Field Study of Air to Water Heat Pump Installation in Southeastern Massachusetts brings together Utility, Contractor and Manufacturer

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ABSTRACT

Air-to-water heat pumps (AWHPs) represent an exciting opportunity to retrofit residential hydronic heating systems formerly served by a boiler. These systems can deliver hot water for radiators and domestic hot water storage, and chilled water for space cooling through fan coils or air handlers. While they offer the potential to reduce fossil fuel use and provide year-round thermal comfort, AWHP retrofits require contractors with expertise in hydronic design installation and need to be integrated with existing distribution systems.

This paper presents a field study conducted in southeastern Massachusetts beginning in summer 2025, where an AWHP replaced a hydronic boiler and a ducted air-to-air heat pump. The system was connected to existing baseboard radiators, three ductless fan coil units, and a ducted hydronic air handler. Extensive metering was used to monitor water flow and temperature, air flow and temperature, and indoor temperature and humidity. The project investigates practical considerations in system compatibility with legacy hydronic components, efficient piping layouts, and the relationship between outdoor temperatures and required water temperature. It also summarizes contractor feedback on installation challenges and training needs, and the potential for water storage to help align system load with grid constraints. Findings from this study offer insights into the technical, workforce, and customer-related factors influencing the scalability of AWHP in single-family residential retrofits.

Introduction

AWHPs are the most common heat pump technology in Europe (Volt, 2025) and have displaced gas heating systems as the most sold in Germany in 2025 (Günther, 2025). AWHPs are not common in the US. While several brands have been available for years, major makers have only introduced models into the US in the last several years.

This paper describes a project that installed a new-to-market AWHP. The project incorporated several factors that were particularly advantageous for testing the introduction of a new-to-market AWHP into a Northeastern U.S. market. They included:

- The project was a cooperative venture between Eversource, Daikin, Tom Fisher of Jim Dorsey and Son. Ridgeline Energy Analytics provided design assistance, instrumentation and data analysis.
- The house presented a chance to test operation of an AWHP heat pump in a variety of scenarios because the house had fin-tube base board throughout and a ducted air handler that had been added to provide cooling to the second floor. The project added two fan coil units to the first floor and converted the second floor air handler to a hydronic air

handler, adding cooling capability but also adding flexibility in heating approaches. Heating could be accomplished by fin tube alone or with a combination of emitters.

- Winter 25/26 proved helpful for testing because temperatures in January and early February not only exceeded ASHRAE 99th percentile design temperatures (9°F) but matching the 99.6th percentile temperatures (2.9°F).[1]
- The contractor and homeowner were flexible in their approaches and very active in this case study, allowing testing of a variety of operating scenarios.
- The Daikin heat pump is equipped with D-checker, a tool that allows collecting up to 150 data points including mode, water temperatures at the refrigerant/ water heat exchanger, and compressor speed.
- The collaboration of the parties allowed each party to directly learn from the project including program design elements, installation elements, and equipment settings and training provision.

Participant Perspectives

The strength of this pilot project was the close and continual cooperation of the electric utility, the manufacturer, and the installing contractor. Their views of the project are outlined below. Additional benefits were open conversations between the parties about heat pump and installation costs, energy costs, program cost-benefit requirements, and feedback to the manufacturer on installation elements.

Utility perspective

Mass Save is the brand name for a comprehensive set of programs, administered by 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 Program Administrators (PAs). Eversource, as one of the PAs, is responsible for equitably delivering energy and greenhouse gas emissions savings for residents, businesses, and communities in its service areas, which includes the site's town in SE Massachusetts.

In the Massachusetts 2025-2027 three-year plan the PAs have committed to investing $4.5 billion in program funds to support statewide decarbonization goals. 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 MWh in energy savings, including targeted initiatives designed to ensure equitable access to program benefits.

Data from the American Community Survey (ACS, 2024) estimates that Massachusetts inventories 1,455,000 homes, of which approximately 50% of homes feature hydronic baseboard fin-tube heating systems driven by natural gas and/ or delivered fuel boilers. This high-prevalence of boiler-fired systems has led multiple stakeholders to express interest and share anecdotal claims regarding the potential for AWHP to serve as a viable drop-in replacement for conventional boilers. Because several manufacturers have now entered the early-commercialization phase in offering AWHP in the United States, there is strong interest in understanding both the technical feasibility and market scalability of AWHP heat pumps in comparison to traditional air-source heat pumps.

[1] ASHRAE Fundamentals, 2021. Listing for Norwood, MA.

Mass Save's energy efficiency programs currently offer significant incentives and rebates for residential AWHP systems, including a base incentive of $2,650 up to $8,500, with enhanced incentives of up to $16,000 for income-eligible customers. Internal Eversource Program data since 2024 indicate that approximately 72 homeowners, primarily income eligible customers, have applied for rebates and have installed systems. Because of this high-skew and low-participation, a separate follow-up research effort in interviewing contractors was conducted and suggests that a majority of installations are occurring outside of the programs in higher-income, luxury residential applications. This is likely because these households are more frequently undertaking major renovations or gut-rehab projects, which makes it possible to install a radiant floor heating system and other hydronic upgrades.

Given these trends, insights from this study may inform and refine the design of the existing program offerings, encourage broader adoption, and potentially contribute to the development of national standards and best practices for air-water heat pumps.

Manufacturer perspective

The Daikin Altherma unit holds a substantial share of the AWHP market in Europe and the United Kingdom. The U.S. market differs from Europe in several ways. Hydronic heating systems are regional in the US(Northeast, northern Midwest), but common across Europe. Hydronic systems are primarily fin tube baseboard in the US, while in Europe panel radiators and underfloor heating are more common. This means that the market for AWHP in the US is not uniform, and for retrofits, requires careful consideration of the existing distribution system.

Because many areas of the U.S. are incentivizing decarbonization, and some regions, such as parts of New York and California, are disincentivizing or prohibiting the installation of new natural gas pipelines, the opportunity for AWHP may be growing.

An AWHP can replace a boiler, hot water heater, air conditioner, or any combination of the three to provide space heating, cooling, and domestic hot water. Replacing a boiler requires an assessment of the existing hydronic radiators and may lead to the addition of higher efficiency fan coils that can be used for either heating or cooling, which could provide cooling where there was none before, or replace less efficient window air conditioners. Scenarios for replacing a boiler and using the existing hydronic radiators could range from optimal, with oversized radiators that allow a low heating water temperature and high coefficient of performance[2] (COP), to more complicated scenarios that require additional emitters, insulation, and air sealing. As noted above this home allowed for testing of fin tube baseboard, fan coil units, and a ducted air handler.

Contractor/ homeowner perspective

At the site in Southern Massachusetts, the homeowner had an aging cast iron boiler (24 years old) and was looking for a way to reduce fossil fuel usage but retain their fin tube baseboard. They had installed solar PV to reduce electricity drawn from the grid. Altherma was a great fit and with convectors added to provide cooling, the system could supplement fin tube during extreme cold snaps.

[2] Coefficient of performance (COP). This is a unitless ratio of heat added or removed by a heat pump to the energy used to move that heat. For example, if 9,000 Btu (2.6 kWh) of heat is added to a home, and this takes 3,000 BTU (0.88 kWh) of electrical energy, the COP of the heat pump is (9,000 / 3,000) or 3.0.

Contractors are hired by homeowners to meet a need at a price that is competitive enough to win but fair to the contractor's business. Pricing is the initial challenge, but contractors must also satisfy multiple facets of each project including local building codes, national energy codes, operational characteristics of the home and technology constraints brought by equipment choices. Homeowners bring their own requirements, based on operational characteristics of their home and user preferences. For example, an AWHP heating a baseboard to 130F instead of 180F will feel and sound different. This study seeks to evaluate how homeowners respond to these changes and examine any effect on user experience.

Emerging technology and other changes -like changes in refrigerants- produce knowledge gaps that contractors need to fill, often very quickly. AWHPs open a range of new options and features for homeowners, for efficiency, indoor climate, and comfort. This new technology brings new challenges for the contractor to provide a functioning system that not only meets the demands of the space but also the expectations of the homeowner. Installing a new technology like AWHP requires that the contractor have expertise in hydronics, can rapidly learn, clearly communicates with the homeowner, and is flexible in their approach. The contractor had experience with a variety of systems including hydronic systems and AWHP. In addition, the contractor was interested in the new technology, and its application.

Design

The home, located in southeastern Massachusetts, is a two-story 2,240 square foot colonial design built in 2002. Prior to the project, the home was heated by a 133,000 BTU/hr boiler via fin tube baseboard. The first floor has 58.5 feet of baseboard, and the second floor has 88.5 feet of baseboard.

Cooling was provided by a 42,000 BTU/hr air-to-air heat pump condensing unit that served a 24,000 BTU/hr ducted air handler in the attic that served the second floor, and two wall mounted 9,000 BTU/hr air to air units that provided cooling to the first floor. Neither system was previously used for heating. All heating was provided by the boiler via fin tube baseboard.

Heat Loss

Ridgeline used Amply[3], a software version of ACCA Manual J that uses the LIDAR scanner on an iPad Pro to precisely dimension each room. Heat loss calculations are shown in Table 1. The basement was previously heated by waste heat from the boiler. A convector was added to the basement so that it could be heated as needed. The heat loss calculations assume that the basement is conditioned space.

[3] Amply is software designed to quickly and efficiently calculate heat loss of homes. www.amply.energy.

Table 1. Calculated Heat Loss of the Home at 10°F

Location	Heating Loads at 10F (BTU/hr)	
	First Floor	Second Floor
Entry way/ hall	1,930	1,933
Living Rm	2,688	
Kitchen	10,344	
Bath	965	1,030
Bedroom 1		3,894
Bedroom 2		2,725
Office/ Family Room/	1,340	2,948
Total	**17,267**	**12,530**
Basement	8,809	
Total	**38,606**	

Source: Ridgeline Energy Analytics, 2025.

Heat pump

An Altherma model EPRA18DAV37 AWHP by Daikin was installed in June 2025. The unit is termed a hydrosplit where the refrigeration circuit is contained in the outdoor unit that contains a plate-and-frame heat exchanger that provides hot and cold water to the home. The indoor unit termed a hydrobox, contains pump, controls and control logic, and an expansion tank. The capacity of the unit with varying outdoor and leaving water temperatures is shown in Figure 1. The unit's capacity peaks at about 12 kW (41,000 BTU/hr). At the site's design temperature of (9°F/ -13C) the capacity is between 36,850 BTU/hr and 40,260 BTU/hr at leaving (supply) water temperatures between 131°F and 149°F, indicated by a vertical dotted line. This indicates that the leaving water temperature needs to approach 149°F to meet heating needs at the local design temperature. The Efficiency in COP is shown in Figure 2.

Air Handler

A nominal 24,000 BTU/hr (cooling) First Company model 8VMB air handler was installed to replace the existing ducted heat pump. While it was initially intended to replace existing cooling, the unit was also used for heating because of its high capacity and ability to heat effectively at lower water temperature than the second floor's fin tube baseboard. Table 2 shows the unit's heating capacity with the set airflow highlighted by a dark border. The measured water flow at the unit is 2 gpm. Even at 120°F SWT, and low water flow, the heating capacity of the unit at 22,158 BTU/hr greatly exceeds the design heating needs of the second floor (see bold italicized text). There are two benefits to operating the air handler for heating the second floor. The first is that at the lower required leaving water temperature the Altherma's capacity to heat the home rises to well above design need and the second is that the efficiency of heating rises.

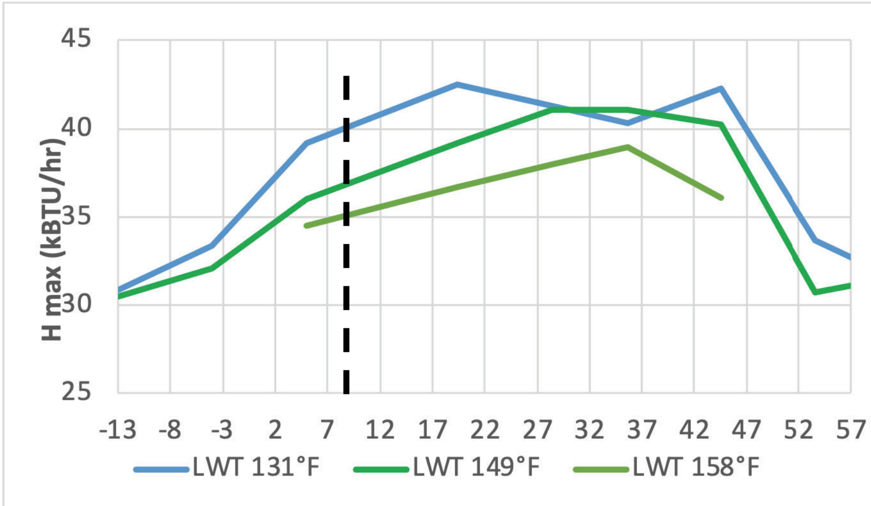

Figure 1. Heating Capacity of Daikin Altherma Unit at leaving (supply) water temperatures of 55C (131°F), 65C (149°F), and 70C (159°F), for various outdoor temperatures. Vertical dotted line indicates local design temperature of 9°F. Source: Daikin, 2026. Design temperature line added by Ridgeline, 2026.

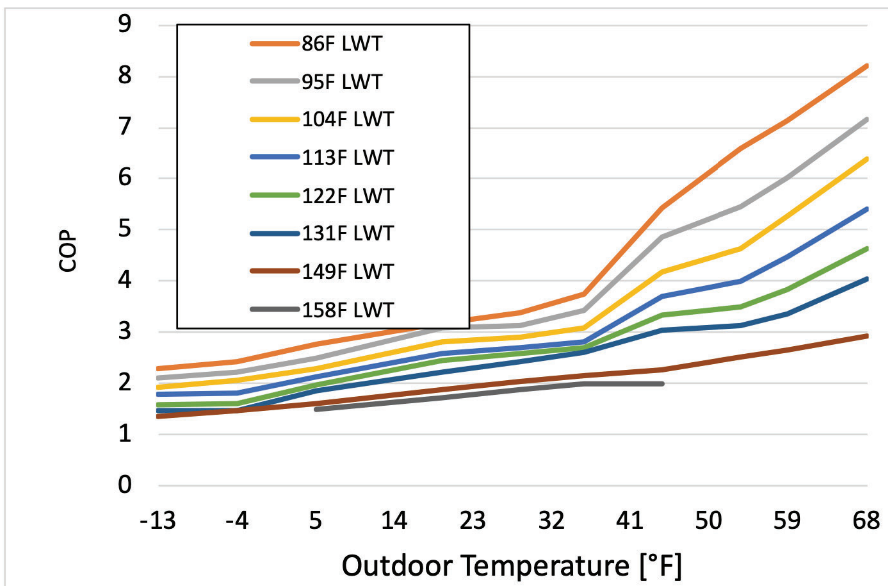

Figure 2. Heating Efficiency of Daikin Altherma Unit in COP for various leaving water and outdoor temperatures.

Fan coil units

The project installed two Altherma model 15AATV3 hydronic convectors, and one Altherma model 20AATV3 convector to replace existing wall mounted air to air heat pumps. These wall mounted fan coil units can both heat and cool. Heating capacities for three fan speeds are shown in Table 3.

Table 2. Heating Capacity of the First Company 8VMB Hydronic Air Handler

Capacity (BTU/hr)		Entering Water Temperature (°F)				
Airflow (cfm)	Water Flow (gpm)	180	160	140	130*	120*
800	6		58,500	45,500	39,000	32,500
800	4.5	68,400	56,000	43,500	37,292	31,042
800	3	63,500	52,000	40,400	34,642	28,842
700	6		53,300	41,400	35,450	29,500
700	4.5		51,100	39,700	34,000	28,300
700	3	58,200	47,600	37,000	31,700	26,400
600	4		45,100	35,100	30,100	25,100
600	3		43,000	33,500	28,750	24,000
600	***2***	***48,700***	***39,800***	***31,000***	***26,558***	***22,158***
500	4		39,800	30,900	26,450	22,000
500	3		38,000	29,600	25,400	21,200
500	2	43,400	35,500	27,600	23,650	19,700

Source: First Company, VMB, Commercial Chilled Water Multi-Position Fan Coil. * indicates extrapolation by Ridgeline Energy Analytics, 2025.

Table 3. Daikin Convector Fan Coil Heating Capacities

Heating Capacity BTU/hr (104/113°F)	15AATV3	20AATV3
Locations	Office	Kitchen, Basement
Min.	2,695	2,525
Med.	4,640	5,289
Max.	6,858	7,268

Hydronic Design

The hydronic layout of the installed system is shown in Figure 3. The outdoor refrigerant unit is shown along with the indoor Hydrobox that contains a backup heater, the primary loop pump, and control logic. The volumizer tank ensures adequate water volume for defrost cycles. The center of the drawing shows a hydraulic separator that allows the primary heat pump flow to differ from the flow in the distribution system. There are four pumped heating zones, one for each floor’s fin tube, one for the air handler serving the second floor, and one for the three convectors. Each of the convectors has a two way valve so it can operate independently. In all there are effectively six independent heating emitters. Domestic hot water is provided through a 3-way valve to an indirect water heating tank. The tank also contains an electric boost heater. The boiler system remains viable and is grayed out in the drawing. It was not used during this pilot study. It is piped so that it can provide both space heating and domestic hot water if needed.

Retrofitting the attic air handler required bringing piping up from the basement. Since there was no pipe chase, insulated heat-rated cross-linked polyethylene (HPEX) tubing was run up the exterior of the building in insulated vinyl channels. The system was filled with 35% propylene glycol to protect from bursting down to -32°F, protected from freezing to 2°F. During one period at roughly 3°F the investigators noticed low flow to the attic air handler and higher pump amperage. This was likely caused by the water glycol mixture beginning to crystallize impeding water flow.

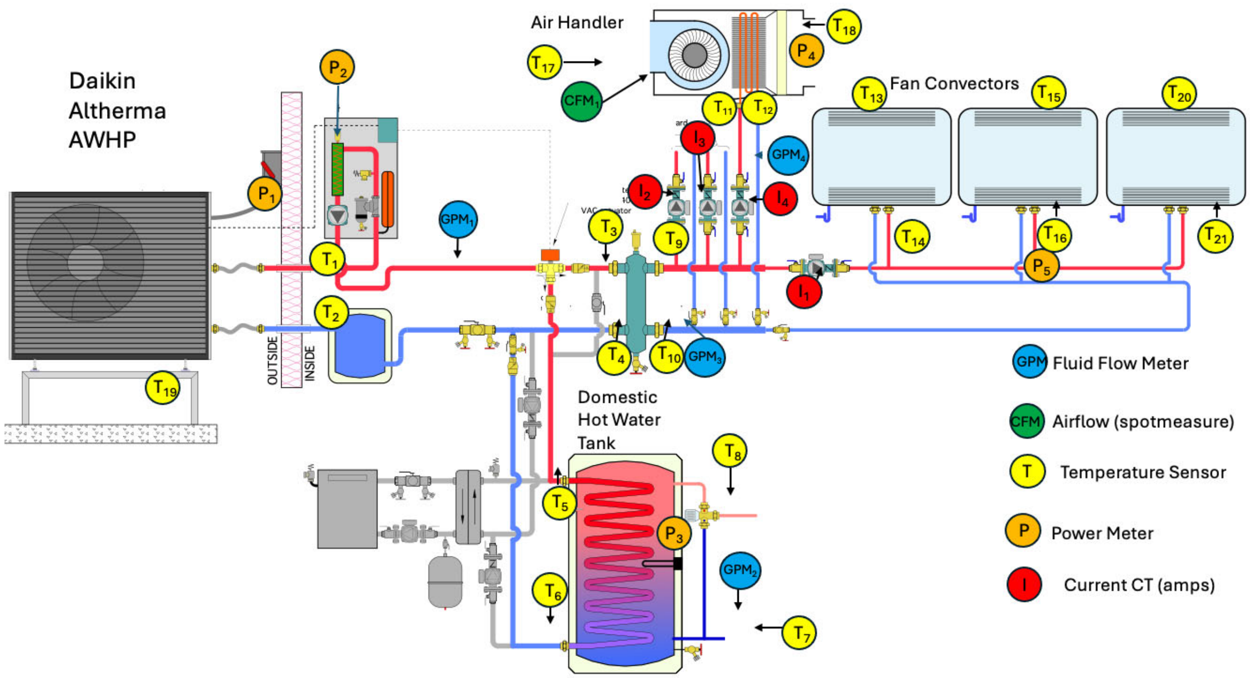

Figure 3. Layout of the hydronic system showing heat pump, emitters and pumps and metering sensors

Control Strategy and Limitations

Any hydronically heated home can experience different room temperatures if multiple rooms are on a single heating zone. When the thermostat reaches its setpoint, its room will be at that temperature, but other rooms can be several degrees warmer or cooler depending on the relative ratios of heat loss and emitter capacity. Changing supply water temperature (SWT) from that provided by the boiler to lower SWTs for the AWHP will require re-examining heat loss and emitter capacity.

While the range of emitters in the home gave flexibility, it also created a control challenge. Each of the fan-powered convectors has a local embedded manual thermostat that can compete with the home's other thermostats. The first floor had a single thermostat that controls fin tube. The second floor has two thermostats: a thermostat located in a bedroom that controls a single zone of fin tube baseboard. The air handler is controlled by a second thermostat that is not integrated with the fin tube thermostat. The setpoint and the primacy of each emitter is manually chosen requiring effort by the homeowner. Ultimately it might be advantageous to have a dual stage thermostat that allowed for easy ordering of heat emitter priority.

The Altherma has the ability to supply two different water temperatures from two different calls for heat. This means in theory that the system could provide one temperature to the air handler and convector zones and a second temperature to fin tube zones. The system is currently set up for a single supply temperature.

The current design uses rib relays and two zone relay boards to ensure that only hot water is supplied to fin tube and hot and cold water can be supplied to the convectors and air handler.

Required SWT - Design

The maximum capacity and supply water temperature that can be provided at a given outdoor temperature is limited by the heat pump. As shown in Figure 1, the Altherma can provide an LWT up to 158°F at the home's design temperature of 9°F. It also shows that because capacity declines with LWT, to meet the home's heat load of 38,606 BTUh, the LWT needs to be roughly 140°F. As discussed below, each floor has its own heat loss and set of emitters, making design slightly more complex. As shown in Figure 4, the first floor using fin tube only needs 144°F and the second floor needs only 115°F. Using all emitters, the SWTs drop to 125°F and 100°F (Table 4).

Table 4. Modeled Supply Water Temperature Summary

SWT Needed at Design 9°F	Fin Tube Only	Fin Tube plus Air Handler, Convectors
First Floor	144°F	125°F
Second Floor	115°F	100°F
Limiting Temperature	144°F	125°F

First floor--modeled

Figure 4 shows the SWT needed for the first floor across all outdoor temperatures. At design (9°F) the SWTs are 144 and 125°F, at 45F they drop to roughly 112F and 100F.

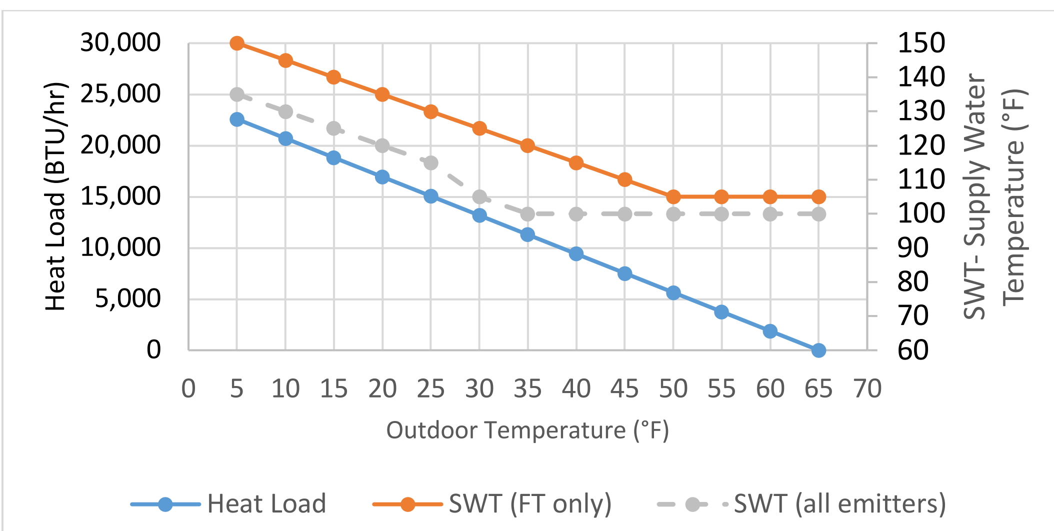

Figure 4. First floor: Heat load and SWT needed by fin tube (FT) alone. The revised load subtracts heat provided by two convectors.

Second floor--modeled

The second floor has a lower heat loss than the first floor and 50% more baseboard, and an air handler capable of heating the floor with low SWT. Figure 5 shows 115°F SWT is needed at design for baseboard only and 100F using all emitters.

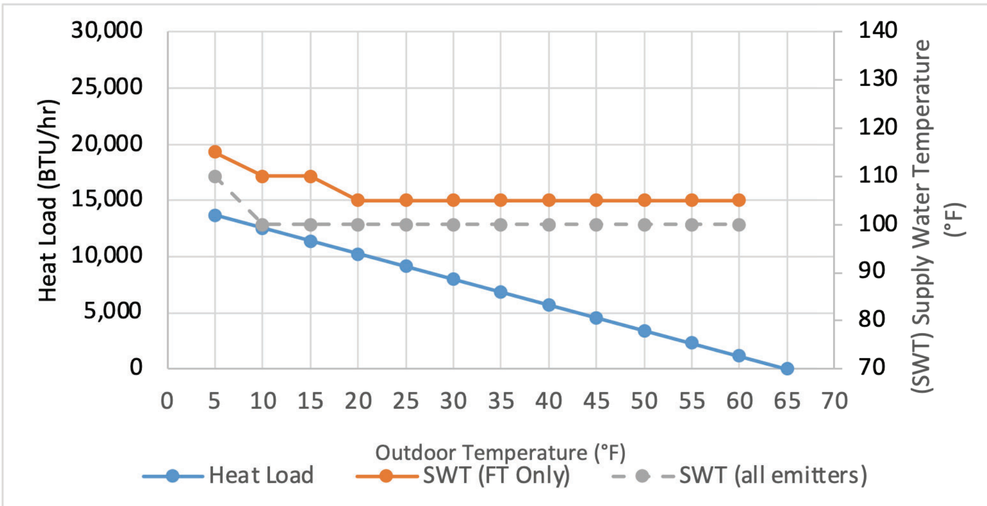

Figure 5. Second floor: Heat load and SWT needed by fin tube alone.

Required SWT - Actual

Figure 6 shows actual operation when only fin tube was used (about 3 weeks). At 7°F, the heat pump is meeting the home's heating needs with 138°F SWT. At 6°F the heat pump was cycling on and off with 145° SWT. This shows the modeling was correct and slightly conservative. The solid line shows actual SWTs, and the dotted line shows a reduction suggested to the contractor (when using fin tube only). Figure 7 shows actual operation with fin tube, convectors and the air handling unit all engaged (about 3 weeks). At each of these data points the AWHP is continuously cycling indicating that cooler SWT would satisfy needs.

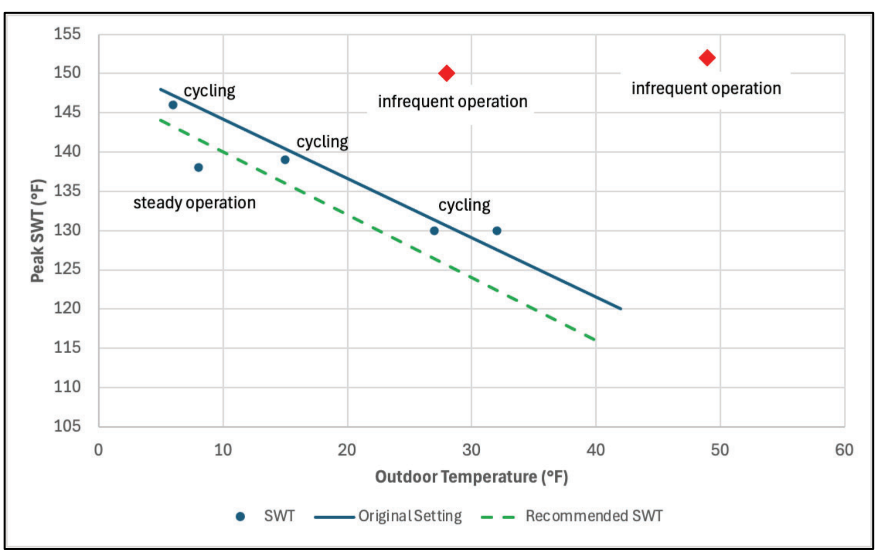

Figure 6. Initial and recommended SWT (fin tube only)

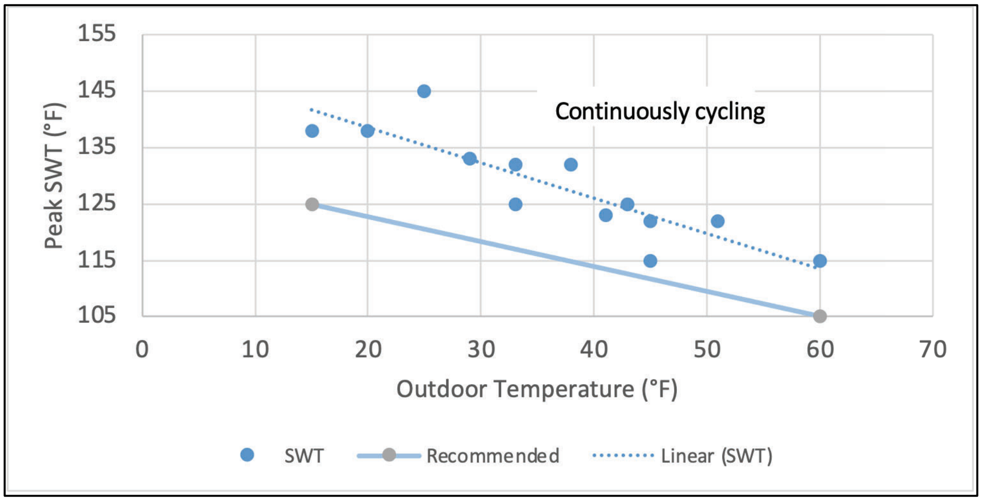

Figure 7. Actual SWT for fin tube, convectors and the AHU and recommended SWT

In practice, the SWT required was similar to modeling. Set points were originally set higher than modeled, particularly for moderate outdoor temperatures. There are several reasons for taking a conservative iterative approach with reducing SWT, primarily centered on the contractor ensuring a happy customer:

- The home was heated to greater than the 68°F used in design calculations, with some rooms at 72°F. Uneven room heating common in most homes, requires higher heating temperatures.
- Each floor's fin tube is in a series loop where the last rooms see water temperatures 15°F lower than the peak SWT. This is not an issue with convectors or the air handler.
- SWT supplied by the heat pump varies, meaning that average SWT can be 5°F or 10°F lower than the LWT setpoint.
- Defrost periods can last for 5 to 10 minutes which are only a concern at actual design (very cold) temperatures.

Operation

In this section we discuss three operational modes: a moderate winter period with multiple emitter types, a cold winter period with fin tube baseboard only, and a moderate to warm period with all emitters used. We wanted to be sure to test on period with cold temperatures and fin tube only.

Example Period 1: Moderate Temperatures--Baseboard, Convectors, and AHU Together

In Mid-January, outdoor temperatures varied from 28°F to 55°F. During this period, the first floor heated with the first floor fin tube and kitchen and office convectors, and the second floor heated with the AHU (Figure 8). Table 5 summarizes conditions. During this period the heat pump and the emitters cycled continuously and setpoints were easily met.

Table 5. Observed Heating Conditions and Performance: Example Period 1

Period	January 10 – January 14
Heating Emitters	Floor 1 Baseboard, Convectors, AHU
OAT	28 – 55°F
SWT	110 – 145°F
Room Setpoints Satisfied	Yes
Heat Provided	9,600 - 16,200 BTU/hr

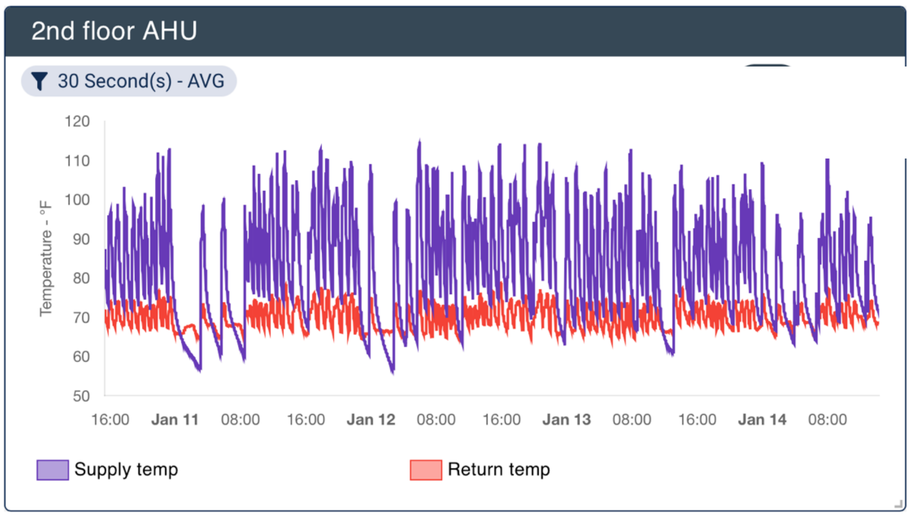

Figure 8. Air handler operation showing supply and return water temperatures and consistent cycling.

Example Period 2: Cold Temperatures—Baseboard Only

From January 20th to the 27th, only fin tube was used for both floors and the outdoor temperature varied widely with a relative maximum of 49°F and two mornings below 9°F (Figure 9 and Table 6).

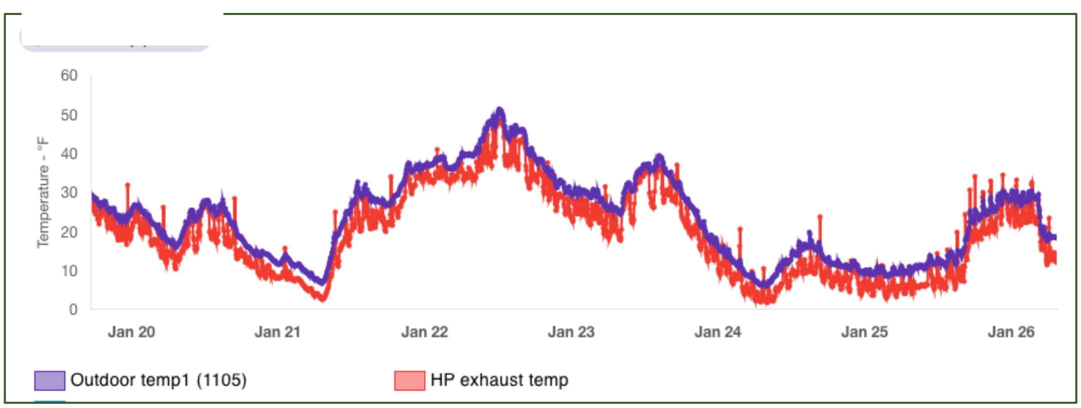

Figure 9. Outdoor and air exhaust temperatures for cold snaps

Table 6. Observed Heating Conditions and Performance: Example Period 2

Period	January 20 – January 27
Heating Emitters	Fin tube only
OAT	Minimum of 6°F
SWT	130 - 150°F
Room Setpoints Satisfied	Yes, except below where one room dipped to 66°F
Delta temp. at heat pump	14°F
Heat Provided	19,000 - 42,000 BTU/hr

Room temperatures are shown in Figure 10. Room temperatures were above 68°F except for brief periods when the outdoor temperature was below the design temperature. These periods could have been handled by the onboard 6kW heater, but that heater was disabled to focus on heat pump performance. It could also be handled by other emitters.

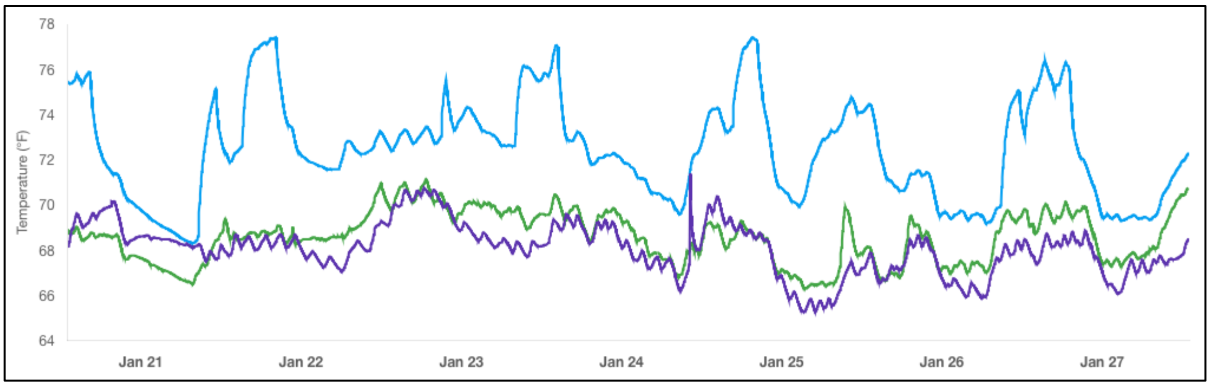

Figure 10. Room temperatures for fin tube only operation during cold snaps

Example Period 3: Moderate to Warm Temperatures--Baseboard, Convectors, and AHU Together

In early March outdoor temperatures varied from 35°F to about 70°F. (Figure 11). Because the house is well insulated, little heat is needed above 60°F.

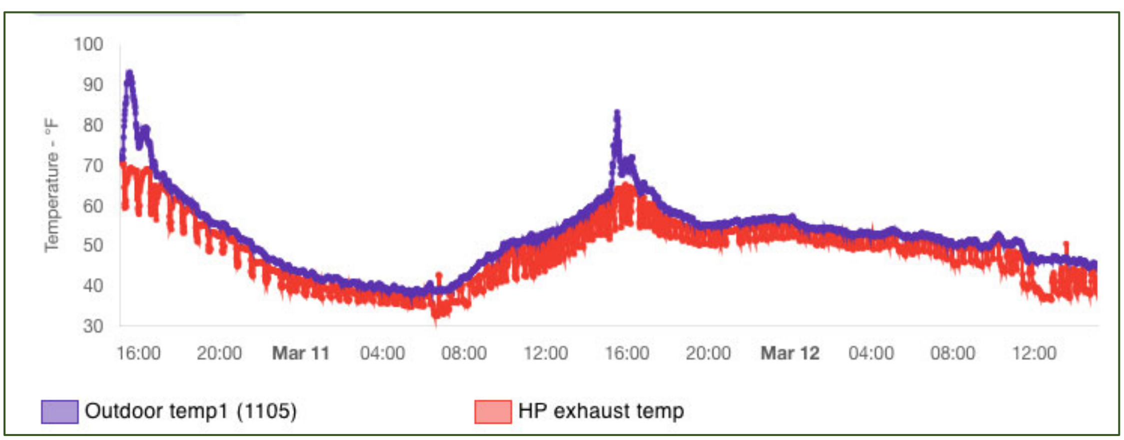

Figure 11. Outdoor and air exhaust temperatures for warm period

For this period the heat pump cycled continuously, indicating that SWTs were higher than needed. As shown in Figure 12, SWTs rose to about 130°F then reduced to about 120°F as outdoor temperatures rose. Room temperatures were satisfied throughout the period according to the homeowner and contractor.

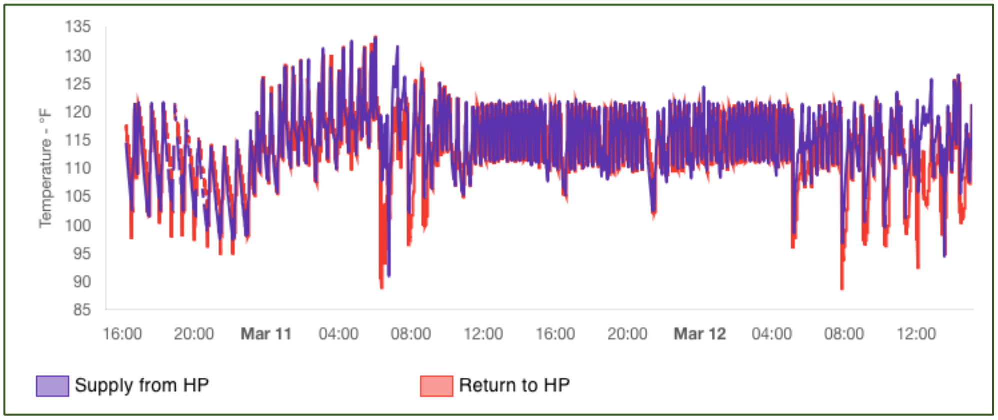

Figure 12. Heat Pump Supply and Return temperatures

Table 7 summarizes operation during the warm period in March.

Table 7. Observed Heating Conditions and Performance: Example Period 3

Period	March 10 – March 12
Heating Emitters	Baseboard, Convectors, AHU
OAT	40 – 68°F
SWT	120 – 130°F
Room Setpoints Satisfied	Yes
Delta temp. at heat pump	12°F
Heat Provided	12,000 - 18,000 BTU/hr

Lessons learned from installation

The correct SWT is a balance between comfort and efficiency. Setting the temperature just warm enough maximizes efficiency but could hamper the heat pump's ability to match heat loads when the homeowner increases setpoints or the unit enters a defrost cycle. Setting the temperature too warm can hamper efficiency as shown in Figure 2. We suggest setting the SWT roughly 5°F higher than needed for initial installation on a reset curve, then observing the house's heating performance and adjusting the curve accordingly.

As noted above, the priority of fin tube versus the air handler on the second floor is set by the homeowner manually setting a temperature difference between two thermostats

Setting the Altherma is a manual process requiring a contractor visit for each revision. Particularly for a pilot, installing a Wi-Fi card or a cloud-based thermostat that allows changing setpoint temperatures would allow for easier testing. Ultimately as Altherma enters the North American market, having the ability for a contractor to remotely change settings might be a labor saver.

For installers, the first unit installed takes the most time. For this pilot, the AWHP model was new to the contractor, and it was also a European model. The model had European electrical labeling, wiring specified in mm rather than AWG, and British piping threads rather than the customary NPT. Each difference in itself takes little additional time but taken together along with model-specific programming yields a steep learning curve. This is similar to the case when European modulating condensing boilers first entered the U.S. market, but the installation was time-consuming, nonetheless.

The system design has a hydraulic separator that separates a primary heat pump loop hydraulically from the distribution loop. This allows the distribution flow to ramp up as various emitters are called by thermostats without impacting the operation of the heat pump. We noticed that the heat pump is constantly reacting to the house and believe that this is caused by minute to minute changes in flows and temperatures on the distribution side. In a future design replacing that separator with an 80 gallon 4-pipe buffer tank would allow for 10 to 20 minutes of latency which might smooth operation.

For AWHP retrofits and new construction designs, the contractor highly recommends including fan convectors. They add cooling and allow for lower SWT throughout the heating season. Adding hydronic cooling requires emitters with drain pans and condensate handling systems, and thorough and extensive pipe insulation. This is especially critical in through-wall piping where condensation could be unseen and cause extensive damage.

Where possible, the piping to interior hydronic emitters should be kept inside the building envelope. As previously noted, a concentration of glycol was required and even with that concentration, some crystallizing of the mixture occurred.

One primary concern of the utility is cost effectiveness of the installation both first cost and operating cost. AWHPs are new to most US contractors, and this can increase installation costs due to lack of familiarity. Installation costs will drop as the number of installations increase. Operating costs are influenced by both relative energy prices and fine-tuning the installation so that achieved COPs are maximized. In this installation COPs approached manufacturer's stated COPs when SWT was set to need. Overly conservative SWT caused COPs to drop.

Conclusions

AWHPs are a viable heat source for conventionally built homes with fin-tube baseboard. Depending on the length and layout of the emitters, they can meet design temperatures with SWTs within typical AWHP capability. For this home, 145°F SWT was sufficient at 9°F outdoor temperature using only fin-tube baseboard.

Adding emitters such as panel radiators, fan-powered convectors, or air-handling units reduces the SWT needed to heat a home. For this home, a 125 °F SWT was sufficient to meet the design heating load. The COP also rose with the lower SWT to about 3.0 at 40°F. Adding emitters to allow for heating with low SWT can cost about $1,500 each, installed. In this study each of three fan powered convectors that allow heating and cooling cost $3,000 each, installed.

The installation of AWHPs requires some design work as would be the case with condensing boilers. This includes a room-by-room heat load analysis, a review of existing emitters, and consideration of adding emitters if needed. The additional design time is modest especially with new room scanning heat modeling tools.

SWT setpoints matter more for AWHPs than for traditional boilers. While providing hotter water than necessary has only a minor impact on boiler efficiency, it can substantially reduce the efficiency of an AWHP. In this paper, we showed that a SWT higher than necessary resulted in cycling of the heat pump.

AWHPs operate, are sized, and are installed differently than boilers; they also feel different to the homeowner and require some design effort. It will take time for AWHP technology to be fully understood and embraced, as has occurred with air-to-air heat pumps and electric vehicles. That adjustment will be worthwhile, because this technology is flexible and can deliver comfort while reducing carbon emissions.

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