CO2 Heat Pump Water Heaters

Utility Energy Forum 2014
Tahoe City, CA

Rob Penney

Senior Energy Engineer

WSU Energy Program

WASHINGTON STATE UNIVERSITY
EXTENSION ENERGY PROGRAM

Project Structure

- Funded by Bonneville Power Administration's Technology Innovation Program
- WSU Energy Program is project lead—Ken Eklund is project Principle Investigator
- Project team includes BPA, participating utilities, Ecotope, Cascade Engineering Services and Mark Jerome, Clear Result

Project Synopsis

WSU and its partners are:

- Performing lab and field testing of a split system, CO_2 refrigerant heat pump water heater manufactured by Sanden International
- Lab test to DOE and Northern Climate Specifications
- Field tests in partnership with the following, one installed in each territory for 12-18 months of monitoring :

Avista	Heating Zone 2
Energy Trust of Oregon	Heating Zone 1
Ravalli Electric Coop	Heating Zone 3
Tacoma Power	Heating Zone 1

- NEEA is also a contributing partner

Lab Test Set Up

Outdoor unit in the controlled test chamber. The fluid lines connecting this to the tank are filled with potable water.

Indoor tank instrumented in laboratory

CO_2 Refrigerant

Advantages:

- Operates effectively across a wide temperature range
- Has a global warming potential that's an order of magnitude less than that of hydrofluorocarbon refrigerants (HFCs)

Disadvantages:

- Operates at 1,400 PSI, which is much higher than HFC systems
- Is more expensive than HFC systems
- Is not yet commercially available in most U.S. applications—but can be used in Portland, Oregon through its Advanced Technology Advisory Committee process.

Comparison with other HPWH

The tested technology is different from currently available HPWH:

- It has a split system instead of unitary tank and compressor
- It takes heat from the outside air instead of conditioned space or a buffer zone (garage)
- CO_2 refrigerant is more efficient than HFC
- Needs a tempering valve

Specifications

Equipment currently built and sold in Australia

- Storage Capacity: 83 gallons
- Tank Set Point: 149° F and not adjustable

Outdoor unit has a variable frequency drive compressor and fan

Water is heated at the outdoor unit. A pump circulates water from the bottom of the tank, to the outdoor unit heat exchanger, heating the water in one pass, and re-injecting the hot water near the top of the tank

No resistance heating element

Accomplishments

The Lab testing was completed last fall and the Field test is currently underway.

The first phase field data analysis will completed later this month

WSU will continue gathering and analyzing field data, survey homeowners on their experiences, and write a final report, completing the project later in 2015

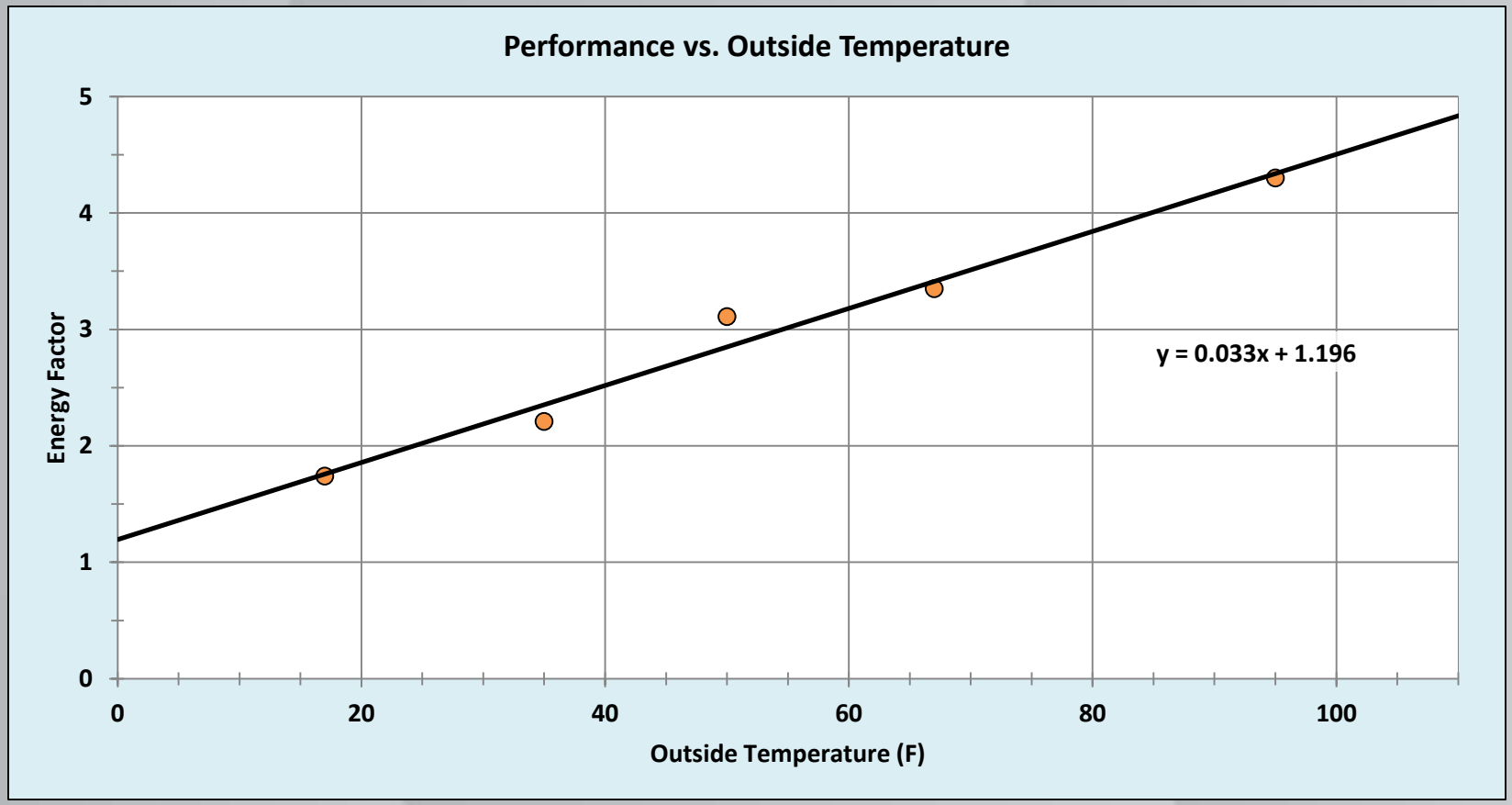
Expected Benefits

- The lab test reported a Northern Climate Specification Energy Factor of 3.2 with a Delivery Rating (# of showers you can take) of 7.5 The highest current listing is 2.2 for EF and 5 for DR, so this is 50% better EF and DR
- The split system has no impact on conditioned space, and the outside unit is very quiet.
- CO2 has a Global Warming Factor of 1— GWF of R410A is between 1,000 and 3,000.

Conservation Value

- 6th Power Plan Target is 50% HPWH by 2030.
- 40% of region's residences or 1,300,000 homes have electric DHW—50% is 650,000.
- If 10% of this number is split system CO2 HPWH, that is 65,000 units.
- The Eco Cute at 3.5 average COP saves 1,400 kWh more per year than unitary HPWH when average space heat impacts are included in the calculation.
- 65,000 Eco Cute units would produce $5.5 million in additional regional annual savings at $60 per MWH. At $30 per MWH wholesale savings drop to $2.75 million.

Energy Factor Based on Lab Results



Calculated Annual Energy Factors

Climate	Annual EF		Climate	Annual EF
Boise	2.9		Minneapolis	2.7
Kalispell	2.6		Raleigh	3.2
Portland	3.0		Boston	2.9
Seattle	2.9		Chicago	2.9
Spokane	2.8		Houston	3.5

CO2 Laundry

- 50% less energy use, no water use
- No drying needed (CO2 flashes)
- Gaseous CO2 is captured, cleaned, reused
- Can pay back in several years
- Disinfects so good with healthcare
- Good for dry cleaners, hospitality, hospitals, with 100-200 pounds per hour capacity

For More Information

- Rob Penney
- (360) 956-2053
- PenneyR@Energy.WSU.edu

- *www.E3TNW.org*

- *www.ConduitNW.org*

WASHINGTON STATE UNIVERSITY

EXTENSION ENERGY PROGRAM

www.energy.wsu.edu