NREL Highlights RESEARCH & DEVELOPMENT

NREL Evaluates Performance of Heat Pump Water Heaters

NREL evaluates energy savings potential of heat pump water heaters in homes throughout all U.S. climate zones.

Heat pump water heaters (HPWHs) have the potential to significantly reduce energy use in homes compared to traditional electric resistance water heaters. Researchers at the National Renewable Energy Laboratory (NREL) completed thorough laboratory testing of five integrated HPWHs—all available in the U.S. market—to evaluate the cost of saved energy as a function of climate.

The performance of HPWHs is a function of surrounding air temperature, humidity, hot water usage, and the logic controlling the heat pump and the backup resistance heaters. The laboratory tests measured each unit's performance across a range of air conditions and uncovered the specific logic controlling the two heat sources, which has a large effect on the comfort of the users and the energy efficiency of the system.

More than other types of water heaters, HPWHs are strongly influenced by—and have an effect on—their surroundings. As these effects are complex and different for virtually every house and climate region, researchers aimed to create an accurate HPWH model from the data gathered during the testing.

Using the results from NREL's laboratory tests, such as the coefficient of performance (COP) curves for different air conditions as shown in the figure, a generalized HPWH model has been developed to enable more accurate whole-house simulations. This allows the interactions between the HPWH and the home's heating and cooling systems to be evaluated in detail for any climate region. Using these capabilities, realistic cost-benefit analysis can be performed for a HPWH installation anywhere in the country. An initial technology assessment was also published, demonstrating strong potential for energy savings in much of the country, but large regional variation in cost effectiveness.

Technical Contact: Bethany Sparn, *bethany.sparn@nrel.gov*

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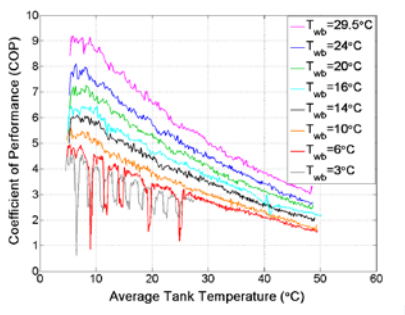

Instantaneous COP as a function of average tank temperature and ambient air wet bulb temperature for one of the HPWHs tested.

Key Research Results

Achievement

NREL measured the performance of five HPWHs across a wide range of operating conditions and performed a national technology assessment.

Key Result

Performance maps and control logic verified during testing will be used to improve the accuracy of HPWH models in whole-house simulation tools. All manufacturers were given detailed feedback on lessons learned from the testing program, and several are modifying their designs based on NREL's findings.

Potential Impact

An accurate HPWH model will help to quantify the energy and savings tradeoffs associated with installing a HPWH in lieu of other water heating technologies. The detailed system performance maps developed by this testing program will be used to: target regions of the country that would benefit most from this technology; promote system enhancements to maximize energy and cost savings and to improve customer acceptance; and pursue development of advanced hot water heating systems.

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NATIONAL RENEWABLE ENERGY LABORATORY

1617 Cole Boulevard | Golden, Colorado 80401-3305 | 303-275-3000 | www.nrel.gov

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