Heat Pumps Are Like Bulletproof Vests and Other Lessons Learned from a Pilot Evaluation

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ABSTRACT

Advances in air-source ductless heat pumps have created new opportunities for energy efficiency as households in cold weather climates can now effectively use this technology for both heating and cooling. The introduction of this technology to homes in cold weather climates that rely primarily on fuel oil for heat poses several interesting concerns for the grid (potential load growth as a result of fuel switching) and benefits for customers (reductions in household energy costs and greenhouse gases). This paper describes the efforts to institute a ductless heat pump program by one Maine electric utility. This utility designed a program that incorporated these concerns into the program design and on-going evaluation, providing $600 rebates and optional on-bill financing for qualifying ductless heat pumps. Interestingly, while most heat pump programs are aimed at saving electric energy by replacing less energy-efficient cooling equipment or baseboard electric heat with more energy-efficient heat pumps, this program is intended primarily as a fuel-switching program that offsets more expensive fuel oil heating with a less expensive electric heating source.

This paper summarizes the results of the impact and process evaluation and the lessons learned by the research team during the two-year research period. These lessons are applicable to any utility considering how air-source ductless heat pumps can offset existing heating systems. These lessons include: (1) the impact of a fuel-switching on customers' energy costs and peak demand (2) measurement of market transformation efforts, (3) the benefits of offering on-bill financing to customers, and (4) the inherent difficultly of assessing impacts of fuel-switching programs that offset fuel oil and other non-metered fuels.

Importantly, our analysis identified significant variation in the usage of the heat pumps during the heating season. As such, the research team explored customer behavior during the heating season via in-depth interviews and in-person case studies. This qualitative analysis, combined with real-world metered data, revealed patterns in how customers operated their heat pumps alongside their pre-existing heating system. These findings will help other program administrators design programs that meet their unique regulatory requirements, market needs, and customer demands.

Introduction

In Maine, heat pumps are a new potential heating source for a population that already relies on multiple heating sources (e.g., boilers and furnaces, wood pellet stoves, fireplaces) to heat their homes. According to the U.S. Energy Information Administration, more than 7 in 10 homes in Maine use fuel oil for their primary heating source.[1] The introduction of this technology in climates that rely primarily on fuel oil for heating poses several interesting concerns for the grid (potential load growth as a result of fuel switching) and benefits for customers (reductions in household energy costs and greenhouse gases). With the energy efficiency and HVAC communities, various organizations have commissioned numerous studies that address these concerns, summarized in a Northeast Energy Efficiency Partnership's "Ductless Heat Pump Meta-Study."[2] In general, this meta-study concluded that ductless

[1] U.S. Energy Information Administration. 2015. "Maine Profile and Energy Estimates." http://www.eia.gov/state/analysis.cfm?sid=ME

[2] Faesy, R., Grevatt, J., McCowan, B., and Champagne, K. 2014. *Ductless Heat Pump Meta-Study.* Prepared for Northeast

heat pumps are capable of delivering heat up to -20°F at up to 60% of their rated output. However, the same study noted that market barriers still exist; including increased incremental cost, lack of awareness, and lack of qualified contractors.

This paper contains the results of an evaluation completed by EMI Consulting of the Emera Maine Heat Pump Pilot Program[3]. It includes the findings from a comprehensive evaluation of the program's impacts on energy costs and peak load. It also includes findings from our assessment of the program's processes. Finally, the paper documents the lessons learned by EMI Consulting during the evaluation research.

The Heat Pump Pilot Program provided $600 rebates and optional on-bill financing for qualifying ductless heat pumps installed in residential homes and small commercial buildings of Emera Maine customers. Emera Maine launched the pilot in November 2012 and it was fully subscribed with a 1000 participants by October 2013. As a result of the pilot, Emera Maine coordinated with Efficiency Maine to launch a full-scale ductless heat pump program. To qualify for the pilot program, participants were required to have:

- been an Emera Maine residential or small business customer; [4]
- used oil, propane, electric resistance heat, or kerosene as a primary heat source;
- spent $1,400 or more on heat annually; and,
- purchased a qualifying heat pump.

The program also paired the rebates and on-bill financing with a number of additional program activities - such as marketing, contractor program training, participant referrals, and contractor registration - all aimed at reducing the barriers to customers purchasing and installing energy-efficient heat pumps to offset heating load from other fuel sources, such as fuel oil. According to the program theory, the primary objective of the Program was that customers would realize an overall reduction in energy costs by purchasing energy-efficient heat pumps. In addition, they would also benefit from non-energy impacts such as increased comfort and indoor air quality.

In pursuit of these objectives, the program undertook six main activities to help overcome four specific barriers identified in the heat pump market (lack of heat pump awareness, lack of information regarding installers, large up-front costs, and limited access to capital). These main program activities involved Emera Maine providing:

1. Marketing and outreach to customers
2. Marketing and outreach to installers
3. An online registry provided by Efficiency Maine for heat pump installers
4. Rebates to customers who installed qualified heat pumps
5. On-bill financing for qualified heat pump purchase and installation costs
6. Referral credits for participants who refer other customers to the pilot program

Methodology

The overall objectives of this research were to determine the impact of the Program on participating customers' overall energy costs, and evaluate the effectiveness of the Program in achieving its desired outcomes. To address these objectives, the research team explored the following three research areas:

1. the program's impact on customer energy use, energy costs, and non-energy benefits;
2. the program's impact on the ductless heat pump market; and,
3. the effectiveness and efficiency of the program's processes.

Energy Efficiency Partnerships.

[3] EMI Consulting. 2014. *Heat Pump Pilot Program Final Report.* Prepared for Emera Maine, Bangor, ME.

[4] Only 38 small businesses participated in the pilot. The remainder of this paper focuses on results from residential customers.

To address these objectives, the research team collected and analyzed data from several sources. The research team conducted:

- Two telephone surveys with a sample of the general customer population. These surveys included 210 residential and 70 commercial customers and focused on identifying trends in awareness and knowledge of heat pump technology, determining the level of customer interest in program assistance through rebates and financing, and assessing the degree to which Emera Maine and Efficiency Maine are perceived as trustworthy and valuable sources of information. The research team fielded the first wave of this survey in January 2013. A second wave was fielded in January 2014, to assess changes in the heat pump market as a result of the program.

- Qualitative research with potential participants. This research included focus groups and in-depth interviews documenting customer perspectives on heat pumps and heat pump incentive programs, as well as testing the efficacy of program collateral through focused usability research. The research team conducted two focus groups with 18 customers, one group in each of Emera Maine's service territories. In addition, the research team conducted 10 in-person interviews with target customers to gauge their responses to heat pumps and potential program designs.

- In-depth interviews with heat pump distributors and installers. The research team conducted interviews with 5 distributors and 20 installers involved in the sale, installation, and distribution of heat pumps in Emera Maine's territory. During the interview, the research team queried distributors and installers as needed to better understand their perspectives on heat pumps and the market for this technology. The purpose of the distributor interviews was to collect data to inform the market baseline for high efficiency heat pumps. The purpose of the installer interviews was to understand their perceptions of how customers interact with heat pumps (e.g., what are their motivations, concerns, and questions) and their experiences with the program.

- Two online surveys with program participants, one conducted at the time of installation and another six months after installation. The research team invited all participants in the program to complete these surveys. Of those participants invited, 301 completed the first survey while 184 completed the second. The objectives of these surveys were to establish a technical profile of participants' homes and business to inform the impact analysis, as well as to understand participants' experiences after participating in the program.

- An analysis of participants' historical electrical billing and fuel oil usage data. These data included monthly electrical consumption data for a sub-sample of the program participants (n=64) and hourly meter data for a sub-sample of Emera Maine participants (n=36). These data were used to establish a baseline pattern of electric usage prior to the installation of the heat pump. In addition, the research team collected baseline fuel oil consumption data to determine any reductions in fuel oil usage, although these data were later deemed too unreliable to be included in the analysis.

- An analysis of data collected from in-home meters that monitored electricity usage minute-by-minute. These meters installed in 64 homes allowed the research team to isolate the usage of the installed heat pumps, and analyze their usage patterns. In addition, the research team

used these monitors to model usage of primary heating sources (e.g., furnaces, boilers) by metering electric load as a proxy value for equipment run-time.

- In-depth interviews with 29 program participants, including 10 on-site interviews in participant's homes. These interviews explored how participants used their heat pumps in relation to the data collected by the in-home meters described above. These data allowed the research team to identify behaviors among participants that contributed to the variation in heat pump performance. A critical aspect of these interviews was discussing behaviors that lead to either relatively high or relatively low heat pump usage.

Results

Impact on Household Energy Costs

Normalized for an average Maine winter using typical meteorological year data (TMY3), participants saved on average $598 dollars in energy costs *by* using the heat pump to partially offset the use of more-expensive fuel oil. These savings are the result of $400 worth of electricity use offsetting $998 worth of fuel oil. Table 1 below details the breakdown of how the reductions in fuel oil use offset the increased electricity consumption and provide net savings to individual households.

Table 1. Impact on Overall Energy Costs for a Typical Weather Year

Season [a]	Energy Use Parameter	Average Heat Pump Use	Avoided Fuel Oil Use	Estimated Savings
Heating (n=51)	Estimated Average	2387 kWh	239 gallons	
	Per Unit Rate	$0.13	$3.90	
	Savings	($310.31)	$932.10	$621.79
Shoulder (n=38)	Estimated Average	163 kWh	17 gallons	
	Per Unit Rate	$0.16	$3.90	
	Savings	($26.08)	$66.30	$40.22
Cooling (n=51)	Estimated Average	398 kWh	N/A	
	Per Unit Rate	$0.16	$3.90	
	Savings	($63.68)	-	($63.68)
Total		**($400.07)**	**$998.40**	**$598.33**

a. Heating Season: October, November, December, January, February, March, April; Shoulder Season: May, September; Cooling Season: June, July, August

To calculate non-normalized heating oil reductions, the research team applied values for heat pump efficiency and the heating value of fuel oil (BTU/gallon) to the heat pump energy use to estimate the equivalent number of gallons represented by this heat pump use. The research team then used the TMY weather data to estimate weather-normalized electricity impacts resulting from the heat pump installations by season. Note that the research team was not able to directly measure reductions in fuel oil usage as part of this study due to logistical limitations with taken fuel oil measurements and questionable fuel oil record data. As such, a key limitation of our approach was that the research team's analysis assumed that the overall heating load of the household remained constant between the pre and post-period. To mitigate the impact of this assumption, the research team eliminated homes from our analysis that experienced external changes that would significantly impact the heating load (e.g., changes in occupancy, major renovations outside of the heat pump addition, long term vacancies).

Overall, participants' use of the heat pump increased their annual electricity consumption across

all seasons by 2,947 kWh (which includes the additional cooling load). As such, the research team's model shows that participants' average annual energy costs decreased by $598.33 as the increased cost of cooling offset savings realized during the heating season.

Variation in Usage

In addition, the research team found considerable variation in the electricity usage of the heat pumps installed under the program, ranging from 342 kWh to 7,372 kWh in the one year period from June 2013 to May 2014. As the in-depth interviews with 29 participants revealed, this wide variation was often driven by differences in how households chose to operate the heat pump their pre-existing heating sources. Table 2 summarizes the patterns the evaluation identified during these interviews.

Table 2. Reporting Period Usage and Heat Pump Operational Characteristics

Heat Pump Usage Level	Operational Characteristics	Typical Heat Pump Thermostat Setting (°F)
Low (less than 300 kWh/month) (n=3)	Manually operated their heat pump, turning it on or off when needed throughout much of heating season	Less than 70˚
Moderate (300 - 900 kWh/month) (n=27)	Allowed thermostat to control heat pump so that it ran automatically, but relied on pre-existing heating sources to heat other living household spaces	70˚-72˚
High (over 900 kWh/month) (n=21)	Allowed thermostat to control heat pump so that it ran automatically, but adjusted pre-existing heating sources	74˚ or higher

The lowest users (those that used less than 300kWh per month during the peak-heating season, December-March) did not operate the heat pumps effectively. These participants often set their heat pumps to "manual," and when in use set the thermostat to a relatively low temperature. Two of the lowest users reported that they manually run and shut down their heat pumps as needed for localized heat in the house. Both explained that they do not run their heat pumps in conjunction with their home furnaces, and were frequently not sure which to use. These users often conflated their new electric heat pumps with past relatively inefficient electric heating sources (e.g., electric baseboard) and as such, avoided operating the heat pumps unless exceptional circumstances called for additional heat (e.g., guests, extreme outdoor temperatures). When in use, the heat pump thermostats were set to 66˚ and 70˚F. Another participant was an extremely frugal energy user who turned off all heat sources while out of the house for over twelve hours every weekday. Additionally, he reported keeping his home at 63-65˚F when home, the lowest reported in the interviews. Finally, one participant only ran the heat pump almost exclusively during the shoulder season, and shut it off completely from December through February, instead relying on a wood stove furnace. This participant also reported setting the thermostat to 66˚F.

Moderate users (participants that used between 300kWh and 900kWh per month during the peak-heating season) differed from the lowest heat pump users as they generally reported leaving their heat pump thermostats set throughout the vast majority of the heating season. However, these users did not fully rely on their heat pumps and used pre-existing heating sources in addition to the heat pump to heat their home. These participants described using the heat pump to heat a core area of the house and allowing the furnace to pick up the heating load in other parts of the house, often running them simultaneously. These customers also reported that due to the configuration of their home, the single zone heat pumps have difficulty heating every conditioned space. As such, low heat pump usage may be caused by the pre-existing heating source increasing the ambient air temperature near the heat pump and shutting it off. Like the lowest heat pump users, customers in this group also generally set their thermostats to a low temperature; a majority at or below 72˚F. Despite these limitations, as mentioned

above, heat pumps were still able to reduce overall energy costs.

High users (participants that consumed over 900 kWh per month during the peak-heating season) took advantage of the heat pump thermostat and relied on the heat pump as the sole source of heat, except in periods of extremely low outside temperature. To accomplish this, the participants coordinated thermostat settings between the heat pump and the pre-existing heating source so that the thermostat for the pre-existing heating source was set 10F˚ degrees lower than the heat pump. This strategy ensured that the household relied on the heat pump for primary heating without constant monitoring or intervention. In addition, high users kept their homes warmer than other participants; a majority reported keeping their heat pump thermostats set at 74˚ or higher. Note that participants often set their heat pump thermostats at temperatures higher than the desired ambient temperature to remain comfortable depending on the placement of the heat pump and the corresponding thermostat.

Peak Demand Analysis

Our research shows an increase in summer and winter peak demand of 0.14 kW and 0.35 kW respectively as the heat pumps created an additional source of electricity demand (offsetting fuel oil as the primary heating fuel and increasing summer cooling load) for many participants. Using hourly-interval regression models, the research team was able to normalize the heat pump usage data and isolate the change in electricity demand due to the program heat pumps for both summer and winter peak periods. These regressions were based on data from both the baseline period (using monthly billing data) and the reporting period (using minute-by-minute metered data) and included variables to capture the change in energy consumption after the installation of the heat pumps. The regressions also included variables to model the relationship between weather conditions and electricity consumption, both before and after the heat pumps were installed. These variables include daily electricity usage, cooling degree days, heating degree days, household size (in square footage) and the presence of a pre-existing air conditioning unit.

For this analysis, the research team used demand resource on-peak hours for the ISO-New England Forward Capacity Market as the peak hour definitions. The ISO-New England Forward Capacity Market hours are defined as non-holiday weekday hours between 5:00 PM and 7:00 PM during December and January (winter), and between 1:00 PM and 5:00 PM during June, July, and August (summer). The results of this analysis are shown in Table 3 below.

Table 3. Predicted Summer and Winter Peak Impacts per Heat Pump, Normalized (n = 35)

	Summer Predicted Mean Value	**Winter** Predicted Mean Value
Baseline Period	0.85 kW	1.32 kW
Reporting Period	0.99 kW	1.67 kW
Absolute Increase	+0.14 kW	+0.35 kW
90% Confidence Interval (+/-)	.02 kw	.015 kW
Relative Increase	16%	27%

Summer Resource On-Peak Analysis. As mentioned in the previous section, the overall trend for participants was an increase in demand of 0.14 kW during peak summer hours. Looking more granularly at the data, the results can be broken out by households with and without pre-existing air conditioning. For participants without previous air conditioning equipment, demand increased by 0.20 kW during peak hours. For participants with previous air conditioning equipment, demand increased less due to customers already having a cooling load, only increasing by 0.07 kW during peak hours. Among all participants, demand in the Reporting Period was higher than in the Baseline Period by 0.14 kW during peak hours.

Table 4. Modeled Cooling Demand Impacts: Average Normalized kW (n=35)

Status	Baseline Period Mean (kW)	Reporting Period Mean (kW)	Change in Demand
No previous A/C	0.80	1.00	0.20
Previous A/C	0.90	0.97	0.07
All	**0.85**	**0.99**	**0.14**

Winter Resource On-Peak Analysis. Similar to the summer demand analysis, the heat pumps contributed to an increase in the peak winter demand. For the seasonal winter peak hours, program participants increased their electricity demand by .35 kW, a relative increase of 27% over the baseline demand. The research team determined an average hourly demand during the baseline period of 1.32 kW and an average hourly demand during the reporting period of 1.67 kW. Based on our modeling, the difference between these two values is attributable to the installation and operation of the program heat pumps. For our analysis, the research team used the ISO-NE nominal peak, which is between 5 and 7 PM in December and January.

Heat Pump Market Effects

Given the 12-month timeframe included as part of the evaluation, market indicators show that the program is having a positive impact on the heat pump market, overcoming awareness barriers regarding the effectiveness of heat pumps as a supplemental heating source in Maine. Research indicates that:

- Among the general population, awareness and knowledge of heat pumps increased from 19% to 35% over the year.
- Per distributors, the market share of energy efficiency heat pumps sold in Maine increased from 50% to 64% over the year.

However, other data provided inconclusive evidence regarding the uptake of heat pumps among residential customers. Based on our survey sample of residential customers eligible for heat pumps, there was no statistically significant change in the number of homes with heat pumps installed. However, sales data from distributors indicated that heat pump installations in Maine have increased dramatically over 2013.

Customer Experiences

In general, participants reported very positive experiences with the program, indicating that "behind the scenes" processes did not present a barrier for participation. In order to better understand how the program may improve engagement with future participants, the research team examined several aspects of the customers' experience, including:

- Awareness of the program and heat pump technology
- Motivations for participating
- Participant satisfaction with the Program
- Experience with program financing

Awareness. As noted above, because the program was a new offering for Emera Maine, it initially faced a challenge in educating potential participants about its offerings. Respondents first learned about the program through a friend or family member (26%), a flyer with a bill (19%), or through a HVAC vendor or contractor (12%).

Motivations. Program participants primarily installed their heat pumps to save money on their

heating expenses, but for some respondents, the ability to use the unit for air conditioning also seems to have factored into the installation decision. The vast majority of survey respondents (81%) said saving on heating expenses was their primary reason for installing a heat pump. **Figure 1** summarizes the primary and secondary reasons respondents chose to install a heat pump.

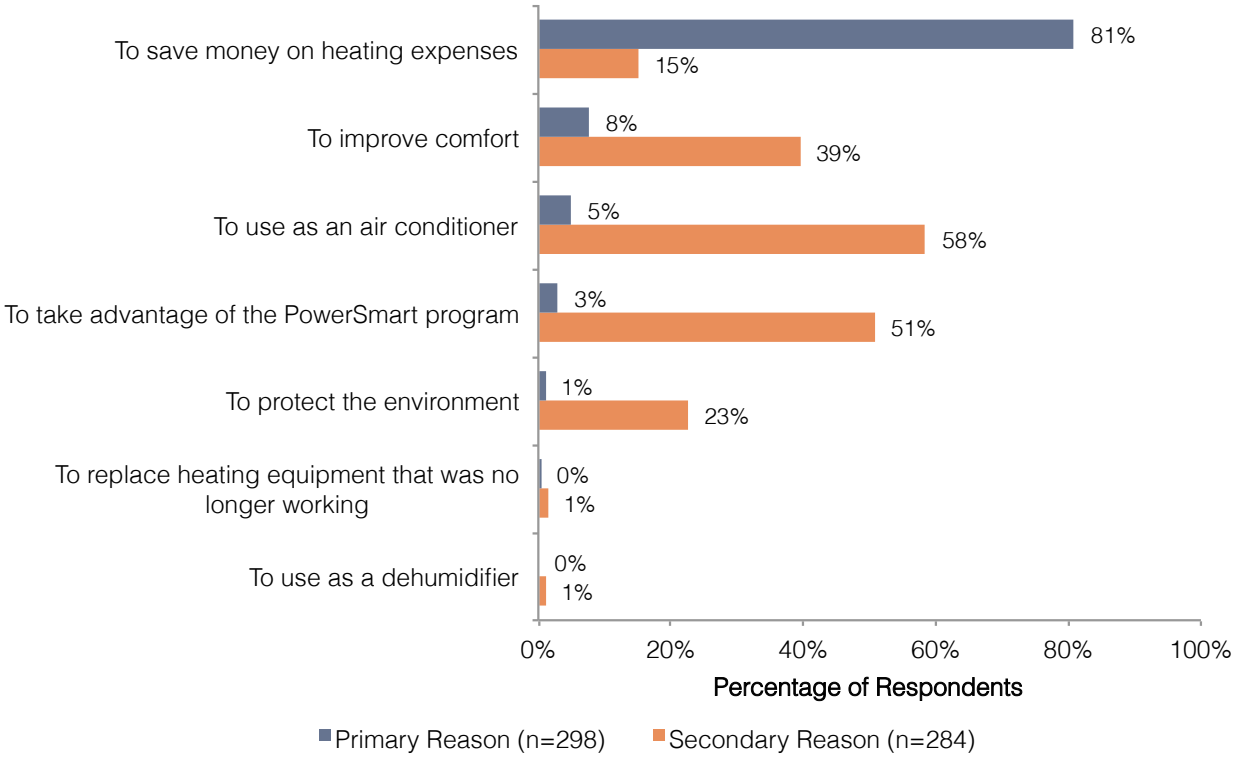

Figure 1. Reasons for Installing a Heat Pump

A common secondary reason for installing a heat pump, cited by 51% of respondents, was "to take advantage of the program." These responses indicate that the program provided a meaningful rebate amount that encouraged participants to purchase the heat pump. While only 5% of respondents said they installed a heat pump *primarily* for air conditioning, more than half (60%) indicated that this feature was among their reasons for choosing a heat pump. Among the 15 respondents who installed a heat pump mainly for air conditioning, eight (53%) had some kind of air conditioning equipment prior to installing the heat pump. This proportion is not significantly different from the overall portion of respondents who had air conditioners before installing a heat pump (51%).

Satisfaction. Overall, participant satisfaction with the program was quite high. This indicates that customers found value in the program, and that the program operated smoothly from a customer experience perspective. Based on responses to an online survey with 184 participants, participants reported that they were very satisfied with the program (85% very satisfied), the heat pump (85% very satisfied), and the savings they have seen (78% of participants noticed savings and 83% of those who noticed savings were very satisfied with the amount of savings). In addition, on average, respondents rated the likelihood that they would recommend the Program a 9.7 on a 0 to 10 scale. This is indicative of high levels of satisfaction with the program and participants' experiences with the heat pumps.

Contributing to this satisfaction, participants in the program reported experiencing significant non-energy benefits, including increased comfort during the heating and cooling season and better air quality in their homes (as reported by participants). When asked, 55% of participants reported that their comfort level during the heating season had increased. Likewise, 88% of participants reported increased

comfort during the cooling season, suggesting that many participants appreciated the cooling and dehumidification capabilities of the heat pump.

Financing. While financing was not a major driver of program participation, it did play some role in allowing potential participants access to the capital needed to purchase and install a ductless heat pump. Overall, 27% of respondents reported using some kind of financing to make their heat pump purchase and about half of these participants took advantage of the on-bill option offered through the Program.

The appeal of the on-bill financing option was mostly due to its ease of use. Of those who used the on-bill financing option, most (24 of 40, or 60%) reported that they chose to take advantage of that option because the utility's application process was easier than other options. Many also indicated they preferred to make their loan payment with their electricity bill (43%) or that on-bill financing was the best option available in terms of interest rates and fees (40%). Roughly a third of these respondents (31%) said they had also considered other financing options before choosing the on-bill option. The most frequently mentioned other financing options considered included (non-specific) bank or credit union loans, credit cards, and home equity loans.

About three-quarters (76%) of the 261 respondents not receiving on-bill financing did not require a loan to proceed with the heat pump purchase, while some (15%) had access to a loan at a better rate. A small portion of respondents (8%) reported they were unaware that such financing had been available to them[5], and only six respondents (2.5%) said they did not qualify for on-bill financing. Of those not receiving on-bill financing, 42 respondents (16%) did finance their heat pump purchase through another source. The most common type of financing was a home equity loan, a (non-specific) bank or credit union loan, a credit card, or a loan from a contractor.

Conclusions

As a result of our research and analysis, the research team drew four significant conclusions regarding the Emera Maine Heat Pump Pilot Program:

1. **Ductless heat pumps are a viable heating technology for cold weather climates such as Emera Maine's territory.** Our analysis of heat pump electricity usage and the participants' experience concluded that, with a back-up heating source, heat pumps can effectively supplement the heating load for residential customers throughout the Maine winter.
2. **Increased use of heat pumps results in increased cost savings.** Participants that previously heated their homes with fuel oil and frequently used their heat pumps for heating were able to successfully offset fuel oil usage and significantly reduce their heating energy costs. However, given that previous electric heating sources tended to be inefficient, some participants remained skeptical and limited the use of their heat pumps. These participants did not offset as much fuel oil use, and therefore limited their energy savings.
3. **Customer education regarding strategic use of their heat pumps is key to maximizing cost savings.** Given that heat pumps were often an additional heating source to participants' homes (instead of replacing a heating system), customers needed to manage both the heat pumps and a pre-existing heat system (or systems) in tandem. Per the research team's analysis, the participants who were most effective at reducing their energy costs controlled their heating systems so that their heat pumps would act as the primary heating system (often via coordinated thermostat settings). However, not all participants were aware of this strategy, and could have benefitted from education and training from either contractors or the pilot program (either via staff or educational materials).

[5] Of these 21 respondents, only 1 said they would have been interested in such financing had they known of it.

4. **Single zone heat pumps have difficulty fully replacing a multi-zone system.** Regardless of the strategies employed by participants, single zone heat pumps have difficulty heating every conditioned space in a residential home. Often the heat pump could effectively heat a single floor (given conducive floor plans), but a single unit could not reliable heat several floors or isolated spaces. Despite these limitations, heat pumps were still able to reduce overall energy costs.

In addition, we have three recommendations for future programs intended to encourage residential customers to install ductless heat pumps:

1. **Educate participants regarding heating strategies.** Unlike many energy efficiency technologies, the installation of ductless heat pumps as supplementary heating sources requires a shift in heating behaviors on the part of customers in order to achieve the desired savings. Given the array of heating options available to homeowners (especially in Maine), we suggest that future programs support participating contractors as they work to educate customers regarding heating strategies that will maximize their savings.
2. **Coordinate with heat pump distributors regarding advancements in multi-zone cold weather units.** Heat pump technology continues to advance at a rapid pace and this study was focused on single head ductless heat pumps. For future program designs, program staff should coordinate with manufacturers and distributors to examine the potential of multi-head units. Implementation of these units would likely address many of the challenges detailed above.
3. **Conduct additional research regarding the potential for ductless heat pumps in fuel-switching programs.** Throughout this research, the research team encountered significant limitations when measuring actual reductions in fuel oil usage. We encountered significant logistical challenges when attempting to directly measure of fuel oil levels and usage. Ultimately, this approach was not included in the study design. In addition, the research team was concerned with the accuracy of the fuel oil purchase records provided by participants and fuel oil vendors. Instead of relying on these data to inform fuel oil reductions, the research team used these data as a secondary, corroborating source with our reduction model.

In conclusion, based on the results of this research, Emera Maine, in consultation with Efficiency Maine, declared the pilot program a success. Both Emera Maine and Efficiency Maine used the results from this analysis to launch a full-scale ductless heat pump program for households and small businesses in Maine. More information regarding the current program is available at the Efficiency Maine website (http://www.efficiencymaine.com/heat-pumps/).