Accelerating Deployment of Rural Beneficial Electrification for Residential Heating and Cooling

Recommendations for identifying leverage points and pathways for deployment of air source heat pumps across Great River Energy service territory.

Humphrey School Capstone Report

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All errors are our own.

Glossary of Terms

Air Source Heat Pump (ASHP) - A technology using refrigeration instead of combustion or electric resistance to heat and cool homes and water. ASHPs gather heat from the air and transfer it into a home, out of a home, or into a hot water tank. ASPHs can be three times more efficient than other sources of heating, but heating performance drops as the temperature gets colder.

Beneficial Electrification - ""Beneficial electrification" means the substitution of electricity for a fossil fuel, provided that the substitution meets at least one of the following conditions without adversely affecting either of the other two, as determined by the commission: (i) saves a consumer money over the long run compared with continued use of the fossil fuel; (ii) enables an electric utility to better manage the electric utility's electric grid network; or (iii) reduces negative environmental impacts of fuel use, including but not limited to statewide greenhouse gas emissions." Minnesota State Statute 216B.1691 Subd. 2b. (10) (i)-(iii).

These upgrades can range from the replacement of a gas car to an electric vehicle, to the adoption of an ASHP.

Carbon Free Standard (CFS) - A MN law enacted in 2023 that requires utilities to generate 100% of their electricity from Carbon Free Sources by 2040. Utilities must Support Energy Efficiency for Energy Assistance, and Carbon free is a measurement in reduction of greenhouse gas reduction.

Distributed Energy Resources (DER) - small, modular, energy generation and storage technologies that are connected to the distribution grid of a utility, and that provide electrical capacity, energy, load management, or other grid support functions. DER are located near the end user. This is in contrast with large central generating plants, which are remote and connected by long transmission lines. DER include, but are not limited to, solar and wind generating systems, home battery energy storage systems, EV car chargers, and demand response resources like controlled loads of air conditioners or water heaters used as thermal energy storage systems.

Heating, Ventilation, and Air Conditioning (HVAC) - The heating and cooling systems of a home which may include forced air furnaces, hot water boilers, radiators, AC units, ducting, and other associated equipment.

Low to Moderate Income (LMI) - Household status that may qualify for Energy Assistance or other energy efficiency incentives.

Executive Summary

This project was conducted as a project for the University of Minnesota Humphrey School of Public Affairs capstone course for the Master Degree program. Great River Energy (GRE), a generation and transmission (G & T) electric cooperative, requested our team to research and develop pathways for accelerating beneficial electrification for residential customers in their largely rural territory. Residential customers are directly served by twenty-seven separate distribution cooperatives that are the member-owners of GRE.

The goal of this project is to develop a playbook of best practices for the adoption of beneficial electrification that can be used to accelerate the reduction of greenhouse gas emissions to contribute to Minnesota's 100% clean electricity standard. To reach this goal, our team gathered information from GRE, conducted an online literature review including case studies from different programs across the nation, and conducted qualitative research interviews with multiple stakeholders involved in beneficial electrification. Although we refer to beneficial electrification as a whole, this report focuses on the transition to air source heat pump (ASHP) technology for residential heating and cooling within the home.

GRE requested that the format of our findings and recommendations follow the Department of Energy's (DOE) Liftoff Report outline. The DOE Liftoff Report style includes an overview of the current state of the target issue, a discussion of potential pathways for success, and an analysis of wider barriers and solutions of the issue. DOE intends the Liftoff Report to be a living document designed to be reviewed and changed with experience and changes in the environment. In this paper, we present our research and analysis, and then move into the Beneficial Electrification Liftoff Report. In this way, the Liftoff Report can be accessed as a standalone report for future use.

Based on our research, we recommend and discuss three pathways for GRE to take to accelerate the adoption of beneficial electrification. We recommend all of the pathways be organized around an initial Launch Point. The Launch Point is an overarching recommendation from which the three Pathways can be implemented to accelerate rural beneficial electrification for rural residential heating and cooling.

Launch Point: All of the recommendations in these pathways require multiple steps for convincing homeowners to make a change from what they know and to adopt newer technology. To succeed, it is important that GRE organizes its resources to begin with influencers. We recommend that GRE identify and begin implementing the pathways with the following stakeholders who can act as influencers on their own and across other peer groups:

- LMI households that are eligible for weatherization assistance when switching to an ASHP.
- Households that rely on delivered fuel (fuel oil or propane). These have a significant monetary savings potential when switching to an ASHP.
- Contractors that seek out education and training on the transition and have high potential to become local champions for beneficial electrification for homeowners.
- Member owners that are leading the charge on many different factors from rebates, bill assistance and working with local contractors who are willing to work with GRE to adopt techniques designed to accelerate the change to electrification.

Pathway 1: Expanding communication campaigns using GRE as a knowledge hub:

Take a more active role in developing a direct and simple education campaign for GRE's member owner utilities and their customers that addresses the "why" and the "how" to transition a home to beneficial electrical heating/cooling, and appliances. GRE can position itself alongside its member utilities and contractors to directly influence homeowners.

Pathway 2: Connecting consumers, contractors, and other local organizations that are active in the transition with GRE member owners:

The role of the contractors and local agencies became very prevalent throughout the interview process. Contractors are the foremost technical expertise in rural areas who are available to help in the assistance of electrification of households. Local agencies provide education and support to consumers when considering the switch. They are the trusted source for rural communities that can provide GRE with a perfect avenue to reach its customers across the state.

Pathway 3: Addressing funding and finance challenges using GRE's scale and connections:

GRE's scale and connections will be a benefit as it can apply for and manage incentive funds from large public and private institutions. There is opportunity in this

pathway to stack the myriad funds and incentives becoming available and direct that support to energy justice and LMI communities while providing Beneficial Electrification. There are also opportunities to support Contractors and customers through financing options.

After discussing the pathways to acceleration of ASHP technology, we discuss challenges to commercialization that will continue to hamper widespread ASHP adoption and list solutions that GRE and their partners can implement to mitigate these challenges. Challenges and suggested solutions explored are:

- Workforce Development
- Availability of Products that Meet Consumer Needs
- High Upfront Costs
- Education on New Technologies
- Unknown Incentives from the ECO Act and the Inflation Reduction Act
- Equitable Distribution so LMI Households Participate in the Transition to Carbon Free Electricity.

Introduction & Objectives

Background

Our client, Great River Energy (GRE), is an electric generation and transmission (G&T) Utility cooperative owned by its 27 rural electric (distribution) cooperatives. Our client has opportunities to develop strategies to deploy distributed energy electrification resources in rural areas. There are many different areas within which GRE can work. Examples include such areas as electric vehicle charging, air source heat pumps, electric water heaters, smart home technology, etc. Each of these sectors have specific challenges and opportunities in the form of funding, technology, policy, regulatory compliance, grid resilience, reliability, affordability, and industry structure. GRE is responding to federal and state policy incentives and goals, including funding opportunities included in the Federal Inflation Reduction Act, the Minnesota Carbon Free by 2040 law, and the Energy Conservation and Optimization Act of 2021, the ECO Act.

Purpose

With the increase of funding and opportunities for Beneficial Electrification projects, there is a need to decide what areas of Beneficial Electrification to focus on, and what opportunities will work best for individual GRE customers across the state. The focus area in this report is the rural residential electrification of heating and cooling, more specifically with Air Source Heat Pump (ASHP) and related technology.

Criteria and Research Questions

The determination on the outcome that is desired from this report, is that the adoption of beneficial electrification reduces greenhouse gas emissions within GREs service territory and working towards meeting Minnesota's 2040 carbon free electric standard. To achieve this goal, the following research questions have been laid out for exploration in this report:

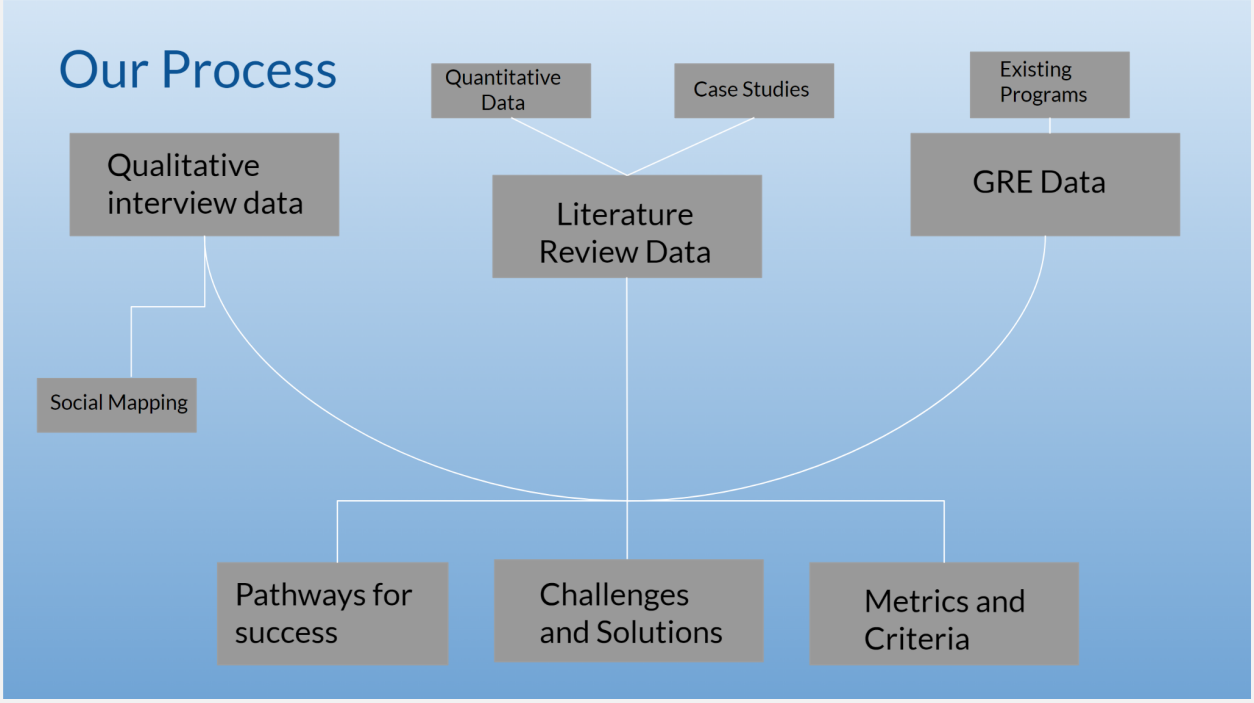
1. How can we expedite the process of increasing rural electrical residential heating and cooling loads?
2. What are the perspectives of the major players that play a role in this electrification?
3. What are their strategies, and how do they think about rural electrification?
4. What are the interaction or leverage points that would be actionable for GRE to apply to future Beneficial Electrification in these areas?

Structure

To present this information, GRE requested that the report take a similar shape to the Department of Energy's Liftoff reports. The DOE views these reports as having "a critical role in accelerating the commercialization of clean energy technologies and enabling the nation's broader industrial strategy – creating high quality American jobs, strengthening domestic supply chains and global competitiveness, and facilitating an equitable energy transition." (U.S. Department of Energy, n.d.) These are similar to goals that GRE has, and GRE would utilize this report as a way to best accelerate the transition of beneficial electrification for heating and cooling in rural areas in their service territory. To stay in line with the DOE liftoff report style, the recommendations for this report are labeled as pathways that GRE could explore to start this acceleration.

Methodology

To meet the defined criteria and objectives, and to provide the deliverables of the Liftoff report structure, we researched many different areas. To gather general information and quantitative data, case studies were studied and are provided throughout this report in sections for which they provide context, mostly in the pathways sections. Quantitative data was collected to provide context to the current state of rural electrification and GRE data, including existing programs, to provide context on what is already taking place at GRE to see how our pathways can build on this work. To understand the current landscape in Minnesota, interviews were conducted across a variety of stakeholders. These interviews provide excellent qualitative data, which is referenced below how it was utilized in the section regarding the social mapping of interviews. The graphic below connects all of the steps and methods of this research.



Research Results

Description and Analysis of Research

The data in this report comes primarily from three sources, GRE produced information, articles and published research on websites and online journals, and interviews with stakeholders. The information received directly from the GRE Member Services department included GRE's Integrated Resource Plan (IRP), the 2023 GRE Annual Report, a 2022 Member Consumer Survey and a 2023 Residential Saturation Survey Report completed by third parties on behalf of GRE, as well as various Minnesota ASHP Collaborative documents. We also surveyed information and its configuration on the GRE website and on the 27 member owner websites.

We conducted a literature search of both journal articles and web sources for technical information on ASHP technology and case studies. We prioritized case studies from cold climates in the U.S. Studies conducted in Maine, Vermont, Massachusetts, and New York (Nguyen, 2021, Rewiring America, 2023, Northeast Energy Efficiency Partnerships, 2017) provided valuable findings that informed our development of the recommended pathways and confirmed our findings on challenges that still exist. We include summaries of case studies after each pathway to provide real-world examples of successful implementations of pathway recommendations.

Concurrently, we conducted qualitative research in the form of interviews and observations with identified stakeholders of Great River Energy. Over the course of two months, we conducted nine semi-structured, confidential interviews with representatives from cooperative utilities (2), equipment manufacturers (2), Minnesota-based nonprofit organizations (3), a university researcher in the field (1), and an HVAC

contracting company. Interviews lasted a minimum of thirty minutes. Most were recorded from which transcripts were produced. If not recorded, written notes were produced. After introducing the topic of our research, questions asked informants about the general state of the transition to beneficial electrification in the residential market from their perspective, what drivers were promoting electrification and what barriers there are to beneficial electrification (See Appendix A) Two observations were made of webinars conducted by Minnesota-based nonprofits.

We used the Grounded theory method to thematically code the data from interviews and observations. Several themes clearly emerged across the stakeholders interviewed.

Theme: *Homeowners need early and easy access to information about available technology and the benefits of electrifying their homes, so they are ready when the need or opportunity arises.*

Discussion: There are early adopters interested in electrifying their homes for environmental benefits and for long-term savings. However, we heard many concerns about the most homeowners who don't seek out or know about newer technologies and who will make a decision only when they have to do so. They need to make a quick decision and are not ready to trust or consider new technology. One informant likened the decision process to a puzzle, and asked, "What's that missing puzzle piece to help people be able to access some of these services or funding in an easier way?" The person added that this question is true across all consumers, "…and a lot of that spans both urban and rural areas."

Theme: *Homeowners are in different stages of readiness for upgrading or changing their heating/cooling, and appliances to new technology.*

Discussion: We heard from a number of stakeholders working on beneficial electrification that the homeowner audience is diverse and complex requiring specific and targeted messaging tailored to a variety of needs. From those planning to build, to manufactured homes, to mobile homes, to an aging housing stock, there is no "one size fits all" utilities need to take a nimble approach to communication.

Theme: *Homeowners have concerns about reliability, comfort, and cost effectiveness. They look to local service providers such as electricians, HVAC and general contractors as trusted advisors when making decisions.*

Discussion: The importance of trusted advisors for making decisions about installing BE technology was a theme that was repeated in all interviews. There is strong agreement that homeowners primarily look to local or regional contractors for advice and assistance. Local/regional contractors, in turn, use the distribution utilities in their regions for information, and are influenced by educational opportunities provided by BE advocacy groups, manufacturers, and partnerships such as ASHPC.

Theme: *Initial cost of equipment and installation is a bottleneck to change that is mitigated but not completely alleviated by rebates and tax incentives.*

Discussion: While rebates and tax incentives are viewed as necessary and deep drivers of adoption, many felt that the initial costs, especially when factoring in preparation or necessary related upgrade costs, are still high enough to present a barrier to many. State rebates from the IRA legislation are not yet available but will significantly increase existing rebates. This will be another opportunity to further incentivize the adoption of beneficial electrification in households. However, many interviewees expressed the need for additional low interest financing options for LMI households.

Theme: *Contractors are seen as the primary source of information and advice.*

Discussion: Local contractors, including electricians, HVAC contractors, plumbers, and general contractors are the primary source of information about home technology, and act as trusted advisors to homeowners making decisions. HVAC contractors that have frequent contact with the utilities and stay up to date on the technology and rebates available sell more ASHPs. The contractor relationship with homeowners can have a negative impact when contractors are not knowledgeable, have little experience with the technology or know little about rebates and tax incentives.

Theme: *There is inconsistent contractor knowledge, buy in, and service in many areas of the state. Contractors have difficulty finding trained technicians for installation and maintenance.*

Discussion: Supply chain problems are starting to ease, but there are still many areas of the rural GRE territory with few options for trained contractors who sell and install ASHPs. The Air Source Heat Pump Collaborative's website currently has only sixteen contractors listed on their preferred contractor network. Contractors have much sparser territories which drives up their costs and limits their reach. We heard in several interviews that the pipeline for trained installation workforce is a major concern. One interviewee said, "... this is what keeps me up at night."

Theme: *Information is complex, confusing, and scattered.*

Discussion: There were many concerns expressed about the complexity of messaging around ASHPs, particularly the rebate and tax incentives, load management programs, performance, and availability. Installers spoke of their own constant need to keep up with technical changes, refrigerants, and installation techniques, much less assisting customers with rebate forms. This quote from an interview sums up the issue, "What's that missing puzzle piece to help people be able to access some of these services or funding in an easier way, and a lot of that spans both urban and rural areas."

Analysis of the Ecosystem

Our literature and website review reinforced all of the themes developed from our interviews. What has emerged is a portrait of a complex system. As several of our informants emphasized, the energy transition is just that, a transition which is a complicated and sometimes contradictory progression toward low or no carbon systems. As one person we interviewed put it, "... transition is not a flip of the switch." There are many interconnected and layered elements, people, and organizations, working toward the ultimate goal of low carbon building systems.

From our literature search and interviews, a very complicated picture emerged. To make sense of the players and their roles, we decided to map the elements and interconnections. We quickly realized we were working with a complex system and our approach needed to be based upon systems modeling and thinking. We used an online mapping software, KUMU (https://kumu.io/), to create the system map shown below.

Rural residential beneficial electrification adoption, as illustrated below, is a complex system.

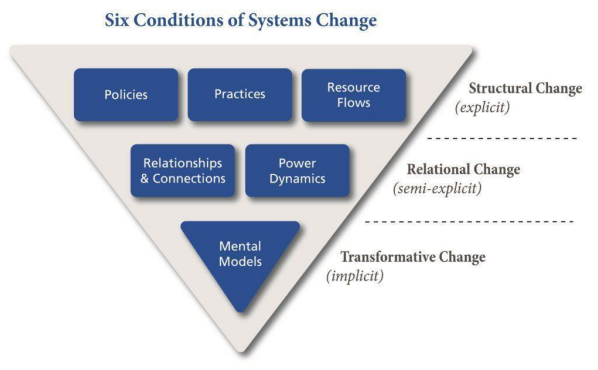
Systems map of Rural Residential Adoption of Beneficial Electrification

The elements of the map (circles) are organized around the central issue of homeowner adoption of beneficial electrification, in this case focused on ASHP technology adoption. The satellite elements contain individual recurring themes influencing the

homeowner distilled from our research. These themes have been simplified into one word or short phrase summaries of the most prominent themes. We initially created the map without an organizing principle in order to create a visual representation of the many influences found repeatedly in our research.

After creating the map, we looked for an overlying system model that would highlight leverage points within the system. We decided to use an organizational change model that one of us has used in a previous project. It is based on the model of systems change developed by Kania, Kramer and Senge in their 2018 paper, The Water of Systems Change. This theory of systems change defines six conditions that typically hold a social or environmental system in place. They organize the conditions into three interconnected tiers ranging from the explicit to the semi-explicit to the implicit. This is visualized as an inverted triangle, known as the triangle of systems change:

Following this model, we organized the basic systems map of beneficial electrification transition into three color coded levels:



Structural elements (Policies, Practices, Resource Flows) are labeled in blue and include such elements as policies affecting rebates and tax incentives, research, costs, and service.

Relational elements (Relationships and Connections, Power Dynamics) are labeled green and include relationships around homeowner trusted advisors, direct and indirect influencers, and partner organizations.

Transformational elements, which we label in the systems map as **Mental Models**. Mental Models, the most implicit level, can be defined as a person's mental representation of the way some aspects of the world work (Holtrop et al, 2021). They are the most challenging to clarify and also the most transformational for long-term change in a system (Kania et al, 2018). Seen in yellow on our systems map, some of the mental models we have identified include the ideas that moving to new technology is financially out of reach ("I'll never be able to afford this change"), it is too complex ("It too much for me to figure out, so I will stick to what is easy"), and there is too much risk in change ("I don't want to be cold all the time", or, "I don't know if it's reliable.")

The size of the interconnections between elements in the map can be changed in the software to indicate greater or lesser importance, and positive or negative feedback. Given the time limitations of our research we were hesitant to make too many definitive statements about which elements were more or less important. A few elements were so ubiquitous in our qualitative research and readings that we felt comfortable showing stronger connections between them. They include the connection between the homeowner and the cost of change, rebates/tax incentives. Cost of change sits in the structural (explicit level) but is a strong lever to change the mental model that adopting

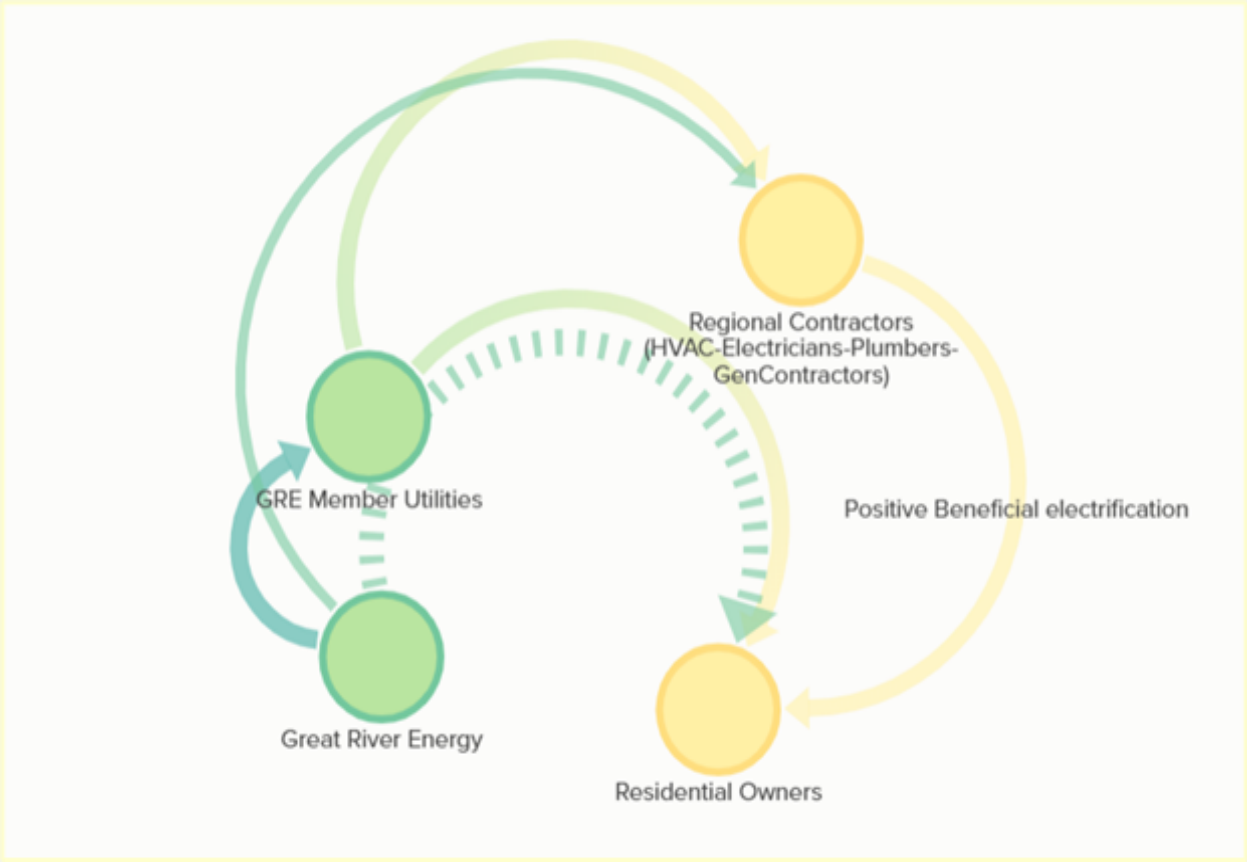
a new heating/cooling technology is financially prohibitive. Another strong connection is between trusted advisors and the homeowner. Trusted advisors were largely defined as local/regional professionals such as HVAC contractors, electricians, and plumbers, but can also include the regional utilities. These elements sit on the relational (semi-explicit) level and have a direct and strong influence on homeowner mental models of trust in the newer technology.

Kania et al., emphasize that working across all three levels of the model is necessary for sustainable change, but that long-term changes occur when people change their hidden bias or mental models. (Kania et al., 2018). Mental models can be seen "... as cognitive shortcuts created by people living through and experiencing years of expectations in a given culture (Kania, 2019)." Mental models are held with varying degrees of specificity and stability (Holtrop et al., 2021) and can be changed over time (Kania, 2019). This model of systems change has informed the development of our pathways to success in the Liftoff Report.

Research Conclusion for Lift Off Report

GRE is poised to play a significant role in the acceleration of ASHP technology in its territory. It is participating in state and regional partnerships with a variety of organizations dedicated to growing this market positioning it as a knowledge interpreter and hub for information. Research conducted through Clearspring Energy Advisors LLC (2023) on behalf of GRE shows that there is ample opportunity for growth in its territory. Clearspring surveyed 20,831 residential customers. Over 80% of the homes were built before 2004. Over fifty-seven percent reported using electric, propane, fuel oil or wood to heat their homes, and 76% reported using electric resistance central or window unit air conditioners. These are all fuels that show significant savings when switched to ASHPs (Schoenbauer, 2017). To leverage the most transformative change in the current state of beneficial electrification, our research has led us to focus on the relationships between Great River Energy, its twenty-seven utility partner members, local/regional contractors, and residential owners. As John Kania explains, "Experience has shown that many efforts to change systems emanating from philanthropy, government and the mainstream nonprofit sector focus the lion's share of activity on change at the first level – the structural level of systems change. Yet successful systems change must place significant attention on the second and third levels of change – the cultural levels."

The pathways we recommend in the following Liftoff report are based on Great River Energy focusing more resources on the relational and transformational (mental models) levels in the Six Conditions of Systems Change model. Practically speaking, that would look like such changes as adding more direct messaging to and influence on residential homeowners and their most direct and trusted source, the regional/local contractor. As a cooperative of cooperatives, GRE must work with its members. We recommend that GRE can be both more direct in its incentive and marketing efforts and include its 27 member utilities, as well as other partnerships.


Regional Contractors
(HVAC-Electricians-Plumbers-
GenContractors)
GRE Member Utilities
Positive Beneficial electrification
Great River Energy
Residential Owners

LIFTOFF REPORT

Current State of Beneficial Electrification with ASHPs

ASHP background

Heat pumps are a familiar technology which, using the same equipment as air conditioners or refrigerators, can both heat and cool a residence as well as provide domestic hot water. This report focused on Air Source Heat Pumps, ASHPs, that have cost advantages over other types, like ground source heat pumps which require equipment to be installed underground. Improvements in the cold weather performance of ASHPs have made them less expensive to operate than other heating sources in most cases (Wilson, 2024). They can be integrated into existing homes or new construction. They can be installed in ducted HVAC systems, radiant heating systems, or in one room at a time using a "mini-split" ASHP.

ASHPs put out relatively less heat as temperatures get cold (McPherson et al, 2020.) This creates challenges and fears about their ability to provide a home's heating needs. First, a week of -25F temperatures may require supplemental heat to keep the home warm enough. Second, as it gets colder, a "switch-over temperature" occurs where the electricity to run an ASHP may become more expensive than the fuel for a gas furnace. Below that temperature, homes may save money on fuel costs by switching to a different heat source. A solution to these concerns often includes having a dual fuel ASHP system with two integrated heating sources so homes have the option to use the ASHP or natural gas, propane, fuel oil, or electric resistance baseboards.

Energy Efficiency, Emissions Reduction, Bill Impacts potential for ASHPs

This report focuses on ASHPs to provide beneficial electrification. It is important to note energy efficiency upgrades will improve the performance and benefits of an ASHP. Throughout the literature and interviews, it was apparent that implementing other energy efficiency upgrades or weatherization is critical for the success of ASHPs to contribute to reductions in energy bills and greenhouse gas emissions.

CEE's report on the electrification of all 1-4 unit homes compared the utility bill change for households that were weatherized versus not. Rural areas of Minnesota, particularly in the north and northwest, have the greatest proportion of electrically heated homes, and thus the largest potential for ASHP savings. (Jones, et al., 2023).

The Weatherization Assistance Program (WAP) provides funding for weatherization upgrades to LMI households at little or no cost. Households that don't qualify for WAP don't have access to funding for upgrading electric panels, replacing installation, and sealing windows. The state is working to create programs to provide these rebates,

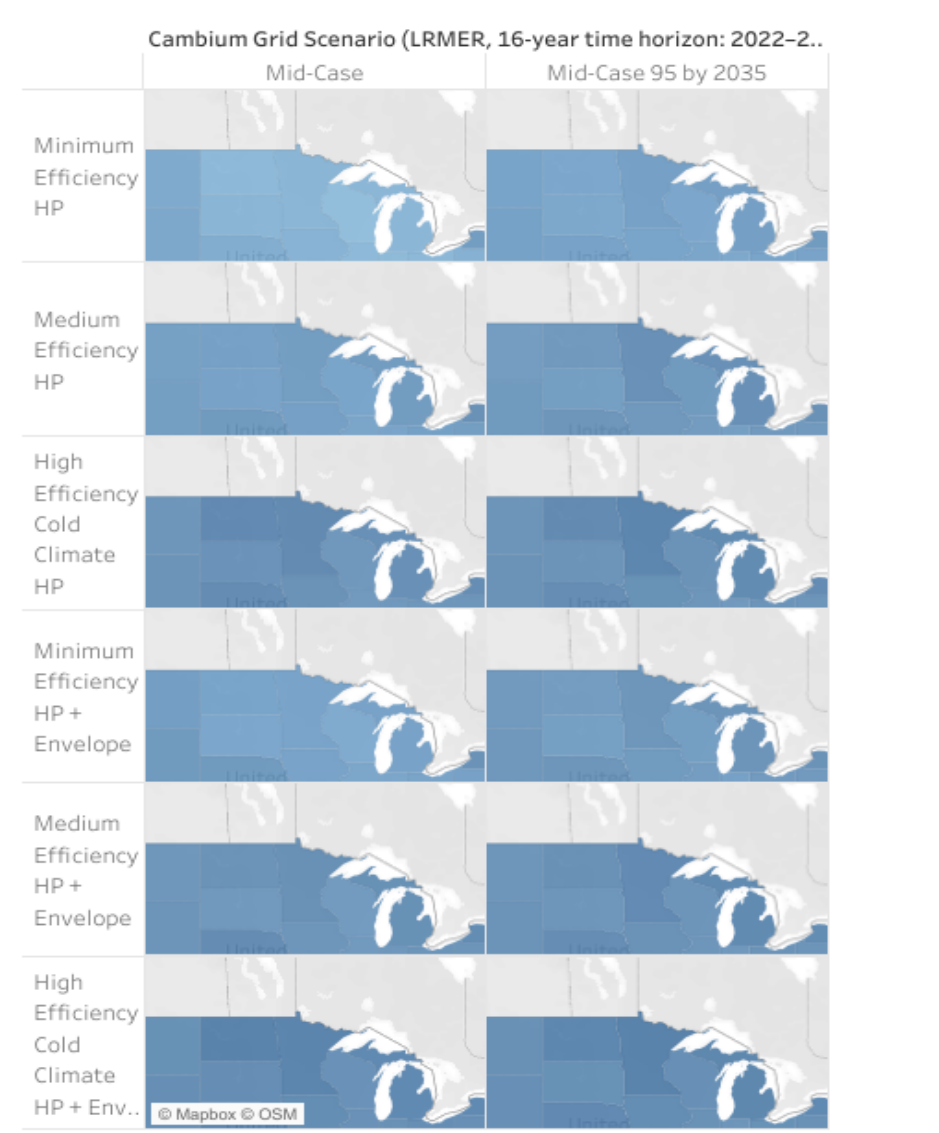
which, when stacked with Federal incentives, can offset the cost of installing upgrades as well as ASHPs. These may be available by the end of 2024.

Home energy use accounts for around 20% of greenhouse gas emissions, with most of that being from natural gas for heating and other appliances. More specifically in Minnesota, over the past 15 years, greenhouse gas emissions have increased by 14% with a peak in 2018 (Lebel et al., 2022). Air source heat pumps can be a way to lower these emissions from households. UC Davis looked at the emissions data changes for a household switching from a furnace to a heat pump over a few different variables. This change projected a 38-53% reduction in carbon dioxide, 53-67% 20-year global warming potential reduction and a 44-60% 100-year global warming production reduction. (University of California, Davis, n.d.) As the price of renewable energy continues to fall and the advancement of technology, the emissions reduction from electrification, will continue to increase.

A recent report from NREL *Heat pumps for all? Distributions of the costs and benefits of residential air-source heat pumps in the United States* used the large dataset of the End-Use Load Profile to create a report detailing the deployment of ASHPs capacity to impact two of the three elements defining beneficial electrification (Wilson et al., 2024). This report and data are very useful for understanding how ASHP deployment will impact customer's bills, energy use, and greenhouse gas emissions. This report is not analyzing how to manage grids.

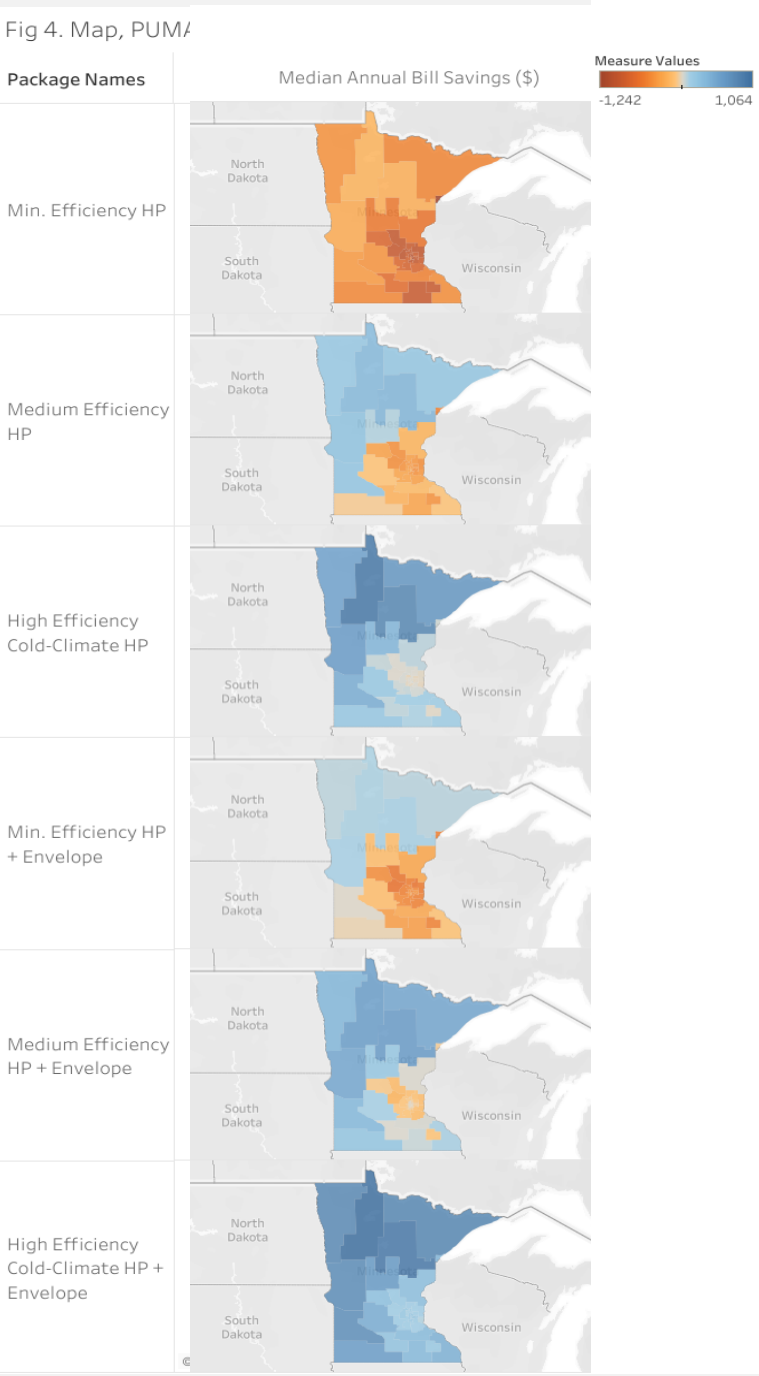
- **Saving a consumer money**
- **Enabling an electric utility to better manage the grid**
- **Reducing greenhouse gas emissions**

This series of tables from NREL's research article "Heat Pumps for all?" explains the potential for ASHPs to impact bills and carbon emissions across a series of scenarios. (Wilson et al., 2024)



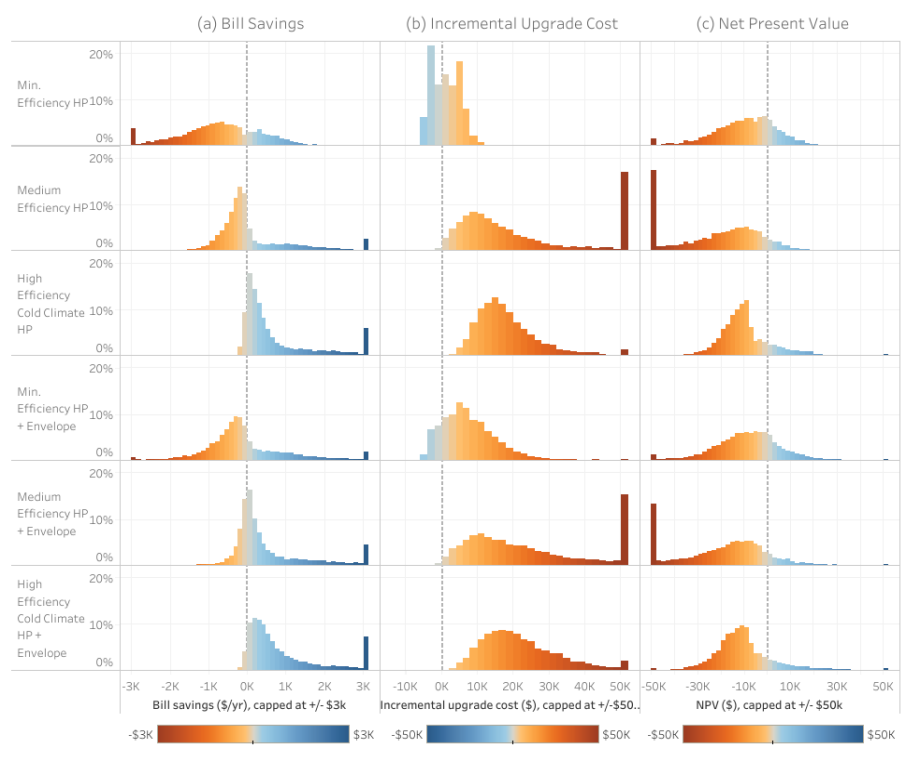
GHG ton CO2e year Minnesota

When an ASHP replaces other HVAC technology, average GHG savings in, both on-site emissions and indirect CO2 emissions from electricity generation, are positive. This scenario represents 95% renewable electricity sources by 2035 (Wilson et al., 2024).

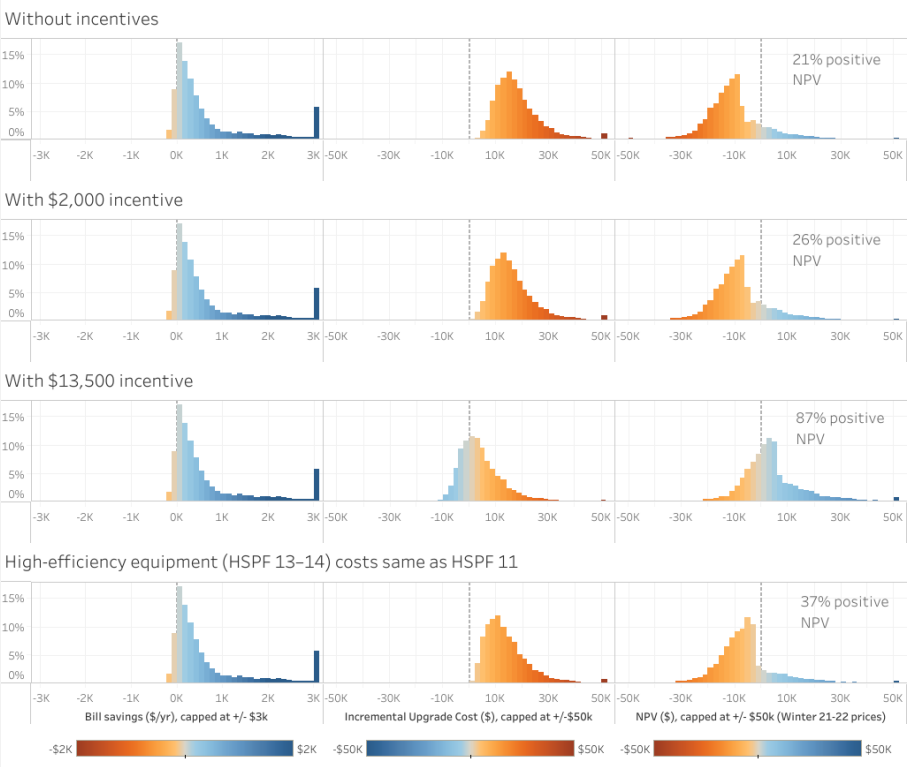


Minnesota Bill Savings with ASHPs by PUMA

Energy bills were calculated using energy prices from winter 2021 to 2022. Note that these results include homes without existing air conditioning that use electricity for air conditioning after receiving a heat pump . The combination of High Efficiency Cold-Climate ASHP plus Building Envelope upgrades provided the most bill savings, and it produced bill savings in every census tract. Some of the highest savings coincides with GRE member owner territory (Wilson et al., 2024).



Bill savings, incremental upgrade cost, and NPV Minnesota (Wilson et al., 2024)



Sensitivity to incentives Minnesota Negative bill savings indicate that it costs more to operate the ASHP than the reference scenario equipment. Negative incremental upgrade cost

denotes that the cost of the ASHP is less expensive than new reference case equipment (e.g., a new furnace and air conditioner). Negative unsubsidized Net Present Value, NPV, means the upgrade scenario would likely cost more than an alternative if financed without any subsidies. The histograms in the bottom chart show the sensitivity of the median NPV to different levels of subsidies to offset the system costs in Minnesota. Without subsidies 20% of ASHP systems would have a positive NPV. To reach 87% positive NPV would require a subsidy of $13,500. The report, (Wilson et al., 2024), and the End-Use Load Profile data from NREL, can be used to analyze much more specific regions and system types than this example of the entire state.

Policy

Minnesota

Minnesota has many policies to assist with beneficial electrification. Minnesota, along with other cold weather states, has a cold weather rule, which prevents utilities from disconnecting households during the cold weather months of October to April if they enter into a payment plan with their utility. Minnesota also is a part of the weatherization assistance program, run through the Department of Commerce, to assist LMI households with energy efficiency upgrades.

During the 2023 legislative session, Minnesota passed an energy bill that requires Utilities to generate 100% of electricity from carbon free sources by 2040, the CFS. Heating and cooling will have a significant role in the clean energy transition nationally Minnesota (Climate Action Framework | Our Minnesota Climate, n.d.). This is the first clean energy standard using reductions in a greenhouse gas as a measurement. To help with this, Minnesota has been developing a rebate program for home energy efficiency upgrades, like heat pumps (Home Energy Rebates, n.d.). The Department of Commerce has not announced dates or details of the program. It is dependent on Federal announcements and funding.

The ECO Act updated the Conservation Improvement Program (CIP) in 2021. This update allowed for an increase in electric usage and load for the purpose of Beneficial Electrification. ECO Act progress is based on energy saved, not reductions in GHG. The State of MN's guide for calculating energy and demand savings is the Technical Reference Manual, TRM. Also, it is now possible to use energy assistance funds for LMI households for energy efficiency upgrades. These include pre-weatherization costs for electric panel upgrades. Another significant change is that utilities are now allowed to provide On Bill Repayment for efficiency improvements.

The MN Clean Energy Finance Authority, MNCIFA, is Minnesota's green bank. It is dedicated to funding clean energy projects for LMI and Disadvantaged Communities. In April 2024, the MN Department of Commerce announced that MNCIFA will receive a subaward from the EPA through the Coalition for Green Capital, a national nonprofit green bank, The Coalition for Green Capital announced on April 4, 2024, that it was awarded $5 billion from the EPA's Greenhouse Gas Reduction Fund.

Federal

The primary existing Federal incentives for ASHP adoption are tax credits for purchase of energy efficient products (Air Source Heat Pumps Tax Credit | ENERGY STAR, n.d.). A source of funds for new support of ASHP deployment are Federal programs from the DOE, EPA, USDA, and IRS (*Inflation Reduction Act*, 2023), which are providing money through loans and grants for energy efficiency upgrades. However, this process is incomplete for many recently approved programs. The amount of money in these programs is large, but the time it takes for processing means that many actionable steps will need to wait.

Pathways for Great River Energy to increase the deployment of Air Source Heat Pumps

This section includes the recommendations for pathways to accelerate the uptake of ASHP technology by homeowners in GRE territory. The first recommendation, the launch point, is a starting point that is applicable to the three subsequent pathways. We have laid out three pathways for GRE to successfully increase beneficial electrification of rural residential heating and cooling. These pathways are laid out with a discussion of the need, how GRE is currently positioned to use the pathway, and major action points, like program and initiative creation. Each pathway is then followed by case studies that directly relate to the actions within each pathway. These case studies are placed specifically to provide context about existing programs or actions that are occurring inside Minnesota and within the nation.

Launch Point:

All of the pathways in this section provide methods that GRE can start to accelerate electrification in its rural service territory. All of the recommendations in these pathways require multiple steps for convincing homeowners to make a change from what they know and to adopt newer technology. To succeed, it is important that GRE organizes its resources to begin with influencers. We recommend that GRE identify and begin implementing the pathways with the following stakeholders who can act as influencers in their own and across peer groups:

- Identify and target Low and Medium Income (LMI) households or households that are eligible for weatherization assistance when switching to an Air Source Heat Pump (ASHP). These households have almost all of the cost covered for these upgrades and also can have the most to benefit from the upgrades due to high energy burden.
- Identify and target households that rely on a type of delivered fuel to switch to an ASHP or dual fuel system. Due to the cost of delivered fuel these households

would see large economic benefits from the switch. Even though they may have questions about reliability, this could be a great opportunity to find local champions that can influence others.

- Early certification of contractors that have sought out and have good education and training on the transition. These would make great first partners that can help to show what education and training is needed and be a model for GRE programs and testimony.
- Work with member owners that are leading the charge on many different factors from rebates, bill assistance and working with local contractors who are willing to work with GRE to adopt techniques designed to accelerate the change to electrification.

Once these groups are identified, mapping them into a GIS tool will help GRE and member owners identify areas with the largest initial impact and leverage for market transformation of ASHP deployment.

Related Case Studies

Heat pumps, already on the rise in rural Minnesota, get boost from new state law (2021):
As the ECO act continues to develop utilities are going to start seeing more benefits from upgrades within their service territory to ASHP. Because the new law allows for these utilities to count fuel-switching toward their energy conservation targets. Areas that have more expensive fuels like propane or oil see higher energy efficiency and economic benefits. "It's kind of a no-brainer in houses with propane furnaces," said Ben Schoenbauer, senior research engineer at the Center for Energy and Environment." This change could occur also at the time that customers are looking at replacing their air conditioners, as they realize that it has that capability. The economic benefits come because utilities might choose to upgrade the level of rebates that they offer. This isn't going to be a quick acceleration, however. Most of the utilities across the state have the switch to ASHP within their plans. This change could result in about a 5% decline in carbon dioxide emissions. (Jossi, 2021)

A Program Design Combining Community Solar and Weatherization for Manufactured Homes in Michigan

This article primarily focuses on how they can pair manufactured homes with community solar gardens to provide cheap, clean energy for their homes. One section of this paper focuses on how the installation of ASHPs helps manufactured households be provided energy assistance with the pairing of community solar gardens and low utility bills. A new weatherization assistance program from the IIJA, provides a new program called the Sustainable Energy for Consumers (SERC) award that aims to drive innovation and strategies to reduce energy burden for low-moderate income homes. This program has already awarded 15 million dollars in awards, with two of those being for manufactured homes. One of these provides funding for the replacement of current heating systems for cold climate air source heat pumps. This is then paired with solar energy to cut electric bills. Other programs are providing net zero single module homes

that utilize a virtual power plant to manage them. Another method of keeping utility bills low is evening out utility bills across the year to reduce the usually higher bills in the cold months financial impact. The rollover of extra energy from community solar gardens is a key factor in the success of these programs (Paulos, 2024).

Pathways

GRE as a Knowledge Hub and Information Distributor

Need:

There is a need for a direct and simple education campaign that addresses the "why" and the "how" to transition a home to beneficial electrical heating/cooling, and appliances. GRE can position itself alongside its member utilities and incentivize contractors to directly influence homeowners.

There are numerous organizations that are conducting research, providing education and reaching out to homeowners. The information, especially for the area covered by the member cooperatives, is scattered and not always easily accessible or in a format that contractors & member utilities can use to convince a homeowner to purchase.

GRE Advantage:

GRE has connections and information resources statewide and nationally that exceed what the member utilities and their networks have the time and ability to access. GRE can use its scale to aggregate information and make it accessible in real time to homeowners and those working directly with the homeowner. GRE is known and trusted by the member consumers in its cooperative network. A 2022 member survey found 88% of consumers in GRE's territory know of GRE and 70% have a favorable impression. (Great River Energy, 2022) In addition, GRE has a network of partners who it can call on to disseminate information directly to contractors and homeowners.

Addresses:

- Allows GRE to create a positive narrative using education to homeowners to address cost, reliability, and comfort concerns.
- Quick contacts for local contractors who sell/install/service smart systems.
- Quick access to rebates/tax incentives and calculators

What this pathway could look like:

Develop the Energy Wise MN website into a platform with a positive narrative and easy navigation to key resources for homeowners and contractors.

GRE has a great start with the Energy Wise MN website. This site appears to be easily

marketed under each member utility name. It has a public facing site that lists all members and links to their rebate pages, and has a web store where EV chargers, thermostats, water savers, and LED light bulbs can be purchased. Signing up for the online store automatically links you to your member cooperative. There are also pages only the member cooperatives can link to, including the searchable list of Quality Installation Certified Contractors. However, the member owner utility sites are centered around their services, connections with members and their own rebates. Only one member referenced CIP rebates and we found little information about the upcoming State rebates through the IRA. The27 member owner websites have a multitude of configurations and little space to focus on education and options. GRE has a chance to build out a site that is focused on audience needs and can educate, guide, and provide a "one stop shop" for beneficial electrification that is place-based.

In addition, consider how contractors could promote this site to homeowners as well as member utilities. Some additional information to add to the website:

- A positive "call to action" narrative explaining the benefits of ASHPs.
- A list of contractors and the services they provide. This can be currently found in searchable spreadsheet form on the ASHP Collaborative site.
- Compilation of rebates available in distribution regions (links currently exist to member utility pages).
- Other rebates for energy efficiency improvements, especially information about and links to the upcoming state rebates, when they may become available and how to access them.
- All forms needed to apply for direct rebates, energy assistance, tax information.
- Provide resources specific to all types of efficiency/electrification, e.g. weatherization, appliances.
- List of local champions that GRE can highlight to show the ability of switching to electric measures.
- Add calculators for rebates/tax advantages, especially from the IRA, but include state/local financial advantages - see example at Rewire America: https://homes.rewiringamerica.org/calculator
- Add calculators from the beneficial electrification toolkit: https://www.betoolkit.org/assessment/heating
- Use mapping software to organize information for local delivery.

Develop in-house expertise as a guide for homeowners, contractors, and member owners.

Web sites are often a first stop and valuable collections of information, but are by nature, passive sources of information. We recommend GRE develop in-house (or contracted) expertise accessible through a help line, similar to an IT helpdesk, that guides member utilities, contractors and homeowners to resources, answers specific questions not readily available online, pinpoint the exact rebates available, and simplify the rebate process for all. This is another direct touchpoint with decision makers and is another source of contact information for future outreach.

Build a focused and diversified community-level direct outreach campaign.

GRE's participation in the ASHP Collaborative gives GRE access to existing outreach materials. GRE can amplify the message with a targeted and local campaign. This can take the form of direct mailings, social media, Google ads to drive members to the website, video testimonials, local and state media ads and interviews, and regional events. Use the Launch Points to target information to the groups that would see the greatest benefit in switching to ASHPS, or who are most likely in a position to upgrade. Use GRE's extensive partnership to disseminate information, especially the growing certified contractor network.

Related Case Study

Efficiency Maine: The Secrets of Their Success (Rewiring America)

The state of Maine met its goal of installing over 100,000 air source heat pumps in 2023. The state is two years ahead of meeting this goal, and on its way to its next goal of installing 175,000 more by 2027. (Buckley, 2024) There are several parallels between Minnesota and Maine. Both are cold climate states; Maine ranks number 3 and Minnesota number 4 in the list of coldest states throughout the year. Like Minnesota, Maine's push is being driven by its Climate Action Plan. There are several drivers promoting the installation of ASHPs, including robust rebates and the fact that Maine is the most heating oil dependent state in the Country (Nguyen, 2021). However, rebates and financial incentives are paired with a robust and intentional education and marketing campaign to ease barriers and change the narrative regarding heat pump performance in a cold climate.

Maine has overcome many of the challenges to ASHP adoption with a multi-faceted approach to systematically remove barriers to adoption. This effort has been spearheaded by the state created nonprofit, Efficiency Maine. Rewiring America in their 2023 case study of Efficiency Maine puts their efforts into four broad categories:

1. Prioritize deployment
2. Engage directly with contractors, distributors, and retailers

3. Build on positive outcomes

4. Maximize accessibility and ease of use

Efficiency Maine drives adoption by working at all levels of the value chain, right down to the consumer level. Relevant to Pathway #1, Efficiency Maine contracts with a company to provide direct education and marketing. On behalf of Efficiency Maine, the company "staffs the phones for all programs and supports retailers, distributors, and installers with inventory management, planning, marketing, consumer education, and more." (Rewiring America, 2023) In addition, the company collects consumer information and mails out flyers pointing consumers to the Efficiency Maine website where they can find certified installers. Efficiency Maine also directly markets through social media, Google ads, and mails information to new home buyers and works with counties to stuff property tax mailings with educational flyers. Efficiency Maine's website lists 700 qualified installers with the ability to rank the installers by how many rebates they've issued. Contractors receive vetted lists of income qualified leads. (Rewiring America, 2023)

Leverage Partnerships: Connecting Consumers with Contractors and other local organizations that are active in the transition

Need:

The role of the contractors and local agencies became very prevalent throughout the interview process. Contractors are the foremost technical expertise in rural areas that help in the assistance of electrification of households. Local agencies provide education and support to consumers when considering the switch. They are the trusted source for rural communities that can provide GRE with a perfect avenue to reach its customers across the state. To be effective, information must be tailored to the individual and delivered by trusted local partners.

GRE Advantage: GRE has an extensive network of partners and allies, especially "upstream" on such as the MN Air Source Heat Pump Collaborative and Electrify Everything MN who are working on and have similar goals as GRE. GRE has the ability to strengthen partnerships "downstream" with advocacy groups, local contractors, and other organizations who are working directly with homeowners to boost the decision to move to beneficial electric with the member owner that services these areas. GRE can connect the players in a way that essentially amplifies the outreach of member cooperatives without the cost of that can benefit both parties and help increase connections in rural communities. These connections will be extremely important in electrification, but also could play an important role in future endeavors that GRE would be pursuing.

What this pathway could look like:

Develop and expand on already existing certification programs with these agencies as certified groups to work with to provide the best reliability, education and technical assistance for electrification:

1. Work to provide certification on the GRE level but create the partnership with contractors and local agencies that are within the member owners service territory.
2. Certification programs would include attending specific training and education events that GRE sees as beneficial.
3. Local agencies would be able to provide education to local areas and work with local member owners to provide resources like on-bill financing.

Develop and place regional "knowledge partners" focused on beneficial electrification that serve one or more member regions who develop:

1. Regional relationships with influential partners like local government, regional business organizations, service organizations, builders, and contractors to promote beneficial electrification plus local member programs/incentives.

2. Work with regional CAP agencies, tribal government, and regional planning agencies to both provide information and to develop equitable access to resources related to beneficial electrification (weatherization, appliance "swap" programs, cooperative discounts).
3. Act as a resource for contractors and provide outreach/education to homeowners considering home.
4. Feed local information back to GRE for online information hub and on the ground knowledge to determine efficacy of incentives and educational programs.

Action items for pathway success:

- These positions could be shared between GRE and member utilities, fully funded by the local member (and tied into the "knowledge partner" network), or fully funded by GRE. In any case, GRE member services would lead this network.
- Partnering with local agencies to provide education specific to the area that they serve, rather than trying to be one size fits all. As GREs service area covers many different communities across the state, it is important that each member owner is doing what is best for their service territory, while keeping messaging consistent.
- Provide updates on the availability of rebates from GRE, state, and federal agencies, along with updates on changes to programs around the state. Making sure that everyone is updated on the finances that are available shows that GRE is trying to look out for the best interest of its consumers.
- Assisting contractors and local agencies in applying for grant and loan dollars to further electrification in rural areas. By providing this service, more information on what these contractors and local agencies need can provide better insight into how to provide better assistance in the future.
- Assist developers and contractors with supplying them with a client list for upgrades, working with local organizations to help support this transition. This would come from the creation or improvement of a certification program that would allow contractors a pipeline of projects by meeting requirements that best fit the areas that they service. Other local agencies could receive certification as well.
- Assist with the development of the workforce in local areas by utilizing contractor certification programs and working with local agencies to promote education and training. This provides a pipeline of workers to fill positions to continue to advance electrification. Contractors are fully staffed and have a

large queue of projects, and GRE sees advanced implementation of electrification.

- Increased education for all stakeholders that are a part of the process. Making sure that all connections and partners are on the same page and having a consistent message.
- Increased incentive programs to increase the willingness of transitioning. Bringing more individuals aboard only increases the trust between GRE/COOP and households.
- Providing larger home appliance upgrades to increase efficiency and savings for consumers. This would provide and create more connections with local contractors that could provide a valuable partnership for future energy efficiency measures.
- Integrate electrification into GRE's IRP to further commitment. Commitment for GRE shows consumers that this is a priority and that certified installers or relationships with local agencies can be trusted and provide quality information.
- Member Owners working with local households to show how the change in different appliances can impact their electric bill and home energy efficiency. This creates a more personable relationship and less of a give and take relationship. Makes future changes easier while providing feedback from the consumer.

Related Case Studies

Modernizing utility programs to advance an equitable energy transition

Fresh energy takes a look at how larger utilities like Xcel, Minnesota Power, Otter tail power, along with gas utilities like CenterPoint use their energy efficiency and conservation programs to promote equity. Minnesota policies like the conservation improvement program (CIP) and the Energy Conservation and Optimization (ECO Act) require that specific utilities must report on their energy efficiency programs. Fresh Energy has found that utilities are not taking full advantage of the programs. Currently utilities still have rebates in place for gas powered appliances, which is hurting the climate goals that have been set out by the state. It is noted that Xcel has a rebate program in place that provides a six-hundred-dollar rebate for households that install insulation and air sealing before they install a heat pump within two years. This could be an excellent model for what other utilities could do across the state to increase energy efficiency and continue to lower energy cost for customers. This report also notes the need for utilities to consider low income customers around continued education, fair incentives in respect to multi family homes and single family homes. Finally, there is a great need for planning for the increase in workforce development to ensure that there is a large enough workforce to meet the demands of both energy efficiency upgrades and also electrification across the board (Olson, 2023).

Programs to electrify space heating in homes and buildings

This report from 2020 focused on analyzing different programs from across the United States including the states of California, Oregon, Washington, Idaho, Montana, Minnesota, Michigan, New York, Connecticut, Vermont, Maine, Rhode Island, and Massachusetts. This report mostly summarized the trends across these states, to determine the overall trends of heating and cooling electrification across the United States. To start, most of these programs are aimed at switching to a heat pump to reduce the use of fossil fuels or electric heat resistance, but most of the programs tend to just focus on one or the other. These programs also encourage weatherization to help improve the energy savings that can come from switching off of natural gas. These programs are also exploring different approaches to when the weatherization occurs in relation to the installation of the heat pump. Programs are also targeting consumers that have the use of delivered fuel in their homes, as the economics of switching to electric heating are far greater than in other areas that only rely on natural gas. Finally, several programs are working to offer upstream incentives to contractors or developers along with providing incentives for fossil fuel savings and putting value on the greenhouse gas emissions reductions, have been successful in increasing participation. This report also outlines that data collection of how consumers respond to different programs and incentive levels is key in determining the past path forward for each state (Nadel, 2020).

Use GRE's Scale and Connections to Address Funding and Finance Challenges

Need: Rebates and tax incentives provide much needed incentives boosting the move toward beneficial home electrification. However, there are challenges to using these incentives. There are a myriad of large new incentives making their way from many agencies for ASHP and efficiency upgrades. These have never been utilized and overlap in ways not yet well understood. The public programs in Minnesota have not opened. LMI and Tribal customers need financial assistance to pay for the installed costs of ASHPs and efficiency upgrades. Costs for ASHPs are high because there is not yet an economy of scale for the most efficient technology for lowering monthly energy bills and reducing GHG emissions.

GRE Advantage: GRE's scale and connections will be a benefit as it can apply for and manage incentive funds from large public and private institutions. There is opportunity in this pathway to stack the myriad funds and incentives becoming available and

direct that support to energy justice and LMI communities while providing Beneficial Electrification. There are also opportunities to support Contractors and customers through financing options.

What this pathway could look like:

Support On Bill Repayment programs for member Coops to provide access to more incentives.

Assist with financial challenges On Bill Financing. Use bill savings to cover part of on-bill financing. As IRA and other funding is available this financed amount can be managed and offset based on need, in this way encourage dist justice.

Track bill savings and, if they are in need of assistance, make contributions to customer's on-bill financing to give the HE CC HP System a NPV based on criteria TBD. Funds to assist paying for this may come from IRA, MNCIFA, Fed Tax Credits, Efficiency measures including electric upgrades, envelope upgrades, HVAC Upgrades included. Opportunity for NGO and Units of Gov to reduce financed amount over time for justice for wealth and distribution.

Application to program and qualifying is complex for some and varies by utility and local gov. Automatic qualification (not opt-in or opt-out) for assistance programs that will reduce admin work. (https://www.smcsustainability.org/wp-content/uploads/Systems-Mapping-Project-Final-Report.pdf)

1. Create a program that member coops can fund on bill financing or repayment to spread the cost for homeowners and avoid need for commercial loans and credit reports for beneficial Electrification. Opportunity for Public/Private to de risk GRE and create opportunity for credit not always available for all customers. LMI justice with focus on correcting negative Net Present Value of installing new ASHPs. (One-time upgrade funding)
2. Create a loan program so contractors can have products in stock for faster installation, and use the power of GRE to negotiate deeper wholesale discounts for contractors especially for High Efficiency Cold-Climate ASHPs.
3. Weatherization/home efficiency. Most programs encourage weatherization to reduce loads in conjunction with purchasing a new heat pump. About one-third of programs require weatherization. A few programs are exploring approaches to improve weatherization uptake before or at the time of heat pump installation (e.g., the Massachusetts Market Value Performance [MVP] program).

Build partnerships to provide education about ASHP incentives and partnerships with providers of technology or services for new ASHP demand response programs.

- Now is also the time to look for partnerships that continue to accelerate adoption of ASHPs with trusted references and technical expertise on incentives. The ASHPC is a great organization. GRE should continue to be

involved with. Other regional partners like CAP agencies, CERTs' Energy Ambassadors, or an Energy District could add more educational expertise and outreach to customers not engaged with contractors.

- Because ASHP's are smaller loads, they provide smaller load control benefits, and because the control interface is built into the ASHP they do not use some of GRE's current technology for load control and demand response programs. Allow someone with existing expertise and motivation to provide a solution and avoid risks of investing in and building a group in GRE for nascent technology. Consider a partnership with a DER Aggregator or DER Management company to provide services and technology for a new DER load management program that works with the technology of today's ASHP controls. This DER aggregator or manager could operate aggregations of ASHPs along with other DER like EV batteries as a virtual power plant for the benefit of member owners and customers.
- Retrofitting existing homes often requires additional upgrades to electrical service, insulation and weatherization, and space/foundation considerations. Consider creating a program to assist specifically with pre-weatherization upgrades to electric panels to ensure they will have the capacity for safe installation of ASHPs, electric stoves, EV chargers, and home energy storage systems.

Related Case Studies

Pilot Tariff On-Bill Repayment Program, Case Study: Norwood Pinion Park

The Colorado Clean Energy Fund, CCEF, is a green bank set up to prioritize funding of clean energy projects in underserved communities. It was formed in 2018 as a non-profit and was funded by the CO Legislature in 2021. The CCEF provides low-cost loans to businesses and residences to pay for clean energy and building efficiency projects. It has also provided funding for a pilot On-Bill Repayment program with the electric utility, the San Miguel Power Association. This program financed upgrades to the heating and cooling systems at the Pinion Park affordable housing project developed by Rural Homes. In this program the Utility is NOT lending money. It is collecting the money to pay back the loan from the green bank which financed the project, the Colorado Clean Energy Fund.

Through the advice of the EPA and use of robust energy and financial modeling, the developer and San Miguel Power Association were able to prove that the savings from the upgrades were less than the cost of repaying the loan from the CCEF and, therefore, were beneficial upgrades that could be financed. Also, the robust modeling showed that the use of ASHPs, instead of natural gas or electric resistance heat, would provide enough savings that solar systems, which were previously impractical, became affordable enough to include in the project. The costs of these upgrades were removed from the project's financing and paid for separately with a loan from the

CCEF. The new homeowners' estimated savings from these upgrades is $7,681.40 over 20 years at 2.5% interest. The new homes included air conditioning, and there was no need to run natural gas lines to this development.

Other notable features of the program include.

- Upgrades are owned by the customer, not the utility.
- The loan is associated with the utility meter like PACE is associated with a property.
- The loan can be paid off early or during a change of ownership.
- The work was done with an authorized contractor. This lender requirement ensures quality installed products.
- The utility will treat delinquency the same as for any other customer and may collect past due amounts.
- A successful project in this modular housing project is encouraging to those concerned with the need for more affordable housing units and weatherization upgrades for modular and manufactured homes.

Challenges to Commercialization and Potential Solutions

The implementation of new technologies, especially in rural households, provides a lot of exciting opportunities, but also can be met with a lot of challenges. Based on our research, this section outlines challenges that were brought up consistently, along with possible solutions. These challenges are ones that not only GRE, but its counterparts across the country and its partners are currently encountering. Laying out these challenges with possible solutions we hope provides GRE with a broader roadmap, and a sense of its importance as a partner to the many organizations working to mitigate these challenges. Many of the solutions suggested here may be beyond GRE's scope or capacity to take on. Awareness of them may be helpful to understanding what may hamper or slow their progress.

Challenge: Workforce Development

The development of a robust work force is the biggest need to make the clean energy transition a reality. This is especially true for rural areas, where the availability and the cost for services is increasing high and hard to come by. The workforce is not only needed for electrification, but also for energy efficiency and weatherization upgrades in homes. This workforce need was studied by the Center for Energy and Environment (CEE), in a report focusing on the electrification and weatherization of all 1-4 unit homes in Minneapolis. Their report found that "A workforce of nearly 1000 electricians, insulation contractors, mechanical contractors, and other trades are needed to

complete the heavy volume of work required." (Center for Energy and the Environment, n.d.) This workforce is not present in Minnesota and especially not in rural Minnesota. To be able to address this challenge GRE must find creative ways to support local contractors across their service territory.

Solutions: There are a few possible solutions to address the workforce needed for electrification. It is important to note that support from other entities is extremely important for solving this issue not just for GRE service territory but for the whole state. Here are some potential solutions:

- Work with contractors to provide them with increased education and continue to provide them with up-to-date education. This could be done as a part of the certificate program from GRE. This program could also require that contractors attend specific training and education programs to remain certified installers.
- Support training centers, unions, and local trade schools to increase awareness around increasing the trades workforce. This would also provide a pipeline for the certified contractors within the GRE program to new talent that is well educated in this field and has a rapport with GRE.
- Provide incentives or rebates for contractors to offer electrification in their service areas. This doesn't necessarily directly link to increased workforce but could encourage contractors to be able to provide ASHP services.
- Work with other non-profits and state agencies to support state led training programs like the one supplied by CEE, which could also allow for contractors in GRE service territory with another direct pipeline to new workers to support their service territory and also support certified GRE contractors.
- The Regulatory Assistance Project suggests that making licensing requirements across the nation the same could make it easier in the creation of education and training. They also stated that partnerships between training centers, regulators, installers and local stakeholders is essential in the development of a robust workforce (Brutkoski, 2023).

These solutions would work well with the trusted partner pathway as a lot of the solutions that GRE can do relies on the fact that there are contractors available to take on projects and workers. The development of a strong workforce benefits everyone, by the ability to provide better and more cost efficient service to consumers, increases the adoption of ASHP for GRE, and provides future relationships with local agencies for future projects.

Challenge: The Availability of Products that Meet the Wants and Needs of Consumers

The technologies around air source heat pumps are continuing to improve and change. Because of this consumers have a wide range of brands and types of ASHP to choose from. This adds a layer of difficulty for rural contractors to be able to provide

specific brands and types of ASHP, along with the added difficulty of being able to have employees educated on a specific brand and have the parts available. This difficulty is harmful to consumers as they might have worries about service if something were to occur to their system. Rural households in Minnesota tend to have backup sources of heating due to the cold climate and the possibility of not being able to be serviced for a period of time during cold climate events. These backup systems also add another layer of difficulty. Not matching a backup system brand to the ASHP brand could possibly void a warranty, create communication issues between the two, and make the system less efficient (Rifat, accessed 2024). There are a lot of issues surrounding the availability of ASHP which can make consumers weary of the new technology.

Solutions: While this challenge mostly relies on a lot of heavy lifting from contractors, there are a few things that GRE can do to assist the consumer directly.

- Encourage consumers to upgrade their appliances ahead of time to ensure that they are able to get what they need or want.
- Focus on areas with few service providers to ensure the rural areas that are the most impacted feel comfortable making the switch to ASHPs. This could come from the certification process or working with rural towns to find service providers in the area.
- Work with contractors to educate consumers on all of the different options that are available to them and what products the contractors feel comfortable providing service for.
- Educate consumers by holding sessions on new technologies and all of the requirements. The certification process could allow for the passage of information, where GRE could present educational material on best practices and technologies.
- Hold pre-consultations between the utility and consumer so that the consumer can hear directly from the utility how a change would impact their household as a whole. This would also discuss contractors that they could use to provide a specific product.

Challenge: Large Upfront Cost to Households

ASHPs cost more to install than many other HVAC systems. Even though an ASHP may be less expensive to operate, the higher cost will prevent many homes from choosing to install one. The high installation cost creates a negative net present value for the most energy efficient and GHG reducing products in many cases (Wilson et al). The GHG reduction may motivate some people to spend the extra money on an ASHP over a less expensive alternative, but LMI households may feel that is not achievable within their

budget. The need for a second HVAC system to capture fuel savings and ensure reliable performance during the coldest months of

Not installing a high efficiency cold climate ASHP at the time of HVAC equipment replacement would result in higher monthly bill costs for the customer and fail to capture the ASHP's capacity to reduce GHG emissions. This is the opposite of beneficial electrification.

Solutions: There are several ways to reduce the cost of installing an ASHP in GRE's territory to accelerate beneficial electrification.

- Create an On Bill Repayment program that lends funds for ASHP and energy efficiency upgrades to homes and allow a customer to choose to repay the loan on their utility bill, and include weatherization upgrades in the On Bill Repayment program.
- Stack incentives from the EPA, USDA, DOE, MN DOC, IRS, and other sources to offset the initial costs of ASHPs and other efficiency upgrades in new developments that benefit LMI homes and throughout energy communities.
- Leverage GRE's scale and connections to procure and maintain an inventory of high efficiency ASHPs that would be accessible for contractors and customers to finance through On Bill Repayment.

Challenge: Education on New Technologies

GRE's member coops and customer members have many things to do, and learning about the best products and practices for ASHP installation and use is not possible for everyone. Not all contractors are on the same level of experience using ASHPs. Knowing which products qualify for incentives and how to best use them is important. Each member Coop also has their unique needs and may prefer to raise awareness for dual fuel systems to manage high winter electric loads and reliability, while another is not concerned by peak load but may want to increase AC for the health of their members.

Solutions: Information should be made available to customers, however, it is **most important** to focus on education for the contractors to support them as trusted partners who spread the education they receive to their customers.

- Use the ASHP Collaborative and GRE Quality Installer program to provide education on ASHP to contractors.
- Create a curated list of qualified contractors who have;
    - Committed to the GRE QI program
    - Received training in ASHPs for the MN climate

    - Received training in utility, state, federal and other Incentives and Rebate programs.
    - Shown the annual certifications and trainings needed to remain on the list of certified contractors
- Build a GIS ecosystem analysis of each of GRE's members to understand their individual needs
- Continue providing interesting and accessible public service announcements and educational opportunities, like this fact sheet, on beneficial electrification that demonstrate how an ASHP can reduce monthly bills, prevent GHG emissions, and save energy.
- Work with regional partners like CERTS and their new Energy Ambassador program to expand educational opportunities.

Challenge: Unknown Incentives from the Eco Act and IRA

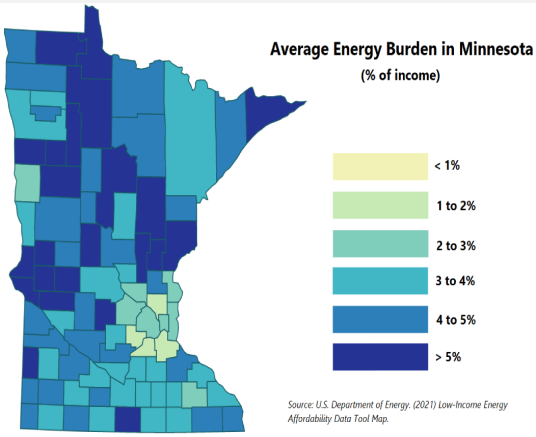
The process of creating and funding home energy incentive programs is not complete. According to the US Department of Energy, funds for these programs will be provided based on the applications received. The MN Dept of Commerce has not released their program and expects the DOE funding to be received "Mid to late 2024" The landing page on their website indicates this development has been ongoing since 2/12/24. Also, the ECO Act is very new, and even though it allows for Beneficial Electrification, the programs are new, and their efficiency is not known. Several other agencies and institutions are also adding to the incentive "alphabet soup," including the EPA, Dept of Ag, Dept of Interior, and DOE.

Solutions: Managing the changing landscape of Utility, State, Federal, and Local incentives is a lot for customers who buy ASHPs. Solutions that reduce the burden could be:

- increase resources for a trusted source to help determine the incentives and products that qualify and how much.
- Training and tools for contractors and one-stop technical assistance so applying for assistance is simple.
- Use the ASHP collaborative website to find utility rebates and cost of service crossover tables so customers have tools to evaluate. Continued development of this type of GIS tool by utility for locations of weatherization and concentrations of housing such as manufactured homes. https://www.mnashp.org/incentives-financing#rebate-map
- Eliminate paperwork and the time waiting for rebates with an automatic rebate at the point of purchase of an ASHP. Simplifying the rebate process would include retailers in the trusted partner role like a contractor.

Challenge: Equitable Distribution of Energy Efficiency Upgrades So That Low and Moderate Income Households Are Not Left Behind

Energy Cost Burden is defined as the percent of median yearly income that households pay for electricity and gas bills. Paying more than 6% on energy bills is considered a high energy burden, while a household that pays more than 10% is considered to have a severe energy burden. In Minnesota, one in three counties has an average energy burden of 5% or higher, all rural. (UMN Extension, 2021) https://extension.umn.edu/rsdp-happenings/reducing-energy-burden-greater-minnesota)



The Current definition of low income household in Minnesota was updated in 2023 with the passage of the ECO Act. A low income household:

(1) is 80 percent or less of the area median household income for the geographic area in which the low-income household is located, as calculated by the United States Department of Housing and Urban Development, or

(2) meets the income eligibility standards, as determined by the commissioner, required for a household to receive financial assistance from a federal, state, municipal, or utility program administered or approved by the department.

Low and moderate income homes are at risk of being left behind in the transition to beneficial electrification, leaving them dependent on increasingly expensive and emissions heavy "stranded" sources of electricity such as wood, delivered fuel and resistance heat. Many low-income households are either deferred or incompletely served by energy efficiency programs because of health and safety (lead, asbestos, mold) or deferred maintenance issues (poor insulation, substandard electrical equipment) in the home.

Solutions:

- An opportunity to expand the services of the Distribution Cooperatives is to have member utilities provide weatherization services for customers. This includes electric panel upgrades.
- Minnesota's ECO Act of 2021 allows utilities to receive credit for pre-weatherization work and allows 15 percent of the spending for pre-weatherization. Also, starting in July 2021, the Commerce Department began allowing Weatherization Assistance Program (WAP) funds to be used for removing insulation, asbestos, and mold (Chan, et al., 2022)

- Maine and Vermont have had success in offering rental of equipment. The homeowner pays a monthly flat fee that includes installation and materials. The utility provides maintenance, and the homeowner pays for the ASHP as a "service" rather than outright ownership. This allows homeowners to avoid the often prohibitive upfront cost of purchase. Maine has passed legislation, "An Act To Enable Low-income and Other Customers Greater Access To Efficient Electric Heat Pumps through Unique Financing and Third Party Installation and Maintenance" allowing transmission and distribution utilities to implement these rental programs. (NEEP, 2017)
- Support Adoption and application of newer ASHRAE Building Performance Standards that support beneficial electrification and renewable energy generation (Amernath, 2024). An example is ASHRAE standard 90.1 that begins adding renewable generation to account for 3% of building loads and will increase over time to 35%. This standard applies to commercial and high-rise residential buildings but is an example of how building codes influence electrification practices in new construction.

Metrics and Milestones

GRE will want to track progress on the extent and pace of residential electrification to ensure tactics implemented from current efforts and from those implemented from these recommendations are working and to show progress toward goals. By tracking and reviewing data, GRE will be able to adjust their programming to emphasize those efforts that have the most impact. We recommend metrics be based on the criteria for this research which are:

1. Reduction of greenhouse gas emissions from households in GRE service territory.
2. Compliance with state law requiring all sources of electricity to be from a carbon free source by 2040.

The metrics we suggest tracking are a combination of requirements for reporting from the state, which GRE is currently reporting, and equipment sales and installations specific to the goals GRE sets for ASHAP technology.

Carbon Emissions Reporting

Beneficial electricity advocates have suggested that metrics tracked and reported should move away from traditional energy efficiency statistics such as kilowatt hours used, and toward energy emissions statistics. They point out that the transition to beneficial electric technology may increase electricity usage, even as it reduces carbon emissions. Measuring electricity efficiency, therefore, is not a complete measure that takes into account the carbon reduction goal central to beneficial electrification. Measuring energy carbon emissions along with traditional measures, or 'emissions efficiency,' is a preferable metric for tracking the effects of increasing beneficial electrification (Dennis, Colburn, Lazer, 2016).

Luckily, carbon emissions tracking is not a metric that GRE will have to create and implement since this is a metric GRE has been tracking for years using the Retail Ratepayer Methodology as described in the 2023 IRP (GRE, 2023). In addition, tracking specific impacts such as cost effectiveness from switching to beneficial electric appliances must be reported to the state Department of Commerce under the Energy Conservation and Optimization Act (ECO Act) now in Minnesota statutes (ECO Act, 2021). Under the ECO Act, utilities must work with the Minnesota Department of Commerce to:

(1) determine whether deployment of a fuel-switching improvement meets the criteria established in subdivision 11, paragraph (d); subdivision 12, paragraph (a); or section 216B.2403, subdivision 8, as applicable; and

(2) calculate the amount of energy saved due to the deployment of a fuel-switching improvement.

GRE uses the Minnesota Technical Reference for Energy Conservation Improvement Programs as well as technical references from other states to track and report savings impacts and cost effectiveness.

Additional Metrics

Some of these metrics GRE must track in order to determine emissions efficiency savings under the ECO Act. In addition, GRE has partners that are tracking some of these statistics statewide. Using these statistics in a review process focused on determining program efficacy will help GRE hone its program to promote and encourage the transition to ASHP and other beneficial electrification uses.

Here are a few additional metrics that GRE consider using, if not already:

- Savings from the switch to an ASHP and further variables
    - Fuel type switched from, ASHP type, contractor worked with
- Number of rebates awarded per member owner
    - By having data on each area of the service territory can help to see what member owners might need more assistance
- Type of ASHPs that have been installed across service territory.
    - Specific types can help contractors to be able to make sure that they are providing the models that consumers are most interested in.
- Households that change more than one appliance to an electric version.
    - This would help to show that making more than one change can provide further benefits to households.
- Number of LMI households that switch to an ASHP.
    - Monitoring the number of LMI households that switch can help member owners provide further assistance to these households.

First Steps

These four first steps have been identified to start this process of accelerating rural electrification. This provides whoever takes over this document with important places to start but could change depending on GRE resources and any future policies.

1 Determining Starting Pathway(s)

Although it might be possible to do all of the pathways to start, picking one and focusing on it allows for any issues that might occur to be handled without being overwhelmed by trying to solve problems for other pathways. Any of the pathways are possible to begin implementing, but we recommend starting with the knowledge hub pathway. The reason for this is to allow GRE to provide a lot of resources that can be beneficial in other pathways. It also will serve as the backbone for the implementation and some of the action items of the trusted partner pathway.

2 Identify Local Champions

Throughout the interviews and conversations with GRE, it was made clear that determining local champions and success stories will be critical in this transition. Finding these local champions not only proves that this new technology can work, but also can help support those in similar situations to do the same. These local champions are not only just households but also contractors, local governments and other state and local agencies that are going to be critical partners as a part of this transition.

3 Create Strategic Relationships

Creating relationships and identifying local champions go hand in hand. The local champions are very key relationships to have, but there are others that will also be needed. Leveraging relationships with member owners is going to be critical for implementation. Continuing to strengthen relationships early will only continue to provide benefit into the future. Creating relationships in partnership with member owners with local contractors will encourage those that are currently champions to continue and convince those that might be falling behind on providing electric options for their customers to become champions. This will in turn continue to raise the floor on this transition across GRE's service territory and create new partnerships for its member owners.

4 Identify Leverage Point Needs:

The final of the first 4 steps is in essence to prepare and ensure that GRE is prepared to take all of the different action and leverage points outlined in this report. Assign internal responsibilities and tasks to team members. Prepare educational resources, information, and plans. Make sure that GRE has the overall capacity to engage member owners to

play a large role in this work. Identifying the need to engage external resources and other organizational partners may be part of the resource plan to implement the plan.

APPENDIX A

Residential Beneficial Electrification Qualitative Research

We conducted qualitative research in the form of interviews and observations with identified stakeholders of Great River Energy. We requested interviews with contacts in industry, unions, nonprofit associations, utilities, and government whose work intersects with the transition toward residential beneficial electrification in the state of Minnesota.

Over the course of two months, we conducted nine semi-structured, confidential interviews with representatives from cooperative utilities (2), equipment manufacturers (2), Minnesota-based nonprofit organizations (3), a university researcher in the field (1), and an HVAC contracting company (1). Interviews lasted a minimum of thirty minutes. Most were recorded from which transcripts were produced. If not recorded, written notes were produced.

Interview Plan for Semi-Structured Interviews

Script

Introduction: Thank you for meeting with us today. We are students at the University of Minnesota Humphrey School of Public Affairs in our capstone class for our Masters degree. This team is studying the promises of and challenges to increasing residential beneficial electrification in Minnesota. *Individual introductions - Carl, Steve, Jane.*

We are interested in learning more about your thoughts, observations, and experience in this area. We assure you that I will keep everything you say in confidence. You will not be identified by name or place of work in our research.

Also, if we ask a question you would prefer not to answer, please let us know and we will move along or stop anytime. We would like to record, if that is okay with you, so that we can give our attention to this conversation more fully. We are the only people who will listen to the recording, and I will delete it as soon as I have a script with all names removed. Do you give us permission to record this interview? *Wait for verbal confirmation or declination.*

We prepared questions to start the conversation (listed below) that were tailored to the type of organization we were interviewing. We allowed follow up and related questions as the interview progressed.

General Questions for all

Please describe what work you and the name of your company/association do that relates to residential beneficial electrification in the state.

How long have you or your organization worked in this area?

Questions for manufacturers/Contractors

What are some of your biggest concerns with the transition to electrification of heating and cooling products?

What do you think a successful transition to electric equipment looks like?

What workforce support for manufacturers is needed during this transition?

Questions for rural coops or municipal utilities

What are some ways that coops or municipal utilities can help support the electrification in residential heating and cooling?

What are some of the concerns and hopes you have regarding this transition?

What resources do you need to support this transition?

What resources do you have now that can support the transition?

Do you see acceptance or rejection of this technology from your customers?

Questions for Advocate groups

What are some ways you have supported or advocated for the transition to electric heating and cooling systems?

What are some of the biggest barriers to making this transition that you see?

What are some of the biggest opportunities in supporting this transition?

Do you have plans to advocate for beneficial electrification?

What are some of the concerns and hopes that others have expressed to you about this transition?

Analysis

We used the Grounded Theory method, an inductive and iterative method, to thematically code the data from interviews and observations. Several themes clearly emerged across the stakeholders interviewed.

Beneficial Electrification Codebook

Theme	Definition	Examples from Transcripts

Homeowners are in different stages of readiness/need for upgrading or changing their heating/cooling, and appliances to new technology.	The homeowner audience is diverse and complex in needs, views, and understanding.	There are "still" a lot of early adopters who want to change [for environmental reasons]. "Mission is trumping the bottom line to some extent." There is not always an interest or willingness for members [homeowners] to move forward with beneficial electrification projects There are many other needs, like weatherization, that are unmet "In large companies, especially multinationals, there are internal drivers to meet carbon reduction goals. Mid-range companies are driven by regulatory changes. For homeowners, most face financial constraints. "Rural customers who are using fuel oil, propane or electric resistance for heat can see tangible cost savings, so that's an easier conversation." People are often not preemptive, they make a change when there is an emergency. "You know, not just the equipment replacement, but some of the pre-work that might need to be done to get the home ready for electrification. I think that that's also a concern. So like if someone has a propane water heater or you know, propane furnace, and they're gonna switch things out like they may need to be doing some electrical upgrades with outlets. Possibly the panel wiring."
Homeowners have concerns about reliability, comfort, and cost effectiveness.	The importance of trusted advisors for making decisions about installing BE technology was a theme that was repeated in all interviews. There is strong agreement that homeowners primarily look to local or regional contractors for advice and assistance.	"I've heard from a number of people. There's a lot of fear about reliability in the system. And can the grid really handle this so kind of that? That speed and sequence." "If you're anytime you introduce something new like that you're not comfortable with right. There's a natural fear over. I don't quite understand how this works. Can I rely on it, or do I just stick with what I know?" Sticker shock comment

Homeowners lack early and easy access to information about available technology and the benefits of electrifying their homes, so they are ready when the need or opportunity arises.	There are early adopters interested in electrifying their homes for the environmental benefits and for long-term savings. However, we heard many concerns about the most homeowners who don't seek out or know about newer technologies and who will make a decision only when forced to when they have to do so. They need to make a quick decision and are not ready to trust or consider new technology.	"And if people can justify like, if they're saving enough money over, you know, a number of years to justify that investment and new piece of equipment. That's a much easier and logical conversation to have with someone." "So I think an opportunity. And one of the things we're trying to work on is getting people to think ahead a little bit more like, go ahead. Wait till the emergency, if you know if it doesn't make sense to replace it ahead of time. But ideally, you've done some research. So you know what the replacement looks like, and you know what rebates you're eligible for." "I think another challenge related to like taking advantage of rebates is being aware of all of the criteria necessary to be eligible for that." Homeowners need … "education through media and all sources possible. Consumers' concerns can be answered with education."
Information is complex, confusing, and scattered.	There are few easily accessible, clear narratives about why and how to decide to upgrade a residence because it is complex and early in the transition to newer technologies.	"What's that missing puzzle piece to help people be able to access some of these services or funding in an easier way, and a lot of that spans both urban and rural areas." "It's all kind of muddled right now. There's not a clear-cut path as to where we are at with the state and federal [rebate] programs." Managing new technology that "…are not always compatible with the ways we have to control them" for load management and require backup heating fuels for winter can be confusing for the homeowner and contractor. It can be complicated for the homeowner to know and understand all the parts that go into changing to a new technology.
Initial cost of equipment and installation is a bottleneck to	While rebates and tax incentives are viewed as necessary and deep drivers of adoption,	On increasing adoption: "on the residential side, if there were incentives to offset the cost of these emerging technologies, because they

change that is mitigated but not completely alleviated by rebates and tax incentives.	many felt that the initial costs, especially when factoring in preparation or necessary related upgrade costs, are still high enough to present a barrier to many.	are more expensive, until the cost is normalized." I think the incentives all this is great. It just going take a little work to make sure you qualify for everything. You know that what you're eligible for? "We need the utilities and the PUC to value wind capacity. Rebates at $100/KWH is not enough." On bill financing is an important option and there is not a lot in Minnesota.
Contractors are often the primary source of information and advice and can encourage or discourage a transition to electrification.	The importance of trusted advisors for making decisions about installing BE technology was a theme that was repeated in all interviews. Local contractors, including electricians, HVAC contractors, plumbers, and general contractors are often the first source of information about home technology, and some act as trusted advisors to homeowners making decisions, while others may discourage a transition.	Having access to trusted electricians and possibly plumbers like this is kind of when it starts to get a little bit more complicated, right? People get overwhelmed by, like multiple steps required. "Then you have these other champions, and I think it can be pretty practical where people go. People are going to the programs that already exist at their utility sometimes, or people like electricians." "Contractors are definitely very important. Especially contractors that engage with us [utilities]." "It's a select few that have taken the time to be engaged with us and understand the rebate and demand pricing available." A role for the utilities is to work with contractors to make sure they know and understand air source heat pumps and related electrification appliances. Then you have these other champions, and I think it can be pretty practical where people go. People are going to the programs that already exist at their utility sometimes, or people like electricians.

There is inconsistent contractor knowledge, buy in, and service in many areas of the state. Contractors have difficulty finding trained technicians for installation and maintenance.		"And now, how do you get them [contractors] to be on board?" "Education of contractors – some is happening, there definitely needs to be more." Workforce issues are "…one of the things that keeps me up at night… what we are definitely finding is that pipeline is shrinking." "…electricians and HVAC contractors – both trades have constraints – not enough people in either." There are challenges for keeping up with knowledge as a contractor. For example, refrigerants are often changing, and that is something we need to keep in stock and available. Rebate and on demand programs change too. A challenge in rural areas is the distance to drive between customers. They [contractors] are stretched for time and higher costs. There is a shortage of tradespeople and potential talent. We found limited curricula for beneficial electrification for the annual builders workshop.

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