# Electrification Stakeholder Engagement

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# Abstract

The Minnesota Department of Commerce, Division of Energy Resources (Commerce), by way of a U.S. Department of Energy grant, conducted an extensive stakeholder engagement process exploring electrification challenges and opportunities as they relate to the State's energy efficiency programs. The process started in 2019 and finished in 2021, with four open stakeholder meetings, a series of technical advisory meetings, and a final summary report. Topics of discussion were consolidated into three categories--metrics, technology and grid impacts--with a particular focus on equity in participation and outcomes throughout the process.

Coinciding with the completion of the stakeholder engagement, Minnesota Governor Tim Walz signed the "Energy Conservation and Optimization Act" (ECO Act) which enables electrification (specifically "efficient fuel-switching improvement") within the Conservation Improvement Program (CIP). The State and stakeholders must now move forward with determining methodologies and procedures for implementing the legislation. It is anticipated that the work of this stakeholder group will directly inform and accelerate the implementation of the new legislation.

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## Background

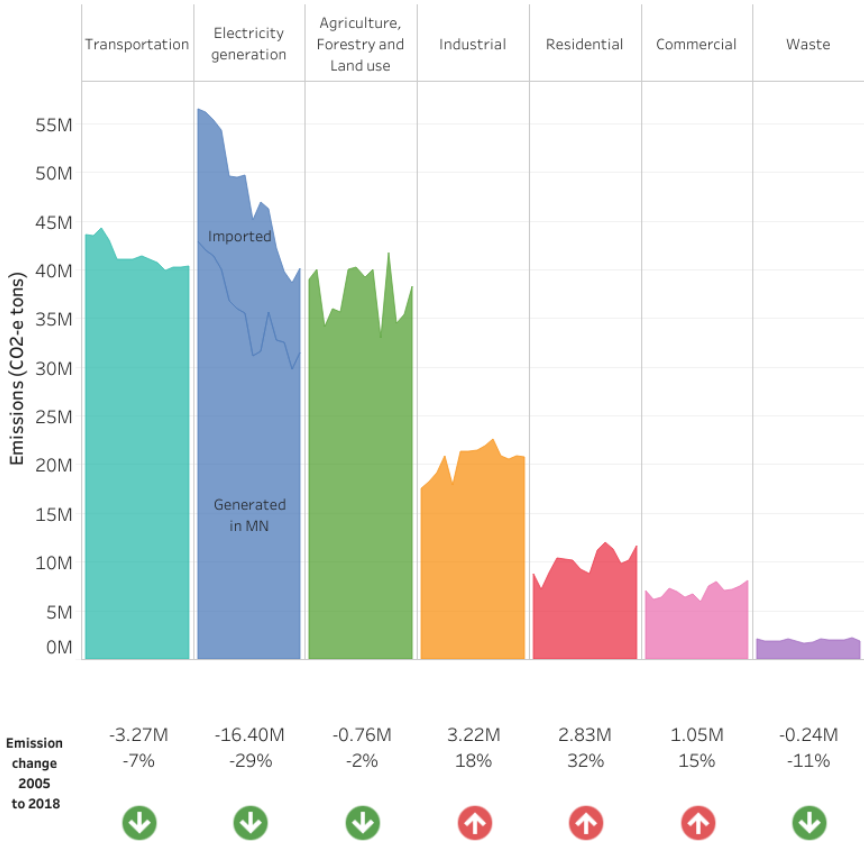
Minnesota has a long history of developing and implementing energy efficiency and renewable energy initiatives to achieve Minnesota's statewide public policy goals. Minnesota has several statewide energy policy goals established by law and codified in statute and rules, including:

- Energy savings goals for electric and natural gas utilities that operate in the State of Minnesota through the Conservation Improvement Program (CIP) (216B.241 Energy Conservation Improvement, 2019).
- A goal that 25% of electric utilities' total retail sales be met from renewable energy resources by the year 2025 (216B.1691 Renewable Energy Objectives, 2019)
- A requirement that all public utilities generate or procure 1.5% of electric generation through solar energy by the year 2020 (206B.1691 Solar Energy Standard, 2019).
- Greenhouse gas (GHG) emission reduction goals of 15% across all sectors by 2015, 30% percent by 2025, and 80% by 2050 (216H.02 Greenhouse Gas Emissions Control, 2019).

Since the establishment of the above energy policy goals, Minnesota has not only achieved but exceeded many of its performance metrics. Renewable electricity generation has increased from 8% percent in 2007 to 28.9% percent in 2020, putting Minnesota on track to exceed its 25% percent by 2025 goal (Minnesota Department of Commerce, 2021). Through utilities' consistent achievement of the energy efficiency resource standard, Minnesotans have saved an estimated $5.0 billion on their energy bills since 2013, with an independent review determining that for every dollar spent on efficiency, three dollars and seventy-five cents are returned to the State's economy (Cadmus, 2020).

Despite energy efficiency and renewable energy achievements, Minnesota, like many states, is behind on hitting economy-wide greenhouse gas emissions reduction targets. According to the most recently published data by the Minnesota Pollution Control Agency (MPCA) shown in Figure 7, as of 2018, Minnesota's annual greenhouse gas emissions were 161 million $CO_2$ equivalent tons. This level exceeds the 2015 milestone target of 148 million $CO_2$ equivalent tons, and thus the State has not achieved its milestone target of a 15% reduction from 2005 levels (Minnesota Pollution Control Agency, 2021).

**Figure 1: Minnesota GHG Emissions by sector 2005-2018**




Amid this lackluster economy-wide performance, Minnesota's electricity generation sector alone has surpassed its goal, reducing $CO_2$ emissions by 29% from 2005 levels. This delta has raised interest in converting fossil fuel end uses to electricity. However, from 2005 until recently, electrification (or "fuel-switching") was prohibited from being included in utility programs working to achieve the State's energy efficiency resource standard (Garvey, 2005).

On May 25, 2021, Governor Tim Walz signed the "Energy Conservation and Optimization Act" (ECO Act) (Office of Governor Tim Walz, 2021). The legislation updates the CIP statutory framework in several ways, including revisions to utility energy savings goals and low-income spending requirements, and the creation of a path for the inclusion of cost-effective load management (peak shaving, load shifting etc.) programs to contribute to overall goals. Importantly for the context of electrification, this law upends the sixteen-year prohibition on fuel switching within CIP energy efficiency programs, creating room for "efficient fuel-switching" programs.

As defined in the legislation, fuel-switching replaces any fuel with a fuel delivered by a utility that participates in CIP (thus either electricity or natural gas). To be considered "efficient fuel-switching" (and therefore be allowable), measures have to meet four criteria: 1) a net reduction in the amount of source energy consumed on a fuel-neutral basis; 2) a net reduction in the State's greenhouse gas emissions; 3) be cost-effective for the utility, participants, and society; and 4) improve the utility's system load factor (HF 164, 2021).

This report, and its associated stakeholder process, were in development well before this legislation passed. Stakeholders met for this project from January 2020 through February 2021—before the passage of this law. However, the ECO Act legislation was a crucial backdrop for the discussions. Many stakeholders participated in a collaborative effort to develop the legislation which narrowly failed to pass in 2019 and 2020.

## Recognizing Systemic Inequalities

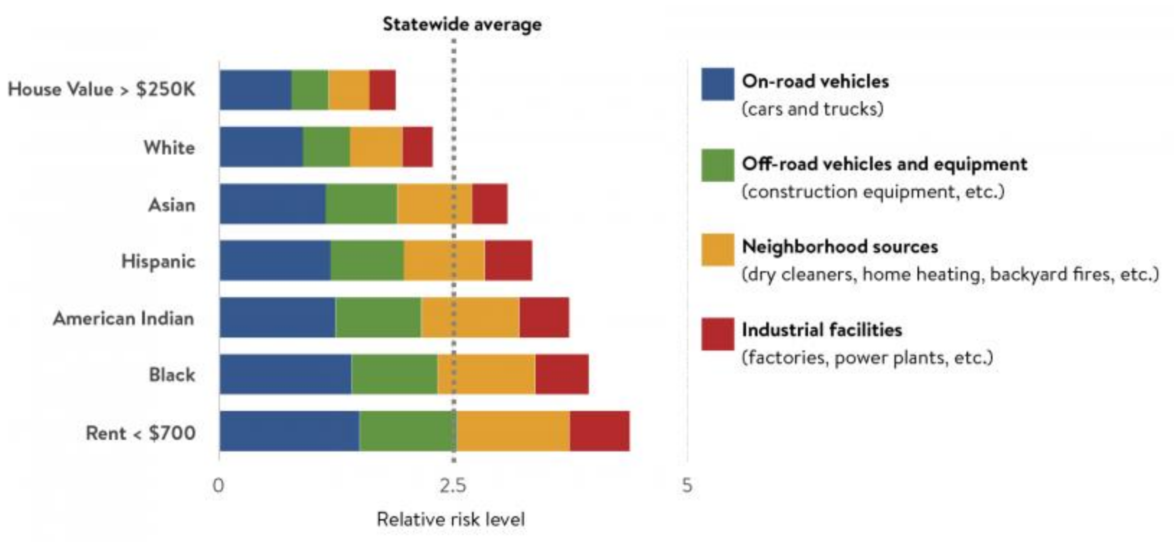
In addition to addressing climate change through electrification, the transformational magnitude of potential electrification investments begs the question, "transformational for whom?" Stakeholders in Minnesota were asking the question about how this new electric infrastructure would be different from the old economic systems that left behind Black, Indigenous, and People of Color (BIPOC) and low-income Minnesotans (who are disproportionately renters and rural residents) (Environmental Intiative, 2019).

For low-income residents the barriers to electrification compound. It's unlikely they can afford to replace old heating and cooling equipment with high efficiency electric equipment, but beyond that, their homes may require air sealing and insulation to be affordable to operate. More significantly, urgent health hazards like mold, asbestos, and carbon monoxide pollution might also need to be addressed (Carmelita Miller, 2019).

As we consider how to equitably electrify, it is important to understand that poverty does not equally affect all demographic groups in Minnesota. Rural residents are more likely to live in poverty. Average earnings in rural Minnesota are only 61% of the State's average earnings (Kelly Asche, 2020). Renters living in apartments in the state are more than twice as likely to be classified as low-income as homeowners (Carl Nelson J. B., 2018). Additionally, almost all non-white ethnicities are more likely to live in poverty than white Minnesotans (Sinner, 2016).

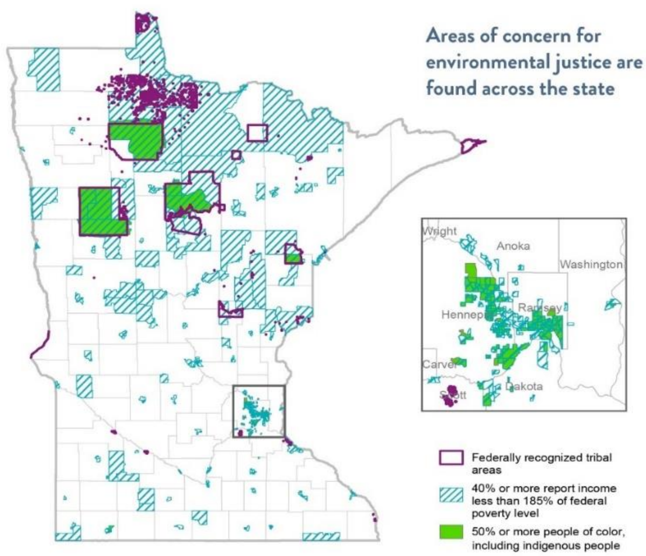
Race is a significant contributor to environmental risk in general. 46% of low-income communities and 91% of BIPOC communities are exposed to a level of pollution from all sources that is above the risk guidelines set by the MPCA (Amanda Jarrett Smith, 2019). Figure 2 summarizes air pollution risk by demographic group and pollution source.

**Figure 2: Air pollution risk by demographic indicators**




Areas of the State with higher populations of low-income and BIPOC residents have been designated by the MPCA as "Environmental Justice Areas of Concern",[1] shown in Figure 3 below.

**Figure 3: MPCA map of areas of concern for environmental justice[2]**




[1] Tribal areas and census tracts with higher concentrations of low-income residents and people of color.

[2] Image credit: Minnesota Pollution Control Agency

# Goals and Methodology

In anticipation of future legislation, Commerce envisioned that this stakeholder process would build common understanding among stakeholders. Implementing electrification would also require preparation to complete tasks such as reviewing and approving utility program proposals, evaluating cost-effectiveness, defining metrics and methodologies, and tracking achievements.

This vision helped define both the target group of stakeholders and the objectives of the stakeholder process. Commerce expected that under the legislation, electrification programs would be proposed and implemented by utilities (akin to energy efficiency programs in Minnesota) and thus focused outreach on CIP stakeholders. The goals of engagement were both education and information gathering. Because the passage of legislation could refine this project's priorities, the engagement plan needed to be flexible.

**Goals of Stakeholder Engagement**

1) Stakeholder Education
    - Share information
    - Develop common understanding
    - Create dialogue
    - Elevate marginalized voices
2) Stakeholder Input
    - Learn key concerns
    - Identify areas of work
    - Glean recommendations
    - Understand stakeholder needs

To conclude the stakeholder process, this written report documents the steps of the stakeholder engagement process and its key learnings. Neither this report nor the stakeholder process it describes, have created a definitive plan for electrification in the State of Minnesota. The process was not a policy development process or a regulatory decision-making process. From the beginning of this process, legislative direction was considered essential for progress on electrification.

This process, and this document, aim instead to enable future decision making. Minnesota has a long history of collaborative planning processes, and Commerce will implement legislation in consultation with stakeholders. By engaging early with stakeholders, Commerce hopes that future decision-making will better reflect insight from stakeholders and that stakeholders will better understand how decisions have been reached. Early engagement with stakeholders also creates opportunities for embedding recommendations to improve equity-related outcomes such as access to programs, distribution of benefits, and appropriate metrics to track.

## Designing inclusivity into the process

Equity is important in both the design and outcomes of this process. During the delivery of this project, many stakeholders and project partners helped focus early attention on the value of designing a more inclusive process and considering equity in the outcomes of electrification. We discuss stakeholders' thoughts on creating equitable outcomes from electrification in the results section of this report.

This project's objective, to convene energy efficiency industry stakeholders, by its very nature, limits participation from non-industry participants. While participation was not explicitly limited to people employed in energy-related fields, and some citizens did participate in open meetings, most participants are employees of either advocacy organizations or other organizations or companies in the energy sector.

The project team recognized that historical biases and inequalities have resulted in disparities in engaging specific populations of Minnesotans in energy issues. Acknowledging and addressing inequalities requires participation and representation from marginalized communities. Therefore, the project team took specific steps to increase the diversity of identities and perspectives represented by stakeholders engaged in this process. The project team identified the following stakeholders as particularly important to include:

1) Rural Minnesotans
2) Indigenous communities
3) Low-income communities
4) Renters
5) Business stakeholders representing affected fuels (propane, natural gas, etc.)
6) Utility staff representing all business types (investor-owned, cooperative, and municipal)
7) Large energy users (specifically industrial facilities)

The project team took these specific steps:

1) Included on the project team a member who had experience in designing inclusivity into stakeholder processes.
2) Consulted with key stakeholders early to understand how representation and inclusivity might be encouraged and learn their perspectives on barriers and realistic engagement.
3) Consulted with Commerce's Tribal Liaison Officer regarding engaging Native nation governments.
4) Named and communicated the challenges and limitations of our work plan and objectives as they relate to fostering broad participation from impacted communities.
5) Included within the literature review research on equity and electrification.
6) Prioritized inviting speakers representing marginalized or under-represented groups.
7) Prioritized inviting women and people of color to present.
8) Included equity as one of the required topics for each technical advisory committee subgroup to consider.
9) Held webinars to accommodate attendees from rural areas of Minnesota.

## Stakeholder Engagement

The stakeholder engagement work consisted of four components:

1. Strategic planning to outline the stakeholder process and conduct a literature review (The literature and policy review can be found in Appendix A of this document).
2. Open stakeholder meetings initially planned and begun in person but completed virtually due to the COVID-19 pandemic.
3. A technical advisory committee tasked with detailed discussions around technology, metrics, and grid impacts.

4. A written report, including white papers developed by participants that explore under-developed themes from the technical advisory committee meetings.

The necessity of flexibility in delivery was an expectation from the outset, and complications did arise. Most significantly, legislation addressing the same topic which halted the process so as not to be seen as a conflict of interest and a global pandemic which altered the timeline for delivery and shifted engagement to online methods. Despite these adaptations, engagement from stakeholders was robust, summaries of the voluntary stakeholder contributions can be seen in Figure 4 below:

**Figure 4: Stakeholder Engagement Numbers**


There were four open stakeholder meetings from January 2020 through February 2021. Education and peer learning were key goals of the meetings and guest presenters provided to majority of the content at each of the four sessions. The project team invited both local Minnesota experts to share as well as national electrification experts. The project website has recordings of the events, when available, and copies of presentations.

The Technical Advisory Committee (TAC) was a particularly strong feature of this stakeholder engagement process. The volunteer participants were divided into three sub-groups each focused on a facet of electrification: Technology, Grid Impacts, and Metrics. Each sub-group was provided input and questions from attendees of the open meetings and were asked to consider these questions: 1) What do stakeholders need to understand about this topic? 2) What needs more research or clarity? 3) What are the policy implications tied to this topic? 4) Does the TAC have any recommendations? With regards to recommendations, it was made clear early in the process that TAC recommendations were not binding or formalized, but rather a place agreement occurred or an action step that might be considered to advance electrification in the State.

The TAC subgroups each consisted of 15 – 20 members (some TAC members participated in more than one subgroup). The TAC met as a whole group both at the beginning and end of their work together. The project team would like to thank each of the stakeholder organizations who participated in the TAC:

Center for Energy and Environment (CEE)
Clean Energy Resource Teams
CenterPoint Energy
Citizens Utility Board of Minnesota
Ecolibrium3
Electrical Association
Fresh Energy
GDS
Great River Energy
Honor the Earth
ICF
Midwest Energy Efficiency Alliance (MEEA)
Minnesota Power
Missouri River Energy Services
Mitsubishi
MN Housing
Otter Tail Power Company
Rochester Public Utilities
Slipstream
The Forward Curve
The Mendota Group
Leech Lake Band of Ojibwe
Minnkota Power Cooperative
Minnesota Geothermal Heat Pump Association
Willdan
Xcel Energy
Minnesota Attorney General's Office (observer)

In addition to this final report, the project website provides additional information and resources, include a series of four white papers commissioned through this engagement effort and written by stakeholders. These white papers[3] serve to elevate specific perspectives and concerns that were not fully explored during the stakeholder and TAC processes. Here are the titles and authors of those white papers:

- "Electrification of Multifamily Housing in Minnesota" – Mari Ojeda (Fresh Energy), Ben Passer (Fresh Energy), Katherine Teiken, and Maddie Wazowicz (MEEA)[4]
- "Equity Considerations in Minnesota's Electrification Policies" – Maddie Wazowicz (MEEA)
- "Rural Electrification and Indigenous Nations of the North Country" –Matt Grimley, Winona LaDuke (Honor the Earth), Pam Fairbanks (Honor the Earth)
- "Integration of Electric Transportation and CIP: A Roadmap" – Kevin Lawless (The Forward Curve)

# Summary of Finding

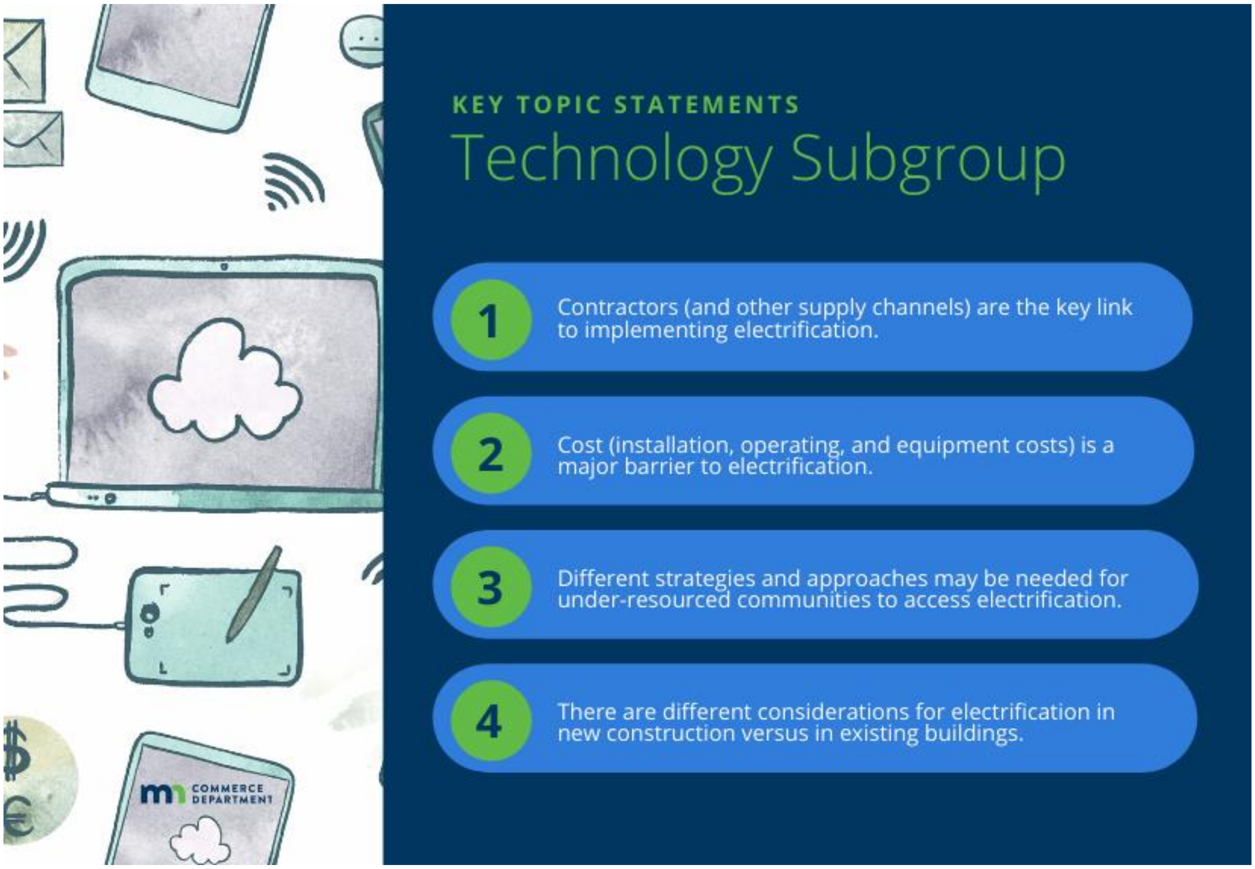
The findings of this report are summarized briefly in the executive summary with infographics of the key topic statements from each of the TAC subgroups, a summarized list of their action steps/research recommendations, and a discussion of cross-cutting findings about equity. Please read the full report for extensive detail on the content of each group's discussions.

The technology subgroup's discussions were notable because of how it did not focus on technology. There was some work done by the group to catalogue the variety of electrification technologies, but the majority of the group's work was focused on barriers to technology adoption. The sense was the

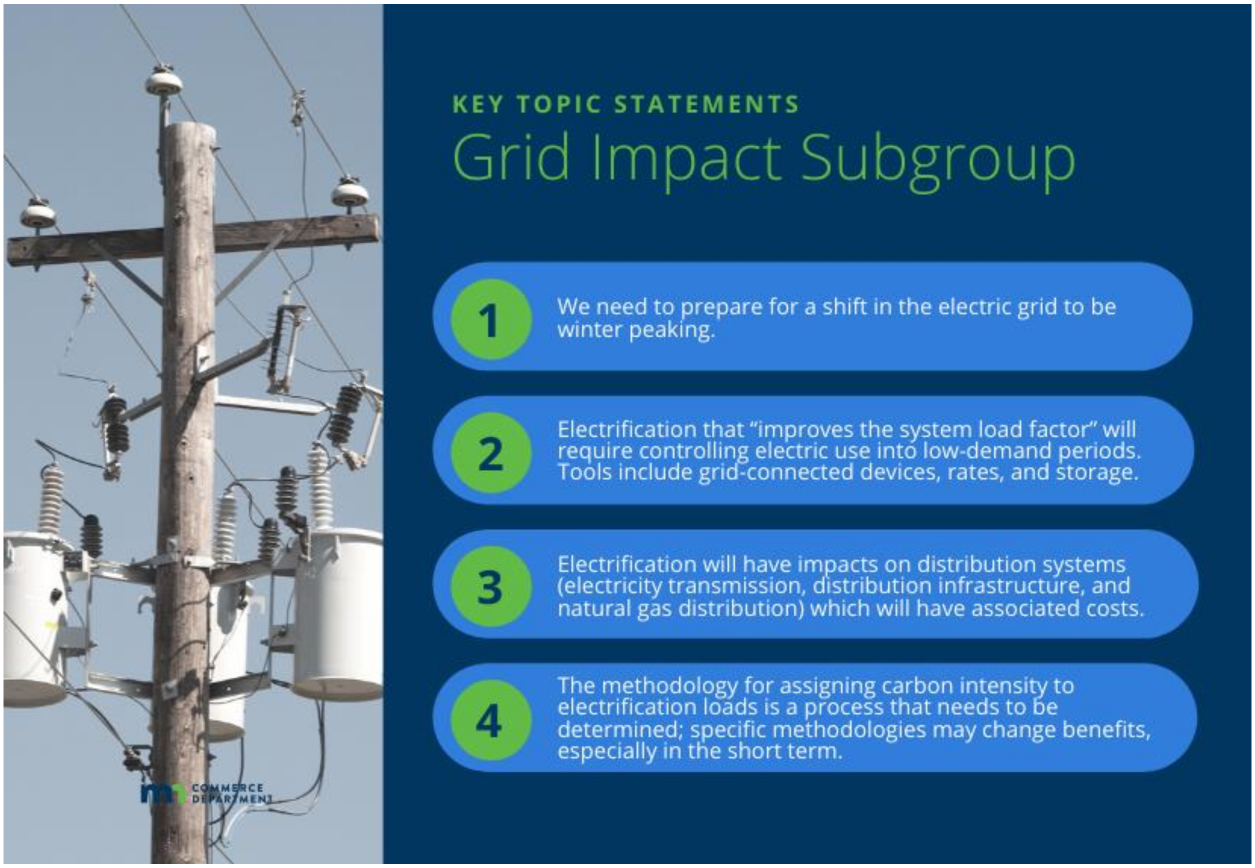
[3] The published white papers can be found at https://michaelsenergy.com/electrification-action-plan/

[4] The authors of the multifamily housing white papers are also leaders of the Minnesota Multifamily Affordable Housing Energy Network.

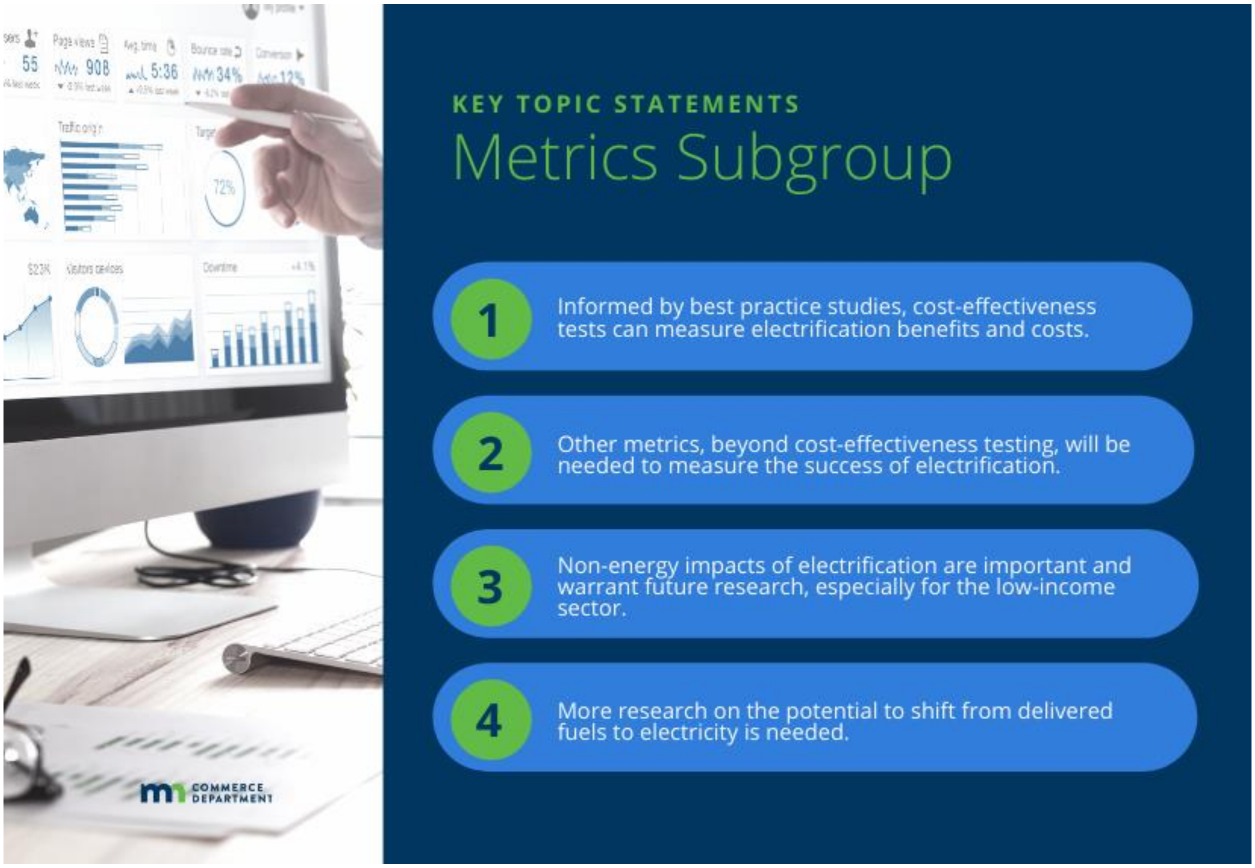
existing technologies are sufficient and available, especially for new construction, but access and implementation of those technologies present numerous challenges. The technology group key statements are summarized below.




The grid impact subgroup had the widest ranging conversation both in variety of topics covered and in terms of the planning horizon under consideration. The subgroup identified that some of the potential challenges of electrification (for instance grid constraints) do not emerge until some future critical mass of electrification has occurred. This group also invested a significant amount of their time into discussing carbon emissions accounting methodologies, which they identified as an essential component to determine whether electrification was beneficial, a process around which there isn't adequate consensus. The grid impacts subgroup key statements are summarized below.




The metrics subgroup had a narrower scope around measuring the cost-effectiveness of electrification from various perspectives. Amid that discussion, the group also identified that metrics beyond standard cost-effectiveness are important to achieve equitable outcomes and made recommendations of ways to consider equity in the goal setting and evaluation of the impacts of electrification efforts. The key statements of the metrics group are summarized below.




Detail about each of the subgroup's statements is contained in the report. The discussion contained in the report can serve as a primer for future conversations, which is important because for some of these topics the subgroup was only able to scratch the surface of the topic. With that in mind, the subgroups also contributed a list of additional research ideas and action items for each of their topics. That list is as follows:

## *Technology*

- Document and replicate lessons learned from the Minnesota ASHP Collaborative for other electrification technologies.
- Research coordination of utility incentive programs, promote the technology to consumers, and support the trade industry for electric technologies.
- Research electric heating rates, as a tool for reducing costs of electric heat. Research should include how many utilities offer electric home heating rates in Minnesota, the terms of those rates, and how many customers use those rates.
- Develop strategies and approaches that could make electrification accessible to under-resourced communities. The process should be inclusive of impacted communities and current practitioners of energy efficiency programs for those communities.
- Study electrification opportunities and barriers for under-resourced communities to support better planning and program design.

- Research the barriers to electrification in new home construction for home buyers, developers, and real estate agents.

### Grid Impacts

- Research how other states approach planning for a shift toward a winter peaking grid, including grid and energy production planning.
- Explore whether Integrated Resource Planning (IRP) or other utility planning processes could include inputs from natural gas planning when considering the impacts of fuel switching.
- Each utility should develop more responsive rate structures and consider amending pricing models to reflect changes in cost due to electrification loads.
- Conduct an analysis of specific adoption scenarios of electric technologies. This planning could help mitigate cost increases.
- Determine whether electrification-driven investments in T&D infrastructure would increase rates or whether the increased sales would offset those costs.
- Determine how natural gas distribution system costs would get shared among fewer users in a future scenario of high adoption of all-electric homes.
- Further analysis on carbon accounting methodology, specifically exploring the impact different methodologies (such as average versus marginal emissions analysis) make on the project and program level.
- Develop load-profiles of electric end-uses, specifically researching technologies without available load profile data.

### Metrics

- Determine the options and necessary changes in cost-effectiveness methodology to accommodate electrification (using guidance from the ECO Act legislation).
- Research how the current electric system may underserve some users and perpetuate inequality. Examples include energy burden and poverty which have locational qualities, which could be better understood in relationship to outages, energy cost, and infrastructure upgrades. Research could work to determine if there are relationships between poverty and negative energy impacts (i.e., more outages in poor neighborhoods).
- Based on the specific goals for electrification developed in statute, research and develop metrics to track progress towards achieving those goals. Metrics might include low-income program participation, geographic participation, jobs created and job training, and location of infrastructure investments.
- Research of non-energy impacts could be included in the State's guidance around cost-effectiveness testing. Categories that are easier to quantify, such as impacts on water and health, could be prioritized. This research could address impacts from both energy efficiency and electrification.
- Research how a reduction in delivered fuel demand would impact delivered fuel prices for customers. Consider impacts on different populations, including indigenous communities, rural communities, and low-income communities, as well as different economic sectors and specifically agriculture.

Finally, one of the most important results of this stakeholder engagement was the way in which equity emerged as a priority both from project team but significantly from stakeholders through surveys, comments, and presentations. Through the work of strategic planning, convening open meetings and the technical advisory committee, and writing the summary report, this process has tried to explore how electrification technologies, programs, and investments could contribute to addressing historical inequalities. These four cross-cutting recommendations were developed:

### 1 Design Electrification Programs with Attention to Inclusion and Equitable Participation

Stakeholders envision electrification programs that break the mold for standard program delivery. They hope for programs with fewer barriers, fewer complicated requirements, more community involvement during development, holistic approaches to energy, and sufficient funding to make the outcomes accessible.

### 2 Proactively Address Energy Affordability

Electrification does not necessarily result in lower costs. Energy affordability is a function of many factors, including the building envelope, equipment, utility rates, usage patterns and maintenance. Electrification for low-income customers must be proactive at addressing all of those facets or else the transformational aspects of electrification are unlikely to be realized. Time of use rates and electric heating rates can also contribute to affordability. Energy affordability impacts all users, industrial users are especially sensitive to energy costs.

### 3 Set Goals that Matter and Track Progress

Programmatic goals need to be created (and tracked) regarding equity-related outcomes. Cost-effectiveness tests, even with addition of non-energy impacts, won't measure all the aspects. Recommendations of goals from the stakeholders and guest presenters include: creating jobs for under-resourced communities, improving indoor and outdoor air quality in environmental justice communities, reducing the overall energy costs for low-income residents who adopt electrification, keeping energy costs low for all customers (including those who do not adopt electrification), reducing carbon pollution to stem the worst impacts of climate change, and ensuring that participation in electrification programs spans economic, racial, and geographic demographics.

### 4 Be Intentional

The definition of equity that was shared throughout this process includes both "elimination of barriers to full participation in the process, and access to the full benefits of the outcome." This process benefitted from including a diversity of stakeholders, who raised valuable issues and questions. The same will be true of the creation and implementation of electrification programs. Because the status-quo is primarily white and wealthy, including diverse voices and perspectives will require that something change from the status quo processes and practices.

## Next steps

The passage of the ECO Act legislation clarifies next steps for the electrification planning process, in that it directly enables efficient fuel switching (among other changes) and instructs the Department of Commerce to lead another round of stakeholder engagement. The legislation directs the commissioner of the Department of Commerce to "work with stakeholders to develop technical guidelines that public utilities and consumer-owned utilities must use to: (1) determine whether deployment of a fuel-switching improvement meets the criteria established [elsewhere in the legislation] …and (2) calculate the amount of energy saved due to the deployment of a fuel-switching improvement. The guidelines must be issued by the commissioner by order no later than March 15, 2022 and must be updated as the commissioner determines is necessary (HF 164, 2021)."

For an improvement to qualify as efficient fuel switching per criteria established in the legislation, the improvement must meet the following criteria (relative to the fuel that is being displaced):

1) *Results in a net reduction in the amount of source energy consumed for a particular use, measured on a fuel-neutral basis*[5]*;*
2) *Results in a net reduction of statewide greenhouse gas emissions… over the lifetime of the improvement….*
3) *Is cost-effective, considering the costs and benefits from the perspective of the utility, participants, and society; and*
4) *Is installed and operated in a manner that improves the utility's system load factor* (HF 164, 2021).

Each of these four criteria were discussed during the stakeholder process, so the continued stakeholder engagement can build upon this body of work. The legislation's implementation will benefit from the foundational work of this stakeholder engagement effort. Providing explicit guidance is the next task. A task that was not possible until legislative changes made the rules of implementation clear.

The contributions from stakeholder during this process – providing significant feedback, hours of volunteer engagement, research, presentations, and attending virtual meetings – position Minnesota to craft a nation-leading approach to electrification and efficient fuel switching based on strong collaborative input.

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1) [5] "Source energy" in the legislation is defined as the "total amount of primary energy required to deliver energy services, adjusted for losses in generation, transmission, and distribution, and expressed on a fuel-neutral basis."

# Introduction

## Background

The Minnesota Department of Commerce, Division of Energy Resources (Commerce) has a long history of developing and implementing energy efficiency and renewable energy initiatives to achieve Minnesota's statewide public policy goals. Minnesota has several statewide energy policy goals established by law and codified in statute and rules, including:

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In addition to these policy achievements, market factors are also rapidly changing how energy efficiency and renewable energy act as a grid resource and help optimize the energy system. Cost reductions for distributed resources such as solar energy and storage technologies enable increased adoption by individual consumers. However, at the State level, maturing markets, new energy codes, lower avoided fuel costs due to cheaper natural gas and renewables, and increasingly stringent federal appliance and lighting standards make cost-effective energy savings more difficult to find. A recent statewide energy efficiency potential study concluded that over the next decade, these trends are poised to significantly change how Minnesota approaches future energy policies, infrastructure investments, and the tools available to continue to create a modern and efficient energy system (Carl Nelson e. a., 2018).

### Background on Utilities and Fuel Consumption

Commerce and the CIP program regulate a complex set of utilities. Minnesota has 213 electric and natural gas utilities, 176 of which are electric (three investor-owned, 47 cooperatively-owned, and 126 municipally-owned) with various generation fuel mixes. One investor-owned utility serves natural gas and electric customers, and a few municipal utilities are also dual-fuel providers.

Small municipal and cooperative utilities are exempt from participating in CIP. Excluding exempt utilities, the State requires approximately 120 electric utilities to participate in CIP. Figure 5 shows the geographic distribution of electric utilities. Figure 6 provides an approximation of the State's natural gas service territories by utility. Both maps are from the State's most recent energy efficiency potential study (Carl Nelson e. a., 2018). Of note, in the context of electrification, much of rural Minnesota does not have access to natural gas. According to Census Bureau, 66% of homes in Minnesota use utility-provided natural gas for space heating, 10% use propane, and 17% use electricity (US Census Bureau).

**Figure 5: Map of Minnesota Electric Utility Coverage**

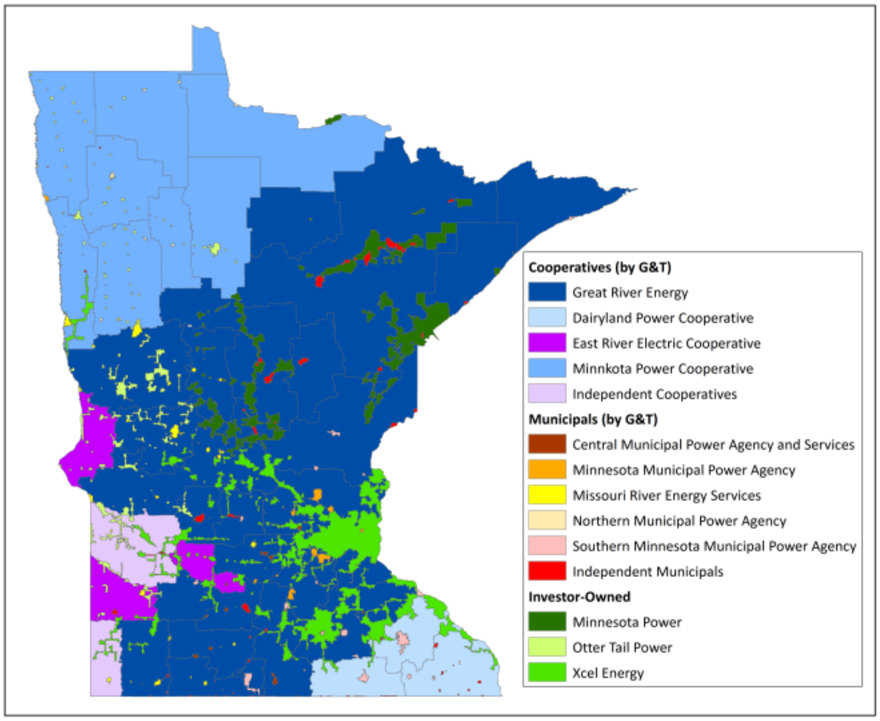
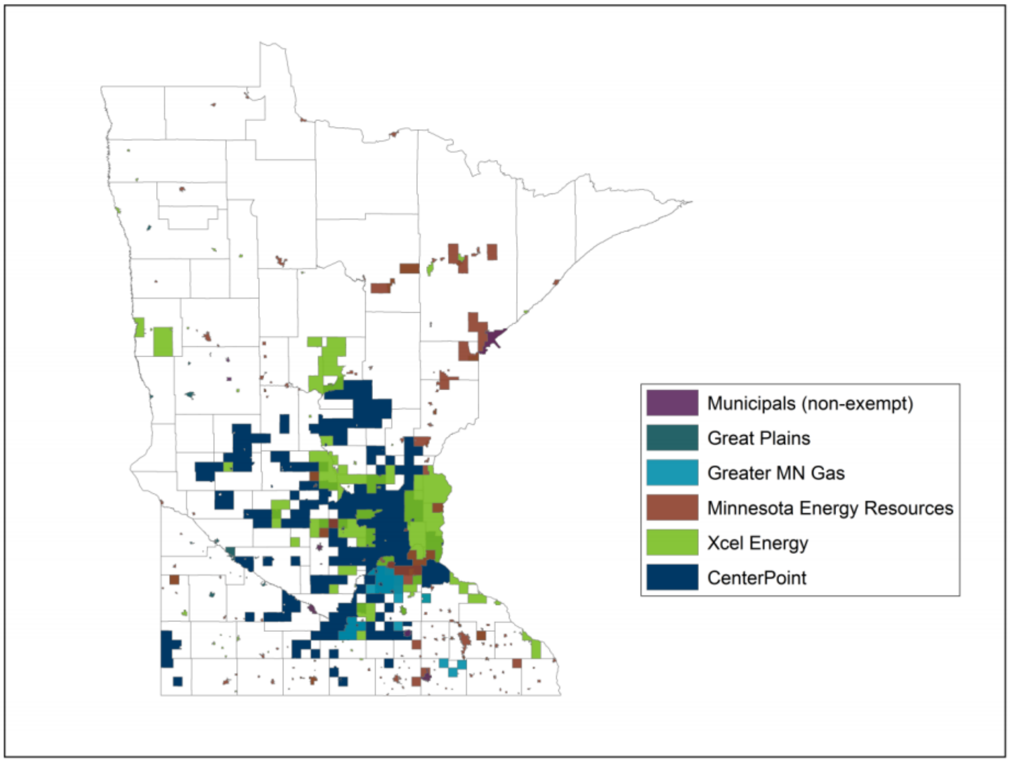


**Figure 6: Map of Minnesota Natural Gas Utility Coverage (approximation)**

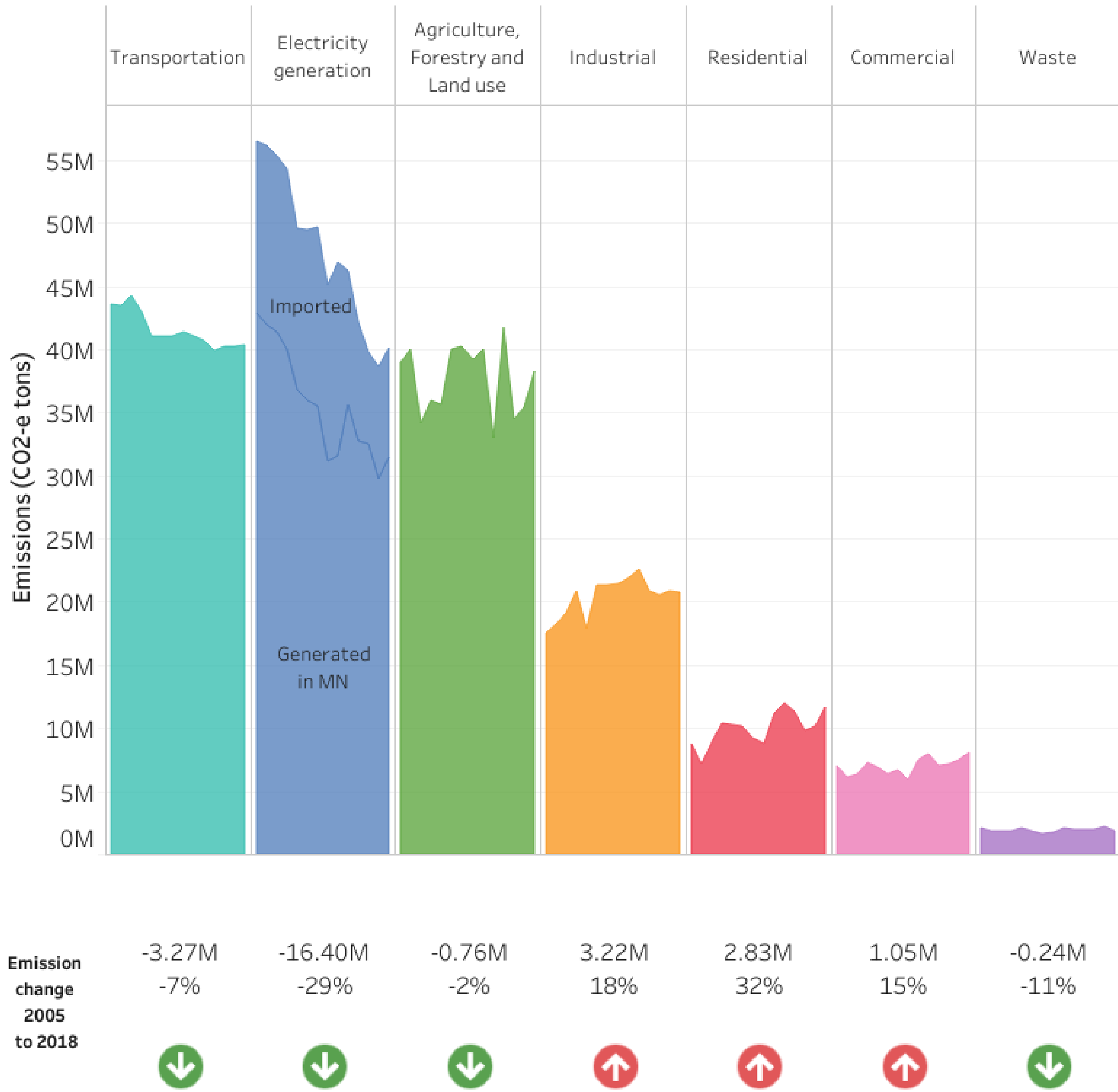



## Minnesota's Progress Reducing Greenhouse Gas Emissions

Despite energy efficiency and renewable energy achievements, Minnesota, like many states, is behind in hitting economy-wide greenhouse gas emissions reduction target. According to the most recently published data by the Minnesota Pollution Control Agency (MPCA), as of 2018, Minnesota's annual greenhouse gas emissions were 161 million $CO_2$ equivalent tons. This level exceeds the 2015 milestone target of 148 million $CO_2$ equivalent tons, and thus the State has not achieved its milestone target of a 15% reduction from 2005 levels (Minnesota Pollution Control Agency, 2021).

Amid this lackluster economy-wide performance, Minnesota's electricity generation sector alone has surpassed its goal, reducing $CO_2$ emissions by 29% from 2005 levels. Figure 7 shows per sector emissions from 2005 – 2018 and the cumulative change over time. While emissions from some sectors, such as transportation and waste, have also declined, direct emissions from the residential, industrial, and commercial sectors (primarily from burning fossil fuels for heat) have increased by 15 – 32%.

**Figure 7: Minnesota GHG Emissions by sector 2005-2018**




## Electrification Policy Context

On May 26, 2021, Governor Tim Walz signed the "Energy Conservation and Optimization Act" (ECO Act) (Office of Governor Tim Walz, 2021). The legislation updates the CIP statutory framework in several ways, including revisions to utility energy savings goals and low-income spending requirements and the creation of path for cost-effective load management (peak shaving, load shifting etc.) to contribute to overall goals. Importantly for the context of electrification, this law upends the sixteen-year prohibition on fuel switching within CIP energy efficiency programs, creating room for "efficient fuel-switching" programs.

As defined in the legislation, fuel-switching replaces any fuel with a fuel delivered by a utility that participates in CIP (thus either electricity or natural gas). To be considered "efficient fuel-switching" (and therefore be allowable), measures have to meet four criteria: 1) result in a net reduction in the amount of source energy consumed on a fuel-neutral basis; 2) result in a net reduction in the State's greenhouse gas emissions; 3) be cost-effective for the utility, participants, and society; and 4) improve the utility's system load factor (HF 164, 2021).

Stakeholders met for this project from January 2020 through February 2021—before the passage of this law. Comments and perspectives contained in this report, therefore, reflect uncertainty about the future of the legislation.

However, the ECO Act legislation was a crucial backdrop for the discussions. Many stakeholders participated in a collaborative effort to develop the legislation. The legislation narrowly failed to pass in 2019 and 2020. Whether it would pass in 2021 was uncertain but was treated as a serious possibility. With that in mind, the stakeholder process tried to approach electrification in a manner that would build off the legislation if it passed while still providing value even without legislation.

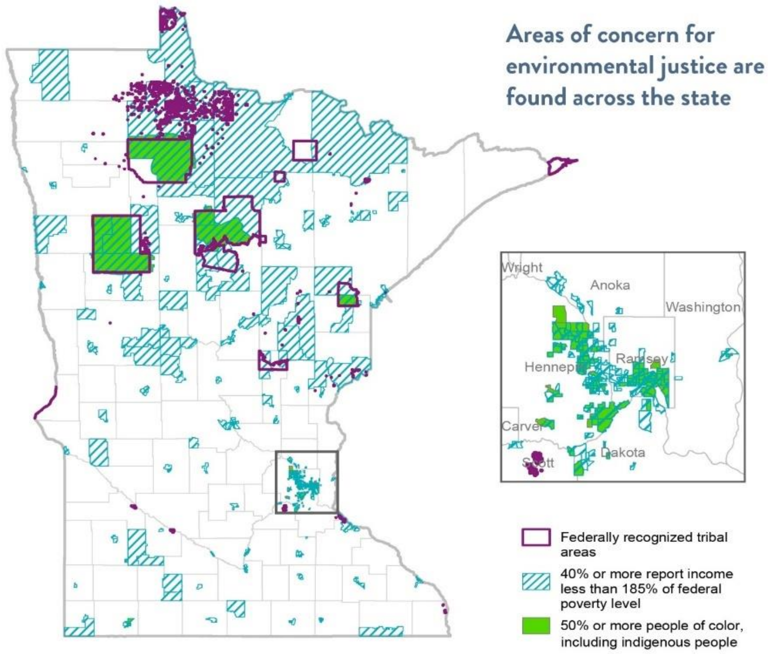
## Recognizing Systemic Inequalities

As the transformational magnitude of electrification efforts has become clear, the opportunity to pursue equity for low-income people and Black, Indigenous, and other people of color (BIPOC) while achieving carbon reductions has become a focus across the nation. Opportunities to advance equity through electrification might take the form of reducing energy burden, including historically unrepresented communities in decision-making processes, creating energy jobs, improving indoor air quality, and reducing pollution in environmental justice communities. Electrification may also create benefits that accrue to all ratepayers or society, like lower costs per kWh or reduced greenhouse gas pollution.

This background section focuses on income and racial inequality, but two additional groups have substantial overlap in their populations: renters and rural residents. As described below, renters are more likely to be non-white and low-income than homeowners, and rural residents are more likely to have lower incomes than their urban peers and have less access to affordable energy options. Areas of the State with higher populations of low-income and BIPOC residents have been designated by the MPCA as "Environmental Justice Areas of Concern",[6] shown in Figure 8 below.

[6] Tribal areas and census tracts with higher concentrations of low-income residents and people of color.

**Figure 8: MPCA map of areas of concern for environmental justice**[7]

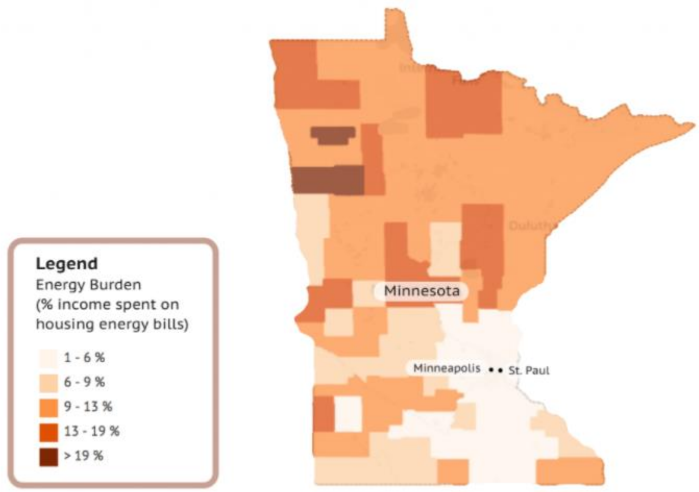



## *Low-income Residents*

It's not yet clear how all the cost variables will play out, electrification has the *potential* benefit of reducing energy bills, either for individuals with upgraded equipment or for all consumers who could benefit from a lower price per kWh (Carmelita Miller, 2019). The cost of energy for basic needs is a particularly outsized burden for low-income residents. Whereas the average US household has an "energy burden" of about three percent, meaning that three percent of the household's income is spent on energy, for low-income households that percentage can be much higher (Ariel Drehobl, 2020). In some counties, Minnesotans spend more than 19% of their income on energy, as shown in Figure 9 below. (Diaz, 2021)

[7] Image credit: Minnesota Pollution Control Agency

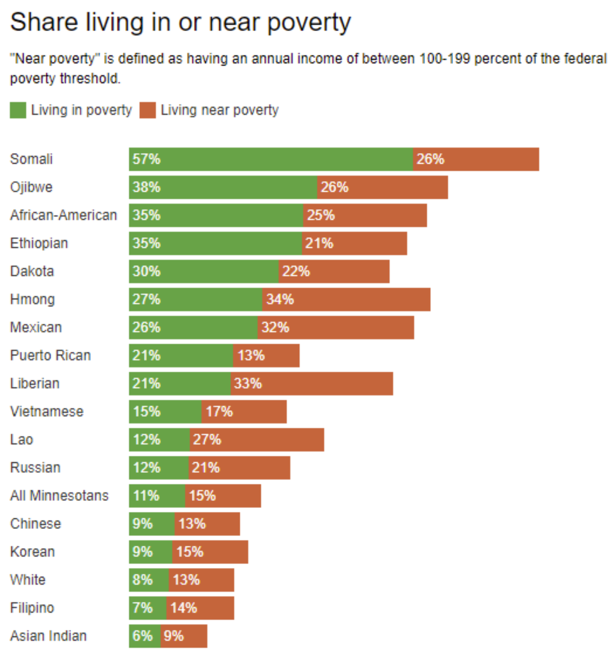
**Figure 9: Map of Energy Burden in Minnesota[8]**




Poverty does not equally affect all demographic groups. In Minnesota, almost all non-white ethnicities are more likely to live in poverty than white Minnesotans, shown in Figure 10 below (Sinner, 2016).

[8] Map image from Citizens Utility Board of Minnesota using data from U.S. Department of Energy (DOE)/NREL/ALLIANCE solar-for-all mapping.

**Figure 10: Population by cultural group living in or near poverty**

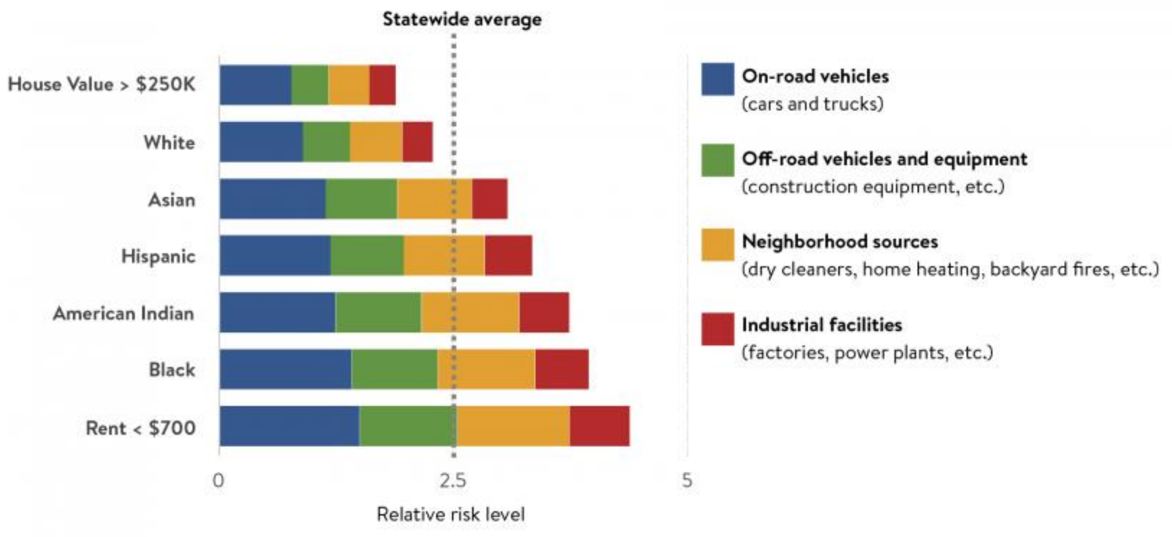



Investing in targeted low-income specific programs to reduce energy burden is not new in Minnesota. The State has required utilities to dedicate funds to low-income energy efficiency programs since 1989 and limited fuel-switching measures within low-income programs have been allowed since 2012 (Division of Energy Resources, 2012). Recently passed Minnesota legislation more than doubled the mandatory investor-owned utility spending on low-income programs (HF 164, 2021).

## *Pollution Burden by Race*

In Minnesota and across the U.S., racial and economic factors affect a person's exposure to pollution, particulate matter, and other environmental hazards such as extreme weather events and other results of climate change (MPCA, 2015). These disparities exist due to historical and systemic practices that have marginalized Black, Indigenous, and people of color across the U.S. For example, interstate highways often pass directly through Black and brown communities. The State of Minnesota is no exception where, in the City of Saint Paul, Interstate 94 displaced one-seventh of the City's Black residents and destroyed the Rondo community. (Archer, 2020). Building highways through and near marginalized communities exposes them to higher levels of air pollutants from cars, trucks, and other motor vehicles, leading to increased health risks for asthma, cardiovascular disease, childhood leukemia, and premature death ( (U.S. Environmental Protection Agency Office of Transportation and Air Quality, 2014). Besides disproportionate exposure to pollution from on-road motorized vehicles, in Minnesota, 46% of low-income communities and 91% of Black, Indigenous, and communities of color are exposed to a level of pollution from all sources combined that is above the risk guidelines set by the MPCA (Amanda Jarrett Smith, 2019). Figure 11 summarizes air pollution risk by demographic group and pollution source.

**Figure 11: Air pollution risk by demographic indicators**

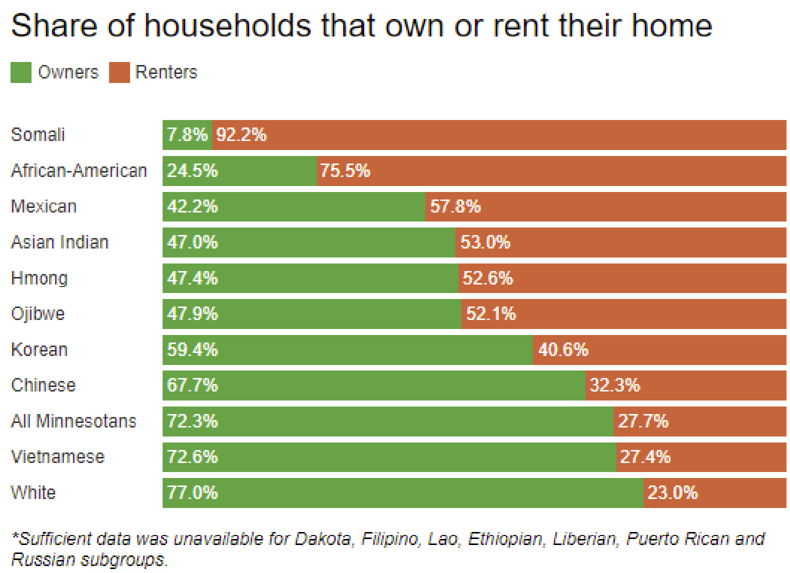



In addition to having higher exposure to pollution, the citing and development of energy infrastructure from power plants, pipelines, and transmission systems have disproportionally impacted the State's BIPOC communities. Examples of this type of injustice are varied. In the early 20th century, at Rainy Lake, colonial settlers built hydroelectric dams that enabled their way of life but destroyed the livelihood of the Ojibwe and Métis communities by damaging the lake's wild rice ecosystem (Johann Strube, 2021). Members of the Prairie Island Indian Community live and work on a small peninsula on the Mississippi River that is also home to a nuclear power plant and storage of nuclear waste (Audrey Partidge, 2020). Pollution from the HERC (Hennepin Energy Recovery Center) garbage incinerator primarily affects North Minneapolis, a community where most residents are people of color. In fact, six of Minnesota's seven incinerators are in environmental justice communities (Hazzard, 2021). Pipelines and transmission lines cross Anishinaabe and Dakota land, and recent citing of that infrastructure is the cause of protest and distrust (Kraker, 2021).

### *Access to electrification for renters*

Renters are an important demographic to consider if electrification programs are to address inequalities because of the population's high overlap with other communities of concern. As stated in the recent Minnesota energy efficiency potential study, "only about one in five residents of a single-family home is low-income, but roughly half of apartment dwellers can be classified as such (Carl Nelson J. B., 2018)". Similarly, data from the Minnesota State Demographic Center show that non-white populations (with the exceptions of Korean, Chinese, and Vietnamese ethnic groups) are more likely to rent their homes as shown in Figure 12 below (Sinner, 2016).

**Figure 12: Share of households by cultural group that own or rent their home**




Renters are a challenging demographic to support through energy efficiency programs because of the "split-incentive" where one party pays the utility bills, but another party owns the equipment (Don Hynek, 2012). Current CIP statute has spending requirements for "energy conservation programs that directly serve the needs of low-income persons, including low-income renters" because the population is hard to serve with traditional programs (216B.241 Energy Conservation Improvement, 2019). Some Minnesota utilities have developed innovative programs specifically for renters which have achieved good participation from multifamily buildings and their occupants (Carroll, 2017).

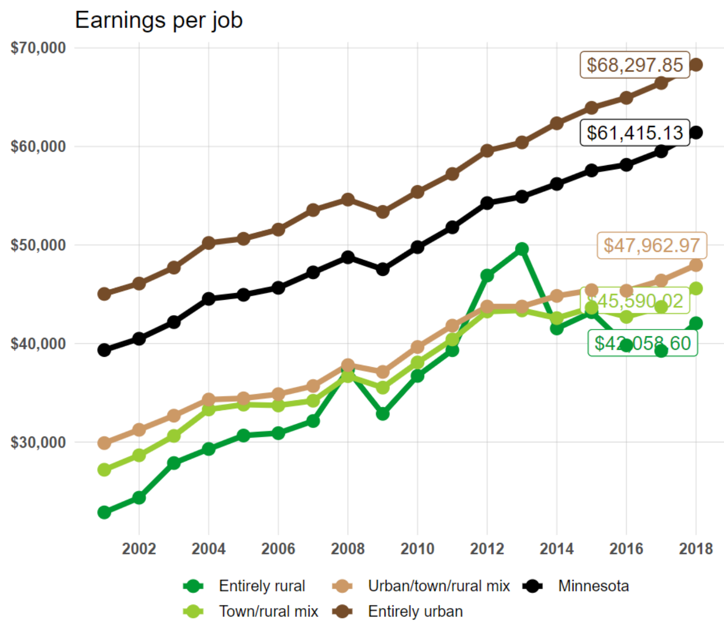
## *Rural Minnesotans*

Minnesotans living in rural areas also deserve special attention when considering equity in energy and electrification. Multiple factors deserve consideration including economic opportunities and access to energy efficiency programs and affordable energy options.

Average earnings in rural Minnesota are only 61% of the State's average earnings (Kelly Asche, 2020). Even in counties with a mix of rural and town populations, earnings are still only 71% of the State's average earnings. Counties with a mix of rural, town, and urban populations have slightly increased earnings at 77% of the State's average earnings (Kelly Asche, 2020). Urban earnings, on the other hand, are higher than the State's average, as shown in Figure 13 below[9].

[9] Chart source for **Error! Reference source not found.**: Center for Rural Policy and Development: https://www.ruralmn.org/2020-state-of-rural-minnesota-report/

**Figure 13: Earning by region of the State**




Another consideration is that the Anishinaabe and Dakota federally recognized tribal lands are predominantly located in rural Minnesota. 60% of Indigenous people living in Minnesota are residents of rural areas or small towns (Sarah Dewees, 2017). As rural residents who are also Indigenous people, they face compounded economic challenges.

Customers served by rural cooperative utilities in Minnesota are about two times as likely to use electricity for heat, usually in the form of expensive electric resistance heating. They are also more likely to use delivered heating fuels such as propane, due to the lack of natural gas infrastructure (Carl Nelson J. B., 2018). Further exacerbating the energy burden faced by many rural Minnesotans, rural cooperative utilities and small municipal utilities can have a hard time delivering energy efficiency programs due to their small size and issues of scale and sufficient resources. Joint programs resolve this issue to some extent, but 19 municipal utilities do not participate in a joint program. Additionally, 18 smaller cooperatives and 51 municipal electric utilities are exempt from CIP requirements. (Carl Nelson J. B., 2018) Therefore, a significant number of rural or small-town residents may be unable to participate in an energy efficiency program which could help reduce their annual energy costs and energy burden.

# Electrification within Minnesota

Electrification is converting end-use equipment historically fueled by the direct combustion of fossil fuels to equipment that uses electricity. When this process results in environmental benefits, cost reductions, and other positive grid impacts, it has been termed “beneficial” or “strategic” (David Farnsworth, 2018). Electrifying equipment historically powered by fossil fuels (e.g., space and water heating and gasoline/diesel vehicles) could result in significant greenhouse gas emissions and air pollution reductions as renewable energy generation continues to represent a growing percentage of the generation mix in Minnesota.

A 2018 White Paper commissioned by the Department of Commerce explored stakeholder perspectives on electrification (Carl Samuelson, 2018). Interviewed stakeholders (which included gas and electric utilities, advocates, and trade groups) commented that electrification could be a path to reducing carbon emissions, specifically within the transportation sector. Many stakeholders were also interested in the potential market growth of residential heat pumps for space and water heating. Stakeholders agreed that the CIP fuel switching prohibition in place at the time limited a utility's role in supporting consumer adoption of these new technologies. Stakeholders also agreed that regulators should be considering this topic, especially as a part of broader grid modernization efforts.

However, stakeholders disagreed on the appropriate role of electrification within CIP. Because CIP is a highly successful utility rate-payer funded conservation and efficiency regulatory model which has effectively coordinated utility-led efficiency and conservation programs in Minnesota, it could serve as a model for a utility-led electrification program. However, stakeholders warned that the goals of efficiency and electrification are not identical. Stakeholders observed that the status quo prohibition on fuel switching within CIP was put in place in part to remove the risk of a utility using a conservation program to promote the sale of its product, and this risk still exists. For electrification to be beneficial, stakeholders stated that the grid must continue to de-carbonize, and projects must be evaluated based on actual grid emissions, in addition to traditional metrics like energy and cost savings.

Stakeholders agreed that there are challenges facing electrification. They include market adoption and consumer interest in technologies like heat pumps and contractor familiarity with these newer technologies. Other challenges lie within current grid infrastructure and electricity supply, especially in meeting the winter peak heating load. Many saw challenges in pursuing electrification cost effectively without impacting Minnesotans' energy costs. Developing an electrification program poses a challenge (and opportunity) to target benefits toward historically marginalized households and communities. Another remaining challenge is the technical methodology for determining when and how electrification or fuel switching would be beneficial.

The conclusion of the 2018 White Paper included a series of questions requiring further consideration during future stakeholder meetings:

- **The programmatic relationship between electrification and energy efficiency:** Should fuel switching and electrification exist within CIP or be promoted within a standalone program? What are the advantages of a parallel program for carbon reductions versus incorporating more measures into CIP? If the measures fall within CIP, how are utilities compensated, and how does it affect savings goals?

- **Utility and grid impacts of electrification:** What goals does CIP have in relation to grid impacts, and will electrification help advance them? What is the value of baseline energy efficiency savings versus demand management and storage? Beneficially electrified technologies could play a more significant role in demand response scenarios.

- **Measuring the benefits of electrification:** How do we calculate the costs and benefits? Specifically, work needs to be done to build nuance into accounting for carbon emissions. Are they calculated using the Midcontinent Independent Systems Operator (MISO) mix or the utility's generation mix? What is an accessible approach to calculating marginal emissions impact? What are the actual costs of electrification, will it achieve carbon reductions at the lowest cost for society, and who will benefit the most? It would be helpful to develop example comparisons for technologies with different fuel mixes, baselines, and controllability using high-resolution emission data.

- **Making electrification equitable:** What needs to be done to make this transition equitable? How can beneficial electrification give opportunities for participation to low-income ratepayers? Does beneficial electrification offer sufficient benefits to non-participant ratepayers? What consideration should be given to the ratepayers of the abandoned fuel who cannot afford to or choose not to convert?

## Project Origin

To help address the questions listed above, Commerce and its partner, Michaels Energy, applied for and received funding from the U.S. Department of Energy through its State Energy Program Competitive Grant Funding process. This funding was intended to help the project team pursue further engagement and planning around electrification's benefits and challenges in Minnesota. The project's goal was to conduct a stakeholder engagement process to examine the possible benefits and concerns of using electrification as a tool for energy efficiency, carbon reduction, and grid optimization in Minnesota.

To accomplish this goal, the project team held a series of stakeholder meetings in 2020 to provide information, facilitate discussion, and solicit recommendations on key electrification topics. Stakeholders included utilities, energy efficiency organizations, business organizations, Native nation representatives, advocates for low-income communities, organizations representing multifamily housing occupants and renters, environmental and climate advocacy organizations, trade-allies, and equipment manufacturers. Topics addressed throughout the process included:

1. ***Electrification Regulations and Policies***. Review of current regulatory frameworks and requirements (federal, state, and local levels). Evaluation of policies guiding the implementation of Minnesota's 1.5% energy efficiency resource standard and the opportunities and barriers these policies present for greater electrification. Examination of Minnesota's renewable energy resource standard, progress to date and forecasted progress, and implications for future electricity emission levels. Determination of where and how electrification fits into existing and potential future policy frameworks.

2. ***Electrification Technologies***. Review of electrification technologies and strategies by residential, commercial, and industrial sectors. Examination of cold-climate heat pump performance, focusing on suitability for water and space heating in Minnesota. Evaluation of electric vehicle technologies, applications, and storage capabilities.

3. ***Electrification Metrics***. Review of energy grid optimization metrics related to electrification and how those metrics can be accurately and consistently measured. Examination of emissions and grid optimization based on a utility's overall generation mix and generation mix for a specific time of day or day of the year.

4. ***Electrification and Grid Optimization***. Examination of grid modernization benefits associated with greater electrification (e.g., greater opportunity to integrate variable renewable electricity through thermal storage). Evaluation of electrification as a tool to achieve system optimization by increasing energy efficiency and renewable energy integration. Assessment of any potential risks associated with increased use of existing electric infrastructure due to electrification.

5. ***Equity of Electrification***. Improve understanding of how societal inequalities are reflected in our current energy system, especially regarding access and affordability of energy and the concentration of pollution from energy production, transportation, and indoor sources in under-resourced communities. Identify strategies to leverage proposed investments to create transformational change.

Outcomes of this stakeholder engagement will help the State of Minnesota better leverage and support electrification as a tool to achieve grid optimization and ensure that risks and stakeholder concerns are understood and taken into consideration. Proactive engagement with stakeholders will prepare the State to be responsive and proactive when circumstances were appropriate for action on electrification. Specifically, early engagement will help smooth implementation if new State policy passes.

# Goals and Methodology

## Stakeholder Engagement Goals

In anticipation of future legislation, Commerce envisioned that this stakeholder process would build common understanding among stakeholders and prepare Commerce for implementation of legislation. Implementing new legislation would include tasks such as reviewing and approving utility program proposals, evaluating cost-effectiveness, defining metrics and methodologies, and tracking results.

This vision helped define both the target group of stakeholders and the objectives of the stakeholder process. Commerce expected that under the legislation, electrification programs would be proposed and implemented by utilities (akin to energy efficiency programs in Minnesota) and thus focused outreach on CIP stakeholders. The goals of engagement were both education and information gathering. Because the passage of legislation could refine this project's priorities, the engagement plan needed to be flexible.

**Goals of Stakeholder Engagement**

1) Stakeholder Education
   - Share information
   - Develop common understanding
   - Create dialogue
   - Elevate marginalized voices
2) Stakeholder Input
   - Learn key concerns
   - Identify areas of work
   - Glean recommendations
   - Understand stakeholder needs

To conclude the stakeholder process, this written report documents the steps of the stakeholder engagement process and its key learnings. Neither this report nor the stakeholder process it describes, have created a definitive plan for electrification in the State of Minnesota. The process was not a policy development process or a regulatory decision-making process. From the beginning of this process, legislative direction was considered essential to set the parameters for future electrification actions.

This process, and this document, aim instead to enable future decision making. Minnesota has a long history of collaborative planning processes, and Commerce will implement legislation in consultation with stakeholders. By engaging early with stakeholders, Commerce hopes that future decision-making will better reflect insight from stakeholders and that stakeholders will better understand how decisions have been reached. Early engagement with stakeholders also creates opportunities for embedding recommendations to improve equity-related outcomes such as access to programs, distribution of benefits, and appropriate metrics to track.

### Designing inclusivity into the process

Equity is important in both the design and outcomes of this process. During the delivery of this project, many stakeholders and project partners helped focus early attention on the value of designing a more inclusive process and considering equity in the outcomes of electrification. We discuss stakeholders' thoughts on creating equitable outcomes from electrification in the results section of this report.

This project's objective, to convene energy efficiency industry stakeholders, by its very nature, limits participation from non-industry participants. While participation was not explicitly limited to people employed in energy-related fields, and some citizens did participate in open meetings, most participants are employees of either advocacy organizations or other organizations or companies in the energy sector.

The project team recognized that historical biases and inequalities have resulted in disparities in engaging specific populations of Minnesotans in energy issues. Acknowledging and addressing inequalities requires participation and representation from marginalized communities. Therefore, the project team took specific steps to increase the diversity of identities and perspectives represented by stakeholders engaged in this process. The project team identified the following stakeholders as particularly important to include:

1) Rural Minnesotans
2) Indigenous communities
3) Low-income communities
4) Renters
5) Business stakeholders representing affected fuels (propane, natural gas, etc.).
6) Utility staff representing all business types (investor-owned, cooperative, and municipal)
7) Large energy users (specifically industrial facilities)

The project team took these specific steps:

1) Included on the project team a member who had experience in designing inclusivity into stakeholder processes.
2) Consulted with key stakeholders early to understand how representation and inclusivity might be encouraged and learn their perspectives on barriers and realistic engagement.
3) Consulted with Commerce's Tribal Liaison regarding engaging Native nation governments.
4) Named and communicated the challenges and limitations of our work plan and objectives as they relate to fostering broad participation from impacted communities.
5) Included within the literature review[10] research on equity and electrification.
6) Prioritized inviting speakers representing marginalized or under-represented groups.
7) Prioritized inviting women and people of color to present.
8) Included equity as one of the required topics for each technical advisory committee subgroup to consider.
9) Held webinars to accommodate attendees from rural areas of Minnesota.

# Stakeholder Engagement Methodology

The stakeholder engagement work consisted of four components:

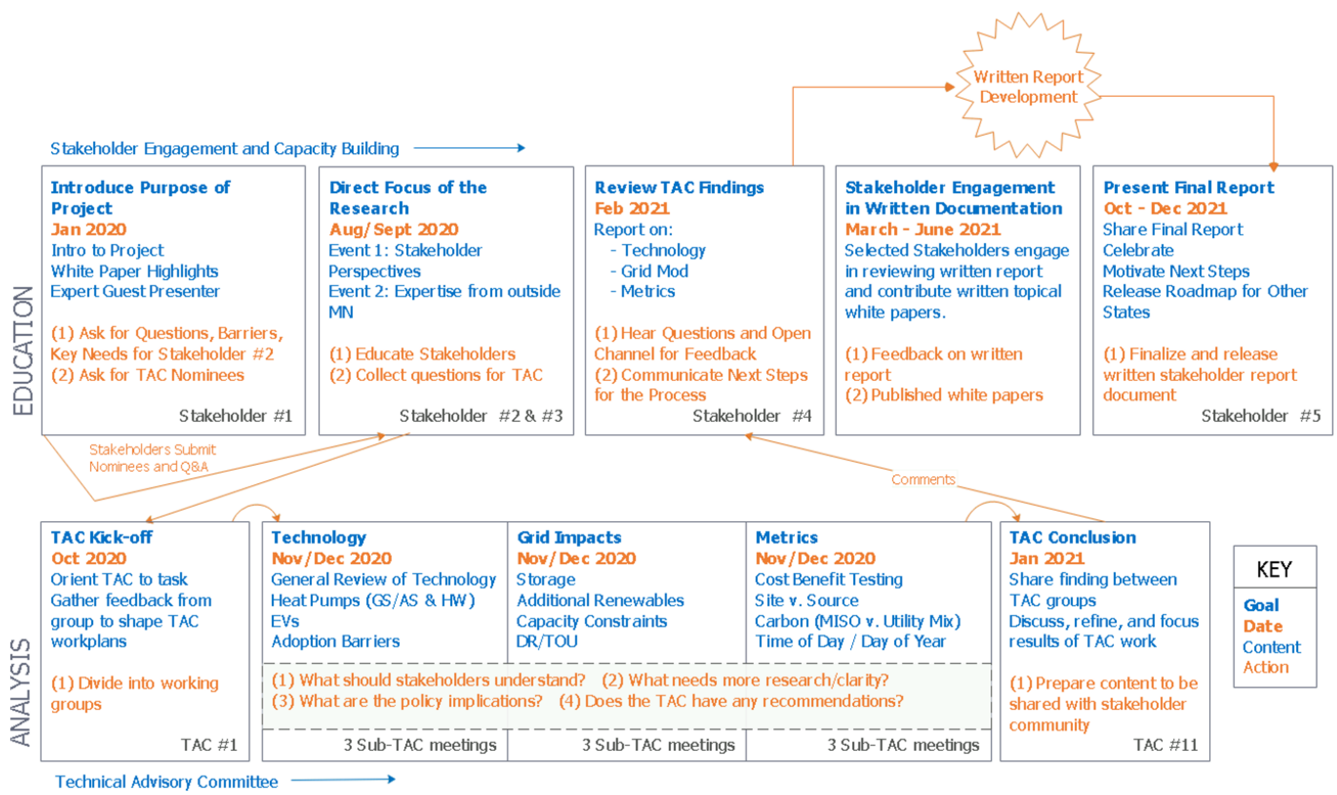
1. Strategic planning to outline the stakeholder process and conduct a literature review.

[10] Appendix A of this document contains a copy of the project's literature review.

2. Open stakeholder meetings initially planned and begun in person but completed virtually due to the COVID-19 pandemic.
3. A technical advisory committee tasked with detailed discussions around technology, metrics, and grid impacts.
4. A written report, including white papers developed by participants that explore under-developed themes from the technical advisory committee meetings.

The necessity of flexibility in delivery was an expectation from the outset, and complications did arise. Most significantly, legislative conflicts and a global pandemic altered the timeline for delivery. The challenge of meeting virtually created an opportunity (perhaps one of necessity) to meet more frequently for shorter durations. The number of stakeholder meetings increased by one, and the number of technical advisory committee meetings increased by five. However, with those adjustments, the process stayed true to its original design. Figure 14 shows the final, revised process details. The project team presented a similar chart during the first public meeting that showed the initially envisioned process.

**Figure 14: Stakeholder Engagement Plan Process Diagram**



## Strategic Planning

Electrification is a topic that excites, motivates, and causes concern among stakeholders. There are economic impacts from selling more electricity and decreasing sales of other fuel types. There is earnest commitment and urgency from some stakeholders to electrify as a carbon emissions reduction strategy. Some stakeholders are committed to any form of electrification. Other stakeholders are committed to resisting electrification. Some stakeholders have not yet deeply engaged in the discussion of electrification.

During strategic planning, the project team created an engagement plan to educate stakeholders on the breadth of opinions, perspectives, and research on electrification. The project team had to balance its goal of educating stakeholders with the need to get technical experts talking to each other about critical details of electrification. Therefore, the project team designed two tracks: open stakeholder meetings oriented around education and the technical advisory committee tasked with a deeper exploration of the key questions.

## Open Meetings

The project team focused open meetings on educating stakeholders. The goals of the open meetings were to share information, build a common understanding amongst organizations with a wide set of interests and perspectives, and gather feedback on proposed options and pathways to electrification.

The project team selected topics for the four open meetings to provide depth and diversity in the information presented to stakeholders. In the first meeting, industry experts introduced stakeholders to economy-wide modeling and forecasting of the impact electrification could have on the future of the energy system including Minnesota specific analyses. In the second meeting, a diverse set of Minnesota stakeholders representing different consumer interests briefly presented their main considerations regarding the future of electrification in Minnesota. In the third meeting, industry experts educated stakeholders about efforts in other states to promote electrification via policies, programs, and regulations. During the second and third meetings, the project team asked participants to provide the technical advisory committee with questions to consider. Finally, in the fourth open meeting, the technical advisory committee presented its findings.

Gathering input from stakeholders during the open meetings was done in a variety of ways. The project team took live questions and comments during the stakeholder meetings. In virtual meetings, the project team used poll and chat functions to gather input from stakeholders. Polls provide an opportunity for all participants to contribute, including stakeholders who don't feel as confident sharing their thoughts out loud. Additionally, some stakeholders scheduled direct conversations with project team members to provide input.

## Technical Advisory Committee

The technical advisory committee (TAC) served to convene a small group of stakeholders with energy industry expertise to explore the implications of electrification and suggesting paths for possible action. The project team solicited members for the TAC from attendees of the first open stakeholder meeting and received a strong response. The project team extended additional invitations to participate at the second and third open meetings. The project team included everyone who expressed interest in participating in the TAC. The make-up of TAC participants was relatively well balanced with regards to expertise, gender, and geography. However, the project team extended a few invitations to specific stakeholders to increase the diversity of the group across these important dimensions.

The TAC served as a focused group of stakeholders to digest information for the larger stakeholder community. Within the larger TAC, the project team created three subgroups to focus on specific facets of electrification (technology, metrics, and grid impacts). Through shared education and discussion, the groups identified key questions, poorly understood topics, research needs, and policy implications. In some cases, the TAC members developed recommendations if there were clear areas of agreement.

The project team asked TAC members the following:

1. What do stakeholders need to understand about this topic?
2. What needs more research or clarity?
3. What are the policy implications tied to this topic?
4. Does the TAC have any recommendations? Recommendations needed to include:
    - What key choice points did the TAC consider?
    - What is the TAC's understanding of the choices' implications?
    - Describe the process by which the TAC made the recommendation.

The TAC met initially as a whole group to discuss each subtopic, contributing to a list of critical questions generated by surveys of the public stakeholder group. After that initial contribution of ideas and questions, the TAC broke into subgroups, each with 15 – 20 members (some TAC members participated in more than one subgroup).

During three meetings, each subgroup used the list of questions to drive their work and develop findings. Topical experts who presented to each subgroup supported the development of these findings. The subgroup used their assigned topic (technology, metrics, or grid impacts) to narrow discussion and refine the context for research, policy implications, and recommendations. TAC members contributed ideas and comments to a shared document throughout the process. The shared document allowed each TAC member to contribute written thoughts outside of the meeting. The group was able to read each other's contributions which fed the discussion at the next TAC meeting.

At the end of the TAC process, the whole group met again to review each subgroup's findings, which the group then shared in a final open meeting. The project team conducted all TAC meetings virtually.

## Final Report

This final report aims to document the outcomes of the stakeholder engagement process. The report summarizes the findings of the technical advisory committee, learnings from stakeholder presentations, and lays out choice points and considerations that could speed future decision-making and planning efforts. The project team also developed a roadmap for other States considering a similar stakeholder process.

Besides this final report, the project team commissioned a series of white papers from four technical advisory committee members that focus on areas of electrification that were not given adequate time or space for exploration during the stakeholder process. These papers are included in the appendices of this report and published separately on the project's webpage: https://michaelsenergy.com/electrification-action-plan/. These white papers focus on:

- "Electrification of Multifamily Housing in Minnesota" – Mari Ojeda (Fresh Energy), Ben Passer (Fresh Energy), Katherine Teiken, and Maddie Wazowicz (MEEA)[11]
- "Equity Considerations in Minnesota's Electrification Policies" – Maddie Wazowicz (MEEA)
- "Rural Electrification and Indigenous Nations of the North Country" –Matt Grimley, Winona LaDuke (Honor the Earth), Pam Fairbanks (Honor the Earth)
- "Integration of Electric Transportation and CIP: A Roadmap" – Kevin Lawless (The Forward Curve)

In writing this final report, the authors conducted additional research to provide readers with a better understanding of the background context of electrification in Minnesota. To write the stakeholder findings section, the authors reviewed the recordings of the TAC and stakeholder meetings. Written stakeholder comments and notes from the stakeholder meetings also supported the writing of this report.

[11] The authors of the multifamily housing white papers are also leaders of the Minnesota Multifamily Affordable Housing Energy Network.

# Process Findings

In the following section, we share findings from the open stakeholder meetings and the technical advisory committees. We summarize the presentations given to the group and attribute them to each guest speaker. We chose not attribute comments to specific stakeholders or TAC members to preserve anonymity. Each TAC subgroup discussed its high-level findings and informally voted on their support for each one. We excluded findings without broad support from the subgroup's members.

## Open Stakeholder Meetings

Stakeholder engagement and attendance throughout the process were excellent. Events frequently had more than 100 attendees. Recruitment and promotion of the events were done primarily through the CIP newsletter email communication list maintained by Commerce which reaches thousands of people. Figure 15 summarizes the number of meetings, attendees, presentations, and hours contributed to the project.

**Figure 15: Stakeholder Engagement Numbers**


### Meeting Schedule and Content

The project team structured the open stakeholder meetings around guest presenters. Below is a short synopsis of each presentation, which provides context for the information shared at the open meetings. Education and peer learning were key goals of the meetings. The resources page of the project website has recordings of the events, when available, and copies of presentations.

#### *January 7, 2020 – Introduction to the Project*

**Anthony Fryer, Minnesota Department of Commerce –** Mr. Fryer provided an overview of the stakeholder process and a history of electrification policy in Minnesota.

**Tom Wilson, EPRI –** Dr. Wilson presented detailed modeling and research that forecasts the potential impact of electrification in Minnesota and nationwide.

**Carl Samuelson, Michaels Energy –** Mr. Samuelson shared findings from interviews with Minnesota stakeholders about electrification and described the planned technical advisory committee process.

### *August 26, 2020 – Perspectives from Minnesota Stakeholders*

**Winona LaDuke, Honor the Earth –** Ms. LaDuke shared concerns about rural energy infrastructure investments. She shared that infrastructure decisions, made without community participation, fail to address climate change or improve energy reliability and have disproportionate impacts on Indigenous people.

**Ben Benoit, Leech Lake Band of Ojibwe –** Mr. Benoit presented his concerns about energy costs and environmental impacts. He shared the tribe's work in energy efficiency, vehicle electrification, and renewable energy generation.

**Jenny Edwards, Center for Energy and Environment –** Ms. Edwards shared technical findings from heat pump research with specific attention to deep energy retrofits, load management, and workforce development.

**Andrew Moratzka, Stoel Rives –** Mr. Moratzka presented his concerns about energy costs, transparency, and reliability from the perspective of a group of industrial energy users that he represents.

**Kevin Lawless, HourCar and The Forward Curve –** Mr. Lawless shared HourCar's plans for new charging infrastructure, electric vehicle deployment, and addressing equity.

**Carmen Carruthers, Citizens Utility Board of Minnesota –** Ms. Carruthers presented perspectives from consumers regarding the significance of investing in new equipment for residents and the importance of using utility rates to influence behavior.

**Ben Passer, Fresh Energy –** Mr. Passer shared the following definition of equity: "Elimination of barriers to full participation in the process, and access to the full benefits of the outcome." He explored historical, social, and economic sources of inequity that need to be addressed in Minnesota.

### *September 9, 2020 – Insights from Regional and State Efforts*

**Ana Sophia Mifsud, Rocky Mountain Institute –** Ms. Mifsud provided information on programs and policies across the nation that are driving building decarbonization. She focused on heat pump programs.

**Samantha Caputo, Northeast Energy Efficiency Partnership (NEEP) –** Ms. Caputo shared the work states are doing in the Northeast to promote electrification, including recent activity in New York, Massachusetts, and Rhode Island.

**Jessica Allison, California Public Utilities Commission –** Ms. Allison presented her experience working to implement California's fuel substitution policy. She provided lessons learned from developing cost-effectiveness tests and reviewing fuel substitution measures.

### *February 4, 2021 – Reports from TACs to Stakeholders*

During this stakeholder event, members of the three TAC subgroups (technology, grid impacts, and metrics) presented their findings. We name the presenting member below but share the findings from each subgroup at length in subsequent sections.

Travis Hinck of GDS Associates shared findings from the technology subgroup.

Jenny Edwards of the Center for Energy and Environment shared findings from the grid Impacts subgroup.

Grey Staples of the Mendota Group shared findings from the metrics subgroup.

## Feedback from Stakeholder Polls

The project team used informal polling at the August and September open meetings to learn more about the background stakeholders had with electrification. Polls created an alternative format for stakeholders to share their comments and questions. We designed some of the poll questions specifically to provide questions and discussion items for the technical advisory committee process.

During the August 26$^{th}$ meeting, a poll showed that over 80% of attendees lived or worked in Minnesota. Figure 16 shows that utility representatives comprised the most significant part of the group—34% of attendees who responded. Employees of government and non-profits were also well represented, making up 20% and 25% of the attendees, respectively.

Attendees were relatively familiar with electrification—over 70% shared that they were either familiar with the topic or would feel comfortable presenting on the topic. Only 4% said they had not heard much about electrification. Figure 17 summarizes this information. Surprisingly, only 35% of attendees also attended the first meeting in the stakeholder process.

**Figure 16: Attendee Organizational Representation**

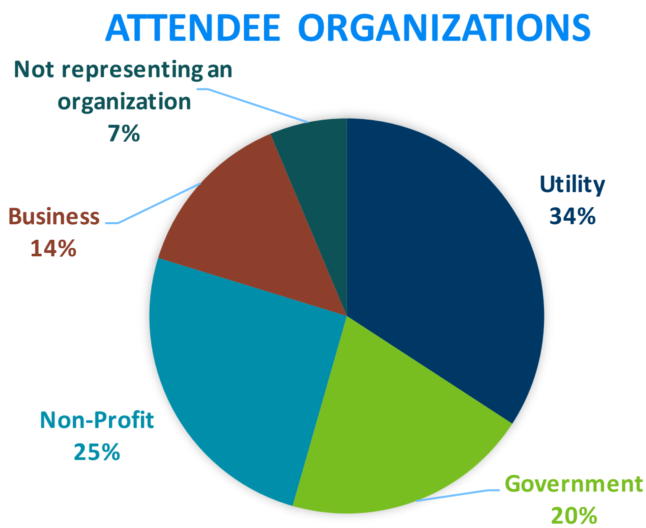
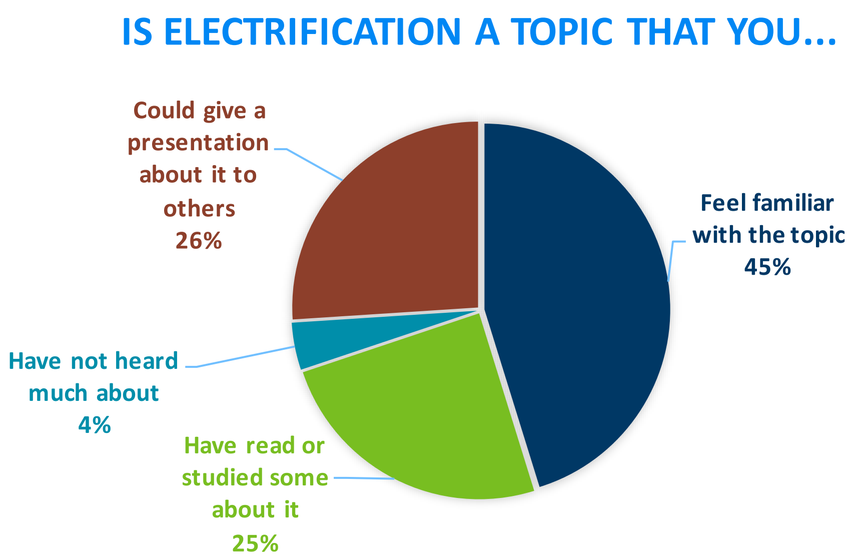



**Figure 17: Attendee Background on Electrification**




The project team asked attendees, "What aspect of electrification is important to you?". They responded with various answers, but the most common themes were: decarbonization/GHG emissions reductions, equity/access for low-income customers, cost/who bears costs, and methodology (i.e., cost-benefit testing and the transition process). When asked about concerns, equity was the most common answer participants mentioned. Stakeholders shared specific concerns such as "making sure the transition is equitable, and that economically disadvantaged households aren't negatively impacted" and "the process will end up increasing the business for utilities without looking after interests of marginalized communities or the environment." Through polls, stakeholders expressed concerns about unclear policy direction. They asked the technical advisory committee to provide clarity on cost-benefit testing, carbon benefits, and impacts on peak loads.

## Technical Advisory Committee Membership

Volunteers from 27 stakeholder organizations formed the technical advisory committee. Those organizations include:

Center for Energy and Environment (CEE)
Clean Energy Resource Teams
CenterPoint Energy
Citizens Utility Board of Minnesota
Ecolibrium3
Electrical Association
Fresh Energy
GDS
Great River Energy
Honor the Earth
ICF
Midwest Energy Efficiency Alliance (MEEA)
Minnesota Power
Missouri River Energy Services
Mitsubishi
MN Housing
Otter Tail Power Company
Rochester Public Utilities
Slipstream
The Forward Curve
The Mendota Group
Leech Lake Band of Ojibwe
Minnkota Power Cooperative
Minnesota Geothermal Heat Pump Association
Willdan
Xcel Energy
Minnesota Attorney General's Office (observer)

The TAC formed three subgroups to focus on grid impacts, metrics, and technology. The project team asked TAC members to volunteer for as many subgroups as interested them, and several participated in more than one subgroup. There was an even distribution of participation between the three groups. The technology group had 17 members. The grid impacts group had 17 members. The metrics group had 18 members.

## Technology Subgroup

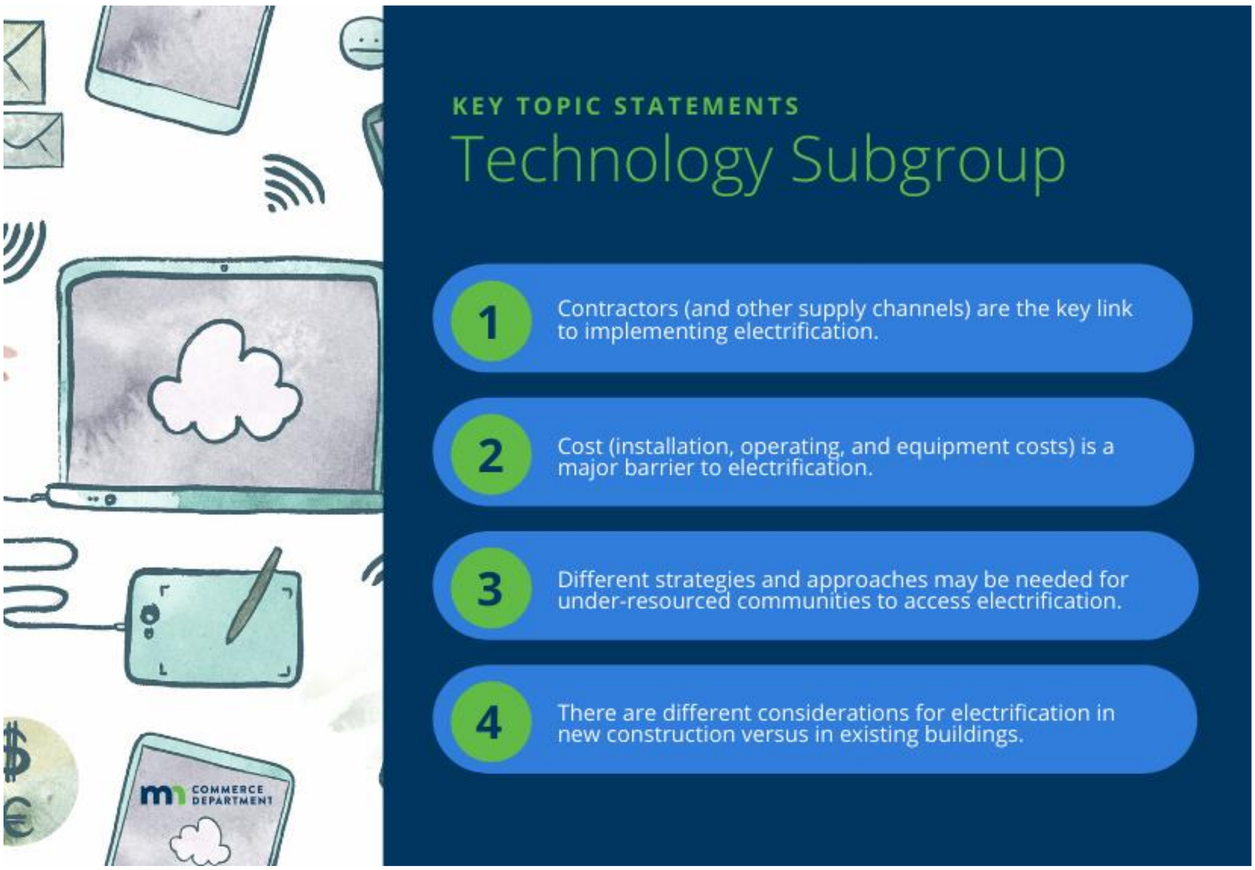
The purview of the technology subgroup was not only behind-the-meter electricity-consuming equipment that customers might consider installing but also customer motivations, market adoption, incentives, contractor relationships, workforce development, and program implementation strategies. The group determined that the greatest barrier to electrification was customer and market adoption rather than the existence of effective technologies. This group documented some of the technologies currently available but focused discussion and problem solving on market adoption issues.

The technology subgroup benefited from heat pump experts who presented to the group. Their presentations covered both ground-source and air-source systems. These presentations included:

**Ben Schoenbauer, Center for Energy and Environment** – Mr. Schoenbauer presented research on air-source heat pumps for space and water heating. He shared recent data on heat pump performance in cold climates and described statewide efforts to organize and educate contractors.

**Will Lange, Water Furnace** – Mr. Lange presented on ground-source heat pumps. His presentation included a discussion of the performance of ground-source heat pumps in winter, cost reductions associated with advanced drilling techniques, and innovative business models including district energy applications.

The technology subgroup's discussions were split between cataloguing the variety of electrification technologies, including and beyond heat pumps, and discussing market and adoption barriers. The group identified these key topic statements:




## Technologies

The are many electrification technologies and applications that could be considered within the technology subgroup. Any piece of equipment that burns fossil fuels to operate could potentially be electrified. Electrification has well-documented opportunities in space and water heating, transportation, cooking, industrial processes, and more. Residential, commercial, and industrial customers all have electrification opportunities. One of the first items the technology subgroup wanted to address was the scope of technologies that they should consider.

Research from the most recent Minnesota potential study showed that space and water heating make up 70-80% of natural gas use in Minnesota's residential and commercial buildings (Carl Nelson J. B., 2018). For space and water heating, heat pump technology has been rapidly improving, with decreasing costs and increasing contractor and customer familiarity. The subgroup determined that heat pumps (both ground-source and air-source), with their vast potential, deserved most of their focus. Heat pumps have applications in commercial, industrial, and residential sectors, but the subgroup tended to discuss the residential sector the most. This is due to the growing number of cost-effective applications in the residential sector and due to the subgroup member's expertise.

However, subgroup members didn't want to ignore other technologies entering the market. Electric vehicles are also experiencing a rapid growth in sales, the number of models available, price reductions, and range increases. It was clear to subgroup members that electric vehicles will play a significant role in electrification in the future. That said, this subgroup chose to keep the purview of their work in alignment with CIP's current jurisdiction: the built environment. Therefore, electric vehicles were not emphasized during discussion.

The technology subgroup assembled a chart of technologies with notes about them including which sectors they might serve. Both subgroup members and the project team contributed to this compilation of information. Figure 18 shows a summarized list from the subgroup's work. It serves as an illustration of the variety of electrification technologies rather than an exhaustive resource.

**Figure 18: List of Electrification Technologies and Applications**

| Single Family Residential | Multi-Family Residential | Commercial | Industrial | Transportation |
|---|---|---|---|---|
| Air-source heat pump<br><br>Ground-source heat pump<br><br>Heat pump water heater<br><br>Grid-interactive electric storage water heater<br><br>Induction stove<br><br>Small engine equipment (lawn mower, leaf blower, etc.)<br><br>Heat pump clothes dryer | Air-source heat pump<br><br>Ground-source heat pump<br><br>District loop heating and cooling<br><br>Heat pump water heater<br><br>Induction stove<br><br>In-wall insert heat pumps<br><br>Variable refrigerant flow (VRF) systems | Air-source heat pump<br><br>Ground-source heat pump<br><br>Heat pump water heater<br><br>Heat pump rooftop units<br><br>Variable refrigerant flow (VRF) systems<br><br>Electric tankless water heaters<br><br>Heat pump water heater<br><br>Adiabatic humidification<br><br>UV sterilization | Heat pump applications for low temp heat<br><br>Induction heating and melting<br><br>Infrared curing and drying<br><br>Electric boilers<br><br>Infrared cement curing<br><br>UV curing and drying<br><br>Ammonia-water heat pumps<br><br>Heat recovery chillers<br><br>Steam presses - convert to compressed air<br><br>Immersion heating<br><br>Grain drying | Electric vehicles (personal)<br><br>Electric vehicles (fleet)<br><br>Electric truck refrigeration units<br><br>Electric lift trucks |

## Contractors

*Contractors (and other supply channels) are the key link to implementing electrification.*

For technologies that are market-ready, specifically air-source and ground-source heat pumps, the subgroup identified contractor engagement, sales, and familiarity with the product as a problematic missing link preventing broader adoption. The subgroup pondered the “chicken and egg” question of whether contractors would more eagerly sell heat pumps if more customers asked for them, or whether contractors would need to stock the product and familiarize themselves with its benefits before customers would increase adoption. Ultimately, both influence adoption. Marketing, rebates, testimonials, and advertising could help create customer demand, but even with increased demand, contractors and vendors will still be a crucial link.

For instance, research conducted by CEE identified three hurdles to achieving the winter potential of air-source heat pumps (ASHPs). They include: 1) control and operation of the heat pump, 2) integration with a backup heating system, and 3) correct sizing for the building’s heating load (Ben Schoenbauer, 2017). All three of these elements are under the purview of the contractor installing the system. The unit’s performance in the winter, and the benefits of this electrification technology, depend directly on the training and expertise of the installing contractor. As subgroup members shared from personal experiences, it is difficult in some parts of the State (including the Twin Cities metro) to get a contractor to install an air-source heat pump to serve as a primary heating source.

The subgroup identified the following barriers and associated potential solutions to implementing electrification:

- Familiarity with the products
    - Demonstration projects and associated reports could be useful.
    - Access to training and support from manufacturer reps.
    - Proactively stocking the products would promote familiarity.
- Workforce training
    - Need to increase capacity of skilled labor (need to train for refrigeration skills for heat pump installation as opposed to combustion-related skills for furnaces/boilers).
    - Recruit high school students to replace aging workforce.
- Controls and operation
    - Customers need to be enrolled in the most advantageous rates for electric heating.
    - Train contractors to help customers optimize the control switchover between heat pump and back-up heating.
    - Develop materials to help contractors feel comfortable training customers on using the new technology optimally.

Finally, the subgroup wanted to clarify that while most home heating systems reach the customer via an HVAC contractor or some other trades person, other electrification technologies follow other market paths. Water heaters were mentioned as frequently being purchased at home improvement stores and installed by homeowners. Food service equipment has dedicated retail and sales teams. Vehicles are sold by dealerships or private parties. Depending on the product, a variety of parties may need to be involved to influence market adoption.

### *Action Steps*

Subgroup members suggested that a collaborative effort to train and engage contractors would help resolve some of the barriers mentioned above. The Minnesota Air Source Heat Pump Collaborative (MN ASHP Collaborative) is an existing model that might be replicated for other technologies. The collaborative is working to increase the number of ASHP installations in Minnesota, coordinate utility incentive programs, promote the technology to consumers, and support the trade industry to adopt cold climate ASHPs and integrate them into their business model[12]. Subgroup members liked this approach and recommended using the lessons learned from the MN ASHP Collaborative to help promote other electrification technologies.

## Cost

*Cost (installation, operating, and equipment costs) is a major barrier to electrification.*

Cost is a multi-faceted problem. Both upfront and operating costs factor into the overall cost picture. Operating costs vary home to home because of factors like building shell, equipment operation, and utility rates. Helping customers navigate the cost trade-offs would improve understanding and adoption.

In the case of retrofits, electrification technologies, particularly heat pump technologies, have an increased upfront cost compared to conventional heating and cooling technologies. Customers must plan ahead. Emergency replacement (when equipment has died) is, according to subgroup members, most likely to be like-for-like. It's rare for contractor to even stock heat pumps as an emergency option.

Long term operating costs are an important consideration of consumers. Keeping these costs low is particularly important for customers with lower incomes. Operating costs during peak heating times using electric resistance back-up heat could be particularly high. Subgroup members recommended that utilities offer electric heating rates, as discussed below, to reduce the per kWh cost. In addition, demand response programs and time-of-use rates might also decrease operating costs.

Low natural gas prices today limit the cost-effective applications of electrification. There may be non-energy financial benefits that help offset increased upfront and operating costs. Personal or corporate goals to reduce carbon emissions could drive some adoption of electric technologies. Those customers might accept moderate price increases to achieve carbon reductions, but mass adoption of the technology will require a net cost reduction or abundant tangible benefits, like improved comfort and performance, in addition to carbon reductions.

Utility incentives designed to reduce any gap in upfront costs might also make the decision easier. Subgroup members suggested financing options as well, including green banks, which have been set up

[12] Minnesota Air Source Heat Pump Collaborative website: https://www.mnashp.org/

in other states to support investments in renewable energy. Addressing costs holistically will be important to improving adoption of technologies. However, utility incentives must pass metrics set by cost effectiveness tests, including tests that account for benefits to non-participants and society. Depending on the benefits realized, it might be unlikely to expect utility incentives alone to push expensive technology into affordability.

### *Action Steps*

Deliberate market transformation efforts will be required to overcome cost barriers and to improve access to the technology. Without some changes to current cost structures, adoption of many electric technologies will remain low. An electric heating rate was identified as an important tool for reducing the cost of electric heat. These rates are lower during winter heating months than in the summer. The subgroup recommends further research regarding how many utilities offer residential electric heating rates in Minnesota, the terms of those rates, and how many customers use those rates. The results could help inform the development of additional electric heating rates, depending on the findings.

## Program Strategies for Under-Resourced Communities

*Different strategies and approaches might be needed for under-resourced communities to have access to electrification.*

Cost, as mentioned above, is a key factor in implementation of an electrification technology. Both upfront costs and operating costs might be higher for some electric systems compared to fossil fuel systems, especially given the current low prices of natural gas. Achieving the lowest ongoing operating cost is one of the most important outcomes needed to promote electrification in under-resourced communities and should be a priority for utility programs serving low-income customers. The subgroup was not satisfied with “inside-the-box” thinking for solving this problem.

The subgroup proposed the primary cost metric should be achieving the lowest operating cost for the building over its lifetime, including maintenance. A key driver of overall home energy load is the building envelop, so programs promoting electrification for under-resourced communities need to also address the building shell. Sealing air leaks, adding attic and exterior insulation, and replacing windows might all be strategies that could reduce operating costs and make an all-electric home an affordable home to operate.

For example, if an air-source heat pump with back-up electric heat were retrofitted to replace a condensing natural gas furnace the annual operating costs could nearly double (Carl Samuelson, 2018). If that same home were to retain the natural gas furnace for peak winter heating, it’s net operating cost could stay comparatively low. Finally, if the home were insulated and air sealed, the operating cost in either scenario would be significantly reduced (Ben Schoenbauer, 2017).

A program that includes a variety of features might also come with a long list of participation requirements. Members of the TAC expressed concern that the requirements could become a burden to customers. Programs should be as accessible and straightforward as possible.

There isn't going to be a single program design that can best serve all under-resourced communities. One of the comments from a subgroup member was that more money needs to be spent serving low-income consumers to make both efficiency and electrification accessible. Part of this recommendation was realized in the recently passed ECO Act legislation which increases utilities required spending on low-income programs.

Some program design ideas shared by TAC members include

- District ground-source loops to reduce per-user investment costs.
- Partnering with Community Action Partnership (CAP) and weatherization agencies on electrification.
- Including solar PV with electrification.
- Pairing electrification with time-of-use rates, electric heating rates, or demand response programs to ensure lower costs.

These ideas are a starting point, and the subgroup recognized that additional work is needed to build innovative programs for multifamily housing residents and low-income households.

### *Action Steps*

The TAC subgroup recommends that the strategies and approaches that could make electrification accessible to under-resourced communities need to be worked on in a dedicated effort. The process should be inclusive of the communities whose needs are intended to be addressed. It should also incorporate the experience and expertise of those who have been involved in implementing energy efficiency programs for these communities.

The subgroup also recommends that a study (or a component of a potential study) be focused on electrification opportunities and barriers for under-resourced communities. Better understanding of the specific issues faced by these communities would result in better planning and program design.

## New Construction

*There are different considerations for electrification in new construction versus in existing buildings.*

Electrification in new construction is entirely different than retrofitting existing homes.

For new construction, the economics of electrification generally work out well. The incremental cost of heat pump equipment is mostly offset in savings from not connecting natural gas to the home. A to-code or above-code building envelope results in a tighter home and lower operating costs. Even a gas stove can be matched in performance by an induction cooktop. Neither technology nor cost are a barrier in new construction. In the words of one subgroup member, "New construction is **solved.** Both technically and economically (at least on the [single family] residential side)."

However, demand for all-electric new homes is not particularly strong. The subgroup discussed some of the barriers that exist. First, builders may see all-electric as a premium in building cost without a clear return in sales price. A sales price premium for features like electric vehicle-ready garages might shift that perspective. Reductions in up-front costs associated with gas infrastructure could also help address the cost issue. Realtors also need to be familiar with the features of all-electric homes to sell the benefits. Consumers need to be interested and educated. Utilities could play an important role in communicating the benefits of low carbon emissions and energy costs from efficient all-electric homes. A carbon emissions label for the home could also help bring visibility to environmentally-conscious buyers. Finally, availability is an issue—there are very few all-electric homes on the market, which makes these strategies difficult to implement.

The picture is different when retrofitting existing buildings for electric technologies. Challenges like service panel upgrades and re-wiring can increase costs of replacements. In addition, given the potential for higher costs during the coldest winter days, the building envelope becomes important, and there are limitations to the extent to which a building envelop can be improved without extensive remodeling.

### *Action Steps*

The TAC subgroup agreed that new construction was a much more desirable market for targeting electrification implementation. The group recommends doing research to better understand the barriers to electrification in new home construction for home buyers, developers, and real estate agents.

## Grid Impacts Subgroup

Grid impacts is a generalized topic which encompasses everything on the utility side of the energy meter. This includes generation, system peak, system planning, customer demand management strategies, and transmission and distribution of electricity.

Different impacts of electrification could be felt in the short term (1 – 5 years) versus the long term (5 – 15 years). Longer-term impacts might depend on some tipping point of market adoption. Forecasting longer-term impacts relies on modeling and assumptions. Short-term impacts, based on current adoption levels, seem more predictable. The group discussed both long- and short-term impacts, with a slight emphasis on identifying longer-term risks.

Members of the subgroup with special expertise presented to the grid impacts subgroup, including:

**Gary Ambach, Slipstream** – Mr. Ambach presented an overview of the grid, system load factor, winter peaking, and load management.

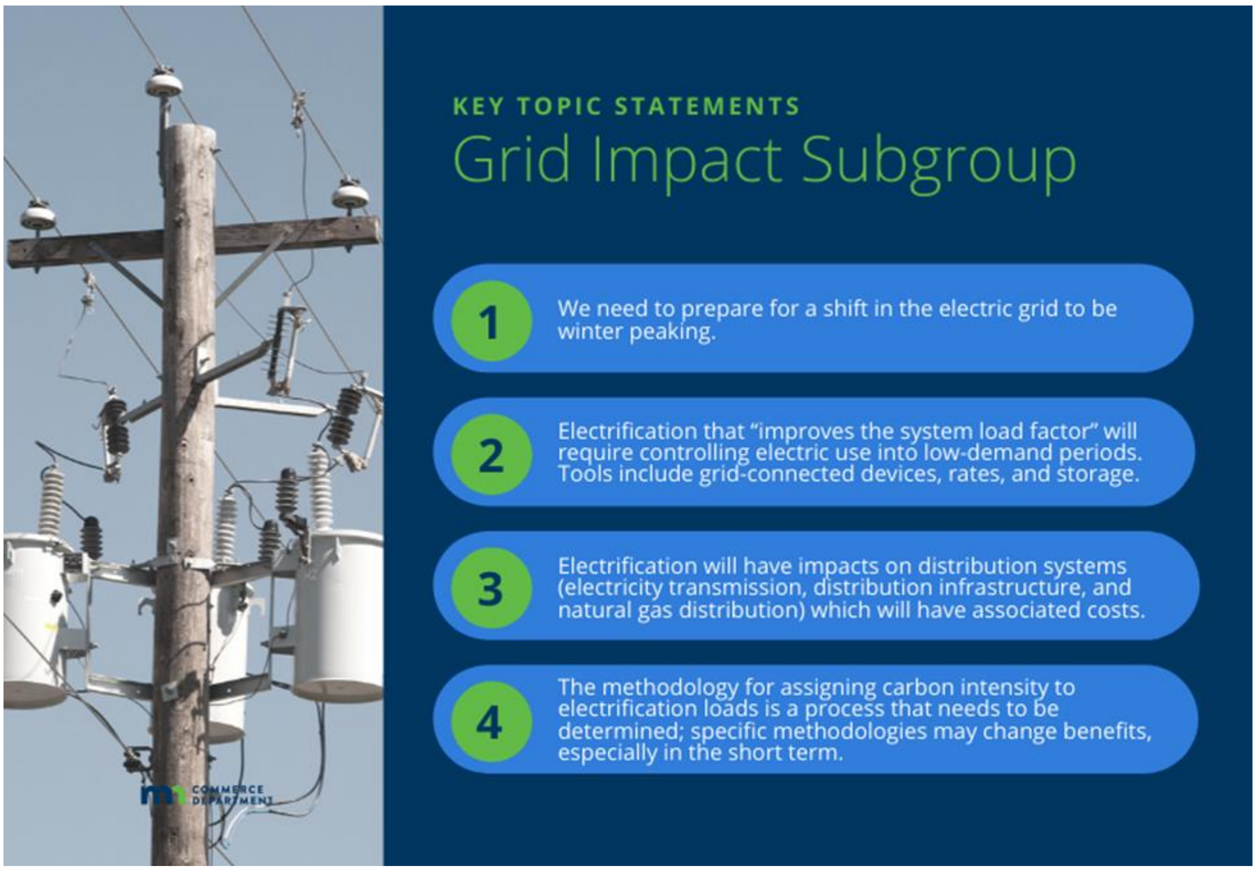
**Jeff Haase, Great River Energy** – Mr. Haase presented findings from Minnesota-specific electrification modeling that EPRI conducted on behalf of Great River Energy, as well as background on power purchasing through MISO and current demand management strategies.

**John Heer, CenterPoint** – Mr. Heer presented information on system design requirements and costs to provide natural gas back-up for electric home heating. He addressed the challenges of providing energy in polar vortex circumstances.

**Patrick Dalton, ICF** – Mr. Dalton shared information about local transmission impacts from added load due to electrification. Increased load is most likely to affect system capacity at the lowest level of the transmission system.

**Nick Dreher, Midwest Energy Efficiency Alliance (MEEA)** – Mr. Dreher provided a framework for considering the equity implications of investment in the electric grid to enable electrification. Nick shared questions to consider around distributive, contextual, and procedural equity.

In summarizing their work, the comments and input from the grid impacts group coalesced around four topic statements, shown below.

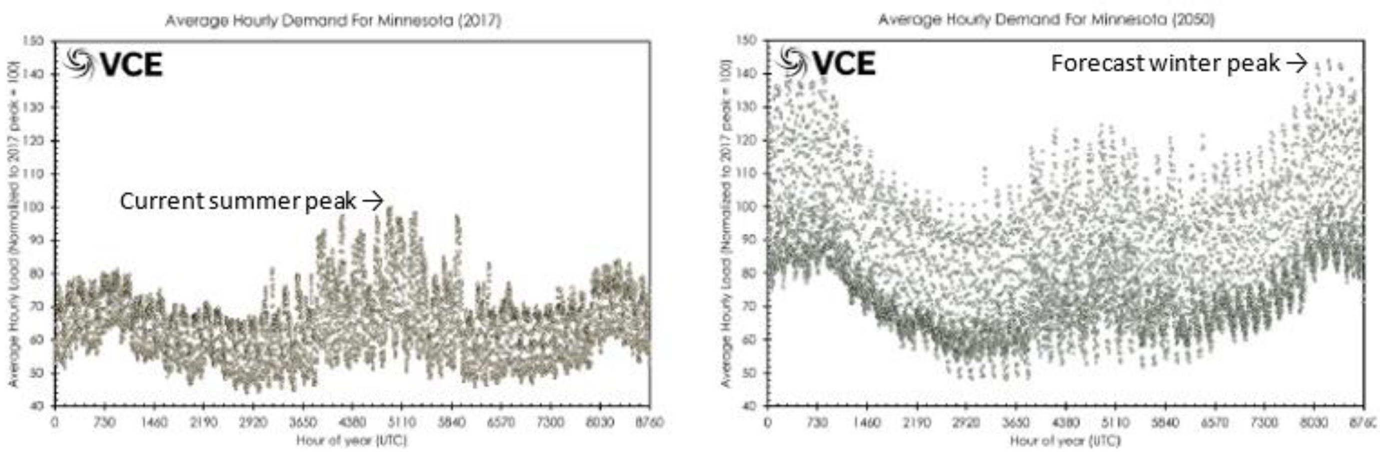



## Shift to Winter Peaking

*We need to prepare for a shift in the electric grid to be winter peaking.*

Based on research presented to the subgroup, increased electrification will result in our electric grid shifting to be winter peaking. While some utilities in the State (especially in Northern Minnesota) are currently winter peaking, the overall trend in modeling is that the entire State will shift to a winter peak in the future (EPRI, 2018). Moreover, the winter peak may be as much as two times larger than our current summer peak (Vibrant Clean Energy, 2018). This shift is primarily the result of electric space heating (with heat pumps) and electric vehicles (whose performance drops in cold weather) and economic growth, even after significant efficiency included. Modeling efforts, one done by EPRI and another by Vibrant Clean Energy (on behalf of the McKnight Foundation), were shared with the group showing this potential winter peak. It is important to note that in both cases the modeled scenarios were designed to reach the State's current goal of reducing Minnesota's carbon emissions 80% by 2050. Figure 19 shows a modeling result from Vibrant Clean Energy's work (Vibrant Clean Energy, 2018). In their 2050 model they project a shift to a winter peak that is nearly 1.5 times the current summer peak.

**Figure 19: Modeling results of hourly demand for MN in 2050 versus 2017**




One key component of a winter peaking grid that the TAC discussed was whether natural gas would be used as back-up home heating for days that are below an air-source heat pump's design range. A presentation from CenterPoint Energy showed that costs for a natural gas local distribution company (LDC) are mostly fixed. The variable cost of natural gas is a pass-through cost for the LDC. As a result, a fixed monthly charge could provide back-up access to natural gas and resiliency for Minnesota's coldest days. If natural gas were to continue providing this insurance for the coldest days, then the demand on the grid in the winter could be reduced. This means that for areas with existing natural gas infrastructure, future system resilience could continue to be provided by a combination of electricity and natural gas.

### *Action Steps*

The TAC subgroup suggested researching how other states are approaching planning for a shift toward a winter peaking grid, including grid and energy production planning. An additional suggestion was made to explore whether Integrated Resource Planning (IRP) or other utility planning processes could include inputs from natural gas planning when considering the impacts of fuel switching.

## Improving the System Load Factor

*Electrification that "improves the system load factor" will require controlling electric use into low-demand periods.*

*Tools include grid-connected devices, rates, and storage.*

One of the requirements of efficient fuel switching in the newly passed ECO Act legislation is that a measure "is installed and operated in a manner that improves the utility's system load factor." (HF 164, 2021) In anticipation of this policy the grid impacts subgroup chose to discuss how implementation of electrification could improve system load factor for a utility.

A utility's system load factor is a comparison of how much demand there is on the electrical grid at a given point in time compared to the energy production capacity. Electricity generation systems operate most efficiently with long steady run-times, rather than frequent ramping and cycling. Increasing the amount of electricity sold during low-consumption periods, while avoiding new peaks and new generation, could reduce per-kWh costs for all consumers. Outside of the ECO Act legislation, this metric was already of interest to utility stakeholders. One large utility shared that they have a goal of improving system load factor.

The subgroup discussed strategies for accomplishing load factor improvement, including time-of-use (TOU) rates, demand response programs, load management programs, and storage.

TOU rates are in nascent stages of implementation in Minnesota, in addition to some pilot rates, the Minnesota Public Utilities Commission just recently approved Minnesota Power's plan to switch all residential customers to a time-of-day electricity rate (Johnson, 2021). By charging a customer a lower amount for using energy during low-demand and high-renewable energy periods (e.g. at night in Minnesota) a utility can influence decision making and push loads away from high-cost, high-carbon peak periods. This kind of strategy can help align customer costs with the actual cost to deliver energy at each moment.

One subgroup member representing an investor-owned utility commented that current volumetric rates likely overstate the cost to serve new electric loads, especially when those loads can be controlled to consume electricity during low-demand periods. The stakeholder further commented that "the space- and water-heating electrification technologies are expected to greatly improve the annual system load factor as they are expected to add significant electric use during low-demand periods both due to the seasonal pattern of usage for space heating (spring and fall months [in systems with natural gas back-up heat]) and the time-of-day pattern of water-heating (morning and evening hours) which requires very little usage during the annual peak hours." The subgroup member commented that TOU rates are a step toward aligning the cost-to-serve with the price per kWh, but other rate strategies might be necessary to improve system performance. "These rate changes may include higher monthly fixed charges that reduce the volumetric charge; declining block rates which reduce the volumetric charge as more energy is consumed, seasonal time-of-use rates, or even (drastically) real-time pricing."

Utilities have a strong track record implementing demand response and load management programs. Most utilities in Minnesota have been offering some element of these programs for decades. The two most common programs are control of air conditioning units in the summer and control of electric water heaters to store energy (heat) overnight. One comment made during a subgroup meeting was that some of the controllable technology being installed today may have a 15–30-year lifespan. During that long lifetime, control of that unit may become much more valuable. Ideally, installations of new equipment today would be control-ready so that over time a critical mass of controllable equipment would be installed. Electric vehicles are a good example of a controllable load with rapidly increasing adoption where a control-ready installation today could make an impact on grid flexibility in the future.

Battery and thermal storage were briefly discussed by the TAC as a strategy for daily mitigation of peaks. Long-term storage to help with seasonal (winter) peaks is not feasible. As storage costs drop, daily load management applications will increase and become more cost effective.

Subgroup members commented that these demand management strategies are good practices to develop today in preparation for future needs, but that the current system can accommodate the short-term forecasted additional electrical load without issues. There is currently surplus generation and transmission capacity at the times of day that electrification technologies would be used. It will take significant adoption of these technologies for the benefits of grid-connected devices, rates, and storage to mature to a place where the grid depends on them.

### *Action Steps*

Prior to the passing of the ECO Act legislation, energy efficiency program guidelines required energy savings to result from measures funded through CIP. This excluded load control or demand response programs that did not also produce an energy (kWh or therm) reduction. Due to the passage of the ECO Act legislation, guidance will need to be created to incorporate demand management strategies into Minnesota's energy efficiency program paradigm.

The subgroup recommends that utilities investigate their costs in order to develop the most accurate pricing models for serving non-peak electric loads. This could improve the financials for adopting electric technologies as well as encourage the use of those technologies during periods of low system load.

## Impact on Distribution Systems

*Electrification will have impacts on distributions systems (both electrical transmission and distribution infrastructure and natural gas distribution) which will have associated costs.*

From presentations to the group, the subgroup members learned about electrification's potential impacts on the electrical transmission and distribution system. The local level of the electrical distribution system is most likely to be impacted by large, new loads. For instance, plugging in a new electric vehicle in a level 2 charger on the street or in a home garage, may cause the local neighborhood transformer to fail. Investment at the neighborhood transformer level tends to lag behind other system upgrades. Transformers and other distribution equipment are often replaced and upgraded on failure, so additional loads might drive upgrades that would have happened much later without the new load.

As long as adoption is gradual, electric utilities ought to be able to respond to occasional outages and needs for system upgrades. TAC members expected this more gradual scenario but identified that achieving current policy goals might accelerate adoption of electric vehicles and push this into a near term (2-5 year) consideration. Similarly, a policy approach like prohibiting new natural gas loads might put more stress on the system and require more proactive system upgrades.

On the gas distribution side, the key planning constraint is system capacity for a design day. A design day is the coldest expected temperature for a winter period. In Minnesota that is -25 °F. This means the natural gas transmission system would be the same if it delivered gas every day of the year or if it only delivered gas in the coldest month of the year. Most of the system costs are fixed costs and TAC members expressed concern about spreading those fixed costs among fewer customers if customers abandon natural gas, especially because early adopters of new technologies are likely higher income residents.

### *Action Steps*

The TAC subgroup suggested that analysis of specific electrification technology adoption scenarios would be beneficial. This analysis could help mitigate uncertainty in system planning. There was a question from the TAC about whether investments in transmission and distribution infrastructure would increase rates or whether the increased sales would offset those costs. This question should be researched further.

Research to better understand adoption rate scenarios (who is likely to adopt electric technologies and when) could help utilities plan for a variety of circumstances. For instance, how do natural gas distribution system costs get shared among fewer users in a scenario of high adoption of all-electric homes. Low-income focused program intervention should be included in the research so as to understand its impact promoting equitable adoption.

## Determining Carbon Intensity

*The methodology for assigning carbon intensity to electrification loads is a process that needs to be determined; specific methodologies may change benefits, especially in the short term.*

One central piece of the conversation across both the grid impacts and metrics subgroups was the question of appropriate accounting for carbon emissions from electricity consumption. The question raised by TAC members was whether average or marginal carbon emissions better reflect the actual emissions caused by adding a piece of electricity-consuming equipment. Using average emissions currently assigns a lower carbon intensity, but it may undercount the true climate impact. Each subgroup agreed there was a need to come to consensus on a carbon accounting methodology, and to better understand the magnitude of impact the choice of methodology would have.

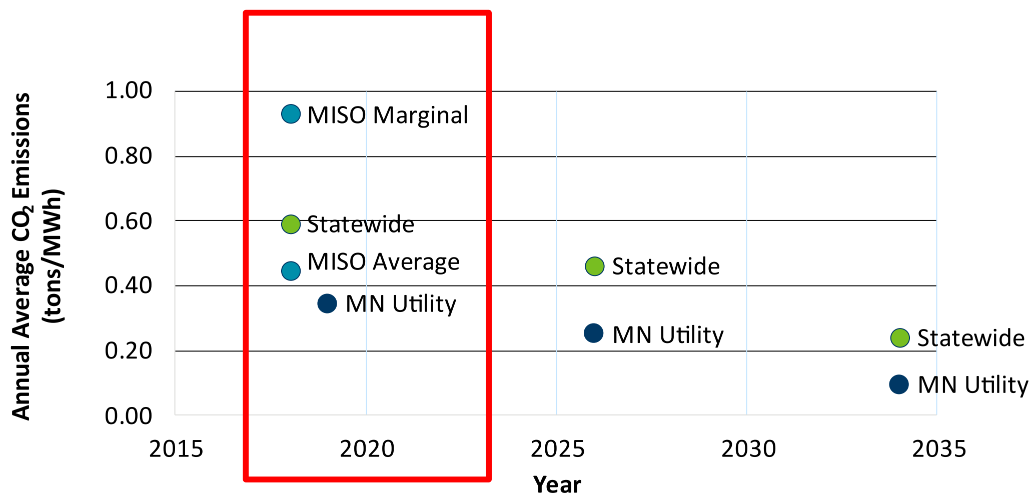
The following are the major methodologies for accounting for carbon emissions from electricity:

1) Average emissions: takes the sum of all emissions for a jurisdiction and then divides those emissions by all kWh produced (over the same period).
2) Marginal emissions: Instead of using all emissions, this methodology only uses the carbon emissions from the last (marginal) generation resource dispatched.

Using average emissions is by far the simplest approach. The trickiest part about determining average emissions is determining the right population of data to average. The broadest measure of emissions would be an average of the emissions from the MISO north region. This grid-level view takes into consideration that power consumption and production fluidly cross borders. On the other hand, the system average emissions *do not* recognize that some utilities are purchasing or producing more renewable energy than others. Another approach would be to determine average emissions based on the utility's generation mix as filed in their integrated resource plan. This, though, would only consider planning circumstances, not performance.

Marginal emissions, on the other hand, account for the fact that as loads are added to (or removed from) the grid, generation resources are ramped up or down to balance supply with demand. These resources are dispatched economically, meaning the lower cost resource is deployed first and higher cost resources are used later. Because balancing the system requires responsiveness down to five-minute increments, generation sources with long start times, like nuclear energy generators, are rarely turned on or off and serve as a baseload generation (EIA, 2020). Coal-fired generators used to be considered baseload, but innovations in their operation (driven by competition with low-cost wind energy) has converted their role so that many coal generation plants ramp up and down and in fact cycle on and off each day to meet load (Jaquelin Cochran, 2013). As a result, the generation equipment ramping to meet the marginal load in the MISO north region is predominately wind turbines and coal and natural gas-fueled generators, and thus carry a higher emissions factor than the region's average emissions. This difference is shown in Figure 20 from an analysis recently completed in a CARD study (Maddie Koolbeck, 2020).

**Figure 20: Emissions analysis completed in a recent CARD study and shared with the TAC**




An average emissions calculation is the simplest approach, but some stakeholders felt that average emissions would understate the carbon impact of adding additional demand on the grid.

There are both mathematical and theoretical questions at play in this discussion. The most accurate answer to calculating carbon emissions in the near term, for a load with a short duration, would be a marginal analysis. It reflects what resource got "turned-on" when, say, an electric car gets plugged in. But a lot of unknowns enter the equation when we are faced with forecasting the carbon intensity of our energy production system in the future. The irony of a marginal emissions analysis is that the grid could be 90% carbon free with only 10% fossil-fueled generation used to meet variable loads and the marginal analysis could still show a high carbon intensity.

Even with surplus capacity and generation, most utilities in Minnesota are pursuing installation of new renewable generation resources, particularly wind and solar. TAC members wanted to know how new renewable generation would impact the carbon intensity calculations. TAC members emphasized in multiple instances that decarbonization of the grid is a prerequisite for electrification to be beneficial. A marginal emissions analysis might get the right number today, but disincentivize investment in electrification technologies whose carbon emissions will drop in step with the grid's decarbonization.

Overall, TAC members struggled to agree on an accurate methodology. They agreed that this issue mattered. They wanted a methodology that balances calculating current, actual carbon emissions with projected, future carbon emissions from an evolving generation mix.

### *Action Steps*

Based on the robust conversation and lack of clarity at the end of the discussion, both subgroups recommended that specific research and stakeholder input processes would be necessary to resolve the issue. The group would like to better understand the difference each methodology would have on a project and program level. Some research has been started on this topic. The market potential study referenced in Figure 20 is a primary example of that (Maddie Koolbeck, 2020).

The group also recommend that work be done to develop load profiles of electric end uses. Some utilities offered that they have already done significant work developing load profiles for air-source heat pumps.

The ECO Act legislation resolves some of the disagreements around carbon emissions accounting. It also creates a path for Commerce to develop an accepted methodology. As the legislation describes "for an efficient fuel-switching improvement installed by an electric utility, the reduction in emissions must be measured based on the hourly emission profile of the electric utility, using the hourly emissions profile in the most recent resource plan approved by the commission under section 216B.2422; (HF 164, 2021). For Consumer Owned Utilities, either their resource plan or the utility's electricity supplier's most recent resource plan, can be used; absent either, "the commissioner must develop a method consumer-owned utilities must use to estimate that value (HF 164, 2021)."

As a result, a clarity around the methodology for carbon emissions accounting will be an important component of the guidance that Commerce issues around implementing the ECO Act legislation.

## Metrics Subgroup

The metrics subgroup had a specific scope: to explore how we measure the impacts of electrification. This encompassed a discussion of cost-effectiveness as well as other metrics related to determining the success of a market transformation program or the equitable implementation of a program.

Expert members of the TAC presented to the subgroup. These presenters included:

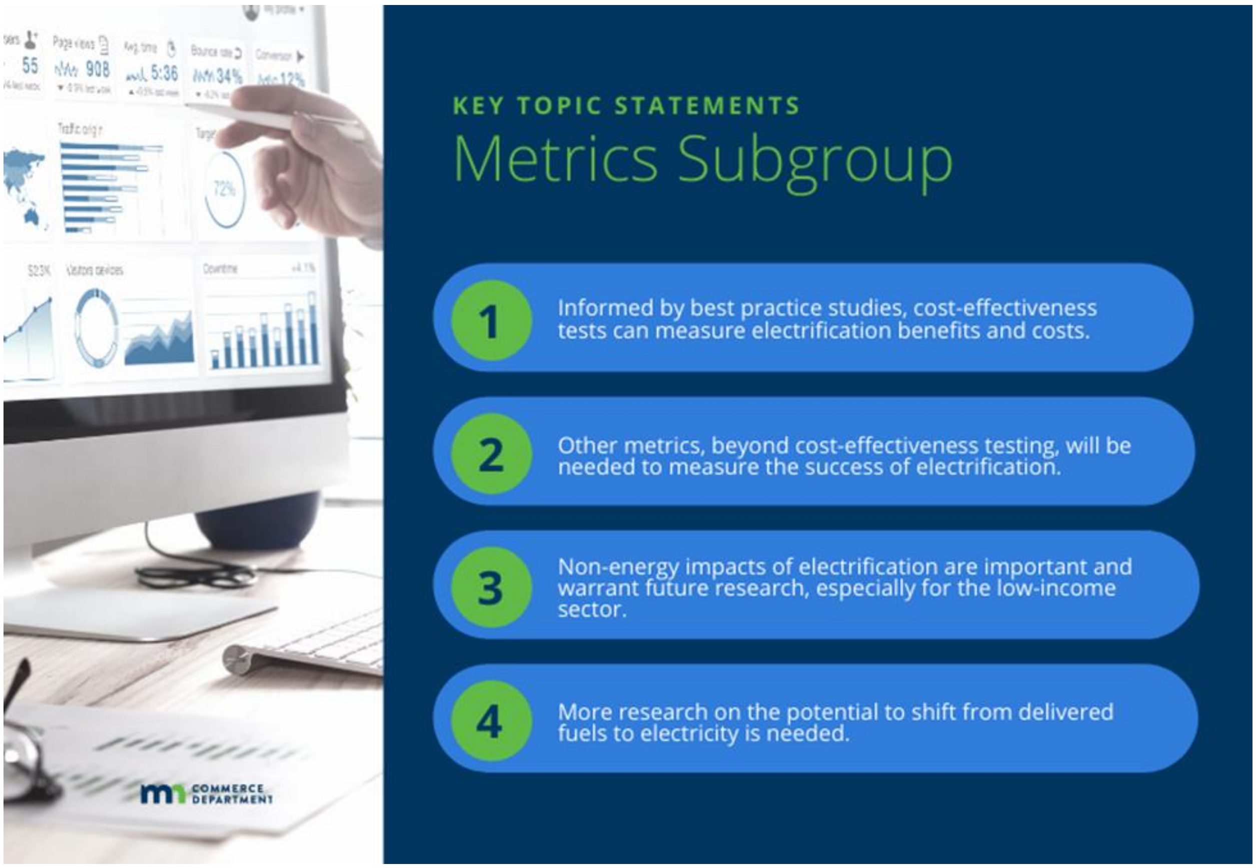
**Grey Staples, The Mendota Group, LLC** – Mr. Staples presented an overview of cost effectiveness testing. He discussed how cost-benefit tests compare a stream of benefits and costs with respect to different stakeholders (the customer, utility, ratepayer, and society).

**Ben Passer, Fresh Energy –** Mr. Passer presented on how metrics might be designed to ensure more equitable outcomes and participation in the decision-making process. He highlighted that many non-energy impacts are not included in current cost-benefit testing.

**Ethan Warner, CenterPoint Energy –** Mr. Warner highlighted the assumptions built into CIPs current cost-effectiveness testing. He proposed that the CIP framework might be a starting point but stated that because goals of electrification are different from goals of energy efficiency, metrics will need to be different as well. Specifically, metrics for electrification need to account for much longer-term changes in the system.

**Jake Millette, Michaels Energy –** Mr. Millette shared an overview of non-energy impacts and their incorporation into cost-benefit tests. He also shared some information on electrification-specific testing models such as the Total Value Test.

After initial discussions, the metrics subgroup summarized their thoughts into several topic statements:




## Cost-effectiveness Tests

*Informed by best practice studies, cost-effectiveness tests can measure electrification benefits and costs.*

Cost effectiveness testing of energy efficiency programs has decades of history and standard practice methodology. The goal of cost effectiveness testing is to ensure that ratepayer dollars are spent in a way that produces net benefits for specific stakeholder groups. Different tests have been developed to measure program impacts from the perspective of stakeholder groups including participants, the utility, ratepayers, and society. In Minnesota, application of these tests for energy efficiency programs is governed by statute and overseen by Commerce (216B.241 Energy Conservation Improvement, 2019).

Recent efforts to update and standardize cost-benefit analyses for distributed energy resources at the national level have specifically addressed electrification in both the context of an energy efficiency program and outside of an energy efficiency program (NESP, 2020). Some of the same researchers completed related work funded by the Department of Commerce through a Conservation Applied Research and Development (CARD) grant to expand on how those national best practices might be applied to the Minnesota context (Erin Malone, 2018).

The members of the subgroup had deep expertise in the application of cost-benefit testing for energy efficiency programs. In addition, the literature, research, and standard practice documentation for cost-benefit testing is robust. As a result, the conversation around cost-effectiveness testing led to an agreement that it would be possible, following current standard practices, to establish a methodology to account for the costs and benefits of electrification.

Such a test would help utility program managers choose whether to create a program to promote a specific technology. Cost-effectiveness testing would also help determine whether a specific application of an electrification technology is beneficial. The group recommended that the specific parameters of a test should be informed by the State's priorities as laid out in statute—for example, the statute should help determine if greater importance is given to carbon emissions reductions or energy consumption reductions.

Some considerations raised by stakeholders included:

1) Impacts of electrification must be measured against appropriate baselines. Guidance around baselines should be developed separately for new construction and retrofit applications.
2) The framework should include non-energy impacts, including harder to quantify impacts like health benefits.
3) A test is needed to evaluate the impacts on non-participant ratepayers of the abandoned fuel. The expectation is that costs may decrease for electric customers as sales increase, but costs may increase for natural gas users as the number of customers decreases.
4) Application of standard testing processes for non-traditional applications like transportation might be challenging and will need some specific consideration.

### *Action Steps*

With the passage of the ECO Act legislation, the TAC recommended creating a working group to assess the options for cost-effectiveness testing methodology for electrification.

## Other Metrics

*Other metrics, beyond cost-effectiveness testing, will be needed to measure the success of electrification.*

Cost effectiveness testing has limitations. One of these limitations is the fact that some desirable outcomes are not adequately represented by a numerical ratio of benefits-to-costs. Some important outcomes will require other metrics designed to track their success. This especially comes to bear when designing programs to more equitably share benefits within society.

An example of a metric designed to track a specific outcome is the MPCA's tracking of carbon emissions by sector for the Minnesota economy. Gathering and reporting on this data is part of delivering on the State's commitment to reduce greenhouse gas emissions. The carbon emissions reduction goal is an absolute target that can be measured by a specific metric[13]. Reporting on that metric informs the public of the progress toward achieving economy-wide carbon reductions.

In the case of electrification, there are some obvious metrics which are tracked for other CIP offerings, such as dollars spent on a program, number of low-income participants, total energy saved, and consumer dollars saved. Tracking these metrics will contribute to an understanding of whether electrification is meeting the goals of reducing carbon, reducing costs, and improving grid performance.

Beyond these goals, the subgroup felt it was important to create metrics that assessed whether the implementation of electrification creates equitable benefits. This was important to the TAC because electrification has the potential to require significant investments. Such spending could follow status quo inequalities or could be used to create positive impacts like new jobs, reduced pollution, and improved health.

It was unclear to the TAC which metrics would best track equity. This was recommended as an area for further consideration. Identifying the addressable problems and creating goals is essential to developing appropriate metrics. Energy burden and energy access are two ways that racial and economic disparities manifest in our society. The location of energy infrastructure investments was identified as a potential source of inequality as well. Indoor air quality and location-based pollution are other important issues to consider. Jobs and involvement in the energy economy could also be tracked as a marker for improving the equitable distribution of economic benefits of electrification.

### *Action Steps*

The subgroup recommended research into how the current electric system may underserve some users and perpetuate inequality. Examples include energy burden and poverty which have locational qualities, and could be better understood in relationship to outages, energy cost, and infrastructure upgrades. Research could work to determine if there are relationships between poverty and negative energy impacts (i.e., more outages in poor neighborhoods).

The subgroup recommends that, based on the specific goals for electrification developed in statute, metrics be developed to track progress towards achieving those goals. Specific metrics should be developed to track the equity impacts of electrification programs. Those metrics might include low-income program participation, geographic participation, jobs created and job training, and the location of infrastructure investments.

[13] Minnesota Pollution Control Agency reporting on GHG emissions can be found at https://www.pca.state.mn.us/air/greenhouse-gas-emissions-data

## Non-Energy Impacts

*Non-energy impacts of electrification are important and warrant future research, especially for the low-income sector.*

Cost-effectiveness testing relies on assessing the impacts of an investment activity, thereby defining a monetary cost or benefit in dollars. Some impacts readily convert into dollar values, for instance, the electric system costs avoided by an energy efficiency investment. We can apply an arbitrary but consistent monetary value to weight the financial equation in favor of positive outcome, for instance applying to value of avoiding of a ton of carbon emissions. Those numbers can be refined or increased as more information becomes available. However, other impacts are not as easy to quantify or assign value, for instance the lifetime impacts of living in a home near a fossil-fueled power plant (which increases exposure to air pollution and negatively impacts health). In some cases, these harder-to-quantify, non-energy impacts might outstrip the energy impacts in terms of overall value if they were able to be quantified. Identifying and quantifying these non-energy impacts can lead to justifying increased investments in energy efficiency and electrification.

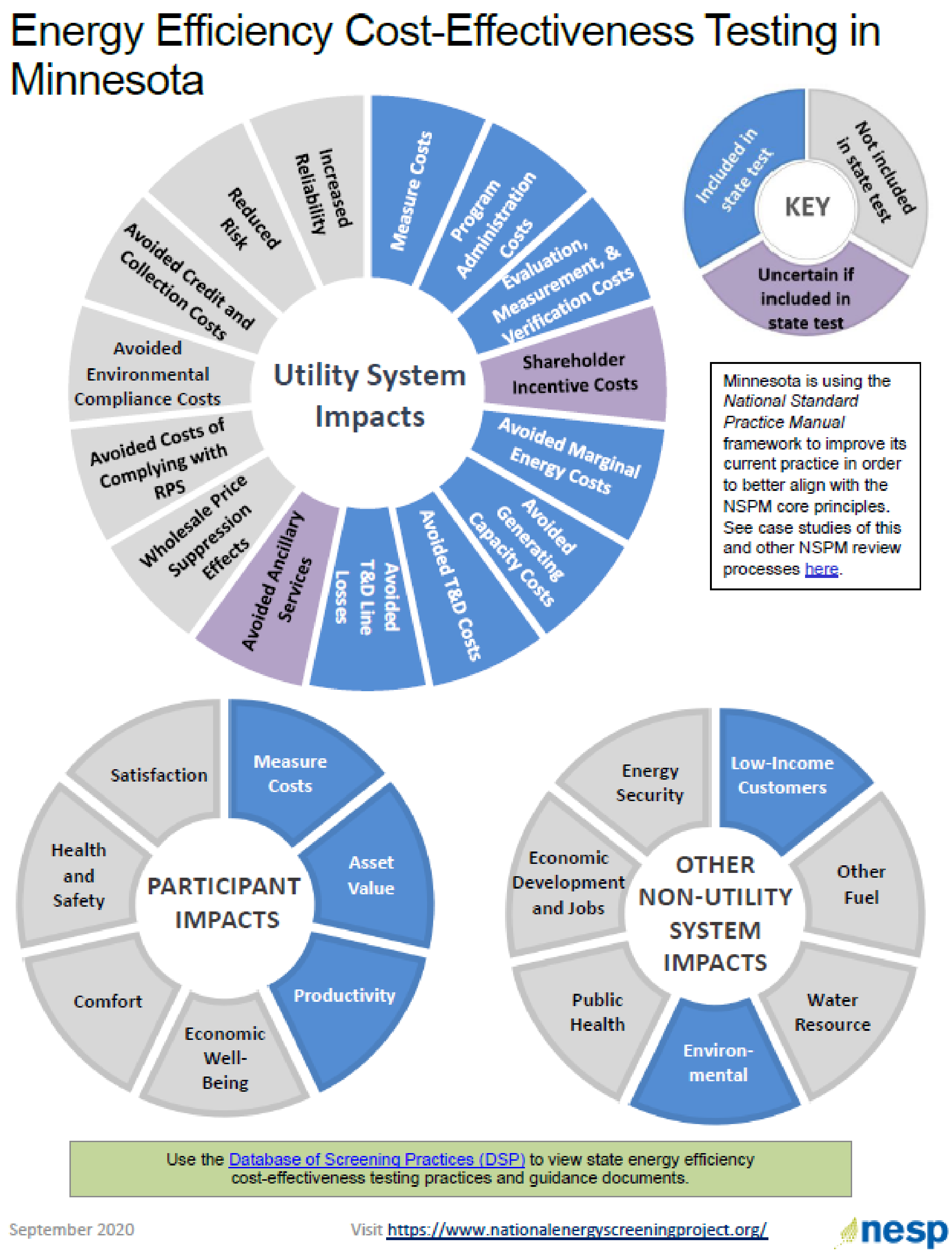
To this end, recent industry research efforts have focused on evaluating non-energy impacts (NEIs) more robustly. This research has aimed to maximize the number of clearly identifiable externalized costs and benefits in the cost-effectiveness analysis of energy efficiency and electrification programs.

Non-energy impacts can include a huge variety of elements including grid reliability, health, employment, water pollution, water savings, and comfort. The National Energy Screening Project (NESP) compiled information on what is and is not included in Minnesota's current cost-benefit testing practices. A subgroup member presented this information to the TAC subgroup and Figure 21 shows the NESP Minnesota fact sheet (NESP, 2020).

One of the subgroup's recommendations was that non-energy impacts should be a primary consideration in low-income energy efficiency and electrification program design. Although Minnesota does not require that its low-income energy efficiency programs be cost-effective, the positive impacts realized from low-income programs might be significantly greater than the current cost-effectiveness test indicates. Reduction in the exposure to air pollution was mentioned as a significant but unquantified potential benefit which would particularly benefit low-income customers.

The group also discussed how geography might affect the non-energy impacts of different program designs. If possible, geography should be included in determining values used in cost-benefit testing. Impacts with geographic variation include weather-dependent impacts, but could also include alternative fuel availability, economic opportunities, costs for system replacement and maintenance, indoor air quality, and property value.

**Figure 21: Impacts included and excluded from Minnesota's cost-benefit testing**




## *Action Steps*

The subgroup, with input from Commerce, was able to identify an action step for non-energy impacts. Starting in 2021, Commerce convened a group to work on preparing cost effectiveness testing methodology for the 2024-2026 triennial. The experience in developing the most recent (2021-2023) triennial was that evaluating the potential to include non-energy impacts demanded more attention than could be provided in the timeframe allowed for preparing the triennial guidance. By starting the process earlier, the expectation is this process can include further consideration of non-energy impacts. As a starting point, categories that are easier to quantify, such as impacts on water and health, could be prioritized. This planning process could address impacts from both energy efficiency and electrification.

## Delivered Fuels

*More research on the potential to shift from delivered fuels to electricity is needed.*

Delivered fuels, in the context of the subgroup's discussion, refers to propane and fuel oil used for heating, cooling, and agricultural end-uses. Depending on the context, petroleum might also be considered a delivered fuel. The subgroup discussed whether switching to electricity might impact the business model of fuel delivery companies and thereby increase their costs-per-unit of fuel delivered. This was a concern presented by the industry to lawmakers during discussions of the ECO Act legislation. The subgroup decided that they didn't understand the markets or system impacts well enough to determine the potential impacts.

Economic principles would indicate that a drop in demand with the same supply should result in a drop in prices in a competitive market. These economic principles played out predictably for the propane market in the winter of 2013 – 2014, when a steep drop in supply caused price increases. A Congressional joint economic committee estimated that Minnesota consumers spent an additional $70,905,941 on propane as a result of the price spike that winter, when compared with the previous five winters (Joint Economic Committee Democratic Staff, 2014). Another consideration is that the number of customers propane customers might not drop, if propane continues to serve as a back-up fuel, only the volume of gas sold or the frequency of tank refills would be affected. This might mute the economic impact of customers switching fuel. Many TAC members expect that fossil fuels, such as propane, will have a continuing role as a back-up fuel.

The TAC members did observe that any cost increases on delivered fuels would disproportionately impact some sectors and populations, which raises concerns of equity and the need for careful planning. Minnesota agricultural users consume 22% of the propane in the State and the equipment powered by this propane might not be easily converted to electricity-consuming equipment (Eric Kuhle, 2017). About 10% of homes in Minnesota are heated with propane, and low-income customers use propane to heat their homes more often than other customer groups (Carl Nelson e. a., 2018). Upfront costs might make adoption of efficient, electric technologies harder for low-income residents, which could leave them "stranded" with the increasing costs of delivered fuels.

### *Action Steps*

The subgroup recommends that further research be conducted to understand how a reduction in delivered fuel demand due to electrification would impact prices for customers. That research should consider different populations, including indigenous communities, rural communities, and low-income communities. The research should also describe the impacts on different sectors of the economy, specifically agriculture.

## Carbon Emissions

The carbon intensity of the electric grid was addressed in both the grid impacts and the metrics TAC subgroups. Both groups agreed it is an important element to get right and that agreeing to a common methodology is important. For simplicity, this report contains both groups' comments in the Grid Impacts subgroup section.

# Cross-Sectional Findings around Equity

In the background section of this paper, special attention was paid to four populations of Minnesotans: 1) low-income residents, 2) Black, Indigenous, and people of color, 3) renters, and 4) rural residents. These groups were selected because consideration of impacts of inequality and plans to address energy inequality need to be made with consideration for specific populations.

Through the work of strategic planning, convening open meetings and the technical advisory committee, and writing the summary report, this process has tried to explore how electrification technologies, programs, and investments could contribute to addressing historical inequalities. Electrification is not a panacea for reducing energy burden or eliminating pollution. However, there are steps that can be taken that would be expected to increase participation and enhance the benefits experienced by those four key populations.

### *Design Electrification Programs with Attention to Inclusion and Equitable Participation*

The TAC subgroups discussed program design as a key opportunity to focus on inclusion and equity. The technology subgroup specifically recommended creativity in program design to better meet the needs of a low-income customers and communities with historically lower participation rates. Presenters in open stakeholder meetings recommended strategies like home insulation and air sealing be included in electrification programs to ensure a net reduction in energy burden for low-income households.

TAC members specifically mentioned that lengthy, complicated program requirements (either for eligibility or for participation) can deter participation and are a burden on low-income participants. Removing barriers to entry would allow the program to be more accessible, at the tradeoff of some control over details of the program. For example, many electric utilities do not know the heating fuel type of a customer. Natural gas territories are considered trade secret and anyone could use propane, fuel oil, or wood for heat. Existing heating fuel is an appropriate detail to collect on an application form, but incomplete application forms are common. If incomplete application forms were the result of language or educational barriers, the outcome might be exclusion of some communities from the program and its benefits. Furthermore, if a program is only eligible to customers with propane heat, recruiting customers is likely to be complicated and confusing. One resident of a county could be eligible and another ineligible.

Program design should also address the particular concerns and needs of multifamily housing residents, specifically renters. It is rare that a program targeted at single family homeowners would also meet the needs of renters. Factors that have led to recent successes in running multifamily energy efficiency programs should be adapted and included in electrification programs. Access to electric vehicle charging for multifamily residents might provide an immediate opportunity. Another opportunity could be retrofitting multifamily heating systems with heat pump technology (Steven Winter Associates, Inc., 2019).

Rural home electrification programs are likely to be some of the lowest hanging fruit because of the lower availability of natural gas to homes in those areas. Coops and other rural-territory utilities have a strong track record of designing programs that can work well in their unique territory.

Metrics subgroup members recommend tracking and including non-energy impacts in the cost effectiveness tests. This would change our understanding of which projects are cost effective, increase the number of projects meeting program criteria in underserved households and communities, and more accurately account for program benefits. Carbon emissions, indoor air pollution, public health, and home value might be some non-energy impacts to consider. Presenters to the stakeholder group expressed the belief that funding is the linchpin to motivating customers. The ECO Act legislation does increase dedicated low-income program funding.

Consider these elements in program design:

- Design with key demographics in mind (rural, renter, low-income)
- Think holistically (building envelope, energy rates, demand response)
- Eliminate barriers (fewer rules, more support for participants)
- Provide sufficient funding
- Capture non-energy impacts in the cost-benefit test

### *Proactively Address Energy Affordability*

Converting from a fossil fuel to electricity does not always result in lower costs. On a per Btu basis, electricity is more expensive. The key to affordability comes from efficiency. Heat pumps are at least two times more efficient than electric resistance heating or fossil fuel combustion (DOE, 2020). The efficiency margin is the element that allows for a cost-effective electrification project. Electric vehicles also depend on overall efficiency to provide a financial benefit over internal combustion engines. So, a combination of highly efficiency equipment and reducing overall usage can drop customer energy consumption and costs, even when electricity is a more expensive fuel per Btu.

With this said, the upfront cost of highly efficient technologies is often higher. In addition, during critical peak winter heating, homes with air-source heat pumps need to switch to a back-up heating source, which in a fully electrified system would be expensive electric resistance heating. Overall energy consumption of a home is a function of the equipment efficiency and the building heating and cooling load. Reducing the building load by improving the building envelope will make heating and cooling that home more affordable regardless of fuel choice. Considering customers' costs holistically is important to ensuring that low-income customers can afford to keep their homes at a safe and comfortable temperature.

The final aspect of energy affordability is the rate a customer pays for energy. Many Minnesota utilities offer a lower cost electric heating rate; this gives homes with electric heat a lower rate during the winter months. One TAC member commented that utilities need to better understand their generation costs for adding non-peak electric loads so that they can sufficiently discount the price for desirable ("valley-filling") loads. Additionally, rates may drop if advocates of electrification are correct and added loads reduce overall electricity rates by spreading out fixed costs and improving system efficiency. The per kWh cost of energy is of particular importance to industrial facilities where energy costs are a considerable input cost and impact their business profitability.

System peak demand drives much of the cost for utilities. Reducing that peak can have significant value, which can in turn be passed on to customers. Peak reducing programmatic strategies include time-of-use rates and demand response programs. Incorporating some or all of these strategies might offer the lowest cost per kWh for customers. However, it's worth repeating the caution that complicated programs are a burden for customers, especially low-income customers. If a TOU rate comes with a steep penalty for using energy during peak hours, that inconvenience and complication could erase most of the benefit for a customer who does not want to (or is unable to) invest time in becoming a sophisticated energy user.

Finally, reducing energy burden in Minnesota is an important goal. Home efficiency and energy affordability are key components to making progress but increasing household income is an equally important part of the equation. Creating more economic opportunities for rural and low-income residents is crucial, albeit a more complex issue than this stakeholder engagement process addressed.

### *Set Goals that Matter and Track Progress*

Historically, goals for energy efficiency programs have focused on either dollars spent or kWh savings achieved, with cost-effectiveness tests creating boundaries for how to spend money. The conclusion from the subgroup discussions is that, in order to craft more equitable programs, that paradigm needs to evolve. Cost-effectiveness testing needs to be quantitatively different by including non-energy impacts and goals need to be qualitatively different and include metrics that track specific equity outcomes.

Goals suggested by TAC members and guest presenters include: creating jobs for under-resourced communities, improving indoor and outdoor air quality in environmental justice communities, reducing the overall energy costs for low-income residents who adopt electrification, keeping energy costs low for all customers (including those who do not adopt electrification), reducing carbon pollution to stem the worst impacts of climate change, and ensuring that participation in electrification programs spans economic, racial, and geographic demographics.

Goals (and the metrics to measure success in achieving them) are unlikely to be achieved if there is not a specific entity responsible and accountable for them. The ECO Act legislation assigned some of the goal setting and tracking associated with electrification to the Department of Commerce. Each utility program administrator also should develop goals for their territory that reflect their community's unique needs and opportunities. A utility like Xcel Energy that services large urban populations would take different steps to implement equitable programs than a utility serving rural Minnesota like Otter Tail Power. Individual utility programs should establish program and community outreach goals and program participation goals to drive participation from key demographics.

Contractor training and job creation is an area where goals can drive real improvement in the lives of Minnesotans. The technology subgroup identified shortages of skilled labor in the HVAC, electrical and refrigeration trades. Coordinated efforts to increase trades education and training in partnership with community groups could result in meaningful job creation and growth in household income. However, diversity in hiring and training does not happen without intentional goals and partnerships. Community and Indigenous organizations, as well as job training and economic development organizations, are essential partners to establish early in the process.

## *Be Intentional*

The definition of equity that was shared throughout this process includes both "elimination of barriers to full participation in the process, and access to the full benefits of the outcome." This definition emphasizes how both inclusion in the process and sharing benefits from the outcomes are essential. Intentional inclusion of those impacted by a decision is key to achieving equitable outcomes.

Because of the diversity of stakeholders, valuable issues and questions were raised. Stakeholders identified indoor air quality as a persistent problem in low-incomes households and shared information about higher-than-average air pollution risks for Black, Indigenous, and people of color in Minnesota. Stakeholders learned that the Leech Lake Band of Objiwe has five different utilities serving their community, and each utility has different rates, programs, rules, and relationships. Stakeholder attention was drawn to the fact that for a homeowner, replacing an HVAC system is a very expensive, once or twice in a lifetime event, and that if information and rebates are not available when the replacement is needed, that homeowner will not be engaged again for quite a while.

Additionally, there is value in asking technical professions to consider the equity implications of their planning. Technical experts benefit from listening to the perspectives of community members and understanding systemic inequalities. Utility program administrators and the State should consider what channels exist or could be developed to collect input from effected communities and then work to develop stronger relationships with those communities to facilitate incorporation of their perspectives in how problems are defined and the design of decision-making processes.

An example of how technical experts might question their assumptions came from the grid impacts subgroup. After identifying that the local levels of distribution infrastructure were the most likely to face interruption from new loads, like those from EVs, the group also recognized that that infrastructure tends to be upgraded only on failure. The result is that neighborhoods where residents can afford EVs are also likely to be the neighborhoods with upgraded infrastructure (and its associated resiliency). This does not need to mean that every piece of infrastructure needs to be upgraded at once—the cost implication could be equally unattractive—but it might mean that infrastructure upgrade plans should consider whether the current practice is creating risks in some neighborhoods compared to others (by leaving older equipment in place) and then address those through planned upgrades.

# Next Steps

This electrification stakeholder process, positioned as it was as a means rather than an end, naturally leads to next steps for research, policy implementation, stakeholder engagement, and program development.

## Recommendations for Additional Research

Each of the technical advisory committee subgroups was asked to identify needs for additional research. For the readers convenience, those research recommendations are compiled into a single list below.

### *Technology*

- Document and replicate lessons learned from the Minnesota ASHP Collaborative for other electrification technologies.
- Research coordination of utility incentive programs, promote the technology to consumers, and support the trade industry for electric technologies.
- Research electric heating rates, as a tool for reducing costs of electric heat. Research should include how many utilities offer electric home heating rates in Minnesota, the terms of those rates, and how many customers use those rates.
- Develop strategies and approaches that could make electrification accessible to under-resourced communities. The process should be inclusive of impacted communities and current practitioners of energy efficiency programs for those communities.
- Study electrification opportunities and barriers for under-resourced communities to support better planning and program design.
- Research the barriers to electrification in new home construction for home buyers, developers, and real estate agents.

### *Grid Impacts*

- Research how other states approach planning for a shift toward a winter peaking grid, including grid and energy production planning.
- Explore whether Integrated Resource Planning (IRP) or other utility planning processes could include inputs from natural gas planning when considering the impacts of fuel switching.
- Each utility should develop more responsive rate structures and consider amending pricing models to reflect changes in cost due to electrification loads.
- Conduct an analysis of specific adoption scenarios of electric technologies. This planning could help mitigate cost increases.
- Determine whether electrification-driven investments in T&D infrastructure would increase rates or whether the increased sales would offset those costs.
- Determine how natural gas distribution system costs would get shared among fewer users in a future scenario of high adoption of all-electric homes.
- Further analysis on carbon accounting methodology, specifically exploring the impact different methodologies (such as average versus marginal emissions analysis) make on the project and program level.
- Develop load-profiles of electric end-uses, specifically researching technologies without available load profile data.

### *Metrics*

- Determine the options and necessary changes in cost-effectiveness methodology to accommodate electrification (using guidance from the ECO Act legislation).
- Research how the current electric system may underserve some users and perpetuate inequality. Examples include energy burden and poverty which have locational qualities, and could be better understood in relationship to outages, energy cost, and infrastructure upgrades. Research could work to determine if there are relationships between poverty and negative energy impacts (i.e., more outages in poor neighborhoods).
- Based on the specific goals for electrification developed in statute, research and develop metrics to track progress towards achieving those goals. Metrics might include low-income program participation, geographic participation, jobs created and job training, and location of infrastructure investments.
- Research on non-energy impacts could be included in the State's guidance around cost-effectiveness testing. Categories that are easier to quantify, such as impacts on water and health, could be prioritized. This research could address impacts from both energy efficiency and electrification.
- Research how reductions in demand for delivered fuels would impact delivered fuel prices for customers. Consider impacts on different populations, including indigenous communities, rural communities, and low-income communities, as well as different economic sectors (specifically agriculture).

# Next Steps for Stakeholder Engagement

There are two categories of continuing stakeholder engagement: those planned from the outset as part of this process and those necessitated by the passage of the ECO Act legislation.

First, from the outset of this stakeholder process, the final report will be shared with stakeholders via an open meeting. This will give stakeholders a chance to provide feedback and for other interested parties to learn about the results of the work. In addition, a few stakeholders were commissioned to write white papers examining under-explored facets of electrification. The aim is to share presentations from each of those authors at the same time or in a dedicated event following the presentation of the final report.

In this same vein, it is worth noting that Minnesota has a highly collaborative regulatory culture, and several other stakeholder processes are underway with related subject matter to this stakeholder process they include:

- Decarbonizing Minnesota's Natural Gas
    - This non-regulatory collaboration is developing recommendations for the natural gas sector around affordability, equity, environment, economy, and system consideration. Recommendations are expected in 2021. https://e21initiative.org/natural-gas/
    - The Natural Gas Innovation Act passed signed by Governor Walz in 2021 establishes process for evaluating the of natural gas in supporting Minnesota's decarbonization and creating frameworks for utility innovation plans (dockets 21-565 and 21-566 (State of Minnesota, 2021).
- Utility program filings

- As utilities propose electrification measures as part of their energy efficiency and efficient fuel switching programs, their filings will be public and public comment will be accepted (as has been current practice).
- CIP cost-benefit process
  - Starting in 2021, Commerce will convene a group to work on preparing cost effectiveness methodology for the 2024-2026 triennial. The collaborative team working on this methodology could also address including non-energy impacts.
- Technical Reference Manual Advisory Committee
  - The Minnesota Department of Commerce convenes a group of stakeholders every few years to provide input on the development of the State's Technical Reference Manual, a document which proscribes energy savings calculation methodology for common energy efficiency measures.

The passage of the ECO Act legislation kicks off another bout of stakeholder engagement. The legislation directs the commissioner of the Department of Commerce to "work with stakeholders to develop technical guidelines that public utilities and consumer-owned utilities must use to: (1) determine whether deployment of a fuel-switching improvement meets the criteria established [elsewhere in the legislation] …and (2) calculate the amount of energy saved due to the deployment of a fuel-switching improvement. The guidelines must be issued by the commissioner by order no later than March 15, 2022 and must be updated as the commissioner determines is necessary (HF 164, 2021)."

For an improvement to qualify as efficient fuel switching per criteria established in the legislation, the improvement must meet the following criteria (relative to the fuel that is being displaced):

5) *Results in a net reduction in the amount of source energy consumed for a particular use, measured on a fuel-neutral basis[14];*
6) *Results in a net reduction of statewide greenhouse gas emissions… over the lifetime of the improvement….[Details of emission accounting discussed in previous section]*
7) *Is cost-effective, considering the costs and benefits from the perspective of the utility, participants, and society; and*
8) *Is installed and operated in a manner that improves the utility's system load factor* (HF 164, 2021).

Each of these four criteria were discussed during the stakeholder process, so the continued stakeholder engagement can build upon the work of these stakeholder groups. The legislation's implementation will benefit from the foundational work of this stakeholder engagement effort. But the work so far has not reached the point of clear black-and-white guidance around determining eligibility of measures. Providing explicit guidance is next task. A task that was not possible until legislative changes made the rules of implementation clear.

Stakeholders were intently engaged throughout this process, providing significant feedback, hours of volunteer engagement, research, and presentations, not to mention attending virtual meetings. Utilities

[14] "Source energy" in the legislation is defined as the "total amount of primary energy required to deliver energy services, adjusted for losses in generation, transmission, and distribution, and expressed on a fuel-neutral basis."

in Minnesota have commissioned additional research on electrification topics and to some degree have been preparing for the opportunity to implement programs enabled by the ECO Act for a few years now. All this preparation and engagement indicates the interest that stakeholders have in electrification. Electrification continues to be viewed as a unique opportunity to improve grid optimization and resiliency, reduce carbon emissions, and improve the equity of our energy system.

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# Appendix A: Literature and Policy Review

### Editor's Note

This literature and policy review was completed in December 2019, during the planning phase of this project with the goal of informing the development of the stakeholder engagement process. Some of the state policies have changed since that time, specifically this literature and policy review to do not address the passage the ECO Act in Minnesota.

### Working Definitions

Clarity of definitions can help align stakeholders. For this stakeholder process, these are the working definitions. In a 2003 report to the Commissioner, Department of Commerce staff defined fuel switching conservation.

> **Fuel Switching or Fuel Switching Conservation**: "A utility's promotion of a measure that will result in a greater increase in that utility's energy sales than if the measure had not been implemented." Or an alternative definition, "converting customers from one fuel to another when the costs of conversion are less than the costs to society of not converting." (Division of Energy Resources, 2003)
>
> **Electrification:** An instance of fuel switching that shifts the fuel use toward electricity regardless of the baseline fuel and regardless of societal benefit.
>
> **Beneficial Electrification:** A subset of electrification, which limits electrification to only those instances when electrification provides societal benefit. The Regulatory Assistance Project (RAP) has done the most work promoting Beneficial Electrification as a term of art. They define Beneficial Electrification as the subset of electrification that "must meet one or more of the following conditions, without adversely affecting the other two: 1. Saves consumers money over the long run; 2. Enables better grid management; and 3. Reduces negative environmental impacts" (David Farnsworth, 2018).

### Literature

## Background

The baseline for electrification through the late nineteenth century and the first part of the twentieth century was not natural gas or propane end uses, but rather, no electric service. Electrification in this context brought benefits like indoor lighting and refrigeration into homes. Electrification enabled a higher quality of life, including safety, education, and clean drinking water. The mission of extending electric service was core to the foundation of rural electric cooperatives, which began to electrify rural communities lacking electricity (Munson, 2005). For the 1.2 billion people in the world currently without access to electricity, electrification can still provide what are now considered basic elements for a higher quality of life. This un-electrified population mostly live in Africa and Asia, but some Americans lack access to electricity, notably Native Americans living on reservations in New Mexico, or Puerto Ricans living in the aftermath of a hurricane. (Angelou, et al., 2013) This kind of electrification is distinctly different than the kinds of electrification being considered in Minnesota today.

Instead, the focus on electrification today is the replacement of technologies fueled by fossil fuels – propane, fuel oil, natural gas, diesel fuel, and gasoline – with electric technologies. While electric utilities have never stopped seeking ways that electrification could provide cost-effective solutions for customers, this new wave of electrification is distinct because its motivation couples increasing sales with achieving a net reduction in carbon dioxide emissions. The concerns around mitigating impacts of climate change unite many policymakers, environmentalists, consumers, and electric utilities behind electrifying a broader cross-section of the economy.

The opportunity to reduce carbon emissions through electrification has been on the minds of certain advocates for years. In 2015, Keith Dennis of the National Rural Electric Cooperative Association wrote a paper in which he referred to a set of electrification technologies providing benefit to the public (Dennis, 2015). Dennis later co-wrote another paper with staff from the Regulatory Assistance Project (RAP), which led to more conversation on the topic (Keith Dennis, 2016). RAP has contributed significantly to the conversation around defining what Beneficial Electrification includes, most recently in a paper released in the summer of 2018 that outlines three key conditions for electrification to be beneficial and three additional papers focusing on end-use technologies (vehicles, space heating, and water heating) which are the primary targets of electrification (David Farnsworth, 2018).

Publications and interest in electrification swelled since late 2017, without signs of dropping in popularity. Major energy research and policy organizations have all released studies on electrification, including studies from the national labs, research institutes, regional energy efficiency organizations, and advocacy/trade associations.[1] In addition to research, politicians and regulators are turning toward beneficial electrification for its potential to reduce greenhouse gas emissions. Utilities have also moved quickly toward beneficial electrification. Most notably, the Tennessee Valley Authority announced in 2018 that it would no longer provide energy efficiency rebates and programs to customers, but instead would provide electrification programs (Crocker, 2018). Cooperative utilities continue to be strong supporters of electrification. One study found 16 cooperatives in the Midwest offered incentives for members to convert from a fossil fuel-powered appliance to an electric one (EESI, 2019).

# Economic and Policy Models

Models are useful tools to help envision the costs and impacts of policies, market drivers, and technological changes over a long period of time. Models are only as good as their underlying data and

[1] Reports in 2018 include studies from NREL, EPRI, AGA, NRDC, RMI, MEEA, and SWEEP. Citations for all the reports can be found in the bibliography.

their assumptions, so it's useful to compare a variety of models. Models seek to capture both economic and policy forces, determining how market behavior would change under specified scenarios.

The National Resource Defense Council (NRDC) modeled what it would take to achieve an 80% carbon dioxide emissions reduction using existing "off-the-shelf" technology. To reach that goal, they relied heavily on energy efficiency (2% annual savings), electric vehicles, and air source heat pumps for residential heating and water heating. They found that achieving their desired carbon reduction by 2050 would cost consumers 1% more per year, compounding. Electricity consumption would rise to about half of all final (end-use) energy, but the total amount of final energy consumed would decrease even while the economy grows, thanks largely to energy efficiency. (Vignesh Gowrishankar, 2017)

The Electric Power Research Institute (EPRI) released their economy-wide modeling of efficient electrification in the summer of 2018 and have continued since then to build state-specific models. Unlike the goal-driven model from NRDC, EPRI built their model based on consumer economic behavior. Technology adoption in their model is driven by consumer cost-effectiveness and operational characteristics. Fuel choice is derived from the outcome of the consumer decision-making model. Consumer choice is influenced in some of their modeling scenarios by the introduction of a carbon price in 2020. One scenario sets the price at $15/ton and the other at $50/ton of carbon dioxide. (EPRI, 2018)

The result of EPRI's modeling also shows electric consumption increases in both scenarios with a carbon price while the total final energy consumption of all fuels drops. In the EPRI study, natural gas use increases in all their scenarios. Natural gas use primarily fuels electricity production, industry, and home heating, including use as a backup fuel for some air source heat pumps. Although the goal of their study was not to hit a specific carbon reduction target, emissions drop by nearly 70% from 2015 levels by 2050 in their scenario with the highest carbon price. (EPRI, 2018)

The American Gas Association (AGA) released a paper in 2018 as well. Their analysis (conducted by ICF) modeled the impacts of "policy-driven" electrification. They looked at the impact of a hypothetical policy that halted all sales of residential fossil-fueled water heaters and furnaces in 2023. Their analysis found 1 to 1.5% of US GHG emissions could be reduced through electrification. Emissions from residential direct fuel consumption comprise 6% of total US GHG emissions. The upper edge of their emissions reduction forecast came from their scenario where renewable energy was the only new resource used to meet increased demand. In their scenario that used natural gas electricity generation to meet load growth, some regions, including the Midwest, were not electrified because emissions would have increased. (ICF, 2018)

The AGA found that a forced approach to electrification resulted in extremely high costs to consumers and a high relative cost per ton of carbon. The average increase in energy-related costs for affected households was between $750-$910. The cost of emission reductions was between $572-$806 per metric ton of $CO_2$. The AGA report states this cost of carbon reduction is many times more expensive than the carbon reduction from other methods like energy efficiency or carbon sequestration. (ICF, 2018) In comparison, the cost is dramatically higher than the carbon price used in EPRI's scenarios as a driver of economic change ($15 and $50). The policy approach chosen for the model drives this price disparity. The AGA models a hypothetical national policy that requires all consumers to convert to air source heat pumps with electric backup at the end of their existing equipment life regardless of cost. The EPRI model includes a policy-driven price of carbon, but EPRI models consumers making the most economical choice. The AGA scenario converts about 60% of fossil-fueled housing stock to electricity by 2035. EPRI's model shows less decline, even with a carbon price, in natural gas heating and a significant role for natural gas as a backup fuel for air source heat pump systems in cold climates. (EPRI, 2018)

In 2018, the National Renewable Energy Laboratory (NREL) released the second report in a multi-year series exploring the impacts of electrification. This report focused on the adoption of electrification technologies. They modeled three scenarios (reference, medium and high) of increasing technological advancement, policy support and consumer enthusiasm for electrification. In their assessment, transportation electrification experienced the greatest transformation toward electrification, with EV penetration ranging between 11% and 84%. Buildings and industry saw less transformational change, but certain end-uses in certain regions saw high adoption of electric technologies. (Trieu Mai, 2018)

In NREL's study, US consumption of electricity increases in every scenario between 1.2-1.9% annually, almost doubling by 2050 in the most aggressive scenario. And for some utilities in heating dominant states, home heating electrification drives a flip from a summer electricity demand peak to a winter peak. (Trieu Mai, 2018)

The Rocky Mountain Institute released a report titled, "The Economics of Electrifying Buildings" in 2018. Their analysis looked at the costs and emissions reductions associated with transitioning residential and commercial space and water heating away from fossil fuels. Their analysis used specific rate designs from five different US cities. They found that for some sectors heat pumps already cost less over their lifetime. This was not true for homes with existing natural gas appliances, but it was true for new construction. The other immediately cost-effective segment was customers using propane and fuel oil to heat their homes. In those cases, switching to electric heat pumps for space and water heating saved money. (Sherri Billimoria Leia Guccine, 2018) The conclusion about cost reductions for existing propane customers but not for natural gas customers has been supported by other research (Jenny Edwards, 2018).

# Grid Impacts

In the Midwest, the Great Plains Institute released the first two of a series of three stakeholder-developed reports developing a "Road Map to Decarbonization of the Midcontinent." The first report focused on the decarbonization of electricity, followed by a report about decarbonization of transportation and a forthcoming report on buildings. In this electricity report, they model for the Midcontinent Independent System Operator (MISO) grid a variety of generation mixes and policy conditions. They found that under business-as-usual conditions, none of the modeled future scenarios resulted in substantial decarbonization. (Midcontinent Power Sector Collaborative, 2018) This led to the conclusion from the stakeholder collective that policy and market drivers would be needed to achieve deep decarbonization of the MISO grid. In the transportation report, the stakeholders affirm the essential role of vehicle electrification in decarbonization, even when using the current generation mix. In their modeled scenarios, EV charging initially flattens the electricity demand profile, but without managed charging by 2050, EVs could create a nighttime spike. Additionally, the best benefits are available from a reduction of overall vehicle miles traveled (Midcontinent Transportation Electrification Collaborative, 2019).

Additional work has been completed in Minnesota focused on achieving economy-wide carbon reductions and integrating renewable energy into the Grid. The McKnight Foundation commissioned an economy-wide modeling study from Vibrant Clean Energy to describe the pathways and feasibility of achieving the state's 80% carbon reduction goal. The study found that to achieve that goal the electricity grid needs to decarbonize at 91% from 2005 levels; their report accounted for significant decarbonization from transportation and heating through electrification (Vibrant Clean Energy, 2018).

In regards to adding additional renewable energy to the electric grid, the Minnesota Solar Pathways Project and the Minnesota Department of Commerce released a report that shows wind and solar energy can meet 70% of Minnesota's electrical load by 2050, and the lowest cost means to achieve this result is to overbuild the capacity and curtail in times of surplus (Putnam & Perez, 2018). Likewise, the state's largest utility, Xcel Energy, released an Integrated Resource Plan for the years 2020-2034 which showed a reasonable and cost-effective path toward achieving 80% production of carbon-free electricity by 2030, and an aspirational plan of achieving 100% by 2050 (Upper Midwest Integrated Resource Plan 2020-2034, 2019).

Another area of research growth is grid integration of electrified end-uses. The Smart Electric Power Alliance released a report in which they issued a call for utility integration and planning for the inevitable growth of electric vehicles even in scenarios where the current business model is unclear or where utilities are not excepting to recover costs via a rate case – good planning and communication can enable the most desirable growth of electric vehicles, where the opposite could hinder its growth (Smart Electric Power Alliance, 2019). In discussing beneficial electrification of electric vehicles, RAP observed that electric vehicles could deliver grid benefits and that numerous vehicle-to-grid pilots are underway, and that time of use rates are successful at altering vehicle charging behavior (Farnsworth, Shipley, Sliger, & Lazar, 2019). Recent research reviewing California electric utility data in relationship to electric vehicle growth in the state has shown that EV load rarely led to required system upgrades and that time of use rates have been extremely effective at encouraging EV drivers to charge in desired time frames. Less than 0.2% of EV installations required a system upgrade. (Allison & Whited, 2018)

# Equity

As the transformational magnitude of electrification efforts becomes clear, a number of parties are calling out the opportunity to pursue equity at the same time as achieving carbon reductions. Considerations of equity come in the form of reducing energy burden, including historically unrepresented communities in decision-making processes, improving both indoor and outdoor air quality, and creating benefits for all ratepayers, even those who don't electrify.

Energy Burden, the percentage of household income spent on energy nationwide, is 3.3% according to a joint ACEEE report. For low-income households, the average energy burden reaches as high as 15%, which is exacerbated by poor housing stock and inefficient appliances. Negative health incomes have been correlated to energy burden resulting from issues like mold, poor indoor air quality, and dampness (Lauren Ross, 2018). In rural areas, energy burden is higher than the national average and rural residents spend a median of 4.4% of household income on energy. This rural aspect of energy burden focuses some of the opportunity for equity on rural cooperatives, a point which is made in an EESI report discussing cooperatives' role in promoting equitable beneficial electrification for rural electric cooperatives (EESI, 2019). The EESI report highlights on-bill low-interest financing as an enabling service that coops could offer to support beneficial electrification for their members.

Including environmental justice considerations in the decision-making process gives voice and influence to groups that have been underrepresented or under-served in past energy-related decision making. These groups include low-income communities, renters, ethnic and racial minority populations, Native American tribes, and people who live near sources of high environmental pollution. A report by the Greenlining Institute focuses on what California can do to equitably pursue building electrification. One piece of specific value for Minnesota is their five-step framework for pursuing equitable decision making: 1) Assess the Communities' Needs, 2) Establish Community-Led Decision-Making, 3) Develop Metrics and a Plan for Tracking, 4) Ensure Funding and Program Leveraging, 5) Improve Outcomes (Carmelita Miller, 2019).

In addition to the reduction of carbon dioxide emissions, environmental justice advocates highlight the benefits of reductions in point-source criteria air pollutants. Burning fossil fuels in cars and home appliances emits nitrous oxide and particulate matter, which, after prolonged exposure, can cause asthmas and health concerns. Replacing the combustion of fossil fuels with electric equipment in homes and on neighborhood roads eliminates those sources of emissions (Carmelita Miller, 2019). This problem may be exacerbated in under-resourced communities because of the higher likelihood of living near a freeway or high-traffic artery, and owning older, poorly functioning appliances.

Efficiency programs have been successful because benefits for all ratepayers can be quantified, and those benefits justify ratepayer support incentives to encourage technology adoption. The same dynamic might be true of beneficial electrification. In a recent report, the ratepayer advocacy group Citizens Utility Board identified potential benefits from electric vehicles, including lower wholesale market energy prices as a result of optimized charging, capacity cost reductions, and lower rates for customers. Without control of the time and manner of charging, high EV adoption could have inverse effects on the electrical grid, so these benefits are dependent on the development of policies like charging rates for electric vehicles and enabling policy to allow utilities to support the market (Citizens Utility Board, 2019).

# Cost-Effectiveness Testing

Building on the topic of quantifying benefits for all ratepayers, work has recently been done to develop a methodology for evaluating the benefits and costs of electrification in a ratepayer funded program context. In 2019, EPRI completed a review of current cost-effectiveness methodologies included in the California Standard Practice Manual, exploring how well they captured the benefits and costs associated with electrification. Their conclusion was that current methodologies were appropriate to use for evaluating electrification's cost-effectiveness, but they also recommended a new test they call the Total Value Test. The Total Value Test amends the Societal Cost Test, which is the existing test that best accounts for non-energy benefits and environmental externalities. The Total Value Test differs by using a higher discount rate (the utility's internal rate of return) which places more value in short term returns and the test allows for the inclusion of the broadest set of non-energy benefits, including those that are difficult to quantify monetarily. (EPRI, 2019)

**Minnesota Policy Review**

# Decarbonization Policy Goals

The Next Generation Energy Act, passed in 2007 by the Minnesota Legislature and signed by Governor Tim Pawlenty, sets clear goals for greenhouse gas emissions reductions, decreased consumption of fossil fuels, and increased energy conservation.

The legislation in Minnesota Statutes §216H.02 subdivision 1 reads, "It is the goal of the state to reduce statewide greenhouse gas emissions across all sectors producing those emissions to a level at least 15 percent below 2005 levels by 2015, to a level at least 30 percent below 2005 levels by 2025, and to a level at least 80 percent below 2005 levels by 2050." Another section of the legislation, §216C.05 Subdivision 2, specifically names the energy policy goal of the state to be a reduction in per capita fossil fuel use by 15 percent by 2015 and 25% by 2025. This will be achieved "through increased reliance on energy efficiency and renewable energy alternatives."

These goals for Minnesota encompass all energy-using sectors, and the Minnesota Pollution Control Agency reports every other year on the annual emissions data for each economic sector in Minnesota. In their latest report published in January 2017, with emissions data through the end of 2014, the electric generation sector's emissions decreased by 17% from a 2005 baseline. The electric generation sector was the only sector on track to meet the emissions reduction target of 15% by 2015. Transportation declined 7%, agriculture declined 2%, and all other sectors increased their emissions from a 2005 baseline. Industrial and commercial emissions both climbed by 20%, residential emissions increased by 19%, and emissions from waste increased 8%. (Claflin, January 2017)

# Efficiency Statutes: §216B.2401 and §216B.241

Minnesota's energy efficiency programs are governed from two parts of the statutes. The first is §216B.2401. In this brief statute, the legislature articulates a goal of "cost-effective energy savings are preferred over all other energy resources." The statute continues, "energy savings should be procured systematically and aggressively in order to reduce utility costs for businesses and residents, improve the competitiveness and profitability of businesses, create more energy-related jobs, reduce the economic burden of fuel imports, and reduce pollution and emissions that cause climate change." The language of §216B.2401 casts a broad scope as to how a 1.5% reduction in energy consumption might be achieved, including non-program related market changes, behavioral programs, and "other efforts."

The second statute, §216B.241, governs many details regarding the creation and implementation of the Conservation Improvement Program. In this more detailed statute, the legislature defines terms, grants authority, sets goals, and creates programs to structure the implementation of energy efficiency in the state of Minnesota.

In §216B.241, commonly called the CIP statute, definitions tighten around what qualifies as an Energy Conservation Improvement. The statute allows for either energy conservation or energy efficiency to be counted as an Energy Conservation Improvement. In the statute, "Energy conservation means demand-side management of energy supplies resulting in a net reduction in energy use. Load management that reduces overall energy use is energy conservation" (§216B.241, subdivision 1(d)). Energy efficiency means measures or programs that are "designed to produce either an absolute decrease in consumption of electric energy or natural gas or a decrease in consumption of electric energy or natural gas on a per unit of production basis without a reduction in the quality or level of service provided to the energy consumer" (§216B.241, subdivision 1(f)).

The terms are distinct in that energy conservation must result in a net reduction of energy use, which is non-fuel specific. Efficiency, on the other hand, is defined in relation to output. Efficiency could result in a net increase in the consumption of electricity or natural gas if output also rose such that productivity increased. Under this definition, efficiency could look like more widgets produced at a decreased kBtu/widget, or perhaps, more vehicle miles traveled (VMT) at a lower kBtu/VMT, or more air heated and cooled at a lower kBtu/CFM.

Neither definition discusses whether energy savings should be measured at the site or at the source. Measuring at the source would include fuel burned at the power plant to generate electricity and is more comprehensive when comparing electricity consumption with direct fossil fuel consumption. Measuring at the site is simpler and sufficient when only analyzing a single type of fuel.

Neither §216B.2401 or §216B.241 specify that the reduction of energy use needs to be achieved by maintaining the use of the original fuel through to the new efficient technology. In fact, §216B.241 subdivision 1(e) explicitly allows for waste heat recovery to be used for electricity or thermal energy. This distinction around waste heat might be interpreted as openness to conservation or efficiency occurring within a measure that switches fuel, assuming either the equipment becomes more productive, or the total fuel use decreases.

The legislature granted the Commissioner of the Department of Commerce authority to interpret and enforce §216B.241, which allows the Department leniency to determine how aspects of CIP are implemented (subdivisions 1c(a), 2(a), and 2(b)). While the topic of fuel switching is not clearly delineated, the statute is clear that activities, including electrification or fuel switching, only belong in CIP if they can achieve a net reduction of energy consumption, or an increase in efficiency. Recent Department staff analysis affirms this delineation: cost savings or emissions reductions alone don't meet the threshold for energy efficiency or energy conservation (Grant, 2018). The issue of whether source efficiency meets the statutory definition of energy efficiency or energy conservation remains to be interpreted by the Department or clarified in the statute.

# Fuel Switching Determinations

The Department made a determination on the question of whether to allow fuel switching within the CIP program in the past. In a 2005 Order (Docket No. G008/CIP-00-864.07), the Department ruled that "targeted fuel-switching projects are not allowed in the Conservation Improvement Program." The process to arrive at this ruling lasted three years and included written commentary, meetings with interested parties, and research by Department staff (Garvey, 2005).

The origin of the order was a proposed filing amendment from Reliant Energy Minnegasco to allow them to provide a large rebate through CIP for power-vented natural gas water heaters to make them more competitive compared to electric water heaters. Natural gas water heaters were losing market share in new home construction due to an inadvertent change to the ventilation requirements in Minnesota's Energy Code. Minnegasco based their justification of the proposal on a "total net energy comparison" to account for the Btu content of the fuel "consumed from the point of extraction to the point of use" (Reliant Energy Minnesgasco, 2002).

This proposal elicited a response from electric utilities who claimed it amounted to fuel switching, which had previously been discouraged in CIP. Otter Tail Power was among the utilities that filed a response. In their response, they stated this project was equivalent to "Otter Tail proposing to replace all gas furnaces with renewable electric geothermal heat pumps, along with a customer rebate of approximately 50% of the additional cost of installation" (Otter Tail Power Company, 2002).

The 2005 Order excludes targeted fuel-switching projects and states that "a Btu comparison is not necessary," and describes how utilities can measure the impact of measures that have an ancillary impact on a fuel not served by the utility (Garvey, 2005). The Order does not provide much justification for its decisions and does not address specifically whether energy savings in source Btus would count as energy conservation. Offering a little more context, the Department staff analysis provided to the Deputy Commissioner recommends that "Utility rebates should be based on the energy savings of the fuel the utility sells" (Division of Energy Resources, 2003).

Department staff also specified that an exception to a prohibition on fuel switching ought to be made to allow utilities to provide more robust programs to low-income customers (Division of Energy Resources, 2003). Nine years later, in 2012, the Department made the allowance for fuel switching within low-income programs provided the fuel being replaced was either a delivered fuel like propane or heating oil, or was natural gas served by a CIP-exempt small natural gas utility (Division of Energy Resources, 2012). It did so on the grounds of equity concerns for ratepayers who paid into CIP programs with their electric bill but had little opportunity to benefit and on the grounds of benefits to ratepayers and society (Kushler, 2016).

Those two determinations, the 2005 decision prohibiting fuel switching and the 2012 guidance allowing fuel switching for low-income programs, provide the existing regulatory interpretation and precedence for this topic in Minnesota.

# Proposed Legislation

During the 2019 legislative session, new legislation was introduced in the House (HF 1833) and the Senate (1915) that would change Minnesota's approach to electrification and fuel switching. The House version of the bill contained the Walz administration proposals. While the two versions were different, and no compromise legislation was passed, the two bills contained nearly identical language around expanding the current Conservation Improvement Program to become an Energy Conservation and Optimization program. The optimization component allowed for a portion of a utility's energy conservation goal (the specific % varied) to be achieved through efficient fuel-switching improvements (called "efficient electrification or conversion improvement" in the Senate bill). In both bills, some entity (the commissioner in the house file and consumer-owned utility working group in the Senate bill) would be responsible for determining whether a propped measure met the following four criteria. Below is the house version of these criteria:

> *(1) results in a net reduction in the cost and amount of source energy consumed for a particular use, measured on a fuel-neutral basis;*
>
> *(2) results in a net reduction of statewide greenhouse gas emissions, as defined in section 216H.01, subdivision 2, over the lifetime of the improvement. For an efficient fuel-switching improvement installed by an electric utility, the reduction in emissions must be measured based on the hourly emissions profile of the utility or the utility's wholesale provider. Where applicable, the hourly emissions profile used must be the most recent resource plan accepted by the commission under section 216B.2422;*
>
> *(3) is cost-effective from a societal perspective, considering the costs associated with both the fuel used in the past and the fuel used in the future; and*
>
> *(4) is installed and operated in a manner that does not unduly increase the utility's system peak demand or require significant new investment in utility infrastructure.* (HF 1833, p. Subd. 8)

This is not Minnesota law and future legislatures that take up these bills may make significant changes. In reviewing the two versions of the legislation, there does appear to be some consensus between the two houses about what criteria to use to evaluate fuel-switching or electrification.

### Peer Practice and Policy Review

In this section, we look beyond Minnesota for insight on how other states have legislated and regulated their utilities regarding fuel switching and beneficial electrification. Other states can specifically help Minnesota answer questions about whether and how fuel switching could be allowed into efficiency programs, and whether and how states are incorporating beneficial electrification into their policies governing utilities.

# Fuel Switching

## Illinois

Since 2013, the Illinois statutory definition of energy efficiency has stated that energy efficiency reduces the total Btus of electricity and natural gas while performing the same output. In 2016, the passage of the Future Energy Jobs Act, which significantly expanded the state's energy efficiency efforts, further tweaked the definition of energy efficiency to cover any fuel. The state's definition now reads: "'Energy efficiency' means measures that reduce the amount of electricity or natural gas consumed to achieve a given end-use. … 'Energy efficiency' also includes measures that **reduce the total Btus of electricity, and natural gas, and other fuels** needed to meet the end-use or uses" (20 ILCS 3855/1-10, emphasis added) (Public Act 099-0906, SB 2814 Enrolled, 2016).

In 2014, the Illinois Commerce Commission ruled that combined heat and power (CHP) measures would be appropriate within utility energy efficiency portfolios (2014, pp. 90-92). It is from this ruling on CHP measures that other fuel switching measures were developed in Illinois (Shah, 2018).

In practice, only three technology applications for fuel switching are included in the Illinois Technical Reference Manual (TRM). They are geothermal heat pumps, ductless heat pumps, and CHP. The TRM measures include a method to calculate energy savings from these technologies by apportioning the credit for saving energy between both the gas and electric utilities that participate in funding the project. As an example, for residential geothermal heat pumps, the natural gas utility claims the therms replaced (by removing a gas furnace) minus the therm equivalent of a new baseline geothermal heat pump measured at the source (energy consumed at the power plant). The electric utility claims the incremental efficiency gained by shifting a customer from a lower efficiency heat pump to a high-efficiency heat pump. (Illinois Energy Efficiency Stakeholder Advisory Group, 2017, pp. 105-121) Or put more simply, the gas utility gets the credit for fuel switching away from their fuel to a baseline unit, and the electric utility gets credit for incremental efficiency above a baseline unit.

## Maine

Maine provides flexibility for residents and businesses to change fuel within the context of the programs offered by Efficiency Maine, their independent state energy efficiency implementer. There is quite a bit of fuel oil use in Maine, and it has been considered a priority to replace that fuel with more efficient and cleaner fuel (Energy Office, 2015). A single statewide efficiency program must serve all the residents of Maine regardless of which utility provides the fuel. This simplifies the equation by avoiding the complication of a utility trying to sell more of their product through the energy efficiency program. And because Maine is part of the Northeast's Regional Greenhouse Gas Initiative (RGGI), there is additional funding available to help cover the costs of decarbonization (Efficiency Maine Trust, 2016).

For example, if a customer currently burning fuel oil to heat their home wants to change to a high-efficiency air source heat pump, Efficiency Maine will provide them a rebate. Part of that rebate comes from energy efficiency funds from the state. The amount of the energy efficiency rebate is calculated by comparing the new high-efficiency air source heat pump with a standard efficiency baseline option. RGGI funds are used to support the transition by providing funding to incentivize the switch from burning fuel oil to buying the baseline air source heat pump. RGGI funds are particularly flexible because, unlike efficiency funding, RGGI can still provide incentives when projects are not cost-effective (Uchtmann, 2018).

In the spring of 2019, the Maine Legislature enacted L.D. 1465, a bill that added a definition of Beneficial Electrification to the Efficiency Maine Trust Act. According to the statue, "'Beneficial electrification' means electrification of a technology that results in reduction in the use of a fossil fuel, including electrification of a technology that would otherwise require energy from a fossil fuel, and that provides a benefit to a utility, a ratepayer or the environment, without causing harm to utilities, ratepayers or the environment, by improving the efficiency of the electricity grid or reducing consumer costs or emissions, including carbon emissions." (L.D. 1464, 2019) This legislation calls for additional research and to develop plans to address barriers to access to electrification for disadvantaged communities, including low-income and rural populations (Efficiency Maine Trust, 2019).

## *California*

Fuel switching is allowed in California and has historically been governed by the three-prong test. The three-prong test permits fuel-substitution in programs where 1) source Btu consumption does not increase, 2) cost-effectiveness tests[2] pass, and 3) there aren't adverse effects to the environment (CPUC, 2013). However, as of April 2018, stakeholders in California have successfully petitioned the CPUC to review the test and provide additional clarity and simplicity in meeting the test's conditions (Seel, 2018).

The petitioners, which include the Sierra Club, the National Resources Defense Council, and the California Energy Efficiency Council, claim that despite its appearance of providing clear guidance, the three-prong test effectively functions as a "roadblock to incentives using utility customer funds for fuel substitution in buildings – even when there are significant climate benefits and energy savings available – and [it] is opaque in terms of the 'burden of proof' required to pass the Test" (Merrian Borgeson, 2017). In addition to a review of the test in light of current California climate and energy policy, the petitioners specifically ask for clarity around the substitution of regulated fuels versus substitution between regulated and unregulated fuels (like propane and wood), and they ask for examples of how programs or projects could be assessed using cost-benefit methodologies (pp. 2-3).

In August of 2019, the California Public Utility Commission issued a decision revising the three-prong test to better accommodate fuel switching. The decision removes the cost-effectiveness test from the approach, so the test has been renamed the "The Fuel Substitution Test" (CPUC, 2019). This new order requires that fuel substitution deliver resource value and environmental benefits by meeting two requirements: 1) the measure must not increase total source energy consumption when compared to a baseline of the original fuel, and 2) the measure must not adversely impact the environment compared to a baseline of the original fuel and must specifically not increase carbon-dioxide-equivalent emissions.

[2] The program/measure/project must have a Total Resource Cost (TRC) test and the Program Administrator Cost (PAC) Test benefit-cost ratio of 1.0 or greater.

The test only applies to building retrofit applications, not to new construction. Utility program administrators may not include fuel substitution measures in their portfolio. Measure incentives are funded by the ratepayers for the fuel which gains a user, but savings requirements are reduced for the abandoned fuel provider. This ruling only covers switching away from natural gas, not unregulated fuels like propane or wood.

# Beneficial Electrification

Some states have made strides toward addressing and incorporating beneficial electrification into the fold of their utility regulation. Other states are at a stage, like Minnesota, of gathering stakeholder perspectives and developing a shared understanding of the opportunities and challenges.

## *Vermont*

In 2015, Vermont enacted a new renewable energy standard (RES) focused on "Energy Transformation." The standard established three tiers of requirements that the state's distribution utilities would need to meet. Tier one reinforces the state's existing renewable energy standard and tier two carves out a portion of that production that needs to be distributed generation (State of Vermont, 2018). Tier three is the part that is particularly relevant to this paper.

Tier three established a requirement for utilities to spend 2% of sales on energy transformation projects in 2017, rising to 12% of sales by 2032. These projects would "reduce customer fossil fuel consumption and save money," and examples of projects include "weatherization, biomass heat, [and] cold-climate heat-pumps" (Ellis, 2015). Transportation demand management strategies and electric vehicle charging can also meet this standard's requirements (Buckley, 2015). To evaluate which projects deserve to be implemented, "Energy Transformation Projects will be screened for life cycle cost-effectiveness under the societal cost test and against an alternative compliance payment of $0.06/kWh, adjusted for inflation" (Buckley, 2015).

Vermont is particularly well-positioned to benefit from electrification. According to the Energy Information Administration, the state has no fossil fuel reserves, no in-state fossil fuel electric generation, and has one of the lowest carbon emission intensities of any state. A majority (about three-fifths) of households heat using petroleum-based fuels (fuel oil, propane). Only three counties in the state have natural gas distribution. (EIA, 2018) The state has a goal to eliminate nearly all petroleum consumption, including heating and transportation (Vermont Department of Public Service, 2016). These factors combine to position residential heating as a key target for reducing carbon emissions through electrification and other approaches, including biomass heating and home weatherization.

The Rocky Mountain Institute (RMI) recently completed a report for Green Mountain Power (GMP), Vermont's largest utility, assessing how GMP could advance their vision of being an energy transformation company. In that report, RMI discusses the tier three energy transformation goals. They identify the best opportunities for GMP as "fuel switching away from natural gas and petroleum to electricity for space heating, water heating, and vehicles. Satisfying these requirements with fuel switching will require tens of thousands of GMP customers to adopt heat pumps, heat-pump water heaters, and/or electric vehicles over the next 15 years" (Rachel Gold, 2017). Some of the programs that Green Mountain Power currently implement that contribute to meeting these goals include no-money-down financing of cold-climate heat pumps and water heaters, build-out of electric vehicle charging stations, support for vehicle charging in homes, and grid-interactive control for water heaters and ductless heat pumps.

Green Mountain Power recently filed its 2018 plan for meeting the tier three RES requirements. In that plan, they shared observations from the first 10 months of implementing programs to meet the goal for 2017. They found that customers were deterred from switching to cold climate heat pumps because fossil fuel prices continued to remain low during 2017. They report that while most customers make decisions based on economic factors, there is a population of customers that make the decision based on non-economic factors, like clean energy objectives, personal comfort, and convenience. They report that approximately 16.5% of cold climate heat pumps installed in their service territory were purchased through the GMP program. They also report that tier three goals have created "a non-collaborative, competitive dynamic" in the relationship between the distribution utility (Green Mountain Power) and the state's energy efficiency utility (Efficiency Vermont) because of competing for thermal savings targets (Green Mountain Power, 2017).

Despite still being early into implementation, the experience of Vermont utilities and regulators could help inform best practices for Minnesota and other states looking to pursue energy transformation.

## *Massachusetts*

Massachusetts passed a new clean energy law that was signed by the Governor on August 9, 2018. This law includes a change to expand the scope of what is permissible within the state's energy efficiency programs. The previous statute read that the electric and natural gas utilities would create a plan that would include "efficiency and load management programs." Now that description is appended to read: "efficiency and load management programs including energy storage and other active demand management technologies, and strategic electrification, such as measures that are designed to result in cost-effective reductions in greenhouse gas emissions through the use of expanded electricity consumption while minimizing ratepayer costs." (M.G.L ch.25 §21) (H.4857)

In addition to adding this flexibility for the type of resources that can be included in the energy efficiency plans, the new law also relaxed cost-effectiveness standards. "It does this by broadening the definition of benefits that are counted and applying cost-effectiveness screening at the sector level, instead of the level of individual programs, as has been the practice in the past," explained the Acadia Center, a non-profit organization working on climate change policy in the Northeast. (Mark LeBel, 2018)

One interesting dynamic is that this legislation passed without expansion to the state's natural gas pipeline capacity. According to the Boston Globe, some business groups, with the backing of utilities Eversource and National Grid, sought that legislation, but "natural gas is the third rail of Massachusetts politics, and House leaders steered clear. The Senate meanwhile approved legislation that would make it harder, not easier, for utilities to expand gas pipelines" (Chesto, 2018). In the end, the legislation only contained a provision to reduce methane leaks in the existing pipeline (Mark LeBel, 2018).

## *New York*

New York has been a leader in innovation in the utility sector in the past few years. New York State's effort Reforming the Energy Vision (REV) has been the source of new ideas, approaches, and pilots trying to tackle the evolving grid, growth of renewable energy, and changing customer expectations. REV takes an active role in designing new initiatives and partnerships to meet the state's energy goals, which by 2030 are a 40% reduction in GHG emissions, 50% renewable electricity, and a 600 Trillian Btu increase in energy efficiency. (New York State, 2018)

Recently the New York State Energy Research and Development Authority (NYSERDA) issued a report called "New Efficiency: New York" in which they laid out key means to achieving the goal of increased energy efficiency. NYSERDA's efficiency goal will be measured in fuel neutral site energy efficiency. This opens the door for fuel switching or beneficial electrification to help New York meet its goals.

A section of the report addresses this dynamic, "Given the magnitude of New York's GHG emission reductions goals (40% by 2030 and 80% by 2050), the Biennial Report to the 2015 State Energy Plan named electrification of thermal end uses in buildings as a core opportunity for New York State. As a key component of New York's continued climate leadership, the Biennial Report called for the State to 'seek to develop electrification policies and opportunities as steps for early action.'" (NYSERDA, 2018)

Renewable Heating and Cooling have been a focus of REV. Thermal energy consumption in the residential and commercial sectors accounts for 37% of the state's net energy consumption. Geothermal heat pumps, cold climate heat pumps, and solar hot water systems are the primary focus for renewable heating and cooling efforts. The state is considering sources for incentives to support these technologies, including thermal-renewable energy credits, ratepayer funds, and REV Clean Energy Fund. (NYSERDA, 2017)

One interesting development from New York comes in the form of a recent rate case for Central Hudson Gas & Electric Corporation. The Public Service Commission approved the utility's joint proposal with stakeholders to create an Earning Adjustment Mechanism to reward the utility for Environmentally Beneficial Electrification (Wyman, 2018). The utility may develop programs for measures like geothermal and air source heat pumps, as well as electric vehicles. Programs will be evaluated based on carbon dioxide savings and reported on in a Carbon Reduction Implementation Plan. (Joint Proposal, 2018)

## *Other State and Regional Activities*

Clearly, the Northeastern states are active in electrification. In addition to New York, Massachusetts, Vermont, and Maine, Connecticut and Rhode Island have also been active. In Connecticut, electrification of transportation and heating end-uses was included as part of a recently developed Comprehensive Energy Strategy (State of Connecticut, 2018). The public utility commission in Rhode Island has embarked on an ambitious visioning and reformation process called the Power Sector Transformation.

One of the deliverables is a white paper on Beneficial Electrification Principles and Recommendations opening the possibility of utility proposals to advance beneficial electrification (RIPUC, 2017).

The Government of British Columbia passed enabling legislation in late 2017, allowing the state-owned subsidiary, BC Hydro, to pursue electrification projects with its customers (Government of British Columbia, 2017). BC Hydro started small pilot efforts for both residential and commercial customers to develop the business case and gauge customer interest (Travers, 2018).

Beyond the state-led activity, Northeast Energy Efficiency Partnerships (NEEP) has led some research and stakeholder conversations on electrification in the region. NEEP is the Regional Energy Organization (REO) for the Northeast. Recently, NEEP published a regional assessment of strategic electrification, which broadly outlined the barriers and opportunities to using electrification as a strategy in meeting Northeastern states' carbon reduction goals (NEEP, 2017). In a follow-up action plan, published in 2018, NEEP identifies near-term action to aggressively move electrification forward in the Northeast (NEEP, 2018). Within this action plan, they identify nine priority strategies with action steps for each and research needs. These strategies include establishing goals, policies, and programs for strategic electrification; building public-private partnerships; protecting consumers; supporting market development; encouraging local leadership; prioritizing low-income consumers; advancing strategic electrification with thermal efficiency; public and consumer outreach; and addressing grid preparedness.

Other REOs across the country are also engaging in this topic, especially as it pertains to residential end-uses. The Midwest Energy Efficiency Alliance (MEEA) released a study on heat pump performance in the Midwest in 2018 (Ian Blanding, 2018), and the Southwest Energy Efficiency Project (SWEEP) released a paper on the benefits of heat pumps for homes in the Southwest (Neil Kolwey, 2018). Both studies show heat pumps have stronger benefits with the utility fuel mix has lower carbon content.

Municipal utilities have had the flexibility to move quickly toward implementing electrification programs. Generally, municipal utilities that have strategic direction from a board of directors or city leadership rather than regulators. This allows them to implement new programs without the same regulatory process as investor-owned utilities. As one example, Sacramento Municipal Utility District (SMUD) has started offering incentives to customers to promote residential electrification, specifically heat pump adoption. These incentives can provide as much at $10,250 to help a customer convert to electric heat pumps. Different building stock and equipment baselines receive different levels of incentives. Scott Blunk, a Strategic Business Planner at SMUD, says that while these incentives are large, they are not generous. SMUD has been able to justify all the incentives by showing a positive net present value from the investments for the organization. (Blunk, 2018)

Cooperative utilities have similar flexibility and have developed programs. Two such utilities include Roanoke Electric Cooperative, which serves a poor region of North Carolina with a declining population. They offered on-bill financing and received funding from the USDA to help their member-owners implement projects. OPALCO, a cooperative utility serving islands in Washington State, also provided on-bill financing with a bias toward funding beneficial electrification projects including ductless heat pumps, heat pump water heaters, and EV chargers. They offer loans with no down payment and 2% interest. (Cooperative Learning Network, 2019)

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