



TIP 338: Application of Combined Space and Water Heat Pump Systems to Existing Homes for Efficiency and Demand Response

Context

There are approximately 1,225,000 electrically heated homes with electric resistance water heaters in the PNW. The region is investing heavily in this market promoting ductless heat pumps (DHP) for space heat and heat pump water heaters (HPWH) for hot water. Most of these homes are in the western part of the region where the cooling load is minimal, and a space and water heating solution is sufficient. This project tests two different products that can supply both space and water heating through a single combination heat pump system. One product uses a conventional refrigerant and the other uses carbon dioxide (CO₂).

The advantage of using the CO₂ refrigerant system is that it brings in a heat pump that provides high performance for both space and water heating that is significantly higher than any set of stand-alone products. In areas where cooling is needed, the conventional refrigerant heat pump system combines a DHP with water heating. Both products allow a one-time investment that brings the home to a much higher level of efficiency for space conditioning and water heating.

Description

The Washington State University (WSU) Energy Program, with its partners, will conduct research on two types of combined space and water heat pumps in field and controlled experiments in existing homes of various efficiencies and climates.

One technology uses CO₂ refrigerant and will be tested for performance at six field sites and at the PNNL Lab Homes for efficiency and demand response (DR) capability. The second technology uses a conventional refrigerant and will be field tested at five locations in the region's hottest and coldest climates as well as in the marine coastal zone. Costs of system installation and energy use will be collected and analyzed. In as many cases as possible, monitoring will be installed prior to installation in order to establish a baseline.

Why It Matters

TIP 326 is studying the performance of CO₂ combo systems in new residential construction. This project expands the research to retrofits of existing homes. TIP 302 researched the DR capability of stand-alone CO₂ heat pump water heaters. With combined space and water

heating poised to become a major cost-effective use of this technology, the DR capability of the system with both loads needs to be studied.

It will also provide technical feedback to manufacturers on needed improvements and give visibility to the concept to encourage future development.

Goals and Objectives

The project has three main goals:

1. Determine performance of two types of combined space conditioning and water heating heat pump systems in existing homes in all of the region's major climate areas.
2. Determine the DR capability of the CO₂ refrigerant combined space and water heat pump system under a wide range of occupant-controlled settings in the high space heating load context of the PNNL Lab Homes.
3. Develop an analysis, using actual performance data and costs, of the benefits and costs of retrofitting existing electrically heated homes to optimized levels and equipping them with combined space conditioning and water heating in the region's three heating zones and major cooling zone.

Deliverables

Deliverables will include:

First Midterm Report with the PNNL Lab Homes Performance and DR report review, and field study review.

Second Midterm Field Study Report to ensure the analysis methods are on track, and that no results indicate the need to extend or redo any of the monitoring.

Final Report and Project Presentation containing final findings, reports, and analysis.

Project Research Paper: A paper based on the project will be submitted to a relevant technical forum.

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Project Start Date: October 1, 2015

Project End Date: September 30, 2017

Reports & References

Links

Participating Organizations

Washington State University Energy Program, Olympia WA

Technical Partners:

CLEAResult LLC

Ecotope, Inc.

Pacific Northwest National Laboratory (PNNL)

Co-Sponsors

Cowlitz County PUD

Energy Trust of Oregon

Idaho Power

Inland Power and Light

Northwest Energy Efficiency Alliance (NEEA)

Pacific Gas and Electric

Puget Sound Energy

Sanden International U.S.A. Inc.

Related Projects

TIP 292—advanced HPWHs,

TIP 302—demand response potential of split and unitary CO2 refrigerant HPWHs, and

TIP 326—functionality and performance of prototype CO2 refrigerant HPWH configured as combination space and water heating systems in highly efficient new homes.

Funding

Total Project Cost: \$790,000

BPA Cost Share: \$395,000

BPA FY2016: \$267,000

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