Field Study of Cold Climate Air-to-Water Heat Pumps

This three-year field project investigated the air-to-water heat pump market and potential applications for Minnesota homes. Four installations, including both low cost and high performance systems were installed and monitored for up to two heating seasons to evaluate the potential of AWHP systems in cold climate construction.

Major Findings

1. **Air-to-water heat pumps (AWHPs) are air source heat pumps!** While somewhat novel in the U.S. market, AWHP systems are a staple of European heat pump initiatives. Dozens of models and configurations are available for a variety of Minnesota residential applications.
2. Like ASHPs, AWHPs primarily function as space heating systems in Minnesota and brought substantial space heating energy savings of **6,300 to 16,600 kWh/yr** for the systems field tested in this study. The projected heating energy savings for similar applications ranges from 27% to 50%.
3. Due to their native hydronic distribution, many AWHP systems can also provide domestic hot water service. The unit measured in this study provided **30% of the domestic hot water with a total energy savings of 40%** compared to the baseline electric resistance unit.
4. Overall, with or without domestic hot water savings, AWHP systems provide compelling overall energy cost savings for customers with electric resistance or propane baselines, ranging from **$453 to $1,450 per year** in this study. The projected energy cost savings for similar applications ranges from 27% to 53%.

Barriers

5. While AWHP systems are compatible with all types of radiators, radiators such as cast iron and older baseboard units designed for high temperatures (160°F and up) may struggle to supply sufficient capacity in cold weather and detailed load and design calculations are required.
6. As a new technology, AWHPs still face significant market barriers including limited workforce experience and lack of standard rating methodologies.
7. While like other ASHP systems, the flexibility of AWHPs to work in many system configurations poses additional complexity and often requires more design work than a boiler or ASHP alternatives.

Opportunity

8. AWHPs have current opportunities in retrofit or new construction homes that feature low temperature emitters, such as radiant slabs. Additional opportunities for application will develop alongside familiarity with the technology.

Recommendations

9. AWHPs carry benefits that are similar to or surpass other types of ASHPs. AWHPs should be treated as ASHPs. Align this subset of ASHP technology with existing ECO models and programs. Existing strategies for overcoming ASHP market barriers should be replicated for AWHPs.
10. Advocate for standardized ratings for AWHP systems and configurations but use established qualified product listings to make AWHP systems compatible with existing ASHP programs, such as the strategy developed by Efficiency Vermont and adopted by MassSAVE and Otter Tail Power.
11. Promote AWHPs as potential customer solutions in any instance where a cold climate ASHP is determined to be beneficial but impractical to implement due to the existing hydronic infrastructure.

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