The Great Thaw: Unfreezing Potential with Minnesota's ASHP Contractor Training

Rabi Vandergon, Center for Energy and Environment (CEE)
Jordyn Purvins, Center for Energy and Environment (CEE)
Mike Daniels, Auer Steel & Heating Supply Co.
Jon Sullivan, Minnesota Power

ABSTRACT

In 2019, a Minnesota nonprofit launched a market transformation program, funded by a utility consortium. The goal was to accelerate the adoption of air source heat pumps (ASHPs) in Minnesota. This program was recently integrated into a new utility-funded market transformation framework, established through bipartisan legislation.

Minnesota's harsh winters historically made ASHPs unreliable as a primary heat source. However, technological advancements led to more capable and efficient cold climate systems, making ASHPs a viable option. For contractors, this "new" technology was riskier than traditional heating systems with proven records surrounding performance and costs. As contractors influence customer decisions on HVAC equipment purchases, it was crucial to build their confidence in ASHPs. This led program staff to initially focus on contractor engagement.

The program's multifaceted contractor engagement strategy capitalized on relationships with utilities, manufacturers, and distributors. In collaboration with these stakeholders, staff delivered statewide trainings for contractors, reaching approximately six hundred attendees in 2023. The training curriculum included principles to transform the market. It highlighted market growth from Minnesota's new fuel-switching legislation and the IRA. It summarized field research on equipment performance in cold climates. It covered load calculation techniques, including realistic equipment sizing and selection. Lastly, it provided an overview of different ASHP types and considerations, focusing on heating and cooling costs, the benefits of dual fuel HVAC systems and rates, and controls opportunities. This training received high satisfaction ratings and served as a prerequisite for a statewide network built to provide contractors with more exposure to customers seeking ASHPs.

Program History and Relationship Development

Center for Energy and Environment (CEE) launched the Minnesota ASHP Collaborative (Collaborative) in 2019 with initial program support from five utilities.[1] The motivation to create this market transformation program was spurred by cold climate ASHP field research and the Minnesota Energy Efficiency Potential Study, which highlighted heat pumps as an enormous energy savings opportunity (Schoenbauer 2017 and CEE 2018). This program focused on alleviating market barriers informed by market transformation experience that the Northwest Energy Efficiency Alliance (NEEA) documented through their ductless heat pump program, which is now in the long-term monitoring and tracking phase (NEEA 2022). Program efforts in Minnesota have focused more strongly on ducted applications, as the ductless market is

[1] These utilities included two investor-owned utilities and three generation and transmission utilities, respectively: Minnesota Power, Otter Tail Power, Great River Energy, Missouri River Energy Services, and Southern Minnesota Municipal Power Agency.

experiencing higher inherent growth and are less applicable to most homes in the state (CEE 2023a).[2] Early market support strategies for the Collaborative included customer education and support, distributor and manufacturer engagement, creation of a contractor network to connect homeowners with qualified installers, incentives and financing aggregation and communication, and contractor education.

As the program scaled up, the program connected to entities showing initial interest in supporting program efforts through event hosting. These included distributors, engaged cities, and municipal and cooperative utilities. These connections yielded unique engagement strategies. Distributors connected the program with engaged contractors across the state for an early touchpoint with the market. These provided one-on-one methods for interacting, which enabled open dialogue about market barriers and opportunities. Engaged City sustainability staff coordinated events for the program and led outreach to engaged contractors. Lastly, with the support of cooperative utilities, the Collaborative connected with groups of contractors at annual meetings hosted by each utility. These were often held in rural Minnesota where opportunities to cost-effectively displace or replace propane heating with ASHPs presented a strong value proposition for the customer.

In 2021, two key pieces of legislation were passed by the Minnesota legislature. The first was the Energy Conservation and Optimization (ECO) Act. This updated the energy efficiency policy in the state to account for new methods to capture carbon and energy savings including demand response and the mechanism to claim savings for switching fuels (such as a gas furnace to an ASHP). The ECO Act accounts for the higher-than-typical rebates for ASHPs in current utility conservation plans in Minnesota (2024–26).

The second piece of influential legislation was the Minnesota Efficient Technology Accelerator, which was inspired by NEEA and early market engagement by the Collaborative. This legislation created the framework for a market transformation program implemented by a local nonprofit to be overseen and managed by the MN Department of Commerce with funding from the five investor-owned utilities (IOUs) in the state. The statute enables an alternative pathway for utilities to claim savings for activities aside from rebating energy efficiency measures under the traditional deemed savings pathway (MN Revisors Office 2023). These include capturing the savings created from market engagement efforts such as contractor training. In addition, it created a long-term tracking method for implementing codes enhancement that supports efficient technology, such as requiring an ASHP instead of an AC (air conditioner).

CEE was selected by the MN Department of Commerce to implement the Efficient Technology Accelerator (ETA) program. Five initial focus areas were chosen by the ETA program: efficient rooftop units, luminaire-level lighting controls, high-performance windows, gas heat pumps, and dual fuel ASHPs. The pre-existing MN ASHP Collaborative program, operating since 2019, was adapted to implement the dual fuel initiative within ETA along with continued support from the founding cohort of utilities composed of consumer-owned generation and transmission utilities.

Under the new ETA framework, a series of preparations were put in place to systematize the market engagement process. Three in-depth reports were published to set the stage for the next five years of program work. These included an ASHP market characterization, a market transformation plan, and an energy savings and market evaluation plan (CEE 2023a). Market

---

[2] Much of the inherent growth in the ductless market is due to the added benefit of cooling and ASHPs' ability to resolve trouble spots in homes, especially those served by electric resistance heat or homes with boilers.

characterization enabled the creation of a logic model outlining barriers, opportunities, and market support strategies. Using this logic model, a robust market transformation plan was formulated. The plan details the primary focus of the initiative — most homes in Minnesota are single-family dwellings with centrally ducted AC and a furnace fueled by natural gas, propane, or electricity. In Minnesota, replacing central AC with an ASHP was identified as the sector with the most energy savings potential, the best value proposition potential, and the largest market barriers.[3]

Key barriers identified within the plan include an undefined or weak value proposition, lack of contractor and customer awareness and experience, a potential for higher operating costs compared to other fuel types (namely natural gas), and inconsistent incentive designs and product specifications across utility, state, and federal offerings. Key opportunities include a growing motivation to reduce carbon emissions and shift to cleaner heating alternatives, fuel flexibility enabling cost savings and resiliency opportunities for customers and utilities, and state and federal codes and standards as a lever to activate when the timing is correct. Lastly, a set of market support strategies were identified for the market deployment stage of the initiative. These include:

- Building contractor champions through the creation of tools and resources as well as training;
- Driving customer awareness through development of resources and collaborating with other organizations, cities, and utilities;
- Facilitating alignment among incentive programs;
- Working with distributors and manufacturers to support appropriate equipment stocking;
- Collaborating with utilities and regulators on new rates and demand response (DR) programs;
- Supporting product development and utility program development to support DR programs; and
- Influencing state or federal code, policy, or an appliance standard to encourage ASHPs in place of ACs (CEE 2023b).

The partnerships and stakeholder relationships are maturing and solidifying after four years of engagement with the Collaborative program and a new policy and program framework undergirding the approach. Manufacturer relationships continue to evolve and prove a helpful conduit to establish and solidify distributor and contractor engagement. The team meets with HVAC distributors monthly to quarterly. These meetings provide a bi-directional flow of information to refine barriers, opportunities, and strategies; are helpful for recruiting companies into the program's Preferred Contractor Network; and are an avenue to promote contractor participation at training events. Moreover, many distributors hold contractor-focused events in the spring and fall and often invite the Collaborative to table material and/or present on technical topics or program-related material.

The methods for delivering training continue to evolve. Beginning in 2023, the Collaborative team used geographic information system (GIS) tools to assess the intersection of available, qualified contractors to meet electrification demand. Variables assessed included the

[3] This application would leave the current furnace in place or replace the furnace and pair with an ASHP instead of an AC.

location of currently enrolled contractors in the preferred network, the distribution of households in the state, utility funder territories, and previously visited training locations. In Figure 1, a subset of the analysis is shown with training locations overlaid on a household population by census tract layer. This analysis allowed the program team to optimize program monies to maximize the training impact on the market to upskill contractors and provide the training prerequisite for the Preferred Contractor Network. Twelve training events were conducted in 2023 and a similar number are scheduled for the 2024 program year across the state in strategically selected locations.

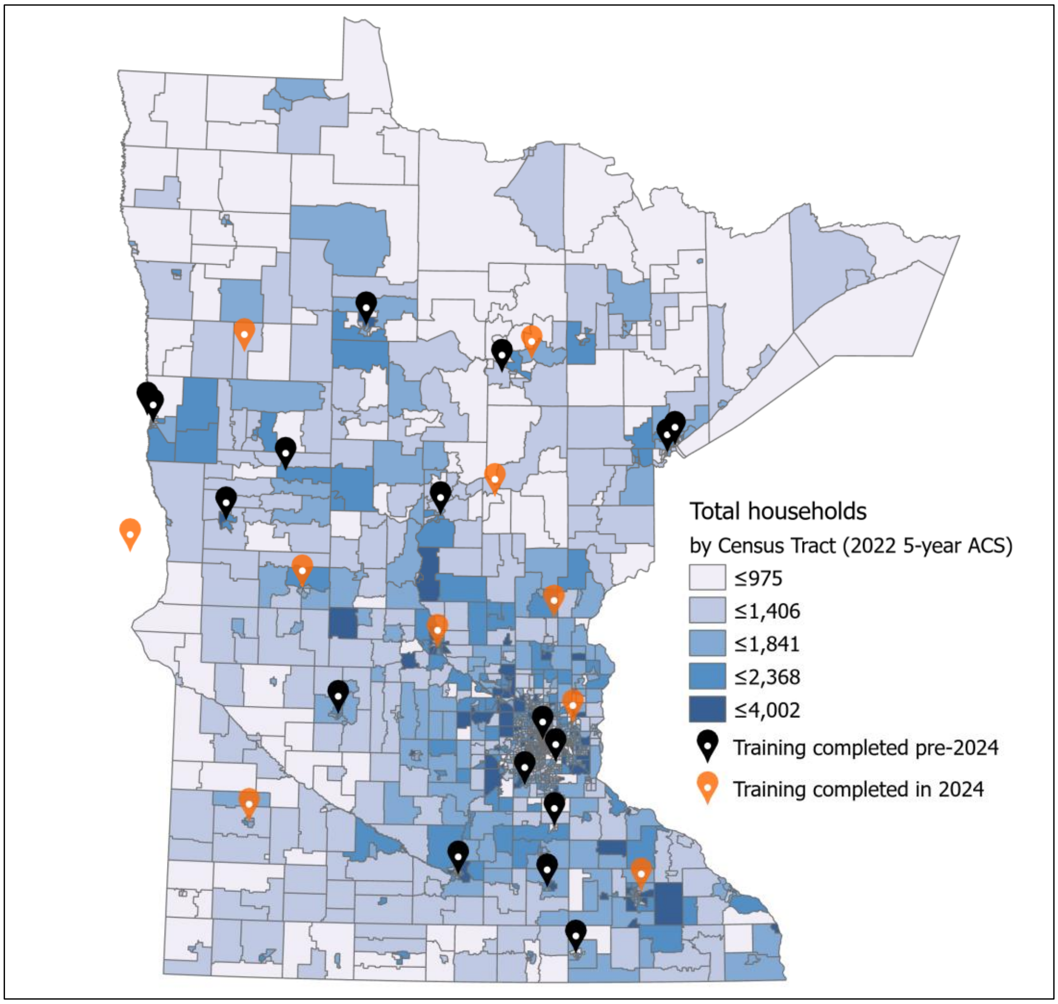

Figure 1. MN ASHP Collaborative training locations and household population by Census Tract

Training Overview

The Collaborative provides in-person and online training to help contractors learn more about heat pump technology and key considerations throughout the sales, installation, and maintenance processes. In-person training events range from two hours to full-day sessions as they are tailored to the needs of partners that host and support the events. The online training module provides about two hours of training content with knowledge checks at the end of each section. Training attendance is required to join the Preferred Contractor Network; this can be satisfied by attending any qualified in-person event or completing the online training module. The length of training depends on a few factors. These include client desires regarding depth as well as meeting the core needs of the market to complement and fill gaps in existing training resources from third parties, manufacturers, and distributors.

The curriculum includes both core sections and supplemental sections. Core sections are required for the Preferred Contractor Network, while supplemental sections are added in some cases depending on the training length or requests from key stakeholders. Table 1 summarizes curriculum sections and subtopics.

Table 1. ASHP training curriculum sections and subtopics

Section	Subtopics
ASHP market and potential in Minnesota	• Consumer interest and sales data • Field research results (performance data and customer feedback) • Incentives and rebates (brief coverage) • National programs driving new technology development
Incentives & rebates (current & future)	• Utility rebates • 25C tax credit and verification resources • Upcoming state and federal incentives • Local programs
ASHP terminology and technology overview	• Definitions of ASHP types, cold climate equipment, coefficient of performance (COP) • Capabilities of single-/two-stage equipment vs. variable speed equipment • Benefits and considerations between ducted dual fuel ASHPs and ducted all-electric ASHPs
Homeowner support & education	• Customer perceptions and priorities • Key support strategies through sales and installation processes • Importance of homeowner education with example topics
Sizing considerations and load calculations	• Manual J and other sizing methods • Risk of oversizing equipment • Importance of a high-effort load calculation instead of a rule of thumb • Ductwork implications and evaluation
Equipment selection and system design	• Overview of sizing and selection resources • Sizing for heating vs. cooling • Review of design challenges and recommendations
Controls	• Thermostat selection and importance of dual fuel compatibility • Balance point types for switchover temperature selection

	• Additional controls settings (droop and upstaging)
Installation considerations	• Unit placement, line set routing and insulation, surge protection • Reference to the Best Practices Installation Guide available through the Collaborative
Example walkthrough	• Overview of an example scenario relevant to the training location walking through the sizing, selection, and installation processes
Summary & closing	• Key takeaways review • Contractor resources, incentives, and financing resources • Preferred Contractor Network overview and next steps for contractors

Homeowner support & education:

The education portion of the homeowner-focused section highlights the key differences between owning a heat pump in place of an air conditioner. Recommended topics to discuss with homeowners include:

- The differences in register air temperatures during the heating season between heat pump and auxiliary heat operation.
- How the heat pump and auxiliary heat system will interact depending on the controls settings and application type.
- Heat pumps operate more efficiently by maintaining a set point over long run times.
- Programming regular setbacks is not recommended for heat pumps though they are standard practice with an air conditioner.
- More frequent defrost operation in cooler ambient temperatures, including the noise and steam release to expect during the process.
- Importance of snow removal around outdoor unit to allow necessary airflow to keep the heat pump operational.
- Utility bill changes: although overall cost savings can be expected in many cases, the homeowners' electric bill will increase while their gas or propane bill will decrease.[4]

Sizing considerations and load calculations:

The section on sizing and load calculations emphasizes the likelihood of oversizing the equipment and the associated operational risks. Even if high-effort load calculations are completed using Manual J or a similar process, built-in safety factors may still result in overestimated heating loads. Load calculation methods are defined by the time and effort required and the anticipated resulting accuracy. The methods caution against referencing existing equipment size or using guidelines that only consider the size of the home such as Btu/sq. ft. The

[4] If the homeowner has an all-electric system, they should expect their electric bill to decrease due to the higher efficiency achieved by heat pump operation over supplemental electric heat systems.

training team touches on industry research such as a recent fieldwork study performed for ComEd finding heating systems to be 3.3 times the design heating load on average (CEE 2024). It is critical to consider the building envelope and local design temperatures in addition to the home size, which can be achieved by higher effort methods like a block load or full Manual J calculation. It is also important to discuss any current or future weatherization improvements the homeowner is considering to ensure the selected equipment will not be oversized for the resulting decreased home loads.

Equipment selection and system design:

The equipment selection section discusses sizing for heating versus cooling and the key operational parameters to consider. While both the heating and cooling loads should always be considered when selecting a heat pump, sizing for heating or cooling depends on the application type, fuel types, and available utility rates.[5] Due to cost challenges related to heating with natural gas versus electricity for the bulk of customers, the typical recommendation is to size heat pumps to the cooling load for dual fuel applications. If favorable electric heating or dual fuel rates are available and have a low cost of entry, which are available in some utility territories, these significantly change the operational economics for heat pump operation (CEE 2023c). The heat pump can be sized to displace more of the heating load if economic benefits can be achieved, but it is important to avoid oversizing the system for the home's cooling load. If the home's cooling load is less than the heat pump's minimum cooling capacity for significant annual operating hours, the resulting low load cycling results in increased stress on the mechanical components, less efficient operation, and negative effects on the dehumidification capabilities of the system.

Controls:

The controls section reviews thermostat selection and compatibility metrics in addition to more specific strategies described in more detail in the following section. For dual fuel systems, it is critical to select a thermostat that is defined as dual fuel compatible and not simply heat pump compatible. Necessary features for dual fuel compatibility include wired or wireless functions that can control the heat pump reversing valve, software protocols that can communicate between the heat pump and auxiliary heating system, and access to outdoor air temperature via sensors or local weather station data to control the system based on the selected switchover temperature. For variable speed heat pumps, proprietary communicating thermostats are the only controls that allow the system to achieve its expected efficiencies in full modulating operation. Third-party thermostats can limit the capabilities of communicating equipment operation since they can only vary system operation by a set number of stages, resulting in losses of efficiency and anticipated cost savings. It is recommended that contractors always engage their distributor or manufacturer's representative for guidance on thermostat selection, especially if the homeowner will only agree to installing or using a third-party product.

Installation considerations:

The installation considerations section walks through several photo examples of proper and poor outdoor unit placement with respect to different considerations such as snow line, drip

---

[5] Heat pumps typically operate cost-effectively, even at lower ambient temperatures and lower coefficients of performance, when compared to electric resistance and propane.

line exposure, wind exposure, and homeowner comfort regarding noise. In the cases where an ideal location cannot be found, risk mitigation strategies such as wind baffles or protective top covers are recommended. Line set topics include routing and insulation. If the line set is routed such that a kink may occur, this can greatly reduce system performance and cause a callback. It is also a difficult problem to identify due to routing and insulation. The full length of the line set should be insulated to reduce efficiency losses, and it is especially important to ensure proper insulation of the section entering the wall penetration to prevent moisture from entering the building envelope. Surge protection is highly recommended for any system that contains microprocessor components, especially since it's a very low-cost option compared to the price of the equipment it's protecting. While the Collaborative provides an installation best practices guide and access to a variety of other third-party resources, it's always recommended for contractors to use resources from their distributors and manufacturers for equipment-specific information.

Summary:

Training development and delivery serves as a key market support strategy to overcome the current barriers to increase heat pump adoption. One of the core focus areas is the value proposition to help contractors understand the benefits of heat pumps and effectively communicate this to their customers. The homeowner education section provides clear talking points around the benefits of heat pumps — examples include fuel rate flexibility, indoor temperature consistency, and increased airflow and ventilation from longer runtimes with variable speed equipment. Increased contractor awareness is a key focus of the Collaborative's efforts, and the training is the most direct contribution to this goal. Contractors are the main interface with a customer purchasing new HVAC equipment, so providing this information to contractors lays the groundwork for extending these valuable messages and resources to their customers. This approach enhances the likelihood of contractors installing heat pumps in their own home, which increases their experience with the technology and further supports sales.

Challenging Training Topics

While the core training materials provide a thorough background on key concepts and quality assurance through heat pump installations, there are a few topics that significantly add time and detail to the core training. Some of these topics are paradoxical within the HVAC profession and need product or technological advancements to resolve barriers.

- The relationship between HVAC sizing and building airflow, pressure, and envelope
- Controls settings and cost implications
- Balancing best practices and creative solutions with practicality

The relationship between HVAC sizing and building airflow, pressure, and envelope

Understanding the relationship between HVAC sizing and building airflow, pressure, and envelope is critical to ensure a quality installation and satisfied customer. These relationships quickly become technically complex, making it difficult to provide valuable guidance through high-level explanations.

In addition to impacting the equipment's ability to deliver heating and cooling capacity, airflow and pressure affect the system's efficiency and ability to remove moisture from the air. A home's sensible heat ratio (SHR) is affected by infiltration, internal gains, and climate. A system's design sensible heat factor (SHF) is affected by indoor wet bulb temperature and indoor unit airflow. The SHR and SHF values should match to ensure the equipment is optimized to provide adequate moisture removal and the delivered cooling and heating loads. Ductwork size, location, and condition are all additional factors that will affect system operation and should be carefully considered through the equipment sizing and selection process. If the ductwork is undersized for the HVAC system, the system performance and homeowner experience will be negatively impacted. Incorrectly sized ductwork has many implications, including but not limited to:

- Delivered air not meeting the expected capacity that the system can achieve
- Increased fan energy use
- Increased noise
- Risk of more regular fan motor replacement
- Risk of coils icing over during the cooling season

If the total external static pressure (TESP) is too high with respect to the recommended range for the system, airflow will be restricted and the system will operate more frequently near full-power operations. While this is the root cause of the main risks previously mentioned, it is also important to note that heat pumps do not achieve their most optimal and efficient operation at high compressor and fan speeds. It is critical to measure and evaluate the system airflow and TESP to guide necessary ductwork improvements to ensure the system will operate as expected.

All these factors require additional time, measurement tools, and calculation processes that are challenging for contractors to incorporate into their standard process. The depth of information required to understand all system interactions and implications makes it difficult to provide valuable content in the standard training offered by the Collaborative. The homeowner's financial situation and the timeline of equipment replacement can further prevent the contractor from making the recommended updates to the ductwork system even if they're able to complete a full analysis.

Weatherization of a home to improve the building's envelope will also significantly impact equipment sizing and selection. HVAC contractors typically do not offer weatherization services, so it can be challenging to select equipment depending on when the heat pump installation occurs in relation to the timing of weatherization work. Through the program's training efforts, the training team encourages contractors to develop relationships with local weatherization service providers to cross-promote each other's work. Many times, a full integration of both separate business models may be uncommon, and so relationship development and cross promotion is identified and recommended as a key solution.

If the customer is interested in weatherization but cannot pay for the service before the heat pump installation, the contractor will need to carefully consider equipment selection so that the heat pump is not oversized for the decreased heating and cooling loads after the home envelope is improved. In this situation, the provided curriculum suggests selecting a unit that has a favorable turndown ratio so that the equipment can still operate most efficiently after the home heating and cooling loads are reduced. The program training team recommends prioritizing a discussion around weatherization with the homeowner so the contractor can make the most informed equipment selection decision.

Controls settings and cost implications

While controls settings are important to ensure comfort and expected system operation, it is also essential to understand the cost implications when controls strategies are set up for a system. Contractors need to understand the different balance point definitions and how to use them as guidance in setting a system switchover temperature and monitoring it over time. Contractors should also understand and implement additional protective controls strategies that can ensure comfort while also helping the homeowner save as much as possible in operational costs. The interplay between these different settings is described in Table 2.

Table 2. Thermal, economic, and comfort balance point

Balance point type	Definition
Capacity balance point	The outdoor temperature at which the heat pump can no longer produce the heat needed for the home, i.e., the thermal balance point.
Economic balance point	The outdoor temperature at which the cost to heat the home with the heat pump is the same or more expensive than the auxiliary heat cost; depends on both gas and electric rates.
Comfort balance point	The outdoor temperature at which the homeowner experiences discomfort when running the heat pump.

The capacity balance point temperature can be identified by the intersection of the heat pump delivered capacity line and the heating load line of the home based on local weather design temperatures.

The economic balance point temperature can be determined by calculating the breakeven coefficient of performance (BeCOP) using utility rates, furnace and ASHP efficiency, and the appropriate constant for the conversion of kWh to another fuel type using the following formula.

$$BeCOP = \frac{(E * C * Ef)}{G}$$

The resulting COP of this calculation should then be used to estimate the switchover temperature based on where it falls between the COP values for the selected equipment at various outdoor air temperatures. The COP values can be found in product data available through the AHRI Directory, the NEEP Cold Climate Air Source Heat Pump List, or manufacturer documentation and tools. The inputs for the formula are:

- E = cost of electricity ($/kWh)
- C = constant (29.3 kWh/therm)[6]
- Ef = furnace efficiency (AFUE %)
- G = cost of natural gas ($/therm)[6]

The comfort balance point temperature cannot be specifically calculated like the capacity and economic balance points since the individual homeowner's experience with delivered air temperatures is subjective. At installation, reference product data to understand how supply air

[6] For propane, the constant C would change to 27 kWh/gal and G would change to cost of propane ($/gal).

temperature will change as ambient outdoor temperature decreases. This will allow the contractor to make an informed estimate of where to set the switchover temperature or apply a compressor lockout to ensure delivered air temperatures stay within a range defined by discussion with the homeowner. A more thorough safeguard includes installing a supply air temperature (SAT) sensor and implementing a control strategy to engage or upstage[7] auxiliary heat if the SAT drops below a defined value.

Consider an example where the homeowner has a propane furnace or a dual fuel utility rate available after a heat pump installation. In this scenario, the economic balance point of the system may be lower than the capacity (i.e., thermal) balance point. The switchover temperature on the controls may be set at or above the capacity balance point as a safety factor to ensure homeowner comfort depending on delivered air temperature values. However, while comfort is the highest priority for the homeowner, they may be losing out on significant operational cost savings. A more thorough solution would be to set the switchover temperature below the capacity balance point and implement additional protective controls strategies, such as a droop temperature and/or time-based recovery,[8] to ensure that supplemental or auxiliary heat is activated when the heat pump can no longer keep up with the home's heating load. The SAT-based controls solution could also fit well here depending on the capabilities of the selected thermostat and integrated system controls. This approach is recommended to achieve maximum operational cost savings and guaranteed comfort for the homeowner.

In addition to the controls strategies that are set up according to the homeowner's priorities of comfort and cost savings, it is also important to consider the operational implications of certain controls settings. It is always recommended to configure controls to allow for the longest possible runtimes as this results in the best possible performance for both the heat pump and the furnace in the case of a dual fuel system. While longer runtimes provide benefits like improved filtration and home destratification, they also improve the annual effective efficiency of the equipment. While rated efficiencies can be expected during standard equipment operation after startup, the effective efficiency also considers the lower efficiencies that occur during initial operation. Effective efficiency provides a more accurate picture of the annual operational efficiency achieved, and longer run times help close the gap between this value and rated efficiency (Schoenbauer et al. 2017). While research on longevity is scarce, pairing a heat pump with a furnace instead of an AC could theoretically prolong the life of the furnace by reducing the number of shorter cycles during shoulder seasons. Since many furnaces are oversized, achieving a control method for dual fuel systems that maximize the heat pump in relation to the customer's goals will assist with this theory of longevity.

Even though controls strategies are set up at equipment installation, it is also important to monitor these selections over time as fuel prices change in relation to one another. If the economic balance point is higher than the capacity balance point during installation, there is a clear opportunity to modify the switchover temperature over time depending on how utility rates change. This is also the case if a utility begins offering a dual fuel rate for customers with heat pump equipment installed. Even if the economic balance point is lower than the capacity balance

[7] In dual fuel applications, the heat pump will turn off to fully engage auxiliary heat. In all-electric applications, the auxiliary heat can be upstaged to run simultaneously with the heat pump and provide additional needed heat.

[8] A droop temperature is a specified value that defines the maximum allowable temperature swing below the heating indoor setpoint before auxiliary heat is engaged. Time-based recovery refers to a controls strategy that checks the indoor temperature in relation the setpoint at a defined time interval (e.g., 30 minutes, 60 minutes, etc.) to determine whether to fully engage or upstage auxiliary heat.

point, it is valuable to assess how it changes over time. Since calculated home loads are typically higher than actual loads due to protective weights in Manual J and similar programs, there is a chance that the real capacity balance point is lower than what is initially calculated. A recommended strategy would be to set the switchover temperature lower than economic balance point and ensure a droop temperature or other protective controls setting is in place; this would result in optimizing the system for more cost savings while guaranteeing comfort.

Balancing best practices and creative solutions with practicality

Given the time constraints to complete jobs, especially in the case of an emergency replacement, it can be difficult to follow all best practices and propose more beneficial, creative solutions to the homeowner.

In the case of best practices, lack of time can affect the amount of effort put into a comfort consultation, home load calculations, equipment selection, and installation. In an emergency replacement, it may be out of scope to discuss weatherization and ductwork updates that would help improve the homeowner's comfort with the new system. If there isn't enough time to complete a Manual J analysis or block load calculation for the home heating and cooling loads, the equipment size may be selected using a general guideline or referencing the size of the previous equipment. However, the latter two methods may result in oversized equipment for the home or inherit issues related to the previous installation's sizing practices. If the homeowner is constrained by upfront cost in an emergency replacement, it may be difficult for the contractor to discuss more expensive equipment that would end up saving the homeowner money over time through reduced operational costs.

Regarding creative solution implementation, time constraints can impact how the contractor is able to use tools to discover solution features beyond a simple replacement as well as how they are able to approach service and maintenance over time with support specific to heat pumps. There are a variety of HVAC tools available to help contractors make more informed decisions on the best possible solutions for each project. Examples include airflow and static pressure measurement tools to analyze ductwork, LiDAR[9] software to assist with load calculations and blower door tests to gain insights on building envelopes. While some types of tools end up reducing the amount of time needed to complete certain processes, the cost and time overhead to obtain tools and train employees on them can inhibit adopting them into standard practice. Given the importance of switchover temperature setting for heat pump operation, there could be some creative approaches to integrate this topic aside from initial installations. Contractors could offer a switchover temperature analysis as part of their maintenance contract offerings to optimize the switchover selection for comfort and economics over time. Controls analysis could also be brought in as an item to assess on service calls even if controls are not the root cause of service needs. Another idea for continuous support pertains to homeowner education — contractors could send out communication to their customers with heat pumps in early fall to remind them of expected defrost operation and the need for snow removal around the outdoor unit.

[9] LiDAR stands for Light Detection and Ranging and is used in HVAC technology to create three-dimensional scans of home interiors.

Resources and Materials

In addition to the focus on training materials, the Collaborative provides online resources for both contractors and homeowners. These materials are easily accessed on the Collaborative website through dedicated landing pages for each audience. A separate landing page for incentives and financing is also available.

Homeowner resources include a heat pump frequently asked questions (FAQ) dialog, case studies, and purchasing guides. A list of contractors in the Preferred Contractor Network, searchable by ZIP code, is provided to guide homeowners to the best businesses in their area when they decide to proceed with purchasing a heat pump.

Contractor resources include a list of upcoming trainings and events, the online training center, the cost of heat comparison tool, and a wide range of technical guides and tools. There is a page dedicated to the Preferred Contractor Network including membership requirements, listing recommendations, and a link to the application.

Since launching the statewide network in 2022, the program has enrolled 50 companies across the state with over 100 contractors in the pipeline. Utilities are referencing the program in various ways, which motivates contractors to participate. Otter Tail Power, for example, uses network enrollment as a prerequisite for a bonus quality-installation rebate (Otter Tail Power Company 2024). Thanks to feedback from contractors through training efforts, the Collaborative successfully worked with utility funders to coalesce around core specifications in their current triennial plans, which helps customers, contractors, and distributors more easily navigate rebate programs and stock products. This spring alone, the Collaborative trained over 300 contractors, nearly 500 in total including utility program staff and distributor staff. Contractors are pleased with the overarching educational framework and find the trainings useful; 79% of post-event evaluation responses marked “very satisfied” on the forms and none responded as “dissatisfied.”

Looking Ahead

Beyond Minnesota, CEE is involved with multiple workgroups at a national level. This involvement provides a method to exchange program lessons, industry trends, and research with stakeholders across the country, as well as bring these developments and best practices back to Minnesota. The following are examples of areas of engagement related to contractor development (excluding other national engagement pathways). The Advanced Heat Pump Coalition (AHPC) convenes multiple workgroups focused on test procedures, ratings, field performance, and equipment roadmaps (MEEA 2024). These AHPC workgroups stay abreast of projects such as those validating test procedures including AHRI 210/240 and CSA SPE-07:23 as well as discuss AHRI 1600 development, which will eventually replace AHRI 210/240. These deep dives are useful to explore concepts such as the variance of equipment performance in real-world conditions versus rated conditions and familiar efficiency metrics (e.g., SEER2, EER2, and HSPF2). Workgroups also discuss proposed metrics and rulemaking that may be considered in the future by efficiency programs such as seasonal cooling and off-mode rating efficiency (SCORE) and seasonal heating and off-mode rating efficiency (SHORE). These latter two metrics are part of a notice of proposed rulemaking and would replace SEER2 and HSPF2 metrics, respectively (DOE 2024a). The program team uses these discussions when training contractors to inform them of performance nuances in the sales and commissioning process.

Relatedly, CEE staff will engage five workgroups hosted by NEEP in 2024 focused on development of content by Pacific Northwest National Lab (PNNL) and its partnering organizations on the following topics: HVAC workforce development, designing and sizing heat pumps in cold climates, extended heat pump performance data, income-eligible program implementation, and the co-promotion of weatherization and heat pump adoption.[10] Engagement in these focus areas will bolster training curriculum through the incorporation of the latest industry trends and information as well as surface gaps to a national audience. Beyond these five new workgroups, CEE continues to engage with the longstanding NEEP workgroup focused broadly on residential heating electrification (NEEP 2024). Lastly, program staff contributed feedback and engaged with a team that developed several resources hosted by the Consortium for Energy Efficiency (CEE1). These include a decision matrix and design guide, controls guides for homeowners and contractors, a duct retrofit guide, system retrofit guide, weatherization guides for homeowners and contractors, and how to live with a heat pump (CEE1 2024).

Starting in 2019, CEE's market transformation initiatives in Minnesota have grown to include other regions. CEE contractor and distributor training efforts now occur in Colorado, Illinois, Iowa, and Utah. Moreover, the program in MN inspired the Midwest ASHP Collaborative, which was launched in 2022 with funding from DOE and PNNL. The Midwest ASHP Collaborative aims to make ASHP technology the primary choice for heating and cooling systems by 2030, focusing on midstream market actors across its 13-state footprint. States in the region are categorized as either Align or Activate, based on their current market development activity and support. The Midwest ASHP Collaborative's efforts center on advancing ASHP technology by addressing opportunities and barriers. In 2023, this included developing an equitable workforce strategy, modeling hybrid heating rates, and sharing best practices. In 2024, the focus is on multifaceted outreach, contractor education, innovative research, and problem-solving, while also working with DOE and PNNL to align similar efforts in other regions. This includes contributions to training modules, workforce development initiatives, and resource development through the Department of Energy Building Science Education Center (DOE 2024b).

Zooming back in at the statewide level, the Minnesota Department of Commerce (MN DOC) will be launching ASHP rebate programs in late 2024 or early 2025 (MN DOC 2024). These rebate programs will be structured around the requirements specified by the DOE for the Home Energy Rebate programs, including the Home Efficiency Rebate (HOMES) program and the Home Electrification and Appliance Rebate (HEAR) program. Additionally, the 2023 Minnesota Legislature passed a bill for additional rebates to support ASHPs and electric panel upgrades, which have their own program requirements. The statute explicitly outlines the requirement for a "heat pump installed by a contractor with sufficient training and experience in installing heat pumps…" and that the "training curriculum must be at a level sufficient to provide contractors who complete training with the knowledge and skills necessary to install heat pumps to industry best practice standards…" (MN Revisor's Office 2023). These training requirements will further enhance the skills of the workforce installing ASHPs in the state.

Relatedly, the DOE Building Science Education Center hosts curriculum guidance for heat pump installation and heat pump comfort advising, which serve as a guidepost for developing future trainings (DOE 2024c). The MN ASHP Collaborative pivoted its training curriculum in 2024 in the direction of these requirements. Currently, the core curriculum meets about 90% of the content requirements for the comfort advising curriculum. If the program is

[10] A sixth workgroup focused on midstream heat pump program development is not an immediate need for Minnesota as most utilities have already received approval for triennial efficiency plans from 2024–2026. Workgroup lessons will be reviewed, but engagement is not needed at this time.

selected to operate a qualified contractor network or deliver training to contractors statewide for the state rebate programs, the curriculum will be fully updated to the requirements outlined by the program administrator.

Conclusion

CEE benefited by standing on the shoulders of giants such as NEEA that have decades of market transformation experience. These exemplary methods enabled the MN ASHP Collaborative to launch a fast-track market transformation program ahead of ETA legislation with a core component focused on contractor skills development. Now, the program has a stable funding stream, rigorous processes and milestones, and methods to evaluate the program at key intervals with widespread participation by MN utilities. Moreover, one of the early identified market barriers related to first costs and the value proposition for the product have been partially alleviated by forthcoming rebate programs from the IRA, state legislation, and the allowance of fuel switching rebates offered by gas and electric utilities. These rebate programs will enable a modernization of the training framework to support a growing network of contractors familiar with the technology and the nuances beyond business-as-usual practice. Many HVAC professionals report feeling overwhelmed with the flood of changes in the market surrounding refrigerants, test procedures, tax credits and rebates, and equipment developments. Close attention in the coming years will be paid toward filling gaps in education as well as streamlining and simplifying training approaches.

References

DOE (Department of Energy). 2024a. “Appliance and Equipment Standards Rulemakings and Notices.” www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=48&action=viewlive.

———. 2024b. “Building Science Education Solution Center.” Building Technology Office. Accessed March 2, 2024. bsesc.energy.gov/.

———. 2024c. “Heat Pump Programs.” Buildings Science Education. Accessed March 3, 2024. bsesc.energy.gov/recognition/heat-pump-programs.

CEE (Center for Energy and Environment). 2018. *Minnesota Potential Study.* www.mncee.org/minnesota-potential-study.

———. 2023a. "Research Data." ETA Minnesota. Accessed March 2, 2024. www.etamn.org/research-data.

———. 2023b. *ASHP Market Transformation Plan.* ETA Minnesota. www.etamn.org/sites/default/files/research-papers/ASHP%20Market%20Transformation%20Plan%20FINAL%201.pdf.

———. 2023c. *Developing Electric Rates for Hybrid Air Source Heat Pumps in the Midwest.* www.mncee.org/sites/default/files/report-files/Developing%20Electric%20Rates%20For%20Hybrid%20Air%20Source%20Heat%20Pumps%20In%20The%20Midwest.pdf.

———2024. *Variable Speed Heat Pumps as Air Conditioner Replacement.* innovate.comed.com/wp-content/uploads/2024/04/ComEd-Customer-Innovation-Variable-Speed-Heat-Pumps-as-Air-Conditioner-Replacement-Executive-Summary.pdf.

CEE1. 2024. "Heating and Cooling Systems: ASHP Quality Installation Resources." Accessed March 2, 2024. cee1.org/program-resources/.

———. 2024. "Weatherization for Contractors" Accessed March 2, 2024. cee1.my.site.com/s/resources?id=a0VTR000000LFTx.

MEEA (Midwest Energy Efficiency Alliance). 2024. "Advanced Heat Pump Coalition." Accessed March 2, 2024. www.mwalliance.org/advanced-heat-pump-coalition#Workgroups.

MN ASHP Collaborative. 2024. "Resources and Guides for Contractors." Accessed March 2, 2024. www.mnashp.org/guides

———. 2024. "Resources for Homeowners." Accessed March 2, 2024. www.mnashp.org/for-homeowners

MN DOC (Department of Commerce). February 12, 2024. "Home Energy Rebates." Accessed March 3, 2024. mn.gov/commerce/energy/consumer/energy-programs/home-energy-rebates.jsp.

MN Revisor's Office. 2023. "Sec. 216C.46 Residential Heat Pump Rebate Program." www.revisor.mn.gov/statutes/cite/216C.46.

———. 2023. "Sec. 216B.241 Subd. 14 Minnesota efficient technology accelerator." www.revisor.mn.gov/statutes/cite/216B.241#stat.216B.241.14.

NEEP (Northwest Energy Efficiency Partnerships). 2024. "Heating Electrification." Accessed March 2, 2024. neep.org/smart-efficient-low-carbon-building-energy-solutions/air-source-heat-pumps.

Northwest Energy Efficiency Alliance (NEEA). 2022. "Ductless Heat Pumps." neea.org/success-stories/ductless-heat-pumps.

Otter Tail Power Company. 2024. "Quality Installation Program." Accessed May 13, 2024. www.otpco.com/ways-to-save/programs/quality-installation/.

Schoenbauer, B., N. Kessler, A. Haynor, D. Bohac, M. and Kushler. 2017. *Cold Climate Air Source Heat Pump.* www.mncee.org/sites/default/files/report-files/cold-climate_0.pdf.

TEC (The Energy Conservatory). 2024. "Knowledge Base." Accessed March 2, 2024. energyconservatory.com/support/