

W3 RESIDENTIAL HEAT PUMP WATER HEATERS

Description of Technology

The typical U.S. house today uses an insulated storage tank and heats water with a gas flame or electric resistance element. The former suffers large standby losses through the flue, and the latter has inherent inefficiencies of electricity generation. The heat pump water heater uses a vapor-compression refrigeration cycle, like a refrigerator or air conditioner, and the COP largely compensates for primary electricity conversion losses. HPWHs are commonly installed in basements, where they take heat from the air at a relatively low temperature and reject the heat at a higher temperature to the water tank; placement for slab-on-grade houses varies with climate. In the process, most units also cool and dehumidify the basement, which can be valuable. Efforts to commercialize the technology have waxed and waned for decades. Current U.S. annual sales are estimated as a few thousand units per year (Sachs 2002).

Current Status of Measure

Within the past few years, several manufacturers abandoned the market, and the only large-scale utility program for residential HPWHs in the continental United States was suspended after 4,000 installations, largely because utility funding was disrupted (DOE 2002e). However, two new residential products have been introduced, and there is substantial interest now. The “Watter\$aver” from ECR International is designed to “drop in” to the same space as an existing 50 gallon resistance water heater and can be installed by a single trade. Its certified EF is 2.4 (GAMA 2003), compared with 0.95 for the best resistance units. NYSERDA offers \$300 incentives for this unit. The alternative, an add-on unit, is exemplified by the Nyle Specialties Nyletherm 110 heat pump water heater. It is a wall-hung, 7,000 Btuh auxiliary unit designed to supplement an existing water heater by replacing the primary resistance element. Its power requirement, 7.25 amps at 120 v., can be met by a conventional wall socket. The unit is new, and there are no independent performance data yet. In the commercial sector, HPWHs have not grabbed a big market. However, DOE recently selected United Technologies Corp. to develop systems with higher water-delivery temperatures and wider operating range for commercial uses (DOE 2003d).

Energy Savings and Costs

The incremental cost of an integrated heat pump water heater today is in the range of \$900–1,000 (Johnson 2003). At average electricity prices (\$0.078/kWh), this would be a four-year simple payback. The add-on HPWH will likely have similar costs and benefits, but certified ratings are not yet available. In a mature, competitive market, the purchase price (without installation) will be about the same as that of the separate technologies, approximately resistance water heater plus a room air conditioner, or about \$500–600. Installation should be the same cost as for a resistance water heater, unless a condensate pump and installation are required (\$100).

Key Assumptions Used in Analysis

We assume: (1) HPWHs displace 30% of all resistance water heaters but no gas water heaters (estimated fraction of customers with electric water heaters and demand at test measure assumption, 66.3 gpd [DOE 2002d], rather than the national average of about 44 gpd [DOE 2001a, Figure 10.1]); (2) Field EF = 2.4, compared with 0.9 for electric resistance water heater; (3) Calculation using methods of GAMA (2003); and (4) Incremental installed cost of \$800.

Recommended Next Steps

The first cost is high, and the products are not widely available. We recommend the following steps, *in parallel*: (1) Continued field demonstrations—if successful, progress toward rebates and contractor training as early MT promotion; (2) Disseminate information (technology, availability, savings calculation methods) to potential large-scale buyers, as FEMP is doing; (3) Work to be sure that ENERGY STAR residential programs encourage use of heat pump water heaters by uniformly providing incentives for EF>2.0, once the technology is well-proven and readily available.

W3 Residential Heat Pump Water Heaters

<i>Description</i>	Vapor-compression cycle water heaters, resistance supplemental		
<i>Market Information:</i>			
Market sector	RES		
End-use(s)	WH		
Energy types	ELEC		
Market segment	NEW, ROB		
<i>Basecase Information:</i>			
Description	50 gallon elec. Resistance storage water heater		
Efficiency	0.904 federal minimum January 20, 2004		
Electric use	4,857 kWh/year	per GAMA directory method	
Summer peak demand	0.64 kW	86% load factor	
Winter peak demand	0.64 kW		
Gas/fuel use	0		
<i>New Measure Information:</i>			
Description	Drop-in Integrated HPWH		
Efficiency	2.4 Nyle, as listed in April 2003 GAMA directory, p. 200		
Electric use	1,922 kWh/year	per GAMA directory method	
Summer peak demand	0.26 kW	86% load factor	
Winter peak demand	0.26 kW		
Gas/Fuel use			
Current status	COMM		
Date of commercialization	2003		
Life	14.5 years	Comparable to elec. water heater (14 year) or refrigerator (19 yr).	
<i>Savings Information:</i>			
Electricity	2,936 kWh/year		
Summer peak demand	0.39 kW		
Winter peak demand	0.39 kW		
Gas/Fuel	0 MMBTU/year		
Percent savings	60%		
Feasible applications	30%	of electric storage water heaters -- those with greatest use	
2020 Savings potential	15,645 GWh		
2020 Savings potential	158 TBtu (source)		
Industrial savings > 25%	NO		
<i>Cost Information:</i>			
Projected Ince. Retail Cost	\$650 2003 \$	Nadel, 2002	
Other cost/(savings)	\$0 \$/year		
Cost of saved energy	\$0.02 \$/kWh		
Cost of saved energy	\$2.16 \$/MMBtu		
Data quality assessment	A (A-D)		
<i>Likelihood of Success:</i>			
Major market barriers	Mixed field record, high price		
Effect on utility	may dehumidify and provide minor AC benefits		
Current promotion activity	Manufacturer and DOE promoting, NYSERDA offers incentives		
Rating	3	(1-5)	Given barriers, a "3" at best
Rationale	20 years of effort have not increased sales.		
<i>Priority / Next Steps</i>			
Priority	Medium		
Recommended next steps	Energy Star would help validate, continued field demos, codes credit.		
<i>Sources:</i>			
Savings	EF ratio		
Peak demand	Russ Johnson, July 25 2003		
Cost	Nadel 2002		
Feasible applications	Estimated as the largest users of resistance heating today		
Measure life	ECRI site, FEMP		
Other key sources	Karl Mayer, karlm@dunkirk.com; http://www.ecriinternational.com/prod_wattersaver.asp		
Principal contacts	John Tomlinson, ORNL, tomlinsonjj@ornl.gov, 865-574-0291		
Notes	Russ Johnson, johnson.research@att.net, 860-633-9020		