

NREL Develops Heat Pump Water Heater Simulation Model

A new simulation model helps researchers evaluate real-world impacts of heat pump water heaters in U.S. homes.

Heat pump water heaters (HPWHs) remove heat from the air and use it to heat water, presenting an energy-saving opportunity for homeowners. Researchers at the National Renewable Energy Laboratory (NREL) developed a simulation model to study the interactions of HPWHs and space conditioning equipment, related to climate and installation location in the home. This model was created in TRNSYS and is based on data from HPWHs tested at NREL's Advanced HVAC Systems Laboratory.

The HPWH model accounts for the condenser coil wrapped around the outside of the storage tank, and uses a data-based performance map. Researchers found that simulated energy use was within 2% of lab results, which confirms the model's ability to simulate realistic performance. Also, the TRNSYS model was used to develop a simplified, yet accurate, model currently used in NREL's building simulation tool BEopt (Version 1.2).

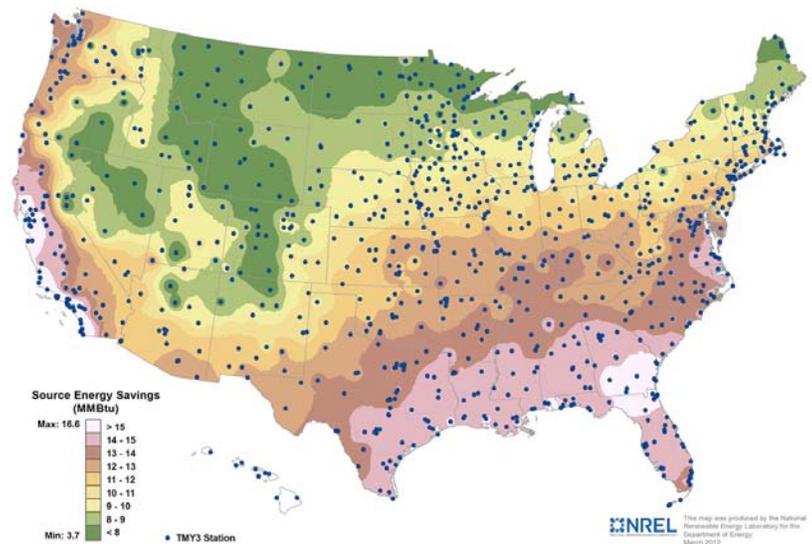
Annual simulations were run in 930 locations throughout the country. The HPWH was modeled in both conditioned and unconditioned space in order to consider its effect on space conditioning equipment. The map of these results shows that energy savings varies based on climate.

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References: Hudon, K.; Sparr, B.; Christensen, D.; Maguire, J. (2012). *Heat Pump Water Heater Technology Assessment Based on Laboratory Research and Energy Simulation Models*. ASHRAE Transactions 2012, Vol. 118, Part 1. www.nrel.gov/docs/fy12osti/51433.pdf.

Maguire, Jeff. (2012). *A Parametric Analysis of Residential Water Heaters*. Master's thesis, Department of Mechanical Engineering, University of Colorado, Boulder, CO.

Annual Source Energy Savings: HPWH vs. Electric WH in Unconditioned Space with ASHP (*source-to-site ratios: 3.365 (electricity) 1.092 (nat. gas)). *When substituting an electric resistance water heater, an HPWH will always save annual source energy, regardless of climate region or installation location in the home. When substituting a natural gas water heater, positive energy savings can only be achieved in southern regions of the country.*



Key Research Results

Achievement

NREL's Residential Buildings team developed and validated a heat pump water heater (HPWH) simulation model.

Key Result

This TRNSYS model can be used in whole-house energy simulations to determine the energy savings associated with HPWHs in all climates and installation locations. A simplified version of the model was incorporated into BEopt Version 1.2.

Potential Impact

An accurate model will help quantify the energy and cost savings tradeoffs associated with HPWHs. It can also be used to identify regions of the United States that would benefit most from this technology.