MIDWEST
COLLABORATIVE

Moving Toward High-Performance HVAC: Applications for Dual Fuel Heat Pumps in the Midwest

May 2025

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ABOUT THE COLLABORATIVE

The Midwest Heating and Cooling Collaborative (Collaborative) is delivered by four mission-aligned nonprofit organizations in the Midwest: Center for Energy and Environment (CEE), Slipstream, the Midwest Energy Efficiency Alliance (MEEA), and Elevate.

The Collaborative aims to cross-pollinate program best practices across the industry to progress toward its goal: making cost-saving, high-performance HVAC technology accessible and the clear first choice for all homeowners and contractors across the Midwest and regionally support the larger goal of establishing U.S. energy leadership in the world. High-performance HVAC technology provides numerous benefits such as lower utility costs and improved comfort for homeowners and grid resiliency for utility providers. The Collaborative provides industry resources to promote research, knowledge sharing, and connections between market players to advance high-performance HVAC technology understanding and uptake.

This report was authored by Slipstream and CEE.

This report references a variety of resources from across the region. If you have any questions, or would like more information or support, please reach out to info@mwcollab.org.

EXECUTIVE SUMMARY

Dual fuel heat pumps are among the highest performance HVAC technology capable of affordably providing both conditioned heating and cooling to a home. This technology expands consumer choice and provides comfort and cost benefits to customers, creates business opportunities for contractors, and enables demand-side management and load flexibility for utilities and grid operators. The project team proposes a pragmatic approach to heat pump application in the residential market that emphasizes dual fuel energy sources and leverages the technology's controllability to achieve superior homeowner comfort and cost savings and a more flexible and resilient grid.

To unveil the pathway for dual fuel heat pump use in the Midwest, the project team completed a literature review, stakeholder engagement, and performance modeling. Our findings identified several key barriers and opportunities. Barriers include a general lack of awareness around the product, lack of cost parity between electric and natural gas prices in the Midwest, limited understanding of the upfront costs and payback periods for customers, complexity and lack of contractor resources around right-sizing equipment and installation best practices, and a fragmented manufacturer market and supply chain constraints.

The recommendations presented are based on a technology and market characterization and analysis that breaks down equipment types, the impact of building envelope and climate effects on space conditioning loads, equipment sizing and selection, fuel costs, and utility incentives. The project team applied these variables to several modeling scenarios to guide recommendations accounting for key value propositions for customers, contractors, and utilities.

Based on the modeling results, the project team presents a set of recommendations that stakeholders can use to strengthen the market for dual fuel heat pumps in their local jurisdiction. Key recommendations to strengthen the path for dual fuel heat pumps to drive high-performance HVAC use in the Midwest include the following.

- Increase awareness of high-performance HVAC systems, like ASHPs as an AC replacement, so that the technology is not overlooked as an option during replace-on-fail scenarios.
- Work with local market partners to upskill contractors in selling and installing dual fuel heat pumps, support whole-home business models, and support new HVAC workforce entrants.
- Unleash the flexible capabilities of dual fuel heat pumps to increase customer choice, lower costs, and improve grid management.
- Ensure programs coordinate and align equipment incentive requirements around common product specifications.

Dual fuel heat pumps are an actionable and flexible technology to deploy across the Midwest. They expand consumer choice, improve homeowner comfort, lower utility costs, and increase energy resilience. Given proper planning and careful consideration of the factors detailed in this report, dual fuel applications of ASHPs are poised to be a clear-cut decision for customers, contractors, and utilities.

INTRODUCTION

The focus of this roadmap is on centrally ducted, dual fuel heat pump systems as a key high-performance HVAC application well suited for Midwest conditions. Air source heat pumps (ASHPs) are flexible and highly energy efficient energy-transferring systems that provide an opportunity to level up performance of space heating and cooling, the largest source of energy use in the residential sector.

In a dual fuel heat pump system, the electrically powered ASHP takes the place of a central air conditioner and is paired with a secondary fuel-fired furnace. The ASHP provides cooling, and in heating mode, the hybrid system alternates between the two sources, maximizing comfort, economics, and efficiency. These systems are also commonly referred to as “hybrid heat pump systems” or generally as “hybrid heat”. While fully electric ASHP system configurations are also possible and gaining market share in warmer climates, there are current limits to their cost-effectiveness at scale in the Midwest.

The limitations of fully electric systems mean that dual fuel heat pumps are a critical tool for regional stakeholders to meet their goals for existing residential buildings in the Midwest and progress toward the Department of Energy’s (DOE) goals to advance high-performance HVAC technology, energy resiliency, and affordability. This report describes how and where dual fuel heat pumps make sense from a cost and participant benefits perspective, impacts from changes in market conditions, and how the opportunity evolves as the market for high-performance HVAC develops.

The project team completed a literature review and stakeholder engagement to characterize the technology, value proposition, contractor and customer deployment considerations, and influential factors impacting market development. We conducted cost and grid modeling of various types of dual fuel heat pumps to illustrate upfront costs and operating costs for customers, impacts of weatherization, and impacts on peak demand and grid constraints. Finally, the project team shares recommendations for states, utilities, and communities to unlock the potential of dual fuel heat pumps to move the Midwest residential building stock toward high-performance HVAC and contribute to United States energy leadership broadly.

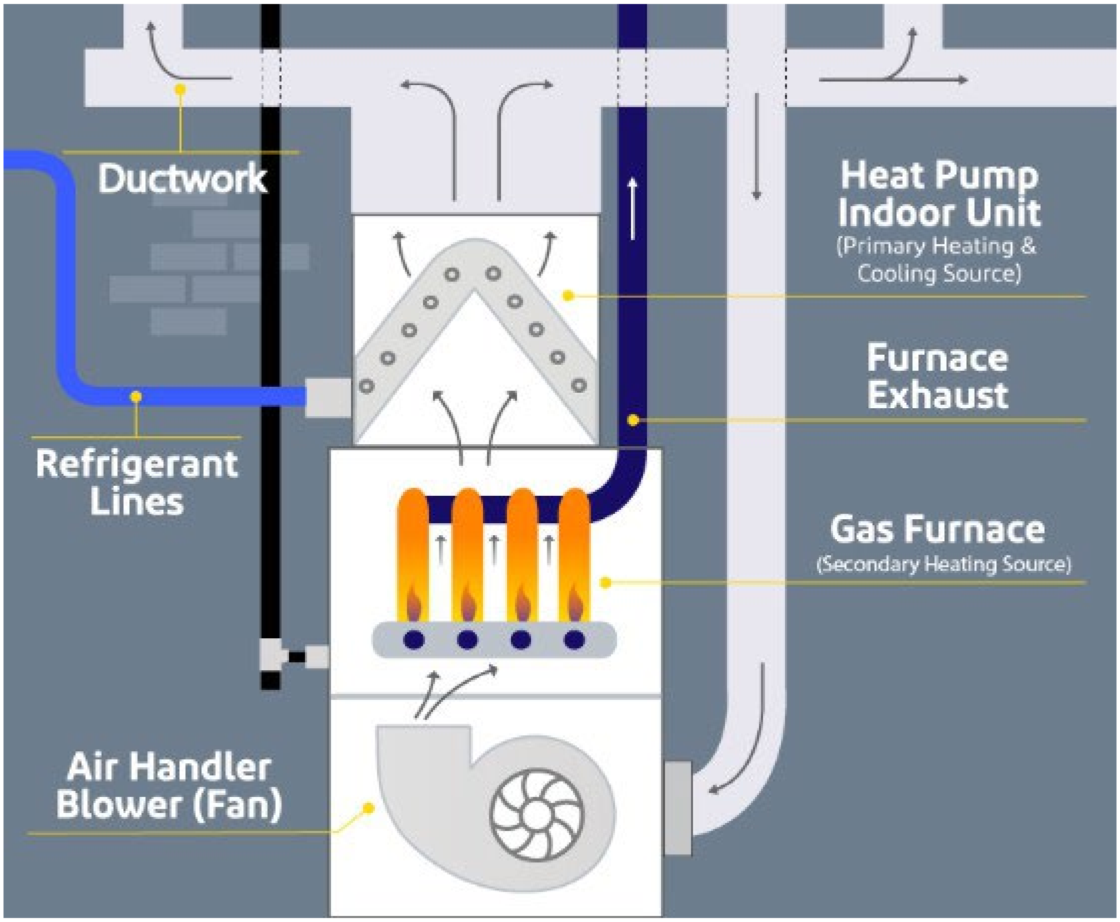
DUAL FUEL HEAT PUMP OVERVIEW

Dual fuel heat pumps are made up of three components: the outdoor unit, the indoor unit, and the new or existing fuel-fired furnace. The heat pump has minimal differences in components from a central air conditioner, simply requiring a defrost board and reversing valve for heating mode operation. Like a central AC setup, the indoor coil is located downstream of the gas burner in the air handler (Figure 1).[1] Only the heat pump or fuel-fired furnace provides heat for the home at any point in time. This setup differs from an all-electric central heat pump, where either the heat pump is the sole source of heat, or can operate simultaneously with an electric booster that meets

[1] Oak Ridge National Laboratory research on dual fuel heat pumps has investigated the viability of placing the indoor coil upstream from the gas burner to enable simultaneous operation, so the gas furnace acts as a booster (ACEEE Summer Study 2022). However, currently there are no products available from the market in this form factor and the project team is not aware of any near-term product releases of a simultaneous fuel-flexible heat pump.

heating needs beyond the installed heat pump's capacity at the coldest temperatures.

Figure 1: Dual fuel (hybrid) heat pump air handler



Types of dual fuel heat pumps

Dual fuel heat pumps are not a new product category, but the range of applications has expanded with the advent of variable-capacity compressors, improved cold climate performance, and standalone add-on inverter or coil-only[2] products that can be installed with an existing furnace. Below are descriptions of the five types of dual fuel heat pumps and a summary of cold temperature performance.

Single-stage: Single-stage, or single-speed, compressors have two settings: on or off, meaning they operate at 100% capacity to reach the desired temperature, then shut off completely once the indoor temperature is reached. Because of the frequent switch from on to off, and because they can only operate at 100% max speed, heat pumps with single-stage compressors are usually the most expensive to operate.

These systems are longstanding and widely available. Single-stage heat pumps are available

[2] The heat pump supply chain often refers to standalone add-on inverter systems as "coil-only" products. The AHRI rating for this system type includes solely the outdoor unit and indoor unit (coil) match and do not include a matched furnace like fully matched dual fuel ASHPs, which include the outdoor unit, indoor unit (coil), and furnace.

from every major HVAC manufacturer of centrally ducted equipment and are typically efficiency rated across many furnace product lines. They do not require manufacturer proprietary controls and are available at a relatively low incremental cost compared to an air conditioner.

However, single-stage heat pumps are highly unlikely to meet ENERGY STAR's cold-climate performance requirements, such as maintaining high efficiency and sufficient heating capacity at 5F, due to their fixed-speed compressors. In the Midwest, where summers are hot and humid, single-stage heat pumps are typically sized according to the cooling load to ensure efficient operation and adequate dehumidification. Oversizing for cooling causes frequent on/off cycling, reducing efficiency and leaving indoor humidity too high, as the system shuts off before removing enough moisture.

Two-stage: Two-stage, or two-speed compressors, have a low and high setting, often at around 65% and 100% capacity. Compared to single-stage systems, the two-stage system provides improved efficiency and temperature control.

Like their single-stage counterparts, two-stage systems have limited performance in cold climates, typically down to around 20°F. Proper sizing in the Midwest market is based on the cooling load at low stage. Two-stage systems must be matched with compatible furnaces, do not require manufacturer proprietary controls, and are relatively low cost.

Inverter-driven (variable speed or variable capacity): Inverter-driven heat pumps can continually adjust the compressor's speed to match the heating or cooling needs of the home, offering the highest efficiency and most precise temperature control. Variable speed systems can operate anywhere from 25% capacity to 100% percent capacity to provide more, or less, pressurization of the refrigerant, varying the refrigerant's flow, in turn varying the indoor and outdoor airflow and the rate of heat transfer to match the home's heating or cooling needs.

While these systems cost more upfront because they can operate at lower speeds during moderate outdoor and indoor temperature differences, they consume less power, which makes them the least expensive to operate over time. Variable speed systems present the most flexibility in sizing. Most of these systems require the heat pump manufacturer's proprietary communicating controls and if they do not, efficiency may be negatively impacted. Some variable speed systems are rated for cold climate performance.

Standalone add-on inverter (coil-only): Often referred to as coil-only systems by supply chain actors, these systems pair a variable speed outdoor unit with an indoor coil that can be installed on any existing fuel-fired furnace, whether the blower is variable speed or not. Many of the growing number of systems available in this product category exhibit cold temperature performance.

Due to their nature of installation with any existing furnace, these systems typically come at a lower cost than fully matched variable speed systems and costs are further lowered for systems sized smaller than the full heating load. Communicating controls are not required.

Multizone inverter-driven (variable speed or variable capacity): In addition to exchanging heat with a central air handler, a multizone inverter system runs the refrigerant line from the outdoor unit to a second zone in the home, such as an upstairs bedroom or office. Conditioned air in this second zone is often provided by a ductless indoor unit. These systems tend to be more expensive high-end products and require communicating controls.

Cold temperature performance

Cold climate heat pumps are a subtype of variable capacity systems. ENERGY STAR's current specifications require the heat pump to meet the energy efficiency metric coefficient of performance (COP) of 1.75 at 5°F and retain a minimum of 70% capacity at 5°F compared to rated conditions at 47°F.[3]

Definitions of a "cold climate" heat pump are not uniform and are shifting. For example, the Consortium for Energy Efficiency, which sets energy efficiency criteria for ASHP equipment to be eligible for the federal tax credit under Section 25C, has communicated planned specification changes for 2025 and 2026.[4] The Department of Energy residential heat pump technology challenge has posed more ambitious cold temperature efficiency and capacity targets that many manufacturers have met.[5]

Many dual fuel heat pump applications in the Midwest may not warrant design for full heating load conditions and rated efficiency and heating capacity at 47°F and 17°F may be more important.

Table 1: Types of dual fuel heat pumps

	Single- stage	Two-stage	Inverter (variable speed)	Standalone add-on inverter (coil-only)	Multizone inverter
Potential heat pump cold temperature performance[6]	No	No	Yes	Yes	Yes
Largest possible heat pump sizing choice[7]	Cooling load	Cooling load at low stage	Heating load	Heating load	Heating load
Furnace blower type[8]	Any	Two-stage or variable speed	Variable speed	Any	Two-stage or variable speed
Proprietary communicating control required	No	No	Yes[9]	No	Yes[9]
Relative upfront cost	Low	Low	Moderate-High	Moderate-High	High

[3] ENERGY STAR v6.2 contains minor changes to efficiency criteria (December 2024).
[4] http://www.cee1.org/
[5] https://www.energy.gov/eere/buildings/residential-cold-climate-heat-pump-challenge
[6] For purposes of this descriptive table, we consider cold temperatures to be below 20°F.
[7] In the Midwest, non-inverter dual fuel heat pumps should not be sized up to the heating load since they would be oversized for the cooling load and would lead to excessive cycling and improper dehumidification during cooling season.
[8] This table outlines the furnace blower requirements for the system to function and be eligible for warranty. For measures that require energy efficiency metrics evidenced by AHRI ratings, if no furnace is listed on the AHRI certificate, the system can be paired with any furnace.
[9] Most systems with inverter-driven compressors require proprietary communicating thermostats/controls. For those systems that do not require proprietary communicating thermostats, some may lose efficiency.

Market Dynamics

Many distributors and manufacturers recognize the value of heat pumps and being a lead innovator in this product category. However, the HVAC market for central cooling products is currently fragmented into two tracks: “one-way” ACs and heat pumps. While a heat pump may cost only ~$150-$400 more to produce than a comparable AC due to the additional components of a defrost board and reversing valve, there are other associated costs and complexities. [10] For manufacturers, the two-track market slows progress on heat pump research and product development. For distributors, the two-track market means higher inventory costs, as more distinct products must be purchased and stocked in warehouses. Strategies focused on the supply chain, such as production or stocking incentives for manufacturers and distributors can drive regional change and serve as a backstop.

Customer awareness and decision-making processes around heating and cooling system replacements limit heat pump demand. Many customers lack awareness of heat pumps and their potential benefits.[11] This means contractors are reluctant to incorporate heat pump options into their sales process when customer demand for the technology is low. This awareness gap combined with the replace-on-fail nature of the central air conditioning market limits time for considering alternatives and often pushes customers to a like-for-like AC replacement, even in scenarios where a dual fuel heat pump could easily have been installed.[12] While dual fuel heat pumps can be considered a like-for-like replacement for a central AC, there are several important differences that can make or break an installation, including selecting a dual fuel heat pump compatible thermostat, setting a switchover temperature that is appropriate for the customer’s goals and current utility rates, and properly locating the outdoor unit for year-round operation.

Historically low natural gas prices in the Midwest mean that all-electric systems are not cost-competitive with most homes’ existing heating systems at current rates. Dual fuel heat pumps present a superior opportunity to realize cost savings and offer benefits to utilities such as increased load factors and peak shaving opportunities through demand response programs that can result in lower cost of service.

Below we summarize the value propositions of dual fuel heat pumps for customers, utilities, and the supply chain and describe in detail both customer and contractor considerations for deployment.

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[10] Stephen Pantano, Matt Malinowski, Alexander Gard-Murray, and Nate Adams, *3H ‘Hybrid Heat Homes’ An Incentive Program to Electrify Space Heating and Reduce Energy Bills in American Homes,* CLASP, 2021, https://www.clasp.ngo/research/all/3h-hybrid-heat-homes-an-incentive-program-to-electrify-spaceheating-and-reduce-energy-bills-in-american-homes/.

[11] Center for Energy and Environment, Messaging strategies to drive heat pump adoption in Minnesota, Efficient Technology Accelerator, 2024.

[12] Center for Energy and Environment, Air Source Heat Pump Market Characterization Report, Efficient Technology Accelerator, 2023.

Value proposition to market actors

In the Midwest, there is a large addressable market for dual fuel heat pump applications. Most single-family homes have centrally ducted furnaces and air-conditioning equipment, consumer demand for central cooling in the region is growing, and most homes are currently heated by natural gas or propane.[13]

Market availability of dual fuel heat pump products is also driven by state and local government energy goals and the strong value proposition these applications present to utilities, distributors, contractors, and customers. We outline a few of the market actor value propositions of dual fuel heat pumps in Figure 2.

Figure 2: Dual fuel heat pumps present a variety of value propositions to market actors

Market Actor	Dual Fuel Heat Pump Value Propositions
Utility	▪ Helps meet energy efficiency goals and drives customer satisfaction ▪ Right-sized, high-efficiency equipment provides greatest peak management ▪ Demand response for winter peak management ▪ Demand response for price arbitrage[14] ▪ Increases off-peak sales for electric utilities ▪ Maintains viability of distribution infrastructure for gas and dual fuel utilities amid growing consumer choice to heat with electrically powered heat pumps
Distributor & Contractor	▪ Sales and revenue growth ▪ Higher profit margin compared to central AC and furnace ▪ Future-proof business model by being at cutting edge and aligning with future codes ▪ Potentially more attractive application to younger workforce ▪ Easier transition to ASHPs meeting all home heating needs ▪ Less expensive and less complex installation for many buildings than all-electric ASHPs
Customer	▪ More energy efficient equipment for both heating and cooling ▪ Potential for both improved comfort and lower energy bills ▪ Energy security and resiliency ▪ Flexibility to adapt to changing fuel prices and choose between two heating sources ▪ Potentially longer equipment life ▪ Increased home resale value[15] ▪ Empowered to lower environmental impact if that is a customer's goal

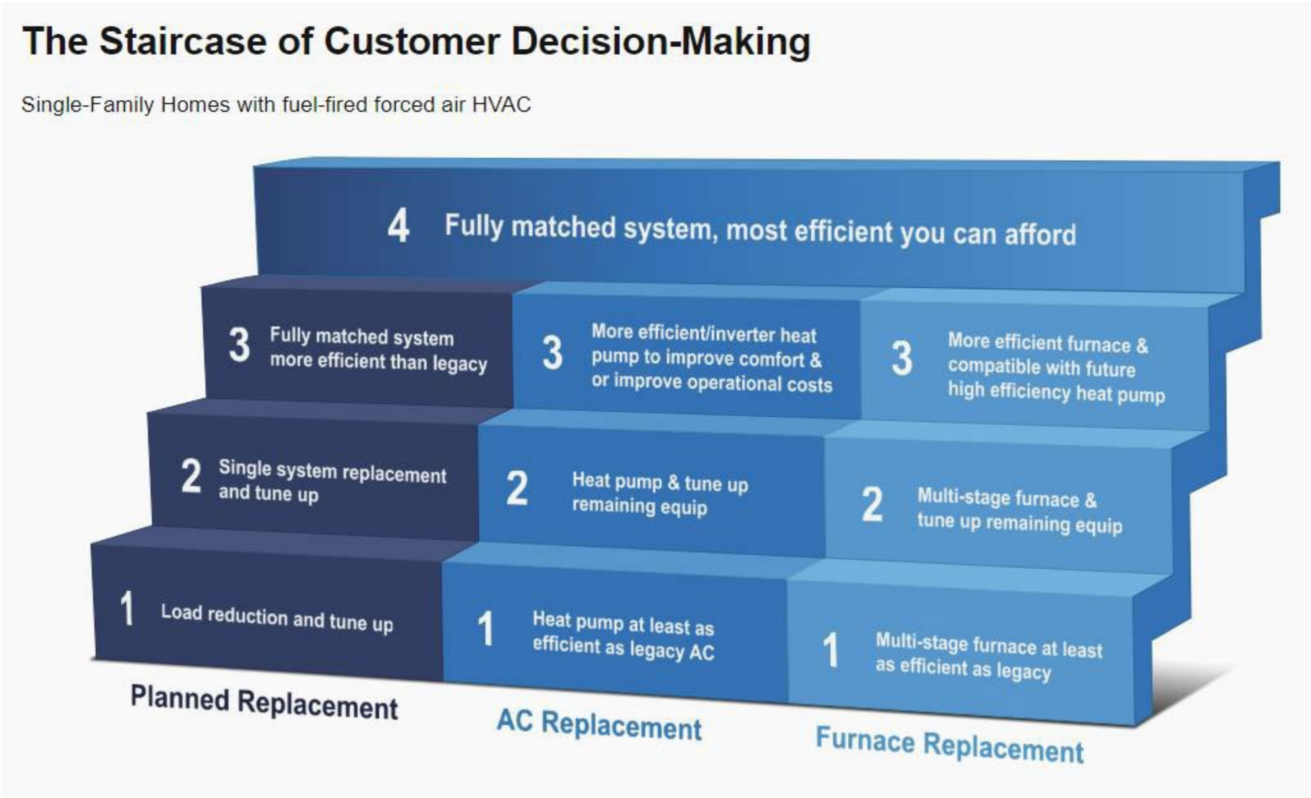
[13] Refer to Midwest Collaborative regional market analysis data dashboard.
[14] Energy or demand price arbitrage generally refers to the practice of purchasing energy when prices are low, during low-cost, off-peak demand periods, then storing and/or reselling energy when prices are high, during high-cost, peak demand periods.
[15] According to remodeling by JLC — Cost vs. Value 2023 | East North Central Region | Remodeling — HVAC conversions rank second highest in remodeling projects "costs recouped" through resale value.

Customer and contractor deployment considerations

Manufacturers, distributors, utilities, and other actors play a pivotal role supporting deployment of dual fuel heat pumps, but HVAC equipment selection is ultimately driven by the interaction between customers and contractors and each of their motivators and behaviors.

Residents typically find themselves in an emergency replacement scenario of HVAC equipment, while some plan for replacement. Each scenario presents unique decision-making parameters where a heat pump can be considered. Figure 3 below showcases a high-level decision map for a customer and contractor to navigate and incorporate heat pumps and what drives the most relevant good, better, and best equipment options for a given customer.

Figure 3: Customer decision journey for homes with forced-air furnaces and central ductwork



Emergency Replacements

When a furnace and/or air conditioning equipment is failing or failed, a homeowner approaches contractors with immediate needs and limited bandwidth and time for decision-making. For many residents, this is a stressful time, and decision-making is driven by the need to make their home comfortable again as soon as possible.

Contractors typically respond to customers in this situation by prioritizing speed and expediency in delivering operational heating and cooling. Many are sensitive to customer perceptions of upselling and have a proclivity toward like-for-like, lowest-cost equipment.[16] Contractors also tend to base a bid on what is readily available from their supply house and within or near the homeowner's budget. In this situation, contractors face a lack of customer demand and time for load calculations, let alone duct assessments.

Whether a contractor replaces a single component or multiple components in a forced air system, there is a need to ensure the furnace blower motor enables rated efficiency. Because of historical changes in refrigerants to R410A and the current transition to low-GWP refrigerants, as well as to be eligible for the full warranty, outdoor and indoor coils need to be replaced at the same time. To address both blower motor and refrigerant compatibility and to avoid redundant labor,[17] contractors tend to prefer replacing the furnace, outdoor unit, and indoor coil all at once. A contractor survey conducted in Minnesota found approximately 50% of the time when either an AC (or furnace) fails, the contractor also replaces the furnace (or AC).[18] Depending on the contractor's business model and their effectiveness in educating customers, full replacements may be sold at a higher or lower prevalence.

If the working furnace or AC is 10 years old or newer, the lowest upfront option is typically to retain it. For a failing or failed AC, some contractors may also offer a standalone or coil-only matched system that replaces the AC with a heat pump, leaving the furnace in place.

In some emergency replacement scenarios, seasoned contractors may have pre-designed packages that allow them to offer at least two options: one addressing the upfront cost and another that addresses operational or long-term costs, comfort, and environmental impact. However, in an emergency replacement scenario, contractors often do not present better equipment options that provide increased efficiency and qualify for incentives such as rebates or tax credits. Emergency replacement scenarios can lead to missed opportunities for future-proofing equipment.

Planned replacements

Planned replacement can include several scenarios in which the customer has equipment that is still operational. Common situations that may spur a customer to plan a replacement include:

- Dissatisfaction with current equipment and/or having comfort, economic, or environmental goals that drive demand for an upgrade
- Anticipating that the current furnace and/or AC is nearing the end of its useful life
- Desire to add central AC if not currently in the home
- Completion of a home audit and/or weatherization work
- Desire to include an HVAC upgrade as part of a remodeling project
- Availability of new incentives

[16] Fossil fuel furnaces older than 2017 were often not condensing gas furnaces above 92% annual fuel utilization efficiency (AFUE) and did not have electrically commutated motors (ECMs). This means that there are likely some efficiency gains even with furnaces that meet the federal minimum standard. Similarly, AC systems at even the base level have higher SEER2 ratings than older equipment and may come with multi-speed compressors and components that allow for greater efficiency or comfort.

[17] Depending on whether HVAC equipment is installed to deliver conditioned air downward or upward, replacement of one indoor component (furnace or indoor coil) may require the removal and re-installation of the other.

[18] Center for Energy and Environment, Investigation of Air Source Heat Pumps as a Replacement of Central Air Conditioning, Minnesota Department of Commerce, Division of Energy Resources, 2022.

When planning an HVAC system replacement, several factors need to be considered and worked through between the homeowner and the contractor. One of the first decisions is whether the new system is designed to cover the whole home's heating and cooling, part of the home's heating and cooling, or a specific problem area. When existing/legacy systems are old, inefficient, ineffective, or simply not what the homeowner is comfortable with, planning provides the most options to consider in identifying good, better, or best equipment.

There are numerous Midwest-specific resources that guide customers through the purchasing journey for dual fuel heat pumps and living with the new technology, such as Wisconsin Focus on Energy's Electric Heat Pump Buying and Operation Guide and ComEd's Go Electric webpage, which includes a savings calculator.[19,20]

The quality HVAC contractor approach

For both emergency and planned HVAC replacements, a quality contractor's journey to select a dual fuel heat pump includes the following steps to identify heating and cooling needs and apply guidance from ACCA Manual S for equipment selection.

1. **Identify resident needs and wants**
   - Residents may have several goals surrounding comfort, economics (first cost, operational costs, and payback), environmental impact, and equipment resiliency. Understanding their needs and wants will help the contractor identify which goals the new HVAC system should be set up to achieve.

2. **Identify the home heating and cooling load and HVAC needs**
   - Just as homeowners' needs and wants must be met, the existing home and HVAC system needs must also be understood while following standard best practices.
   - ACCA Manual J is a standard for calculating the heating and cooling needs of a building based on location, home size, insulation levels (including windows), air and duct leakage, and internal devices and appliances. Manual J has safety factors built in that, when associated with the proper winter and summer design temperatures, can provide a safe guide to the next step of equipment sizing.
   - ACCA Manual D provides standards that can support evaluation of the ductwork for existing forced air systems. Existing ductwork must be assessed to ensure it can handle the airflow for the new heating and cooling system. For more on duct assessments, it is recommended to use the Duct Retrofit Decision Guide created by the Consortium for Energy Efficiency.[21] If duct modifications are determined to be necessary, the contractor will need to redesign key pieces of ductwork to reduce total external static pressure (TESP) and increase airflow.
   - ACCAs Manual S is the companion standard that defines how to size the HVAC to meet the home's heating and cooling loads or needs. A quality contractor utilizes calculation methods that generally align with the ACCA manuals to right-size the equipment.

[19] https://flipbook.focusonenergy.com/view/161641822/
[20] https://goelectric.comed.com/
[21] https://cee1.org/images/pdf/CEE_Duct_Retrofit_Decision_Guide_TRC_01.16.24.pdf

3. **Select equipment that meets resident needs and wants and home load and HVAC needs**
   - Ultimately, the customer decides the equipment — it is the contractor's responsibility to present good, better, and best options. Typically, these options are presented based on first cost but ideally account for both home needs and customer goals. Some contractors only provide a better option when both the homeowner and home's needs are well identified. Regardless, including a dual fuel heat pump option for homeowners to consider is recommended for every heating and/or cooling bid in homes with fuel-fired furnaces and central ductwork.

4. **Install properly, set controls, and educate residents on equipment operation**
   - Quality contractors discuss their customers' installation options, complexity of controls, goals of control strategies, necessary maintenance, and the experience of living with a heat pump if the homeowners have not had this experience before. A quality contractor also measures and commissions equipment for proper airflow and refrigerant charge.

Sizing

While it may be possible to size a heat pump to meet the entire heating load, by definition in a dual fuel application, the heat pump is intended to partially displace fossil-fuel heating rather than serve as a whole-home replacement for the furnace. A heat pump in a dual fuel system should always be sized to at least cover the entire cooling load of the home, as it is replacing an air conditioner. Exceptions to this rule may include homes where certain rooms are very rarely used or when selecting multiple heat pumps (e.g., some ducted and some ductless) to meet the home's heating and cooling needs. If the home has made envelope improvements, the existing central AC may be oversized for the lower cooling load, highlighting the importance of carefully sizing the new system.

Heat pump sizing needs to account for the ratio between the home's heating and cooling load. In most Midwest homes, the heating load is larger than the cooling load and dual fuel heat pumps enable some flexibility in sizing since a fuel-fired furnace is included to heat the home during the coldest days and hours of the year.

- When the heating load is equal to, or larger than, the cooling load, the recommended practice is to size the heat pump to the cooling load. Generally, for a two- speed system, this sizing approach for cooling is based on capacity at the lower speed. For a variable speed system, this sizing approach for cooling is based on the lower third of the equipment's capacity range.
- When the heating load is less than the cooling load, the goal is still to size the heat pump to meet the cooling load, but with the ability to meet as much of the heating load as the ductwork and building layout allow.

A helpful approach to determine sizing is to follow ACCAs Manual S for sizing or NRCAN's Air-Source Heat Pump Sizing and Selection Guide. Additionally, NEEP, DOE, and the Consortium for Energy Efficiency have developed a suite of resources that are helpful for contractors and programs to reference that include guidance on sizing, equipment selection, and more.[22,23,24,25]

Controls

Thermostat selection is a critical component of the installation of any heating and cooling system. It is essential for the contractor to ensure the selected thermostat is compatible with the equipment being controlled. Dual fuel heat pumps require dual fuel compatible thermostats. Dual fuel compatible thermostats have a means to switch between heat pump operation and furnace operation. Table 2 displays common controls strategies for dual fuel heat pumps. The Midwest utility ComEd has published an ASHP controls guide for contractors which describes dual fuel compatible thermostats in more detail, including third-party and proprietary controls and further explanation of the controls strategies below.[26]

Table 2: Most common dual fuel heat pump controls strategies

Controls strategy basis	Metric driving switch to furnace operation	Metric inputs
Outdoor air temperature (OAT)	Capacity balance point	Heat pump capacity and home heating load
	Economic balance point	Heat pump/furnace efficiency and electricity/furnace fuel price
	Comfort balance point	OAT at which homeowner subjectively experiences discomfort running heat pump
Indoor air temperature (IAT)	Indoor air temperature droop	Difference between thermostat setpoint and IAT (commonly 1°F–3°F)
	Algorithm	Algorithm logic anticipating need to meet thermostat setpoint
Supply air switchover	Supply air temperature	Uses delivered air temperature to engage supplemental heat

The most common controls strategy for a dual fuel heat pump is a switchover based on the economic balance point. The economic balance point can be based on optimizing for the instantaneous outdoor air temperature at which it becomes more expensive to operate the heat pump than the fuel-fired furnace. However, this economic balance point is more difficult to maintain due to changing fuel prices and many customers may find it sufficient to configure dual fuel heat pump operation based on a seasonal economic balance point. This outdoor air temperature switchover method changes operation from the heat pump to the furnace based on

[22] Department of Energy Cold Climate Heat Pump Decision Tool
[23] Design Load Calculation Tools
[24] NRCAN ASHP Sizing and Selection Guide
[25] CEE1 Contractor and Homeowner Resources
[26] https://slipstreaminc.org/sites/default/files/documents/downloads/001443_ComEd_ControlsGuide_Final_ADA.pdf

cost parity for the entire winter season or full year if accounting for savings from more efficient cooling compared to the previous system. For dual fuel heat pump installations in low- to moderate-income customer homes, by minimizing operational cost, the instantaneous economic balance point can help reduce energy burdens.

Addressing Envelope Deficiencies

Weatherizing a Midwest home before installing a dual fuel heat pump leads to lower heating loads that align more closely to the cooling load and enables smaller equipment to be specified and achieve deeper energy savings.

There is more flexibility in variable speed heat pumps being slightly oversized for cooling. If weatherization measures are made after the HVAC upgrade, variables speed heat pumps can more likely retain status of modulating to the new heating load and cooling loads. This means variable speed dual fuel heat pumps are better at future-proofing the home because they can modulate capacity and enable weatherization improvements without sacrificing performance. The Northeast Energy Efficiency Partnership's (NEEP) advanced sizing tool generates detailed data on thermal balance points and can visualize the proportion of heating and cooling loads covered by a cold climate ASHP.[27]

Weatherization measures in the home impact heating and cooling loads differently. Higher levels of insulation, double-pane windows, and lower levels of air infiltration reduce heat transfer between inside and outside the home, which reduces heating load. These envelope measures lower the externally driven cooling load gains, but interior cooling loads do not change. Since weatherization has a larger overall impact on reducing heating loads than cooling loads, it can make it easier to size a variable speed heat pump for both heating and cooling. Further insights on the impacts of weatherization are included in the modeling results

[27] https://neep.org/blog/not-too-big-not-too-small-new-tools-improved-air-source-heat-pump-selection

MODELING DUAL FUEL HEAT PUMP IMPACTS METHODOLOGY

To generate annual energy impacts for all home and system archetypes, the project team used an hourly building energy conservation model developed in R, a programming language for statistical computing. The model incorporates data on building construction, the HVAC system, and weather for an archetype existing single-family home. Details about the modeled home are in Appendix A.

Three generation and emissions assessment (GEA) regions and three ASHRAE climate zones align with most of the Midwest's footprint (Figure 4). To account for regional climate and grid differences, the project team selected four locations for the modeled home described in Figure 5.

Figure 4: Map of GEA regions (left) and ASHRAE climate zones (right)[28, 29]

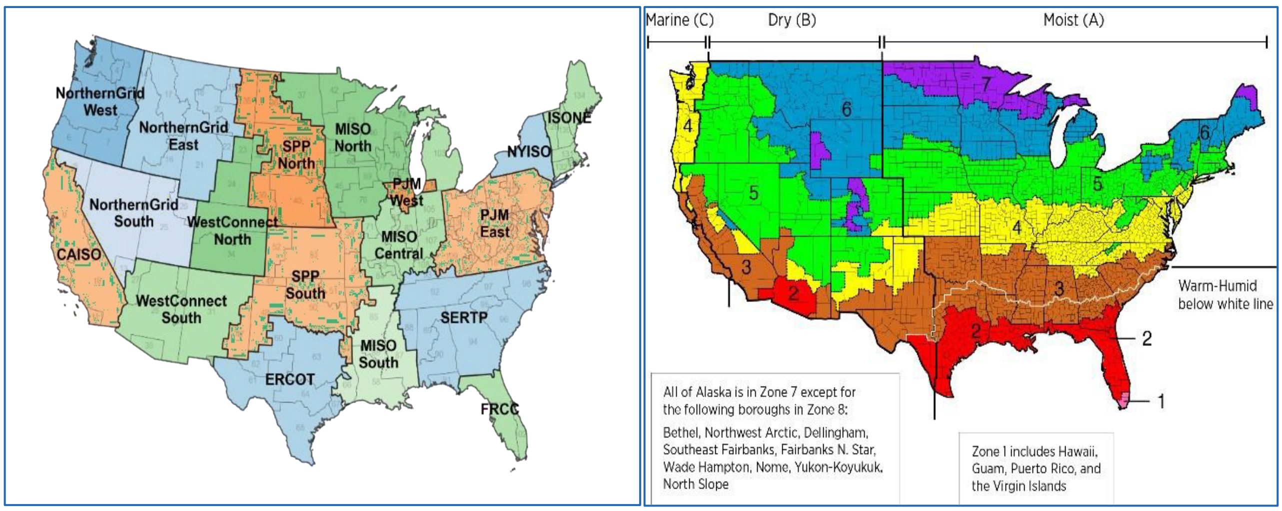
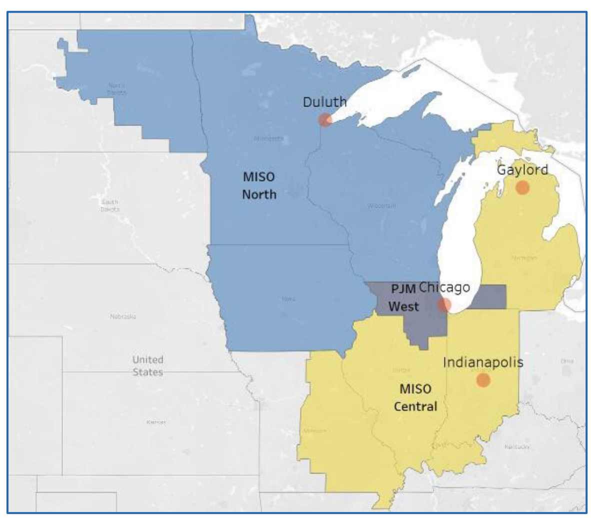


Figure 5: Modeled locations[30]

Location	ASHRAE Climate Zone	Cambium GEA Region	Heating & Cooling Design Temp
Duluth MN	VII	MISO North	-12°F 82°F
Gaylord MI	VI	MISO Central	-1°F 83°F
Chicago IL	V	PJM West	3°F 90°F
Indianapolis IN	V	MISO Central	8°F 89°F



[28] NREL Cambium
[29] The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
[30] Design temperatures based on 99% heating and cooling design temperatures.

Heating and cooling loads

The modeled home is an 1,863 square foot existing single-family dwelling with central HVAC and ductwork.[31] The project team calculated heating and cooling design loads using ACCA Manual J8 certified software Wrightsoft for a "high" and "low" weatherized version of the home. Design heating loads ranged from approximately 51–67 KBTU/Hr for low weatherized homes to approximately 37–49 KBTU/Hr for high weatherized homes. Modeled design heating and cooling loads were matched as closely as possible to these design loads.[32]

Table 4: Heating and cooling design load calculations for archetype homes

Location	Weatherization Level	Heating Design Load (btu/h)	Cooling Design Load (btu/h)
Duluth, Minnesota	Low	67,311	22,623
	High	49,056	20,893
Gaylord, Michigan	Low	59,319	19,905
	High	42,418	18,764
Chicago, Illinois	Low	54,140	26,986
	High	39,501	24266
Indianapolis, Indiana	Low	51,171	26,559
	High	37,125	24,114

HVAC system types, sizing, and costs

As shown in Table 5, three types of dual fuel heat pumps are modeled to reflect distinct tiers of efficiency, flexibility in sizing, and cold temperature performance. For comparison, model results are included for a central AC and furnace and an all-electric cold climate ASHP. System size and assumed installed cost details for each location and home archetype are in Appendix A.

Table 5: Modeled HVAC Systems

Equipment	Heat pump sizing approach	Range of heat pump size	Average installed cost[33]
Central AC + Furnace	Cooling load	24–30 kbtu	$10,100
Two-stage ASHP + Furnace	Cooling at low stage	30–36 kbtu	$13,100
Avg. vsASHP + Furnace	Cooling but maximize heating potential[34]	36 kbtu	$15,600

[31] 1,863 square feet is the average conditioned square footage of a Midwest single-family home (EIA 2020).
[32] Modeled heating loads varied +/-6% in a few cases.
[33] Rounded to nearest hundred dollars.
[34] PNNL, Not your Parent's Heat Pump: Training and Tools to Size Heat Pumps for Heating, ACEEE Summer Study 2024.

ccASHP + Furnace	Capable of meeting most heating load (80%)	36–48 kbtu	$18,100
ccASHP all-electric (no backup heat)	Sized for design heating load	48 kbtu	$17,700
ccASHP all-electric (+ 5kW electric boost)	Sized for max available heat load	60 kbtu	$20,100

HVAC system parameters include heating and cooling efficiency and capacity, modeling changes across outdoor air temperatures.[35] The model accounts for the effects of fan energy and required cubic feet per minute (CFM). Switchover temperatures based on outdoor air temperature are a key input for all dual fuel heat pump scenarios and range from 10°F to 40°F. The resulting output is annual HVAC energy consumption for a typical year's operation.

Estimated HVAC system total installed costs are based on equipment wholesale prices for outdoor unit, indoor coil, and furnace /air handler with a 3x markup to account for labor. From experience working with installers in the Midwest, the project team has generally found that markups may range from approximately 2.5–4x the equipment costs to the contractor. For any given system, equipment cost varies according to the home archetype and the size of equipment installed to meet the home's heating and cooling needs. Table 5 displays average installed costs for each HVAC system modeled. Incremental installed costs for heat pumps versus a central AC and furnace baseline ranged from approximately $3,000 for a lower cost two-stage dual fuel heat pump to $10,000 for an all-electric cold climate heat pump with booster heat.

Electricity and fuel prices

In post-processing analysis on modeled energy use, the project team applied 2023 average Midwest prices for electricity, natural gas, and propane (Table 6).[36]

Table 6: 2023 Average Midwest electricity and fuel prices

Electricity	Natural Gas	Propane[37]
$.14/kWh	$1.21/therm	$2.08/gallon for furnace baseline $1.92/gallon for dual fuel ASHPs

Results

Economic Impacts

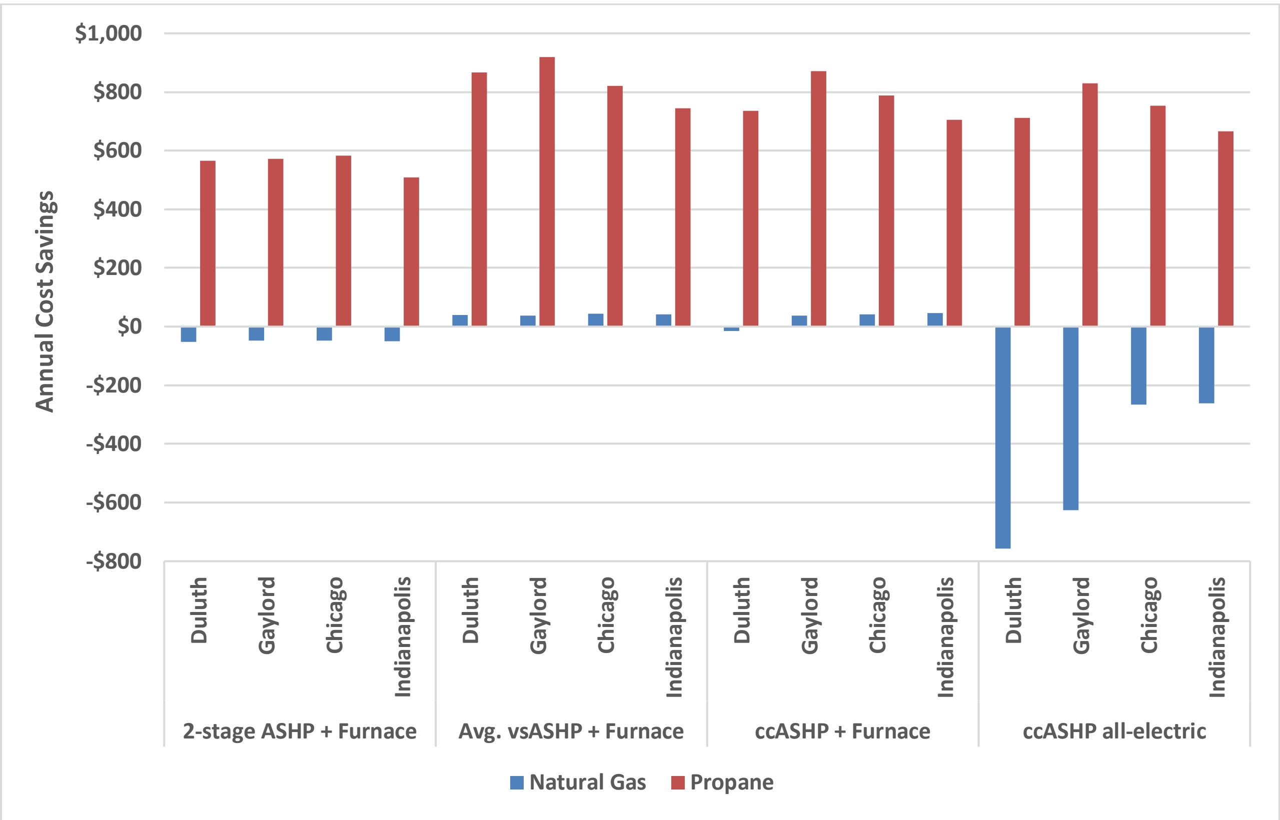
While dual fuel heat pumps are highly energy efficient, they require some level of shifting the heating fuel source to electricity. This means customers and contractors must not only account for the performance of the heat pump itself, but also the impact of the relative costs between the existing fuel source and the new electric fuel source to understand bill impacts and affordability. Applying regional average fuel and electricity prices, all modeled dual fuel ASHPs paired with a

[35] We used rated heat pump COPs and capacities. To account for field performance being lower than rated performance, we derated the two-stage ASHP COP by 25% and the remainder of the variable capacity ASHPs by 15%.
[36] Average prices and cost-equivalent COP by Midwest state in MEEA's footprint for these three fuels are in Appendix B.
[37] We applied a lower seasonal cost for propane in dual fuel heat pumps given that these systems typically avoid the need for a second annual propane tank fill during winter high-cost periods. Price for baseline furnace heating is based on annual average due to high likelihood of need for two tank fills annually.

propane furnace achieve operational cost savings, whereas only a subset of dual fuel ASHPs paired with a natural gas furnace results in lower operational costs.

For each location, Figure 6 displays annual cost savings for each modeled system compared to the baseline furnace and central AC. The modeled switchover temperature (40°F, 30°F, 20°F, or 10°F) for the dual fuel heat pump that resulted in the lowest operational cost is used. To minimize operational costs, all homes with a natural gas furnace switch from heat pump to furnace operation at the highest modeled switchover temperature of 40°F. For homes with propane, the average variable speed ASHP + Furnace with a 20°F switchover results in the highest cost savings for all locations.

Figure 6: Annual heat pump cost savings for high-weatherized home archetypes (Central AC + Furnace baseline) ($.14/kWh, $1.21/therm)



Dual fuel heat pumps with a propane furnace and a cost-minimizing switchover temperature achieved approximately $500–$900 annual savings. These operational savings were driven both by the highly efficient electric heat pump and the lower cost for propane fuel due to the avoided second tank fill and $.16/gallon lower price during the low-cost season. These large annual savings result in simple paybacks ranging from 4–12 years.

Most average variable speed and cold climate ASHPs with a natural gas furnace achieved savings with a 40°F switchover, but the maximum was $45 per year for a cold climate ASHP + Furnace in Indianapolis. Even with the highest modeled switchover of 40°F, the two-stage ASHP + Furnace did not achieve operational cost savings in any of the locations. None of the modeled dual fuel heat pumps with a natural gas furnace achieve a simple payback.

The negative all-electric cold climate ASHP savings compared to a central AC and natural gas furnace appear substantial but it's important to keep in mind that if a home fully electrified their end uses, the monthly fixed fees for natural gas service would no longer be incurred. For example, avoiding a hypothetical monthly fixed fee of $22/month offsets the all-electric heat pump's $266 annual incremental operational costs and results in operational cost parity in Chicago. If the electric utility has an electric space heating rate, that will also improve the affordability of the all-electric heat pump.

Again, using average regional fuel prices, Figure 7 illustrates how annual operational costs do not significantly change for a given dual fuel heat pump when switchover temperature to the backup furnace changes. A lower switchover temperature for a dual fuel heat pump results in slightly higher operational costs when the home's furnace is fueled by propane and slightly lower operational costs when the home's furnace is fueled by natural gas. For example, in Duluth the average variable speed ASHP + Furnace annual operating cost increases approximately $75 when changing the natural gas furnace switchover from 40°F to 30°F and decreases by approximately $250 when changing the propane furnace switchover from 40°F to 30°F. This results in average total monthly bill changes of approximately +$6 and -$20, respectively.

Figure 7: Annual operational costs for high-weatherized Duluth home with natural gas (left) and propane (right) ($.14/kWh, $1.21/therm)

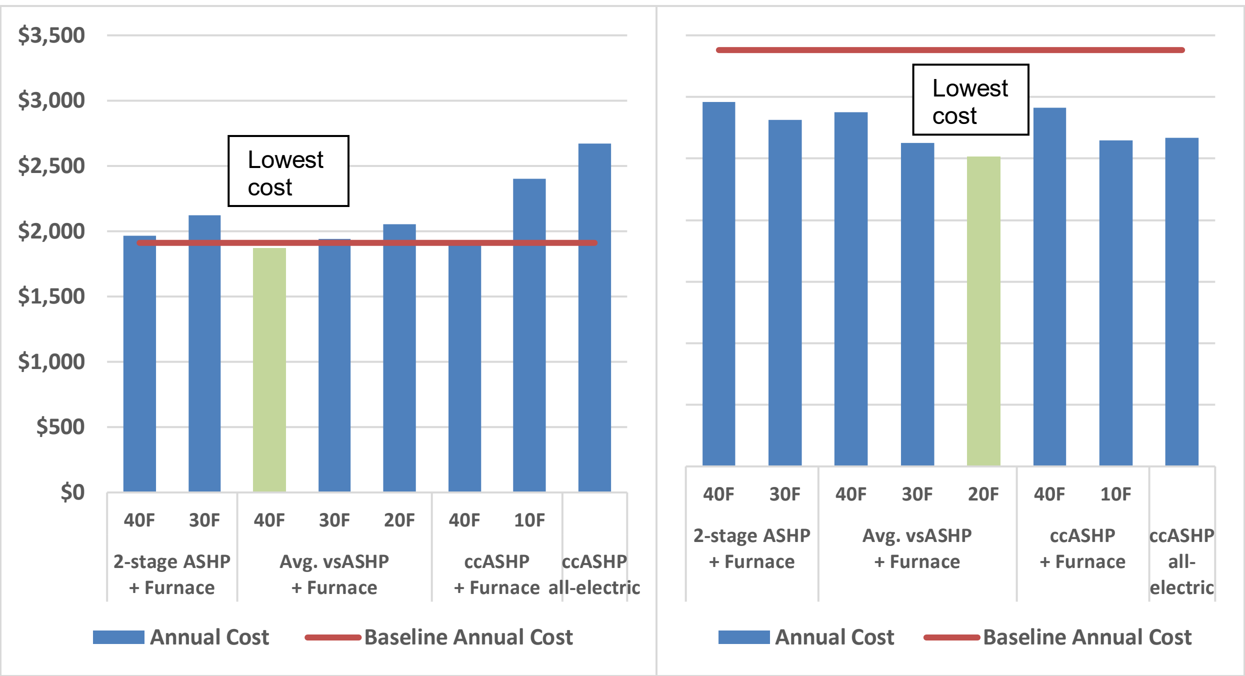
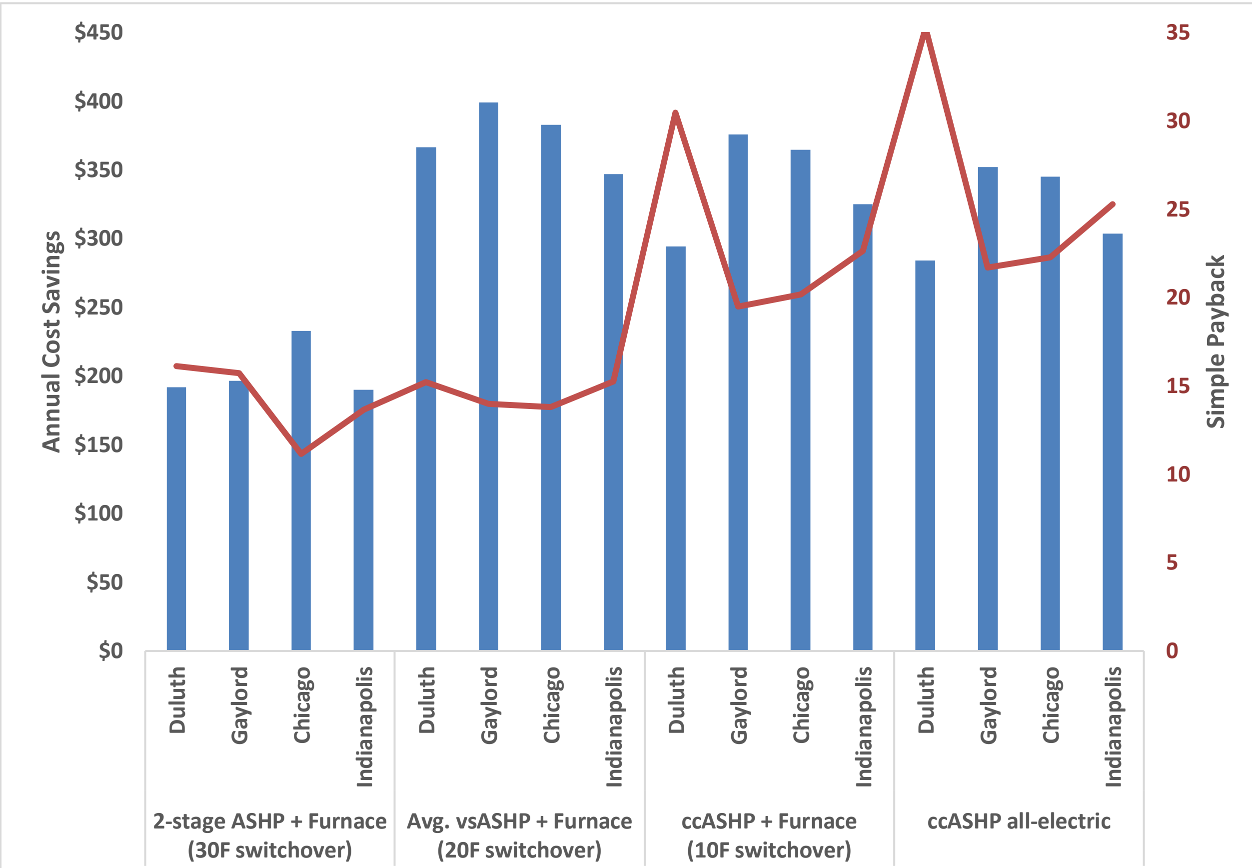


Figure 8 displays annual costs for dual fuel heat pumps using the cost-minimizing switchover temperature for a high-weatherized home with natural gas and a lower electric rate of $.08/kWh. Some electric utilities offer lower rates for homes with primary electric space heating or dual fuel heat pumps, and some customers utilize low-cost behind-the-meter residential solar. This more favorable scenario for dual fuel heat pump affordability translates to the lowest possible switchover temperature for each dual fuel heat pump archetype resulting in the highest cost savings. Simple payback for these dual fuel systems range from 11 to 30 years with the average variable speed ASHP + Furnace achieving the quickest simple payback in the colder regions of Duluth and Gaylord and the two-stage ASHP + Furnace achieving the quickest simple payback in Chicago and Indianapolis.

Figure 8: Annual heat pump cost savings for high-weatherized home with natural gas (Central AC + Furnace baseline, $.08/kWh, $1.21/therm)



Simple paybacks will also be faster if incremental costs of the dual fuel heat pump are lower. For a two-stage ASHP, these incremental installation costs may be closer to $1,000 (compared to ~$3,000) over a central AC and $2,000 for an average variable speed ASHP (compared to ~$5,500).[38] These lower incremental upfront costs result in simple paybacks of less than 10 years for both system archetypes in all locations.

The impact of rate variability on operational cost savings is further illustrated in Table 7. This table displays the operational cost savings for the average variable speed ASHP + Furnace installed in a high-weatherized home in Chicago with electric rates ranging from $.08-$.20/kWh. When the relative cost of electricity to natural gas lowers, the cost-minimizing switchover temperature will rise. The relationship between natural gas costs, operational cost savings, and the cost-minimizing switchover temperature for the dual fuel heat pump will be the inverse. As natural gas rates go up, operational cost savings from the dual fuel heat pump increases, and the cost-minimizing switchover temperature decreases. The fuel flexibility of dual fuel heat pumps helps shield residents from relative changes in electricity and natural gas or propane.

[38] ComEd (2024), Variable Speed Heat Pumps as Air Conditioner Replacement, Prepared by Center for Energy and Environment.

Table 7: Annual cost savings for average variable speed ASHP + Furnace in Chicago high-weatherized home with natural gas ($1.21/therm)

Electric Rate	Annual Utility Cost Savings	Modeled Cost-Minimizing Switchover Temperature[39]
$0.08	$383	20°F
$0.12	$92	30°F
$0.14	$44	40°F
$0.16	$2	40°F
$0.20	-$81	40°F

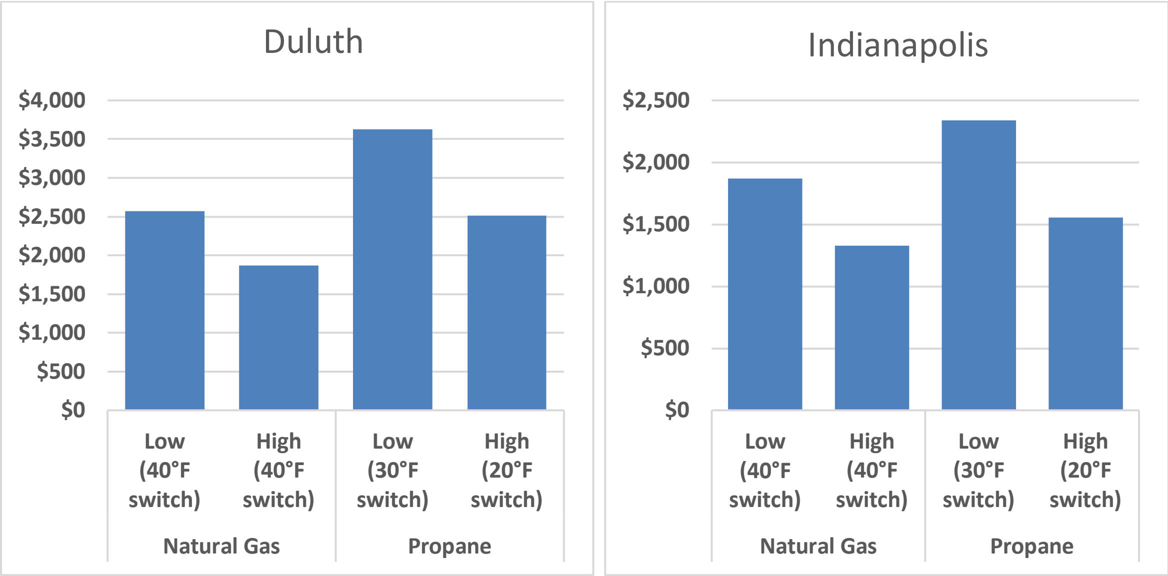
These results illustrate directional economic impacts from the use of dual fuel heat pumps for heating and cooling and how they highly depend on electricity and fuel prices and the upfront incremental cost of a heat pump over an AC. For program planning purposes, we encourage any individual utility or community to apply local prices for electricity, natural gas, and propane.

Weatherization Impacts

Weatherization greatly impacts heating and cooling costs regardless of the HVAC equipment. Figure 9 displays the annual operating costs for the average variable speed heat pump + Furnace in two locations. The switchover temperature with the lowest operational costs is selected for each location, fuel, and weatherization level.

In a high-weatherized home with natural gas, annual operational costs are approximately $700 lower in Duluth and $500 lower in Indianapolis compared to the low-weatherized home. With propane, this system's annual operational costs are approximately $1,100 lower in Duluth and $800 lower in Indianapolis. Deeper savings are available in propane-heated high-weatherized homes due to the higher cost of propane fuel and the lowest cost switchover temperature being 10°F lower.

Figure 9: Annual operational costs for average variable speed dual fuel heat pump in low-versus high-weatherized home ($.14/kWh, $1.21/therm)



[39] The real cost-minimizing switchover temperature is dynamic and will change at all relative fuel cost ratios. We only modeled switchover temperatures in 10°F increments down to the capacity balance point of the heat pump archetype.

As shown in Table 8, in both Duluth and Indianapolis, the design heating load is 27% lower for the weatherized home. For the average variable speed ASHP + Furnace, the furnace can be sized 20 kBTU smaller, resulting in slightly lower upfront costs. The 36 kBTU heat pump operates more frequently and efficiently at low-stage and can meet the heat load at lower temperatures. For example, in both Duluth and Indianapolis, the temperature at which the heat pump can no longer carry the heating load and backup heat starts to engage is ~30°F for the low-weatherized home, whereas it is ~20°F for the high-weatherized home.

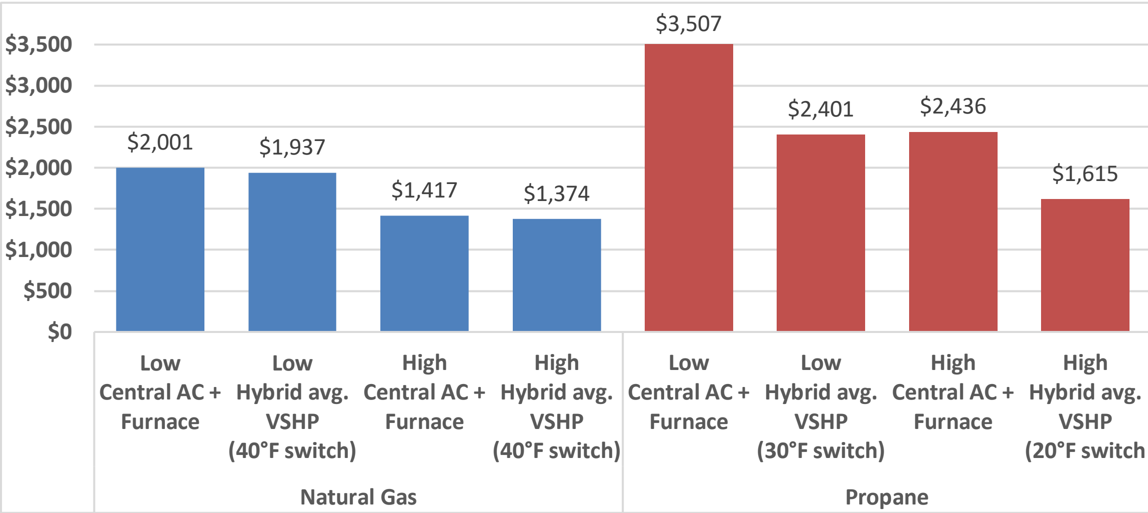
Table 8: Impacts from weatherization for an average variable speed ASHP + Furnace installed in Duluth and Indianapolis ($.14/kWh, $1.21/therm)

Location and HP Type	Reduction in…				
	Heating design load	Furnace size	Furnace upfront cost	Annual operating costs (natural gas)	Annual operating costs (propane)
Duluth avg. vsASHP + Furnace	27%	20 kBTU	$235	$699	$1,110
Indianapolis avg. vsASHP + Furnace	27%	20 kBTU	$329	$539	$785

The weatherization package included in the model may cost approximately $3,000–$6,000 depending on a variety of factors. The significant savings for the identical heat pump type and size result in a rapid simple payback of these weatherization measures, which may be as fast as three years in a home with propane, or five years in a home with natural gas, located in Duluth.

Also using regional average fuel prices, Figure 10 displays operational costs of the average variable speed ASHP + Furnace alongside the central AC + Furnace for a home in Chicago. In this case, a home with natural gas achieves ~$600 savings in annual operational costs simply from weatherization and an additional $43 from use of the average variable ASHP. A low weatherized home with propane switching to an average variable speed ASHP + Furnace results in more savings than simply weatherizing, but an additional ~$800 annual operational savings can be achieved by weatherization.

Figure 10: Impacts from weatherization on annual operational costs for Chicago home ($.14/kWh, $1.21/therm)

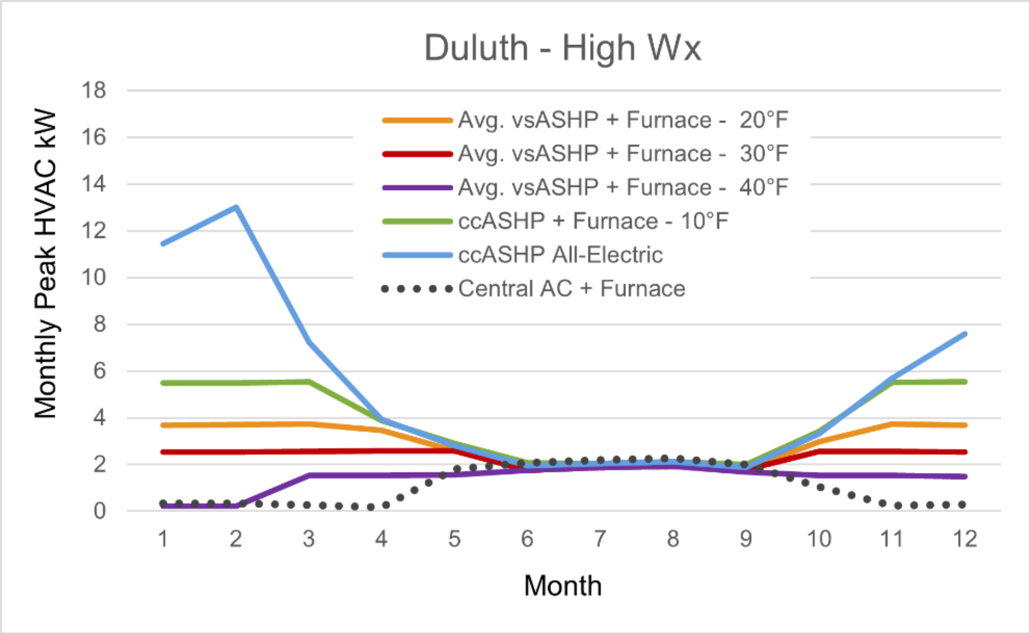


These results highlight how coordination of weatherization and dual fuel heat pump retrofits can unlock deeper bill savings and customer flexibility to operate an identically sized dual fuel heat pump at colder temperatures. Utilities or community programs will benefit from coordinating weatherization and dual fuel heat pump programs and activities surrounding incentives, awareness building, or education and training activities to customers and contractors.

Electric Demand Impacts

The installation of heat pumps to completely or partially displace traditional natural gas or propane furnaces can significantly impact electricity demand, particularly in colder climates. Utilities in the Midwest are typically summer peaking, although a trend toward more dual peaks or winter peaking scenarios may emerge should more gas and propane heating systems be replaced with electric heating. Figure 11 shows the peak hourly kW demand occurring in each calendar month for several scenarios.

Figure 11: Monthly peak kW demand associated with the HVAC system in each modeled scenario for a high weatherized (Wx) home in Duluth



With the baseline furnace and AC, the summer cooling peak is the primary concern, around 2.3 kW, as the heating system requires minimal electricity demand. As scenarios assume more of the heating load is served by an electric heat pump, the winter demand for electricity grows. Dual fuel heat pumps with higher switchover temperatures will slightly increase this demand, and may not exceed the summertime cooling peak, as is the case with the average variable speed dual fuel heat pump with a 40°F switchover. A lower switchover temperature raises the winter electric peak demand as the ASHP addresses larger heating loads, likely exceeding the summer cooling peak in a heating-dominated climate like Duluth. Comparing the three average variable speed ASHP + Furnace cases demonstrates the flexibility of this system type to allow for peak shaving in winter, lowering from nearly 4 kW with a 20°F switchover to near-baseline levels with a 40°F switchover in the coldest times of year. Inclusion of the electric resistance auxiliary heat source in an all-electric cold climate ASHP system results in a large winter peak of up to 13 kW in the modeled scenario.

Figure 12: Monthly peak kW demand associated with the HVAC system in each modeled scenario for a low-weatherized (Wx) home in Duluth

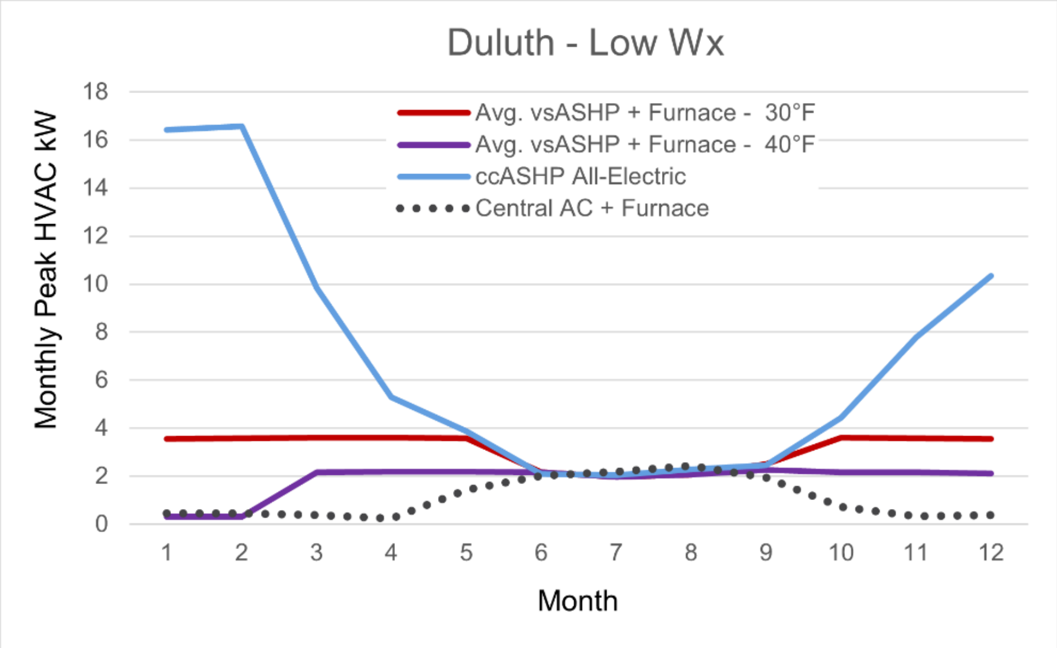


Figure 12 displays these same results for cases applied to the low-weatherized home, also in Duluth. Without the benefit of load reduction from weatherization, all peaks are higher year-round. There is a notable reduction in flexibility for these system options. The average variable speed heat pump, sized the same as for the high-weatherized home, is now unable to provide for the entire heating load below around 28°F. This capacity limitation eliminates any real benefit to lowering the switchover temperature below 30°F, thereby eliminating the 20°F scenario as an option for this home. The addition of further weatherization measures therefore unlocks additional options for ASHP system types. The all-electric cold climate ASHP system now runs at maximum capacity during the coldest periods of winter, fully utilizing the cold climate ASHP and the electric resistance in tandem and raising the peak demand to over 16 kW in the coldest hours of winter.

Dual fuel heat pump systems in both weatherization scenarios can avoid contributing to potential wintertime peaks by operating only outside of grid peak conditions, typically during the coldest hours of the year in winter-peaking regions. Conversely, the all-electric cold climate ASHP could contribute significantly to the winter peak, particularly in homes with larger heating loads like the low-weatherized case.

Table 9: A comparison of peak demand in summer and winter for modeled scenarios in Duluth and Indianapolis.

	Duluth				Indianapolis			
	High Wx		Low Wx		High Wx		Low Wx	
	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Central AC + Furnace	2.3	0.3	2.4	0.5	3.0	0.3	3.1	0.4
Avg. vsASHP + Furnace - 20°F	1.9	3.7	2.1	3.7	2.7	3.7	3.4	3.6
Avg. vsASHP + Furnace - 30°F	1.9	2.5	2.1	3.6	2.7	2.5	3.4	3.6
Avg. vsASHP + Furnace - 40°F	1.9	0.2	2.1	0.3	2.7	1.5	3.4	2.2
ccASHP + Furnace - 10°F	2.1	5.5			2.6	5.3		
ccASHP All-Electric	2.1	13.0	2.3	16.6	2.4	9.0	3.4	14.1

Table 9 displays the change in peak kW within the coldest month of winter and the warmest month of summer in Duluth and Indianapolis, using weather data for a typical year. The peak summer load occurs in August in both climates, whereas the peak winter load is in February for Duluth and January for Indianapolis. The values displayed for Duluth match these months as previously shown in Figures 11 and 12.

In nearly every case, the higher-efficiency ASHP outperforms the baseline central AC and furnace, lowering the summertime peak by up to 0.4 kW in Duluth's milder summers, and up to 0.6 kW in Indianapolis' warmer climate. The sole outlier is the low-weatherized home in Indianapolis, where the baseline AC is sized 6 kBtu/hr smaller than the comparative average variable speed dual fuel heat pump option, resulting in a handful of hours during which the cooling load is unmet above the design temperature. The ASHPs meet these loads with their higher capacities, thereby increasing the summer peak slightly, but also improving comfort in the warmest hours of the year.

Comparing weatherization scenarios shows the further peak-shaving benefits of load reduction year-round. In Indianapolis, increased weatherization enables an additional summertime savings lever by allowing for the use of a smaller capacity cold climate ASHP with a higher cooling efficiency. These additional cooling savings are associated with downsizing from a 5-ton ASHP with a SEER rating of 16.2, to a 4-ton ASHP with a higher SEER rating of 18.3, about a 13% cooling efficiency improvement.[40] Summertime peak demand reduction can provide value to the grid in the near term, for as long as electric suppliers continue to experience their annual peak demands in the cooling season.

Some electricity suppliers operate in regions with existing winter peaks, such as those in territories with prevalent electric resistance heating. Others may expect a trend toward winter peaking with the increase in electric heat pump systems within their territory. In such cases, retaining wintertime flexibility with dual fuel heating systems can be valuable. In climates like Duluth, operating an average variable speed dual fuel heat pump with a switchover of 40°F can leave the winter peak unchanged compared to the baseline system in the coldest months. While systems with lower switchover temperatures continue to operate in these months, it is unlikely they will contribute to the winter peak as peak demand conditions are not likely to occur above these switchover temperatures.

[40] Note that the model estimates cooling efficiency purely from SEER and does not specifically adjust expected efficiency when factoring in modulation.

KEY FACTORS INFLUENCING MARKET DEVELOPMENT

States, utilities, and communities across the Midwest face diverse fuel costs, electric grid conditions, and heating/cooling demand profiles. These stakeholders also hold diverse energy goals and perspectives that affect market development and consumer choice of dual fuel heat pumps. In the following, we describe three key factors influencing market development and consumer choice of dual fuel heat pumps across the region.

Technology advancements

Residential heat pump technology continues to rapidly evolve for a variety of applications. Residential air-to-water heat pump solutions that that feature “drop-in” high-temperature hydronic distribution systems, high efficiency at cold temperatures, and thermal storage capabilities are poised for further market availability. New cold climate ASHPs with alternative form factors, such as window heat pumps, packaged terminal heat pumps (PTHPs), and single-packaged vertical heat pumps (SPVHP) for cold climates are also emerging. For example, building off the success of the cold climate window heat pump technology challenge in New York, in 2025 NYSERDA is offering grant funding for product development and demonstration of cold climate PTHPs.[41] Some manufacturers are also beginning to phase out single-stage heat pumps, and two-stage ASHPs are likely to grow as the baseline ASHP product as inverter-driven variable capacity systems become more common and continue to improve cold temperature efficiency and capacity retention. For example, multiple manufacturers successfully met the DOE’s residential cold climate heat pump challenge specifications.[42]

Research, product development, and program integration of enabling hardware and software for heat pump installers and customers continue to accelerate as well. A few examples include third-party and embedded connected diagnostics for commissioning and ongoing fault detection and diagnosis, advanced heat pump control solutions, and 3D object scanning load estimate software. Many of these products include guided workflows and automated calculations that make the quality contractor installation process easier and the customer experience using a heat pump more seamless. Smart thermostats and other control technologies for dual fuel heat pumps continue to advance and can help manage peak demand. Advanced demand response mechanisms can allow dual fuel heat pumps to switch from electricity to gas during periods of grid stress, resulting in reduced peaks and improved grid reliability.

Dual fuel heat pumps can also be integrated with thermal energy or battery storage systems. Combining these technologies enables greater peak load management and resilience. Customers and utilities can leverage thermal energy storage systems to shift heating and cooling loads away from peak hours to lower system costs and customer utility costs if efficient price signals are in place.

[41] https://www.nyserda.ny.gov/All-Programs/packaged-terminal-heat-pump-program
[42] https://www.energy.gov/eere/buildings/residential-cold-climate-heat-pump-challenge

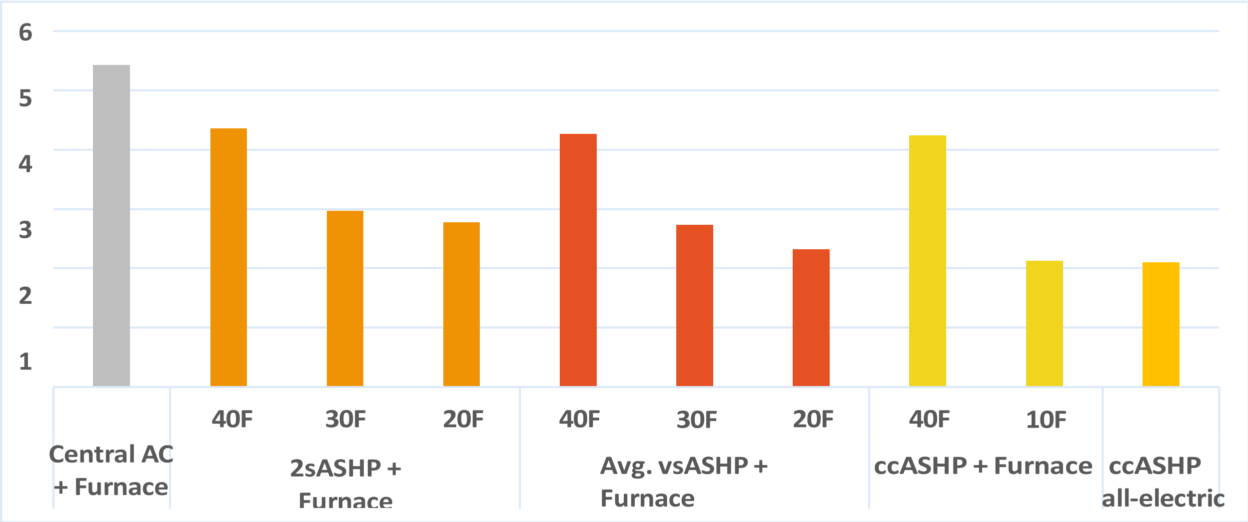
Technology advancements in ASHPs as a high-performance HVAC technology are poised to expand consumer choice. States, utilities, and communities will benefit from monitoring technology development and exchange lessons learned from research, pilots, and program integration. By doing so, these stakeholders can ensure local market development efforts expand consumer choice, lower energy costs, and foster a more reliable, resilient, flexible, and secure energy system serving their constituents.

State, utility, and community energy goals

State, utility, and community energy goals vary across the Midwest region and pose implications for the dual fuel heat pump market. For example, Illinois' Climate and Equitable Jobs Act (CEJA) set a goal of 100% clean energy by 2045 and Minnesota's Climate Action Framework targets net-zero emissions by 2050. Dual fuel heat pumps may be seen by some states as a steppingstone to support a transition to clean energy, by introducing customers to heat pumps in cold climates. Dual fuel heat pumps also increase consumer choice for customers to flexibly meet their own energy goals.

To illustrate the co-benefits of emissions reductions that dual fuel heat pump present for states, utilities, communities, or individual homeowners with environmental goals, we compare the emissions impacts of different dual fuel heat pump types and switchover temperatures. Figure 13 displays levelized annual emissions for all system types for a 2025 installation in a Chicago-based high-weatherized home with natural gas drawing from long-run marginal emissions rates from NREL Cambium's 95% decarbonized grid by 2050 scenario.[43]

Figure 13: Levelized annual emissions (metric tons CO2e) for all system types for high-weatherized home in Chicago with natural gas



Notably, even with a rapid grid decarbonization forecast over a 2025 installed HVAC system's life, a cold climate dual fuel heat pump with a switchover of 10°F has comparable emissions to an all-electric cold climate heat pump. Out of all heat pump system archetypes, the two-stage dual fuel heat pump results in the lowest emissions reductions per individual home. However, because this

[43] https://www.nrel.gov/analysis/cambium.html

system archetype poses the lowest upfront incremental cost above a central AC and furnace, significantly more homes can be served from a program incentive budget that covers the heat pump's incremental cost, achieving higher overall emissions reductions from the program. This conclusion applies across the Midwest region and is an important consideration for states, utilities, or communities with programs focused on emissions reduction goals.

Beneficial Electric Rate Structures

As illustrated from the modeling results, customer utility cost savings from dual fuel heat pumps are largely influenced by the cost differential between electricity and fossil fuels. To balance the goals of grid and societal benefits and customer utility cost affordability, beneficial electric rate structures are becoming more common. Electric utility innovations in rate structures can have a major impact on dual fuel heat pump market development in the Midwest.

Flat or block-rate structures do not reflect the true costs of electricity during peak times, leading to inefficient use patterns, and often fail to reward energy-saving behavior or adoption of energy efficient and high-performance HVAC technologies like dual fuel heat pumps. Dual fuel heat pumps can help avoid winter peaks, improve summer peak performance, and increase annual electricity sales, justifying a reduced electric rate. Lower rates are balanced by increased electricity use, meeting utility revenue requirements. Additionally, dual fuel heat pumps enhance utility load factors, enable peak shaving via demand response, and improve resource efficiency, with studies indicating potential load factor improvements of 200%–470%.[44]

The following are common types of electric rate structures that positively impact dual fuel heat pump affordability.

Electric space heating (ESH) rates differ from dual fuel heat rates in that they don't necessarily include a demand response requirement. ESH rates are often slightly lower than the standard rate and have been shown to be cost-competitive with natural gas furnace operation in the Midwest.[45] Utilities may alternately offer ESH rates to customers with heat pumps. ESH rates also support decarbonization by encouraging electricity consumption, but they differ from dual fuel heat rates in that they don't necessarily include a demand response requirement (eligibility rules vary by utility). One example is Xcel Energy's ESH rate structure, which is in the final stages of regulatory approval and will offer heavily discounted rates on the order of roughly 40% discounts from the standard electric rate for customers using electric space heating equipment as their primary heating source, which is defined as covering greater than half of the heating load.

Off-peak interruptible or dual fuel rates are specifically for customers using electric space heat in conjunction with a supplemental heat source of a different fuel type. Eligibility generally requires customers to enroll in a separate billing structure and agree to allow the utility to switch the heating source to an alternate fuel backup during periods of peak demand and/or high wholesale costs. The installation of a separate meter to monitor heat pump energy consumption may also be required, although use of advanced metering infrastructure (AMI) may eliminate this requirement. These direct

[44] https://www.mncee.org/developing-electric-rates-hybrid-air-source-heat-pumps-midwest
[45] https://www.edockets.state.mn.us/edockets/searchDocuments.do?method=showPoup&documentId=%7bA0A79092-0000-C61C-AA77-E0180D1C981A%7d&documentTitle=202410-210974-01

load control systems and off-peak rate structures are typically more prevalent in rural areas without gas service, run by smaller utilities who may already experience winter peaks and often leverage radio signals that operate simple relays to interrupt power to controlled devices.

Time-of-use (TOU) rates incentivize operation of the heat pump during off-peak hours and encourage backup fuel use during high-cost peak periods.

Table 10: Rate type examples

Energy Charges (¢/kWh)	Xcel Energy Standard rates June-Sept: 13.07 Oct-May: 11.36	Dakota Electric Association Standard rates June-Aug: 13.77 Sept-May: 12.38	Duke Energy Indiana Standard rates First 300 kWh: 18.66 Next 700 kWh: 13.58 Over 1000 kWh: 12.31
Electric Space Heat	Oct–May: 6.54	N/A	N/A
Dual Fuel Rate	Oct–May: 5.93	Year-round: 6.31	N/A
Time-of-use	On-peak, weekdays only (6pm-10pm) June–Sept: 20.44 Oct–May: 16.25 Base (all other hours) June–Sept: 13.31 Oct–May: 11.36 Off-peak (12am-6am) Year-round: 7.48	On-peak, weekdays only (4pm–11pm) June–Aug: 21.26 Sept–May: 19.86 Off-peak (11pm-4pm) Year-round: 9.45	On-peak: 21.41 5pm–9pm year-round 6am–8am Nov-March Off-peak: 14.28 All other hours Discount: 8.57 12am–4am year-round

Electric space heating rates and off-peak interruptible rates are becoming more well known as being beneficial in concert with ASHP rebate programs to optimize customer operational costs. Several utilities in the Midwest, including Xcel Energy (Minnesota) and Dakota Electric Association (Table 9), have examples of these beneficial rate types. The main market appeal of these specialized rate types is their impact on ongoing customer energy costs — namely, customers using dual fuel heat rates can have similar or lower annual operating costs compared to the natural gas baseline scenario. The MN ASHP Collaborative hosts a cost of heat comparison tool that shows how these different rate types impact customer operational costs.[46] Dual fuel heat rates may be only slightly lower than standard (non-space heat) rates, but as mentioned in the modeling results, operating costs are sensitive to rates — a reduction of just a few cents can significantly impact system economics. While issues with adoption and logistics remain, dual fuel heat rates can facilitate high-performance dual fuel heat pump use without increasing operating costs for customers.

[46] Minnesota ASHP Collaborative cost of heat comparison tool

RECOMMENDATIONS

Dual fuel heat pumps are primed to grow their market share as a comfort improving, cost-saving, and flexible high-performance HVAC technology that is actionable to deploy and expands consumer choice. With strategic planning, dual fuel heat pumps are positioned to bring immediate benefits to customers, drive a market transition to more high-performance HVAC solutions, and further United States energy system leadership. We outline four recommendations for states, utilities, and other market influencers to strengthen the path for dual fuel heat pumps as a solution toward high-performance HVAC in the Midwest.

Increase awareness of high-performance HVAC systems, like ASHPs as an AC replacement, so that the technology is not overlooked as an option during replace-on-fail scenarios.

As described in this report, general awareness of ASHP technology among Midwest customers is relatively low; one study found roughly 80% of Midwest customers know little to nothing about the technology.[47] Additionally, the study reveals that word-of-mouth and utilities are the most trusted sources of information about home heating and cooling systems. To build momentum around this opportunity, programs should focus on baseline education and awareness around heat pumps as an AC replacement to prime customers for when they need to replace a failed AC or furnace. By increasing baseline awareness, this will ease the sales process for contractors and increase customer pull for heat pumps at the time of emergency replacement.

Resources exist through the MN ASHP Collaborative on customer messaging research and templates to build awareness and generate marketing activities for the technology.[48,49] Messaging from these resources can support awareness building efforts around dual fuel heat pumps across the region in addition to the suite of high-performance HVAC educational resources the Midwest Heating and Cooling Collaborative has compiled, which include decision guides, videos, savings calculators, and user tips.[50]

Work with local market partners to upskill contractors in selling and installing dual fuel heat pumps, support whole-home business models, and support new HVAC workforce entrants.

Without proper design, sizing, product selection, controls configuration, and installation, HVAC systems may operate for years without living up to the technology's performance potential. Additionally, if contractors lack confidence in the nuances of high-performance HVAC systems, like ASHPs, they will be less likely to sell and confidently specify the technology. For dual fuel heat pumps to realize their promise as a high-performance HVAC technology, a committed, qualified, and supportive workforce of installation contractors is pivotal.

There are plenty of third-party training providers and resources available. DOE recognizes training providers as part of the Energy Skilled Program that outlines learning outcomes for both

[47] https://www.etamn.org/messaging-strategies-drive-heat-pump-adoption-minnesota
[48] Ibid
[49] https://www.mnashp.org/marketing-resources
[50] https://mwcollab.org/resource-library

comfort advisors/sales staff and installers of heat pump technology.[51] Third-party training initiatives to upskill existing contractors to optimize energy performance of heat pump technology can significantly bolster the extensive training infrastructure already offered by heat pump distributors and manufacturers. For example, states, utilities, or communities can host contractor summits that highlight the clear local value proposition of dual fuel heat pumps alongside manufacturers, distributors, and supportive programs.[52] Applying this market partnership approach, some utility programs have worked to increase contractors buy-in of heat pumps and installation competence through qualified contractor networks such as the Minnesota Air Source Heat Pump Collaborative and Michigan Heat Pump Collaborative. Contractors who complete training can apply to join the Collaboratives' Contractor Network. Joining the network is an added incentive to attend trainings, as it provides lead generation for participating contractors.

While the audience and approaches may differ, a market partnership approach is recommended to support whole-home business models and new HVAC workforce entrants. Efforts to support contractors in implementing whole-home business models can ensure high-performance HVAC technology like dual fuel heat pumps maximize their benefits by being installed in high-performance homes. There are a variety of entry points for HVAC contractors or contractors who have predominantly focused on solar, home performance or other trades to expand their business operations to provide whole-home services to residents. Adoption of a partnership collaboration cycle can support new entrants in their pathways to career development. A variety of innovative market actor partnerships can support the growth of new workers positioned to install dual fuel heat pumps and further the goal of high-performance HVAC.[53]

Unleash the flexible capabilities of dual fuel heat pumps to increase customer choice, lower costs, and improve grid management.

Dual fuel heat pumps are a flexible demand-side solution that increases customer choice and can improve grid management and energy affordability. Customers' ability to alternate between two fuel sources and the flexibility to call on electric heating systems to switch to an alternative heat source during times of high wholesale pricing or peak demand can be an enormous asset to meet energy affordability and reliability goals.

All states in the Midwest region incorporate some process for grid resource planning where dual fuel heat pump technology can play a key role. Utilities and regulators should consider innovative rate structures for dual fuel heat pumps that better align system and customer electricity costs. Utilities and regulators should periodically review rate structures to adapt to changing electricity supply and demand and transmission and distribution constraints.

We also recommend utilities and regulators leverage burgeoning technology solutions that make demand response implementation easier and less costly. For example, electric utilities can use advanced metering infrastructure (AMI) data to offer dual fuel heat rates. AMI technology allows systems to automatically report customer energy use to utilities at more frequent intervals, which would eliminate the requirement for a second meter. There are also future potential standards like

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[51] https://bsesc.energy.gov/recognition/heat-pump-programs
[52] The Midwest Collaborative has produced a contractor summit toolkit for stakeholders interested in hosting an event to advance high-performance HVAC technologies, like ASHPs. https://mwcollab.org/contractor-summit-toolkit
[53] https://mwcollab.org/program-administrators/hvac-workforce-development-toolkit

AHRI 1380[54] meant to streamline demand response interfaces for variable speed ASHPs across manufacturers. This standard is not yet widely used by utility programs but could hold future potential.

Ensure programs coordinate and align equipment incentive requirements around common product specifications.

While dual fuel heat pumps offer more flexible options for system types, sizing, and controls, upfront costs remain a market barrier given the higher incremental cost of a heat pump over a central AC. Across the Midwest, various incentives for dual fuel heat pumps may be available from states, utilities, or communities to bring down upfront costs. However, the complex nature of incentives and conflicting requirements can be difficult for customers and contractors to navigate.

Alignment of incentive program requirements around common product specifications so they can be stacked to maximize upfront cost savings can alleviate this first cost barrier. Program coordination can enable a more seamless customer and contractor experience, optimizing the efficient use of program funds, and helping distributors optimize their purchasing and stocking decisions. When possible, efforts to coordinate weatherization and heat pump programs will help advance consumer choice. Market actors desire simplicity and stability. Careful attention to seize opportunities for program coordination and alignment will make dual fuel heat pumps more accessible and spur market development, so that dual fuel heat pumps can realize their promise to unlock energy prosperity and subsequent cycles of high-performance HVAC innovation.

[54] https://www.ahrinet.org/system/files/2023-06/AHRI_Standard_1380_I-P_2019.pdf

APPENDIX A: MODEL ASSUMPTIONS

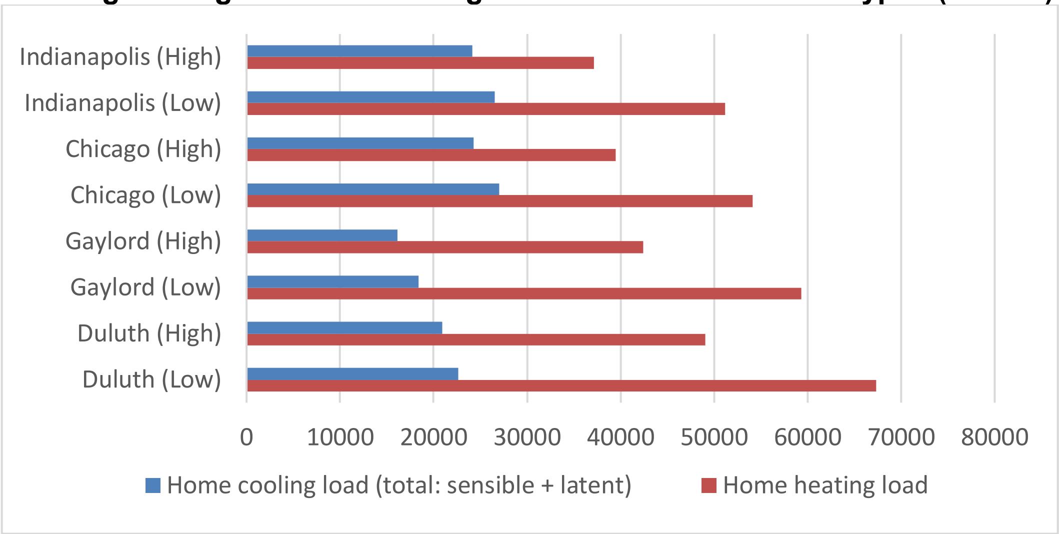
Home Archetype

Home Archetype consistent variables	
Home Type	Existing Single-Family
HVAC setup	Central HVAC w/ ductwork
Square footage	1863
Occupancy	2 adults, 2 children
Floors	2 floors plus basement
# bedrooms	3
Typical appliances	1 fridge, 1 freezer, range with hood, dishwasher, clothes washer, and dryer. Allowance electric appliances and lighting.
Thermostat setpoint	70°F for heating, 75°F for cooling (ASHRAE defaults)
Heating indoor dry bulb temp	74°F
Cooling indoor dry bulb temp	70°F

Differences in low- and high- weatherized home archetype

Home archetype variable inputs	Baseline Weatherized Home	Better Weatherized Home
Construction Type	2x4 construction with R13 wall and R19 in attic	2x4 construction with R16 wall insulation and R60 attic insulation
Window type	Single-pane with storms	Double-pane windows
Infiltration	3 ACH	.5 ACH

Design heating/cooling loads for low-/high-weatherized home archetypes (BTU/hr)



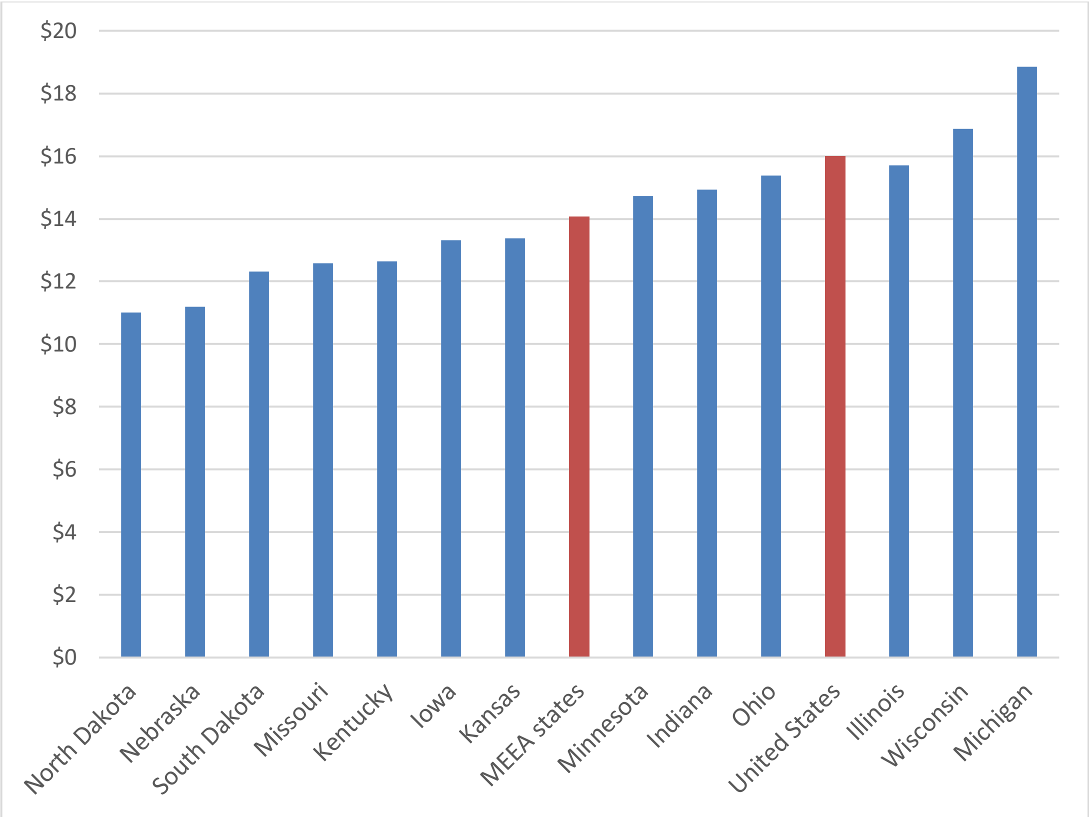
HVAC system modeled sizes and installed costs

Equipment	Sizing approach	Furnace Size (kbtu)	Outdoor Unit Size (kbtu)	Install Cost	Home archetype
Central AC + Furnace *(SEER2: 14.2)* *(AFUE 95%)*	Cooling load	50	24	$10,047	Duluth (high), Gaylord (high)
		60	24	$10,047	Gaylord (low)
		70	24	$10,282	Duluth (low)
		60	30	$10,295	Chicago (low), Indianapolis (low)
		40	30	$10,008	Chicago (high), Indianapolis (high)
Two-stage ASHP + Furnace *(SEER2: 15.7)* *(AFUE 95%)*	Cooling at low stage	50	30	$13,142	Duluth (high), Gaylord (high)
		60	30	$13,142	Gaylord (low)
		70	36	$13,531	Duluth (low)
		60	36	$13,244	Chicago (low), Indianapolis
		40	36	$12,605	Chicago (high), Indianapolis (high)
Average variable speed ASHP + Furnace *(SEER2: 16.2)* *(95% AFUE)*	Cooling optimized for heating	70	36	$15,860	Duluth (low)
		60	36	$15,625	Chicago (low), Gaylord (low), Indianapolis (low)
		50	36	$15,625	Duluth (High), Gaylord (high)
		40	36	$15,296	Chicago (high), Indianapolis (high)
ccASHP + Furnace *(SEER2: 17.1)* *(AFUE 95-96%)*	Capable of meeting most of heating load (~80%)	30	36	$17,368	Chicago (high), Indianapolis (high)
		50	36	$17,958	Gaylord (High)
		80[55]	48	$19,011	Duluth (high)
ccASHP all-electric *(SEER2: 18.3)*	sized for max available heat load	none	48	$17,691	Gaylord (high), Chicago (high), Indianapolis (high)
ccASHP all-electric +5kW boost *(SEER2: 16.2)*	sized for max available heat load	5 KW electric heat	60	$20,060	Duluth (high), Duluth (low), Gaylord (low), Chicago (low), Indianapolis (low)

[55] Two-speed 96% AFUE furnace with variable-speed blower required to accommodate 48kbtu heat pump and cooling size limits.

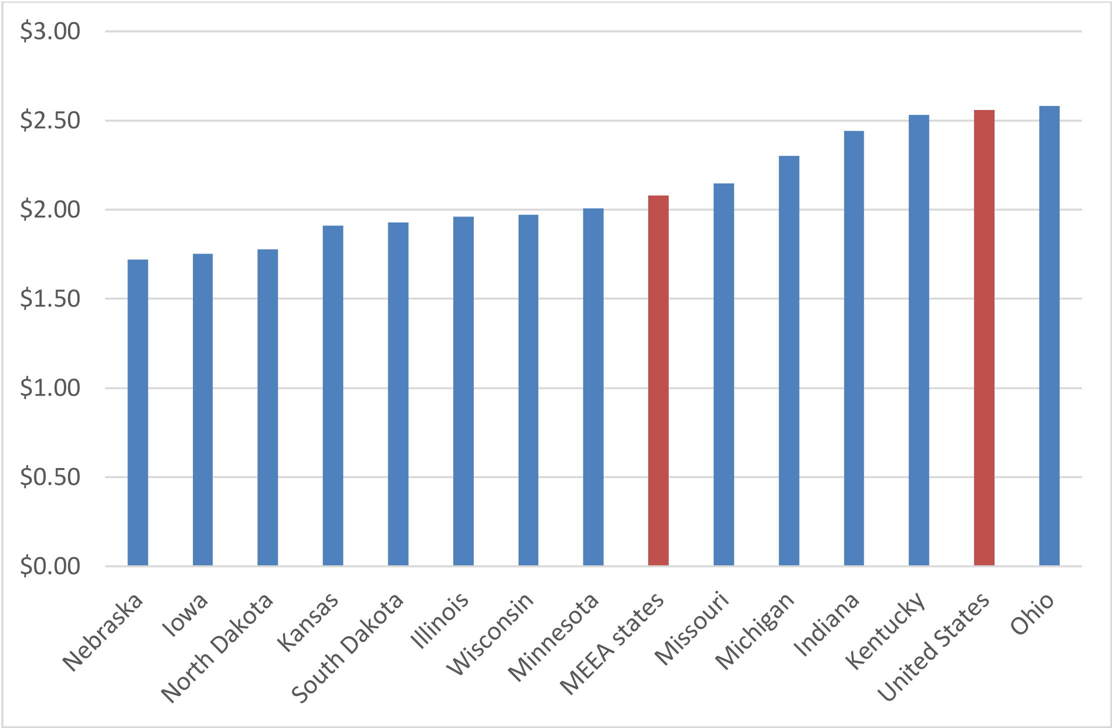
APPENDIX B: ELECTRICITY AND FUEL PRICES[56]

2023 Residential average electricity retail price ($/kWh)

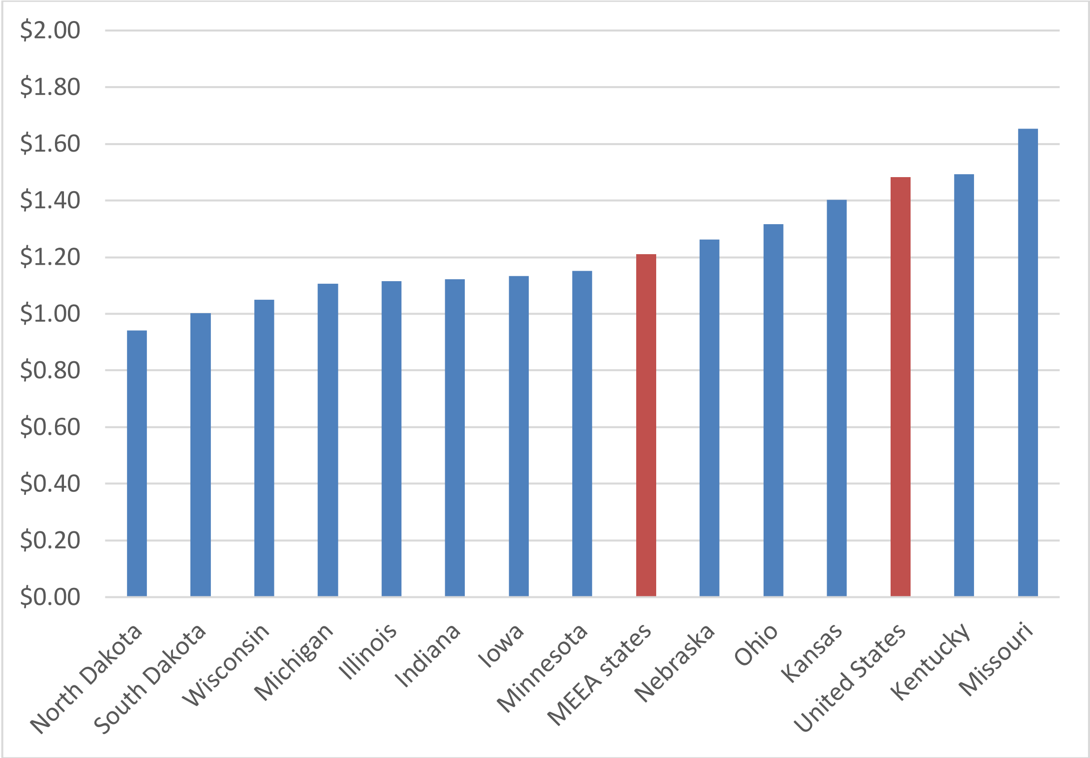


[56] Source: Energy Information Administration (EIA)

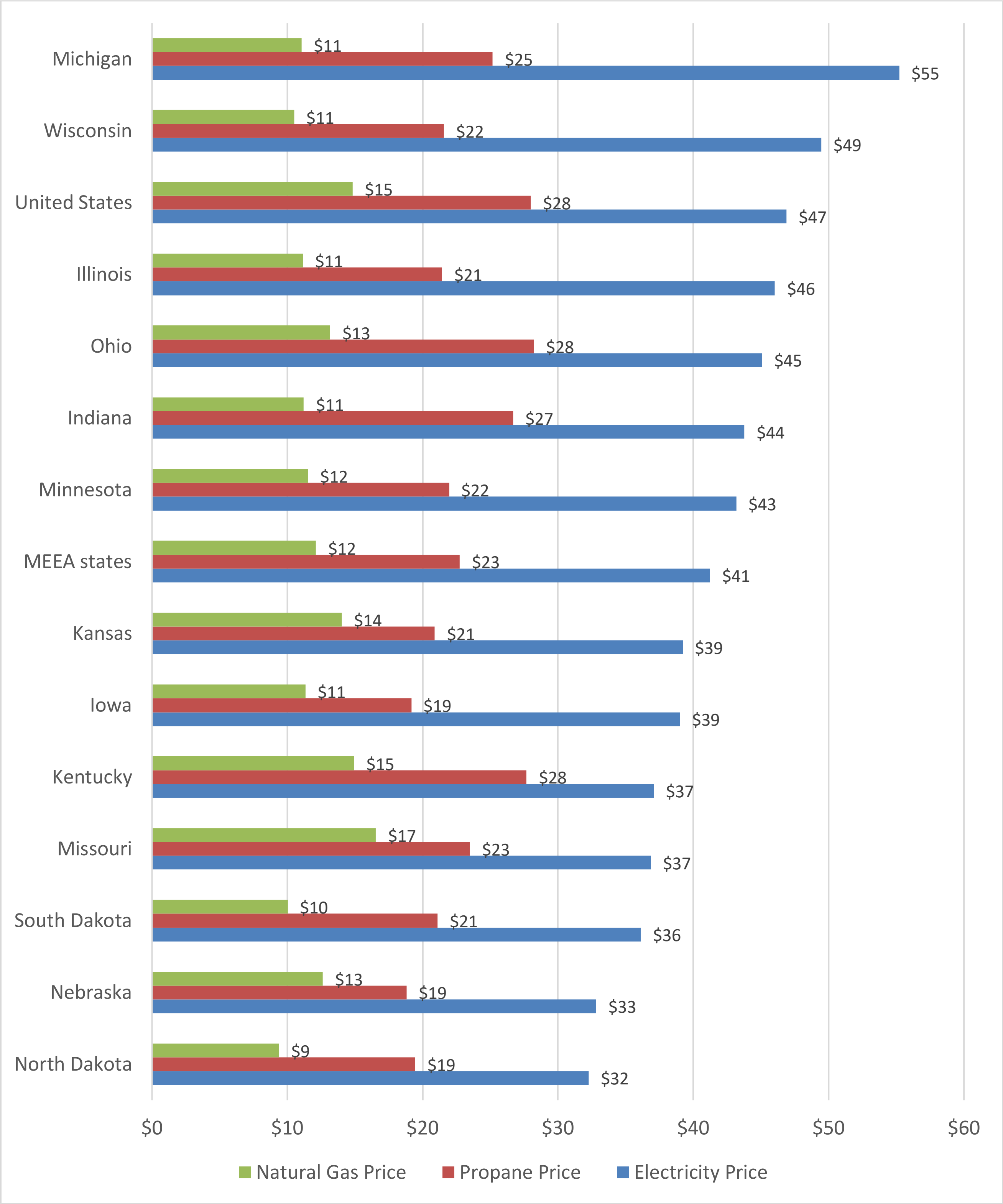
2023 Residential propane prices ($/gallon)



2023 Price of natural gas delivered to residential customers ($/therm)



2023 average fuel prices by state ($/mmbtu)



Electricity cost parity coefficient of performance (COP) using 2023 average fuel prices