FOCUS ON ENERGY EERD REPORT:

Air Source Heat Pumps in Wisconsin Multifamily and Single-Family Applications

Center for Energy and Environment

Elevate Energy

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Executive Summary

The purpose of this project is to help Focus on Energy (Focus) maximize energy savings from air source heat pumps (ASHPs), with an additional benefit of exploring ASHP applications that could result in greenhouse gas (GHG) emissions reductions in the future. The project conducted research and analysis in five areas:

I. Economics and market potential
II. HVAC contractor research
III. Multifamily building owner and manager research
IV. Review of current Focus programs
V. Program best practice review

Insights relevant to Focus programs are provided in each of these areas in the main report. We used these insights to develop the following conclusions and recommendations to help guide Focus efforts around maximizing program performance:

1. The ASHP offering will need to dramatically expand in the coming years to meet current and future savings goals; it is a critical element of the Focus portfolio.
2. The A/C replacement market is the most critical market-driven priority in the short term.
3. The largest retrofit opportunity is the nearly 400,000 Wisconsin housing units currently heated with electric resistance.
4. Especially high barriers to participation exist for multifamily electric resistance customers.
5. Develop tiered ASHP rebates based on equipment efficiency and application.
6. Develop a “heat pump for A/C” initiative.
7. Conduct additional contractor engagement, including training.
8. Develop additional customer education materials and targeted campaigns to support contractor sales.
9. Explore partnerships with rural utilities to develop additional heat pump opportunities in rural areas, particularly for propane applications, which present member and customer benefits as well as GHG savings opportunities.
10. Develop a comprehensive offering for multifamily customers, focusing on electrically heated multifamily buildings.

Introduction

ASHPs are an efficient heating and cooling technology with the potential to improve space heating and cooling and lower energy costs, especially in homes located in cold climate regions. ASHP technology has been available for decades, but continuous improvements to the technology since the 2010s have resulted in impressive increases in cold climate performance. Prior to these changes, limits to ability of ASHPs to produce heat with outdoor air temperatures below 40°F resulted in contractor and customer concern over the effectiveness of ASHPs in colder climates. Now, ASHPs can produce heat well below zero and offer energy efficiency and GHG emissions reduction opportunities.

There are two main types of ASHPs in common usage: ducted systems, which are primarily unitary and serve the whole home through ductwork (but can also include short-run ducted systems that provide zonal heating and cooling), and minisplits, or ductless heat pumps. Ducted systems are appropriate for homes that have existing forced air heating and cooling systems. They can replace a central air conditioning (A/C) unit to provide cooling as well as heating. Minisplit systems couple an outdoor unit with one or more indoor "heads" that distribute heating and cooling to individual zones or rooms within a home — multiple heads would be needed to serve an entire building. According to HVAC contractors, minisplits saw an especially large uptick during the COVID-19 pandemic as at-home offices needed comfort enhancements. The industry continues to innovate with new features, configurations, and performance improvements. Figure 1 shows what common ASHP systems looks like.

Figure 1. Exterior and interior equipment of ducted ASHP (left) and ductless minisplit (right).

Cold Climate ASHPs

Research conducted by Center for Energy and Environment (CEE) and others has demonstrated that while the efficiency and capacity of older ASHPs does drop significantly for outdoor temperatures below 40°F, the newest generation of ASHPs can operate down to -20°F — and in moderate temperatures, these technologies are more than three times as efficient as standard electric heating systems (especially ductless minisplits).[1] The improved performance of this newer generation of ASHPs is attributed to the addition of an inverter-driven compressor and updates to the refrigerant, which make the systems better suited for cold climate heating. The inverter-driven compressor allows the compressor speed to modulate and increase capacity during periods of colder outdoor air temperatures.

This new generation of the technology is often referred to as cold-climate ASHPs (ccASHPs), and both ductless minisplit and ducted ASHP product lines can have this cold climate functionality. Most major manufacturers carry a ccASHP product line. The Northeast Energy Efficiency Partnership (NEEP), Northwest Energy Efficiency Alliance (NEEA), and the Minnesota ASHP Collaborative (implemented by CEE), each define ccASHPs as having inverter-driven technology. Additionally, the NEEP Qualified

[1] CEE research looking at ducted ASHPs recorded one temp reading as low as -21F: https://www.mncee.org/resources/projects/cold-climate-air-source-heat-pump-field-assessment/

Products List rates a piece of equipment as cold climate if the Coefficient of Performance (COP) is 1.75 at 5°F.[2] Many utility programs that do not use the NEEP QPL define a ccASHP as having an HSPF above 9 for ducted systems and above 10 for ductless systems.

CEE field research in Minnesota (with residential heating loads like those in Wisconsin) found that ccASHPs performed to their rated specifications for both system capacity and efficiency — coefficient of performance (COP) or heating seasonal performance factor (HSPF).[3] With proper sizing, installation, and integration with back-up heating systems, ccASHPs are an attractive heating system retrofit in housing with electric or propane heating. Further, CEE research showed that cold-climate ductless minisplits can reduce energy use and cost by more than 50% when replacing electric resistance heat, and ducted ccASHPs can reduce energy use by ~60% and cost by ~40% when displacing propane heating. In providing an opportunity to electrify some of the heating load in homes with existing natural gas or propane systems, ASHPs can also provide a GHG emissions reduction opportunity. This exact opportunity is dependent on the Wisconsin electric grid and warrants further investigation, as discussed in the Conclusions and Recommendations section.

Key Technical Considerations

In many ways, heat pumps represent a new category of HVAC for most northern-climate contractors. They have many features, applications, and configurations that are not customary for natural gas and delivered fuel heating options. Some of their key features includes:

- **Heat pumps provide both heating and cooling and offer a dual fuel heating solution.** While the name suggests that this technology mainly provides heat, it is also a highly efficient cooling solution. Installing a heat pump (ducted or ductless), allows the homeowner or tenant to add cooling in situations that previously had none or need an A/C replacement, as well as supply heating. ASHPs, especially ducted systems, represent a dual fuel heating solution as they can be paired with a natural gas or propane furnace. In these instances, the heat pump is the A/C and can serve as a supplemental or primary heat source, with the original heating source acting as a back-up heating option. Supplemental heating is typically more common in these situations (mainly due to economics, as discussed later in this report), but an ASHP with cold climate functionality can easily perform as primary heat source.
- **When installed to provide most of the heating load, heat pump equipment must be sized for heating capacity, which is typically greater than cooling capacity.** In Wisconsin's climate zone, the heating load is as much as two times greater than the cooling load. Thus, when installed for heating as well as cooling, an ASHP must be sized for greater capacity to meet low-temperature heating needs (this also due to the ASHP's change in COP at colder temperatures). However, there is a tradeoff between sizing the system to meet the full heating load, which might require a five-ton system, versus sizing it to meet some or *most* of the heating load or matching to the A/C load (which might be a two-ton system). As with any heating and cooling system, an initial home inspection and analysis of optimal system design

[2] The COP is the ratio of energy input to energy output. For example, a COP of 1.75 indicates that 75% more energy is produced by the system in heating energy than goes into the system in terms of electricity. The fact that the COP can be greater than 1.0 (or 100% efficiency) is since ASHPs do not directly heat the air, but rather move it from one place to another via the vapor-compression cycle.

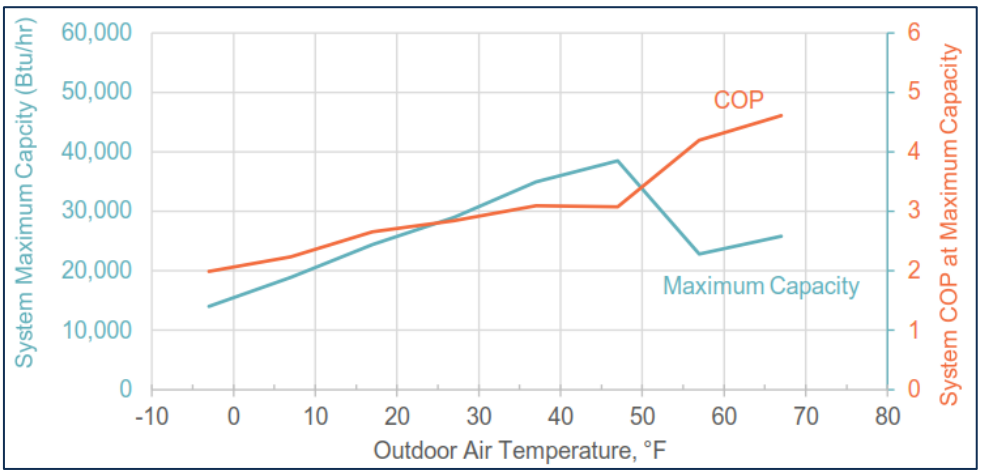
[3] *Cold Climate Air Source Heat Pump Field Assessment*, Center for Energy and Environment (2017): "Inverter-driven cold climate ASHPs are capable of operating at very cold temperatures. The monitored performance of the heat pumps systems verify that their installed performance is in line with the manufacturer performance specifications." https://www.mncee.org/cold-climate-air-source-heat-pump-final-report

is recommended. This inspection would ensure the ductwork could handle the ASHP capacity and could provide suggestions for home envelope/air sealing upgrades.[4]

- **Ductless minisplits can provide zonal/single room heating and cooling.**
  A ductless minisplit indoor unit, called a head, can be installed in zones or rooms that do not have access to ductwork or exist within homes that do not have ductwork. These housing types include those that are heated hydronically (with a natural gas boiler) or heated with electric baseboard panels. Ductless minisplits in these applications are particularly useful for solving comfort issues, such as by adding A/C functionality, or adding additional heating or cooling to a specific zone or in "bump out" or new room additions.

- **Energy performance decreases with colder air temperatures.**
  Not only do colder temperatures require increased capacity to meet the load, but the conversion efficiency also decreases (see Figure 2, below). As the unit reaches its design minimum operating temperatures, the COP approaches 1.0, which is no better than electric resistance heating performance.

Figure 2. Illustration of ducted ASHP COP and capacity variance by outdoor air temp.



One significant implication of the variability of ASHP performance is that the economics of heating vary by outdoor air temperature. Certain back-up heat fuel types are more economic for meeting heating loads during very cold temperatures, even if the ASHP can technically perform. A contractor can set a "switchover temperature," which tells the system what outdoor air temperature that heat is provided by the ASHP versus the back-up source, to maximize cost-effectiveness and heating performance. Homeowners can also adjust the switchover temperature.

- **In most cases, back-up heat is needed for peak winter cold snaps.**
  Related to the considerations noted above, in most cases a back-up heating source is recommended to meet Wisconsin peak winter heating loads. This is the case even when ASHP systems are sized correctly, but especially for systems that are sized primarily to meet cooling loads. However, ASHPs, and especially cold climate ASHPs, are highly effective at capturing most of the heating load, limiting the need for back-up heat to winter cold snaps. Most heating days are

[4] CEE would not recommend sizing the ASHP to ductwork capacity, as that could limit system performance. Instead, we recommend sizing for the correct application and testing the ductwork as part of the QI process. While CEE research has shown ductwork is most often insufficient for the correct ASHP size to heat the home effectively, the corrections to the ductwork are relatively minor; they just need to be identified prior to installation.

typically well within the ASHP's designed effective performance range. This means that the original heat source is left in the place and a thermostat communicates between it and the ASHP.

- **Controls and system design can be more complex than traditional HVAC systems.** Heat pumps are not a new technology, but their limited use in cold temperatures prior to recent technology advances has meant that there is much for contractors to learn about installation, sizing and system design, and helping customers control heat pump systems. Controls can be more complex than traditional HVAC systems due to the integration of the heat pump with an existing heating and cooling system and the communication with the back-up heat source. Contractors and customers who are not familiar with controls may not design or operate the system in a way that delivers optimal savings.

Focus EERD Multi- and Single-Family ASHP Research

Purpose

The purpose of this research is to help Focus maximize energy savings in the residential sector (both multifamily and single-family housing) from ASHPs in the current and future quadrennial periods. The new construction market was excluded from this assessment. However, there are gray areas in which bonus rooms or additions may be considered retrofits or new construction, depending both on how they are recorded in Focus' SPECTRUM database and how contractors consider them. Broadly speaking, the research team conducted secondary and primary market research and analysis, including:

- **Economics and market potential** – We collected Wisconsin and Focus market data and conducted analysis of ASHP economics and market potential by housing and existing fuel type.
- **HVAC contractors voice of the customer research** – We conducted HVAC contractor market research including a survey and a focus group of 30 Wisconsin contractors.
- **Multifamily building owner and manager voice of the customer research** – We conducted multifamily building owner and manager one-on-one interviews and two focus group sessions.
- **Best practice review** – We conducted a review of program best practices, informed by a literature review and interviews with five utility program managers overseeing ASHP programs in cold climates across the Northern U.S.

Insights from our research are provided in each of the sections below. These insights have informed a list of 10 conclusions and recommendations that we present for consideration and further discussion, to help further the goal of maximizing ASHP energy savings potential.

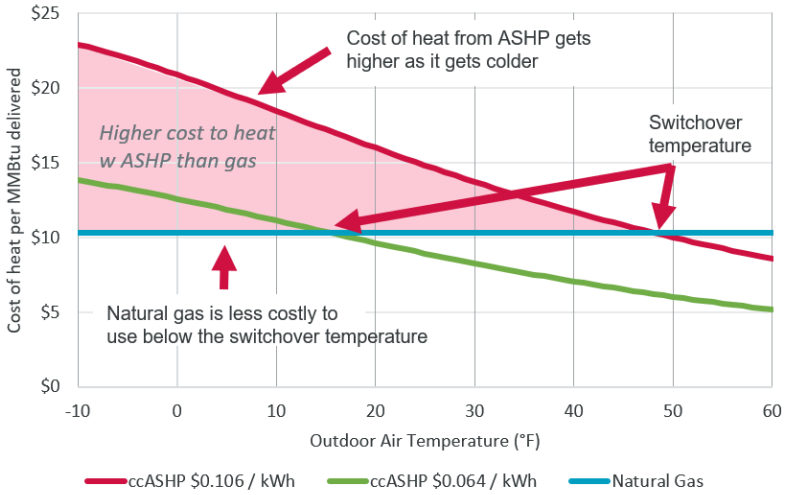
Heat Pump Economics and Market Potential

Economics

Heat pump applications in existing homes are a unique HVAC retrofit in that they typically do not completely replace the existing heating source in cold climates. Instead, they are typically designed to displace a portion of the home heating load, while keeping the existing heating source in place as back-up heat for the coldest days of the year. The temperature at which back-up heating is *needed* will depend on the heat pump product specifications, the sizing of the system, and the building envelope. However, the temperature at which back-up heating is *preferred* by the customer likely depends on how much it costs to heat, as well as comfort and individual GHG reduction goals. Comparisons of heating costs are shown in Tables 2 and 3, below (for natural gas and propane, respectively). An example illustration of relationship between operating costs and outdoor air temperature is shown in Figure 3.

Importantly, these calculations are not static but depend on changing fuel and electricity prices, heat pump performance, and building factors. The figures and tables below are meant to be illustrative of different heat pump applications and the impact they could have on customer's heating cost and energy use. Note that customers will also experience cooling savings and performance benefits).

Figure 3. Illustration of impact of switchover temperature on operating costs.



To provide insight into the customer economics for different existing fuel types, the research team conducted custom modeling based on research of ccASHP performance (ducted and ductless). We used the following assumptions:

Table 1. Key assumptions used in engineering calculations.

Assumption	Value
Cost of electricity (WI ave. rate)	$0.1066/kWh
Cost of electricity (lower rate)	$0.07/kWh
Cost of natural gas	$0.81/therm[5]
Cost of propane	$1.83/gallon
Baseline/existing furnace AFUE	90%
Heating load	643 therms
Weather station data	Madison

The tables below demonstrate customer and energy savings for ASHPs (ducted and ductless) by fuel type and with three separate switchover temperatures for ducted ASHPs. The ASHP modeled for these scenarios represents the typical performance of a variable speed ASHP on the Northeast Energy Efficiency Partnership's (NEEP's) qualified products list.[6] These modeled numbers are subject to variability in real-world scenarios (for example, there will be variable performance dependent on home envelope, system design, customer behavior, and contractor knowledge of ASHP optimization).

[5] "Residential, Average Delivered" price is $8.39/MCF which is $0.81/therm – via the EIA Annual Energy Outlook projection for 2022 price for East North Central region (this is Wisconsin's region).
[6] In 2019, NEEP published an updated ccASHP product list based on ccASHP specification V3.1: COP @5°F >1.75 (at maximum capacity operation).

Table 2. Engineering calculations for ASHP situations with existing natural gas furnaces.

	Energy Use			Customer Heating Cost			
Application	**Gas (MMBtu/yr)**	**Gas Reduction (MMBtu/yr)**	**Electric Increase (kWh/yr)**	**Gas & Electric (Ave. Rate)**	**Ave. Rate Savings**	**Gas & Electric (Lower Rate)**	**Lower Rate Savings**
Baseline – gas (condensing)	*75*	*n/a*	*n/a*	*$ 607*		*$ 607*	
Dual fuel 5°F switchover	17	58	5,847	$ 762	$ (155)	$ 537	$ 70
Dual fuel 25°F switchover	37	38	3,479	$ 673	$ (66)	$ 540	$ 67
Dual fuel 45°F switchover	66	9	650	$ 602	$ 5	$ 577	$ 30

Table 3. Engineering calculations for ASHP situations with existing propane furnaces.

	Energy Use			Customer Heating Cost			
Application	**Gas (MMBtu/yr)**	**Gas Reduction (MMBtu/yr)**	**Electric Increase (kWh/yr)**	**Gas & Electric (Ave. Rate)**	**Ave. Rate Savings**	**Gas & Electric (Lower Rate)**	**Lower Rate Savings**
Baseline – propane (condensing)	*75*	*n/a*	*n/a*	*$ 1,495*		*$ 1,495*	*n/a*
Dual fuel 5°F switchover	17	58	5,847	$ 964	$ 531	$ 740	$ 755
Dual fuel 25°F switchover	37	38	3,479	$ 1,114	$ 381	$ 981	$ 514
Dual fuel 45°F switchover	66	9	650	$ 1,381	$ 114	$ 1,356	$ 139

Table 4. Engineering calculations for ductless minisplits in electric resistance retrofits.

		Energy Use		Customer Heating Cost	
Sector	**Application**	**Electric (kWh/yr)**	**Electric Reduction (kWh/yr)**	**Electric Heat Cost**	**Savings**
Single Family	*Baseline – SF electric resistance (ER) baseboard*	*18,840*	*n/a*	*$ 2,008*	*n/a*
	Ductless minisplit w/ ER back-up	12,228	6,612	$ 1,303	$ 705
Multi-Family	*Baseline – MF electric resistance baseboard*	*9,962*	*n/a*	*$ 1,062*	*n/a*
	Ductless minisplit w/ ER back-up	6,047	3,915	$ 645	$ 417

In the ductless minisplit scenarios in Table 4, CEE modeled retrofit applications that allow for the maximum displacement of the original heat source (i.e., not minor zonal heating in additions or an add-ons), while optimizing customer savings based on energy savings and the upfront cost.

Note that in ductless minisplit applications, it is not typically cost-effective to put a minisplit head in every room. Many homes, as well as multifamily units, have a bathroom or small back bedroom that has such a small heating load that the extra cost of adding a minisplit to capture that load does not make economic sense. This results in the ductless minisplit system not displacing as much of the heating load as it is technically capable of. Please see Appendix E for ASHP heating hours and load proportions.

Market Potential

As shown above, single-family homes heated with electric resistance, followed by multifamily units heated with electric resistance, have the best per-housing unit customer economics and should be priority markets. Additionally, single-family homes heated with propane will nearly break even on energy costs, while capturing a large portion of their heating load and adding comfort and price stability to their home heating and cooling. Since the existing heating fuel type is such a significant indicator of the economic and savings potential for heat pump retrofits, our market analysis looked at the scale and geographic distribution of housing and heating types to demonstrate heat pump market potential.

Table 5 shows the number of Wisconsin housing units for each major heating source (electric, propane, natural gas furnaces and boilers). For electric and propane heated housing units, it also shows the percentage of that housing and heating type that are income eligible (using Focus' standard of income eligibility). For example, there is a notably high percentage of electrically heated multifamily units that are income eligible, as well as a high total number. These are statewide data, so there are 14 non-Focus-member utilities included (which represent mostly Western Wisconsin rural cooperatives).

Table 5. Total market size by existing fuel type.[7]

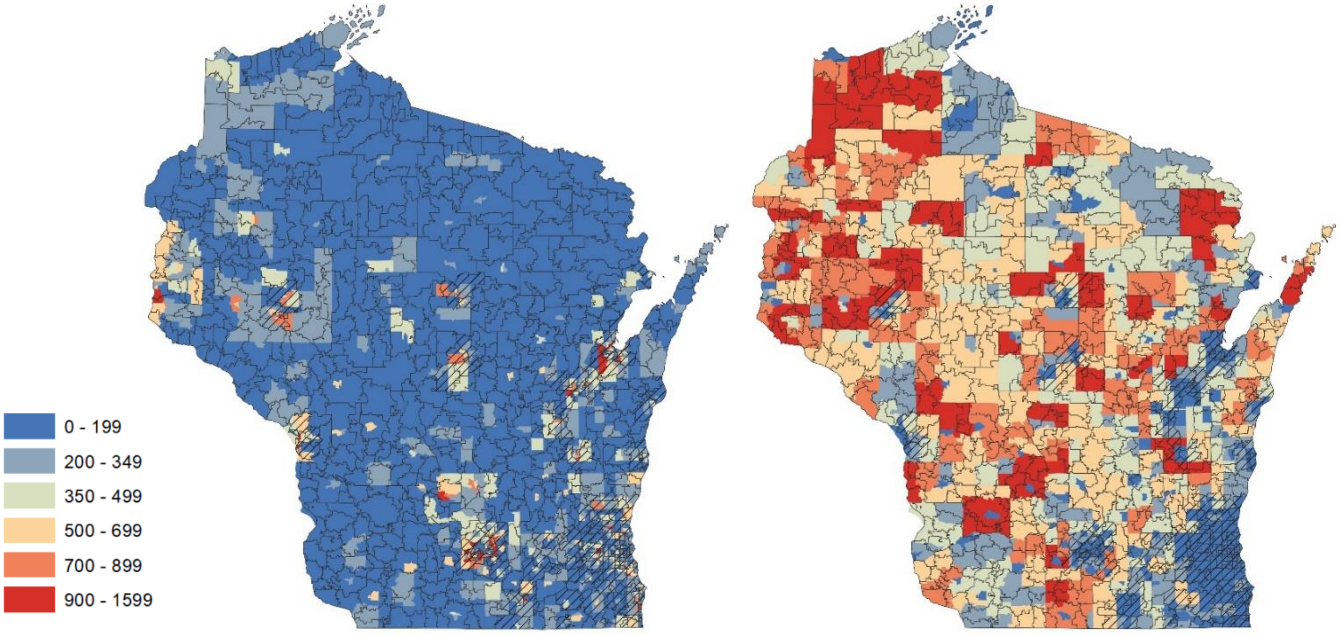
Existing fuel type	Single family units (% income eligible)[8]	Multifamily units (% income eligible)	Type of HP – SF/MF[9]
Electric resistance	157,210 (42%)	221,138 (67%)	Minisplit / Minisplit
Propane	247,274 (37%)	5,572 (73%)	Ducted / Minisplit
Natural gas total	1,276,125 (36%)	224,557 (63%)	NA
Natural gas – forced air[10]	1,046,422	121,261	Ducted / Minisplit
Natural gas – boiler	38,283	53,894	Minisplit / Minisplit

The following maps (Figures 4 and 5) show the geographic distribution of electrically heated and propane heated housing units, represented in number of housing units, not percentages. The lines on the map are zip code boundaries and the color variations per housing and heating type fall along Census tracts. Zip codes that are rural-eligible are clear and zip codes that are not rural eligible have diagonal lines running across them.

[7] IPUMS data, or Census micro-data were used.
[8] The research team used an R script to determine the percentage of housing units that are income eligible.
[9] Note: SF = single-family and MF = multifamily. Heat pump types listed are those predominant for the application (either ductless minisplit or ducted systems). In almost all multifamily housing with greater than four units, ductless minisplits are the heating/cooling solution. However, there are sometimes gray areas, such as single-family homes heated with ducted electric furnace or a multifamily unit with an in-unit furnace.
[10] Numbers from IPUMS data and penetrations of furnace type determined by the Focus 2016 Potential Study Appendix A (baseline data). MF standard/low-income central gas boiler is .54; MF standard/low-income central gas furnace is .24; SF standard/low-income central gas boiler is .03; SF standard/low-income central gas furnace is .82.

As shown in the maps, the prevalence of heating fuel types varies throughout Wisconsin. The maps here show the number of units with each heating type rather than the percentage of units with each heating type. This gives the greatest sense of potential for where Focus heat pump programs can achieve savings. For example, some areas that do not have a high percentage of electrically heated housing, such as Madison and Milwaukee (which are natural gas dominant) have an overall high number of total electrically heated units. These occur primarily in multifamily housing. Overall, the areas of Madison, La Crosse, Menomonie, and Eau Claire are ideal areas to target as they contain significant number of multifamily units and large number of electrically heated homes. In Appendix A, we provide additional maps that demonstrate heating and housing types as a percentage as well.

Figures 4 and 5. Maps of Wisconsin housing units heated with electricity (left) and propane (right). Zip code boundaries are shown; non-rural zip codes have a diagonal line pattern.



Key Findings

1. The largest per-unit economic and energy savings potential exists in single-family homes with electric resistance heating.

The greatest energy savings and reduction in customer energy bills occurs from ASHPs installed in single-family homes. It is very cost-effective for homeowners with electric heating to install ASHPs, so this segment should be a programmatic focus. Since electric resistance baseboard heating (the main type of electric resistance heating found in Wisconsin) has a long design lifetime and does not need maintenance, HVAC contractors are not likely to visit these homes on service calls or to replace heating systems. Therefore, marketing and customer education campaigns are likely needed to reach customers with electric resistance heating and spur demand. This increased demand needs to be met with contractor buy-in and proficiency with installing heat pumps (which entails a contractor training and engagement approach).

2. ASHPs can economically displace a portion of the propane heating load and provide a near-breakeven retrofit when displacing a portion of the natural gas heating load.

The price of propane tends to fluctuate widely and can increase significantly in cold snaps when there is high demand and a shortage of supply. At the current price of propane (see Table 1, above),

ASHPs can economically displace the majority of the heating load while also providing price and winter heating stability for the customer. Additionally, with the current natural gas price and average Wisconsin cost of electricity, ASHPs can cost-effectively provide heat during temperatures in the shoulder seasons (generally, CEE refers to temperatures greater than 40°F as "shoulder season" temperatures). This scenario provides homeowner with flexibility for heating and a breakeven point for costs. However, the cost savings decrease in natural gas installation scenarios when operating ASHPs down to cold temperatures (5°F and lower). That said, displacing a portion of the natural gas heating load can provide cost savings for the customer if there is a lower electric rate (e.g., an opt-in dual fuel or electric heating rate).

3. Rural-eligible zip codes have highest potential for propane heating ASHP retrofits and there are obvious call-out areas with high amounts of electric heating.

The maps above show zip code outlines, with non-rural zip codes demonstrating a diagonal pattern, and all rural-eligible zip codes showing up as non-patterned. The propane heating map shows many rural zip codes with high numbers of propane heating. These present a great opportunity for installing ducted ASHPs to help customers stabilize their heating costs against the fluctuation of propane prices. Additionally, as the Wisconsin electric grid becomes cleaner, these areas present an opportunity for GHG reduction.[11] The electric heating map shows less overlap between electric heating and rural-eligible zip codes. However, a few call-out areas with rural-eligible zip codes and many electrically heated units include: the Hudson-to-St. Croix Falls area on the Western border; Superior in the far Northwest; and North of Madison (the Wisconsin Dells area). Through an initial load analysis, and later billing analyses for more exact targeting, Focus or member utilities can identify which areas have significant loads (i.e., are mainly full-time occupied) and confirm the presence of electric heating.

4. Most electrically heated housing units are income eligible, especially in multifamily.

The research team investigated the relationship between low-income eligibility and electric heating. For this we used Focus' eligibility standard: 80% SMI (which varies per number of people in the home). Of electrically heated multifamily units, nearly 70%, (147,421) are income eligible. Of electrically heated single-family homes, around 40% (66,609) are income eligible. As electric resistance is already an expensive way to heat, customers in this housing type can be expected to have the highest energy burden of anyone in the state. They are the most in need of efficiency programs to help them reduce that energy burden. The research team also considered the relationship between housing type (e.g., large multifamily, small multifamily, single-family, etc.) with heating fuel. Our research showed that medium multifamily buildings (in the 5–19 and 20–49 units size range) are more likely to have electric heating. Further research is needed to confirm that relationship.

HVAC Contractor Market Research

HVAC contractors are critical partners in the advancement of the air source heat pump market. Prior heat pump market research reflects that multiple stakeholders — program administrators, manufacturers, distributors, contractors, and customers — consider contractors to be the critical sales agent for ensuring that the market grows.[12] Customers tend to rely on input from the contractor, and only a small segment of customers ask for heat pumps without prompting from the contractor. And

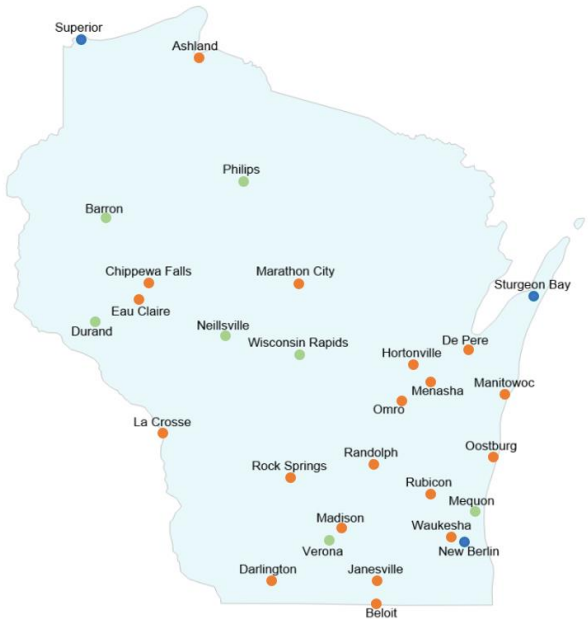
[11] ASHPs are truly a future-looking technology. The trend is for state electric grids to become "cleaner," or to have a generation mix that is composed of a higher percentage of renewable energy sources. As this happens, electrifying heating loads becomes a no-brainer for reducing GHG emissions. The 15–20-year lifespan of ASHPs suggests that utility programs should be planning for this future *now*.

[12] Cadmus study: Most program administrators indicated that installers are the greatest driver of cold-climate air source heat pump adoption.

yet, contractors tend to recommend heat pumps infrequently.[13] It is widely observed that HVAC contractors are more interested in providing an uncomplicated service (i.e., with few to no call backs) than they are in selling or upselling an item that can be more complicated to install and more difficult to explain to the customer.[14] For these reasons, recommending ASHPs as a first-choice item will not come easily to contractors, but it needs to in order to advance the market.

The research team conducted a survey and focus group with Wisconsin HVAC contractors. The team's survey reached 23 contractors, and the focus group included 10 contractors. There was an overlap of three contractors between the survey and the focus group, so 30 unique contractors were reached through this project. The lists of contractors reached out to were provided by the implementers of Focus' Residential Trade Ally Solutions and Midstream Solutions. The map in Figure 6 below shows where the contractors were located. See Appendix B for detailed contractor engagement results.

Figure 6. Map display of contractors surveyed (orange) and focus group participants (green). Three contractors were surveyed and focus group participants (indigo).



Key Findings

Similar themes arose in the responses collected in the survey and the focus group. Overall, nearly all the contractors the research team engaged with had a positive impression of heat pumps (only two contractors responded to the survey that they felt heat pumps can never be a solution in Wisconsin's climate). Yet, survey responses were mixed on whether contractors considered heat pumps to be a growing part of their business (12 yes; 10 no; 1 no answer). Below, we discuss some of the barriers to and opportunities for advancement, gathered from our contractor research.

[13] NEEA: Conclusion 2: Installers recommend DHPs to customers when they consider the units to be the most appropriate application; however, more than half of HZ3 installers recommend them infrequently.
[14] This insight is shared anecdotally from many ASHP programs, including those observed in this report: Efficiency Maine; Efficiency Vermont; NYSERDA; Consumers Energy; and the Minnesota ASHP Collaborative.

1. The low cost of natural gas can make heat pumps a less attractive heating solution.

Contractors are closely attuned to the costs of heating with different types of fuels. Consistent with our findings in the economics section, contractors felt that affordable natural gas makes heat pumps a less attractive option when serving single-family customers. Nearly all the contractors participating in the focus group stated that fuel cost has a big impact on selling ASHPs. The cost of electricity ($/kWh) is typically greater than the cost of natural gas ($/therm) — though this can change in areas where an electric utility offers an electric heating rate.[15] This cost calculation dictates which heat pump applications are seeing the largest growth. When the customer base is primarily served by natural gas, this barrier limits heat pump installs to ductless minisplit applications serving bonus rooms or garages not served by ductwork. For an analysis of how the electric rate can affect ASHP economics, see Table 2 and Table 3, above.

2. Contractors are not fully comfortable with ASHP systems with back-up heat.

Contractors are typically focused on providing the most cost-effective, simple solution for customers and may overlook newer system configurations that involve two heat sources, even though such systems can provide highly efficient cooling and heating and a high degree of customer comfort. These hybrid system configurations are more complex and there is more potential for things to go wrong. This is not a large barrier for contractors, as they will install these systems if it is a business opportunity, but they may be less likely to aggressively promote them. This may especially limit contractors recommending these systems for propane use, where there could be a huge economic benefit to the customer. This indicates an opportunity for further contractor education to increase heat pump adoption. Additionally, there is an opportunity to educate contractors on the cost of heating with an ASHP versus propane as a primary heating source. Some of the participating contractors expressed a believe that propane is nearly as cheap as natural gas, but the current cost of propane (per MMBtu) is are roughly double the cost of natural gas. At that cost, ASHPs can economically displace propane.

3. Lack of customer knowledge of heat pump operation and benefits is a sales barrier.

Contractors noted that educating the customer about heat pumps can be a significant time expense and sales challenge. While over half of the contractor participants “actively recommend” heat pumps for the appropriate situations, contractors also indicated that they primarily sell heat pumps when customers ask for them. This indicates that there may be opportunities in which heat pumps would be a good solution, but they are not recommended by the contractor because the customers did not ask for them — i.e., contractors may be partially disinclined to recommend ASHPs due to a lack of customer understanding. This is a self-reinforcing cycle: customer education is an important piece of the puzzle to ensure there is demand, but most customers will ultimately follow the advice of the contractor. The research team believes that contractors are the most critical force in growing heat pump program participation, so this perceived customer education barrier is an important one to address. Programs can support contractors in addressing this concern by providing them with educational and marketing materials to share with customers, connecting them with training opportunities on how to sell heat pumps more proactively, and by launching ASHP sales/marketing campaigns that boost contractor confidence and the customer value proposition (these are particularly effective in coordination manufacturer promotional sales campaigns).

4. Contractors are not effectively educated about benefits / applications of heat pumps.

Contractors we engaged with expressed that heat pump technology “isn’t there yet” — implying that they felt that heat pumps could not produce heat effectively in cold climates. This feedback is mostly given regarding ducted systems. While there are many factors that contribute to the contractor’s perception (or misperception) of the technology, one issue that is frequently observed is that contractors

[15] Further market research and utility engagement is needed to identify utilities that have either a reduced electric heating or dual fuel rate.

have not received adequate training on the variety of heat pump applications and their respective installation and system design requirements, selling points, and cost analyses. Additionally, it is common for contractors to express a lack of confidence in heat pump technology when what they mean is that the payback is not good for customers. CEE recommends developing materials and training for contractors that are especially related to switchover temperature, energy costs, system design and sizing, system selection, and proper installation.

Nearly all the contractors who participated in this research had attended a manufacturer training (most noted was Mitsubishi's training). However, manufacturer training focuses on the technology performance and typically lacks the details pertinent to making a persuasive case to a customer. When contractors lack training on design and installation best practices for the full array of heat pump applications, especially for cold climate heat pumps, they may install heat pumps with a sub-optimal system design, which would lead the customer and contractor to incorrectly believe the heat pump has poor performance.

Multifamily Owner/Manager Market Research

The Elevate research team engaged 12 multifamily building owners and managers through interviews and focus groups. These represent a spectrum of company types and portfolio sizes from all over Wisconsin and they represent over 15,000 residential units throughout the state. Details about the building owners and managers are in Appendix C.

Multifamily Housing and Heat Pumps

Multifamily housing units most commonly have a smaller heating load than single-family homes — they have less square footage and fewer outside-facing walls. However, as noted in the market research section above, multifamily housing has a high prevalence of electric heating and income-eligible customers, so customers are more likely to be energy burdened. Another common heating type in multifamily housing is hydronic heating, which is generated by a natural gas boiler and entails hydronic pipes in tenants' rooms. Since the most prevalent heating types in multifamily housing do not entail ductwork, the most applicable heat pump for this housing would be ductless minisplits. Contractors also note that ductless minisplits have been an amazing low-sound cooling solution when compared to loud air conditioners. Customers commonly note that they cannot hear the equipment running. See Figure 7 below for ductless minisplits in multifamily housing.

Figure 7. Ductless minisplits in multifamily units.[16]

[16] Image sources: Left image: https://mechanical-hub.com/mini-splits-lead-to-multi-family-efficiency/
Right image: https://americanhomewater.com/central-air-vs-mini-split/

There are also multifamily buildings with ductwork, as well as multifamily units with in-unit furnaces and air conditioners. These heating systems types are not where the highest heat pump retrofit potential lies — though in-unit ASHPs accounted for the highest number of Focus ducted ASHP rebates in 2020 when we included new construction applications in our analysis.

Multifamily Customer Types

The research team refers to properties with three or more residential units as multifamily housing. Multifamily housing properties can be either market rate or affordable housing.

One customer type in the multifamily sector with particular incentive and financing considerations is subsidized affordable housing. If utility bill costs shift so that residents pay either more or less in utility bills, utility allowances will be impacted. A utility allowance is an estimate of a tenant's "reasonable consumption" of tenant-metered utilities — it is a critical factor in a property's rental income as it affects the rent paid by the tenant, the rent received by the owner, and (where applicable) the subsidy provided to the property. For example, in a Low-Income Housing Tax Credit (LIHTC) property with no on-going operating subsidy, a rent of $500, and a utility allowance of $50, the tenant pays the owner $450 and is expected to pay $50 in utilities. This is a balanced calculation, so it can be impacted by a change in utility costs. Additionally, depending on the type of the housing program, either tenants or the housing agency subsidizing the property are responsible for the cost of tenant-paid utilities. From the owner's perspective, the party responsible to pay the tenant-paid utilities and the amount of the utility allowance can directly impact the property's rental revenue. These relationships and the amount of utility allowance influences the likelihood of investing in energy efficiency.

Table 6. Multifamily property and customer types.

Property Type
Market rate housing: Rental units that do not receive a government rental subsidy. This housing represents around 80% of the Wisconsin market (430,042 units), and encompasses a range of affordability, from luxury units to units with lower rents because they are in a lower-income building, which is considered unsubsidized affordable housing or naturally occurring affordable housing (NOAH).
Unsubsidized affordable housing: A sub-set of market rate housing that is affordable for tenants on a lower income, but not subsidized. As noted above, this housing type is also known as NOAH. While income-eligible customers may live in these units, it may be more difficult for programs to target these buildings. It is not generally publicly known if a building or a unit is NOAH or not. No public list exists of all NOAH buildings exists and rent rolls are not generally public information.
Subsidized affordable housing: Affordable housing that receives a government subsidy and where rents are restricted (pursuant to terms of affordable housing financing or land use concessions). This includes housing funded through the federal and state LIHTC programs and federal, state, or local government rental assistance subsidy programs (i.e., Section 8), as well as properties operated by Public Housing Authorities. This housing represents around 20% of the WI market (95,580 units).
Owner Type
Real-Estate / Investor-Owned Developer: can develop, own, and manage market rate multifamily.
For-profit Affordable Housing Owners & Developers: can develop, own, and manage both market rate and affordable multifamily housing.
Nonprofit Affordable Housing Owners & Developers: develop, own, and manage affordable multifamily housing.

Key Findings

1. Cost and payback period is a significant barrier to installing heat pumps, but there is opportunity to improve this in buildings heated with electric resistance.

Every building owner/manager we engaged with mentioned money, incentives, or cost of new equipment as a barrier that greatly affects purchasing decisions. Owners/managers noted having retrofit projects ready to go presently that they would consider a heat pump for, if given an adequate incentive. WHPC, the state's largest affordable housing owner and developer, noted "money is the number one hassle." Wisconsin Management Company noted similarly, "Number one challenge: upfront capital expense." It is difficult to name a rebate amount that is both large enough to help with upfront costs and cost-effective. Three owners and managers (two nonprofits and one for-profit) stated that a rebate that covered 50% of the install cost would move the needle on making a heat pump purchase.

However, there is an opportunity to increase the rebates for the products with the highest savings opportunity for multifamily buildings — which is ductless minisplits replacing electric resistance heating. The current Focus on Energy rebate is $500 per install. Our research shows that a minisplit installation can cost more in a multifamily setting, easily up to $5,000, due to contractor unfamiliarity with multifamily installs, labor time, or complications with running the refrigerant line longer distances.

2. Owners and managers consider efficiency in retrofits/design but Focus rebates may not be top-of-mind.

All participants were familiar with Focus on Energy and most had received incentives for a project. The change in administrators or points of contact, rebranding, process for reimbursement or receipt of incentives, and incentive fund availability added to the confusion about the program. Some of this is also due to the complicated nature of how multifamily buildings are developed, owned, and managed. For example, one owner participant expressed that in the new construction context, it wasn't clear if they had received an incentive since the construction company was responsible for submitting the incentive application and did not report back the results.

Participants also noted that when their company conducts rehab projects, they do think about energy efficiency — since it is otherwise difficult to justify a replacement or new install without an equipment fail — yet in those rehab or equipment fail situations, rebates offered by Focus on Energy might not be apparent as an available resource. Participants expressed being confused about the incentive options, which results in them seeking the program after the design process instead of integrating it as part of the design. When rebates are acknowledged and applied, the experience is positive. AK Management stated, "I had a Focus on Energy project done in a duplex: insulated and done some upgrades. The tenants' bills decreased significantly; it was a good experience."

3. Lack of knowledge about heat pump operation and maintenance is a barrier.

Seven out of the nine multifamily owners and managers interviewed mentioned that technical support, in the form of either more knowledgeable contractors or training for their operations and maintenance staff would be important for considering heat pumps. There are technical knowledge gaps in sizing and design of heat pump installs (e.g., placement of condensers, proper zoning, etc.), and a need for support for digital thermostat programming alongside zoning. This has significant implications for tenant comfort and retention concerns. If tenants report comfort issues and property maintenance staff are not able to immediately resolve them, heat pumps can become a long-term liability. Access to more examples in the market, training for building maintenance staff, and any other resources that can help bridge the comfort gap would result in more uptake of heat pumps.

Additionally, owners/managers noted interest in contractors becoming a more helpful resource and many respondents also expressed a lack of access to contractors due to an overwhelming demand

for their work. When contractors are available to consult with owners/managers, they typically push them toward more conventional heating and cooling systems or aren't very interested in talking through heat pumps as a solution.

4. Ability of heat pumps to keep tenants warm below zero degrees is a concern.

Half the interviewees mentioned being concerned about supplying heat to customers or needing a back-up heat source and noted interest in seeing heat pump performance. One respondent stated, "We have concerns of the performance when it gets [to] sub-zero temperatures — we would like to see an application in southeast Wisconsin." Owners/managers expressed reluctance to be at the forefront of technology because of past negative experiences. One participant expressed being "burned" when implementing electric heat pump technology in a large retrofit project where the system was not designed properly, resulting in significant complaints from the senior residents. Fortunately, there are also positive experiences with heat pumps. One interviewee that had installed a heat pump on two wings of a 10-unit apartment building in Black River Falls and noted, "ASHP efficiency goes down to about 14F before it calls for auxiliary heat or back-up heat. It is a very good system." This points to a need for more education of heat pump performance and the benefits of heat pumps in specific multifamily applications. Also, as most heat pump applications require back-up (either electric resistance or another fuel), and the back-up heating source would eliminate any concerns about cold-temperature performance, it may just be an education issue. Contractor training can mitigate this issue, as well as Focus on Energy marketing case studies of positive multifamily heat pump examples.

5. Nonprofit-owned affordable multifamily housing developers face unique challenges and require a tailored approach.

Affordable multifamily housing, specifically nonprofit-owned, operates under different constraints than market rate multifamily housing and for-profit affordable housing. From a financial perspective, nonprofit affordable housing providers are working under different margins and have little flexibility to consider HVAC systems that inherently come with operational or financial risks. Housing providers are also very aware and concerned with minimizing or transferring costs to their residents. For example, in boiler-heated buildings, switching from a heating system whose operation is typically paid for the by the property owner to an in-unit heating system poses a risk of transferring costs to tenants, making their housing expenses unaffordable. It is hard for non-profit affordable housing developers to consider heat pumps because they are not working with the same margins as market rate housing developers. An owner/manager participant stated, "Nonprofit developers take any profits back into their properties and for-profit [developers] get out after 15 years. I cannot reiterate enough that nonprofit affordable housing providers need more help." However, subsidized affordable housing developers also experience unique benefits. Where utility allowances are employed, if the cost of tenant utilities decreases, affordable housing owners can capture that difference in additional rent. This is particularly critical to nonprofit-owned affordable housing owners with smaller profit margins.

6. The design-build nature of multifamily new construction poses a challenge.

Building owners and developers embarking on new construction developments face unique challenges when it comes to integrating energy efficiency into their designs, especially with equipment such as heat pumps. The residential market in Wisconsin is focused on the design-build project delivery method, where the design and construction are provided by one entity. As a result, mechanical, electrical, and plumbing design is not an engineered solution and instead is subcontracted to the design/build firm or another contractor, and far from a building owner's reach. By the time the subcontractor in charge of designing the building systems in engaged, it is too late to propose newer solutions like heat pumps, and funds are limited.

Owners/developers are motivated to consider energy efficient strategies at the point of acquisition, when refinancing subsidized properties, or when receiving a financial incentive through Mortgage Insurance Premiums (MIP) breaks or tax credits (at which they pursue green building standards and certifications including Wisconsin Green Built Home or Enterprise Green Communities). Focus on Energy's New Homes program is one pathway to comply with the Green Built Home standard and a potential vehicle for incentivizing heat pumps.

Review of Current Focus Offerings

Focus has been offering incentives for ducted ASHPs since 2014 and for ductless minisplits since 2016. As of 2020, the two product types are offered through different programs (or Solutions, such as Residential Trade Ally Solutions for ducted ASHPs and Midstream Solution for ductless minisplits). Two features are the same between programs: the customer receiving the rebate must be served by a utility that is a Focus member, and the installation contractor is the point of sale (i.e., the customer is not buying the equipment from appliance stores or distributors). The installation contractor is also responsible for recording details about the heat pump installation — customer information, product information (such as performance ratings), and basic installation information, such as "ductless minisplit electric replacement, add A/C." Also, while Focus has a registered Trade Ally list, installation contractors do not need to be registered Trade Allies to participate in the rebate programs.

A ducted ASHP system must have the following AHRI ratings to qualify for a rebate: 15+ SEER and 8.5+ HSPF at 47° F. A ductless minisplit system must have the following AHRI ratings to qualify for a rebate: an output capacity equal to or less than 65,000 Btu per hour, 18+ SEER and 9+ HSPF, and has inverter technology. As of 2021, both ductless minisplits and ducted ASHPs can be rebated in applications with any original heating fuel type (e.g., electric resistance baseboards, natural gas furnace or boiler, propane furnace, etc.).

Focus made significant changes to their heat pump and A/C programs in 2020 and 2021. First, as noted above, in 2020 Focus moved ductless minisplits into their Midstream Solution. This means that the rebate is now given to installation contractors by participating distributors and passed on to the customer as an instant discount on their invoice. For ducted ASHPs, the delivery model is still "downstream," so the rebate is provided as a check from Focus directly to the customer, with installation contractors collecting information from the customer and providing paperwork to Focus. Second, in 2021 Focus discontinued their residential A/C rebates for single-family homes. However, Focus still has a rebate for vertical heating and cooling units that use natural gas for heating, commonly called "magic-paks," and commonly installed in multifamily housing

In 2021, a new measure was added to the TRM for ducted ASHPs that replace or displace natural gas. There is also a rebate for ducted ASHPs installed in propane heated homes, however, the funding for that rebate comes from a different fund than Focus rebates and is subject to different rules regarding the amount (it is lower than the rebate Focus provides for ASHPs installed into natural gas heated homes). Also, while electric savings could be claimed from installing an ASHP into a propane heated home (with the baseline being a less efficient ASHP), Focus cannot collect heating energy savings from propane displacement because propane is a non-regulated fuel source.

With the addition of the natural gas measure and the ability to count gas savings from natural gas displacement, as of 2021 Focus offers the following heat pump rebates:

Table 7. Focus on Energy heat pump program rebates (for multi- and single-family application).

Technology	Application	Rebate Amount	Program Delivery
Ducted ASHP	Dual fuel/natural gas furnace replacement	$1,000/unit	Downstream/Residential Trade Ally Solutions
Ducted ASHP	Dual fuel/ propane furnace replacement	$300/unit	Downstream/Residential Trade Ally Solutions
Ductless minisplit	Any original heating fuel type; no specifications.	$500/unit	Midstream Offering

See Table 8 for results from data analysis of SPECTRUM Focus on Energy ducted ASHP and ductless minisplit measure data. We discuss key insights from this analysis below the table.

Table 8. Focus on Energy ducted ASHP and ductless minisplit SPECTRUM measure history.

	Ducted ASHP Measures	Ductless Minisplit Measures
Total historical projects	386[17]	1,070[18]
2018-19 participation Δ	+ 190% (26 → 76)	+ 7% (169 → 181)
2019-20 participation Δ	- 26% (76 → 56)	+ 180% (181 → 506)
Most prolific measure	Air-Source Heat Pump, ≤ 65 MBh, SEER 18 and 9.0 HSPF	Ductless minisplit replacing electric resistance and no AC
Total contractors	136	160[19]
# contractors with > 10 projects	3	10
Top manufacturers by install volume	Bryant (85/22%), Lennox (84/22%), Carrier (62/16%), Trane (45/12%)[20]	Mitsubishi (64%), Bryant (12%), and Daikin (9%)
Top 5 cities by install volume	Blair (15), Prairie Du Chien (14), Eau Claire (12), Madison (12), River Falls (10)	Sturgeon Bay (56), Eau Claire (41), Green Bay (31), Chippewa Falls (26), Bailey's Harbor (24)[21]

Key Insights

1. Ducted and ductless measures are capturing a small amount of the potential market.

The total number of both ducted ASHP and ductless minisplit projects is a small fraction of the markets with the highest potential for heat pumps. For example, 386 ducted ASHP projects is less than 0.2% of the number of propane-heated single-family housing units heated. This is not to say that those 386 projects went into propane heating applications — it is just a demonstration of the low scale of penetration of ducted ASHP measures in a market that has a high savings potential. While the number of ductless minisplit projects is higher (1,070), the scale of penetration is still low at 0.3% of

[17] This number does not include new construction projects.
[18] Program years of 2016 to May 2021. Projects do not include obvious new construction applications, though there are some that might not be easily identified in SPECTRUM.
[19] In 2019, data started to come from distributors instead of contractors; both contractors and distributors are included here.
[20] 63 installs did not contain manufacturer information.

electrically heated housing units (the highest savings potential application). Anecdotal evidence from contractors also suggests that a large portion of the existing minisplit market is not in fact being installed to displace electric resistance heating, but rather for bonus room additions (often as renovations of natural gas-heated homes), or the addition of A/C for boiler-heated homes.

The low percentages of market capture reflected here could be due to low Focus program capture and/or low overall market penetration. There may be heat pump installations for which the contractor does not utilize Focus rebates and they are not recorded in SPECTRUM. For instance, in a recent NEEA ductless heat pump market report, 50% or more of the installs recorded in Idaho, Montana, Oregon, and Washington are non-incented installs.[22] This can happen for a variety of reasons but can be attributed to the value proposition of the heat pump versus the value of the rebate. If a rebate is not considered crucial for the sale, contractors would just as soon not complete the paperwork for it.[23]

2. A small number of contractors conduct the majority of installs.

There are a total of 136 contractors who make up the ducted ASHP projects and nearly 90% of them have five or fewer installations logged in SPECTRUM. The highest performing contractor completed 8% of the installs and the top five contractors make up 23%. Best practices from other ASHP programs in the U.S. show us that a small, concentrated contractor network is better for cultivating a list of reputable, high-achieving contractors; however, five high-performing contractors is too few to help grow program participation. Low contractor participation means that there are service gaps such that customer demand cannot be met by knowledgeable, heat-pump-ready contractors. As for ductless minisplits, in 2020, data are collected from distributors, rather than contractors. With that in mind, two distributors make up 47% of all installs, only 10 contractors installed more than 10 minisplits, and five contractors installed more than 20 minisplits.[24] 146 contractors and distributors make up the remaining installs — 56% of them only have one install recorded in SPECTRUM. While there is slightly greater contractor engagement with ductless minisplit measures, (suggesting the value proposition for this product category is more obvious), this network could also be developed.

3. Program changes likely resulted in increased ductless minisplit rebate participation.

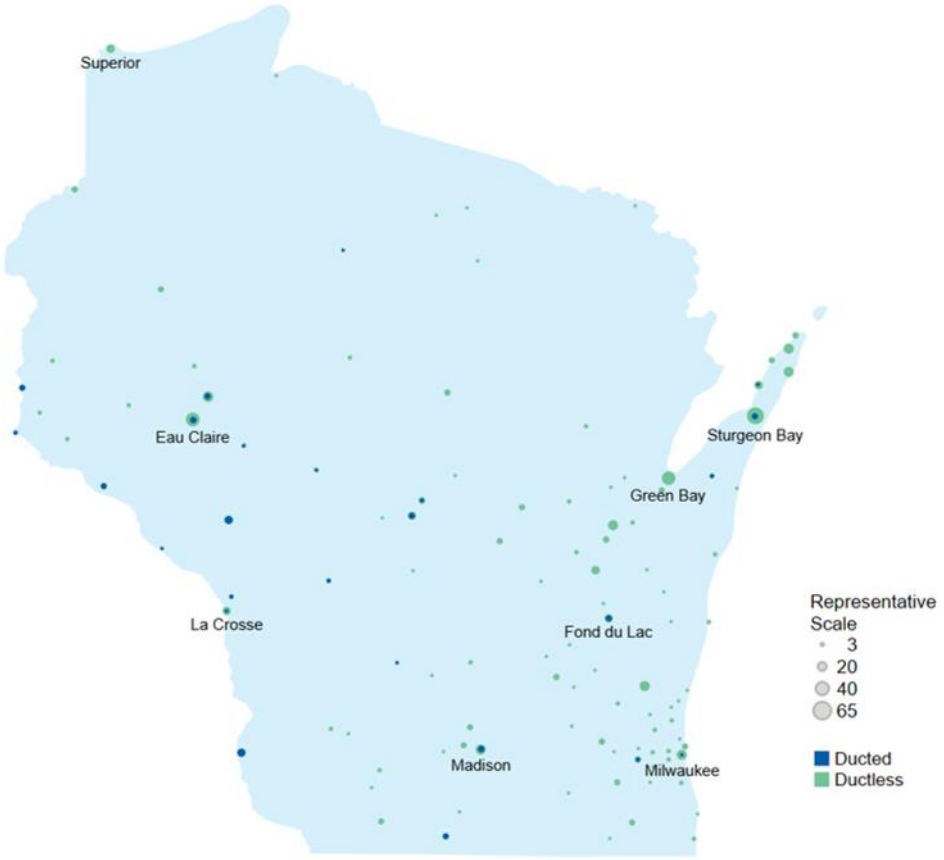
For ductless minisplit measures, we observed that there was a 180% increase in rebates from 2019 to 2020, following three program years with increases ranging from just 6% to 25%. While there can be a many factors affecting this increase (such as an increased emphasis on home comfort when more people were working from home in 2020 due to COVID-19), one significant program change that likely resulted in increased participation is the expansion of eligible ductless minisplit measures to natural gas applications. In some cases, an increase in program participation can correspond with a switch in program delivery from downstream to midstream (this is theoretical: the structure of midstream programs entails bundling the bureaucratic/paperwork components with the distributor and providing incentives to the contractor, both of which can spur sales).[25] Further detailed data analysis would need to be conducted to confirm the cause of this significant participation increase, as well as to explore ways in which the program could be further adjusted to capture more of the heat pump market.[26]

[22] NEEA report: https://neea.org/resources/ductless-heat-pumps-2020-long-term-monitoring-and-tracking-report (2020).
[23] This can also reiterate the point that contractors are not proactively growing their heat pump sales if they are primarily selling heat pumps to customers who would have bought them no matter what (which is a small segment at present). More market research and funding to buy full category sales data from distributors would be needed to prove or disprove this in Wisconsin.
[24] Gustave A Larson Company (28%) and Auer Steel & Heating Supply Company (19%).
[25] E Source article: *Swimming upstream: When DSM programs can benefit from upstream incentives* (2015).
[26] CEE program managers recommend a downstream delivery model as the best way to create a lot of demand and engage contractors. Midstream delivery can be helpful when the market has "taken off," and can be self-maintaining.

4. Installs are not occurring where there is the greatest potential for savings.

Only about half of the cities with the highest installs occur within rural-eligible zip codes. More importantly, there are gaps in program participation in areas with large numbers of propane and electrically heated housing units. This suggests that Focus' heat pump programs are missing out on strong potential for claiming savings from heat pump measures. To capture that potential, there will need to be greater customer demand (spurred by marketing campaigns or contractor sales) that is met with contractor salesmanship and proficiency in best practices for optimal heat pump installation, which will ensure customer satisfaction and greater energy savings. See Figure 8 below for geographic distribution of installs.

Figure 8. Distinct rebate counts for ducted and ductless HPs for cities with > three installs.



To grow Focus' program reach and capture heat pump potential in rural Wisconsin, Focus will need to conduct more engagement with HVAC contractors, as well as spur customer demand with marketing. In the final section of this report, we discuss recommendations to Focus.

Technical Reference Manual Review

The research team reviewed the TRM for the appropriateness of its assumptions regarding air source heat pumps (ducted and ductless). We found the Wisconsin TRM savings calculations for heat pump measures to have a robust approach that is similar to TRMs used in other cold climate states. We present our findings below:

- **The Focus TRM assumes that heat pumps are sized for the load and will meet full heating load hours — this is not realistic for many applications.**

The 2021 Focus on Energy TRM assumes by default that heat pumps will meet the full load hours for the size of heat pump chosen. However, as discussed above, heat pumps are not often sized to meet the full heating load. Further, it may not be economic for customers to run the heat pump to its lowest design heating temperature. Therefore, for some heat pump applications — such as heat pumps installed for A/C replacement or heat pumps in bonus rooms in homes with forced air furnaces — a more realistic savings number can be arrived at by down-adjusting the full heating hours and/or sizing. While more realistic, this would entail claiming less savings from heat pumps. However, please see below for ways in which savings may be underestimated.

- **The Focus TRM does not count efficiency gains from modulating-speed heat pumps.** The HSPF and SEER calculate efficiency based on meeting the load at a single temperature. Manufacturers work to optimize their equipment for performance at those temperatures. However, in real world applications, overall system efficiency is strongly impacted by the performance of the system across a range of temperatures. Systems that modulate their output according to the load can show dramatic improvements in the overall efficiency. There are two reasons for this: 1). Modulating systems can dramatically decrease fan and compressor speeds needed to heat or cool a house, allowing for higher efficiency operation; and 2). Because the variable capacity can adjust to meet the loads of the home in real time, cycle times for variable-speed systems are much longer than single-speed alternatives.[27] Longer runtimes decrease the energy losses associated with startup and cool down conditions.

  Inverter-driven heat pump systems have the greatest ability to modulate load and provide the greatest performance benefit, but even two-stage systems will see a performance increase over single-speed systems. So, even for equipment with the same SEER or HSPF rating, a variable-speed system will achieve higher efficiencies in the real world than a single-speed system.

  A measurement that is important to the overall efficiency of the system, that is not considered in HSPF or SEER, is the turndown ratio. The turndown is a measure of the systems operational range. It is the ratio of the maximum to minimum capacity. The higher the turndown ratio, the more efficiently the system will be able to operate over a wide temperature range, as it will be able to avoid short cycling, a major source of HVAC energy loss.

While there are some complications with how the Focus TRM counts heating savings from heat pump measures, these are fairly universal across U.S. heat pump programs. In general, the issue of counting heat pump heating savings requires a level of complexity higher than what TRMs are designed for. Focus has already employed some of the common solutions, such as introducing tiered savings or using multiple, separate measures for different heat pump applications.

Program Best Practices Review

The research team conducted an air source heat pump program best practices review. This included a literature review and interviews with program managers. Through the literature and anecdotally based on industry knowledge, the research team identified high-performing heat pump programs in cold climates to select programs and conduct interviews. We collected the information below. Note that “S” stands for standard and “CC” stands for cold climate.

[27] The relationship between fan speed/flow rate and power is nonlinear, with power varying with the cube of the fan speed; thus, cutting fan speed in half will reduce the power needed to run the fan by nearly 90%, so the benefits of reducing fan speed are greater than it might seem at first.

Table 9. Results of cold climate heat pump program information research.

	Type	Rebate	Eligibility Rating	Participation
Consumers Energy (Michigan)	Ducted	S: $150–$250 CC: $1,000	S: SEER 15-15.99–16+ CC: NEEP QPL	S: NA CC: NA
	Ductless	S: $250–$350 CC: $1,000	S: SEER 18-20.99–21+ CC: NEEP QPL	S: 100-200/year CC: 10 (2020 pilot)
Consumers Energy – IE (2020 pilot)	Ducted	CC: Fully funded	NEEP QPL	NA
	Ductless	CC: Fully funded	NEEP QPL	276 MF installs 78 SF installs
Efficiency Maine	Ductless	S: $400/1st indoor unit; $200/2nd indoor unit CC: $800/1st; $400/2nd	S/Tier 1: HSPF 12+ w/1 indoor; 10+ w/ multiple indoor units CC/Tier 2: HSPF 12.5+, each unit is single-zone	~16,000 projects; (20,000 indoor units; ~17,000 outdoor units)
	Income Eligible	$2,000 for 1st heat pump ≤$400 for 2nd heat pump		NA
Efficiency Vermont	Ducted	≤2 ton: $1,000 >2–<4 ton: $1,500 ≥4 ton: $2,000 IE bonus: $200	NEEP QPL	~300 installs (In 2020, 1st prog. year)
	Ductless	≤2 tons: $350 >2 tons: $450 IE bonus: $200	NEEP QPL	10,000 projects (In 2020, 6th prog. year)
MassCEC (2020 pilot)	Whole home ccASHP projects	$2,500/install • IE Tier 1: $5,000 • IE Tier 2: $7,500 Efficiency/Electrification Adder: ≤$2,500	NEEP QPL	6,000 total units ~1,800 ducted >3,000 ductless ~1,000 mixed
Minnesota Power	Ducted	S: $400/install CC: $1,200/install	S: ≥8.5 HSPF; ≥15 SEER CC: NEEP QPL	S: 21 CC: 34 (2019 & 2020)
	Ductless	S: $400/install CC: $1,200/install	S: ≥8.5 HSPF; ≥15 SEER CC: NEEPL QPL	S: 66 CC: 364 (2019 & 2020)
NYSERDA	Ducted	CC: $1,000–$2,000 full-load (90%–120% home heating load) $/10,000 Btu/h max. heating capacity	NEEP QPL	1,658 partial load projects (minisplit) 2,421 full load (multi-head or forced air) (In 2020) ~40% MF
	Ductless	CC: $500–$800 partial load/minisplit $/system	NEEP QPL	
Otter Tail Power	Ducted	S: $400/ton CC: $900/ton	S: 15+ SEER, 12.5+ EER, 8.5+ HSPF CC: 9+ HSPF, or 15+ SEER & 9+ HSPF	S: 82 CC: 114 (2019 & 2020)
	Ductless	PTHP: $400/ton CC: $700/ton	S: 15+ SEER, 12.5+ EER, 8.5+ HSPF CC: 10+ HSPF, or 15+ SEER & 10+ HSPF	S: 17 CC: 200 (2019 & 2020)

Key Observations

1. Rebates tend to be higher than Focus rebates for ducted systems and programs offer tiered rebates for higher efficiency or cold climate heat pump systems.

The rebate levels of the programs analyzed include much higher rebates for ducted ASHP systems, as well as efficiency tiers or a cold climate rebate tier, which offers a larger rebate for higher-performing equipment. “Large” is a subjective term when referring to rebates and it is not usually strictly related to quantitative criteria, such as a percentage of the incremental cost. However, many successful ASHP programs tend to offer a ducted ASHP rebate around $1,000 per system. There are two important notes to make about this. First, ASHP system costs, especially for ducted systems, are highly variable, situation-dependent, contractor-dependent, and simply not predictable with any level of accuracy. Second, and related to the first note, the program representatives we interviewed discussed the importance of rebates as an indicator of a vote of confidence from an authoritative entity (like Focus on Energy), and an upselling tool for contractors that simply looks attractive. $1,000 looks like a big rebate; customers tend to feel like they are getting a good deal on a new-age technology if there is a $1,000 rebate, even if that rebate does not necessarily cover the incremental cost. In this way, rebates can be more like behavioral tools, rather than affordability tools (not including income-eligible customers). This also implicates the contractor as a critically important sales agent. The sale will not rest on the rebate alone; it requires the contractor to make the case for the equipment and then present the rebate to make the customer more comfortable with the purchase.[28]

The NYS Clean Heat program reported 50% more full-load applications in their 2020 heat pump pilot, which spanned from April 2020 to October 2020 (2,421 full-load and 1,658 partial-load applications in that time). This NYS Clean Heat rebate pilot, which launched in 2020, offered a large full-load rebate based on heat pump performance for in situations in which the heat pump system will supply 90% to 120% of the home heating load.

2. A key challenge identified was contractor buy-in and engagement.

Program managers noted that staying connected with contractors and ensuring that they are promoting and properly installing heat pumps (especially in heating situations) was a key challenge to program growth. The representative from Efficiency Maine noted that many contractors in their territory remain focused on furnaces and air conditioners and do not feel motivated to sell ASHPs. To address this issue early on in their ductless program, Efficiency Maine worked with a small group of contractors in a pilot to spur ductless minisplit market growth. Efficiency Maine engaged these contractors closely to learn about their barriers and identify training needs. Learnings from this pilot led to the development of a trade ally engagement program that focused on connecting contractors, distributors, and manufacturers and emphasized volume of sales over strict training requirements. Efficiency Maine’s network includes a customer-facing contractor list and map that features contractors based on their number of heat pump rebates submitted; the only required certification was for refrigeration. This leads to a very competitive atmosphere and an open program with few barriers to entry. Efficiency Vermont also noted the importance of engaging with contractors. However, their program has more training requirements to be qualified to offer rebates. This leads to fewer contractors engaged, but with more likelihood for high quality installs.

[28] Importantly, while these tactics seem like they may be part of a market transformation approach, the programs analyzed here are resource acquisition programs, with the exceptions of MassCEC, which has a different accountability mechanism since they mainly run pilots, Consumer’s Energy, which received NRDC funding for their cold climate rebate, and Otter Tail Power, which has heat pump programs that help the utility achieve both savings and load growth.

3. Ductless minisplit installs for cooling and partial heating are dominant applications.

Each program reported greater ductless minisplit installs for single-zone and partial-heating-offset than whole-home ducted or multi-zone ductless minisplit projects — and Efficiency Maine only rebates ductless heat pumps. This is the case despite fuel switching being allowed in Maine, Vermont, and New York, and a high prevalence of fuel oil and delivered fuels Maine and Vermont. Prior to 2020, the New York heat pump program saw the majority of installs going in as partial-heating or cooling-only installs. NYSERDA billing analysis from 2017 to 2018 showed that 50% of minisplit installs were not being used for heating. In addition, there were a higher number of ductless, partial-load installs than full-load installs (which can be multi-zone ductless or ducted systems).

4. The NEEP QPL provides ease to contractors — however, there are concerns regarding non-cold climate applications.

Efficiency Vermont, Consumers Energy, MassCEC, and the NYS Clean Heat program all used the NEEP QPL list for heat pump rebate eligibility. There are no other well-known or widely used and reputable QPLs beyond the NEEP QPL and AHRI product lists. The Efficiency Vermont representative noted that their supply chain network loves the NEEP QPL, especially distributors — using the NEEP QPL got contractors, distributors, and efficiency programs on the same page and streamlined the eligibility verification process. Of the programs interviewed, Efficiency Maine was the only program that used AHRI's HSPF rating instead of the NEEP QPL list. However, MassCEC noted that their utility efficiency program counterpart, Mass Save, decided against using the NEEP QPL because they wanted to allow more options for standard heat pumps (versus cold climate heat pumps) to give more flexibility to homeowners interested in dual fuel systems, newly rebated integrated controls, or A/C-based systems. In cold climate states, it might make most sense to keep the AHRI rating edibility criteria to grow the market without too many technology requirements. However, an additional cold climate or higher performance rebate that uses similar criteria to the NEEP QPL can ensure that cold climate heat pumps are incented, especially for whole-home applications (such as electric baseboard or propane heating retrofits) in which the heat pump needs to carry more of the heating load.

Conclusions and Recommendations

1. Participation in heat pump offerings will need to dramatically expand to meet current and future savings goals; they are critical to the Focus portfolio.

Focus has taken the forward-looking step of transitioning its central A/C rebate to a rebate structure that favors heat pumps. This will help achieve greater energy savings in the long term. However, to get there, Focus will need to place additional attention and resources to ensure a successful transition to a heat pump-prevalent HVAC market. Focus' current heat pump program participation is relatively low compared with the statewide market potential, especially in the applications with the greatest savings potential (electric and propane heating in single-family homes and electric heating in multifamily housing). The most important frame of reference for how much these programs will need to grow (discussed earlier in this report) is how the ductless minisplit program participation represents 0.3% of electrically heated housing units. While there is a lot of room for growth, this means there is a great opportunity for savings, which we recommend Focus pursue primarily through increased contractor engagement and training, as well as through consideration of increased rebates for ductless minisplits in electric resistance heating applications.

2. The A/C replacement market is the most critical priority in the short term.

The Wisconsin A/C replacement market is on the order of 80,500 homes per year.[29] Additionally, from 2018 to 2019, Focus provided 5,198 A/C rebates. All the prior A/C installs represent opportunities for savings from installing ASHPs. This is a large market with the added cooling savings of highly efficiency ASHPs. As summers trend warmer, now is the right time for Focus to capitalize on customer interest in A/Cs to grow ASHP program participation. In addition to present savings opportunities, this growth can help ensure that the equipment in Wisconsin homes 15 years into the future will provide an opportunity for customers to electrify part or all of their heating load for potential GHG emissions reductions.

3. The largest retrofit opportunity is the 150,000 homes that use electric heating.

The strongest economic value proposition for heat pumps exists for single-family homes that heat with electric resistance (there can be benefit to multifamily tenants installing electric resistance heating as well but the savings the customer stands to gain versus the upfront costs will depend on the square footage of the unit). Ductless minisplits installed in these applications also provide an efficient cooling source that does not take up window space, so they result in high customer satisfaction as well. Focus can use Census micro-data to target programming — both contractor engagement and marketing — at areas in Wisconsin with a high number of homes with this heating type. Further, Focus' member utilities can conduct a detailed billing analysis to identify exactly which premise numbers have electric heating. CEE has demonstrated success (i.e., accurate identification of electrically heated homes) in using an R script to do this. See Appendix F for the results of such an analysis, performed for Focus members WPPI Energy and Madison Gas and Electric.

4. Multifamily customers with electric heating experience high barriers to participation.

Tenants in multifamily buildings heated with electric resistance are largely low-income (about 70% of electrically heated multifamily housing is income-eligible) — and these tenants typically pay their heating bills, unlike most tenants in centrally heated buildings, and they experience among the highest energy burdens (cost of energy relative to income level). While tenants would benefit from reduced energy costs, the upfront costs of heat pumps can be prohibitive. Some multifamily building owners and managers are willing to pay for upgrades that improve occupant comfort and satisfaction, but this requires additional outreach and support for owners and managers, who tend to be uncertain about heat pumps and do not have the time to research them.

5. It is recommended that Focus develop tiered ASHP rebates based on equipment efficiency and/or application.

Focus currently offers rebates that are tiered based on income level, but there is no increased incentive for higher efficiency heat pump products. We recommend a rebate structure that encourages or rewards customers who want to capture more of their home heating load to justify the heat pump installation as an economic heating source. For example, in electric resistance and propane heating situations, a lower efficiency or mid-performance heat pump will not serve the customer well in colder temperatures and the customer will be inclined to rely more on their more costly back-up heat source. Focus rebates should encourage customers to install heat pumps that will provide the best performance and satisfaction for their application. Tiered rebates also reward early adopters who install high efficiency or ccASHPs for principled reasons.

[29] Calculated using data from the Focus 2016 Potential Study regarding the penetration/installation rate of A/Cs. We estimate this rate to be 70%. Additionally, we incorporated the penetration of forced air furnaces, which is around 82% (also from the Focus 2016 Potential Study) and applied both percentages to the total number of single-family homes in Wisconsin with an assumed A/C replacement rate of 15 years (the A/C measure life).

A tiered rebate structure would be similar to A/C and furnace rebates, which are commonly tiered based on efficiency. Focus' rebates require the following performance specifications for the ducted ASHP rebate: 15+ SEER, 8.5+ HSPF at 47°F. The research team recommends the following tiered rebate options, which are displayed with more numeric detail in Table 10:

- **Standard efficiency tier** (A/C replacement application): This is suited for ducted ASHP installations in natural gas furnace applications. This has lower performance requirements and does not require a cold climate specification, as the equipment would not typically be used in extreme cold temperatures. This would incentivize a more affordable ASHP option for the segment of the market that is looking to replace a central A/C system.
- **High efficiency tier**: This is suited for applications in which the ASHP will capture more of the heating load. While customers who would benefit most from a high-performance heat pump are likely to be electric resistance or propane heating customers, customers with existing natural gas heat would also be able to receive a higher rebate for a more efficient system. Focus could require that the ASHP be specified as a cold climate heat pump.[30]

Table 10: Example of tiered ducted ASHP rebate structure.

	SEER	HSPF	Cold climate?	Rebate $	IE Bonus[31]
Standard efficiency tier	15+	8.5+	N	$750	$250
High efficiency tier	18+	9.5+	Y	$1,250	$250

For ductless minisplits, Focus' rebates require the following performance specifications to be eligible for the rebate: an output capacity equal to or less than 65,000 Btu per hour, 18+ SEER and 9+ HSPF, and has inverter technology. The research team recommends the following tiers for a per-system (i.e., per outdoor unit) rebate structure (detailed in Table 11):

- **Standard efficiency tier**: A rebate again targeted towards a marginal heat — mainly for the ductless minisplit to add A/C. High-performance minisplits are not needed in this application.
- **High efficiency tier**: A high-efficiency (and potentially cold climate performance) heat pump, installed to capture a greater portion of the heating load, as in electric heating or propane heating situations. Note that because of the additional value for and difficulty reaching the electric resistance market, we recommend a bonus rebate for that segment — please see below.
- **Electric resistance bonus**: This is targeted toward ductless minisplit applications replacing electric resistance heating. Customers could receive an additional $250 for purchasing a heat pump for this application, and another $250 if it is a high efficiency heat pump. This incentivizes more effective (and more cost-effective) heating for these retrofit scenarios.

Table 11: Example of tiered ductless minisplit rebate structure.

	SEER	HSPF	Cold Climate	Rebate $	Bonus for ER	IE Bonus
Standard efficiency tier	16+	8+	N	$500	--	$250
High efficiency tier	19+	10.5+	Y	$750	$250	$250

[30] This could be done in a variety of ways; the most common is to require listing on the NEEP Qualified Products List.
[31] https://www.focusonenergy.com/Tier2

6. It is recommended that Focus develop a "heat pump for A/C" initiative and focus on downstream program delivery of ducted ASHPs.

As noted, in 2021 Focus discontinued their A/C rebates. This program shift can result in an increased emphasis on ASHPs as an A/C alternative or replacement. However, there will initially be a gap in savings because Focus will not be capturing A/C savings and ASHP sales will not automatically increase without additional marketing and outreach. The research team recommends a Focus-branded promotional "heat pumps for A/C" initiative, for both ductless minisplits and ducted ASHPs.

This promotional initiative should at a minimum involve content development on the Focus website and channel content development and delivery through traditional marketing means. Significant contractor outreach will also be needed for this initiative. Contractors will appreciate that customers are aware of and asking for heat pumps and Focus will increase their program attribution by capturing customers that would otherwise install an A/C (regardless of the lack A/C of rebate).[32]

We also recommend keeping the ducted ASHPs as a downstream initiative for now, as downstream incentives can be more visible to the customer and a more valuable sales tool for contractors than midstream incentives. This could be re-evaluated in the future as the market evolves.

7. It is recommended that Focus conduct or coordinate additional contractor engagement, including training.

Based on CEE's experience with heat pump programs, we recommend engaging with contractors more frequently and listening to their comments and concerns about how the program is going. As a non-conventional product, ASHPs typically require upselling and education from the contractor to the customer. Contractors are an important sales agent for selling ASHPs, and they should be viewed as collaborative partners in increasing program attribution.

Contractors generally like heat pumps but need to better understand their applications and benefits. However, they would benefit from additional support in selling more of them. All contractors in the focus group expressed interest in growing their heat pump business, and most of the contractors who responded to the survey noted interest in receiving additional training. When training occurs alongside promotional/increased rebates and customer marketing campaigns, the market advances because the contractor is prepared to positively meet new demand as it increases.

In addition to sales techniques and more information on the benefits of heat pumps, contractor engagement and training should also focus on the variety of heat pump applications (such as dual fuel applications, which contractors express discomfort with), and cold climate heat pump performance.

8. It is recommended that Focus develop additional customer education materials and targeted campaigns to support contractor sales.

Focus should also develop customer-facing materials to help contractors sell ASHPs, particularly for customers who heat with electric resistance and propane. As noted by focus group participants, customer educational materials would help contractors feel supported in more actively promoting heat pumps. Contractors are actively seeking supportive materials, further indicating their interest in selling more heat pumps and a high likelihood of increasing their sales upon obtaining those materials. Materials could be especially helpful if targeted at certain customer types or if they contained clear visuals indicating energy and cost savings per application.

ASHPs are the most cost-effective for electric resistance customers, but these customers are unlikely talk to HVAC contractors unless they are seeking solutions, as electric resistance rarely breaks. There

[32] The upfront cost of an A/C is typically less than that of a heat pump (or at least, at par), such that customers will probably opt for an A/C if they aren't aware of heat pumps as a cooling solution.

are 221,138 electrically heated multifamily units in Wisconsin. Given the savings potential and cost-effectiveness of ductless minisplit retrofits in units that are electrically heated, it makes sense to target outreach to areas with high numbers of electrically heated units and large multifamily properties. As we have shown through this project, electric resistance customers can be identified through an analysis of electric bills. These customers could then be the targeted for a focused marketing campaign. In areas with high concentrations of electric resistance customers, community-based marketing efforts could support traditional email and direct mail campaigns.

9. It is recommended that Focus explore partnerships with rural utilities for additional opportunities in rural areas.

Rural areas have additional barriers to ASHP adoption — for example, the contractor base is typically smaller and less robust than in denser urban areas — as well as additional opportunities. Our data shows that there is currently low Focus program participation in rural areas, particularly given the larger potential from the higher concentration of propane and electric resistance heating. While ASHP installations in a propane heating application can currently be rebated, Focus cannot claim savings from as propane is not a regulated fuel. This results in lower rebates for propane, since the rebates are not based on a savings and cost-effectiveness equation, even though the energy savings potential is higher.

At the same time, many rural utilities have a strong interest in promoting ASHPs as a dual fuel option for propane customers. The load shape of ASHPs in dual fuel applications is particularly attractive as it happens during low-cost hours for electricity generation while avoiding peak winter fuel spikes (electric cooperatives often have much higher winter peaks than the Wisconsin average due to the high portion of electrically heated homes in their territories). In most cases, these applications would be economically beneficial to the cooperative, beyond what the efficiency benefits are.

This creates an opportunity for a deeper partnership with Focus. We suggest exploring a partnership with rural utilities that would be focused on overcoming barriers that can be especially difficult in their territories, through activities such as:

- Providing increased rebates for dual fuel propane/ASHP applications
- Conduct contractor training and outreach
- Conduct additional supply-chain engagement (distributors/manufacturers) to discuss stocking practices and coordinate promotions and marketing efforts
- Developing a quality installer list to provide customers, of HVAC contractors that are more knowledgeable and experienced with dual fuel ASHP installs
- Conduct quality assurance/quality control to make sure installs work as expected
- Monitor market barriers, and continuously develop ways to overcome those barriers

CEE has helped to develop such an initiative in Minnesota, called the Minnesota ASHP Collaborative. It is collaboratively funded by a group of seven utilities (including cooperative and municipal aggregators that represent dozens more member utilities).

10. It is recommended that Focus develop a comprehensive offering for multifamily customers, focusing on electrically heated multifamily buildings.

A program design targeted at electrically heated multifamily buildings would maximize savings opportunities and address a key gap in Focus' portfolio of offerings. This can be partially addressed with the electric heating bonus incentive recommended above but should contain additional sector-specific program components. The different multifamily customer and property segments noted in this report have different pain points, and heat pumps are more technically complex than conventional forms of heating and cooling. The research team recommends developing a program to help multifamily building

owners, managers, and maintenance staff plan for and successfully install, operate, and maintain heat pump systems. This will lead to increased program participation, as well as increased likelihood of customer satisfaction when heat pumps are installed. We recommend the following components:

- Ensure that Focus' energy advisors assist with the following, or create an account manager position to conduct the following:
    - Assist with completing rebate paperwork.
    - Facilitate learning between the contractor and O&M staff about proper use of the heat pump systems and how to support tenants if issues occur.
    - Coordinate additional heating and/or cooling upgrades, such as building envelope improvements, to optimize heat pump performance.
    - Promote or help connect customers with other financing mechanisms, such as Property Assessed Clean Energy (PACE) Wisconsin and energy service agreements. (Focus could also hire an outside entity to connect those dots.).
    - Engage customers more — meet at the beginning of the year to introduce the year's incentive programs; schedule meetings around critical decision points, such as at the point of acquisition, when refinancing subsidized properties, and when receiving a financial incentive such as Mortgage Insurance Premium (MIP) breaks or tax credits.
- Develop educational materials and programming on heat pump system operation and maintenance for building/facility personnel. Coordinate with building operator programs to provide a competency-based training and certification program for facility personnel working with heat pumps. This could be integrated as part of the nationally recognized Building Operator Certification (BOC) program.
- Incorporate into the current design assistance program a design incentive for multifamily customers to bring in an early design, such as at a 20% complete design drawing. Design assistance is necessary for successful heat pump installations, which can entail additional engineering and design considerations. It is important to integrate a design incentive early in the process to mitigate the challenges that come with the design-build process.
- Provide a higher rebate for ccASHPs, as well as for electric resistance applications. This will help tenants capture the most heating savings and ensure maximum comfort.

Bonus recommendation: It is recommended that Focus and/or Wisconsin stakeholders conduct further study into the GHG emissions reduction potential of ASHPs.

While this research shows the importance of heat pump retrofits in electric heating applications, it also discusses the economic benefits of heat pumps in propane furnace applications, as well as the break-even cost scenario in natural gas furnace applications. This analysis uses a customer cost lens. Another perspective is an analysis of heat pumps from a GHG emissions reduction lens. Most Midwestern electric grids still have a large amount of coal as an energy generation source — but grid generation mixes are increasingly composed of renewable sources. As grid changes occur, it is likely there will be GHG emissions reduction benefits from installing heat pumps in gas and propane furnace applications. We recommend this be researched so that there can be an understanding of the value of heat pumps from this perspective as well. Research questions worth exploring might be: what is the projected GHG reduction from electrifying the residential heating load with heat pumps for a variety of grid composition scenarios? What are the considerations for counting GHG emissions from natural gas, for which methane leaks are typically under-counted?

Appendix A: Wisconsin Market Maps

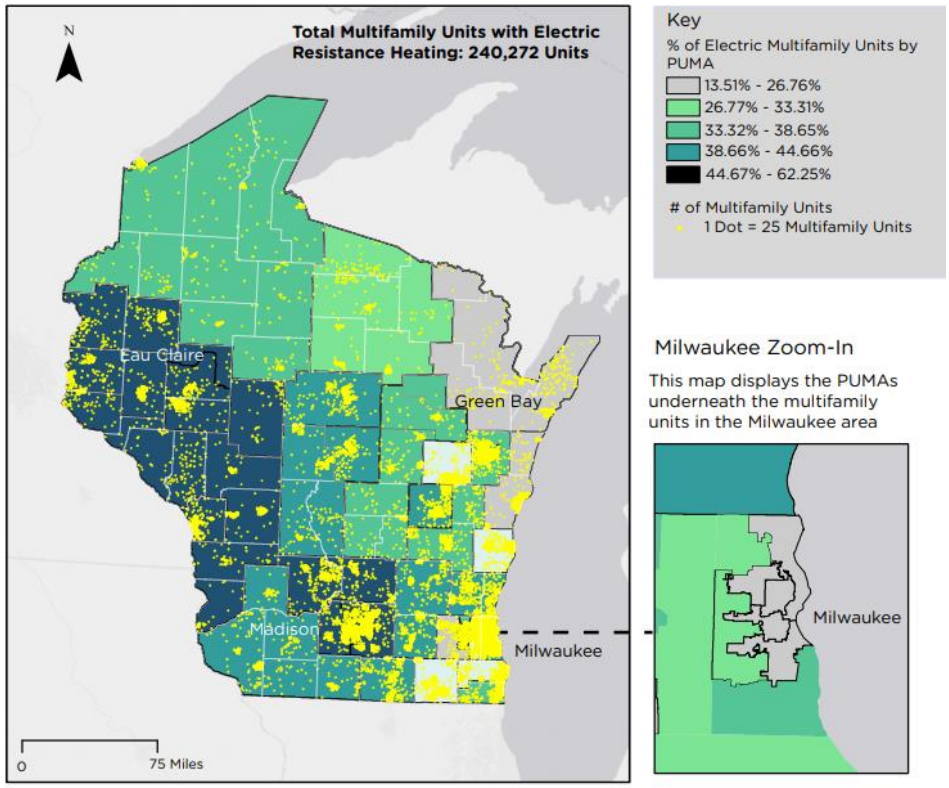
The geographic area being used to collect the percentages of electrically heated multifamily units in Figure 9 and Figure 10 below are PUMAs (Public Use Microdata Area). These are geographic boundaries that are used by the U.S. Census Bureau to collect data. PUMs (Public Use Microdata) is commonly used when two different summary tables need to be combined, such as where data housing unit type and heating fuel type are overlayed.

Explanation of figures

Figure 9 displays the percentage of multifamily units that use electric heating and their location, with darker shading demonstrating a greater percentage of electric heating. The yellow dot clusters represent the total multifamily units in each PUMA with each dot representing 25 multifamily units. The yellow dots do not represent only electric multifamily units. They represent all multifamily units in the PUMA. PUMAs with the darker shade and larger yellow dot clusters represent a larger opportunity as they illustrate significant number of multifamily units and relatively large percentage of electrical heating penetration.

For example, in the gray PUMA located in the Northeastern-most corner of Wisconsin (which includes Green Bay) 13.51–26.76% of the multifamily units (represented as the yellow dots) are electrically heated, which the research team would consider a relatively small number of multifamily units and low penetration of electric heating. In contrast, in the dark blue PUMA located around Madison, ~45–60% of multifamily units use electric resistance heating. This area ideal to target for heat pump programming because these customers are likely energy burdened. The Madison area, La Crosse area, Minnesota Twin Cities border are, Menomonie, and Eau Claire are also ideal areas to target.

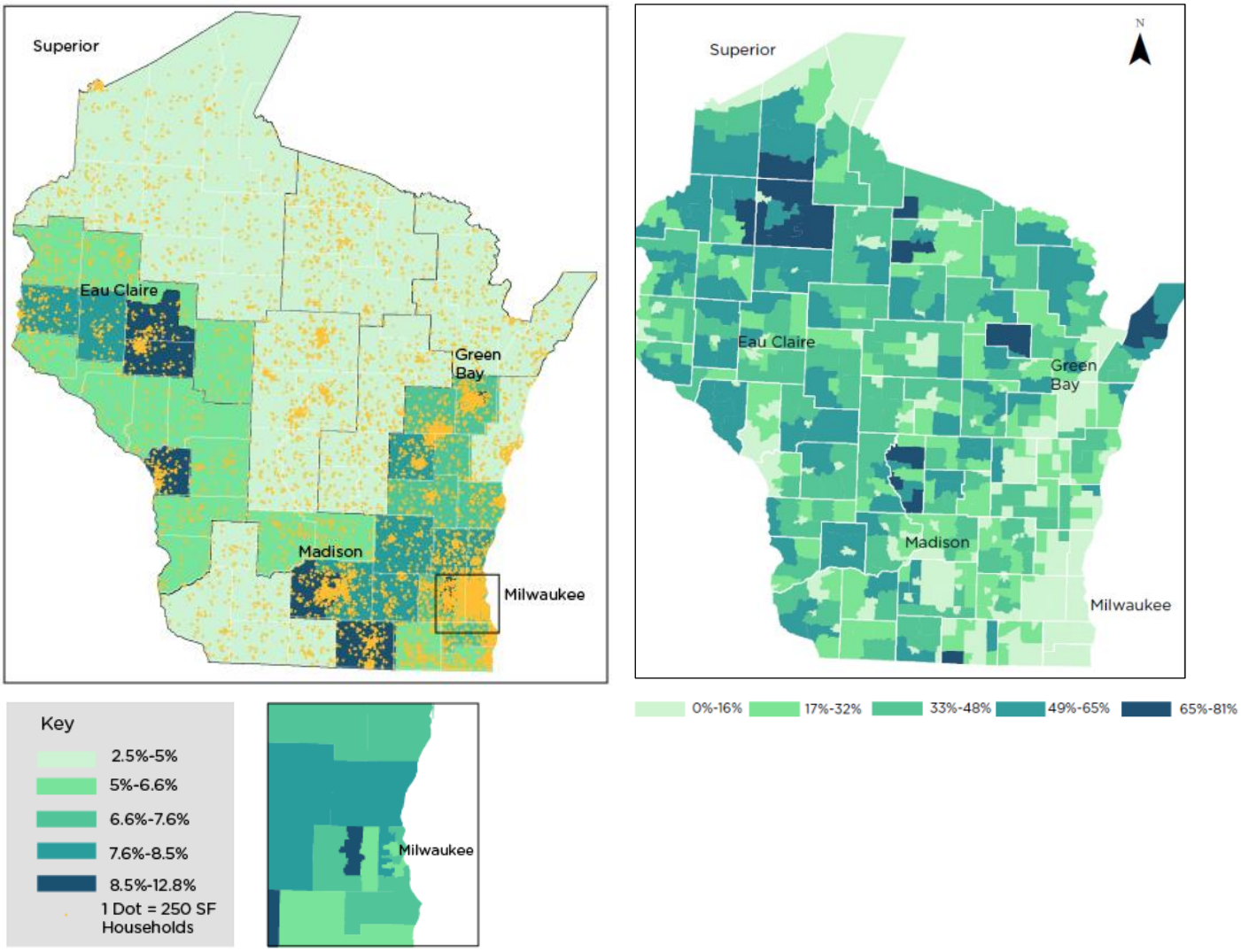
Figure 9. Percentage of Multifamily Homes with Electric Resistance Heating.[33]



[33] Source: ACS 2018 5-Year Estimates Table B25040 “House Heating Fuel,” ACS 2018 5-Year Estimates Table B25024 “Units in Structure.”

In Figure 10, it is apparent that the Beloit/Janesville area, Madison area, La Crosse area, and Eau Claire area are ideal areas to target as they contain significant number of single-family units and large percentage of electrically heated homes. Figure 11 illustrates that more rural areas use propane as a heating fuel. East of Green Bay, the Menominee Reservation, and the areas around the Chequamegon-Nicolet National Forest have a high prevalence of propane heating. The housing units in this figure are not distinguished between multifamily or single-family.

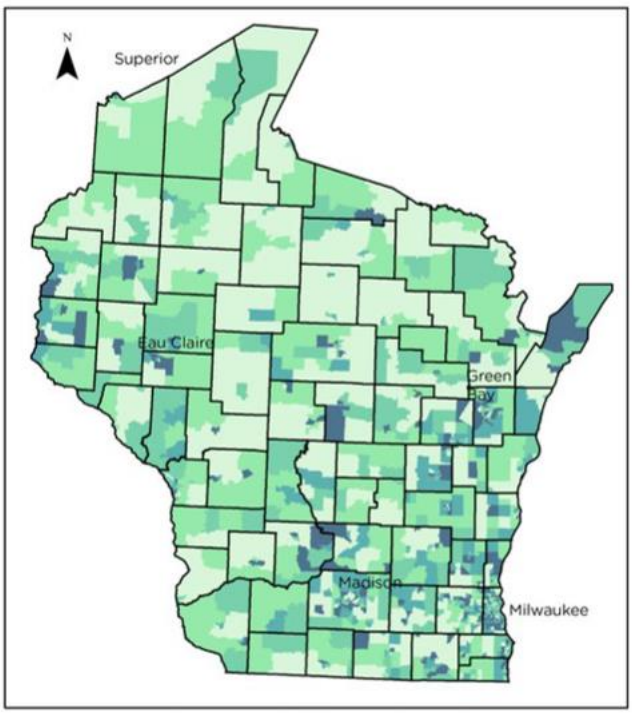
Figures 10 and 11. Percentage of Single-Family Homes with Electric Resistance Heating and Percentage of Homes with Propane Gas Heating. [34,35]



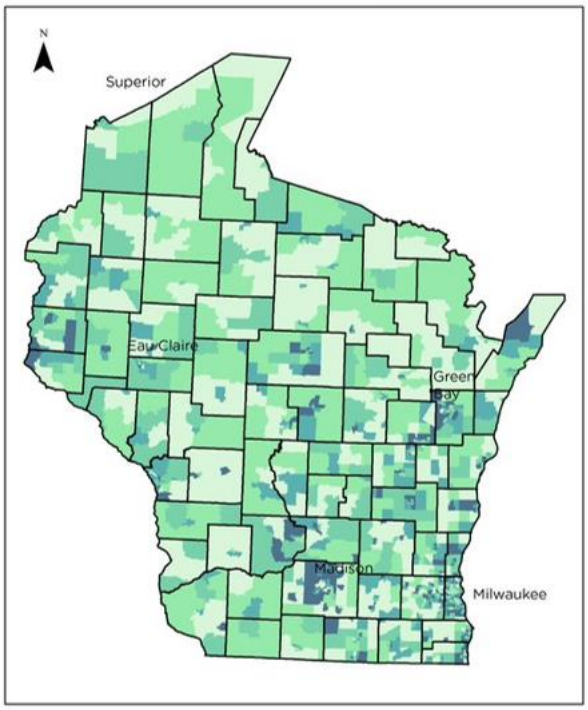
[34] Source: ACS 2019 5-Year Estimates Table B25040 “House Heating Fuel,” ACS 2019 5-Year Estimates Table B25024 “Units in Structure.”
[35] Source: ACS 2019 5-Year Estimates Table B25040 “House Heating Fuel.”

Figures 12, 13, and 14 illustrate multifamily units in small-, medium-, and large-size buildings. Small-size buildings are defined as buildings with 3–9 units. Medium-size buildings are defined as buildings with 10–49 units. Large-size buildings are defined as having more than 50 units.

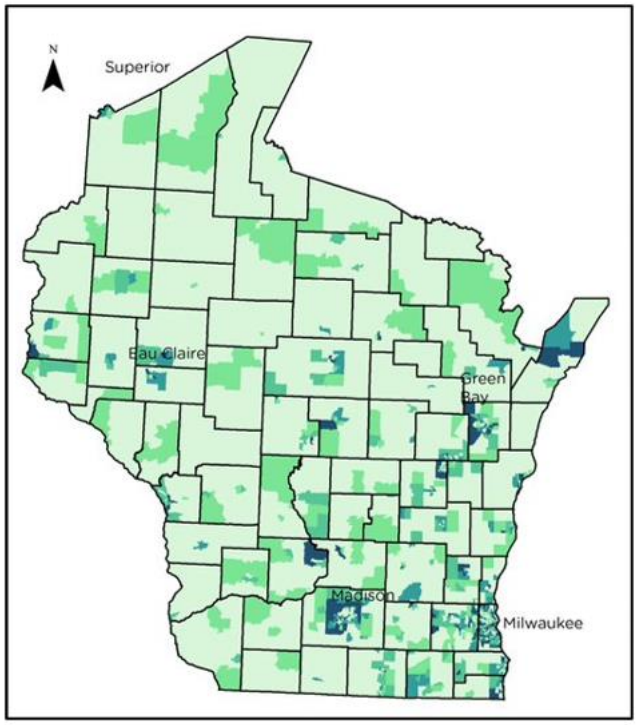
Figures 12–14. Units in Small-, Medium-, and Large-Size Multifamily Buildings.[36]



Small is defined as buildings with 3-9 Units



Medium is defined as buildings with 10-49 Units



Large is defined as buildings with 50 units

[36] Source: ACS 2019 5-Year Estimates Table B25024 “Units in Structure.”

Appendix B: Contractor Engagement Results

The team's survey reached 23 contractors, and the focus group included 10 contractors. There was an overlap of three contractors between the survey and the focus group, so 30 unique contractors were reached through this project. The lists of contractors reached out to were provided by the implementers of Focus' Residential Trade Ally Solutions and Midstream Solutions. The survey was conducted in October and November of 2020 and the focus group was conducted on February 23, 2021. Of the surveys, 11 responses were collected via an emailed, online survey and 12 were obtained through phone calls. For the focus group, contractors were recruited by phone. One of the participants came from a referral by Mitsubishi. All the contractors who responded are registered Trade Allies with Focus on Energy, and responses came from both Residential Trade Ally Solutions providers and Midstream providers.

The pages below contain the engagement summary and results tables and charts.

Table 12. Summary table of contractor participants in the survey and focus group.

Location	Survey/Focus Group (FG)	Approx. Installs / Year[37]	Size of Company	Participant Title
Ashland	Survey	10	*Likely under 10*	President
Beloit	Survey	30-40	4	Office Manager
Chippewa Falls	Survey	6	5-10	Sales
Darlington	Survey	20	Unknown	Owner
De Pere	Survey	70	*Likely over 10*	Sales
Eau Claire	Survey	30	*Likely over 10*	Owner
Hortonville	Survey	15	Unknown	Co-Owner
Janesville	Survey	8	Unknown	Sales / Manager
La Crosse	Survey	25	12	Sales / Installer
Madison	Survey	60[38]	Unknown	Owner / Sales
Manitowoc	Survey	85[39]	Unknown	Owner
Marathon City	Survey	45	Unknown	Sales
Menasha	Survey	35[40]	Unknown	Installer
New Berlin	Survey	15	5-10	Owner
New Berlin	Survey/FG	25	40	Sales / Installer
Omro	Survey	10	Unknown	Office Manager
Oostburg	Survey	25	*Likely over 10*	President
Randolph	Survey	15	5-10	President
Rock Springs	Survey	8	Unknown	Owner
Rubicon	Survey	8	Unknown	Office Manager
Sturgeon Bay	Survey/FG	100	23 (14 HVAC)	Sales
Superior	Survey/FG	100	14	Sales / Installer
Waukesha	Survey	6	Unknown	Sales
Barron	Focus Group	100	18	Co-Owner
Durand	Focus Group	50	35-40	Sales
Mequon	Focus Group	30	33 (16 HVAC)	Vice President
Neillsville	Focus Group	40	5	Co-Owner
Philips	Focus Group	25	8	Owner
Verona	Focus Group	80	25	Owner / Sales
Wisconsin Rapids	Focus Group	150	30	Sales / Manager

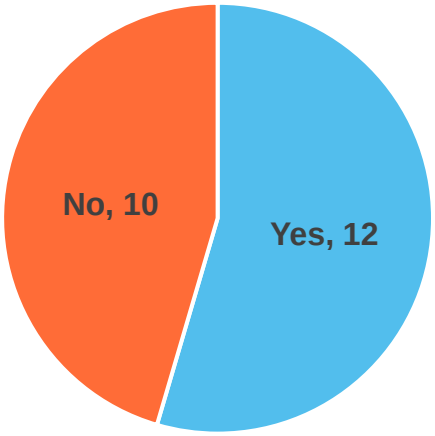
[37] Self-reported number. Ductless and ducted installs are included, though most of the installs were ductless.
[38] The respondent noted 50 ducted and 10 ductless installs, which is an unusual proportion.
[39] Note that this respondent gave conflicting responses, and it is unclear whether he was referring to geothermal heat pumps or air source heat pumps.
[40] This was a very incomplete response and there is reason to doubt the number. Virtually no question was answered except this one, and the respondent noted 25 ducted installs and 10 ductless installs, which is an unusual proportion.

Results

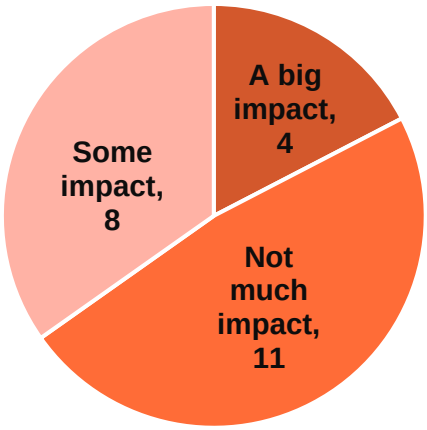
The charts below demonstrate the findings from the Wisconsin contractor research. Most of the charts show survey results versus focus group results because the number of survey responses allowed there to be a more quantitative display, whereas the focus group responses were more qualitative.

Figures 15–18. Survey results showing the number of contractors who see heat pumps as a growing part of their business; impact rebates on sales; customer derivation of sales; and heating installs.

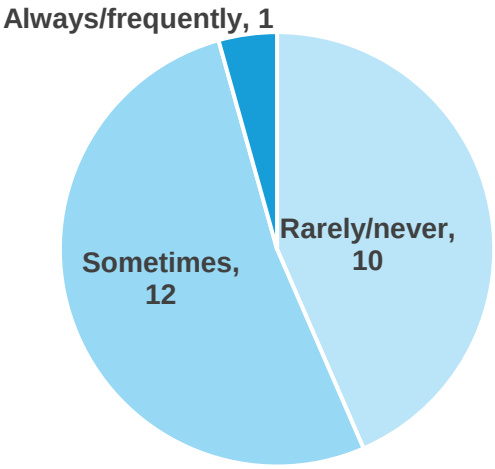
Fg. 15. Do you see heat pumps as a growing part of your business?



Fg. 16. How much of an impact do heat pump rebates have on the decision to purchase a heat pump?



Fg. 17. Are your customers asking about heat pumps (ductless/unitary)?



Fg. 18. If you promote heat pumps, how frequently do you promote them for heating as well as cooling?

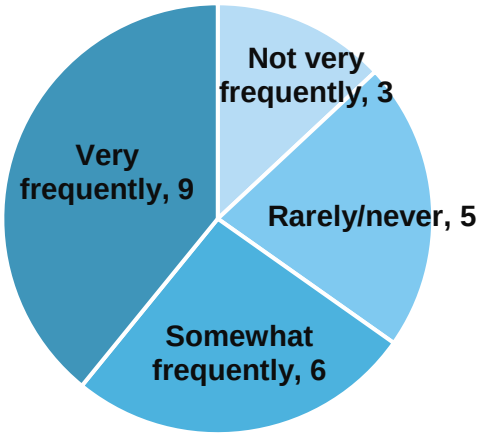


Table 13. Survey responses to whether contractors actively recommend heat pumps.

Do you actively recommend heat pumps to your customers, and why or why not? Are they typically cold climate / variable speed heat pumps?	
Yes, recommend; Yes, cold climate 8 Responses	Yes, very much.
	Yes, actively recommend, and yes cold climate.
	With LP users: definitely for forced air or centrally ducted situations. With Mitsubishi minisplits: almost always.
	Yes. If they currently have a heat pump, we recommend a new energy efficient one.
	Mitsubishi, yes. They offer a good alternative for cooling and supplemental heat.
	Yes, easy solution to a heating or cooling where you can't get duct work to. Most are cold climate.
	All variable speed, but not always cold climate. Natural gas = doesn't recommend cold climate, but propane = will recommend cold climate, but hard to cover the load, so commonly won't recommend cold climate. Will recommend down to 5 degrees. Always recommends cold climate with baseboard; sizes to meet 80-90% of load.
Yes, with caveats 8 Responses	Yes, depending on the situation.
	Yes. Mitsubishi only comes in heat pump for multi-system, and if the customer wanted a single head, I would still recommend for redundancy purposes.
	Yes, usually just standard, not high efficiency.
	Yes, for certain applications. Recommend 2 stage or cold climate.
	We actively recommend *whenever a ductless minisplit is installed.* We use the cold weather style when the home has electric heat or when the heat pump is the main source of heat.
	Always offer but typically people don't buy the idea until there is a situation where it's needed, such as an addition. Yes, cold climate.
	If a customer uses LP, I will mention it as a secondary heating option. Since heat pumps cannot be used as a primary heat source in Wisconsin, I do not actively recommend them.
	Depends on applications. Split systems no. Ductless yes.
No 4 Responses	Not as much as they used to because propane is almost as cheap as natural gas right now. Not always variable speed because of price difference. Gives 3 options, one is usually variable speed.
	Only do them when the customer wants it. All situational. Mostly when there's no ductwork. Mostly not whole home applications. Gas furnace and A/C work; does not recommend heat pumps unless needed for specific situation, like addition or no ductwork. Doesn't promote central units; most customers are natural gas.
	No. Because they're in addition to a minisplit. Only usable during shoulder seasons.
	Most of the heat pumps require emergency heat because of the colder climate conditions. When propane and natural gas prices are less than electricity, which is most of the time in Wisconsin, customers are not saving any money.

Table 14. Survey responses on most common heat pump install applications.

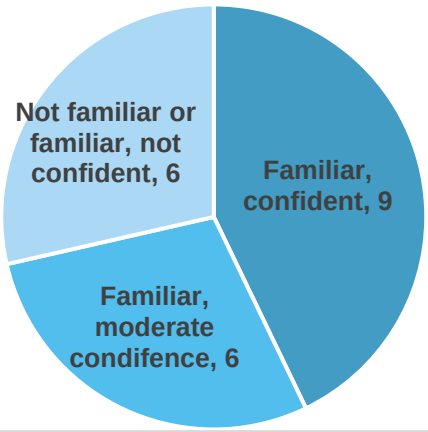
What are the most common applications / situations in which you install heat pumps?
Bonus rooms, poor heating areas
Mostly propane boiler or hard-to-reach areas like bonus rooms/garages. A few all electric.
Whole home/addition.
Ducted - oil heating, LP attached to furnace. Ductless - additions, bonus rooms, garages, etc.
Propane heat.
Natural gas boiler without central air; addition.
Primary heating/cooling in a portion of the home often replacing electric resistance heat.
Hydronic heat with no AC.
4 season porches, adding cooling to houses w/out.
Lots of cabins with propane furnaces. Natural gas w/out ductwork - cooling only.
Mostly additions. Zone cooling. Usually install ccASHPs.
Primarily for cooling.
Ductless heat pumps and central heat pumps where they have LP gas or electric heat.
For centrally ducted, customers are mainly LP customers.
When price of LP is high, promote the split system / forced air.
Customer request.
3 season rooms above garage; offices.
Applications w/out ductwork.
Most common application - single zone for living room.

Table 15. Survey responses on barriers to increasing heat pump sales.

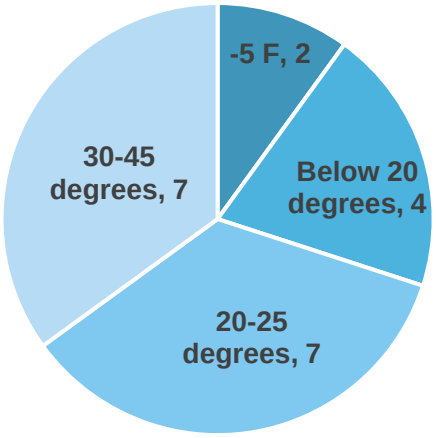
What are some barriers to increasing sales of either centrally ducted or minisplit systems?
Price of equipment.
HPs are much more expensive than air conditioners.
Better electrical rates or incentives.
Visual look; cost.
Cost, climate is cold enough where they don't work all year.
Cost of gas.
Not being able to use HPs as a primary heating source.
Majority of homeowners w/ central heating/cooling have 97% efficient furnaces = no value of heat pump.
Focus on Energy program for ductless has too much paperwork, wait is too long for the rebate. Make it the same as other rebates or we won't be offering the rebate anymore.
Natural gas territory; depends on need. All special circumstances.
More education. Homeowners aren't familiar but getting better.
Our responsibility to ask good questions of customers. Should assist with finding the proper fit for the situation / budget. Heat pump is not always right solution. Sometimes, it is the perfect solution.
Reliability. If the technology is reliable, then it will be promoted.
[Customer] demand.
More advertising of rebates and different types of solutions to heating or cooling issues in the home
Most people get a furnace with ductwork because it's more cost effective. Only installs for cooling.

Figures 19–20. Survey results showing contractor familiarity and confidence with cold climate heat pumps; and heat pump setpoints (most applicable to ducted systems).

Fg. 19. How familiar are you with cold climate heat pumps, and how confident are you in their performance down to temperatures below 0?



Fg. 20. When installing heat pumps for heating, what temperature setpoints do you typically use?



Regarding Figure 19, contractors provided the following contextual comments:

- I believe a back-up heat should be required always.
- Most heat pumps have too low of a BTU capacity for heating. You have to oversize the air conditioners to get more heat for the heating season. 2-stage compressors are high priced and larger in outdoor unit dimensions.
- For minisplits, if they are sized properly for the space they are working in, they do very well. Variable speed forced air products are great until they run out of BTU output for the space.
- We have to know what the right fit is for the situation or the customer will be very disappointed.

Regarding Figure 20, contractors provided the following contextual comments:

Responses for below 20 and -5 degrees:

- Ductless with inverter technology: - 5 degrees
- Minisplits: depends on the situation. For those with electric heat the heat pump is almost an always a solution. For others, it may be when the temps outside are 20 degrees and above.
- [Mitsubishi] Hyper Heat: -13.
- [Mitsubishi] Mid-tier: -5. Mostly sell mid-tier because Hyper Heat costs more.

Responses for 30-45 degrees:

- Set point with current price of propane.
- Set point for dual fuel / central systems.

Figure 21. Focus group results showing how contractors size heat pumps.

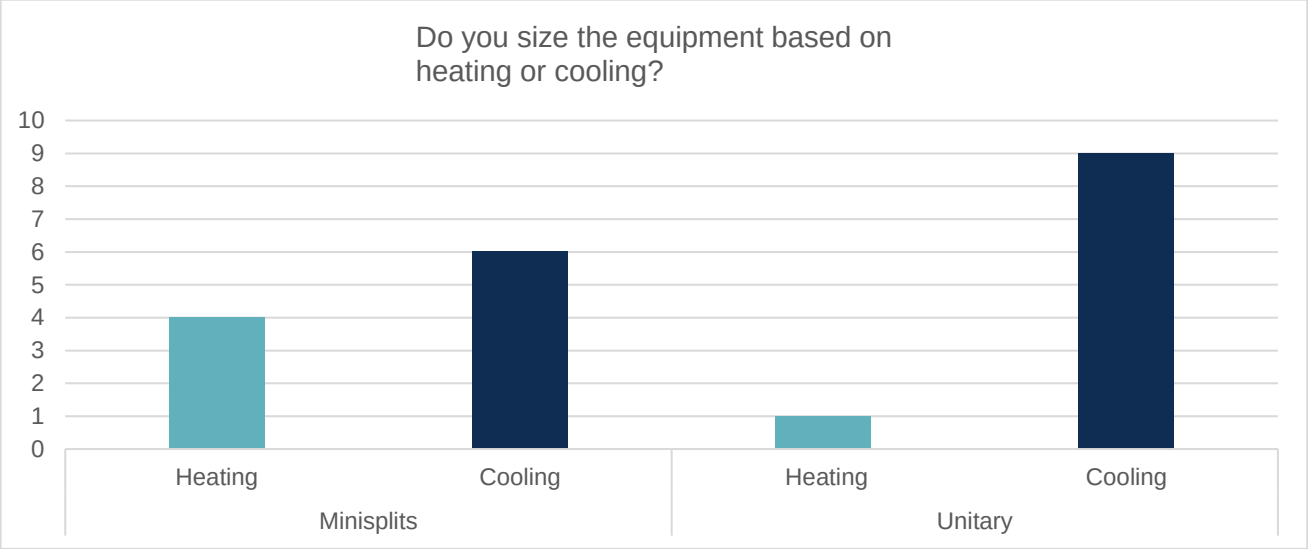
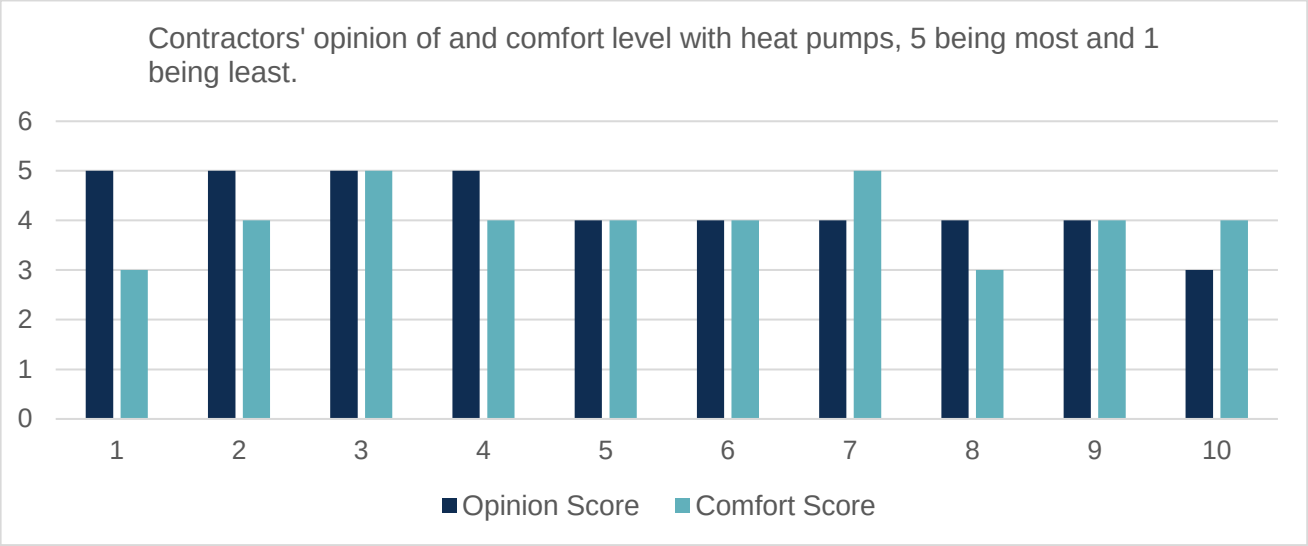


Figure 22. Focus group results showing contractor comfort and opinion of heat pumps.



Regarding Figure 22, opinion scores refer to how well heat pumps performed as expected; comfort scores refer to how comfortable contractors are recommending and selling heat pumps. This chart shows that contractors have an overall high opinion of heat pumps, as well as a high level of comfort with heat pumps (some responses were slightly lower for comfort scores, but not significantly lower). Contractors were asked about instances in which their comfort scores were less than their opinion scores (respondents 1, 2, 4, and 8), and they offered the following thoughts:

- Have not fully dived into heat pumps. In Milwaukee, there are a lot of furnaces and A/Cs. I'm mainly working in bonus rooms, so I have to diversify my knowledge in heat pumps.
- Technology going in a good direction; however, it seems like the unitary system technology is not improving much anymore.
- If the technology were to allow it to be the only system the customer needs, I could sell more. I can sell it, but I have to maintain this other system. [*Many agreed with this comment*].
- On unitary side, it becomes a cost factor — manufacturer cost and operation [fuel] cost.

Appendix C: Multifamily Owner/Manager Research Summary

Elevate Energy conducted interviews with multifamily building owners and managers from October 2020 through April 2021. At the time of this report, the Elevate research team has conducted interviews with nine Wisconsin property owners or management companies. These represent a spectrum of company types and portfolio sizes from all over Wisconsin. Additionally, the interviews conducted represent over 15,000 residential units throughout the state. The name and type of organizations interviewed, as well as the location of their portfolio, are listed in Table 16 below.

The 60-minute interviews were all conducted over video conference. An interview guide was used to gain insights into program design questions related to ASHPs. In addition to the one-on-one interviews with multifamily building owners and managers, Elevate conducted two, 60-minute focus groups — one for owners and managers from the Madison and Milwaukee area and another focused on the rest of the state. The goal of hosting two separate groups was to promote a candid conversation and to identify any differences in geographies. Several owners and managers were invited to participate. The participating organizations represent more than 7,000 multifamily units attended the two focus groups and are also included in the table below.

Elevate worked with a trusted local partner in Northern Wisconsin who had connections / access to building owners and managers. Owners and managers were incentivized to participate by selecting a charity to donate an incentive to. A discussion guide was used to gain insights into program design questions around ASHPs. Questions were formatted to evoke a roundtable discussion where each participant provides an answer, open discussion, or responds to a poll.

The following page contains the multifamily owner/manager engagement summary.

Table 16. List of multifamily organizations interviewed

Multifamily Org. Name	Multifamily Type	Location of Properties	Interview Type	Number Units
Wisconsin Management Company	Large for-profit property management company	Northeast, Southwest, South Central, and Central Wisconsin, Milwaukee/Greater Milwaukee, and Northern IL	One-on-One	5,000
Housing Initiatives, Inc.	Medium-Large non-profit developer	Madison, Wisconsin	One-on-One	151
AK Development	Small real estate developer	Milwaukee, Wisconsin	One-on-One	40
Wangard Partners, Inc	Commercial real estate investment company	Primarily in Southeast Wisconsin	One-on-One	1,000
West CAP—West Central Wisconsin Community Action Agency, Inc.	Medium non-profit affordable housing developer	Northwestern Wisconsin	One-on-One	250
HoChunk Nation	Nonprofit affordable housing developer	Northwest and Central Wisconsin	One-on-One	196
The Morgan Partners	Small, for-profit development company	Oshkosh, Wisconsin	One-on-One	200
KM3 Management	Small, for-profit development company	Madison, Appleton, and Milwaukee, Wisconsin	One-on-One	600
FORE Investment Group	Small for-profit management company	Appleton, WI	Focus Group	150
New Year Investments	Medium for-profit management company	Madison, WI	Focus Group	1,000
Lincoln Avenue Capital	Large for-profit affordable housing developer	Operates across 15 states and based in Madison, WI	Focus Group	15,000 (Average 1,000/state)
Wisconsin Housing Preservation Corp	Large non-profit developer (largest owner of affordable housing in WI)	58/72 counties in Wisconsin	One-on-One & Focus Group	8,400
Total Units Engaged in One-on-One Interviews				15,587
Total Units Engaged in Focus Groups				7,150

Appendix D: Costs of ASHPs and ccASHPs

We conducted pricing research into current equipment costs for cold-climate ASHPs. This is a rapidly evolving product category, and thus costs here are a snapshot at a given point in time.

ASHPs and ccASHPs typically cost more than equivalent cooling-only units (i.e., air conditioners). Costs will vary depending on the install application and building type (e.g., single-family versus multifamily) due to labor hours and building needs. When considering heat pump costs, it is important to keep in mind what the competing heating or cooling system is, even if it includes no heat pump at all. While incremental measure costs tend to focus on the difference between a more efficient heat pump and a less efficient heat pump, the customer's decision to buy a heat pump is mainly influenced by the comparison to alternatives to heat pumps. This being the case, while we present ductless and ducted heat pump costs in the table below (collected from distributor-listed information). This does not include the cost of installation, which is expected to be similar or slightly higher to install costs for A/C systems.

Table 17. Ductless minisplit cost comparisons.

Manufacturer	Model	Ratings / Size / # of Zones	Low Temp?	Cost
Mitsubishi	M-Series	18 SEER; 9.5 HSPF / 25K Btu / 2 zones	5F	$3,497.25
	M-Series, Hyper-Heat	18 SEER; 11 HSPF / 27K Btu / 2 zones	-13F (Inverter-driven)	$4,835.25
Daikin	MXS	17.9 SEER; 12.5 HSPF/ 24K Btu / 2 zones	5F	$2,946.00
	MXL	17.9 SEER; 12.5 HSPF/ 24K Btu / 2 zones	-13F	$3,612.00
Fujitsu	Halcyon HFI	18 SEER; 9 HSPF / 21K Btu / 2 zones	5F	$2,386.35
	Halcyon HFI XLTH	21.5 SEER; 10.3 HSPF/ 21K Btu / 2 zones	-13F	$2,897.45

Table 18. Ducted system cost comparisons.

Manufacturer	Ratings / Size / VS?	NEEP CC?	Cost
Lennox	20 SEER; 10 HSPF / 2-5 tons / Yes VS	No	$6,578
	23.2 SEER; 10.2 HSPF / 2-5 tons / Yes VS	No	$5,918–$8,170
Mitsubishi	18.4 SEER; 12.2 HSPF/ 1-3 tons / Yes VS	Yes	$4,900–$6,526
	18 SEER; 12.6 HSPF/ 1-3 tons / Yes VS	No	$4,279–$4,807
Daikin	16 SEER; 10.4 HSPF/ 1.5-5 tons / Yes VS	Yes	$7,790
Carrier	19 SEER; 11 HSPF / 2-5 tons / Yes VS	No	$6,405
	20.5 SEER; 13 HSPF / 2-5 tons / Yes VS	Yes	$9,003

Appendix E: ASHP Calculations Including Hours and Load

This analysis looked at the savings results and loads for three different switch-over temperatures for dual fuel systems. The percentage of heating hours represents the number of heating hours the ASHP would generally operate in these scenarios, compared to the back-up gas/propane system. The percentage of heating load represents the how much of the home's heating load the ASHP meets compared to the back-up system. This takes into account use of the ASHP versus the back-up source for heating at really cold temperatures, when the load is greater.

Table 19. Engineering calculations, including heating hours and percentage of load, for ASHPs installed with existing natural gas furnaces.

	Energy Use			Customer Heat Cost		Heat Pump Use/Load	
Application	**Gas (MMBtu/yr)**	**Gas Reduction (MMBtu/yr)**	**Electric Increase (kWh/yr)**	**Ave. Rate Savings**	**Lower Rate Savings**	**% of Heating Hours**	**% of Heating Load**
Baseline – gas (condensing)	*75*	*n/a*	*n/a*			n/a	n/a
Dual fuel 5°F switchover	17	58	5,847	$ (155)	$ 70	92%	81%
Dual fuel 25°F switchover	37	38	3,479	$ (66)	$ 67	75%	53%
Dual fuel 45°F switchover	66	9	650	$ 5	$ 30	37%	13%

Table 20. Engineering calculations, including heating hours and percentage of load, for ASHPs installed with existing propane furnaces.

	Energy Use			Customer Heat Cost		Heat Pump Use/Load	
Application	**Gas (MMBtu/yr)**	**Gas Reduction (MMBtu/yr)**	**Electric Increase (kWh/yr)**	**Ave. Rate Savings**	**Lower Rate Savings**	**% of Heating Hours**	**% of Heating Load**
Baseline – propane (condensing)	*75*	*n/a*	*n/a*		*n/a*	*n/a*	*n/a*
Dual fuel 5°F switchover	17	58	5,847	$ 531	$ 755	92%	81%
Dual fuel 25°F switchover	37	38	3,479	$ 381	$ 514	75%	53%
Dual fuel 45°F switchover	66	9	650	$ 114	$ 139	37%	13%

CEE modeled the ductless minisplit application as a retrofit that is intended for the heat pump to become the primary heat source or providing *most* of the heat (i.e., not in an addition or an add-on for new zonal heating and cooling). The disparity between % of heating hours and % of heating load can be attributed to two factors for our calculations: 1. The ductless systems are going to run at any outdoor air temperature, so they run for 100% of hours (ductless systems have the ability to operate down to extremely cold temperatures, such as -20F). However, on the coldest hours, they will not meet the full load; and 2. The customer/contractor would likely only install minisplit indoor units in areas that are the most cost-effective for the tenant/homeowner. That is, there are diminishing returns on savings to the customer to add a ductless minisplit unit to rooms that have very small heating or cooling loads. Thus, for these modeling scenarios, we assume that the ductless minisplit units will economically and sensibly displace 67% of the heating load.

Table 21. Engineering calculations, including heating hours and percentage of load, for ductless minisplits in electric resistance retrofits.

		Energy Use		Customer Heat Cost	Heat Pump Use/Load	
Sector	**Application**	**Electric (kWh/yr)**	**Electric Reduction (kWh/yr)**	**Electric Savings**	**% of Heating Hours**	**% of Heating Load**
Single Family	*Baseline – SF electric resistance (ER) baseboard*	*18,840*	*n/a*	*n/a*	n/a	n/a
	Ductless minisplit w/ ER back-up	12,228	6,612	$ 705.0	100%	67%
Multi-Family	*Baseline – MF electric resistance baseboard*	*9,962*	*n/a*	*n/a*	n/a	n/a
	Ductless minisplit w/ ER back-up	6,047	3,915	$ 417.0	100%	75%

Appendix F: Electric Heating Analysis Results

As part of this research, CEE conducted a billing analysis of the monthly bills for segments of members/customers for WPPI Energy (WPPI) and Madison Gas and Electric (MGE). The research team ran billing data through a script to identify customer accounts that are likely to have electric heating. This analysis can provide more exacting and granular detail about where electric heating is prevalent, which can help Focus and its members target this customer segment for ASHP retrofits.

It is important to consider that for this analysis, the script CEE used ensures that we are reasonably certain that those units identified as being electrically heated *are* electrically heated, *however,* it is not a comprehensive list of all electrically heated units. We erred on the side of potentially excluding some electrically heated units with small heating loads, rather than potentially including some units that may have dual fuel heating.

WPPI Energy

For WPPI, the team analyzed three years of monthly billing data for 39 WPPI municipal utilities. The results of that analysis are below, showing total accounts (or housing units) analyzed, number of units determined to be electrically heated, and the corresponding proportion of electric heating for that utility. Overall, we identified 36,415 units as multifamily units, 17,773 units as electrically heated units, and 8,128 units that are *both* electrically heated and multifamily. To give an idea of the picture this paints, this means that about 22% of the multifamily units are electrically heated and about 46% of the electric heating occurs in multifamily units.

Now, as noted above, because the script used may have excluded electrically heated units with very small heating loads (such as the case in multifamily units with a small square footage), it is possible (and even likely), that there are more multifamily units with electric resistance heating than our results show. To be sure, given the small heating load of these units, they might not be the best candidates for ductless minisplit retrofits anyway.

The heating load shown in Table 22 is what our script modeled as the annual MWh used for heating for those identified as having electric resistance heating.

Madison Gas and Electric

For MGE, the team analyzed two years of monthly billing data for [redacted] customers in three identified zip codes: [redacted]. The customer accounts from those zip codes were selected as users with at least 320 kWh of energy use in each of these four timeframes: January 2019, February 2019, January 2020, and February 2020. The results of the analysis show total number of units determined to be electrically heated and presumed condo or multifamily accounts.

Please see below for the results tables for these analyses.

Table 22: Billing analysis results of prevalence of electric heating in 39 WPPI municipal utilities.

Utility	Total Units	Electric Heated	Electric Multifamily	Proportion Electric	SUM Heat Load
Sun Prairie Utilities	15,074	1,831	1,262	12%	7,672 MWh
Kaukauna Utilities	13,872	1,504	475	11%	8,685 MWh
Stoughton Utilities	7,910	1,039	353	13%	5,672 MWh
Sturgeon Bay Utilities	7,442	1,039	401	14%	5,922 MWh
River Falls Municipal Utilities	6,121	980	634	16%	4,578 MWh
Plymouth Utilities	7,288	909	350	12%	5,006 MWh
Oconomowoc Utilities	15,120	838	328	6%	3,942 MWh
New Richmond Utilities	4,485	720	331	16%	4,142 MWh
Menasha Utilities	8,269	712	339	9%	3,200 MWh
Hartford Electric	6,726	702	333	10%	3,477 MWh
Jefferson Utilities	3,564	624	393	18%	2,881 MWh
Cedarburg Light & Water Utility	5,744	537	184	9%	2,528 MWh
Mount Horeb Utilities	3,373	501	180	15%	2,514 MWh
Black River Falls Municipal Utilities	2,231	454	266	20%	2,442 MWh
New London Utilities	3,537	435	225	12%	2,127 MWh
Evansville Water & Light	3,407	394	174	12%	1,779 MWh
Waunakee Utilities	5,873	378	164	6%	1,548 MWh
Slinger Utilities	2,323	347	245	15%	1,987 MWh
Waupun Utilities	4,108	308	134	7%	1,325 MWh
New Holstein Utilities	2,231	295	98	13%	1,707 MWh
Boscobel Utilities	1,421	267	119	19%	1,280 MWh
Brodhead Water & Light	1,533	249	99	16%	1,264 MWh
Prairie Du Sac Utilities	1,890	248	107	13%	995 MWh
Lake Mills Light & Water	3,800	230	79	6%	917 MWh
Two Rivers Water & Light	5,561	222	61	4%	1,005 MWh
Waterloo Utilities	1,520	203	72	13%	1,143 MWh
Hustisford Utilities	1,312	202	76	15%	1,132 MWh
Whitehall Electric Utility	776	187	123	24%	913 MWh
Oconto Falls Municipal Utilities	1,349	180	95	13%	774 MWh
Columbus Water & Light	1,933	172	47	9%	878 MWh
Lodi Utilities	1,457	150	48	10%	574 MWh
New Glarus Utilities	1,068	130	57	12%	675 MWh
Cuba City Light & Water	962	128	69	13%	566 MWh
Muscoda Utilities	914	128	42	14%	659 MWh
Juneau Utilities	1,360	126	66	9%	766 MWh
Westby Utilities	1,005	118	5	12%	766 MWh
Florence Utilities	1,326	104	25	8%	481 MWh
Algoma Utilities	1,695	100	44	6%	352 MWh
Eagle River Light & Water Utility	1,007	82	25	8%	371 MWh

Table 23: Billing analysis results of prevalence of electric heating in three zip codes in Madison Gas & Electric territory.

Total accounts:	[redacted]	
Electrically heated accounts:	[redacted]	
Proportion of electric heat:	~11%	
Likely condo accounts:	[redacted]	
Likely condo electrically heated accounts:	[redacted]	
Multifamily accounts:	[redacted]	
Multifamily electrically heated accounts:	[redacted]	
Single-family accounts:	[redacted]	
Single-family electrically heated accounts:	[redacted]	
Electric heat count and ratio per zip code:		
	Electric heat count	**Electric heat ratio**
Zip code 1: [redacted]	[redacted]	~14.7% [redacted]
Zip code 2: [redacted]	[redacted]	~9.2% [redacted]
Zip code 3: [redacted]	[redacted]	~12.1% [redacted]

Appendix G: ASHP Propane Retrofit Case Studies

The following two case studies were developed by CEE as part of their implementation of the Minnesota ASHP Collaborative. In 2020 and 2021, CEE conducted voluntary quality control inspections on ASHP installations in participating utility territories. With the resulting information, the Minnesota ASHP Collaborative team developed a few case study one-pagers to demonstrate the details, benefits, and customer perspectives of ASHPs — especially in dual fuel applications.

The first case study includes a standard efficiency ASHP that had a switchover temperature set at 20°F–25°F. The second case study includes a ccASHP that had a switchover temperature set at -5°F.

Heat Pump Upgrade in Savage, MN

ASHP
air source heat pump collaborative

James Neuenfeldt had an important decision to make about heating and cooling after moving into his new home. Built in 1984, the home contained an inefficient propane furnace and a defective heat pump. After weighing his options carefully, Neuenfeldt decided to upgrade the old heat pump to its high-efficiency successor—an air source heat pump (ASHP).

"The air quality and comfort are great, and you barely know it's on," says Neuenfeldt.

Neuenfeldt, an engineer, appreciated the innovation of the ASHP technology. He purchased a unit with a variable speed motor to heat and cool his home to achieve the best performance and efficiency. Since installing his new ASHP, Neuenfeldt only needs to use his backup propane furnace on the coldest winter days. Plus, the efficient setup gives him greater peace of mind as an environmentally conscious homeowner.

"It just makes financial sense."

Neuenfeldt acknowledges that ASHPs come with higher up-front costs than other heating systems, but he expects the prices will drop as the market grows. He believes the long-term energy savings make them the clear economic choice for both heating and cooling. "It just makes financial sense," says Neuenfeldt.

House Details

- Built in 1984
- 2,375 square feet
- Located in Savage, MN
- Utility: Minnesota Valley Electric Cooperative
- Utility rebate: $500

Equipment Details:

- Centrally ducted
- SEER 20 and HSPF 9.6
- 3-ton system
- 20–25-degree switchover temperature
- Propane backup

Learn more

Visit mnashp.org to find more resources or email us at **info@mnashp.org** with additional heat-pump questions.

Cold-Climate ASHP in Pelican Rapids, MN

ASHP
air source heat pump collaborative

Steve Haiby likes to get the best performance out of his home systems. A few years ago, he was on the hunt for a high-efficiency solution for heating and cooling his home built in 1998. After researching his options and gathering information from other homeowners, Haiby landed on a cold-climate air source heat pump (ASHP).

"It's been wonderful," Haiby reports. **"This high-efficiency ASHP worked out so well."**

Haiby was aware that some homeowners worry ASHPs won't perform as well as advertised on cold winter days. However, he was confident in the technology and decided to take full advantage of his unit's capacity by setting the changeover temperature to -5°F.

Haiby carefully tracked his ASHP's performance during the 2020–2021 winter and was pleased with the results. His unit met the entire heating load of his home throughout November and 85% of his heating needs in January. Even during a polar vortex in February that brought 11 below-zero days and eight nights below -20°F, Haiby only had to run his backup propane furnace one-third of the time.

"It's a win–win for everyone."

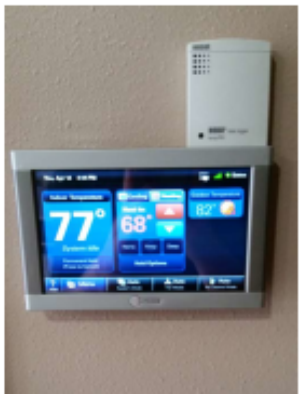
As time has passed, Haiby has been increasingly pleased with his heat pump. "Operating costs for both heating and cooling are low with super-efficient tech like this, and it brings carbon emissions down, too," Haiby says. "It's a win–win for everyone."

House Details

- Built in 1998
- 2,480 square feet (1,240 main, 1,240 walkout basement)
- Located in Pelican Rapids, Minnesota
- Utility: Lake Region Cooperative Electric Association
- Utility rebate: $480–$630

Equipment Details:

- Centrally ducted
- SEER 18.75 and HSPF 9.5
- 3-ton system
- -5°F switchover temperature
- Propane backup



Learn more

Visit mnashp.org to find more resources or email us at **info@mnashp.org** with additional heat-pump questions.