Maximizing the Potential of Heat Pumps in Vermont: Opportunities and Challenges

By Joshua Valentine
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This report is the result of a 10-week internship led by EAN Senior Fellow Christine Donovan.

Project Purpose

This report is the result of a 10-week summer internship project led by Energy Action Network (EAN), a non-profit collective impact organization based in Montpelier, Vermont**.** Comprised of professional staff and more than 250 organizations, state agencies, and businesses who are network members, EAN works to achieve Vermont's climate and clean energy commitments in ways that create a more just, thriving, and sustainable future for Vermonters.

The purpose of the project was to research and assess what is needed in Vermont to help scale up heat pump sales, installations, and utilization to achieve strategic electrification pathways modeled for the 2021 Vermont Climate Action Plan.[1] The report resulting from the project applies a systems-thinking approach to assess the opportunities and challenges for rapidly expanding the heat pump market in Vermont. This included researching four key components:

- Consumer demand and awareness;
- Heat pump technology – the types of heat pumps, how they work, and consumer perception and experience with the technology;
- The sales, installation, and service infrastructure and workforce; and
- The existing policy and regulatory framework and utility and other programs stimulating market uptake.

Results of research conducted for this report were used to:

- Identify existing or potential gaps or barriers that could limit growth in the heat pump market in Vermont;
- Assess consumer experience with heat pumps in Vermont; and to
- Recommend strategies for addressing gaps and barriers moving forward.

Key questions addressed during the project included:

- What is the level of market activity needed to meet the greenhouse gas reductions modeled for heat pumps in the Vermont Climate Action Plan?
- What is the current level of market activity for heat pumps in Vermont and who are the key market players?
- Based on interviews with key heat pump market players, as well as related industry and literature research, what is working well in Vermont, what are the anticipated future

[1] 2021 Vermont Climate Assessment.

challenges and barriers to market scale-up, and what activities or initiatives are needed (or underway) to address anticipated challenges and barriers?

The desired impacts and outcomes of this project include advancing the conversation in Vermont on actions needed to achieve the level of market activity necessary to meet Vermont's greenhouse gas (GHG) reduction requirements. The heat pump market is composed of many complex pieces including the roles of and interaction between the private and public sectors. For this reason, it is important to take a systematic approach and address each market component concurrently to ensure the markets' ability to scale efficiently. Another desired outcome is helping to ensure that equitable access to heat pump technologies is addressed in current and future programs, rebates, and incentives that are intended to continue to transform the market. Ideally, this work will contribute to helping the market successfully scale in both an economical and profitable way for businesses as well as in an equitable way for consumers.

Methodology for Assessing the Heat Pump Market in Vermont

Figure 1: Key Components Needed to Transform the Heat Pump Market

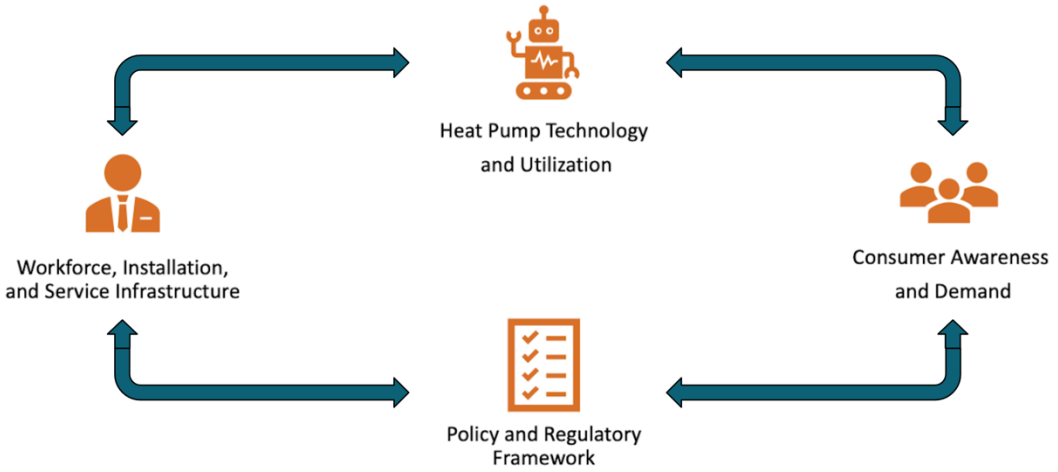


Figure 1 depicts four key components needed to successfully introduce and achieve widespread market acceptance of new technology in any sector, including clean energy technology. Heat pumps are an example of a clean energy technology that has been undergoing substantial market uptake in a variety of regions in the U.S., initially in warmer climates with high cooling demands for buildings. The development and use of heat pumps for both heating and cooling in colder climates (such as in Vermont) is more recent, starting in Northern New England within the last decade.

As a relatively new technology that is generally in the early stage of market adoption in Vermont, there is still a lot to learn and understand about the technology and how to successfully

scale the market to help achieve greenhouse gas reductions targets established in the 2021 Vermont Climate Action Plan. When assessing the Vermont heat pump market, it is important to consider all four of the key components needed to successfully scale the market. For example, a strong and prepared workforce is only advantageous to a market when consumer awareness and demand are high enough to sustain businesses' needs for job consistency for existing staff. The reverse is also true: effective marketing resulting in high consumer awareness and demand is most advantageous when there is sufficient workforce to meet the needs of consumers. The status of each of the four key components is discussed below for the current heat pump market in Vermont.

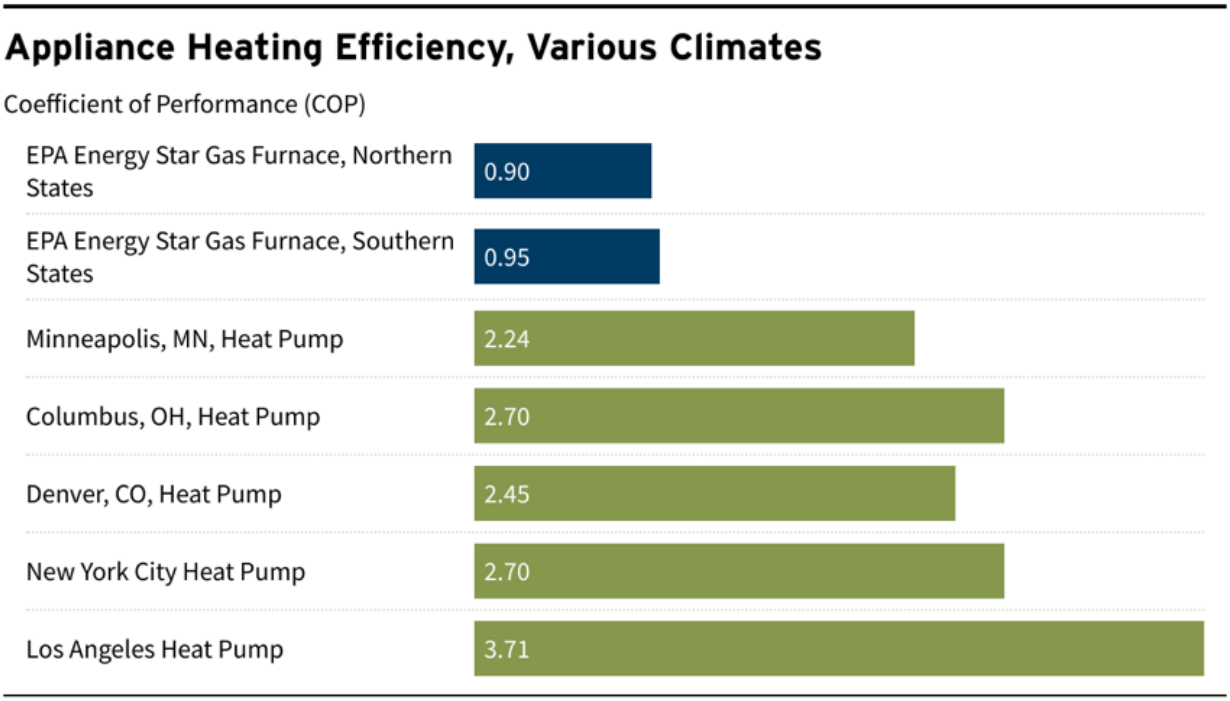
Overview of Heat Pump Technologies and Applications

Various 'renewable (or clean energy) thermal technologies' are being developed with the aim of reducing carbon emissions and enhancing energy efficiency in the thermal/buildings sector. These technologies encompass biofuels, pellet boilers and furnaces, waste and compost heat recovery processes, as well as various heat pump technologies.[2] Heat pumps, considered one of the most efficient ways to heat homes,[3] operate by extracting and amplifying heat from the surrounding air, ground, or water rather than by generating heat themselves.[4] This makes them far more efficient than conventional heating methods like boilers or electric heaters, resulting in potentially lower running costs. Additionally, during the summer months, heat pumps can be utilized as cooling devices by transferring heat out of the home.

Comparing heating technologies based on efficiency and effectiveness involves using a measurement referred to as the Coefficient of Performance (COP). It represents a ratio of energy input to output. A COP of 1 signifies 100% efficiency. Traditional heat generation technologies, such as gas and oil furnaces, cannot achieve this level of efficiency because of inherent energy losses during heat production.[5] In contrast, heat pump technologies primarily transfer heat instead of generating it, allowing them to achieve COP values well above 1. A study by the Rocky Mountain Institute (RMI) demonstrated that heat pumps perform well in both mild and cold climates, achieving a COP of over 2 in the coldest climate and almost 4 in the warmest climate.[6] This means households in warmer climates obtain nearly 4 kWh equivalent of heat output for every 1 kWh of energy input with their heat pump compared to a COP value of 0.95 for gas furnaces in warmer climates. Examples of heat pump Coefficients of Performance among locations with varying climates are presented in Figure 2.

[2] "Renewable Thermal Energy." 2023. Connecticut's Official State Website. June 2023.
[3] "Heat Pump User Tips." Efficiency Maine.
[4] "How A Heat Pump Works – The Future of Heat Pumps." IEA.
[5] Rene Langer. 2023. "Coefficient Of Performance – What Is a Good COP For Heat Pump."
[6] Lacey Tan and Jack Teener. 2023. "Now Is the Time to Go All In on Heat Pumps." Rocky Mountain Institute. July 6, 2023.

Figure 2: Heat Pump Efficiencies Among Various Climates



Note: The study did not account for geothermal heat pumps
Source: https://rmi.org/now-is-the-time-to-go-all-in-on-heat-pumps/

There are a variety of types and sizes of heat pumps, allowing a consumer to choose the system that best fits their heating, cooling, and financial needs. The three main types of heat pumps for residential and small-to-midsize commercial buildings include: Air Source Heat Pumps (ASHPs), Ground Source/Geothermal Heat Pumps (GSHPs), and Water Source Heat Pumps (WSHPs).

Air Source Heat Pumps

ASHPs transfer heat between a building and the outside air. There are three main types: ducted, ductless, and air-to-water. ASHPs are currently the most commonly sold and installed heat pumps, primarily because they are the most widely available and are comparatively inexpensive.[7] Ductless mini-splits are the most popular of the three types of air source heat pumps, making up the majority of ASHP installations due to their ease of installation since they do not need new or existing ductwork. For consumers who have pre-existing ductwork, ducted ASHPs can be an attractive option because they offer centralized heating and cooling for an entire building, as compared to single zone systems.

[7] "Heat Pump Systems." Energy.gov.

Ground Source Heat Pumps

GSHPs, also known as geothermal heat pumps, transfer heat between a building and the ground. There are multiple types of GSHPs. They range in price, how they are installed, and their heating and cooling capacity. GSHPs are the most efficient and reliable type of heat pump, but they cost substantially more to purchase and install than ASHPs[8]. One of the reasons for the higher cost is that GSHPs require underground piping, in contrast to many other types of heating and cooling systems. When GSHPs are used for a single building (rather than a collection of multiple buildings), the piping costs represent a significant portion of the total cost to the consumer.

One of New England's largest electric and gas utilities, Eversource, is seeking to make use of their underground piping equipment and service expertise (from their gas utility experience) in a new way. Eversource is currently operating a pilot project in Framingham, MA to determine if networked geothermal systems (connecting multiple buildings to one shared geothermal heat pump system) are viable, cost-effective, and affordable for consumers. Through the pilot, Eversource is assessing if a networked, heat pump-based, geothermal system can lower the upfront cost for consumers, thereby alleviating a financial barrier to market uptake. [9] In Vermont, Vermont Gas Systems (VGS) is seeking to launch a similar pilot project in their service territory. However, VGS is waiting for a second round of funding from the U.S Department of Energy as well as approval from the Vermont Public Utilities Commission before moving forward with the pilot program.

Water Source Heat Pumps

WSHPs operate similarly and as efficiently as GSHPs, except they extract heat from water instead of the ground. However, WSHPs are much less common since they require a river or lake to extract water from, thereby limiting locations where such heating and cooling systems can be installed.[10] Costs vary drastically given the wide variety of possible project conditions. Due to this, there is not enough information to report accurate cost ranges.

[8] "McDevitt, Casey. 2022. "Air Source Heat Pumps vs. Geothermal Heat Pumps." *EnergySage* (blog). October 21, 2022.
[9] "Networked Geothermal Pilot in Massachusetts." Eversource.

[10] "Water Source Heat Pumps." *GSHPA*.

Heat Pump Costs

Table 1: Heat Pump Costs Based on National and Regional Data

Type	Type	Unit Cost	Installation Cost	Total Cost	Life Expectancy	Annual Maintenance Costs
Air Source Heat Pump (ASHPs)	Ductless	$1,000 - $3,000	$1,500 - $8,000	$2,500 - $11,000	10 - 20 years	$100 - $200
	Ducted	$2,000 - $5,500	$4,000 - $8,000	$6,500 - $13,500	10 - 20 years	$100 - $200
	Air-to-Water	Technology still developing				$100 - $200
Ground Source Heat Pump/Geothermal (GSHPs)	Horizontal Loop System	$2,000 - $16,000	$8,000 - $24,000	$15,000 - $30,000	20 - 50 years	$100 - $500
	Vertical Loop System	$2,000 - $16,000	$8,000 - $24,000	$25,000 - $40,000	20 - 50 years	$100 - $500
	Open Loop System	$2,000 - $16,000	$8,000 - $24,000	$10,000 - $30,000	20 - 50 years	$100 - $500
	Closed Loop System	$2,000 - $16,000	$8,000 - $24,000	$25,000 - $30,000	20 - 50 years	$100 - $500

Note: All costs noted in the Table are prior to the application of the variety of state and/or federal rebates and tax credits available for heat pumps, which when combined, can decrease the net cost to consumers substantially. Information in the Table was obtained from a variety of published sources noted in the footnotes below. [11], [12], [13], [14], [15]

Presented in Table 1 are ranges for the variety of costs associated with purchasing, installing, and servicing different types of heat pumps. Labor costs for ducted heat pumps assume that ductwork is already installed. Costs increase significantly if ductwork installation is needed. Costs vary depending on the size of the building, how large of a system is needed, and the number of units

[11] Moore, Timothy. 2023. "How Much Does Heat Pump Installation Cost?" Forbes Home. July 20, 2023.
[12] Wallender, Lee. 2023. "How Much Do Geothermal Heating and Cooling Systems Cost?" Forbes Home. March 14, 2023.
[13] "Vermont Heat Pump F.A.Q." Vermont Energy Contracting and Supply Corp.
[14] Biermeier, Deane. 2023. "How Much Does Heat Pump Maintenance, Service and Repair Cost?" Forbes Home. March 13, 2023.
[15] "Geothermal Heat Pumps." North Carolina Sustainable Energy Association.

installed. The prices of units vary by manufacturer, the quality of technology, and location. Labor costs for installation also vary by location. All life expectancies assume proper and consistent maintenance. Price ranges also depend on the size of the system needed to be installed.

Overall, heat pumps are an energy efficient and cost-effective heating and cooling technology. While certain types of heat pumps, such as ASHPs, don't perform as efficiently in colder climates, according to RMI, when they are properly installed and operated, ASHPs perform two times better than the most efficient gas furnace in colder climates (using the metric of COP).[16]

The Policy and Regulatory Context for Heat Pumps in Vermont

Due to many years of hard work by many state legislators, climate and clean energy advocates, and numerous key influencers in Vermont, there is currently a strong policy and regulatory framework in Vermont supporting the rapid scale-up of clean energy technologies to mitigate greenhouse gas (GHG) emissions from fossil fuel use. The journey began nearly 25 years ago, around the turn of the century, with the establishment of Efficiency Vermont (EVT) as an energy efficiency utility (EEU). EVT pledged to reduce energy costs for Vermont residents and help protect the environment. Vermont has three EEUs, the others being Burlington Electric Department (BED) and VGS that are also working to advance energy efficiency and clean energy through an array of programs and projects.

Moreover, two critical state-level laws were passed within the last decade, further enhancing the policy and regulatory framework for energy efficiency and clean energy technology in Vermont. These include the Renewable Energy Standard (RES) and the Global Warming Solutions Act (GWSA). Additionally, at the federal level, recent efforts led to the successful passing of the Inflation Reduction Act (IRA), which includes many significant components directed at greenhouse gas mitigation efforts. The implications of each of these for the current and future heat pump market in Vermont are discussed below.

Renewable Energy Standard (RES)

In 2015, the Vermont Legislature put in place a Renewable Portfolio Standard (RPS), referred to as the Vermont Renewable Energy Standard. This resulted in the establishment of new renewable energy requirements for Vermont. RPS' are "policies that mandate that a minimum

[16] Lacey Tan and Jack Teener. 2023. "Now Is the Time to Go All In on Heat Pumps." Rocky Mountain Institute. July 6, 2023.

share of a state's electricity supply must be generated using renewable resources such as wind, hydro, and solar."[17] The RES requires Vermont to achieve:

- 75% renewable energy by 2032
- With 10% coming from in-state sources

Vermont's RES resulted in the development of two new market activities in Vermont. First, the RES resulted in the creation of what is referred to as "renewable energy credits (RECs)," with each credit representing the value of a unit of electricity produced by renewable energy. Second, it resulted in development of a new market for the generation and sale of RECs, with those producing RECs able to sell them to those needing RECs to meet state renewable energy requirements. RECs serve as a market-based mechanism to distinguish between energy derived from renewable sources and energy produced from non-renewable sources. They allow utilities and/or consumers to verify their use or provision of renewable energy. The Vermont RES has three categories (or tiers) of obligations for Vermont's electric sector:

- Tier I: Total Renewable Energy
- Tier II: In-State Renewable Energy
- Tier III: Energy Transformation

Tier III is the most relevant for heat pumps. It requires distribution utilities (DUs) to reduce fossil fuel consumption by their customers through energy transformation projects, which can include weatherization and electrification. These projects contribute to a quantitative standard for fossil fuel reductions, equivalent to a portion of electricity sales, set by the RES that every utility must meet each year. As a result, many utilities offer rebates to incentivize the purchase of renewable energy and energy efficiency technologies in order to help meet their RES requirements. As the heat pump market started developing in Vermont (after enactment of the RES), some utilities expanded their rebate programs to include heat pumps in addition to the other clean energy technologies previously included in their offerings.

Global Warming Solutions Act (GWSA)

In September of 2020, the Vermont Legislature passed the Global Warming Solutions Act (GWSA) which put in place GHG emissions reduction requirements for the state. The GWSA requires Vermont to reduce GHG emissions by:

- At least 26% below 2005 levels by 2025

[17] "Renewable Energy Credits." Renewable Energy Vermont.

- At least 40% below 1990 levels by 2030
- At least 80% below 1990 levels (and net zero by 2050)

The GWSA also created the Vermont Climate Council and charged it with drafting the state's first Climate Action Plan (CAP). Vermont's first Climate Action Plan was developed during 2021 and was approved by the Council in December 2021. Per the GWSA, the plan will be updated every four years. Since adoption of the CAP, the Vermont Agency of Natural Resources has begun adopting new rules and regulations consistent with the plan. Vermont's CAP lays out mitigation pathways for the highest GHG emitting sectors in the state's economy, including the thermal/buildings sector. The CAP outlined two high-level pathways for reducing thermal-sector emissions:

1. Reduce energy use in buildings through scaling cost-effective weatherization and energy efficiency improvement efforts
2. Reducing the carbon content of fuels used by buildings

Within these two pathways, a variety of strategies and actions were recommended, including the development and implementation of a Clean Heat Standard (CHS).[18] The subsequent passage of the Vermont Affordable Heat Act (AHA) in 2023 set in motion a two-year process currently being overseen by the Vermont Public Utilities Commission (PUC) to establish the rules and implementation for a CHS for Vermont. At the completion of the two-year process, the rules and implementation approach recommended by the PUC will require legislative approval. Assuming such approval occurs, it is anticipated that implementation of a CHS will result in heating fuel suppliers in Vermont gradually adopting lower carbon fuels and heating alternatives to offer to consumers in order to help meet Vermont's GHG reduction obligations. Because heat pumps operate using electricity and because the vast majority of electricity used in Vermont is generated from carbon-free fuels, increasing the use of heat pumps is expected to be a key pathway for meeting the GHG required by Vermont's GWSA.

Inflation Reduction Act (IRA)

In August of 2022, the Inflation Reduction Act (IRA) was passed by the US Congress and signed into law by President Biden. The IRA stands as the largest and most impactful climate bill ever to pass at the federal level, and it will result in greatly expanded federal funding and new programs designed to address climate change mitigation for many different sectors and industries in the U.S. One of the focuses of the bill is on helping to reduce thermal sector emissions. The bill has rebate and incentive programs targeted at reducing the financial barrier for energy

[18] 2021 Vermont Climate Assessment.

efficiency technologies and projects for all market players involved. Many of the incentives have financial caps or specific timelines, meaning they won't last forever.

Current Heat Pump Programs, Rebates, and Incentives in Vermont

Over the years, clean energy and climate legislation in Vermont has led to the establishment of numerous programs aimed at promoting energy efficiency and the use of clean energy. The programs encompass a wide range of initiatives, such as financial incentives, grants for workforce development, support for individuals and households with low-to-moderate-incomes, educational resources explaining programs and products, technical assistance, and more. While many of the programs and incentives predate concern about reducing GHG emissions, they serve as a valuable learning opportunity. They offer insights into what does and does not work effectively when seeking to cause utilities and consumers to increase energy efficiency and clean energy use as a means of reducing GHG emissions from fossil fuels. Ongoing evaluation, measurement, and verification (EM&V) of existing programs results in continuous program design and process improvements, helps drive innovation, and increases impact – for both existing and new programs.

Various entities implement energy efficiency and clean energy programs in Vermont including the three EEUs, community action agencies, distribution utilities (DUs), local and state agencies, and private businesses. Each entity secures funding from different sources, including grant money, internal budgets, and/or Vermont's energy efficiency charge (EEC) integrated into electricity rates.

For emerging technologies, such as heat pumps, that can have relatively high upfront costs, financial incentives play a crucial role in increasing market uptake. Such incentives are often dynamic, with periodic changes in incentive values in order to align with the most recent market activity and technology utilization.

Both state and federal incentives are (or will be) available for heat pumps in many states, including Vermont. Such incentives can include: rebates paid to consumers who purchase heat pumps; rebates paid to manufacturers and distributors of heat pumps; and/or federal, state, or local tax incentives.

Presented in Table 2 are rebates (as of August 2023) provided to consumers in Vermont who purchase and install heat pumps. Currently, customers of Green Mountain Power (GMP), Washington Electric Cooperative (WEC), and Vermont Electric Cooperative (VEC) are eligible for rebates offered by their Distribution Utility as well as for rebates offered by Efficiency Vermont, the Energy Efficiency Utility that serves all of Vermont except Burlington and Vermont Gas Supply's service territory. This is because Efficiency Vermont rebates are funded

by an Energy Efficiency Charge on customers' utility bills except for Burlington Electric Department (BED) customers. Since BED operates as both an Energy Efficiency Utility and Distribution Utility for its customers, BED also offers incentives for heat pumps to their customers, as does VGS.

Table 2: Heat Pump Rebates in Vermont as of August 2023

Company	Equipment	Efficiency VT Rebate	Incentive	Type	Additional Incentives	Type	Additional LMI Incentives	Type
GMP	Approved Ducted	$1,000 - $2,400	$400	M			$300/$600	
	Approved Ductless	$350 - $850	$400	M			$300/$600	
BED	Approved Ductless	N/A	$350 - $450	M	$500 - $2500	D	$400	D
	Standard Ducted	N/A	$1000 - $2000	M	$1250 - $3250	D	$400	D
	"High-Performance" Ducted	N/A	$1000 - $2000	M	$2250 - $6250	D	$400	D
	Air to Water HP	N/A	Up to $12,000	M/D			$400	D
	Geothermal (< 10 tons)	N/A	Up to $15,000	M/D				
	Geothermal (>10 tons RES and COM)	N/A	Up to $250,000	M/D				
WEC	Ductless	$350 - $850	$100	D				
	Ducted	$1,000 - $2,400	$100	D				
	Air to Water HP		$500	D				
	Geothermal (< 10 tons)	Up to $2,100/ton	$2,000	D				

	Geothermal (10-20 tons)	Up to $2,100/ton	$1,000	D	
	Geothermal (20-50 tons)	Up to $2,100/ton	$500	D	
	HP Water Heater (only if replacing fossil-fired system)	$300 - $600	$100	D	
VEC	Thermal Effiency Bonus	N/A	$150	D	

Note: "Type" represents the type of rebate being received. 'M' stands for midstream, meaning the seller or installer receives the incentive, naturally lowering the price of their estimate, so the benefits are recognized at the point of sale. 'D' stands for downstream, meaning the consumer receives the cash in hand after having the installation done and filing the appropriate paperwork.

In addition, new rebates and/or tax incentives are expected in late 2023 due to the passage of the Inflation Reduction Act of 2022. However, the specifics of the incentives are not yet known, nor is their potential interaction with existing state incentives. It is important to note that incentive levels are subject to change. The values included in Table 2 are intended to provide an overview of the entities providing rebates and the range of incentive amounts offered at a specific point in time. Information in the table is expected to change over time, and the amounts noted above will likely remain the same overtime.

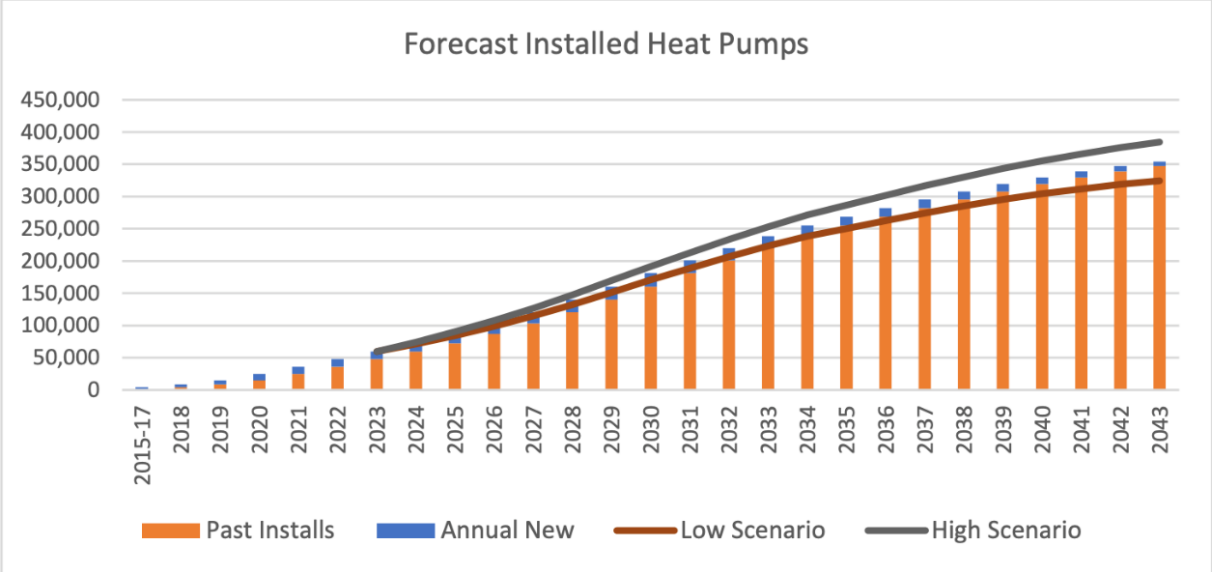
Financial incentive programs, primarily in the form of rebates, play a vital role in reducing barriers to entry in the heat pump market. However, substantial consumer investment is also needed in addition to the incentives. Especially for low-to-moderate-income households, the affordability of heat pump technology can be a challenge. To ensure a swift and equitable transition to this clean heat technology, additional initiatives like the credit program that is intended to be established as a result of implementation of Vermont's Affordable Heat Act is expected to be crucial. It will be essential that the program proposed for implementing the CHS specifically and thoroughly addresses how to ensure heat pump technologies are available to and affordable for low-to-moderate income households, as required by Act 18.

Heat Pump Adoption Needed to Meet the GWSA Requirements

As shown in Figure 3, heat pump installations in Vermont have nearly doubled since 2021. This is a positive sign, showing that early adoption programs for heat pumps are working. As of

January 2023, it is estimated that about 55,000 heat pumps had been installed in Vermont.[19] Using Efficiency Vermont data, an estimated 45,000 of the installations met BED or EVT's technical efficiency criteria, thereby qualifying them for rebates. The remaining 10,000 were deemed to be lower quality, less efficient technologies not included on the list of "eligible technologies" for the rebates. The Vermont Public Service Department (PSD) states in their 2023 Annual Energy Report that it is anticipated that new heat pump installations will increase by 13,000 in 2024.[20] The heat pumps are anticipated to be high-efficiency cold-climate heat pumps, ideally as a result of efforts to lower the net cost to consumers of qualified high-efficiency heat pumps to below the net cost for unqualified lower quality heat pumps through rebates. The PSD's 2023 Annual Energy Report's historical and forecasted cumulative installations figures for heat pump sales and installation in Vermont are presented in Figure 3.

Figure 3: Vermont Heat Pump Forecast from 2015 to 2043



Source:https://publicservice.vermont.gov/sites/dps/files/documents/2023%20Vermont%20Annual%20Energy%20Report_0.pdf

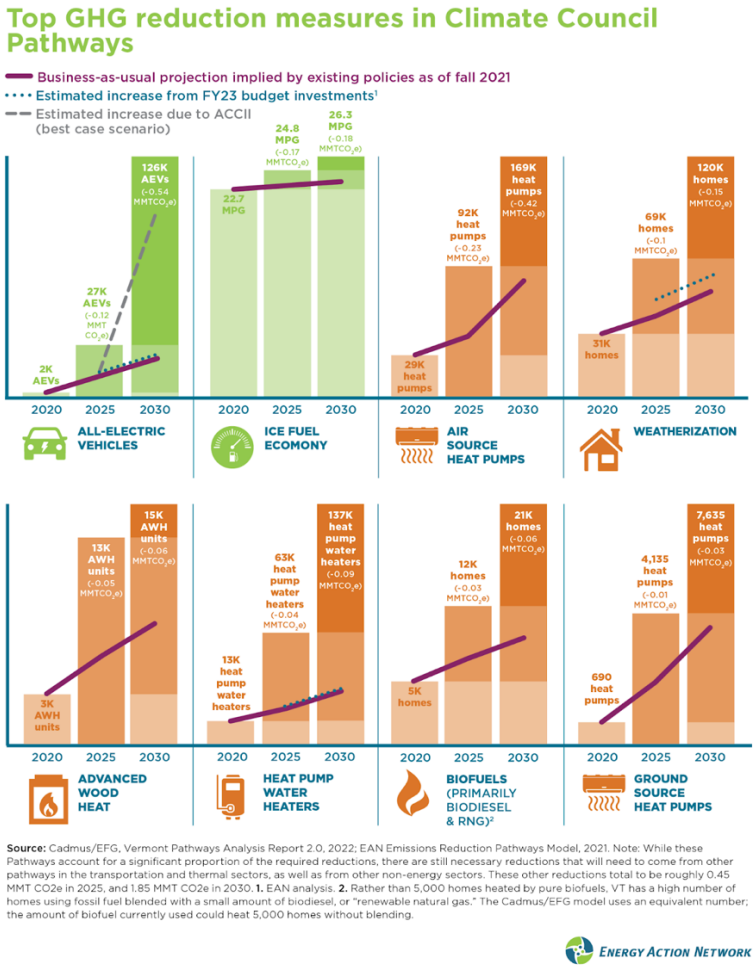
This figure highlights two significant issues: the forecasted consistency in annual heat pump installations and the fact that eventually the market for new installations will (ideally) become saturated and will be replaced by a much smaller market for new construction and replacements combined. Vermont's building stock is comprised of approximately 350,000 buildings, including residential, commercial, and all other buildings. According to the PSD model, the year 2030 is

[19] Vermont Public Service Department. "2023 Annual Energy Report." Public Service Vermont, January 15, 2023.
[20] Ibid

projected to be the peak installation year, with an estimated 20,700 installations, followed by a gradual decline in annual installations in subsequent years.[21]

Despite the eventual expected decline in installations per year, the PSD model predicts that almost all buildings in Vermont will have some form of a heat pump by 2043. However, one possible misinterpretation of this model is that each installation doesn't necessarily represent a new installation in a building without a previous heat pump. Buildings may undergo repeat installations in a short period if consumers add more units to their homes, or in the long term, when early adopters seek replacements after 10 to 20 years. These factors could affect the model's forecast and potentially lead to an underestimate of the time required to reach heat pump penetration across almost all of Vermont's building stock.

Figure 4: Top GHG Reduction Measures in the Vermont Climate Council Pathways



[21] Ibid

Figure 4 provides a broader perspective on the scale of thermal efficiency improvements and uptake required to achieve the GHG reduction requirements established by the GWSA. It aligns with the projected number of installations depicted in the PSD's figure, aiming to encompass a significant portion of the housing stock before 2050. However, it illustrates that relying solely on heat pumps will not be sufficient to accomplish GWSA targets. While heat pumps are highly efficient and have substantial potential for reducing thermal sector emissions, additional efforts and technologies will be needed.

Options such as wood heat and biofuels can serve as viable alternatives to or complements to heat pumps for some consumers. Additionally, prioritizing weatherization is crucial, as conserving heat and energy within a leaky building will yield more significant results than solely focusing on altering the heat source.

Opportunities and Challenges for Maximizing Heat Pump Use in Vermont

Informed by the information above and drawing upon interviews conducted for this report with multiple heat pump professionals in Vermont, the purpose of this section is to summarize and discuss what is currently working well and where there is room for improvement in further scaling the heat pump market in the state. Each of the key components needed to scale the heat pump market (discussed above) are addressed, including:

- Heat pump technology – the types of heat pumps, how they work, and consumer experience with the technology;
- Consumer demand and awareness;
- The sales, installation, and service infrastructure and workforce; and
- The existing policy and regulatory framework and utility and other programs stimulating market uptake.

Heat Pump Technology and Current versus Predicted Utilization in Vermont

Heat Pump Technology

Over the years, heat pump technology has benefitted from significant performance improvements. Advancements include newly developed refrigerants capable of absorbing more heat at lower temperatures, as well as more effective and efficient compressors and heat exchangers. It's important to note, and this will be reiterated in the workforce section, the need for an educated and experienced installer and service technician. Heat pumps commonly use a refrigerant called hydrofluorocarbons (HFCs), which has extreme global warming potential if leaked or disposed of incorrectly, experts warn[22]. While the technology is not flawless and may

[22] Simon, Julia. 2023. "6 Things to Know about Heat Pumps, a Climate Solution in a Box." NPR. April 1, 2023.

require a secondary heating system in colder climates once temperatures drop below a certain point, it proves effective when proper measures are taken.

One crucial measure is weatherization, which aids in heat conservation and is recommended as the primary step in enhancing a building's heating efficiency[23]. As demonstrated in Figure 2 and discussed previously, when weatherization measures are carefully considered and implemented as needed, heat pumps exhibit superior performance even in colder climates, surpassing gas furnaces by more than two times in efficiency.

Another crucial aspect to consider with heat pump technology is how the technology is used. There are a variety of viewpoints about the most efficient way to use a heat pump, making it essential for consumers to understand and determine which approach best suits their needs. A study conducted in 2020[24], in alignment with the beliefs of many Vermont experts, revealed a prevailing theme about usage, suggesting that using heat pumps to maintain a constant temperature, rather than frequently adjusting it, is preferable when a secondary heating source is also available.

The emerging best practice appears to be setting a heat pump to the desired temperature and then configuring a secondary heating source a few degrees below the heat pump's temperature, thereby allowing the heat pump to operate continuously. This is increasingly being referred to as the "set it and forget it" method for maximizing performance of heat pumps[25]. Such an approach addresses the problem that attempting to adjust heat pump temperatures frequently and for short periods of time (such as reducing the temperature overnight) may actually lead to increased energy consumption as the heat pump returns to the previous higher temperature in the morning[26].

A heat pump consumer with deep energy efficiency and clean energy experience interviewed as a case study for this report notes significantly reduced heating costs and a consistently comfortable home by using the "set it and forget it" method. The consumer has three separate, single-zone, ductless mini-splits installed, one on each floor of a well-weatherized home. The consumer reports that they live in a cold arid climate where temperatures reach well below freezing for sustained periods of time throughout the winter. When using the “set it and forget it" method for heat pumps, the secondary heating source was only relied upon a few times throughout the winter for supplemental heat. In contrast, the consumer's experience with a previous attempt to use setback thermostats for the heat pumps was not successful. The consumer reported little to no savings using the setback thermostats and varied comfortability. This was because the secondary heating system was used more frequently to meet comfortability

[23] “Save Today and Save Tomorrow Before Installing a New HVAC System.” NYSERDA.
[24] Carroll, P. et al. 2020. “Air Source Heat Pumps Field Studies: A Systematic Literature Review.”
[25] “Heat Pump User Tips.” Efficiency Maine.
[26] Ibid

needs, since the heat pumps required more energy when getting back to the higher temperature setting during the day.

Lastly, industry experts have raised a growing concern about multi-zone ductless systems. As previously noted, ductless systems come in two types: single zone and multi-zone. Among these, multi-zone setups are typically favored and widely adopted due to their enhanced aesthetics and affordability. These systems function by incorporating multiple indoor units into a single system, controlled by a universal thermostat, and linked to a sole outdoor compressor. Despite their attractive economic and aesthetic benefits, they have proven to be less efficient than a similarly installed single zone system. Multi-zone systems require a proportional outdoor compressor to the number of indoor units installed in order to meet high heating and cooling load demands. When only a small load is needed, which is typically the case when a "set it and forget it" use method is implemented, a large amount of energy is required to power a larger outdoor unit for a little bit of heating/cooling load.

In contrast, a single zone ductless mini-split functions with each indoor unit operating as an independent system. Each indoor unit is equipped with its own thermostat and outdoor compressor, allowing for a unit to measure the immediate surrounding temperature and use a properly sized fan for maximum efficiency. While a full house single zone setup results in less appealing exterior infrastructure on and around the consumer's home and a higher installation cost, industry experts are saying it is more effective than the multi-zone systems.

In Vermont's current market landscape, notable issues with multi-zone systems have been reported. Frequently, the thermostats for these systems are placed within the same room as just one of the indoor units. This setup leads to temperature readings that do not accurately represent the entire building, resulting in inconsistent and uncomfortable heating or cooling experiences. This anomaly is not observed with single zone ductless mini-splits, which rely solely on their individual thermostats to effectively regulate the temperature within their designated zone.

Further investigation is necessary to delve into this potential problem, and effective communication of the findings will be crucial.

What's Working Well and Should be Continued?

- Continued R&D by manufacturers is resulting in increasingly efficient cold-climate heat pumps.
- The identification of and increased messaging about the value of the "set it and forget it" method for using heat pumps. Let the heat pump do the work.
- The effective use of single-zone ductless mini-splits when a centralized system is not desired, including their effective built-in thermostats.

Where is There Opportunity for Enhancement?

- There is a need for increased training for awareness among heat pump sales, installation, and service professionals on the improved performance of heat pumps when using the "set it and forget it" method.
- There is also a need for expanded outreach and messaging by heat pump rebate providers targeted at new and existing heat pump consumers on the improved performance of heat pumps when using the "set it and forget it" method.
- More attention is needed to ensuring ease of use for heat pump consumers and consistency in usage messaging.
- More outreach and messaging is needed about the proper location of thermostats for multi-zone ductless systems. More information about and messaging on the pros and cons of a multi-zone system versus multiple separate single zone systems is needed.

Heat Pump Utilization by Consumers

Heat pump utilization is affected by consumer experience with the technology and how the technology was marketed compared to how it actually performs once operated by a consumer. If an early adopter is not experiencing the expected benefits of a heat pump - such as a consistent comfortable temperature and a certain promised cost-effectiveness - that could result in the consumer not using the heat pump to its full potential.

Heat pump experiences that do not meet consumers expectations can occur for a number of reasons, including improper installation and/or a lack of consumer awareness about the optimal way to use a heat pump. It is very important that those marketing heat pumps and providing rebates for heat pumps be accurate and realistic about anticipated performance and cost-effectiveness. If only the "best-case" maximum heating and cooling results are assumed and implied in marketing and outreach materials, that could result in setting consumers expectations too high compared to the results actually experienced. Since it is generally understood that neighbors talk to neighbors and friends talk to friends when assessing new energy efficiency and clean energy options, it is very important that early adopters of heat pumps actually realize the benefits they were encouraged to expect. This helps avoid consumer dissatisfaction and potential distrust in the technology and the organizations and agencies promoting the technology.

Low rates of utilization can also occur when consumers end up using heat pump technology in more limited ways than the technology can successfully deliver. An example of this is the growing understanding that many heat pumps are being marketed as a new, cost-effective source of summer cooling as an alternative to traditional air-conditioning units, without mention of the heating capabilities. A recent study completed by Burlington Electric Department determined that almost one quarter of their customers with heat pumps only use them for cooling. For those customers, the heat pumps are therefore not displacing fossil fuel use during the heating season

(and thereby not contributing to a reduction in greenhouse gas emissions, two key objectives of BED's rebate program).

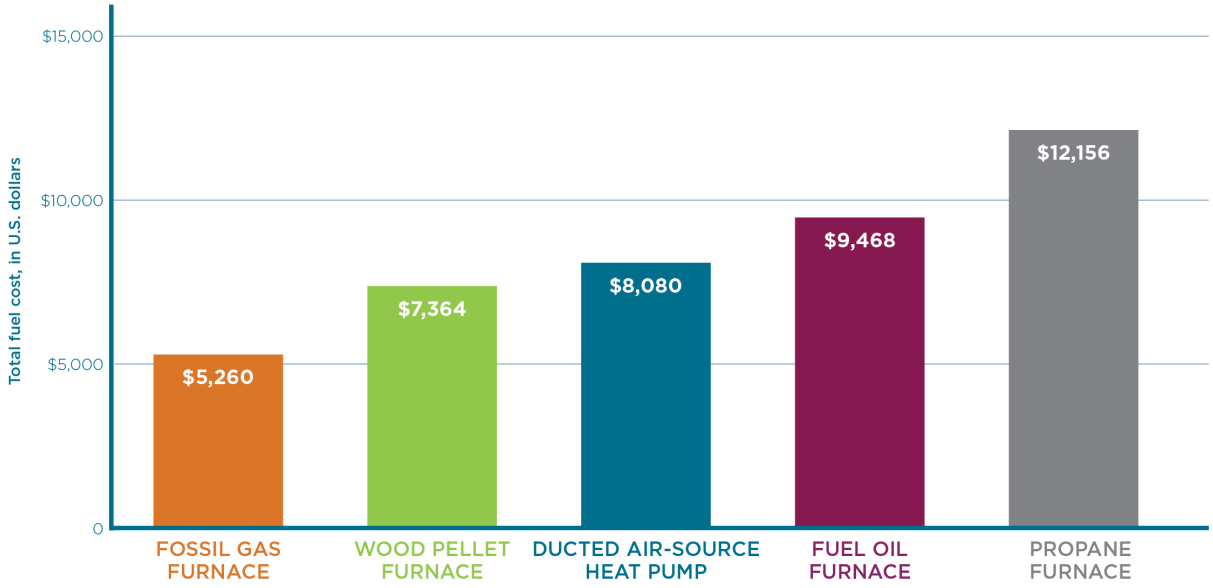
Table 3: Estimated and Verified Savings from Heat Pump Use by BED Customers

Type of Project	BED Reported kWh Saved	BED Reported Winter Peak kW	BED Reported Summer Peak kW	PSD Verified kWh Saved	PSD Verified Winter Peak kW	PSD Verified Summer Peak kW
MOP	348,307	84.091	8.594	128,066	32.657	39.912
Retrofit	-18,862	-4.125	-0.433	-10,233	-3.186	-0.182
Totals	329,445	79.966	8.161	117,832	29.471	39.730
Verified Totals	329,445	79.966	8.161	117,832	29.471	39.730

Source: West Hill Energy and Computing. 2023. "Residential Heat Pumps." BED FCM21 Project Report.

Presented in Table 3 are the estimated and subsequently verified energy savings by BED customers using heat pumps. Columns 2, 3, and 4 in the table represent the estimated kWh savings, the winter peak kW savings, and the summer peak kW savings. Columns 5, 6, and 7 depict the calculated and verified kWh and peak savings as a result of subsequent EM&V analysis completed after program implementation. The findings indicate that actual, verified energy savings were 64% below the estimates and the actual winter peak load reduction was 63% lower than previously estimated. This information indicates significant underutilization of heat pumps for heating purposes. The underutilization of heat pumps for heating is resulting in BED and WEC considering reducing the value of their incentives which could further increase the upfront financial burden in investing in a heat pump. In addition, VEC has stopped their heat pump incentive program altogether.

Figure 5: 5-year Heating Costs by Fuel in VT, 2018-2022



Sources: Propane and fuel oil prices: Vermont Department of Public Service, Retail Prices of Heating Fuels, 2023. Electricity prices: EIA, 2023. Fossil gas prices: VGS, 2023. Wood pellet prices: Biomass Energy Resource Center, 2023. Monthly heating degree days: NOAA/National Weather Service, 2023. Average efficiency rates of heating equipment and average heating load of a VT household: TAG Tier III Annual Report, 2021.

BED's recent study presents the current utilization patterns of Burlington customers and sheds light on the implications of overestimating heat pump output and usage during early adoption of the technology. It is important to acknowledge that BED's customers, being in VGS territory, primarily use fossil gas as their primary heating source, which is one of the lowest-cost fuel options (Figure 5). Therefore, Burlington's low levels of heat pump utilization for heating may reflect economic considerations that are unique to its region. Models suggest that heat pump usage is more cost-effective in regions where propane and/or fuel oil are used for heating. Heat pump utilization rates should be studied in regions that rely on these more expensive fuels to better understand statewide usage trends. The actual performance of heat pump technology statewide will become better understood as more evaluation, measurement, and verification is done overtime in counties that use these other heating sources such as oil and propane. As the market continues to develop, verification of actual savings and utilization will be essential to help highlight areas of opportunity for improvement. Rebates and incentives play a crucial role in driving the market, with sales and installations increasing each year. Increased focus on the utilization of heat pumps for both cooling and heating could help ensure the longevity and success of heat pump incentive programs going forward and the true reduction of GHG emissions in the thermal sector.

What's Working Well and Should be Continued?

- There are multiple examples of proper sizing and installation of all types of heat pumps by respected, well-trained, and customer-focused HVAC contractors, heat pump sales and installation companies, HVAC contractors, and licensed electrical contractors.
- Vermont is benefitting from having a large cohort of professional, experienced energy efficiency and clean energy professionals leveraging decades of successful program design and implementation experience. In addition, early EM&V results are already beginning to be used to continuously improve heat pump program offerings in the state and it seems certain such continuous improvement will occur time again moving forward.
- Rapid increase in usage for cooling (with heat pumps being much more efficient than traditional air conditioning), thereby improving comfort and helping grow the market in Vermont during this still relatively early stage of market transformation and maturation.

Where is There Room for Enhancement?

- Lack of transfer of information or inconsistent information on proper usage from contractor to consumer. Additional installer training on proper usage could help address this.
- Inconsistent assumptions/estimates on useful heat output by heat pumps leading to inaccurate savings estimates and potentially resulting in setting consumers' expectations too high. As actual EM&V results are developed, this should provide new sources of real-world data that can help inform assumptions used in future modeling and forecasts.
- Underutilization of the use of heat pumps for heating, as noted in a recent evaluation of the use of heat pumps by BED customers. This could be due to the relatively low cost of natural gas in BED's jurisdiction. This may not be as much as of a factor in other areas of Vermont not served by Vermont Gas Systems. Future EM&V analyses should reveal new information about how heat pump consumers in other parts of Vermont are using their heat pumps. Since electricity in Vermont is virtually carbon free, it is important that heat pumps be used both for cooling and to replace fossil fuel-based heating in order to result in a reduction in GHG emissions.

Consumer Awareness and Demand

The level of consumer awareness and demand greatly impact the rate of adoption of heat pump technology and have significant overlap with other key components for rapid market uptake. Effective marketing and educational efforts are essential to ensure consumers are aware of the heating, cooling, greenhouse gas reduction, increased comfort, and cost benefits of using properly installed and operated heat pumps. Achieving sufficient demand to meet heat pump goals established in modeling for the Climate Action Plan will depend on marketing

effectiveness, positive perception of the technology, and the availability of rebates and incentives (among others).

As noted above, as of January of 2023, an estimated 55,000 heat pumps have been installed in Vermont, with approximately 80% (or 45,000 heat pumps) being high-efficiency, rebate-eligible products[27]. The remaining nearly 20% (or 10,000 heat pumps) are lower-efficiency products not deemed eligible for rebates. The list of eligible products was determined by Efficiency Vermont and BED via partnerships with various distributors and upon careful review of heat pump quality and performance criteria. Data on the number of heat pump installations is based on the receipt of rebate forms. The explanation for why there are 10,000 ineligible installations thus far include (and may not be limited to) the following: the installations occurred before inception of the rebate program (and therefore the list of eligible technologies) and rebates were applied retroactively for only those brands on the list), even once the list was developed consumers ended up choosing brands not on the list, etc.

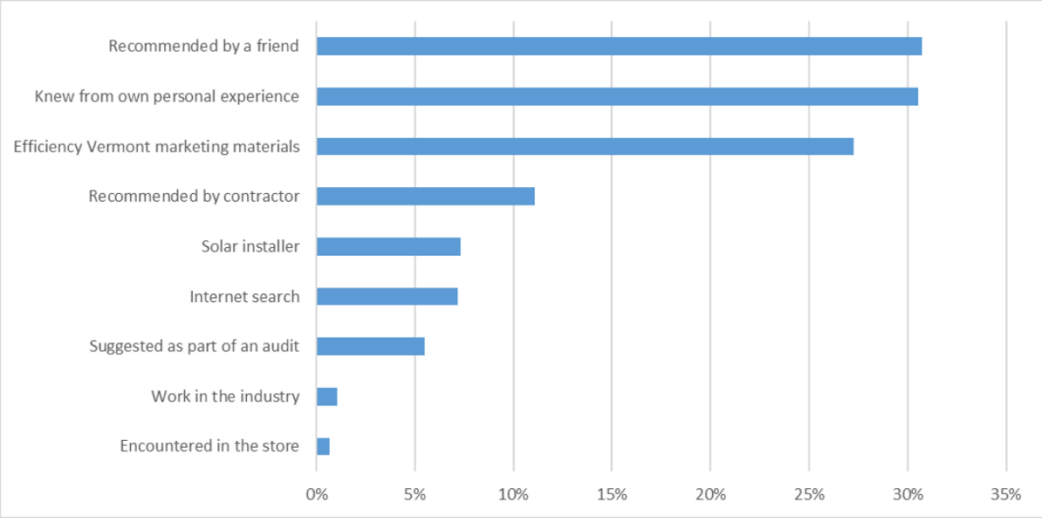
As installations continue to grow in the future, it will be essential that rebate and incentive programs reduce the financial barrier to high-performance heat pumps, bringing them ideally to the same affordability level as cheaper alternatives. Additionally, it will be important that EVT and BED periodically update their respective lists of eligible products while maintaining the highest standards for efficiency and performance.

According to interviews conducted for this report with a variety of heat pump professionals in Vermont, it is generally believed that additional marketing and outreach about heat pumps could help further stimulate market uptake. BED, Efficiency Vermont, VGS, and a variety of other utilities in Vermont feature information about heat pumps and existing rebate programs on their websites. In addition, well-established companies, such as Vermont Energy Contracting (VTenergy), VGS, and SunCommon, have executed successful marketing campaigns. VGS launched a heat pump program in which they install and service heat pumps in-house. VGS reports that within weeks, its heat pump program was fully booked for months ahead. However, marketing and outreach focused specifically on heat pumps is not regularly done by the many smaller, more locally focused electrical contracting companies, independent licensed electricians, and smaller plumbing and heating companies also selling and installing heat pumps (ie local "the boots on the ground" companies). Often relatively small in size, these companies already tackle multiple roles including managing crews, doing payroll and bookkeeping, paying quarterly and annual federal and state taxes, etc. - leaving little time for marketing other than via word of mouth, neighbor to neighbor. Moreover, for companies that are not primarily HVAC-focused, the array of products and services they offer adds another level of complexity to any advertising efforts. As a result, such companies often rely on partnerships, word of mouth, and their hard-earned reputation to drive business. While these prove difficult challenges to solve, it is

[27] Prevost, Lisa. 2023. "Vermont Gas to Install Electric Heat Pumps." Energy News Network. May 15, 2023.

important for further market expansion for the consumer to hear directly from the people installing and servicing the product, not just from a third-party such as Efficiency Vermont or a utility not actually installing the products themselves. The positive implications of VT Energy, VGS, and SunCommon's successful campaigns suggest it could be worth exploring innovative ways to manage marketing efforts efficiently and collaboratively for smaller, "boots on the ground" companies.

Figure 6: PSD Heat Pump Consumer Awareness Survey



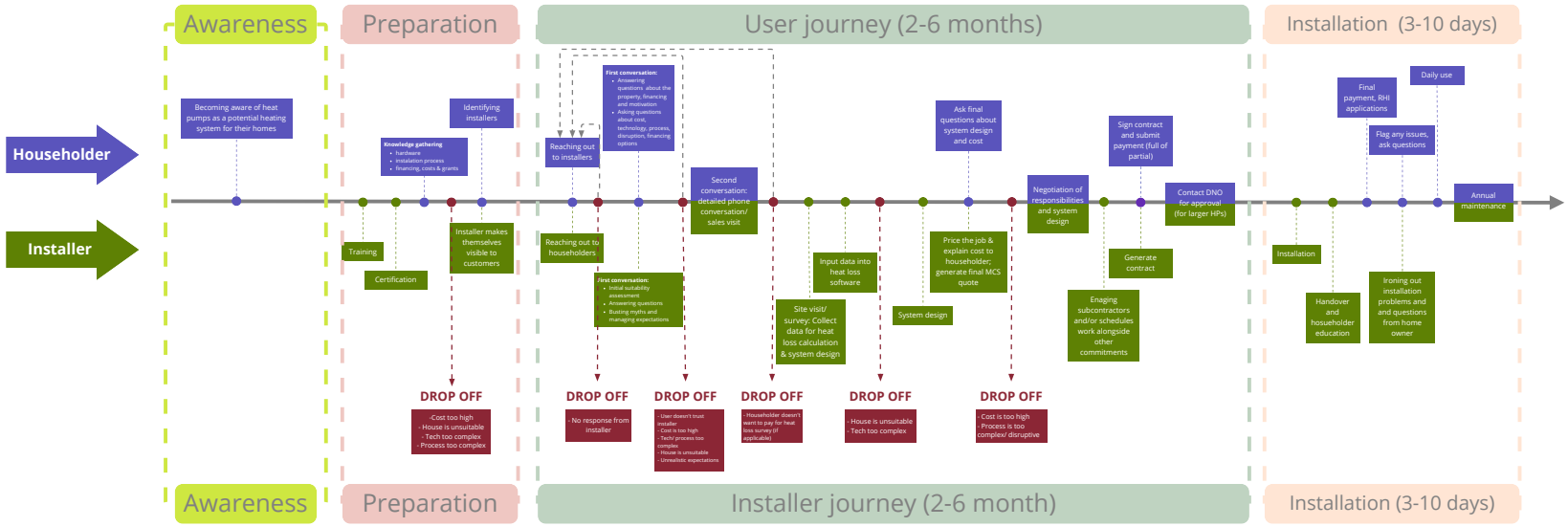
Another prevalent issue is one that is well described by an old Benjamin Franklin quote. "It takes many good deeds to build a good reputation, and only one bad one to lose it." Heat pumps work incredibly under the right circumstances (Figure 2) and have extreme potential in displacing fossil fuel use used for heating in the thermal sector. But even with lots of correctly installed, effectively operating heat pumps in Vermont, a small number of negative experiences can disrupt continued rapid adoption of the technology. These systems are an investment for a consumer, costing multiple thousands of dollars. They can require weeks or months of financial preparation and planning for families to be able to execute on the investment. So, when the possibility of this newer technology not providing the promised benefits is learned, the investment can be seen as a risk to the consumer. It may become no longer a "no-brainer" decision with guaranteed economic benefits. It may become a long thought-out decision. This element of risk introduced into the consumers decision can now make known reliable alternatives, like possibly a fossil fuel system, seem much more appealing. This dynamic emphasizes the importance of ensuring reliable, consistent, and positive heat pump experiences because friends and neighbors talk. In a 2017 study conducted by the PSD, the top result for how consumers became aware of heat pump technology was through word of mouth (Figure 6). While this has the potential to help increase consumer demand for heat pumps, it also has the potential for the spread of false narratives or negative user experiences. Numerous conversations conducted in variety of casual settings

throughout the summer of 2023 revealed consistent responses of inaccurate information about heat pumps and doubts about the technology and its effectiveness in cold climates.

Consumers may also be forming opinions based on published works by popular and trusted media outlets such as Forbes. In two articles discussing heat pump technology and costs,[28] [29] Forbes discourages investment in heat pumps in colder climates. Given the array of outlets that could result in discouragement of such investment, it is imperative that Vermont help facilitate a process in which its heat pump consumers prevalently and confidently share their user experiences with the technology. This is done through a collective process of improving the consumer's journey to installation, ensuring proper effective installation, and a comfortable and convenient user experience. Figure 7depicts the typical process that a consumer and installer go through, starting from the initial interest in investing in a heat pump and concluding with its installation. The figure also highlights the most common points where consumers may drop off from the process.

[28] Orentas, Geraldine. 2023. "10 Types Of Home Heating Systems To Know." Forbes Home. March 3, 2023.
[29] Moore, Timothy. 2023. "How Much Does Heat Pump Installation Cost?" Forbes Home. July 20, 2023.

Figure 7: NESTA's Heat Pump User Journey Map



https://www.nesta.org.uk/sustainable-future/ nesta

Note: A British think tank designed this Heat Pump User Journey map. It is not identical to Vermont's processes, yet it offers a visual understanding of the relatively standard process for obtaining a heat pump. It highlights many potential "drop-off" points for a consumer that have been observed over and over again by British contractors in a heat pump market that is well-developed and more advanced than the current market in Vermont. This figure can be found here for a more readable and interactive view: https://www.nesta.org.uk/project-updates/how-understanding-user-journey-heat-pump-adoption-will-generate-innovation/.

What's Working Well and Should be Continued?

- There are now consumers with properly sized, installed, and operating heat pumps who have demonstrated that the technology can work very efficiently and can cost-effectively deliver heating and cooling in cold climates such as Vermont.
- There is a demonstrated increase in the market uptake of heat pumps in the state, which recent modeling and forecasts are projecting to continue.
- Burlington Electric Department, Efficiency Vermont, the Energy Co-op of Vermont, VGS, and Washington Electric Cooperative are promoting heat pump use on their websites and offer rebate programs to incentivize consumer demand.
- There are now a variety of well-established, professional, and properly trained HVAC contractors, licensed electricians, and plumbing and heating companies with 5 to 10 years of experience successfully serving heat pump customers in Vermont.

Where is There Room for Enhancement?

- As is often the case with emerging technologies in the early phase of adoption, consumer experiences using the technology vary and can inadvertently result in market confusion. This may impede the rapid scale up in the use of heat pumps modelled for Vermont's Climate Action Plan.
- Modeling completed during development of the Vermont CAP (as well as for other purposes previously) has sometimes assumed that heat pumps would be displacing fossil fuel use for heating in all cases. However, initial EM&V completed recently for the BED heat pump program indicates this is not yet the case (at least in BED's service territory). BED customers with heat pumps largely are using them for cooling. This indicates the need for increased consumer awareness of the full range of comfort possible from heat pumps and of the greenhouse gas reduction potential for expanding use of existing heat pumps to offset fossil-fuel based heating.
- Mixed (and sometimes discouraging) reporting about the performance and cost-effectiveness of cold climate heat pumps from trusted media sources. Unless the basis for such reporting is addressed directly and quickly during early market adoption, this could lead to continued consumer uncertainty about the true potential of the technology.

Workforce, Installation, and Service Infrastructure

Workforce development challenges extend beyond the HVAC contracting sector in Vermont, likely having the largest impact on weatherization efforts. The entire state is grappling with an aging blue-collar workforce and although Vermont boasts a strong high school graduation rate, only about 50% of these graduates pursue higher education.[30] To address this issue, various efforts are underway to educate young individuals about the potential of pursuing careers in the trades and to encourage enrollment in post-secondary technical training programs.[31] In addition

[30] Steve Zind. 2013. "Why Do So Few Vermonters Choose College?" Vermont Public Radio. November 19, 2013.
[31] Huntley, Katharine. 2022. "State Tries to Encourage More Vt. Students to Consider Careers in the Trades." WCAX. August 23, 2022.

to a host of other technical high schools in Vermont, the city of Burlington (for example) is currently building a new high school that will include the Burlington Technical Center. The center is intended to provide and stimulate interest in vocational education.[32]

Another initiative in progress is the "Talent Pipeline Management" initiative being developed by the EAN Workforce Development Network Action Team. The initiative aims to attract talent and foster growth in Vermont's blue-collar workforce. Additionally, at the federal level, the "Home Energy Efficiency Contractor Training Grants" program (which is part of the Inflation Reduction Act) is providing $150 million in grants in Vermont the purpose of which will be to support training, testing, and certification of residential energy-efficiency and electrification contractors.[33] Applications for the grants, along with a 'Community Benefit Plan,' are expected to be due in late September of 2023.[34]

These activities are urgently needed in order to ensure a sufficient workforce to achieve the rapid scale up in the heat pump market modeled during development of the Vermont Climate Action Plan. As noted in Figure 3 (above), an expansion of the use of heat pumps is forecast through 2030, after which the installation of new heat pumps is projected to gradually decline as Vermont reaches a point when most buildings are expected to already have heat pumps installed. It is not yet well understood the extent of workforce growth that will be needed to service and maintain existing heat pumps in the future, and to replace aging heat pumps as they reach the end of their useful life. However, it is reasonable to assume that demand will continue at some level of activity for heat pump servicing and maintenance work over the mid- and long-term.

Vermont is fortunate to have experienced, reputable providers of heat pumps with multiple years of experience. But as the market continues to grow, an increasing number of smaller “Mom and Pop” companies are adding the sales and installation of heat pumps to their electrical contracting or plumbing and heating businesses. This is, in part, because there is a relatively low barrier to entry. Presently, the entrance of new market participants is seen by some to be causing fragmentation in the market and is resulting (at least for a while) in a reduction in the portion of the market being served by t established and properly trained companies with years (or decades) of experience. As new companies enter the market with minimal years of successful heat pump installation and service experience (yet), there is a risk that pricing and the quality of installation may vary widely, resulting in consumer confusion and potential distrust of heat pumps. Efficiency Vermont and utilities offering heat pump rebate programs have the ability to review pricing trends and assess customer satisfaction. They may find that new approaches are needed to further certify heat pump installers and/or take other measures to ensure market expansion and continued customer satisfaction.

[32] “BHS/BTC 2025 Update May 31, 2023: Demolition, Timeline, and Funding!” Burlington School District.
[33] “Biden- Harris Administration Announces $150 Million for States to Train Residential Energy Efficiency Contractors Through Investing in America.” Energy.gov.
[34] “State-Based Home Energy Efficiency Contractor Training Grants.” Energy.gov.

As new contractors enter the heat pump market, ensuring consistency in both installation practices and usage education is important. While although the market is still in the early phase of development in Vermont, it is sufficiently matured to the point where real-time results of the technology, including best installation and usage practices, can be observed. It is essential for licensing and certification programs to maintain consistent and up-to-date curricula aligned with these best practices, ensuring a unified understanding and ability among all heat pump sales and installation professionals.

To address the scarcity of a skilled blue-collar workforce in Vermont some companies, like Energy Co-op of Vermont and VTenergy, have taken proactive measures. Recognizing that individual licensing and certification can be costly and time-consuming, these companies have developed apprenticeship programs to train and certify heat pump installation and service technicians. Through these initiatives, participants receive paid training, steady employment during the training, and the opportunity to shadow and assist experienced professionals who have years of heat pump installation and service experience. These apprenticeship programs serve multiple purposes beyond workforce expansion; they enable new workers to become familiar with the technology, by starting with simpler tasks and gradually progressing to more complex situations in the field.

However, a significant challenge faced by such companies is the financial burden of paying for every employee's licensing and certification. While this investment is valuable in the long run, there is a risk that an employee may choose to leave the company after completion of such training. This can hinder the potential scaling of the companies. To incentivize employers to take on more untrained employees and offer an apprenticeship program, a solution could be a program that offers employers partial or full compensation for in-house training expenses. This could encourage companies to invest in workforce development, expand their teams, and ultimately foster a more robust and skilled workforce in the heat pump industry.

Several industry experts report a significant disparity in the pricing of heat pump installations when reviewing estimates and contracts included in applications from customers for heat pump rebates. The industry experts cite applications for seemingly similar projects that differ threefold in the price charged to the consumer. The variability in pricing could be due a variety of factors. Some companies may not have extensive heat pump installation experience yet and are pricing high to manage the risk that an installation may take longer than expected. Some consumers may have no experience purchasing a heat pump and are uncertain what a fair price should be. The impact of future market expansion and increased competition on pricing is uncertain. Increased outreach and education on appropriate ranges for heat pump purchase and installation costs may be needed by independent third parties such as Efficiency Vermont and utilities offering heat pump rebates to their customers.

After a heat pump installation is completed, it should be serviced once a year (similar to a furnace or boiler) and occasional servicing may be required due to a part needing to be replaced. Established companies such as VTenergy, the Energy Co-op of VT, and VGS have well-developed service teams. They may serve as models for other installation companies, as the heat pump market continues to develop.

What's Working Well and Should be Continued?

- Important workforce development efforts and initiatives are underway to help expand the blue-collar workforce needed to install and service heat pumps, such as the "Talent Pipeline Management" project potentially starting in Vermont, and federal funding from the IRA to be used for "Home Energy Efficiency Contractor Training Grants," among others.
- As the market continues to mature, established contractors and staff continue to gain valuable knowledge and experience.
- Energy Co-op of Vermont, VGS, and VT Energy's in-house apprenticeship programs have proven to be effective. They allow an employee to gain the knowledge and skills necessary under one roof by offering training and education as well as the ability to shadow experienced professionals.

Where is there Room for Enhancement?

- The need for a more thorough barrier to entry for amateur companies looking to begin installing and servicing. This could be an experience requirement and/or an exam with a variety of real-life situations in which the installer addresses complex thermal problems and described how they would handle them.
- Becoming licensed and certified on one's own is significant investment of time and money and requires time away from work. Providing financial support to help offset such costs may be needed to ensure sufficient properly trained and certified heat pump installers as market demand continues to grow.
- Established companies that offer in-house training and apprenticeship programs report needing support to scale. They take on the financial risk of training and licensing a new employee or apprentice. This discourages companies with existing apprenticeship programs from scaling rapidly because of the cost of the licensing and certification process, and an employee has the freedom to leave a company whenever they please. An initiative that removes some of the financial burden on companies by offering financial incentives or reimbursement for employers that train workers and pay for their licensing could help address this.
- Inconsistent knowledge about proper installation and servicing. An updated and consistent curriculum in trades schools and licensing programs addressing proper installation, servicing, and usage practices could help address this.

- Inconsistent pricing among similar projects. Future EM&V of programs providing ratepeyar and/or public support for heat pump installations may choose to monitor this issue and determine if any additional consumer education and outreach or heat pump program design and implementation approaches are needed to ensure fair pricing practices across the market.

Policy and Regulatory Framework

The policy and regulatory framework affecting the advancement of heat pumps in Vermont was previously discussed to provide context for how various programs have developed in support of reducing Vermont's GHG reduction requirements. Vermont is fortunate to have a variety of strong climate action and clean energy polices, legislative mandates, and regulations intended to achieve aggressive climate action and clean energy targets. Presented below is an assessment of what's working well and where there is still room for enhancement.

What's Working Well and Should be Continued?

- Through passage of the Global Warming Solutions Act, the establishment of aggressive, legally mandated, quantitative GHG reduction requirements in Vermont.
- The passage of the Affordable Heat Act intended to result in a sustained, orderly transition away from fossil fuels currently used for heating in most Vermont buildings
- Multiple state policies that incentivize key market players, such as Distribution Utilities, to be proactive in incentivizing a shift away from fossil fuels and towards electrification that is generated from carbon-free fuels
- State policy that sets quantitative goals for electricity to be primarily sourced from renewable energy sources to ensure increased electrification of buildings (and transportation) directly result in a reduction in fossil fuel usage

W***here is there Room for Enhancement?***

- Putting in place new policy levers and/or making program design and implementation adjustments aimed at addressing potential heat pump underutilization and ensuring that incentives are delivering the desired GHG reductions in practice.
- While it is hoped by climate action and clean energy advocates that the program design and implementation plan for achieving the Affordable Heat Act currently under development by the Vermont PUC will receive the required legislative approval in 2025, it is not certain that will occur. This is a huge policy and regulatory issue that will need to be carefully watched and worked on aggressively in order to achieve approval. If what the PUC recommends does not receive legislative approval, it will be very difficult to achieve Vermont's legally-binding GHG reduction targets within the timeframe mandated by the Global Warming Solutions Act.

- As the market for heat pumps continues to expand and mature in Vermont, there may be need for new policies and/or regulations not foreseen at this time to help stimulate market uptake and ensure high quality installations through increased training and/or certification of installers. (This was the case, for example, during ramp up of solar electricity markets in the US starting about 30 years ago. As consumer awareness and demands started to grow, leading program design and implementation professionals began requiring customers seeking solar incentives funded by ratepayer and/or public monies to use only NABCEP-certified solar installers for their new solar installation. This helped ensure a minimum and consistent level of training for solar installers and helped ensure well-designed and installed solar systems.) Public policy advocates, trade associations, and other climate and clean energy professionals may be key in helping to identity such needs and recommend new policy or regulatory solutions not yet contemplated or understood to be needed at this time as the heat pump market continues to expand. Vermont has a long history of working collaboratively and strategically engaging multi-stakeholders with varying self-interests to achieve effective policy solutions. That history and those skills may well be needed in the future in order to achieve the full market potential of heat pumps in the state.

Conclusion

Both consumers and the many public and private sector entities involved in climate action and clean energy in Vermont benefit from over two decades of thoughtful and strategic development of effective policies, regulations, and programs delivering energy efficiency and a range of clean energy technologies to the market. As a result of recent interest in strategically electrifying buildings in the state, Vermont currently has a collection of heat pump rebate and incentive programs offered by Burlington Electric Department, Efficiency Vermont, Vermont Gas Systems, and Washington Electric Cooperative. Periodic evaluation, measurement, and verification is starting to be done of the programs. Such analysis is resulting in real-world results and data that can help inform continuous improvement in future program design and delivery approaches. In addition, ongoing assessments are being done of the market uptake of heat pumps, the results of which can be used to identify market segments not being reached or served well through existing initiatives around the state. Moving forward, periodic review of heat pump rebate values will be needed, and rebate values will likely need to be adjusted periodically, based on actual market activity at that time.

As with any market still in the early stage of adoption, it is starting to become apparent there are unrealized opportunities for expanded partnerships in marketing efforts promoting heat pumps as a cost-effective, energy efficiency alternative to heating with fossil fuels. Such efforts could be

especially helpful for small, locally focused contractors who may not have the time, expertise, and/or financial resources to do their own heat pump marketing and advertising. An increased focus on ensuring consumers are aware of the benefits of using heat pumps for heating as well as cooling appears to be needed to ensure heat pumps are contributing to the reduction of GHG emissions for those using fossil-fuel-based heating. Rebate programs likely will need to adjust their approaches and/or incentives levels in order to help ensure heat pump users are benefiting from both their heating and cooling capabilities. In addition, it is important that attention be paid to heat pump market uptake statewide, especially in more rural areas and those locations known to have substantial low- to moderate-income households. New approaches and initiatives may be needed to address any inequity in access to cost-effective, affordable, high performing heat pumps for all market segments, especially low to moderate income households.

Key Takeaways

1) **Watch for and address potential underutilization** - Vermont cannot achieve its greenhouse gas reduction requirements if heat pumps are not effectively displacing fossil fuel use. Further evaluation, measurement, and verification analysis is needed to better understand statewide usage trends to solve this issue.
2) **Continue rebates and incentives** – Rebates and incentives are a key driver for the market and need to be sustained to achieve market maturation and the desired uptake of heat pumps.
3) **Listen to "boots on the ground"** - The installers are the people doing the actual work, handling the technology, understanding consumer needs and desires, and experiencing the workforce issues. They need to be involved in continuous program review. They need to have their needs, challenges, and inside perspectives on the market listened to and heard by those design the programs that bring the rebates to market.
4) **Use verified heat pump output values -** Future models and forecasts should use real-world heat pump performance metrics to help ensure realistic expectations about "real **world" performance. One approach could be creating situational modeling that shows consumers how different heat outputs, weatherization levels, and overall level of building efficiency can have on the cost-effectiveness heat pump technology. This could help reduce the possibility of setting consumers expectations too high if only the best-case values are used for heat output, weatherization levels ex.**
5) **Consider developing collaborative marketing approaches for use by small, local "boots on the ground" heat pump installers -** It is important for consumers to hear from both the installers and rebate providers. VT Energy and SunCommon are examples of companies that have executed very successful heat pump marketing campaigns. However, smaller companies may not have the resources to do that on their own.

6) **Provide support to employers for providing apprenticeships and training for employees –** A few established HVAC contracting companies in Vermont have implemented and run successful heat pump apprenticeship programs. They allow for inexperienced employees to obtain the necessary training and licensing on the company's dollar while having consistency in work and the ability to work alongside established expert installers. Such companies have expressed the need for financial support in order to continue to train and license employees.
7) **Maintain a strong focus on equity -** It is important to keep an eye on how effective heat pump program offerings are in reaching low- to moderate-income households to ensure they are receiving a just opportunity to be a part of the transition to heat pumps.
8) **Ensure a successful user journey and experience -** It is essential that realistic expectations are set for a consumer and those expectations are met, sustaining a satisfied customer base.
9) **Achieve positive media and outreach on heat pump technology's capabilities -** Inaccurate and misleading news reports on a technology's capability can harm widespread acceptance and disadvantage effective word of mouth advertising.
10) **Promote the "set it and forget it" method -** Installers need to be up to date on the best usage practices for heat pumps and effectively communicate that knowledge to their customers.

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Appendix

Heat Pump Market Ecosystem Map