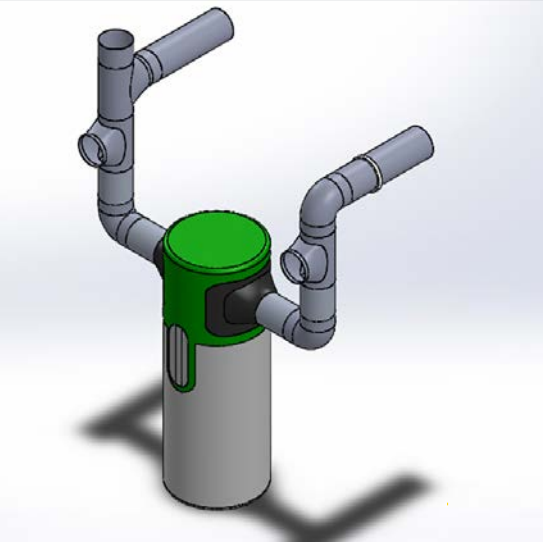
U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy



Building America Case Study
Efficient Solutions for New and Existing Homes

# Effect of Ducted HPWH on Space Conditioning and Water Heating Energy Use – Central Florida Lab Home

Cocoa, Florida

## PROJECT INFORMATION

**Project Name:** Flexible Residential Test Facility - Effect of Ducted HPWH on Space Conditioning

**Location:** Cocoa, FL

**Partners:**
Building America Partnership for Improved Residential Construction, *www.ba-pirc.org*

**Building Components:** HVAC and Water Heating

**Application:** Single Family

**Years Tested:** 2014–2015

**Applicable Climate Zone(s):** Hot-Humid

## PERFORMANCE DATA

Potential cooling energy reduction:
Closed loop: 0.86 kWh/day
Open loop: -0.26kWh/day

Potential heating energy increase:
Closed loop: 0.42 kWh/day
Open loop: 1.38 kWh/year

Data for experiments conducted in the FRTF are available through *http://www.infomonitors.com/rtf/*

Building America® U.S. Department of Energy

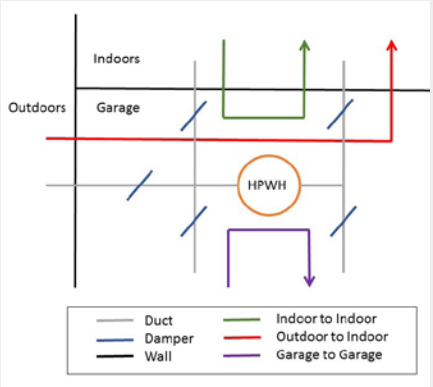
The Building America Partnership for Improved Residential Construction (BA-PIRC) investigated the impact of ducted heat pump water heaters (HPWHs) on space conditioning and water heating energy use in residential applications. Two identical HPWHs, each of 60-gallon capacity, were tested side by side at the Flexible Residential Test facility (FRTF) laboratories at the Florida Solar Energy Center (FSEC) campus in Cocoa, Florida. The FRTF's residential buildings feature the same square footage (1535 ft2), orientation, and envelope characteristics, with the only current difference being the floor material. The same water heating experiment was run in each test house from July 2014 to February 2015.

During testing, air was either drawn from the conditioned space (indoor to indoor or closed loop), or outdoors (outdoor to indoor, or open loop), sent across the HPWH evaporator coil, and then directed into the conditioned space.

The impact on the building's indoor air enthalpy (h) change was investigated during the cooling season. An average monthly auxiliary net cooling effect (Δh) provided by the HPWH increased from about 5.6 kBtu/day in July 2014 to 12.9 kBtu/day in November 2014 when utilizing the indoor-to-indoor airflow configuration (green bars in Figure 1). This resulted in an approximate savings of 0.86 kWh/day, or 3.8%. When using the outdoor-to-indoor airflow pathway (yellow bars in Figure 1), the HPWH was unable to completely mitigate the load imposed by the outdoor air, and a small net cooling load was added to the building during peak summer months. This resulted in a small (1%) cooling energy penalty, which is very minor considering the outdoor air could constitute approximately 30% of the mechanical ventilation requirements of ASHRAE 62.2.

During winter months, the closed-loop configuration imparted approximately 16.5 kBtu/day of heating load on average, resulting in a heating energy penalty of about 6%. The open-loop airflow configuration added approximately 26.3 kBtu/day of heating load on average, resulting in a heating energy penalty of approximately 17.5%. This result points to the potential to optimize whole house annual energy savings by being able to direct HPWH exhaust away from the conditioned living space during winter.

### Ducted Heat Pump Water Heater




Heat pump water heaters were retrofitted with duct kits (shown below without insulation) and manual directional dampers to study the impact of different airflow pathways.

For more information, see the Building America report, Effect of Ducted HPWH on Space Conditioning and Water Heating Energy Use - Central Florida Lab Home, at *https://www1.eere.energy.gov/ba/pdfs/65358.pdf*.

Image credit: All images were created by the BA-PIRC.

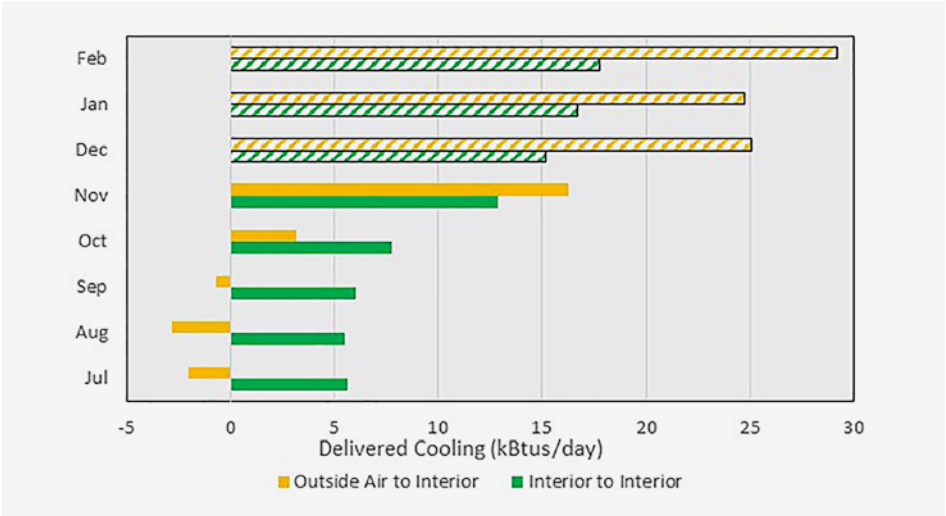



Figure 1. Summary plot comparing airflow pathways and their monthly net effect on indoor building enthalpy change

## Lessons Learned

- Cooling and mechanical ventilation provided by the exhaust of a HPWH is a function of runtime, which is influenced primarily by the seasonal hot water gallons used (incoming water temperature) and HPWH thermostat setpoint.
- Cooling efficiency demonstrated by the HPWH was measured and averaged across all airflow configurations resulting in a Coefficient of performance (COP) of 1.5 (1.12 to 1.9).
- Seasonal hot water heating efficiency of the HPWHs showed little variation for the seasonal hot water load imposed (34–53 gallons per day), averaging a COP of 2.0 and 2.1 for the east and west FRTF buildings.

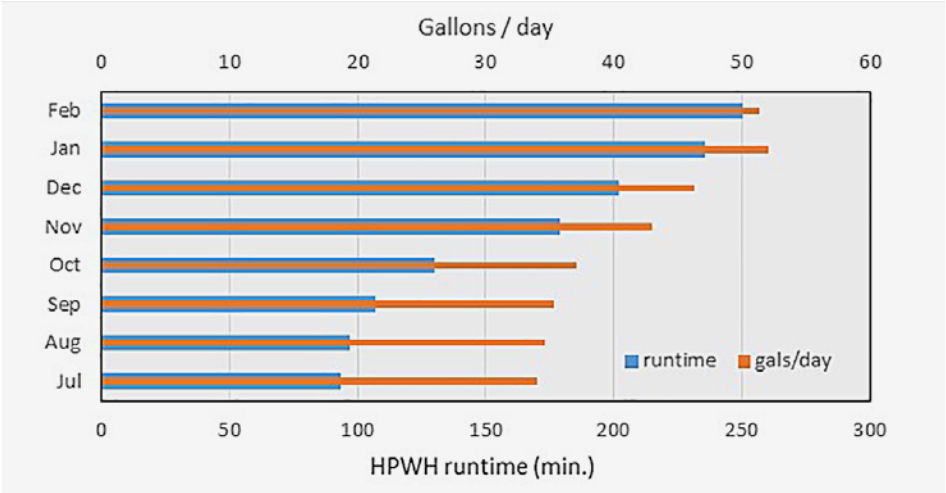



Figure 2. Variation in imposed hot water draw and HPWH runtime response throughout the testing period