proper or standardized valuation methods for buildings/microgrids that can be tapped as a grid resource Aggregation of GEBs, Micro/Mini Grids, DR Devices, etc., as an energy resource and proper valuation	8/25/2020 9:55 AM
17	Full utility deregulation/separation of ownership of electricity generation from distribution	8/25/2020 9:44 AM
18	Regulatory treatment of operating expenses versus, performance-based regulation, and shared	8/25/2020 9:26 AM

Appendix E: Pre-Workgroup Survey – Summary of Results, cont.

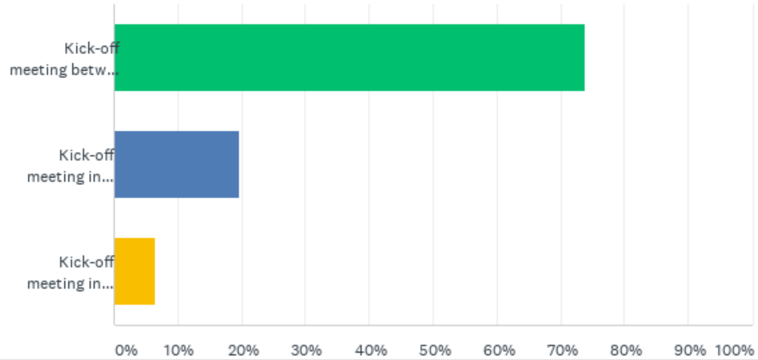
	savings mechanisms.	
19	regulatory treatment of operating expenses that replace traditional utility capex (e.g., DER-based services in lieu of "pole & wires" investments); PBR/PIMs, shared savings mechanisms to encourage utilities to support customer-owned solutions that lower total system costs	8/25/2020 9:24 AM
20	Regulatory consideration of measuring energy efficiency savings in Britih Thermal Units (BTUs) versus kWh for electricity and therms for gas, or as a third option.	8/24/2020 7:38 AM
21	strong performance based regulation, incentives to avoid investments and be more flexible/nimble	8/23/2020 5:34 PM
22	Increasing private solar energy installations beyond 1% of total electrical consumption. Time of use pricing for inflow or outflow kwh	8/22/2020 11:53 AM
23	Off grid living Environmental impact of each energy choice -how many choices do consumers have?	8/22/2020 7:46 AM
24	customer-sited generation is often discouraged/disliked by utilities - enabling equal treatment (with incentives or changes to capital expense accounting, etc) would be an important topic to discuss	8/21/2020 10:37 PM
25	Past and current MPSC policy orientations are still almost exclusively focused and driven by the traditional centrally managed energy generation and distribution business model. MPSC almost totally ignore the multiple value-added benefits which can be derived from facilitating and promoting the deployment of a "behind the meter" Public/Private locational distributed energy management. approach	8/21/2020 6:04 PM
26	Most of the topics that I prioritize would come under the heading of and could best be analyzed as building decarbonization or with EVs as strategic or beneficial electrification. The regulatory and business model challenges are how we support load growth other than line extensions and how we support fuel switching.	8/21/2020 11:45 AM

Q4 Are you agreeable with an October Commission launch of this workgroup?



Appendix E: Pre-Workgroup Survey – Summary of Results, cont.

Q5 What are your preferences for the kickoff meeting timing? Please select one.



Q6 If you have specific concerns regarding the timing of the Commission launch of this workgroup and the kick-off meeting, please share them below.

Answered: 9 Skipped: 44

#	RESPONSES	DATE
1	The timing of this workgroup should consider the available utility resource to meet the needs of this workgroup and the other pending MI Power workgroups.	9/8/2020 4:15 PM
2	While an Oct start date is possible, Consumers Energy would prefer a January start date as scheduling issues and existing regulatory work are considered.	9/8/2020 11:05 AM
3	The sooner the better. Michigan has fallen years, if not decades, behind other jurisdictions. The new technologies are proliferating much faster than the speed of required regulatory reform to enable the new technologies. We are at very real risk of billions of dollars of stranded costs.	9/3/2020 1:46 PM
4	Sooner is better. In many ways, Michigan is playing catch-up to other states that have been more proactive with efforts to reform the grid. We have plenty of work to do, so let's get going!	9/3/2020 11:39 AM
5	Unclear what the scope of this is - seems broad	9/3/2020 11:09 AM
6	How can I join the workgroup?	9/2/2020 11:59 AM
7	I agree there is a lot going on, which makes it difficult to participate (particularly for small, non-utility organizations)	8/25/2020 9:45 AM
8	For energy efficiency, any new technologies that are to be included in the Michigan Energy measures Database (MEMD) for the following year much be submitted by April 1st of each year, so timing is important to meet that deadline for 2021 or 2022 submissions.	8/24/2020 7:41 AM
9	Many individuals work from 8-5 For inclusion purposes any meetings during those time effectively exclude a large portion of your stakeholders	8/22/2020 7:48 AM

Appendix F: Stakeholder Recommendation Survey

New Technologies and Business Models Workgroup

Stakeholder Resource Recommendations

MPSC Staff is planning the stakeholder process for the MI Power Grid New Technologies and Business Models workgroup. You can learn more about the workgroup and its tasks, as detailed by the October 29, 2020, Commission order for case no. U-20898 here. Please share any resources or recommendations you might have for the topics below:

-Behind the meter & community solar
-Combined heat and power
-Electric vehicles
-Microgrids
-Space & water heating using heat pumps
-Storage
-Alternative business and ownership models
-General new technologies and business model topics

1. Please provide your contact information, in case Staff wants to follow-up.

Name

Company

Email Address

Phone Number

2. Please share any resources you recommend for the above topics. Links are appreciated.

3. Please share any example existing or planned projects you recommend for the above topics, detailing the project name, location, brief description, and any links, that you believe will be informative to the workgroup.

Appendix F: Stakeholder Recommendation Survey, cont.

4. Please share any case-studies you wish to examine for any of the topics above. Staff is interested in utility ownership as well as customer and third-party ownership case-studies.

5. If you know any speakers/presenters you recommend for the above topics, please share their name, organization, area of expertise, and contact information. Areas of interest for each topic include: technical capabilities, potential benefits or impacts, cost and adoption trends, barriers and potential solutions, and alternative configurations or ownership models.

6. If you have any other comments or recommendations, please include them here.

Done

Appendix G: Stakeholder Recommendation Survey – Summary of Results

A total of fourteen survey responses were received. A summary of the recommended resources, projects, and case studies from survey results are provided below. No information regarding the survey respondents' contact information or recommended speakers will be provided. Please note that inclusion of any resources, projects, or case studies provided by survey respondents below does not signify that the MPSC or Staff support or recommend the associated resources, projects, case studies, or associated businesses and organizations.

Appendix G-1. Recommended Resources

The resources below were recommended by stakeholders in survey responses.

- General
  - Publications from Electric Power Research Institute ("EPRI"), Smart Electric Power Alliance ("SEPA"), Guidehouse (formerly Navigant), Rocky Mountain Institute ("RMI"), Edison Electric Institute ("EEI") and other entities.
  - Best practices from Minnesota's E21 stakeholder process
  - www.illinoisabp.com
  - www.srecdelaware.com
  - www.trecsnj.com
  - Germany 2020 Energy Policy Review
- Alternative Business & Ownership Models
  - JouleSmart – infrastructure-as-a-service provider for small and medium businesses in Westchester County, NY
  - PG&E meter-based pay-for-performance system (demand flexibility framework)
  - Ameren Illinois use of smart meter data to identify and help small businesses in disadvantaged communities hardest hit by COVID to provide services to lower energy bills
  - Connecticut Case Study: The Power of Metered Efficiency and Advanced M&V
  - A Regulatory View of Meter-Based Efficiency
  - Demand Flexibility Can Fix the California Grid
  - Virtual Peaker Plant
- Behind the Meter & Community Solar
  - Minnesota Community Solar (Resource 1 & 2)
- Combined Heat and Power
  - Michigan CAT
- Energy Storage
  - Armada Power – energy storage/demand management via water heaters
  - Energy Vault – gravity and kinetic energy based, long-duration energy storage solutions

Appendix G-1. Recommended Resources, cont.

- Leading the Way: U.S Electric Company Investment and Innovation in Energy Storage - October 2018
- Green Mountain Power Storage
- Maryland Storage Pilots (Resource 1 & 2)
- PG&E Storage Projects
- PG&E WatterSaver Program: Behind-the-Meter Thermal Energy Storage Program

- Electric Vehicles
  - DTE Charging Forward Annual Status Report - May 2020
  - New US Building Codes will Make Every Home Ready for Electric Cars
  - These New Building Codes Could Finally Ensure New Houses are Ready for Charging Electric Vehicles
- Heat Pumps
  - Dandelion Energy and its New York's Clean Heat Program
- Microgrids
  - Bronzeville Community Microgrid - Commonwealth Edison
  - Blue Lake Rancheria Microgrid
  - Smart Neighborhood Microgrid- Alabama
- Multiple Technologies
  - EIA – Distributed Generation, Battery Storage, and CHP System Characteristics and Costs in the Buildings and Industrial Sectors - May 2020
  - Germany landlord-to-tenant electricity supply

Appendix G-2. Recommended Existing or Planned Projects

The projects below were recommended by stakeholders in survey responses. Any projects that were recommended, but also previously recommended as resource, is not listed below to eliminate duplication.

- Consumers Energy existing or planned projects pertaining to:
  - Electric Vehicles: PowerMIDrive and PowerMI Fleet
  - Storage: Customer-sited and utility-scale projects
- Arizona Public Service - currently has a pilot with Armada Power designed to optimize TOU and use water heaters for mid-day solar sponging along with demand response.
- Dayton Power & Light - pending settlement which would implement a pilot low-income program designed to use water heaters as a storage and demand response resource to lower impact to the state's Percentage of Income Payment Program fund. Provide underserved community access to energy management tools which do not impact comfort.

- Co-ops - eight distribution coops across the U.S. using water heater tech for demand charge reductions and TOU rate benefits to members. Central Electric (5 members), Coast, Ozarks, and Brunswick
- Burcham Park Community Solar
- Several Michigan hospitals are developing CHP projects but cannot be publicly identified at this time.

Appendix G-3. Recommended Case-Studies

The following were recommended case-studies from survey respondents.

- Programs that successfully drove rapid behind the meter and community solar adoption
  - Illinois Adjustable Block Program,
  - New Jersey Transitional REC Program, and
  - Delaware SREC Procurement
- NYSERDA's Heat Pump Potential Analysis and Benefit Study
- Brattle Group's report on heating sector decarbonization, including the role of GSHPs
- Minnesota Community Solar Case Study
- Capturing Value form Electric Water Heaters as a Non-Invasive Demand Response Resource: Market Trends, Applications for Grid Services, and Recommendations for Utilty Program Design
- CHP Roadmap for Michigan

Appendix H: Behind the Meter and Community Survey

New Technologies and Business Models Workgroup

Behind the Meter and Community Solar

On March 10, 2021, the MI Power Grid New Tech and Business Models Workgroup will hold a meeting covering behind the meter and community solar. This survey will gather stakeholder input to help guide the panel discussion. This survey covers both behind the meter and community solar. For the purposes of this survey, working definitions of behind the meter solar and community solar are provided below.

Behind the Meter Solar Definition
Behind the meter solar projects are installed on a customer's premises and designed to enable the customer to use the solar on-site and reduce utility purchases. Behind the meter solar projects may or may not be configured to export excess generation to the utility distribution system.

Community Solar Definition
A flexible program with a central solar source and multiple subscribers, which may provide economic, environmental, and/or community benefits with known objectives.

The community solar working definition above is derived from the work of the Third-Party Community Renewable Energy stakeholder engagement process. MPSC Staff modified the definition to include solar as the renewable resource. The definition intends to incorporate both third-party and utility ownership models.

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Appendix H: Behind the Meter and Community Survey, cont.

New Technologies and Business Models Workgroup

Behind the Meter Solar Projects

1. Please rank the behind the meter solar processes that are effective in Michigan from 1 to 7 (with 1 being the most effective):

- Interconnecting with distribution utility
- Utility standby rate tariffs are understandable
- Utility standby rate tariffs reflect appropriate rates for standby service
- Excess generation purchase price accurately reflects the costs and benefits
- Utility program options for behind the meter solar are understandable and meet customer needs
- Access to customer usage data
- Ability to finance project

2. If there are other behind the meter solar processes that are effective in Michigan and not listed above, please specify below.

Appendix H: Behind the Meter and Community Survey, cont.

3. Some utility and regulatory challenges that may impact the development of behind the meter solar projects are listed below. Please rank the following challenges in Michigan from 1 to 6 (with 1 being the biggest challenge):

- Lack of utility program options
- Interconnecting with distribution utility
- Difficulty calculating impact of utility standby rate tariff
- Utility standby rate tariffs are too high
- Excess generation purchase price does not accurately reflect costs and benefits
- Regulatory and/or technical barrier(s) not allowing aggregation of meters located on the same customer site

4. Some other challenges that may impact the development of behind the meter solar projects are listed below. Please rank the following challenges in Michigan from 1 to 7 (with 1 being the biggest challenge):

- Identifying potential customers
- Identifying a sales and installation company
- No hosting capacity data
- No public solar project cost market data
- Access to customer usage data
- Financing options
- Consumer protection

5. Are there any additional challenges that you think may impact the development of behind the meter solar projects?

Appendix H: Behind the Meter and Community Survey, cont.

6. Please describe behind the meter solar business/regulatory models you would like to see in Michigan.

7. What are the advantages of regulated utilities owning customer behind the meter solar projects?

8. What are the disadvantages of regulated utilities owning customer behind the meter solar projects?

9. Is there anything else about behind the meter solar that was not captured in the survey questions that you would like to add?

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Appendix H: Behind the Meter and Community Survey, cont.

New Technologies and Business Models Workgroup

Community Solar Projects

10. Please select the community solar business models that you would like offered by rate regulated utilities.

- ☐ Small-scale, utility-owned, located in subscriber community
- ☐ Small-scale, non-utility-owned, located in subscriber community
- ☐ Large-scale, utility-owned, located away from the subscriber community
- ☐ Other (please specify)

11. If rate regulated utilities offered a low-income community solar program, how should the program subscriptions be funded?

- ☐ Voluntary donations
- ☐ Grants from foundations, non-governmental organizations, or federal government
- ☐ Other (please specify)

12. Please describe a business model in which an entity (utility or otherwise) initially owns a community solar project and customer subscription fees include payments to purchase a portion of the solar project. Please share any implemented examples of the described business model.

Appendix H: Behind the Meter and Community Survey, cont.

13. Is on-bill crediting necessary for community solar to flourish?

- ◯ Yes
- ◯ No

14. What community solar subscriber consumer protection issues should be considered?

15. Please select any applicable barriers you have experienced related to community solar in Michigan.

- ☐ Cost
- ☐ Technology barriers
- ☐ Coordination with utility
- ☐ Regulatory barriers
- ☐ Legislative barriers
- ☐ Customer/ resident interest and demand
- ☐ Project siting
- ☐ Other (please specify)

16. Is there anything else about community solar that wasn't captured in the survey questions that you would like to add?

Prev Done

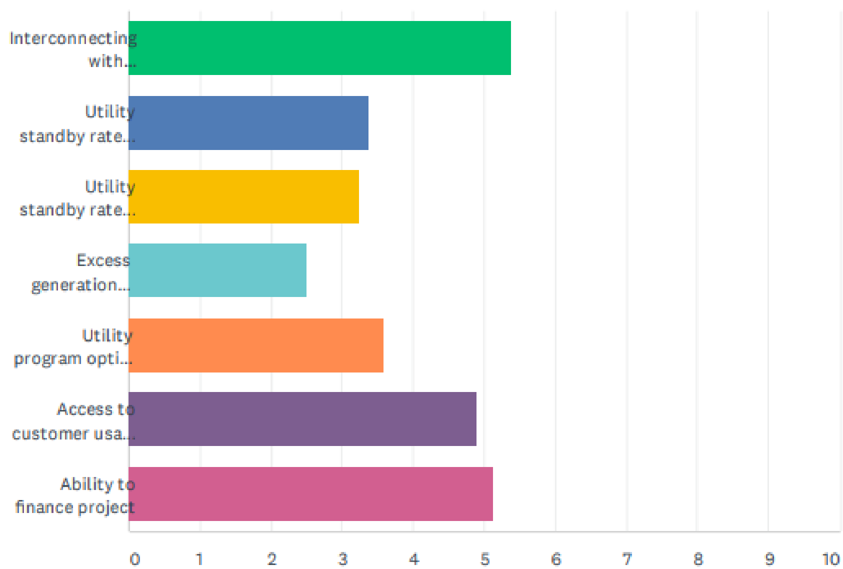
Appendix I: Behind the Meter and Community Survey – Summary of Results

Written responses with multiple components may have been listed as multiple points. Therefore, the number of bulleted written responses may exceed the total number of respondents for the question. Information that may help identify the respondent has been removed.

Appendix I-1. Behind the Meter Survey Responses

Q1 Please rank the behind the meter solar processes that are effective in Michigan from 1 to 7 (with 1 being the most effective):

Answered: 28 Skipped: 6



	1	2	3	4	5	6	7	TOTAL	SCORE
Interconnecting with distribution utility	34.62% 9	11.54% 3	34.62% 9	3.85% 1	11.54% 3	0.00% 0	3.85% 1	26	5.38
Utility standby rate tariffs are understandable	4.55% 1	18.18% 4	4.55% 1	18.18% 4	13.64% 3	18.18% 4	22.73% 5	22	3.36
Utility standby rate tariffs reflect appropriate rates for standby service	8.00% 2	8.00% 2	8.00% 2	8.00% 2	20.00% 5	40.00% 10	8.00% 2	25	3.24
Excess generation purchase price accurately reflects the costs and benefits	0.00% 0	4.00% 1	8.00% 2	12.00% 3	20.00% 5	20.00% 5	36.00% 9	25	2.48
Utility program options for behind the meter solar are understandable and meet customer needs	7.69% 2	3.85% 1	11.54% 3	38.46% 10	7.69% 2	15.38% 4	15.38% 4	26	3.58
Access to customer usage data	14.81% 4	40.74% 11	7.41% 2	7.41% 2	18.52% 5	7.41% 2	3.70% 1	27	4.89
Ability to finance project	36.00% 9	16.00% 4	20.00% 5	8.00% 2	4.00% 1	4.00% 1	12.00% 3	25	5.12

Appendix I: Behind the Meter and Community Survey – Summary of Results, cont.

Q2 If there are other behind the meter solar processes that are effective in Michigan and not listed above, please specify below.

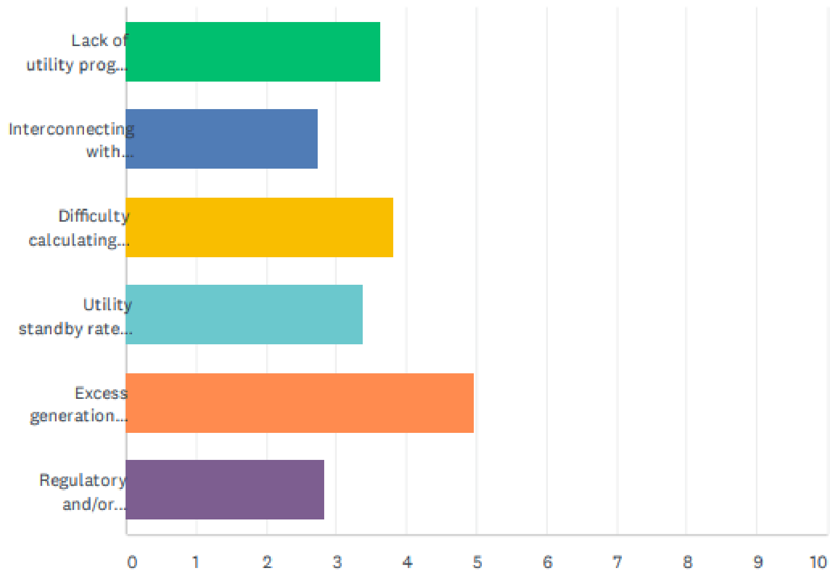
Answered: 9 Skipped: 25

- None of the above is effective in Michigan.
- I do not think many are effective at all. Rather than rank 1-7, I would prefer to give each of them 6 or 7 except for financing.
- This ranking didn't fully provide ability to share how difficult #3 - #7 are for installers. because the impact of utility rates not reflecting benefits of solar makes it difficult to understand and difficult to finance.
- These processes are largely effective from the utility's perspective, as evidenced by the number of customers participating in our programs. We prioritize DG and net metering programs and interconnection requests. Every year, our number of interconnection applications increases and we can accommodate those within the 10 business day statutory limit. We expect these numbers to continue increasing in the future and we plan to handle the interconnections and contracts with the same level of quality and timeliness.
- The cap on installed DG Solar capacity (should be raised).
- Restriction on recharging customers' energy storage with energy purchased from the grid during low demand periods (counterproductive).
- Inclusion of energy efficiency measures as part of a solar package. Minimized load can minimize solar design options.
- Grid free.
- Skipping utility interconnection and installing off-grid solar and battery backup systems is effective. Installing additional solar to meet my increased consumption for EV charging did not make economic sense for me to do grid tied; it would have resulted in earlier loss of net metering for the existing system, and the larger overall system size would result in larger net inflow & outflow which would penalize me, while providing profitable peak power for the utility to sell to my neighbors.
- What about other BTM solar processes in Michigan that are NOT effective, or are blocking success?

Appendix I: Behind the Meter and Community Survey – Summary of Results, cont.

Q3 Some utility and regulatory challenges that may impact the development of behind the meter solar projects are listed below. Please rank the following challenges in Michigan from 1 to 6 (with 1 being the biggest challenge):

Answered: 29 Skipped: 5

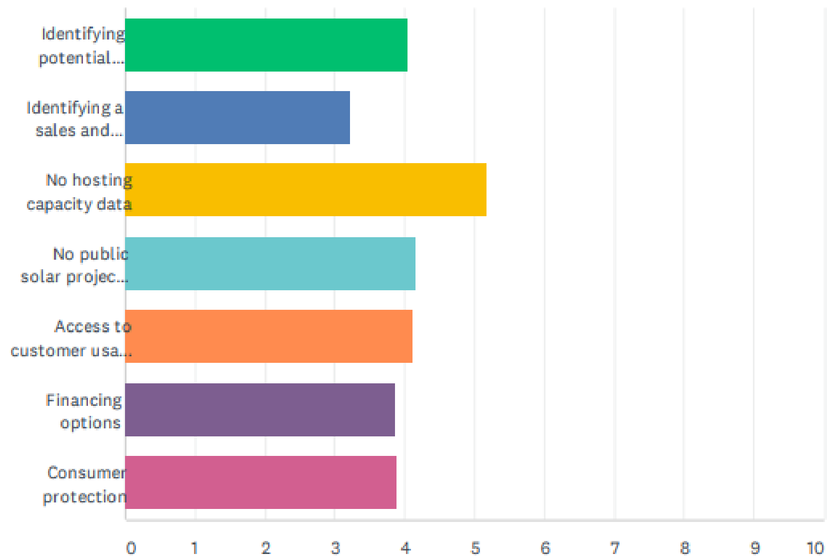


	1	2	3	4	5	6	TOTAL	SCORE
Lack of utility program options	19.23% 5	30.77% 8	0.00% 0	15.38% 4	11.54% 3	23.08% 6	26	3.62
Interconnecting with distribution utility	10.71% 3	3.57% 1	21.43% 6	14.29% 4	14.29% 4	35.71% 10	28	2.75
Difficulty calculating impact of utility standby rate tariff	15.38% 4	15.38% 4	30.77% 8	19.23% 5	11.54% 3	7.69% 2	26	3.81
Utility standby rate tariffs are too high	7.14% 2	25.00% 7	17.86% 5	10.71% 3	25.00% 7	14.29% 4	28	3.36
Excess generation purchase price does not accurately reflect costs and benefits	50.00% 14	21.43% 6	10.71% 3	10.71% 3	7.14% 2	0.00% 0	28	4.96
Regulatory and/or technical barrier(s) not allowing aggregation of meters located on the same customer site	3.57% 1	3.57% 1	21.43% 6	28.57% 8	28.57% 8	14.29% 4	28	2.82

Appendix I: Behind the Meter and Community Survey – Summary of Results, cont.

Q4 Some other challenges that may impact the development of behind the meter solar projects are listed below. Please rank the following challenges in Michigan from 1 to 7 (with 1 being the biggest challenge):

Answered: 27   Skipped: 7



	1	2	3	4	5	6	7	TOTAL	SCORE
Identifying potential customers	15.38% 4	23.08% 6	3.85% 1	15.38% 4	11.54% 3	11.54% 3	19.23% 5	26	4.04
Identifying a sales and installation company	13.64% 3	0.00% 0	9.09% 2	13.64% 3	18.18% 4	27.27% 6	18.18% 4	22	3.23
No hosting capacity data	33.33% 8	20.83% 5	16.67% 4	4.17% 1	8.33% 2	16.67% 4	0.00% 0	24	5.17
No public solar project cost market data	4.00% 1	20.00% 5	24.00% 6	8.00% 2	36.00% 9	0.00% 0	8.00% 2	25	4.16
Access to customer usage data	8.00% 2	24.00% 6	24.00% 6	4.00% 1	12.00% 3	12.00% 3	16.00% 4	25	4.12
Financing options	20.00% 5	8.00% 2	12.00% 3	16.00% 4	0.00% 0	28.00% 7	16.00% 4	25	3.84
Consumer protection	12.00% 3	8.00% 2	8.00% 2	36.00% 9	16.00% 4	4.00% 1	16.00% 4	25	3.88

Appendix I: Behind the Meter and Community Survey – Summary of Results, cont.

Q5 Are there any additional challenges that you think may impact the development of behind the meter solar projects?

Answered: 19 Skipped: 15

- Lack of transparency from MPSC and utilities
- Hostile utility involvement.
- An unclear and complex path through the interconnection process with the utility when dealing with behind-the-meter projects above 150kw (with or without outflow)
- Current "Utility Standby Rates" are far too complex, confusing and not uniform State-wide. They may be acceptable for the most sophisticated industrial customers but are not appropriate for residential or small commercial DG customers.
- Michigan rate structures are still subsidizing BTM generation. The technology and pricing has matured to the point where the option should stand on its own and not shift costs to other customers, subsidies put further pressure on all customers but particularly those Failure of both dealers/installers and customers to understand viable business models that do not require export of electricity. who cannot afford BTM generation.
- Consumers Energy believes there remains a cost subsidization issue to non-participating customers – there are fixed costs associated with the grid, particularly distribution system costs, that due to the volumetric nature of rates are largely shifted to customers without BTM solar - and we would like to see this issue addressed as part of the upcoming DER rate design workgroup. Addressing the price discrepancy first will make Consumers Energy more comfortable with developing broader solutions to faster DER deployment in Michigan.
- DTE & Consumers DG tariff should be like UPPCO, I understand that the outflow credit usage is not limited to use for power supply charges. Otherwise, a reasonable sized system, in fact a system properly sized under net metering, can result in a buildup of credit that can never be consumed (until the customer ceases service or changes rate maybe, triggering a cash-out of the account). For those customers with increased consumption now, adding more grid tied solar does not make sense.
- Inflow-outflow in general; lack of TOD pricing in many utilities making storage as a solution; ability to cross parcel lines with solar generation (on a brownfield, for example) to a commercial business adjacent or nearby.
- Ability to forecast cost/benefit for a reasonable number of years (5-7).
- Uncertainty regarding future changes to regulation and compensation. For example, on-again off-again wait lists due to the 1% cap, loss of net metering, uncertain future DG outflow rates, stand-by charges, demand charges, all make this a very difficult determination.

Appendix I: Behind the Meter and Community Survey – Summary of Results, cont.

- The Distributed Generation Cap is creating too much uncertainty. Lift the cap.
- A wide array of "Utilities/DG-customers" investment participation options needs to be made possible. A clear and fair definition of "regulated behind the meter assets" and related regulations for both the utilities and the DG customers will be needed.
- There are regulatory and business model barriers to utilities working with third-parties to deploy these behind-the-meter ("BTM") solar solutions to meet customer needs. For example, MPSC approval was needed to move forward with Consumers Energy's Bring Your Own Brightfield proposal in the Voluntary Green Pricing ("VGP") case, which was intended to leverage local installers to meet a customer's need, and would have been a win/win solution for the local installers, utility, customer participating, and non-participating customers by keeping costs to non-participating customers neutral while maintaining safety and reliability of the system.
- There are challenges around consumer protection – third-party providers are not regulated by the MPSC, and customers have no remedies for bad actors – this issue is magnified when behind-the-meter resources are not properly integrated into the distribution system. Based on our past experience, we have testimonials from customers that are more comfortable working with regulated providers than unregulated providers of energy products and services.
- Disconnected from total energy performance of a home or building. Disconnected from time of use rates. Can't oversize systems.
- If utility is guaranteed the build on specific sites, the procurement process protections for customers need to be carefully considered. Traditional RFP won't work, but need to make sure competitive opportunities drive down costs.
- Hosting capacity data access is more of a problem for larger projects.
- The statutory limit on project size (meaning that projects above 150 kW cannot qualify for the DG program) is a challenge.
- The instantaneous measurement of inflow/outflow makes it literally impossible to calculate costs and payback period. Every MPSC and utility presentation uses hourly netting, but that is not how costs/credits are being calculated.
- Benefits of energy storage at the DG customer level are currently mostly ignored. It limits achieving the full benefits of smarter-grid development and increasing the effective utilization of utilities' assets. It limits the customers' ability to manage their loads in ways that maximize the economic benefit of their self-generation and contributes to reducing their demand at peak-time.
- Pro-active DG-deployment strategy and supporting regulation are lacking. Utilities would need to be compensated for the resulting loses of energy sold to DG customers. This could be achieved with carefully crafted performance incentives.

Appendix I: Behind the Meter and Community Survey – Summary of Results, cont.

- Full integration of behind the meter resources such as Solar, Dispatchable Storage, Smart Inverter and Communication Interface with DSO will be key to maximizing the benefits to the DG/DER customers, the utilities and Michigan.
- The most critical requirement for maximizing these benefits will be for the utility DSO to efficiently manage "dispatching orders" sent to DG Smart Inverters in real-time to optimize the full potential of DG energy storage (including electric vehicles when connected).
- DG Smart Inverters need to be able to capture and send consolidated multi-source metering data to the utilities (Users' consumption, Self-generated solar energy, State of charge of the DG energy storage capacity, Inflows of energy from the Grid).
- Developing and progressively refining, through multi-year field experimentation, the artificial intelligence software imbedded in smart-inverters to optimize the flows of energy behind the meters of DG customers. This will provide utilities with the predictability and reliability of automated behavior from behind the meter DG equipment.
- DER currently receive no value for the benefits they provide to the distribution system. The current compensation mechanism does not accurately and fairly compensate DER owners for current value or contemplate future additional services that DER could provide.
- The energy literacy necessary to understand the value proposition for solar energy is lacking.
- Energy storage prices. (Battery pricing).
- High cost of code inspections

Q6 Please describe behind the meter solar business/regulatory models you would like to see in Michigan.

Answered: 24 Skipped: 10

- Instead of inflow/outflow, which is difficult to model, finance and manage for a household, would recommend first going to TOU on monthly billing. You could create optional inflow/outflow for those who would participate in an incentivized battery program.
-
- An uncapped DG program that fairly compensates for exported energy.
- Utilities are part of the solution in this early phase where we are testing options and business models that can leverage other installers in Michigan – we understand we will not be the only providers of behind-the-meter solutions, but think that utilities working with third-parties to deploy these solutions can offer benefits, while minimizing impacts to non-participating customers. Additionally, regulated utilities have oversight by the MPSC which is important from a consumer protection perspective – the more that the behind-the-meter market grows with third-party providers, the more oversight may be

taken away from MPSC, and increased consumer price and other risks can result to Michigan customers.

- State certified contractors; Utility based finance options; Benchmarks for market penetration; Battery storage
- Grid free
- SREC market. On bill financing. Sell as part of community solar.
- Value of solar
- Virtual net metering for multi-occupant buildings.
- Ability for utilities to own BTM renewable projects and support for more innovative, flexible, and comprehensive pricing options. For example, should DG customers participate in CPP and/or demand response programs designed to better manage the impact of their system on the grid.
-
- I would like to see utility analysis of "better" places to put the solar given grid capacity and where a customer may not want to sponsor it alone, create community solar opportunities, so we use our best sites.
- In general, this is NOT a regulated market. The utilities should not be owning or operating BTM solar (or storage) projects. To do so without explicit authorization from the legislature would be allowing the utility unreasonable access to an unregulated, competitive market.
- Value of solar or similar pricing for outflow No cap Value of storage to solar system because 1/2 of installs now include storage
- Removal of the 150 kW DG net meter cap.
- Open market, ease of access to customer data, fair excess purchase price, 100% interconnect, fixed rates
- Fair, simple, understandable standby rates that accurately reflect the actual cost of providing standby service. The utility standby rates have been a farce for 35 years.
- Fully integrated behind the meter equipment at the customer grid interface level will transform "regular customers" to a status of "cooperating prosumers" A significant evolution of the business model and regulatory environment of power utilities will be necessary to gain their acceptance of the Distributed Energy Resources deployment and pro-actively participate in the transition. Power utilities will most likely need to establish new independent business units to manage a mix of regulated and non regulated relations with their emerging DG/DER prosumers. The regulatory framework governing DG/DER will likely need to focus on specific performance and market penetration incentives and/or a higher guaranteed return on the investment of utilities for their DG/DER operations. To facilitate and speed up deployment of the DG/DER, their tariff setting framework and billing mechanisms would likely be closer to those already successfully implemented in the

Appendix I: Behind the Meter and Community Survey – Summary of Results, cont.

telecommunication and entertainment businesses rather than the "cost-of-service" approach currently in use for the regular customers.

- DER aggregation to provide grid and resource services.
- DG tariff based on value of solar
- Net metering. Open community storage. Grid storage demonstration projects.
- When making a purchasing decision, the customer needs the ability to estimate their ROI / payback period with reasonable accuracy. Instantaneous netting of consumption / production and TOD rates make this quite difficult. The regulatory model guarantees the utilities a return of their bond interest costs and a return on equity. BTM solar customers deserve some economic certainty as well. The 10-year grandfathering of net metering was too short, and undermined confidence. Early systems had been purchased with longer paybacks than 10 years.
-
- I would recommend looking to Ohio and New York models.
- ZERO regulation of and clear understandings of unfettered opportunities for customers to employ non-export BTM projects.
- I want to join a BYOD VPP to supply peak energy back to the grid, from solar and battery backup, like Ohm Connect. This could also be a utility owned system like Vermont's Green Mountain Power battery program. I want to supply power to a community solar system, and receive power from the community solar system at other locations. All of these programs would reduce utility rates by limiting utility (ratepayer funded) expansion of generation, especially nat. gas generation.
- I want a DG outflow credit that is not limited to use for power supply inflow charges. There should be a minimum required percentages of distributed generation and storage for the utilities, instead of the current "1%" cap of DG. With only minor incentives or lack of disincentives, customers can invest directly instead of allowing the utility to build and charge for more generation.
- Buy and sell energy at the same all inclusive price.

Appendix I: Behind the Meter and Community Survey – Summary of Results, cont.

Q7 What are the advantages of regulated utilities owning customer behind the meter solar projects?

Answered: 27 Skipped: 7

- None
- None
- None
- None that I can see.
- Not the best model.
- Few to none.
- No costs for customers. Customers can earn lease payments.
- Ability to standardize model, and regulate impact on local grid.
- I am not aware of any circumstance where it makes sense to allow regulated utilities to own BTM solar.
- Regulated monopoly utilities should not be allowed to own anything behind the meter. It creates an immediate, proven cost shift to ALL rate payers because the utility is ratebasing staff, product and investment. The utility should not be able to control the spicket of who gets to install solar - if there is a DG cap, there cannot be utility owned BTM projects.
- Low cost of capital and advantageous customer acquisition through captive customer base and full data on those individuals
- Safety, reliability, and consumer protection are challenges that should be prioritized in addition to providing customers behind-the-meter options – and regulated utilities are part of the solution to balancing these variables. As the level of DERs on the system increases, there will be increasing safety and reliability challenges to address to accommodate increased DERs – particularly non-dispatchable DERs like solar. As discussed in question #5/6, utility behind-the-meter solar can offer many benefits – price transparency, a trusted partner, consumer protection, financing options that work for the customer, leveraging third-party installers - and owning and operating these resources while balancing across safety, reliability and affordability concerns for all customers. Duke, Green Mountain Power, and other utilities have programs with utility owned and operated DERs, which offer vast benefits and options to customers.
- Additional financing options for customers.
- Quality of system design; reduction in entry level barriers; minimized risk for homeowners
- Advantages to this would be that the utilities would be able to (presumably) more accurately model the financial impact of a project because they would understand the rate structures very well.
- Makes it more affordable. Back up power during outage.

Appendix I: Behind the Meter and Community Survey – Summary of Results, cont.

- To whom? To the utilities: they can mix into their rates and raise those rates per certificates of need. To customer: no upfront cost and presumably solid OM from utility.
- Reduced opposition by regulated utilities
- Financing, experience owning and operating
- Known counterparty with high financial capacity, long-term presence.
- Utilities should NOT own behind the meter solar projects.
- Competition but all "approved" providers should be able to compete. Open market
- Deploying energy storage at the customer level reduces energy transiting through the gid and keeps it available at the customer level for use during grid blackout periods induced by climate change.
- Utilities can benefit from discounts on large quantity orders for DG/DER related equipment. However, small private solar equipment installers could achieve a similar outcome by creating and owning shares of joint equipment purchasing cooperatives buying in large quantities.
- Multiple "shared-ownership" options and financial assistance mechanisms (regulated or not) can be offered by utilities to promote, facilitate & speedup customer engagement (rental of customer premise space, renting or leasing of critical equipment, provision of free equipment as a compensation for DG services provided in support of grid system operations….). An enlarged business model similar to COMCAST should be considered.
- Utilities' upfront investments in behind customers meters would make it possible and speed up low income customers' engagement.
- Utilities will not voluntarily commit to facilitate deploying DG + Storage without modification to their current business model. They will need to be fairly compensated for the negative impact of deploying DERs on their bottom line.
- Pro-active involvement of utilities DG/DER deployment will have a positive environmental impact associated with electricity production (increased ratio of clean energy)
- Storing DG real-time surpluses of solar energy at the customer level for delayed use at peak-time (without transiting through the grid) will reduce stress on the grid at peak-time, the negative economic impact of the "Duck-curve" and excessive unproductive generators "spinning-reserve" mode of operation.
- Efficiency, reliability, cost-effectiveness and real-time programmability of behind the meter equipment already makes them cost effective for meeting multiple overall system operations and efficiency needs.
- The most critical equipment to be under the control and command of the utility DSO will be the "smart-inverter" in order to secure reliability of behind the meter automated operations at the customer level.

Appendix I: Behind the Meter and Community Survey – Summary of Results, cont.

- The smart inverter will also be a multi-meter capable of capturing and transferring to utilities the behind the meter operations data, either in consolidated or real-time. (Solar energy self-generated, energy purchased from the grid, state of energy stored, energy used to charge electric vehicles, and premise energy consumption)
- Line losses and grid congestion at peak-time will be reduced when electricity is generated and stored at or near the point of end use.
- The possibility to "island" DG/DER premises during grid blackouts will provide participating customers with a backup reserve of energy. This will likely be a critical customer motivation factor in the context of increasing frequency and amplitude of grid disturbances caused by climate change.
- Regulated utilities should only be allowed to provide services to segments of the BTM market that are not adequately served by the competitive businesses.
- It might cause the utilities to put up fewer roadblocks. If the utility can operate the inverter or control certain settings, it can provide ancillary services (but that does not require ownership). Also, utilities like standards and stick to them - for too long. Solar and storage technology continue to evolve rapidly; we don't want to still be installing 2020 technology 20 years from now. Also, what happens when the property changes hands? Can the new owner and/or the utility renegotiate the deal? Can they demand that the system be removed? Also, customer owners are incented by TOD rates to maximize production during peak periods (e.g. trackers, south-west facing). Will the utility have the same incentive?
- Vermont's Green Mountain Power is an example. I'm not sure that the utility needs to fund and own behind meter solar & storage. Just remove disincentives built into the DG tariff (unfair outflow rate and credit only for power supply), allow participation in demand response VPP programs like OhmConnect, and many more customers will buy their own. The utility and ratepayers will not need to fund it.

Appendix I: Behind the Meter and Community Survey – Summary of Results, cont.

Q8 What are the disadvantages of regulated utilities owning customer behind the meter solar projects?

Answered: 27 Skipped: 7

- None.
- Unfair competition
- Suppressing competition
- No transparency. No open market competition. Allows the monopoly to maintain control.
- If they are the only party allowed, that is major issue. Open market but regulated to protect the consumers
- Stifle competition. They have usage data that is being denied to third party developers.
- Creates unfair competitive market due to utility's ability to leverage extended financing, use of its rate base, use of customer information.
- As a general policy, regulated utilities should not be able to leverage the competitive strengths they enjoy by virtue of their monopoly status. It is significantly anti-competitive.
- Monopolists taking advantage of customers. Monopolists interfering with open competitive markets.
- Utility owned projects are the riskiest for ratepayers, because the cost of investment is immediately on all ratepayers. Rather, the state could encourage BTM projects (with storage) that utility can be paid to "send signals to" to help provide grid services. You get the same benefits, but at a lower cost, deployed quicker, and with the least risk option to rate payers. Let the private market work.
- I believe that a utility's natural monopoly has no place behind customer's meters. The competition and innovative provided by the private sector is invaluable. If regulated utilities are able to participate, they will have such a strong and unfair advantage that it will hurt the marketplace.
- Currently, utilities have a different tax equity treatment than other providers, an inequity that should be resolved at the federal level. However, allowing utilities to test our role in this space will help Michigan regulators and stakeholders to understand these tradeoffs. For example, the higher cost can be counterbalanced by the stability a regulated utility brings to the deal structure, which can help grow this market in partnership with developers.
- Minimized customer motivation; foreclosure of innovation; price structure monopolization
- Trust from the customer to the utility. A big reason a business or individual might pursue BTM solar is to get further away from the utility.
- Stealing the economic benefits
- May not help people save.

Appendix I: Behind the Meter and Community Survey –Summary of Results, cont.

- Ability to maintain, have safe access to facilities
- Utilities are (for legal and financial reasons) sharply limited on risk they can take. Private companies can accept risk, so better pricing options for customers may be foreclosed.
- In general, this is NOT a regulated market. The utilities should not be owning or operating BTM solar (or storage) projects. To do so without explicit authorization from the legislature would be allowing the utility unreasonable access to an unregulated, competitive market.
- What happens if the solar system damages the property? How do the utilities value hosting? What happens if the customer still wants to own? What about legacy solar property?
- Large investments by utilities in ownership of behind the meter equipment of DG/DER customers will limit their ability to invest in required grid reinforcement to improve service delivery, resilience, and electrification of the transportation sector.
- Legal issues will need to be managed to ensure the fair transfer of contractual obligations when a DG/DER sells the contracted premise to a new owner.
- Early adopters of new technologies and systems may end up incurring costs that could be avoided in later adoptions by learning from early experiences. They will likely need to be incentivized to compensate for participating in experimental demonstration projects with utilities and the regulator. (cost of initial learning curve)
- If power utilities neglect getting proactively engaged in early deployment of DG/DER, private third parties will fill the void. This would limit the ability of the utilities' DSO to efficiently dispatch customers energy storage in real-time. Power utilities would be wise to remember the hard lessons learned by the telecommunication, computer manufacturing and entertainment industries when they neglected to recognize the consequences of the emergence of competitors capitalizing on new technologies and operations practices.
- The wrong people are in charge of the system and energy. The users should own the system.
- Adds additional layer of complexity to calculation of cost of service.
- If the utility owns it, the customer is basically just renting them space; their is less economic benefit and no pride of ownership. The utility is unlikely to work with the customer to identify their personal objectives in getting a solar system and design a system to meet those objectives. Customers don't think of this like buying a bond; there's security from power outages, price of ownership, a showpiece for their friends and neighbors, increased property value, etc.
- Lack of incentive to take advantage of ITC. Stifling of development of free market for third party solar resulting in few contractors entering the market. Increased complexity to complete project, resulting in solar contractors operating in other states, especially NY.

- I guess the utility billing system which already seems shaky might need to handle additional rates or tariffs for Critical peak events where more outflow is requested? But, no, a third party VPP can handle that, and customer can just be on the time of day or dynamic peak rate. Reverse direction power on outer sections of the grid? No, only from one house to the half a dozen neighbors still cranking their AC in a heat wave. The result is just less overall load on the grid.
- See above and flip the propositions.

Q9 Is there anything else about behind the meter solar that was not captured in the survey questions that you would like to add?

Answered: 12 Skipped: 22

- Buy-all, sell-all programs for customer-sited DG, like Rhode Island's ReGrowth Program, are really good models that can drive cost-effective DG deployment, as system's can be sized to match the full siting opportunity and not be constrained by on-site load. Think of parking garages as a perfect example -- very little load but significant siting opportunity within the built environment.
- Do current statutes and regulations allow for utilities to own behind the meter generation, or is that an unregulated market that the utilities as regulated entities cannot operate in?
- The IOU's are obsolete and a failed business model and should be returned to public control
- Modeling at the residential and CI space is done contractor by contractor. Most customers don't have the sophistication to know if the models pan out. For local governments, this often causes them to not go forward on a project given the unknowns and the risk. What about providing QA to projects that comes from the State via modeling tools a customer could use to double-check a contractor's numbers and include experts with whom a customer could speak?
- Exploring how to minimize subsidies and adverse grid impacts associated with BTM generation.
- Value for solar needs to be considered instead of paying a penalty with standby charges.
- Innovative tariffs that are simple to understand and fairly compensate customers for dispatchable standby generation from their in-house battery needs to be developed.
- Simplicity means making the rates easy to understand and administer so that average prospective users can most easily estimate what their investment costs and energy charges will be, based on a few straight-forward cost determinants.

Appendix I: Behind the Meter and Community Survey – Summary of Results, cont.

- Customers with efficiently managed and well-maintained on-site clean self-generation and storage should see higher percentage cost reductions for the energy they buy from the grid.
- Demonstration projects, demographic statistics about the numbers and types of customers using on-site generation and storage, along with the size and types of equipment in use, should be a starting point. Michigan already has more than 3,000 customers equipped with solar energy generation capacity. This already constitutes a significant base for the experimental (demonstration) deployment of energy storage and smart-inverter behind their meters
- If multiple resources are concentrated in specific locations, benefits will accrue in terms of avoided costs throughout the utility system, including distribution, transmission, and generation.
- Accurate aggregated data about DG/DER customers' locations and the timing of their energy usage, on-site self-generation and use pattern of storage will allow for the progressive development of (evolving) tariff rates specifically designed for long-term sustainability of the distributed concept and utilities' economic viability.
- To achieve this objective, it will be necessary to have the regulatory commission working with, and in support of, utilities to ensure that relevant DG/DER information is being analyzed on a global and location-specific basis.
- The regulatory authority and utilities' system operators will need to deploy a wide array of regulatory and technical assistance tools to provide potential customers with economic incentives to encourage deployment of DG/DERs that produce the best support for the electric grid as a whole.
- For consumers and suppliers of services to those consumers to make good decisions regarding solar installations, both groups need the ability to forecast costs and benefits for greater than 2-3 years. The MPSC and Utilities need to forecast with some accuracy so that the markets (and utilities/MPSC) can make intelligent decisions.
- TOD rates can have a significant impact on BTM solar economics and system operation (now that batteries are becoming a common part of system design). Logically, peak rates should reflect a significant portion of distribution costs, since the distribution system must be continually resized (at the circuit level) to support peak load.
- Competition for development with other states whose regulation encourages solar development - have worked with developers who pulled out of or failed to start working in MI after reviewing the opportunities in MI compared to other states.
- Something is going to have to change to keep me on the grid, I'm already most of the way there. Granted, December and January are still a challenge, but it won't take more than another 10 panels to do it. My only other concern is wasting all the solar production in the

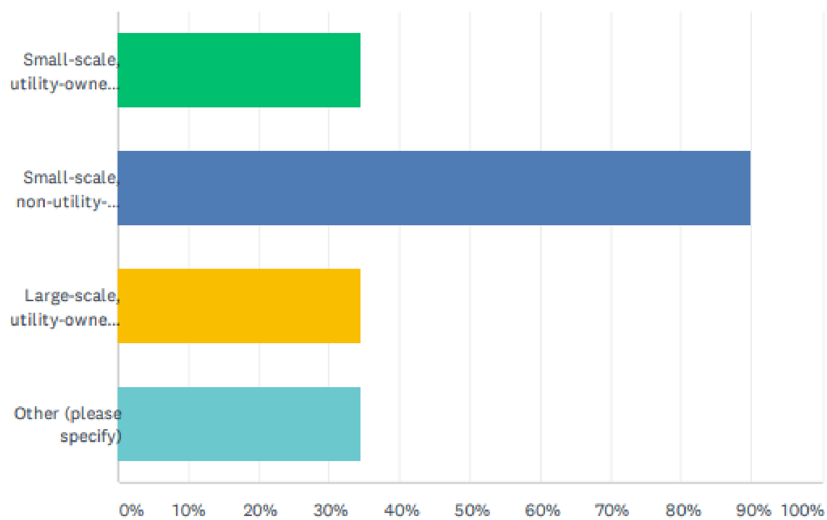
summer, no battery is big enough, I'll just ask my neighbors to charge their cars at my house in the summer. Don't worry DTE, I'm probably an anomaly. ;>)

- EVs will be a big part of this distributed architecture in a few years. This will be a huge challenge on both supply and storage.

Appendix I-2: Community Solar Survey Responses

Q10 Please select the community solar business models that you would like offered by rate regulated utilities.

Answered: 29 Skipped: 5

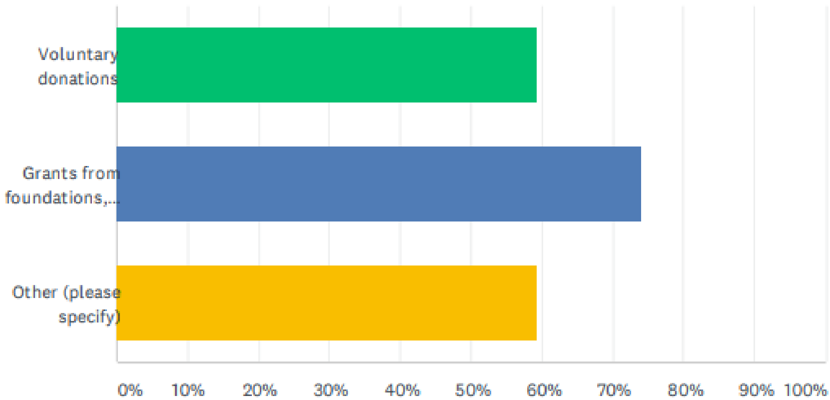


ANSWER CHOICES	RESPONSES	
Small-scale, utility-owned, located in subscriber community	34.48%	10
Small-scale, non-utility-owned, located in subscriber community	89.66%	26
Large-scale, utility-owned, located away from the subscriber community	34.48%	10
Other (please specify)	34.48%	10
Total Respondents: 29		

Appendix I-2: Community Solar Survey Responses, cont.

Q11 If rate regulated utilities offered a low-income community solar program, how should the program subscriptions be funded?

Answered: 27 Skipped: 7



ANSWER CHOICES	RESPONSES	
Voluntary donations	59.26%	16
Grants from foundations, non-governmental organizations, or federal government	74.07%	20
Other (please specify)	59.26%	16
Total Respondents: 27		

Q12 Please describe a business model in which an entity (utility or otherwise) initially owns a community solar project and customer subscription fees include payments to purchase a portion of the solar project. Please share any implemented examples of the described business model.

Answered: 14 Skipped: 20

- N/A
- I'm confused by this question. It sounds like most community solar programs in which customers subscribe to output and pay a fee for the right (and associated bill credits) of that output. Is this question talking about subscribers actually taking ownership interests in the project via their subscription? If so, I believe some early community solar program structured their deals this way, in which subscriber bought via a larger upfront payment a portion of the garden. The downside of this approach is that it requires subscribers to have capital, which makes it more exclusive to participate.
- Utilities should own and offer all the options customers are interested in, willing to pay for, and permitted by law. Non-utility owned options are off the table in the Michigan model. We don't support the model described in this question - by 2040, Consumers

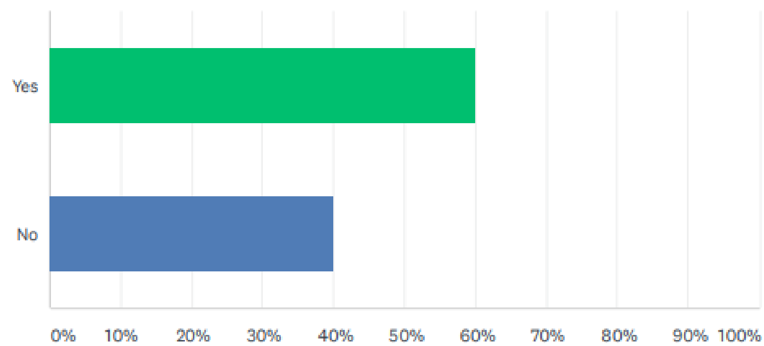
Energy will be carbon neutral, and we don't believe customers would benefit from taking over a small and potentially near end of life solar project at a time when the Clean Energy Plan has been achieved. As the Clean Energy Plan is realized, the need for small-scale community solar is likely to diminish.

- Non-profits can install a project using investors who are able to capture the incentives and rebates, provide a PPA to the host facility, and transfer the project at depreciated value at a future date after achieving their ROI.
- Look at Lansing, Traverse City or all over the state of MN.
- East Lansing Community Solar Park
- The low-income program must at the end provide savings to the customer and not higher price.
- Modeled after NY's CDG program. This allows open market competition. Funded with riders.
- One of the best models to date https://www.arcadia.com/ Requires all parties to be involved including utility
- I have the feeling that customers will be more inclined to invest in individual private DER projects rather than community solar projects
- I'm not aware of any projects that follow that specific model. I will poll my colleagues in other regions.
- Single purpose LLC or Co-op formed to own generation asset. Members purchase share of ownership (potentially tied to price of one solar panel). Array constructed behind the meter for large community based end user (school, rec center) who purchases entire generation. Members receive portion of the proceeds from sale of power as either direct payment or as a credit on their utility bill.
- See NRRI Research papers about COMMUNITY SOLAR (NRRI 16-07) and Low-Income Solar (Insights paper, December 2020), plus utility tariff on-bill financing insights paper (January 2020). In response to next question: TOB financing is not necessary, but I see no reason why it should not be provided. Michigan utilities have been refusing to adopt that PROVEN practice for increasing energy waste reduction and financing cost-effective renewable resources for 20 years already. ENOUGH!
- Finance initially and charge subscription as well as usage fees based on the cost for generating and distribution for that community

Appendix I-2: Community Solar Survey Responses, cont.

Q13 Is on-bill crediting necessary for community solar to flourish?

Answered: 25 Skipped: 9



ANSWER CHOICES	RESPONSES	
Yes	60.00%	15
No	40.00%	10
TOTAL		25

Q14 What community solar subscriber consumer protection issues should be considered?

Answered: 15 Skipped: 19

- Standard customer disclosure forms and processes. There are many examples of well-functioning community solar subscriber consumer protection in other states.
- Utility owned and operated community solar offerings can solve for any consumer protection issues as they are regulated by MPSC. Appropriate MPSC oversight is provided through regulatory proceedings and related stakeholder engagement, administrative rules, and utility programs and tariff reviews – in addition, customers can contact the MPSC for support with real or perceived issues.
- Because an installed system needs no fuel purchase, the consumer should be entitled to a non-escalating rate structure defined by years of life left in the system.
- Transferability of subscriptions, assurance of proper bill credits resulting from subscriptions
- If the solar plant underperforms because of the SPE's fault: modeling, poor OM. If utility changes offtake T+Cs in its favor.
- This is a free market - and as such, consumer protection should be left both to the market and to the Attorney General's office (for regular consumer protection complaints).
- There are many. Fixed price or indexed power price if not fixed program with customer or third-party investment.

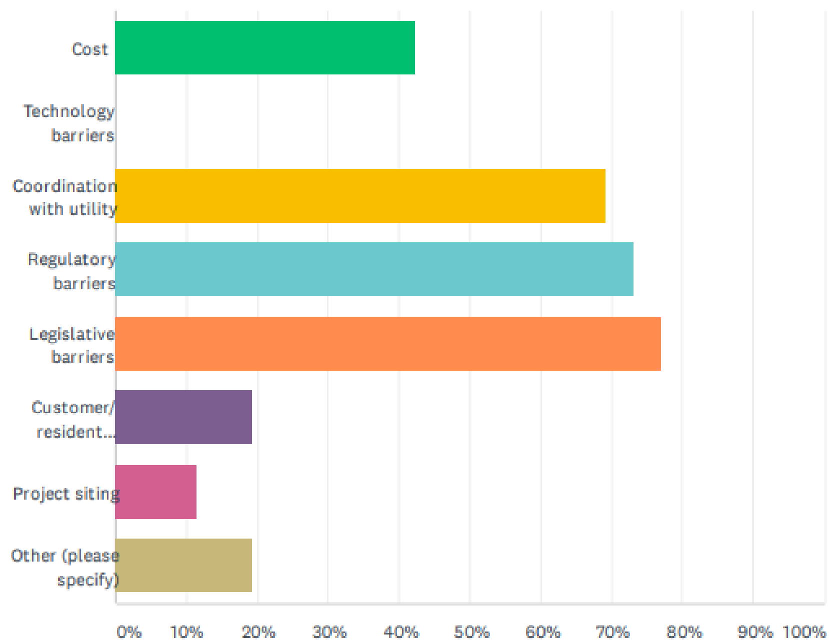
Appendix I-2: Community Solar Survey Responses, cont.

- Allow subscribers to shop every 3 years.
- Pricing, operation & maintenance, performance guarantee, payment & disconnect, insurance
- Third-party owned community solar can present many of the same issues that arise in competitive retail electric sales. Illinois has addressed the issue extensively and effectively.
- Transparency about all financial aspects
- It is a long term project that needs a good long term, solid plan for operation and maintenance for 25 years. How many businesses can guarantee to be in business for 25 years?
- COMPLETE consumer protections should always be provided. Subscribers should have full protections that ensure only good investments and positive cash flow for participants. Ease of entry and exit from the programs. Etc. Programs should also be designed to produce and maintain good LOCAL employment for those who need jobs.
- This is why it would be best if DTE owned the community system. If they do not then this can become a major issue unless standardized.
- None - community solar should not be permitted as it is conflict with ROA caps and retail utility business models

Appendix I-2: Community Solar Survey Responses, cont.

Q15 Please select any applicable barriers you have experienced related to community solar in Michigan.

Answered: 26 Skipped: 8



ANSWER CHOICES	RESPONSES	
Cost	42.31%	11
Technology barriers	0.00%	0
Coordination with utility	69.23%	18
Regulatory barriers	73.08%	19
Legislative barriers	76.92%	20
Customer/ resident interest and demand	19.23%	5
Project siting	11.54%	3
Other (please specify)	19.23%	5
Total Respondents: 26		

Q16 Is there anything else about community solar that wasn't captured in the survey questions that you would like to add?

Answered: 9 Skipped: 25

- With more and more communities making commitments to renewable energy as a major part of their climate protection goals, the availability of community solar would be a great tool to enable buy-in towards the shared goal. Neighborhood and community enthusiasm could be generated towards creating small sale community solar powered resiliency centers where the buy in includes contributing to emergency preparedness.

- I think it's important that the subscribers can SEE the system. It should be located locally both for community development, and pride of ownership.
- We should be thinking about community solar (plus storage plus full integration with comprehensive energy and water waste reduction), in the context of post-COVID "build back better" strategies. Our regulatory utility planning and policies need to be fully integrated with equity, social justice, environmental justice, economic development, public health, and climate change imperatives.
- Again, a highly distributed energy environment is in the future except in areas of high concentrations of populations. This is even more critical as we start to deal with large EV loads in the immediate future. Having 100KWhr batteries sitting in everyone’s garages needing to be charged is really going to change everything.
- Community solar should not be permitted as it is conflict with ROA caps and retail utility business models.
- Your questionnaire is obviously focused on the deployment of "community solar" rather than the deployment of customer sited "Distributed Energy Resources". This is a too limited focus.
- No. Thank you.

Appendix J: Survey of Michigan Tribes

New Technologies and Business Models Workgroup

Survey of Tribes

The New Technologies and Business Models workgroup is a MI Power Grid stakeholder workgroup initiated on January 27, 2021. The Commission envisions this workgroup to be educational in nature to share information on technologies and their potential applications and to focus on regulatory, business model, economic, or other barriers. Please visit the workgroup website to learn more and to sign up for the listserv and updates.

Please fill out the survey below to share your Tribe's interest, experience, and barriers it has or continues to face regarding implementation of energy technologies.

1. Please share your contact information, should we wish to follow-up.

Name

Tribe

Email Address

Phone Number (optional)

2. Please select any of the following energy technologies your Tribe or your Tribal members implemented.

- ☐ Behind the Meter Solar (Note: Behind the meter solar projects are installed on a customer's premises and designed to enable the customer to use the solar on-site and reduce utility purchases. BTM solar projects may or may not be configured to export excess generation to the utility distribution system.)
- ☐ Community Solar
- ☐ Combined heat and power
- ☐ Electric vehicles and charging infrastructure
- ☐ Microgrids

Appendix J: Survey of Michigan Tribes, cont.

- [ ] Space & water heating using heat pumps
- [ ] Energy storage/batteries
- [ ] Other (please specify)

3. If your Tribe or Tribal members implemented any of the above energy technologies, were any barriers to implementation and operation experienced?

- ◯ No
- ◯ Yes

4. If yes, what were those barriers?

5. Please select any of the following energy technologies that your Tribe or your Tribal members are interested in implementing.

- [ ] Behind the meter solar
- [ ] Community solar
- [ ] Combined heat and power
- [ ] Electric vehicles and charging infrastructure
- [ ] Microgrids
- [ ] Space & water heating using heat pumps
- [ ] Energy storage/batteries
- [ ] Other (please specify)

Appendix J: Survey of Michigan Tribes, cont.

6. What are some barriers that your Tribe or Tribal members face in implementing the energy technologies indicated in your response to question 5 above? Please select any that are applicable.

- ☐ Cost
- ☐ Technology barriers
- ☐ Utility cooperation
- ☐ Regulatory barriers
- ☐ Legislative barriers
- ☐ Customer/resident interest and demand
- ☐ Project siting
- ☐ Other (please explain)

7. Has your Tribe pursued any new business models when implementing energy technologies? For example, partnering with the local utility and/or an energy services company on energy upgrades to Tribal government buildings.

- ○ No
- ○ Yes

8. If yes, please share any new business models that were pursued below.

Appendix J: Survey of Michigan Tribes, cont.

9. If your Tribe has long-term energy or carbon reduction goals, please share them below.

10. What do you believe are your Tribe's most significant energy needs over the short and long-term?

11. What type of assistance does your Tribe desire regarding the evaluation, implementation, and operation of new energy technologies?

12. If there is there anything else about new energy technologies, business models, or barriers that you would like to add, please share it below.

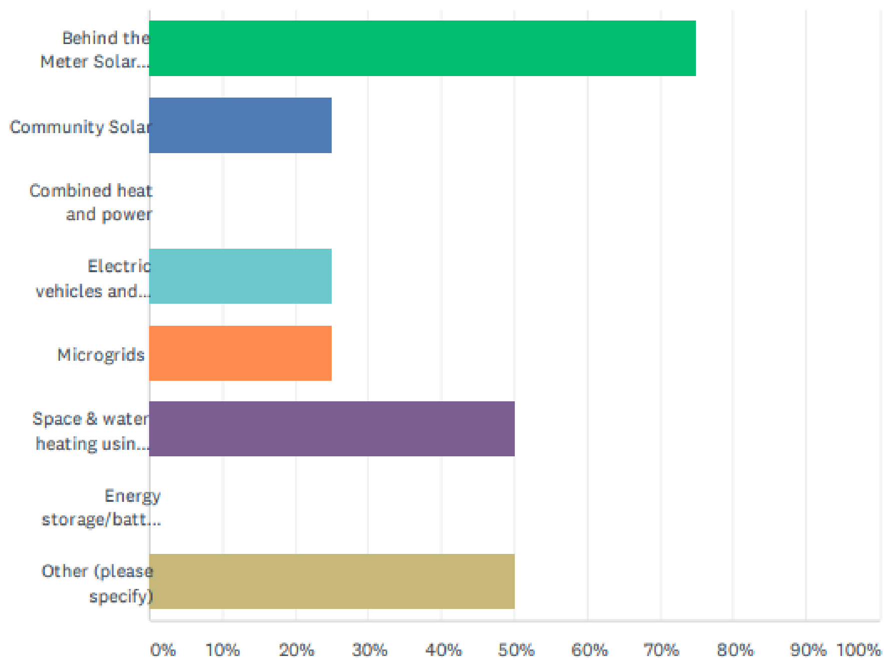
Done

Appendix K: Survey of Michigan Tribes – Summary of Results

A total of six survey responses across five Tribes were received. The following Tribes responded: Bay Mills Indian Community, Little Traverse Bay Bands of Odawa Indians, Pokagon Band of Potawatomi, Saginaw Chippewa Indian Tribe, and Sault Tribe of Chippewa Indians. The following summarizes the survey responses, with the exception of the first question regarding contact information.

Q2 Please select any of the following energy technologies your Tribe or your Tribal members implemented.

Answered: 4 Skipped: 2



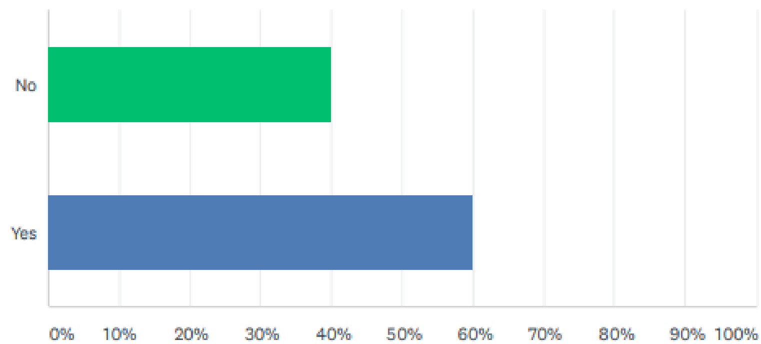
ANSWER CHOICES	RESPONSES	
Behind the Meter Solar (Note: Behind the meter solar projects are installed on a customer's premises and designed to enable the customer to use the solar on-site and reduce utility purchases. BTM solar projects may or may not be configured to export excess generation to the utility distribution system.)	75.00%	3
Community Solar	25.00%	1
Combined heat and power	0.00%	0
Electric vehicles and charging infrastructure	25.00%	1
Microgrids	25.00%	1
Space & water heating using heat pumps	50.00%	2
Energy storage/batteries	0.00%	0
Other (please specify)	50.00%	2
Total Respondents: 4		

Appendix K: Survey of Michigan Tribes – Summary of Results, cont.

- Other (please specify)
  - Geothermal
  - Built substation interconnected with transmission company as foundation infrastructure to build future grid-scale energy projects in economically depressed area.

Q3 If your Tribe or Tribal members implemented any of the above energy technologies, were any barriers to implementation and operation experienced?

Answered: 5 Skipped: 1



ANSWER CHOICES	RESPONSES	
No	40.00%	2
Yes	60.00%	3
TOTAL		5

Q4 If yes, what were those barriers?

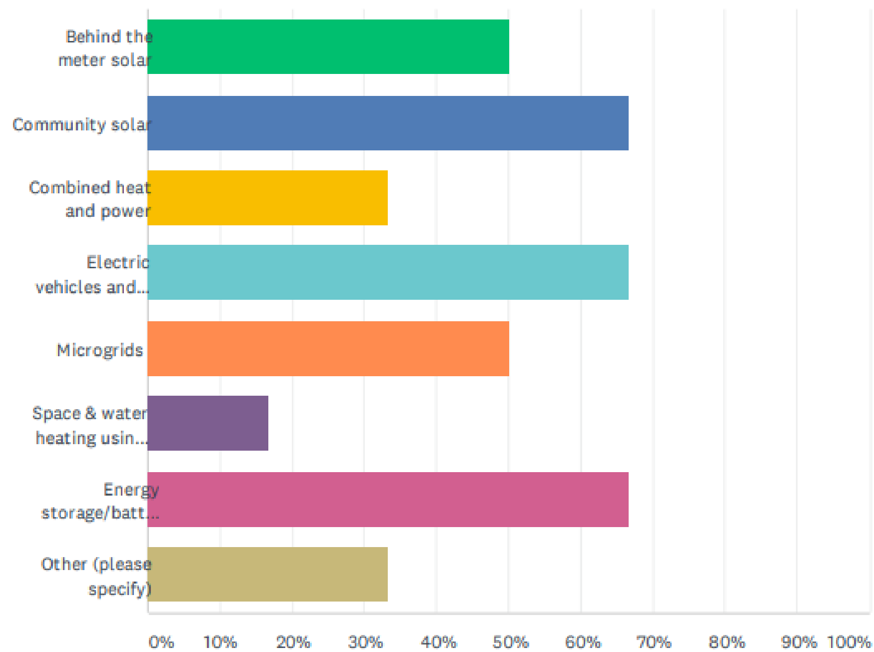
Answered: 3 Skipped: 3

- Internal knowledge capacity regarding MISO and project capital
- Mainly funding
- Information from energy provider regarding residual cost, etc.

Appendix K: Survey of Michigan Tribes – Summary of Results, cont.

Q5 Please select any of the following energy technologies that your Tribe or your Tribal members are interested in implementing.

Answered: 6   Skipped: 0

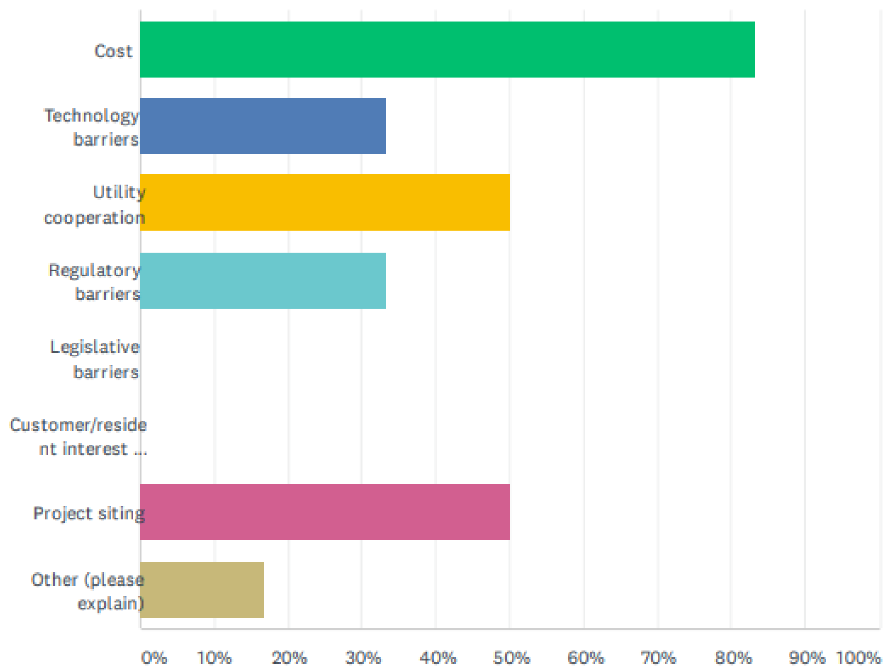


ANSWER CHOICES	RESPONSES	
Behind the meter solar	50.00%	3
Community solar	66.67%	4
Combined heat and power	33.33%	2
Electric vehicles and charging infrastructure	66.67%	4
Microgrids	50.00%	3
Space & water heating using heat pumps	16.67%	1
Energy storage/batteries	66.67%	4
Other (please specify)	33.33%	2
Total Respondents: 6		

- Other (please specify)
    - Bioreactor or biomass power generation
    - Wind mill

Q6 What are some barriers that your Tribe or Tribal members face in implementing the energy technologies indicated in your response to question 5 above? Please select any that are applicable.

Answered: 6 Skipped: 0



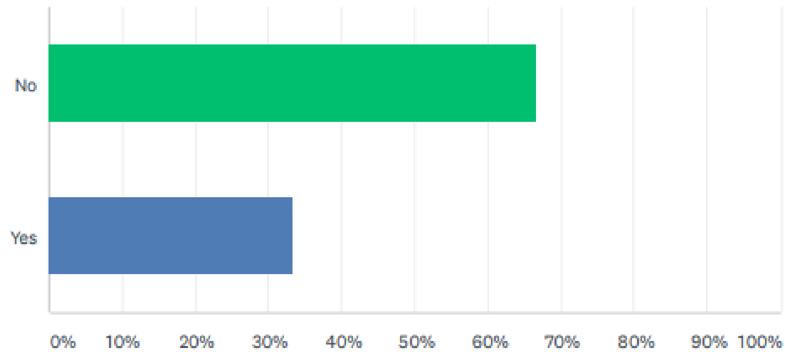
ANSWER CHOICES	RESPONSES	
Cost	83.33%	5
Technology barriers	33.33%	2
Utility cooperation	50.00%	3
Regulatory barriers	33.33%	2
Legislative barriers	0.00%	0
Customer/resident interest and demand	0.00%	0
Project siting	50.00%	3
Other (please explain)	16.67%	1
Total Respondents: 6		

- Other (please explain)
  - Raising capital. Potential projects are within Qualified Opportunity Zones and getting any Opportunity Zone Fund manager interested in the projects is difficult.

Appendix K: Survey of Michigan Tribes – Summary of Results, cont.

Q7 Has your Tribe pursued any new business models when implementing energy technologies? For example, partnering with the local utility and/or an energy services company on energy upgrades to Tribal government buildings.

Answered: 6 Skipped: 0



ANSWER CHOICES	RESPONSES	
No	66.67%	4
Yes	33.33%	2
TOTAL		6

Q8 If yes, please share any new business models that were pursued below.

Answered: 3 Skipped: 3

- Creating one of the few Tribal Electric Authorities that exist within Indian Country. Building a Tribal utility to serve both Tribal facilities and non-Tribal entities located within Tribal Trust Land.
- Two net metered systems
- Energy audits, discussion with utilities of potential projects, interval studies, etc.

Q9 If your Tribe has long-term energy or carbon reduction goals, please share them below.

Answered: 2 Skipped: 4

- Tribe has developed a long-term energy plan.
- Just in the process of defining our carbon print via layered mapping and such.

Appendix L: After Meeting Survey Example

The survey below is for the initial kickoff meeting. All after meeting surveys were similar, with only the date and topic changed.

New Technologies and Business Models Workgroup

Post-Meeting Stakeholder Survey

This survey is to capture additional stakeholder feedback, as stakeholders may have less opportunity during online meetings to provide comments. Please share your thoughts on the recent stakeholder meeting in this survey.

1. Did you attend the workgroup meeting on January 27, 2021, or watch the recording?

- ◯ Yes
- ◯ No

2. Overall, how would you rate the meeting?

- ◯ Excellent
- ◯ Very good
- ◯ Good
- ◯ Fair
- ◯ Poor
- ◯ Not applicable

3. What did you most like about the meeting?

Appendix L: After Meeting Survey Example, cont.

4. What did you least like about the meeting?

5. What did you think about the meeting length?

- ◯ Very satisfied
- ◯ Satisfied
- ◯ Neither satisfied nor dissatisfied
- ◯ Dissatisfied
- ◯ Very dissatisfied

Any comments regarding meeting length:

6. How likely are you to attend future workgroup meetings?

- ◯ Very likely
- ◯ Likely
- ◯ Neither likely nor unlikely
- ◯ Unlikely
- ◯ Very unlikely

7. If you have any additional thoughts about the meeting or meeting content, please share them here.

Done

Appendix M: After Meeting Survey - Summaries of Results

Appendix M-1. Multiple Choice Responses

Summary of the multiple choice responses are provided below for all meetings. Respondents are noted in parentheses for each question

Meeting	Date	Sample (#)	Q1. Did you attend the meeting or watch video?	Q2. Overall rating of meeting	Q5. What did you think of meeting length?	Q6. How likely are you to attend future workgroup meetings?
Kickoff	1/27	10	Yes=100%	E=30%, VG=40%, G=20%, F=10%	VS=10%, S=60%; NSD=30%	VL=70%; L=30%
Electric Vehicles	2/10	10	Yes=100%	E=40%; VG=60%	VS=2-%; S=50%, D=30%	VL=90%; L=10%
Heat Pumps	2/24	8	Yes=100%	E=75%, VG=12.5%, G=12.5%	VS=37.5%; S=27.5%; NSD=25%	VL=75%; L=12.5%; NLU=12.5%
Solar	3/10	8	Yes=100%	E=37.5%; VG=37.5%; G=12.5%, F=12.5%	VS=12.5%; S=25%, NSD=37.5%; D=25%	VL=75%; L=25%
Storage	3/24	8	Yes=100%	E=37.5%; VG=62.5%	VS=12.5%; S=37.5%, NSD=12.5%; D = 37.5%	VL=87.5%; L=12.5%
CHP	4/7	10	Yes=100%	E=20%; VG=70%; G=10%	VS=20%; S=60%; NSD=20%	VL=70%; L=30%
Microgrids	4/21	6	Yes=100%	E=20%, VG=50%; G =16.67%	VS=16.67%; S=50%; NSD=33.33%	VL=66.67%; L=16.67%; NLU=16.67%
Tribal Forum	4/28	1	Yes=100%	VG=100%	S=100%	L = 100%
Alt. Bus. & Own. Models	5/19	8	Yes=100%	E=25%; VG=50%; F=25%	VS=12.5%; S=50%; NSD=37.5%	VL=75%; L=12.5%
Closing	6/16	8	Yes=100%	E=62.5%; VG=12.5%; G=25%	VS=12.5%; S=75%; NSD=12.5%	See Note 2 below.

Note 1: Combined Heat and Power is abbreviated CHP, Solar is the Behind the Meter and Community Solar meeting, and the Alternative Business and Ownership Models meeting is abbreviated Alt. Bus. & Own. Models. For Q2, E = excellent, VG = very good, G= good, F = fair, P = poor, NA = not applicable. For Q5, VS = very satisfied, S= satisfied, NSD = Neither satisfied nor dissatisfied, D =dissatisfied and VD = very dissatisfied. For Q7, VL = very likely, L = likely, NLU = neither likely nor unlikely, U = unlikely, and VU = very unlikely.

Note 2: For the closing meeting, respondents were asked how likely they were to review Staff's draft report for the workgroup. Responses were very likely (75%) and likely (25%).

Appendix M-2. After Meeting Survey Written Responses

Appendix M-2.1. Kickoff Meeting (January 27)

Q3 What did you most like about the meeting?

Answered: 9 Skipped: 1

#	RESPONSES	DATE
1	Discussion with city representatives	2/9/2021 5:25 PM
2	Broad range of presenters. It's good to have input from differing stakeholders.	2/2/2021 2:19 PM
3	Different perspectives provided about DER	1/28/2021 7:55 AM
4	The length of time spent on each topic kept the flow of information moving without diving into the weeds right at the beginning. Fast paced.	1/27/2021 5:08 PM
5	NREL & ERPI	1/27/2021 5:07 PM
6	Diversity of presentations and speakers	1/27/2021 5:06 PM
7	Quality presenters	1/27/2021 5:06 PM
8	The overview by NREL & RMI	1/27/2021 5:05 PM
9	Diverse set of speakers.	1/27/2021 5:04 PM

Q4 What did you least like about the meeting?

Answered: 8 Skipped: 2

#	RESPONSES	DATE
1	High-level overview of technologies and solutions that I personally am already familiar with	2/9/2021 5:25 PM
2	Not much analysis on information presented. It is a kickoff meeting so that's somewhat understandable.	2/2/2021 2:19 PM
3	Questions submitted while presenters were speaking - this was quite distracting to me.	1/28/2021 7:55 AM
4	At the opposite end of fast paced is information overload and catching up on concepts that one is not familiar with.	1/27/2021 5:08 PM
5	The Utility presentations. They talked almost exclusively about things already underway - old news.	1/27/2021 5:07 PM
6	More discussion and interactivity would have been helpful.	1/27/2021 5:06 PM
7	Not being able to be live and in-person due to the necessary quarentine provisions	1/27/2021 5:06 PM
8	Some made mistatements and I hope those are not taken as fact.	1/27/2021 5:04 PM

Q5 What did you think about the meeting length?

Comments:

- Maybe try to break these up and make them shorter? They are quite the time investment and I end up getting distracted and pulled into things.
- 1 longer break instead of 2 or 3 would be better in my opinion
- Joy did a good job with placement and length of the breaks.
- Pretty long, but understandable to fit all the content in

Appendix M-2.1. Kickoff Meeting (January 27), cont.

- A little long, but good to have the breaks.
- just right

Q7 If you have any additional thoughts about the meeting or meeting content, please share them here.

Answered: 4 Skipped: 6

#	RESPONSES	DATE
1	If the meetings stay structured in a similar way going forward we almost need a follow-up meeting for discussion. These topics we're reviewing are dense. I think it would be useful for the work group to focus on areas of Michigan law that we can change easily to accommodate these new technologies. We can see the positives and negatives based on the presentation of information but we need easily actionable steps coming out of this work group.	2/2/2021 2:19 PM
2	Looking forward to this series of exploratory meetings.	1/27/2021 5:08 PM
3	Can the slides be made available? Could they even be provided before the meeting?	1/27/2021 5:07 PM
4	I am on Staff so you can ignore my input if you like.	1/27/2021 5:04 PM

Appendix M-2.2. Electric Vehicles Meeting (February 10)

Q3 What did you most like about the meeting?

Answered: 9 Skipped: 1

#	RESPONSES	DATE
1	Excellent detail on the various issues we will need to resolve when absorbing large numbers of EVs onto the grid	2/17/2021 9:06 PM
2	The regulatory panel and utility updates.	2/10/2021 5:36 PM
3	I loved the breadth of speakers and their knowledge.	2/10/2021 5:06 PM
4	It covered the whole EV ecosystem	2/10/2021 5:06 PM
5	timely topics and knowledgeable speakers	2/10/2021 5:05 PM
6	The discussions on keeping Michigan competitive and a leader in the automotive space.	2/10/2021 5:04 PM
7	Great variety of perspectives.	2/10/2021 5:02 PM
8	first 2 panels	2/10/2021 5:02 PM
9	Great speakers, lots of Information and plenty of food for thought. Matteo Muratori was terrific. All the panel discussions were managed well.	2/10/2021 5:00 PM

Q4 What did you least like about the meeting?

Answered: 6 Skipped: 4

#	RESPONSES	DATE
1	There could have been more focus on business models and what is needed to help move various markets forward.	2/10/2021 5:36 PM
2	Technological issues. Grrrr........ Not anyone's fault.	2/10/2021 5:06 PM
3	meetings are too long. Wind up multi-tasking and taking calls.	2/10/2021 5:05 PM
4	The V2G discussions didn't get at how challenging that is economically. I would have rather heard from EV companies in MI and what they would like to see to make MI more competitive. Cycling your battery to sell to MISO is much less compelling than keeping the state competitive.	2/10/2021 5:04 PM
5	The MPSC did not share their perspectives; this would be helpful.	2/10/2021 5:02 PM
6	not enough / short breaks	2/10/2021 5:02 PM

Q5 What did you think about the meeting length?

Comments

- It was a bit long, but not sure what I would have left out. Two meetings instead of 1?
- Can they be shortened to 2 hours?
- This was in depth and very valuable, so while long it was all worth it. Hats off to staff for organizing such a great cast of guests.
- Very long.
- 2-3 hours would be more manageable

Q7 If you have any additional thoughts about the meeting or meeting content, please share them here.

Answered: 4 Skipped: 6

#	RESPONSES	DATE
1	I hope we can still get a few more speakers on new business models, and specific pilots that are testing vehicle-grid revenue generation opportunities.	2/10/2021 5:36 PM
2	Good and helpful. It will be very difficult to balance infrastructure and decarbonization and rates.	2/10/2021 5:06 PM
3	Frankly this was the best and most interesting MPSC meeting I've ever attended. Well done!	2/10/2021 5:04 PM
4	Please keep these meetings coming!	2/10/2021 5:00 PM

Appendix M-2.3. Heat Pumps for Water and Space Heating Meeting (February 24)

Q3 What did you most like about the meeting?

Answered: 7 Skipped: 1

#	RESPONSES	DATE
1	Provided the most up to date information and asperations for the future.	3/2/2021 12:47 PM
2	The focus on the heat pump technology from how it works to how to get it in the hands of end users. Also, the willingness to explore all opportunities and barriers, whether physical like climate or policy or regulator or education.	2/26/2021 11:12 AM
3	The variety of speakers giving their insight into the questions of HPs in MI. Chair did a good job keeping time and getting questions answered.	2/24/2021 5:13 PM
4	information from others doing this work	2/24/2021 5:07 PM
5	The discussion on the technology and examples of implementation were helpful.	2/24/2021 5:02 PM
6	Different perspectives and examples from Maine	2/24/2021 5:02 PM
7	Numerous presenters and perspectives and good chat questions	2/24/2021 3:30 PM

Q4 What did you least like about the meeting?

Answered: 3 Skipped: 5

#	RESPONSES	DATE
1	Not being able to answer all the questions in the time allotted.	2/26/2021 11:12 AM
2	We could have used this information last March Ironically maybe more time needed... but very well done !!	2/24/2021 5:07 PM
3	The RMI presentation did not seem very realistic.	2/24/2021 5:02 PM

Note: There were no comments for question 5 for this meeting.

Q7 If you have any additional thoughts about the meeting or meeting content, please share them here.

Answered: 4 Skipped: 4

#	RESPONSES	DATE
1	Excellent meeting and collection of speakers	2/26/2021 11:12 AM
2	I am curious about the attendees and their impression of the meeting content. What are the next steps and how do we move forward from here?	2/24/2021 5:13 PM
3	this was an extremely well planned and informative meeting. I have many take away items and plan on connecting with others who are doing the work! Again Thank you - GREAT job	2/24/2021 5:07 PM
4	This was my first meeting.	2/24/2021 3:30 PM

Appendix M-2.4. Behind the Meter and Community Solar Meeting (March 10)

Q3 What did you most like about the meeting?

Answered: 7 Skipped: 1

#	RESPONSES	DATE
1	Panel discussions	3/10/2021 7:44 PM
2	There was a lot of dialogue with several sides of issues represented.	3/10/2021 5:00 PM
3	The panels were great! Cody and Julie were great moderators.	3/10/2021 4:58 PM
4	Excellent range of presenters.	3/10/2021 3:33 PM
5	Getting information about current trend of renewable energy	3/10/2021 3:32 PM
6	Jenny Heeter's presentation	3/10/2021 3:31 PM
7	The sharing of experiences from various places.	3/10/2021 3:29 PM

Q4 What did you least like about the meeting?

Answered: 4 Skipped: 4

#	RESPONSES	DATE
1	In the last session, the panel participants seemed to be very aggressively "go after" utilities in a way that was not at all constructive. They don't seem to be willing to listen - only to have others listen to them.	3/10/2021 5:00 PM
2	the time length	3/10/2021 4:58 PM
3	Felt very long, but presentations were all high quality.	3/10/2021 3:33 PM
4	Quarantine with no face to face	3/10/2021 3:31 PM

Q5 What did you think about the meeting length?

Answered: 8 Skipped: 0

Comments

- allowed robust deep dive
- Ending at 4:30 would be helpful, although I understand the desire to allow for as much discussion as possible.
- very long
- Anything more than 2.5 hours long is really challenging to stay engaged. more shorter meetings are preferable..
- It was long, but chock full of good information
- To keep up with other work during a 4 hours period it would be helpful to have at least a 15 minute break.

Appendix M-2.4. Behind the Meter and Community Solar Meeting (March 10), cont.

Q7 If you have any additional thoughts about the meeting or meeting content, please share them here.

Answered: 3 Skipped: 5

#	RESPONSES	DATE
1	I really, really hope that the very clear, very cogent arguments to bring back net metering, eliminate the cap, and create a true path for community solar and LMI access will be taken very seriously by those who hold power, like the MPSC. I did not get the sense that this was true.	3/10/2021 7:44 PM
2	Julie did great as moderator.	3/10/2021 4:57 PM
3	Thank you. Well done.	3/10/2021 3:29 PM

Appendix M-2.5. Storage Meeting (March 24)

Q3 What did you most like about the meeting?

Answered: 8 Skipped: 0

#	RESPONSES	DATE
1	The speakers were very constructive in their discussion, versus confrontational. The breaks are very helpful.	3/24/2021 5:02 PM
2	Hearing from the individual companies involved.	3/24/2021 5:01 PM
3	Presentations from companies in this industry	3/24/2021 5:01 PM
4	Robust discussion between talented subject matter experts.	3/24/2021 5:01 PM
5	The presentations were very interesting	3/24/2021 5:00 PM
6	good presenters	3/24/2021 5:00 PM
7	Invited speakers were great. They were knowledgeable and their presentations were very informative. I appreciated the wide breadth of subjects covered.	3/24/2021 4:05 PM
8	presentations and timeliness	3/24/2021 2:29 PM

Q4 What did you least like about the meeting?

Answered: 6 Skipped: 2

#	RESPONSES	DATE
1	Not in person.	3/24/2021 5:01 PM
2	Utility representatives "challenges" and slow-roll pilot programs, when storage has been well-proven in other States.	3/24/2021 5:01 PM
3	I had to jump off for the middle for a couple other commitments.	3/24/2021 5:01 PM
4	The minor technical difficulties (I understand it was not the fault of the hosts)	3/24/2021 5:00 PM
5	Speakers often didn't circle back and address questions in chat. Breaks too short.	3/24/2021 4:05 PM
6	overall length	3/24/2021 2:29 PM

Appendix M-2.5. Storage Meeting (March 24), cont.

Q5 What did you think about the meeting length?

Comments

- 30 - 60 minutes reduction would help.
- Hard to grab 4 uninterrupted hours. Posting the meeting recordings do help by letting people go back later to see what they missed but you lose the opportunity for questions. Also, it's hard to absorb such a large amount of information effectively all in one go.
- about an hour too long

Q7 If you have any additional thoughts about the meeting or meeting content, please share them here.

Answered: 1 Skipped: 7

#	RESPONSES	DATE
1	The aggregated water heating controller option sounds like it would be relatively cheap and easy to do. The MPSC should give that some serious attention.	3/24/2021 5:01 PM

Appendix M-2.6. Combined Heat and Power Meeting (April 7)

Q3 What did you most like about the meeting?

Answered: 8 Skipped: 2

#	RESPONSES	DATE
1	I liked the discussion of the CHP technology and addressing barriers and opportunities.	4/7/2021 5:08 PM
2	Learning people/organizations involved in MI CHP industry	4/7/2021 5:08 PM
3	Focus on CHP and WHP technologies	4/7/2021 5:03 PM
4	Hearing about new greener gas options.	4/7/2021 5:03 PM
5	The speakers were very realistic about the capabilities of the technology.	4/7/2021 5:03 PM
6	I liked the variety of presenters and technologies.	4/7/2021 5:03 PM
7	Individual presenters from the CHP organizations	4/7/2021 5:02 PM
8	The Panel: Speaking from Experience – CHP Motivations, Barriers, & Realities	4/7/2021 4:04 PM

Appendix M-2.6. Combined Heat and Power Meeting (April 7), cont.

Q4 What did you least like about the meeting?

Answered: 5 Skipped: 5

#	RESPONSES	DATE
1	The emphasis that combusting a fossil fuel through CHP help us reach carbon neutrality, then stating that the emissions are simply lower. The comparisons were versus 95% coal based generations whereas there slides showed coal was only 20-30% of actual grid electric generation.	4/7/2021 5:08 PM
2	No electric utility side point of view for CHP was presented	4/7/2021 5:08 PM
3	Nothing	4/7/2021 5:03 PM
4	The panels: they didn't seem to have as much content or solutions	4/7/2021 5:02 PM
5	NA	4/7/2021 4:04 PM

Q5 What did you think about the meeting length?

Comments

- It was long, but I played it in the background while working. I probably wouldn't have made a 4 hour in person meeting.
- Sometimes I have to jump out for other commitments.

Q7 If you have any additional thoughts about the meeting or meeting content, please share them here.

Answered: 2 Skipped: 8

#	RESPONSES	DATE
1	Well done! Thank you for providing this focus on the opportunities and barriers for CHP and WHP in Michigan.	4/7/2021 5:03 PM
2	Thanks for offering this webinar.	4/7/2021 5:03 PM

Appendix M-2.7. Microgrids Meeting (April 21)

Q3 What did you most like about the meeting?

Answered: 6 Skipped: 0

#	RESPONSES	DATE
1	In depth and honest information about the utility of microgrids.	4/27/2021 12:15 PM
2	The talk about the barriers to expansion of microgrids	4/22/2021 2:39 PM
3	Wide range of views.	4/22/2021 8:13 AM
4	Eaton Corporation content on microgrid operations and grid integration was very informative and insightful.	4/21/2021 5:22 PM
5	The Eaton panel	4/21/2021 5:03 PM
6	It was interesting in providing different perspectives. Although there seemed to be a lot of overlap so I am not sure they are all valuable.	4/21/2021 2:37 PM

Q4 What did you least like about the meeting?

Answered: 4 Skipped: 2

#	RESPONSES	DATE
1	Some of the presenters struggled with the presentation technology (TEAMS). Maybe better dress rehearsals in the future?	4/22/2021 2:39 PM
2	Not a deep enough discussion of the regulatory barriers, and models for improvement.	4/22/2021 8:13 AM
3	I'm sorry and don't mean to criticize the individuals, but the incumbent utility panel was actually instructive and reinforces the regulated electric utility monopolistic and protectionist world view which perceives innovation and deployment of microgrids as destructive to earnings and incongruent in a rate base model. It might have been useful to allocate 5-10 more minutes to unpack the Texas microgrid operations experience during the recent Texas freeze and lessons learned. Microgrids are not solely for emergency or extreme events but certainly provide added value when the larger grid is impaired. One lesson for MI regulators may be to better understand how ERCOT was on razor's edge of calamity and how did local generation assets like UT Austin, TECO and EXXON CHP backstop the whole economy.	4/21/2021 5:22 PM
4	There was no context about how some of the ideas and case studies fit into current Michigan law and were very lite on addressing the equity issue of microgrids.	4/21/2021 2:37 PM

Q5 What did you think about the meeting length?

Comments

- Still, a bit long for my tastes, though I don't have an alternative for you.
- I would recommend making them shorter and reducing the case studies because they seemed to overlap. Quality is more important than quantity.

Appendix M-2.7. Microgrids Meeting (April 21), cont.

Q7 If you have any additional thoughts about the meeting or meeting content, please share them here.

Answered: 2 Skipped: 4

#	RESPONSES	DATE
1	I commend the MI Public Service Commission for exploring CHP and Microgrids and reaching out to industry for real-world experience.	4/21/2021 5:22 PM
2	Would like to know how the idea of microgrid fits into the existing Michigan statutory construct.	4/21/2021 2:37 PM

Appendix M-2.8. Tribal Forum (April 28)

Q3 What did you most like about the meeting?

Answered: 1 Skipped: 0

#	RESPONSES	DATE
1	The subjects covered.	4/28/2021 2:53 PM

Q4 What did you least like about the meeting?

Answered: 1 Skipped: 0

#	RESPONSES	DATE
1	Not many tribes made it on the call.	4/28/2021 2:53 PM

No comments to question 5 and no response to question 7 were received for this meeting.

Appendix M-2.9. Alternative Business and Ownership Models Meeting (May 19)

Q3 What did you most like about the meeting?

Answered: 7 Skipped: 1

#	RESPONSES	DATE
1	Real world applications and success (or failure) stories. I appreciate concrete examples.	5/19/2021 5:15 PM
2	Useful to identify some trending topics/solutions that could be part of MI's future	5/19/2021 5:04 PM
3	The discussion of future opportunities and technologies along with their anticipated impacts on customers and utilities.	5/19/2021 5:04 PM
4	All the presenters did great and kept it interesting	5/19/2021 5:03 PM
5	content and perspectives	5/19/2021 5:01 PM
6	The variety of presentations	5/19/2021 5:01 PM
7	Some of the speakers were very realistic about the grid and how it operates.	5/19/2021 4:46 PM

Q4 What did you least like about the meeting?

Answered: 6 Skipped: 2

#	RESPONSES	DATE
1	Abstract policy statements. Anytime the word "monetize" is used in a presentation.	5/19/2021 5:15 PM
2	Lack of opportunity for participation and engagement by attendees. Too many topics covered, resulting in no "center" to indicate what reforms may be prioritized	5/19/2021 5:04 PM
3	It was information overload.	5/19/2021 5:04 PM
4	needed more breaks	5/19/2021 5:03 PM
5	less interactive than I had hoped	5/19/2021 5:01 PM
6	There were a number of speakers that are unaware of the needs of the grid, and models presented could create significant issues if adopted.	5/19/2021 4:46 PM

Q5 What did you think about the meeting length?

Comment

- was sometimes easy to zone out after a while, more breaks could help

Q7 If you have any additional thoughts about the meeting or meeting content, please share them here.

Answered: 2 Skipped: 6

#	RESPONSES	DATE
1	I wish there was more time for a short Q&A, but acknowledge lots of information in a short period. Some good questions in the chat window deserved verbal time. I thought the meeting was run very well; no issues of connectivity / audio / or video problems. Very good for online meeting. This is my first meeting of the "New Technologies and Business Models", I will go back and play the recordings on previous meetings.	5/19/2021 5:15 PM
2	The topics are diverse and you have done a good job of presenting many different technologies and business models through all 8 sessions.	5/19/2021 5:04 PM

Appendix M-2.10. Closing Meeting (June 16)

Q3 What did you most like about the meeting?

Answered: 8 Skipped: 0

#	RESPONSES	DATE
1	The discussion at this meeting was very helpful! Staff did a great job facilitating the workgroups, which I believe were very effective.	6/17/2021 8:52 AM
2	Learned many new topic details that has given me ideas to explore deeper.	6/16/2021 8:47 PM
3	The in depth analysis of the emerging technologies.	6/16/2021 4:46 PM
4	breakout room discussions	6/16/2021 4:44 PM
5	interactive nature of the meeting was good. Better	6/16/2021 4:44 PM
6	The discussion about Possible Solutions	6/16/2021 4:04 PM
7	Breakout sessions	6/16/2021 3:51 PM
8	Breakouts were well done.	6/16/2021 2:38 PM

Q4 What did you least like about the meeting?

Answered: 6 Skipped: 2

#	RESPONSES	DATE
1	This was the best one, I think.	6/17/2021 8:52 AM
2	We did not have the ability to switch to other subgroup topics.	6/16/2021 8:47 PM
3	N/A	6/16/2021 4:46 PM
4	nothing	6/16/2021 4:44 PM
5	the length of the breakout session was to short for all the items to be covered.	6/16/2021 3:51 PM
6	Could not connect with phone during breakouts, had to be at laptop.	6/16/2021 2:38 PM

Q5 What did you think about the meeting length?

Comment

- Its long but necessary to cover so many topics.

Q7 If you have any additional thoughts about the meeting or meeting content, please share them here.

Answered: 3 Skipped: 5

#	RESPONSES	DATE
1	I recommend you offer links to all the break out sessions. It would have been fun to join the different groups and listen in on the topics. I had interests in multiple topics. Thanks!	6/16/2021 8:47 PM
2	There is no improvement upon perfection. The meeting was very well organized and professional. Kudos to the organizers!	6/16/2021 4:46 PM
3	Heat pumps are not one size fits all. All heat pumps ground source, air source mini splits and central including dual fuel, and water to air all need to be promoted/incentivized equally based on the equipment costs. All homes can benefit from a heat pump of some kind but you can't favor one over the other given DTE and CE have customers in all housing types rural, suburban, and urban.	6/16/2021 3:51 PM