

Air Source Heat Pumps for Residential Heating and Cooling

Sudbury Public Housing Development

OVERVIEW

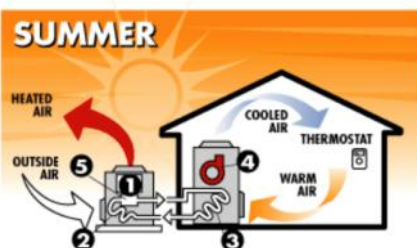
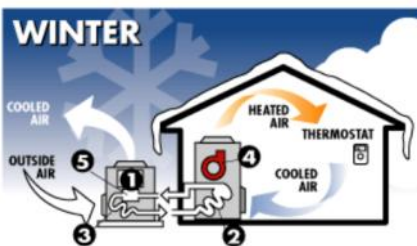
The Sudbury Public Housing Development is a low income housing development composed of 21 single family and duplex units which are primarily occupied by elders. Most of the buildings within the development were constructed in the 1960's.

With approximately 30-40 residents inhabiting the units, the Sudbury Public Housing Development provides a community to low income and retired elders. Prior to the installation of the air source heat pumps (ASHPs), each unit was heated using electric baseboard heating. Each unit was equipped with a thermostat allowing the residents to set the temperature to their personal comfort levels. These electric baseboard heating systems use large amounts of electricity, are expensive to maintain and repair, and can pose as a fire hazard. The Department of Housing and Community Development (DHCD) noticed that the electricity cost of each unit was around \$130 monthly, exceeding their target of \$100 monthly. In order to reduce this cost, the DHCD acquired full funding from the DOER to implement a pilot program testing the cost savings of ASHPs over electric baseboard heating.

Two ASHPs were installed in pilot units in November, 2013 and wired for PowerWise along with two control units. Two additional ASHP pilot units were added in March, 2015 and wired for PowerWise along with two additional control units. In September, 2015, the PowerWise monitoring system was adjusted to reflect accurate data but substantial data to complete a cost analysis has not been gathered. However, utility bills from the first winter of operation indicate a potential electricity savings of 68-80%.

SYSTEM DESIGN AND INSTALLATION

The four pilot units were equipped with Fujitsu Model 15RLS2 ASHPs to provide the residents with heating in the Winter, and cooling/dehumidification in the Summer. These ASHPs are operated using a remote control that is placed within each unit. The resident uses this remote to set the temperature of the room. When placed on the "auto" setting, the ASHPs will cycle on and off in order to maintain this temperature.



Air Source Heat Pump Diagram

The ASHPs are composed of a condenser that is placed outside the units and an inside vent that distributes the air to the room to maintain the temperature of the unit. The condensers are placed behind the units, so aesthetics is not a concern. The inside vents require a fair amount of wall space which some residents find unappealing. In order to connect the inside vent to the outside condenser, piping was placed throughout the shared hallways in the units. These pipes are rather large and have been the source of complaints from the residents and housing director.

The installation of the two initial ASHPs at Sudbury went very poorly because they were installed by electricians instead of HVAC specialists. Since the complex is a public housing development, all major projects must be put to public bid and the lowest bid chosen. Because of this, they ended up hiring a firm of electricians with no ASHP experience.

AT A GLANCE:

- ♦ 21 single family and duplex rental houses for low income families, occupied primarily by elders
- ♦ DHCD decided to install Air Source Heat Pumps in 4 pilot units based on per-unit power usage
- ♦ No feasibility study was done for this project
- ♦ PowerWise power consumption monitoring system installed in the 4 pilot units as well as 4 control units
- ♦ Saved 68-80% on electricity during first Winter

LEARN MORE:

- ♦ Community Housing Office: <https://sudbury.ma.us/cho/>
- ♦ Renewable heating and cooling in Massachusetts: <http://bit.ly/renewablethermal>



Sudbury Public Housing Development Duplex Unit

OPERATIONS AND MAINTENANCE

To keep the ASHPs running smoothly, they require the filters to be cleaned every six months. Since there are only four ASHPs within the Sudbury Public Housing Development, maintenance for these systems hasn't been integrated into the housing development's maintenance plan, and thus the responsibility lies with the residents of the pilot units. One such resident has stated that maintaining his system is easy, and that he even helps out the other residents with maintaining their ASHPs. His wife however noted that for many of the elders there, maintenance would be very difficult to perform on their own.

IMPORTANCE OF FEASIBILITY STUDIES

The Department of Housing and Community Development decided to install these four pilot units in the Sudbury Public Housing Development because of the high costs of running and maintaining the electric baseboard heating systems in the units. However, they didn't have a feasibility study done that would have more accurately projected the savings and success of this project. Without the feasibility study, they went into a project without truly understanding all the details of the project process and the obstacles they could have encountered along the way.

They also didn't have feasibility study to determine the effectiveness of different styles of metering systems in their situation. The metering system they decided to use, PowerWise, is internet based, which poses an issue because the Sudbury Public Housing Development has unreliable internet connection at times. One of the main reasons for this is that there is not a central internet access account at the complex, so this metering device was using a resident's personal internet to upload data. This has historically caused some the energy usage data to be inaccurate. Had a feasibility study been conducted, the challenges of implementing PowerWise here may have been detected.

PROJECT OUTCOMES

The residents who have the ASHPs installed in their units are very pleased with the climate controlling capabilities they provide. One resident is quoted as saying "It's the best invention ever. They should've had these fifty years ago!" There are concerns about the residents having trouble becoming accustomed to operation of the ASHPs, but with proper training this shouldn't be an issue in the future.

While the ASHP technology functions very well to provide heating and cooling to the residents, there were many problems with utilizing the PowerWise monitoring system. During the initial installation, the ASHPs were connected to a shared meter rather than to the meters of the individual units making it difficult to differentiate unit power use on PowerWise. Additionally, since the unit buildings are from the 1960's and have since been renovated, the breaker panels are difficult to navigate, especially when trying to determine which circuit powers which appliance. Some of these issues could have been avoided if a study was done before deciding to do the project.

LESSONS LEARNED

To ensure a smooth startup process for air source heat pump installations, the DOER has some recommendations:

- ♦ Perform a feasibility study – For Sudbury Public Housing Development no feasibility study was commissioned, and feasibility studies provide not only recommendations for the specifics of the renewable technology to be installed, but in many cases also provide background information on the building/units themselves. Had this study been conducted, the many challenges of installing a pilot program, and working with PowerWise may have been exposed.
- ♦ Consider the application of the system – The cost effectiveness of the ASHPs has been hard to measure not only because the PowerWise data has been inaccurate, but it is possible that also the ASHPs are not being used in a cost effective way. The system manufacturer recommends to have the ASHPs in "auto" mode in order to work at its optimal efficiency. However, the elderly residents were not educated on proper usage habits for the system and treat the controls like they would a thermostat. The constant changing temperature causes the ASHPs to switch on and off rather than auto regulating the room's climate, which is very inefficient. Had the application of this renewable technology been analyzed prior to installation, the elders could have been properly educated on the best use of these technologies and these issues could have been avoided.



Air Source Heat Pump Indoor Vent



Air Source Heat Pump Outdoor Condenser