Packaged Window Pump Insights in Income-Eligible Multifamily Programs

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ABSTRACT

Traditional decarbonization solutions in Massachusetts (MA) multifamily buildings often involve comprehensive engineering-to-design variable refrigerant flow (VRF) systems. As a lower-cost alternative, packaged window heat pumps (PWHP) are emerging as a viable option offering reduced complexity, labor, material requirements, and implementation time. Therefore, PWHPs may present a more accessible pathway for electrification across the 686,000 multifamily customers in MA.

To assess the implementation and market scalability of PWHPs, this paper presents a field study of an income-eligible multifamily building in Hyde Park, MA, consisting primarily of studio and single-bedroom units heated exclusively by electric baseboard. Each unit is retrofitted with a single PWHP unit in the main living area and paired with a third-party smart thermostat that integrates control of both the PWHP and existing baseboard heat. This setup enables displacement and optimization of baseboard heating, while maintaining backup heating capability for below design day conditions via outdoor temperature reset control

The study examines purported manufacturer performance claims, installation cost and labor time, customer expectations (including tenants and property owners), equipment sizing relative to design-day conditions, and optimization of switchover temperatures in respect to decarbonization and customer utility bill savings. Findings from this project will provide insight into the feasibility and scalability of PWHPs as a competitive alternative to VRFs and mini-split systems in multifamily buildings, and the potential implications for energy efficiency programs.

Introduction

Mass Save® is a collaborative of Massachusetts' electric and natural gas utilities and energy efficiency service providers including Berkshire Gas, Eversource, Liberty, National Grid, and Unitil (collectively known as the Mass Save Sponsors or, sometimes, as the Program Administrators), who jointly administer the Mass Save programs. Mass Save is the brand name for a comprehensive set of programs, administered by the Sponsors within each of their own service territories. Eversource, as one of the Mass Save Sponsors, is responsible for equitably delivering energy and greenhouse gas emissions savings for residents, businesses, and communities in its service areas, which includes Mattapan, Massachusetts.

In the Massachusetts 2025-2027 three-year plan the Program Administrators (Pas) have committed to investing $4.5 billion in program funds to support statewide decarbonization goals (MassSave 2024). This investment supports the installation of heat pumps in over 119,000 homes, weatherization in 184,000 homes, reduction of GHG emissions by 1 million metric tons in 2030, and delivery of 8.3 million kWh in energy savings, including targeted initiatives designed to ensure equitable access to program benefits (MassSave 2024).

In a high-level perspective, Massachusetts's multifamily residential segment inventories 127,928 buildings encompassing 686,204 unique customer accounts (DNV n.d). Collectively this building stock consumes approximately 19.3 million MMBtu of gas and 3.2 billion kWh of electricity. This equates to approximately 2.38 million metric tons (MMT) of potential decarbonization savings[1], which represents a significant opportunity for statewide emissions reduction.

As both a partner in this project and a long-standing leader in advancing energy efficiency in the city, The Boston Housing Authority (BHA) recognizes its role as one of Boston's largest residential utility consumers. In 2014, its measured annual consumption included approximately 90 million kWh of electricity, 1 million MMBtu of natural gas, 250,000 gallons of #2 heating oil, and 90 million cubic feet of water (BHA 2014). As part of its current strategic sustainability plan, the BHA has set ambitious goals to reduce energy and water use, with a projected reduction potential of 53,750 MMT of emissions (BHA 2023). In realizing the goals, key objectives include eliminating fossil-fuel use by 2030, upgrading buildings to support decarbonization, implementing renewable energy technologies, and accelerating the adoption of high-efficiency equipment.

Although mini-split heat pumps (MSHP) and variable refrigerant flow systems are common practice within the programs, many multifamily customers face a variety of constraints including but not limited to project cost, installation timelines, and electrification barriers that limit the feasibility of a more comprehensive electrification strategy.

Therefore, packaged window heat pumps (PWHPs) showcase a promising alternative pathway for building electrification and decarbonization. These systems offer a simpler, more affordable option where traditional MSHP and VRF installations may be disruptive, space-constrained or prohibitively expensive. Depending on the complexity of the fenestration details, many manufacturers claim a rapid installation time of under 30 minutes, which makes them highly appealing. In addition, many PWHP models are designed in alignment with the Consortium of Energy Efficiency's cold climate performance specifications which support reliable operation at near design day conditions throughout the Northeast region.

Study Objectives

This field study aims to explore the technical feasibility and programmatic implications of PWHPs in income-eligible multifamily buildings. The research presented in this paper discusses qualitative and observational aspects of the technology in a step-by-step perspective for other utilities and implementors to understand the technical risks, barriers to adoption, level of program support, and other topics to develop a more comprehensive program offering and strategy. Because of unforeseen implementation delays, some early measurements and verification data are pending completion, but some technical performance data is presented in this paper at a high-level. Overall, the study seeks to answer the following questions:

- What implementation barriers arise when deploying PWHPs in income-eligible multifamily buildings?
- What logistical, behavioral, or other external factors influence overall performance and realized savings? How do programs overcome these challenges?
- What program design elements in equipment eligibility, bidding, and control strategies are necessary to support scalable adoption of PWHPs?

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[1] Massachusetts specific carbon emission values of 0.424 mT per MWh for electricity and 0.06354 MT per MMBtu for fuel

Benchmarking and Energy Modeling

Hassan apartments is a four-story multifamily building that features 100 dwelling units residing on 2.05 acres of land. Built in 1975, it features 55 studios, 40 one-bedroom units, and 5 two-bedroom units (Byerley and Ferguson 2021). The site has master-metered electric service, but no natural gas, delivered fuel, nor renewables, excluding an onsite generator used in the event of an emergency. As its main heating system, each unit features baseboard electric heat controlled by original line-voltage wall thermostats. Studio, one-bed, and two-bed units feature one, two, and three thermostats respectively for each thermal zone. Lastly there are common spaces and administrative offices on the first floor, and coin-operated shared laundry centers on each floor.

Overall, the site consumes an annual 1,364,084 kWh in energy on average, where heating and cooling represent 639,234 kWh and 27,561 kWh respectively. This equates to a site energy use intensity of 62.0 kBtu/ft^2 which is within the range specified by Energy Star's metric for multifamily residences at 59.6 kBtu/ft^2 (EnergyStar 2024). In its history the walls of the building were injected with spray foam via pinhole technology in 2023, which was modeled to save approximately 5% of its energy use. It is interesting to note that savings from the insulation estimates a modest decrease in energy consumption normalized by degree day for the heating load of 2022 to 2025, yielding 129.4 kWh/HDD to 123.3 kWh/HDD, representing a 4.7% decrease. In addition, the cooling load increased from 33.8 kWh/CDD to 38.5 kWh/CDD during the same period, representing a 13.8% increase, which is attributed to tenants installing additional window air conditioning systems.

Table 1. Modeled annual heating and cooling building energy consumption results in kWh in respect to heating and cooling degree day (HDD and CDD).

Year	2022	2023	2024	2025	Avg.
Total	1,365,360	1,222,200	1,338,717	1,530,060	1,364,084
Heating	623,870	591,200	498,121	685,380	639,234
Cooling	27,587	24,694	27,048	30,914	27,561
Base Load	637,833	606,306	775,922	769,096	697,289
CDD	816	1026	863	804	877
HDD	5411	4649	5111	5923	5273
Cooling/CDD	33.8	24.1	31.3	38.5	31.9
Heating/HDD	129.4	127.2	104.8	123.3	121.2

Manual J design results[2] for the one-bed (433 ft^2) and two-bed apartments (730 ft^2) yield latent heating loads of 8,036 Btu/h and 11,914 Btu/h, wherein the studio apartments are assumed to have a similar result to the one-bedroom units. Although the apartment features double-hung sliding windows, dimensions of the bedroom windows are too narrow to accommodate the product, so only the living room area with one (9,000 Btu/h) PWHP can be installed in each tenant unit. Because of this physical design constraint, energy modeling for the site models a partial-displacement scenario where a portion of the baseboard electric heat is displaced by the new equipment. Early energy saving models estimate that the project may conservatively yield 241,000 kWh to 222,000 kWh in electric heating savings, representing a 65% to 60%

[2] Analysis conducted with Boston weather zone 13°F design day, 70°F inside design temperature

displacement strategy of the net heating load. Lastly, energy savings for cooling were not considered significant since most of the tenants did not have a pre-existing cooling appliance to quantify with uncertainty a measurable and meaningful energy efficiency savings.

Code Compliance of Older Electrical Panels

Several primary challenges in older building stock such as Hassan includes (1) the presence of outdated and unsafe Federal Pacific panels equipped with Stab-Lok breakers, (2) limited breaker capacity, or (3) calculated electrical loads that approach or exceed the panel's allowable rating, as shown in Figure 1. Because contractors are generally risk-aversive when working on projects that calculated a generous increase in calculated electrical loads nearing the permissible limitations of the panels rating, projects detailing an MSHP scope often include additional costs for a panel upgrade.

As a necessary precaution recommended by the subcontractor, official city inspectors were consulted prior to permitting on the compliance of the incumbent panel rating in respect to the PWHP's electrical requirements for an available 120-volt appliance outlet; so, they do not need an additional breaker or a dedicated circuit. Based on that review, the existing Federal Pacific panels were allowed to remain in place because they were deemed sufficient based on calculated electrical and breaker loads. Similarly, the General Electric panels were also calculated within permissible limits of the National Electrical Code (NEC). In greater detail, studio units include circuits for a stove, hot water heater, kitchen receptacle, dining room receptacle, disposal unit, baseboard resistance heat, appliance receptacle, lighting receptacle, and two spare circuits. One- and two-bedroom units follow the same configuration but utilize the spare breaker slots for additional heating-zones. The calculated panel loads for these configurations ranged from 17.7 kVA to 21.1 kVA. Final calculations with the added PWHP load (of 1,500 VA) increases from 19.2 kVA to 22.75 kVA, which is below the panel's Federal Pacific's and General Electric panel ratings of rating of 24 kVA and 36 kVA respectively.

Figure 1. (Left) Federal Pacific Stab-Lok 12-space, and (Right) General Electric 16-space breaker panel.

Program Implementation Strategies

The Mass Save® Sponsors utilize a lead-vendor delivery model to facilitate and sub-contract work for the major steps in the project workflow, including but not limited to pre-inspection, energy modeling, installation, and post-inspection. Customers applying to the market-rate or income-eligible program are served with incentives and rebates that cover either the full cost in income-eligible, or a portion of the total cost in market-rate based on accepted statewide criteria for benefit-to-cost ratio. The lead-vendor contracts heat pump installers participating in the Mass Save programs to execute complex energy-efficiency strategies including MSHP, VRF, and weatherization. Therefore, adapting the lead-vendor model for PWHP systems may anticipate inflation to installed costs due to administrative overhead stacking, and misalignment of skilled labor for a technology that values general labor.

Training Housing Authority Staff

Although it has been suggested anecdotally by the PWHP manufacturers that two inexperienced people can complete the installation in less than 30 minutes, scaling efforts in multifamily require additional oversight. Two practical implementation strategies for multifamily programs identify two delivery-installation models: train housing authority maintenance staff or utilize the existing lead-vendor program partners. In part of this investigation, Eversource staff were invited by the manufacturer to observe a separate multifamily project at Lynn Apartments, where the manufacturer trained housing authority maintenance staff for the installation.

Figure 2. (Left) Bracket assembly also highlighting light carpentry work, and (Right) positioning equipment in window while maneuvering around furniture.

Crew composition for the installation in Figure 2 consists of four workers. Two individuals specialized in weather stripping and prefabrication of the mounting bracket. The other two individuals carried the 120+ lb. unit to the second floor but required additional assistance from a third individual to aid in final positioning in the window due to furniture placement.

In a time-of-flight study the installation measured an approximate 35-minutes of labor time, which can be reduced to less than 20-minutes if the bracket is pre-assembled. By estimating an average of 30-minutes, a 4-person crew yields a total of two crew hours. Because the installation costs are not known, this theoretical exercise models unskilled labor rates at a generous $50 per hour, for a total anticipated labor cost of $100 per window unit.

In addition to labor, material involved in this project includes a 2 x 4 wood spacer with 4 inch-dry wall screws to provide optimal clearance in preventing interference with the decommissioned steam radiator as highlighted in Figure 2. Bulk pricing of these materials yields $12 for 8’ boards and $6 for 1 lb. of nails. Therefore, a conservative estimate values $20 of material, and $100 of labor cost per unit yielding a grand total of $120 per window unit. In this project, thermostats and other controls were not installed since the incumbent steam-fired equipment anticipated a planned decommissioning, representing a full-displacement strategy.

Lead Vendor Managed Installation

In the Eversource's lead-vendor approach for Hassan Apartments the physical labor is essentially the same, but the crew composition differed from Lynn Apartments. The lead-vendor provided two individuals to install the equipment while the housing authority provided two staff members to coordinate tenant logistics and provide some assistance as shown in Figure 3.

Figure 3. (Left) towing unit with cart to tenant unit (Right) positioning equipment in window.

The installation process itself is efficient. The crew arrives early, typically around 7:30 a.m. with a commercial box truck carrying PWHP units, pre-assembled brackets, and materials for light carpentry work. They transport each unit using a hand cart and the common elevator, then mount the bracket and weather-stripping at a steady practiced pace that takes less than 20 minutes per PWHP unit. Because of project delays the thermostats were installed on a separate visit but required minimal installation time of approximately 15 minutes per thermostat.

In theory, this workflow allows for an installation rate of up to 24 units per day per crew. However, in practice, tenant coordination and constraints in logistics introduce significant delays that reduce actual productivity to approximately 4 to 6 units per day per crew. An ambitious goal of 10 units per day or multiple crew members is possible, but alleviating this bottle neck requires greater efforts in coordination with the tenant's schedules.

Final inspection of the equipment confirms adequate clearances and fitment with the interior windowsill and exterior façade components with a cut-to-length piece of PVC trim in Figure 4. Overall, the unit rests firmly with no expression of motion if perturbed with any force and remains secured in place with the appropriate window locks to prevent would-be theft attempts. Thermostats were upgraded to a Wi-Fi-enabled programmable system replacing the older model line-voltage controls for each thermal zone. Lastly security screens on the first floor-level are pending removal.

Figure 4. (Top-left) Final product in assembled in window, (Top-middle) product clearance with transition and interior windowsill, (Top-right) light-furnishing with PVC trim on exterior bracket leg, (Bottom-Left) old line-voltage thermostat, (Bottom-middle) newly installed Wi-Fi programmable thermostat, and (Bottom-Right) security screens pending removal.

Installer Improvements

When considering that installing PWHP in both models is labor intensive, improving ergonomics is a critical element in reducing occupational safety risks for the crew and tenant. Installers should consider the following key takeaways.

- Using a cordless screwdriver not an impact drill to reduce wrist strain required during bracket fitment and adjustment of the 10 Philips button-style screws.
- Magnetic driver bits may prevent screws dropping on the ground and falling out the window during the final installation of the bracket to the windowsill.
- For longer distances, a hydraulic assisted scissor-lift cart similar to the one used by the lead-vendor installation in Figure 3 may allow one crew member to deliver the equipment to its destination and provide better positioning due to the height adjustment on the cart. Also lessens handling and positioning to reduce risk of dropping the unit and injuring crew members and tenant property.
- Kneeling cushions for knee support may reduce constant straining during bracket assembly if assembled on-site and adjustment on the tenant’s floor when a suitable work surface is not (typically) available.

Project Timeline

Facilitating the implementation of any novel emerging technology requires careful planning and anticipation of risks that may delay completion. In this field study, the project team anticipated a two-month installation period, with a three-person crew installing a minimum of 6 units per day, equating to 30 units per week, and an overall 120 units per month.

However, several external factors have severely hindered progress including manufacturer supply issues, thermostat wiring complications, tenant scheduling conflicts, and other unforeseen challenges. The project began on July 31, 2025, with an anticipated completion date of September 30, 2025. The project completed installation December 2, 2025, with four units still pending installation but were deemed inaccessible due to biohazard risks identified as pest control and a deceased tenant. Several of the major issues encountered during the project were:

- A 30-day work stoppage on August 12th due to supply chain related delays. Scheduled replacement with updated condensing atomization nozzles during early spring by the manufacturer.
- Thermostat re-wiring issues reported on October 8th caused by installation of the incorrect vendor supplied relays that led to the thermostat batteries draining and leaving tenants without immediate control to electric base board heat.
- Ongoing fleet management network connectivity delays due to strict network security policies preventing use of the manufacturer's mesh-network solution in preference to a qualified installed by the housing authority.
- Biohazard restrictions that prevented access to four units which impeded full project completion.

Measurement and Verification

Despite these challenges, 96 out of 100 units were successfully installed during a four-month two-day installation period. As for measurement and verification, equipment was progressively installed starting October 8th to collect data on power consumption on every installed PWHP unit using WI-FI-enabled plug load data loggers. Additional data is collected through the equipment manufacturer's cloud-enabled service, and the thermostat vendor's dashboard interface for indoor temperature and comfort analysis. Specific performance data on the vapor compression side was not collected due to scale and complexity.

Because of the aforementioned project delays, measurement and verification officially began from February 1 to March 27 (79 days). Early results indicate that the tenants if left with the equipment without appropriate training and instructions, did not utilize the equipment in favor of the incumbent electric baseboard. And so PWHP participation rates were approximately 12% to 20%.

After identifying these issues, tenants were trained and provided with translated operating instructions for both the equipment and back-up heating system, and the building will institute a global lock-out temperature for the electric base board heaters. This lock-out sets an indoor temperature reset curve that ensures only one heating system operates at a time. In practice, if the indoor temperature drops below 65°F the electric baseboard heat will engage as a backup for supplemental heating. Once the space temperature meets this threshold, the PWHP will operate to reach the final temperature selected by the tenant limited within a specified range from 70°F to 75°F.

Once all tenant training and global-temperatures lockouts were fully complete around early March, participation rates rose to 50%. Although there were fewer degree-days a weather normalized analysis sampling tenant units primarily heating with electric baseboard and PWHP yield energy consumption rates of 53.56 kWh/HDD and 8.91 kWh/HDD. However, customer meter telemetry analysis indicates no significant pre- and post- energy efficiency savings due to multiple factors in equipment control and tenant operational education that yield a highly variable participation rate. Therefore, continued monitoring in the 2026-2027 heating season may finalize savings with confidence for this partial-displacement PWHP strategy.

Recommended Bidding Model

Initially, Eversource's multifamily program implementor received a non-competitive bid from Vendor 2 of $1,125,000 for installing 100 units with 150 thermostats, which equate to $11,250 per unit. The equipment itself represents less than half the cost at approximately $2,700 to $3,000, so the additional $4,000+ per unit for controls and labor immediately raised concerns. This prompted Eversource implementors to initiate a deeper engineering review which triggered the project to invite two additional competitive bids as shown in Table 1.

Table 1. Vendor and equipment bid summary costs re-calculated for best option.

Item	Amount	Vendor 1	Vendor 2	Vendor 3
Thermostat 1 (T1)	$62,181			
Thermostat 2 (T2)	$34,646			
Heat Pump 1 (HP1)	$278,100			
Heat Pump 2 (HP2)	$309,000			
Shipping	$13,000			
HP2 Labor		$120,119	$205,975	$281,000
HP2 Total		**$429,119**	**$514,975**	**$590,000**
T2 Labor		$43,707	$159,396	$205,819
T2 Total		**$105,888**	**$221,577**	**$268,000**
Grand Total (HP2 + T1)		$548,007	$749,553	$871,000
Adj. Total (HP2 + T2)		$520,492	$722,038	$843,485

All vendors were instructed to submit bids that included both HP1 and HP2, including costs for the T1 thermostatic control system. During review, implementors determined that the cost of T1 was higher than anticipated, which prompted a separate sole-source quote for the lower-cost T2 thermostat to reduce overall project expenses. Subsequently, labor installation costs for each bid were recalculated using the highlighted totals in Table 1 and updated to reflect the adjusted bid incorporating the lower-cost T2 thermostat as a final recommended option. Similarly, a separate analysis was conducted, and decision in selecting the higher cost HP2 was preferable due to equipment availability from ongoing federal tariff discussions affecting manufacturing overseas supply, and subsequently execution of project timelines. Therefore, the anticipated per-unit cost including material, labor, and thermostat hookup yields $5,053.

Notably, once competitive pressure was introduced, Vendor two reduced their proposal to $749,553, representing a 33% decrease and bringing the per-unit cost down to $7,496. This substantial reduction underscores the value of competitive procurement and highlights the importance of cost scrutiny in day-to-day implementation.

Vendor Experience

After finishing the project, the vendor was asked to compose time and material costs tabulated in Table 2 to better understand the actual costs of the project. Because of the delay from bid around April 8th to time of purchase approximately on July 22nd, actual project costs have changed between Table 1 and Table 2.

Notably, heat pump material costs increased from $309,000 to $350,693 (+11.8%), shipping decreased from $13,000 to $11,960 (-8.0%), and thermostats increased to $34,646 to $36,225 (+4.4%). In terms of the accuracy for each itemized labor cost, the vendor overestimated heat pump labor allowances by a difference of $88,494, and underestimated electrician labor costs by a difference of $30,813; but this accounts for issues in re-wiring. Specific labor rates for installing the heat pump yield $57.5 per hour, where a two-person crew would yield an hourly rate of $28.75, while a certified electrician wiring line-voltage thermostats comes out to $103.50 per hour. Therefore, the total per unit cost for this project yields $5,364 per unit which represents a 6.2% cost overrun for this project from the initial project estimate of $5,053 per unit.

In an ideal scenario where none of these identified barriers/issues are present. Each PWHP unit would require approximately 40 minutes of labor from two general laborers and 30 minutes from a certified electrician per unit. Where material, shipping, permitting costs, and other ancillary support costs remain unchanged. By using the calculated labor rates inferred from Table 2, total labor allowances for both the heat pump and thermostats would yield $7,836 and $7,762 respectively. When extrapolated across all units this totals $490,893, which is about $4,908 per unit, representing a 2.9% reduction compared to the initial project estimate.

Table 2. Vendor and equipment bid summary costs re-calculated for best option.

Heat Pumps	**Heat Pump Cost**	**$350,693**
	Shipping	$11,960
	Additional Materials (trim, weatherstripping, locks, etc.)	$3,738
	Labor (550 hrs.)	$31,625
	Total	**$398,015**
Thermostats	T-stat Cost	**$36,225**
	Shipping	$403
	Additional Materials (relays, conduit, wiring, etc.)	$52,541
	Labor (720 hrs.)	$74,520
	Permit	$575
	Total (96 Units)	**$164,264**
Overall	Total Exact Cost	**$514,957**
	Cost per Unit	**$5,364**
Projection	Extrapolated Cost	**$536,413**
	Vendor Loss	**$15,921**

The lead vendor also summarized their perspectives that explain the increases in project costs and the installation timeline:

- Reliance on the BHA tenant coordinators for access and clearing pathways through tenant units routinely delayed work by an additional 30 minutes.
- Some units required repeated extermination visits or had tenants who refused entry; installation teams often arrived but could not proceed due to health and safety hazards, with some units requiring eight or more access attempts.
- Miscommunication with the thermostat vendor resulted in incorrect relays being ordered and installed in roughly one-third of units, requiring significant rework.
- Electrical issues discovered during thermostat installation had to be resolved by the RISE electrician on site to avoid further project delays.
- Manufacturer-related inventory delays limited consecutive installation days and caused downtime between deliveries.
- Inability to safely stage equipment onsite required daily transport of units and multiple elevator trips for each installation.
- Installers and electricians often could not access the same units simultaneously, leading to multiple return visits.
- Lack of a dedicated service elevator increased wait times and slowed movement of equipment and personnel.
- Miscommunication on window assignments required additional installation days to correct errors.
- The lead vendor team provided extensive on-site support for kickoff meetings, training, marketing events, and special site visits.
- Due to these constraints, the team averaged four installations per day; with reliable access and coordination, productivity could have reached approximately ten units per day, significantly reducing costs.

Customer and Manufacturer Experience

Ongoing conversations with housing authority staff throughout the progression of the project revealed a mix of positive and negative feedback. Many tenants expressed enthusiasm and appreciation in the new addition to their heating and cooling system. However, despite hosting several training sessions to inform both tenants and staff members about the project and product, some tenants refused entry during the installation phase, citing a variety of explanations that indicate that they may not have attended or fully understood the information sessions. Housing authority tenant coordinators alleviated each concern by providing verbal clarifications, which allowed the installations to move forward with minor delays. However, in retrospect, keeping an attendance record in respect to unit numbers and collecting preferred appointment times through a pre-sign-up sheet would likely have reduced these delays.

During the early heating season, numerous “no heat” work orders were submitted. This is because of a combination of factors which combine incorrect in-unit thermostat relay wiring and a simple misunderstanding in part of the tenants. Because the PWHP does not communicate directly with the in-unit thermostat that controls the incumbent supplemental electric-baseboard heat, a wiring issue in the thermostat relay drained its backup battery, which unintentionally disabled the baseboard system. At the same time, many tenants had either unplugged the PWHP to make available an outlet or set incorrect temperature setpoints under a simple misunderstanding that the equipment was solely for cooling.

In response, housing authority maintenance staff were frequently observed pacing with 9-volt battery packs to replace dead batteries on each service call and verified that both the PWHP and electric baseboard equipment were operating properly. They also provided additional instruction to tenants on how to best utilize the equipment. In-person mandatory educational training seminars recording attendance were performed to teach the tenants on equipment operations prior to executing the global thermostat lock-out of the electric baseboard equipment.

During the early cooling season, no widespread complaints were identified. Instead, many tenants have expressed their satisfaction with the equipment, noting its quiet operation, better air quality, and comfort compared to their older model window air-conditioners. Although the equipment does not feature an economizer or high-performance filter, it is uncertain whether perceived air-quality improvements are directly attributed to improved interior air circulation, increased infiltration, or simply as a placebo.

One significant pain-point identified by both the participating manufacturer and the housing authority's sustainability team is in the challenge of enabling fleet-wide controls. Because many tenants do not have Wi-Fi to establish network connectivity, a mesh network system consisting of Wi-Fi routers was proposed by the manufacturer at an added cost. This network will enable the housing authority to best optimize a balance between tenant comfort, operating expenses, and sustainability goals. However, due to strict network policies, the housing authority cannot use the recommended equipment and installers proposed by the manufacturer. Instead, a qualified preferred controls vendor selected by the housing authority's information technology staff have unintentionally caused substantial delays in its implementation.

As a result, the building operators currently do not have insight into the usage of the equipment and cannot verify whether the tenants are using the equipment appropriately. This has raised concerns that tenants are using portable resistance heaters, or worse, following unsafe advice circulating on social media misinformation such as using ovens for space heating.

Program Eligibility Requirements

In Massachusetts, program offerings are designed prescriptively on a dollar-per installed ton or per quantity basis to accelerate market adoption and generate quantifiable savings for reporting to state regulators. In more complex projects, an alternative custom pathway that relies on detailed energy modeling requires greater diligence, time, scrutiny to cost and calculated savings. In developing guidelines for a PWHP program, multiple discussions with the residential groups for single-family and multi-family included specific committees with residential-rebates, market-rate, and income-eligible who highlighted specific concerns on the equipment's portability, security, code-compliance for full displacement projects, and power requirements triggering service/panel upgrades.

Savings Persistence

Program administrators are particularly concerned that renter-owned equipment may be removed when tenants move out, which introduces risks on claimable savings over the full useful life of the equipment. Because programs cannot realistically enforce stringent requirements that the equipment remain with the building, administrators would need to apply in-service realization rate as an overall adjustment to reflect the fraction of savings that can be confidently claimed. This reduces the cost-effectiveness of the measure in the prescriptive pathway but is considered as an initial short-term remedy once a detailed evaluation study is conducted to determine specific impacts.

In a similar concern addressing the equipment's relatively high retail value, limited market availability, and strong demand for multifamily customers, theft and security are a critical program risk. In alleviating this concern, requirements for window locks, secured sashes, and additional anti-tech hardware can be made as an overall programmatic requirement, especially for equipment near ground level. This may slightly increase overall project costs but minimizes risks in fully claiming savings where the equipment is owned by the building owner.

Code Compliance

In its applicability in full-displacement scenarios, program administrators consistently raise concerns about how PWHPs align with the current language of the Massachusetts building code. The state adopts International Energy Conservation Code 2021 (IECC) with Massachusetts specific amendments (780 CMR), while some municipalities include higher energy efficiency standard known as Stretch Code (225 CMR). For buildings less than or equal to three stories as defined in section R202, multifamily buildings must follow the residential building code, and likewise for buildings greater than three stories follow the commercial building code as defined in section C202 (IECC 2021).

In the residential code the specific conflict occurs under IECC R403.7, where heating equipment must be sized using Manual J load calculations and selected using Manual S, or equivalent methodologies. At heating design day temperature, the building's heating requirements increase greater than the capacity rating of the PWHP, which make them non-compliant for full-displacement applications.

Although installing multiple units per room could theoretically meet the required Manual J load, language within Manual S prohibits the use of multiple independent appliances to serve a single zone unless the manufacturer certifies them as a combined system (ACCA 2023). So, because PWHP manufacturers do not explicitly define these products as whole-home heating systems, they fall into a code-compliance gray area. Consequentially, individual municipalities may conditionally approve full-displacement projects featuring PWHPs in scope unless the design includes substantial supplemental electric heat or, which adds cost, complexity, and undermines the value proposition of the measure.

In the commercial energy code, IECC section C403.1.1 requires that HVAC equipment must be sized using approved load calculation methods in accordance with ANSI/ASHRAE/ACC-A Standard 183 or an equivalent procedure (IECC 2021). This requirement presents technical concerns for the use of PWHPs, since it applies only to the sizing methodology and not the type of equipment. Similarly, IECC table C403.3.2(4) establishes the minimum efficiency requirements for a room air-conditioner heat pump of up to 14,000 Btuh. Where the efficiency values for the PWHPs exceed the minimum threshold values and thus satisfies all applicable IECC criteria. Therefore, a multifamily building project governed by commercial building code does not present challenges and technical gray areas that may arise in a residential code context.

Integrated Controls

The solution would be to use PWHPs as a partial-displacement option, but program administrators are also concerned in the equipment's behavior with the existing heating system.

Without integrated controls, there are risks identified as simultaneous heating and cooling, tenant/owner forcing a backup system override, and other unpredictable performance behaviors that result in increased energy consumption. Experience in the heat pump programs have addressed these issues by implementing requirements on outdoor temperature-based switchover controls to ensure that the backup system only engages below a specified threshold.

However, PWHPs do not communicate directly with antiquated wall-mounted thermostats. line-voltage thermostats. Although the units offer Wi-Fi BMS integration, program administrators may need to consider requiring buildings to install a networked thermostat solution that supports an indoor/outdoor temperature-based control strategy, at an additional cost. As a result, the risk of Tenants operating two heating systems falls on the building owner's controls contractor, which may increase persistence in savings assuming appropriate schedules and set points are set. In addition, it is unclear when manufacturers develop additional hardware control products that will allow for a more seamless integration of the two heating systems within in their product development road map.

Delivery and Contractor Alignment

Conversations with multiple PWHP manufacturers indicate a consistent preference in delivering the product to HVAC contractor-based distribution channels as opposed direct to consumer big-box retail stores. Manufacturers believe that certified contractors are better suited to hand installation of their product, and remove liabilities associated with the customer's lifting and installing the units themselves. However, this raise concerns in the multifamily programs who worry that relying solely on the heat pump contractor network may elevate costs, especially if contractors attempt to recover value from jobs that might have originally been fulfilled by an MSHP installation.

In addition, HVAC contractors are skilled tradespeople whose expertise is not fully aligned with this product class, which is simpler and requires a different skill set. Therefore, this product may be best served by a vendor model that serves the multifamily programs operating as a sub-contractor with the lead-vendor and heat pump contractors to deliver consistent and cost-effective installations. Under this model, the subcontractor's scope of work would include Tennant coordination, customer training, light-carpentry work, furniture moving, and thermostat wiring. While more complex tasks such as integrating two heating systems, setting up Wi-Fi networks, configuring building-level controls are retained by the lead vendor and heat pump contractors.

Conclusion

The field study of PWHPs at Hassan apartments demonstrates that PWHPs represent a promising scalable pathway for electrification within income-eligible multifamily buildings where traditional MSHP and VRF solutions cannot be easily integrated without significant cost. While manufacturers present the technology as a simple to install solution requiring minimal resources to realize meaningful energy efficiency savings in the incumbent heating system, this field study revealed that a successful deployment in a lead-vendor managed multifamily program model requires extensive planning and coordination with all project stakeholders.

Although the installation is marketed by some PWHP manufacturers as an easy DIY installation, real-world deployment in this study was significantly influenced by building characteristics, tenant access, need to align specialized labor, and supply chain logistics. These factors substantially increased labor hours relative to manufacturer claims and required additional material to furnish the product.

The original vendor provided an all-inclusive bid of $11,250 per tenant unit. Once competitive pressure was introduced, the final bids decreased substantially, resulting in a selected all-inclusive cost of $5,053 per unit, underscoring the value in competitive procurement. However, complications during installation extended the timeline and expanded costs, and the vendor ultimately incurred a final all-inclusive cost of $5,364 per unit for 550 hours of labor, resulting in a net loss of $311 per unit. When re-calculating labor rates on the original 30-minute installation time, the ideal installed cost for the installation should have been $4,908, which requires 50 hours of labor. This stark difference in expectations was largely due to a lack of effective and efficient coordination with tenants to gain timely access, supply chain related constraints that reduced consecutive number of installation days, and wiring issues involving the in-unit thermostat. Overall, an ambitious 10 unit per day goal was reduced to 4 units per day, which significantly extended the timeline.

Customer and housing authority feedback further emphasized that tenant education is paramount in the successful implementation. When considering that most tenants in income-eligible multifamily buildings are multi-lingual seniors and adults with disabilities, additional accommodation and resources are required. Although multiple training sessions and translated flyers were helpful, a more structured approach featuring a participant sign-up sheet and scheduled appointments may reduce turn-aways and increase daily installation rates

From program design standpoint, the program administrators addressed several concerns related to potability, theft, code compliance, integrated controls, delivery, and other issues related to the persistence in savings and barriers. A key issue with tenant purchased equipment is the risk that the equipment may move with the tenant, which complicates claiming savings over the assumed 10-to-15-year measure-life. Additionally, multifamily buildings governed by residential code may be required to add supplemental electric resistance heating systems in full displacement implementation. While partial displacement scenarios where a BMS system is not present and an integrated control system is required, adding an independent Wi-Fi thermostat on a mesh network will introduce additional costs. But it may resolve competing control issues in both heating systems in competing and shift the responsibility from tenant to building owner's control contractor.

Overall program administrators acknowledge that multifamily buildings introduce multiple complexities that must be addressed to improve implementation success, cost effectiveness, and long-term savings realization rates. Despite project delays from supply chain setbacks, thermostat wiring complications, and limited Tennant access, 96 out of 100 units were successfully installed with PWHPs, and lays out the groundwork for ongoing measurement and verification. Quantitative performance data collected through data loggers and connected management dashboards will provide critical insights in real-world energy displacement, Tennant behavior, and system optimization that inform future program design and market scalability.

Moreover, this field study demonstrates that PWHPs can fill a critical market gap by providing a low-cost electrification pathway for multifamily housing. Especially in income-eligible housing that supports underserved communities where cost-effectiveness and ease of deployment are paramount. However, realizing the full value in this technology requires unskilled subcontracted labor workflow, improving integrated control strategy, refining program eligibility requirements, and leveraging competitive procurement to ensure fair pricing.

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