







High-Performance High-Capacity Heat Pump Summary

At a Glance

-  High-Performance High-Capacity Heat Pumps (HPHC HPs) save 30-50 percent on energy over standard electric resistance (ER) heating.
-  HPHC HPs offer reliable cold weather performance.
-  Nighttime thermostat setback on centrally ducted systems increased both energy and peak demand.
-  Correct system sizing and quality ductwork impact performance and cost-effective energy savings.

THE ENERGY CHALLENGE

The Northwest's grid is under increasing strain, particularly during winter morning and summer evening peak demand periods. In homes, HVAC systems often use the most energy. Traditional heat pumps that rely on inefficient backup ER heat further stress the grid.

This study assessed if modern HPHC HPs could provide a solution by providing direct relief to household budgets and the strained grid.

Program and Policy Recommendations

- Promote Advanced Technology:** Prioritize and incentivize variable-speed heat pumps paired with advanced controls that are configured to maximize energy savings and eliminate unnecessary ER.
 - Cultivate Expertise:** Develop resources and encourage proper system sizing, ductwork evaluation, advanced control settings, and the energy savings from limiting thermostat setbacks.
 - Rethink Backup Heat:** Eliminate or limit backup ER heat and prioritize systems that can meet heating loads without ER backup, thereby protecting the grid during critical peak events.
 - Modernize Metrics:** Focus program investments on real-world efficiency. Incentivize performance indicators that are predictive of in-field success in cold climates, such as coefficient of performance (COP) at 17°F Heating Seasonal Performance Factor 2 (HSPF2) and Energy Efficiency Ratio 2 (EER2).
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Study Design and Methodology

This multi-year field study tested the real-world performance of modern heat pumps by collecting high-frequency energy data from resident-occupied sites across the Bonneville Power Administration (BPA) service territory. The study included 57 residential sites across three Pacific Northwest climate zones, featuring 34 unique systems from seven different manufacturers. In partnership with eight utilities and four Tribal partners, sites that relied primarily on electric heat were recruited to allow for accurate pre- and post-installation energy comparisons. A standardized metering package was deployed to remotely collect consistent data on energy consumption and system performance. This metered data was then cross-referenced with historical utility billing records to establish a credible performance baseline and quantify final energy savings.

Ending Electric Resistance

A primary goal of this study was to determine if HPHC HPs could eliminate the need for inefficient ER heat. The findings confirm this is largely achievable. With proper heat pump sizing and a consistent thermostat setting, ER can be eliminated.

In the populous Puget Sound Heat Zone 1 (HZ1), systems sized to a 20°F balance point entirely met household heat loads and effectively eliminated the need for backup ER heat. Even in colder zones (HZ2), HPHCs significantly offset backup ER use.

Although these modern HPHC HPs performed very well mechanically, the study also revealed a critical, but solvable barrier. Settings on the heat pump may result in excessive ER use despite sufficient heat pump capacity. This was caused, in part, by suboptimal controls and thermostat setbacks which triggered ER heat during the morning recovery period.

Appropriate sizing will help households to transition away from costly ER. But to fully realize these grid and consumer benefits, the industry must adopt tighter control strategies that prioritize the HP and lock out unnecessary backup heat. This change will strengthen the grid and maximize resident savings.

Set It and Forget It

Contrary to common belief nighttime thermostat setbacks increased peak demand. Energy use across 14 monitored centrally ducted homes was about six percent greater. This is because in the mornings, the HPs worked aggressively to recover from the setback and used inefficient ER instead of relying on the more efficient HP.

