

West Village, Davis Ca, United States

Central Heat Pump Water Heater (HPWH) installed on student apartments at the University of California, monitored by Alliance for Residential Building Innovation.

Key facts

Building

Location	West Village, Davis Ca, US
Heat distribution	four pipe system
Heated area	1320 m ²
Level of insulation	very good

Heat pump and source

Number of heat pumps	1
Installed capacity	37 kW
Operation mode	electric
back up in hot water storage tank	
Heat source	outside air
Brand and type:	A.O. Smith (E-Tech1) WH115-HTC
Refrigerant	R134a
Sound level	dB

Heating system

Heating temperature	35 °C
---------------------	-------

Domestic hot water

Type of system	collective
Max. Temperature	55 °C
Circulation system - Time/temperature recirculation control; 1-1/4" insulated hot water supply and return lines.	
Legionella measures	thermal
Storage size	545 litres
Number of storage tanks	2

Other information

Investments costs incremental costs are estimated at ~\$0 versus individual gas water heaters, \$10,000 versus central gas water heating, and \$20,000 versus central electric.

Experience

[Multifamily Heat Pump Water Heater Evaluation](#), M.Hoeschele and E.Weitzel, Alliance for Residential Building Innovation, March 2017, Prepared for: The National Renewable Energy Laboratory, Subcontract No. KNDJ-0-40340-00

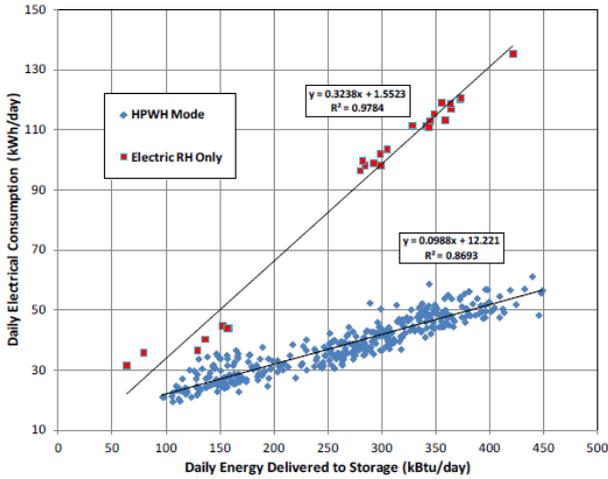


In this project, the Alliance for Residential Building Innovation team monitored the performance of a central Heat Pump Water Heater (HPWH) installed on student apartments at the University of California, Davis, West Village zero net energy community. The HPWH system, one of 32 currently installed at West Village, was monitored in detail during a 16-month period. Monitoring results were used to validate a Transient System Simulation (TRNSYS) model. The validated model was then applied to six U.S. climates to evaluate performance using local weather and utility rates.

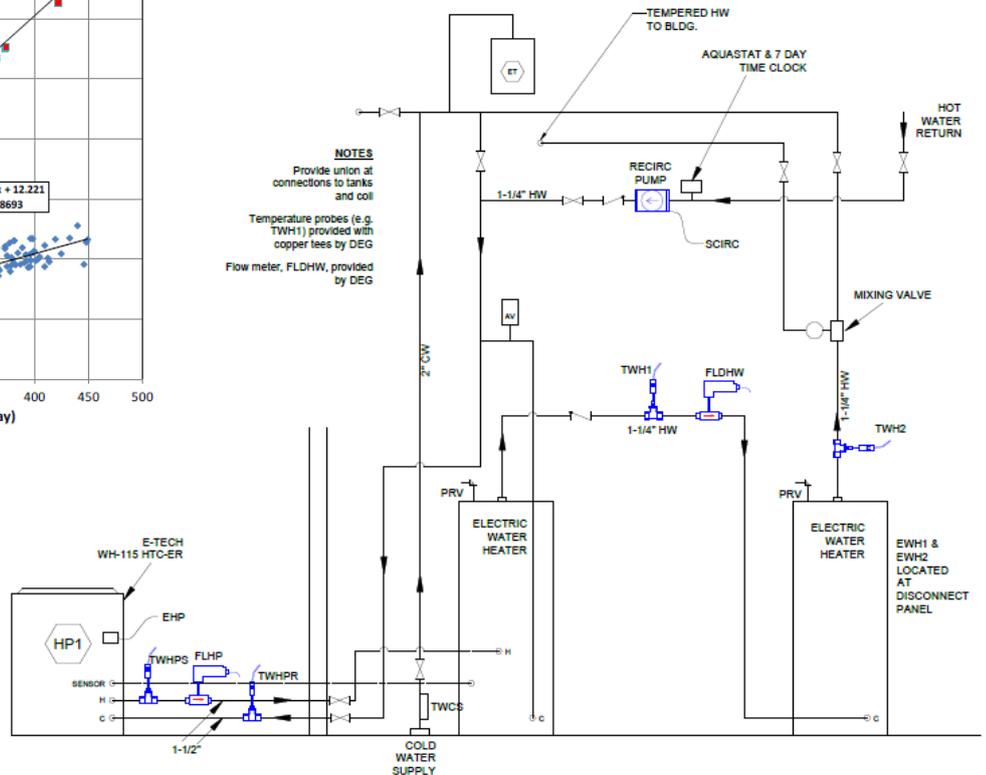
The nominal 37 kW E-Tech air-source HPWH was installed with two 120-gal storage tanks in series (with electric elements of 54 kW for supplemental heating) to provide hot water to a 12-unit apartment building serving 32 occupants. The system was monitored from October 2011 through February 2013.

When the monitoring was initiated in 2011, the HPWH was not operating properly primarily because of a lack of contractor familiarity with the technology. The initial problems were corrected. Steady-state operating COPs, in the range from 3.0–4.0, matched well with manufacturer values—although both heating capacities and power demand were 10%–20% lower than nominal values, primarily due to higher HPWH inlet water temperatures and lower system flow rates through the HPWH heat exchanger. Monitoring during the 16 months indicated that operating cycles were frequently short, resulting in lower average efficiencies due to performance degradation during system start-up. Next to fairly high standby parasitic energy consumption it resulted to an annual average COP of 2.12. This degradation most pronounced during the summer months when lower hot water loads.

West Village, Davis Ca, United States, Technical details

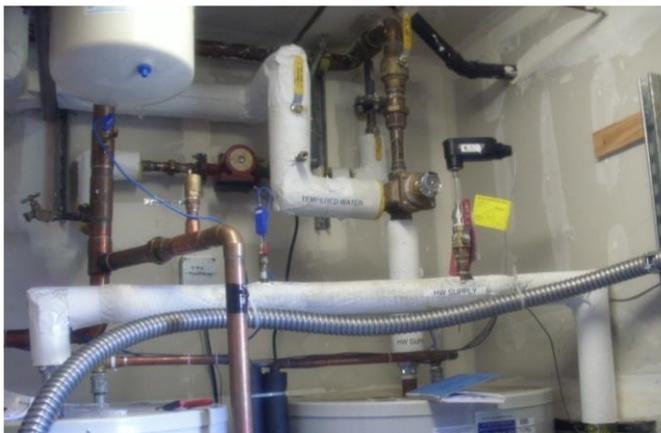


The graph plots measured daily kWh use as a function of increasing hot water load.



Description of the technical concept

The manufacturer suggested that the system be configured so that the HPWH maintains water temperatures of 60°C in the primary storage tank. Resistance elements in the two electric storage tanks were scheduled to maintain minimum tank temperatures of 49°C, allowing the HPWH to meet the bulk of the water-heating load. A tempering valve downstream of the second storage tank was set to limit the supply water temperature to the recirculation loop at 49°C. A hot water recirculation loop pump serving the building is controlled by both a return water temperature sensor and a timer that shuts it off during part of the night.



- HPWHs perform best when outdoor temperatures are more moderate, inlet water temperatures to the unit are low, and operating cycle times are long enough to ensure regular steady-state operation. If cycle times are short, performance will suffer. This was evident in the summer monitoring, which showed the lowest average operating COPs during the year. Multistage compressors, oversized storage, or wider thermostat deadbands will increase cycle times and improve performance.
- The installing contractor and service personnel should be familiar with the HPWH technology. Startup issues in the initial construction phase contributed to early performance problems. These were remedied in later project construction phases.
- Savings of 49%–59% are expected in typical applications relative to electric resistance water heating, with paybacks of 6–10 years (without incentives). The comparison relative to gas water heating is more challenging because gas rates in much of the country are quite low.
- Mechanical designers should carefully size the unit relative to the load and provide sufficient storage to allow units to operate with extended run cycles to maximize efficiency.