

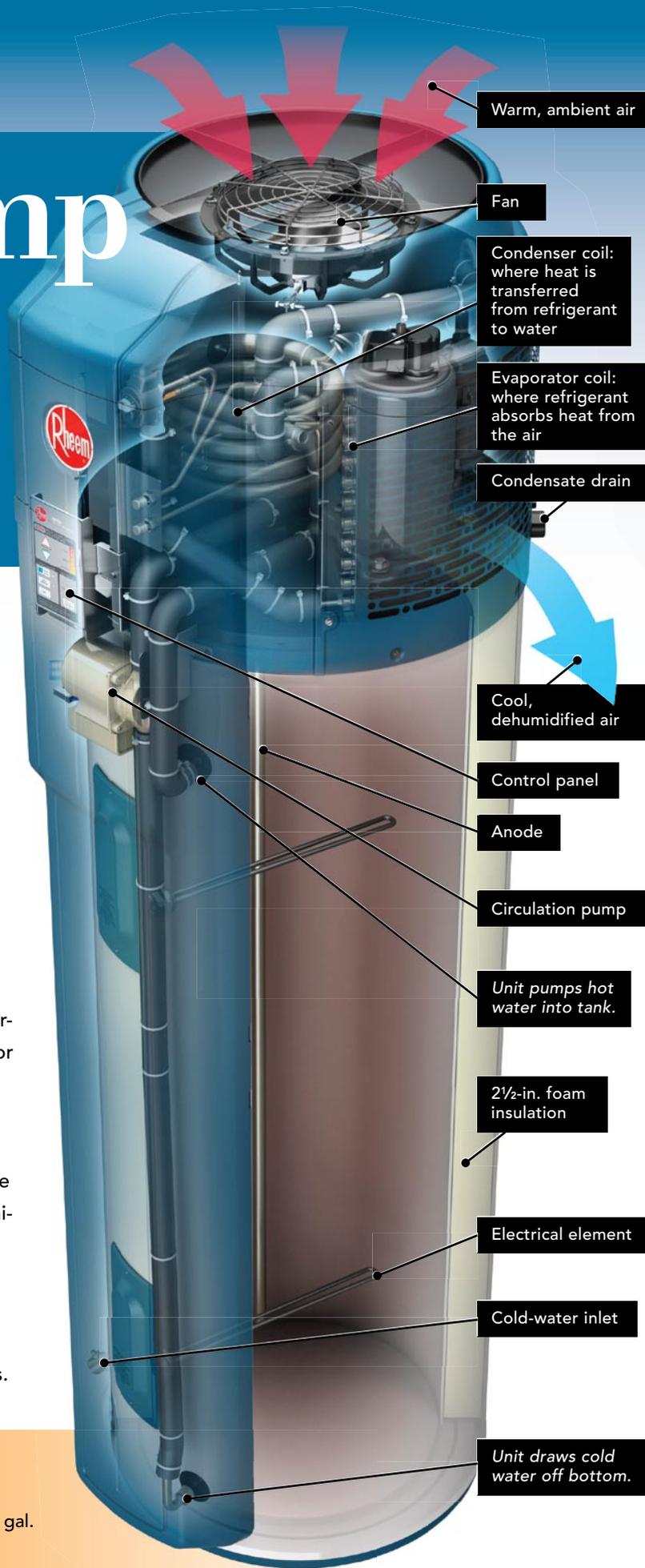
# Heat-Pump Water Heaters

A new breed of water heater uses time-proven heat-pump technology to cut energy consumption in half

BY SEAN GROOM

## INSIDE A HEAT-PUMP WATER HEATER

A heat pump warms water in the storage tank by compressing and expanding refrigerant in a closed loop. The fan and compressor are the only necessary electrical draw, and they pull much less current than a traditional electric water heater. The electrical-resistance element is used as a backup if the ambient air falls below the heat pump's minimum operating temperature, around 40°F, and can be activated to shorten recovery time during periods of unusually high demand. A HPWH generates a stream of cool, dry air and condensate as by-products.



**Rheem** [www.rheem.com](http://www.rheem.com)

- **Model:** HP-50 • **Type:** integrated • **Capacity:** 50 gal.
- **Energy factor (EF):** 2.0 • **First-hour rating (FHR):** 67 gal.
- **Cost:** \$1600 • **\$1500 tax-credit applicable:** yes

**H**eat-pump water heaters have been around for about 25 years, but I didn't know they existed until energy costs spiked a few years ago. The relatively low cost of energy over the past 30 years is one reason for the technology's anonymity. Another reason is that until recently, heat-pump water heaters were sold only as retrofit kits. Some homeowners might have been turned off by the Franken-tank appearance of a conversion or leery of energy-saving claims associated with bolting a metal fan box to a water heater.

That has changed recently as some big players—Rheem, GE, Stiebel Eltron—have entered the heat-pump water heater (HPWH) market with integrated appliances. With these companies' large marketing budgets and distribution channels, and government incentives, you can expect HPWHs to become more commonplace.

### Unbeatable efficiency

Energy factor (EF) is a rating of a water heater's efficiency based on the amount of hot water produced per unit of energy while accounting for standby losses from the storage tank and for cycling losses.

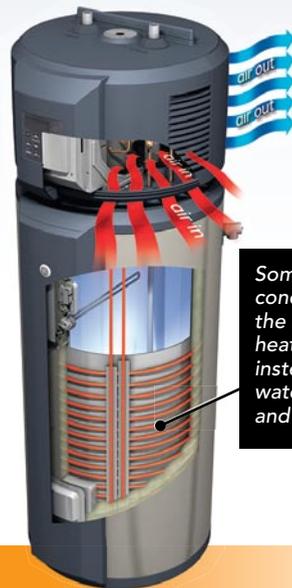
Traditional electric water heaters have an energy factor that theoretically approaches 1. That means that an electric water heater is able to convert almost all the electricity to heating the water. Oil and natural gas are less efficient; the most efficient combustion tank-type water heater has an EF of 0.67. (A typical gas-fired tankless water heater has an EF of 0.82, but a few have ratings from 0.96 to 0.98.) The downsides to electricity are that it's expensive in many parts of the country and that it's only as efficient and clean as the fuel source, which is often coal (see "Taking Issue," *FHB* #211 and online at FineHomebuilding.com). HPWHs, however, are able to generate more energy (in the form of hot water) than they consume, and register EF values between 2.0 and 2.8.

### Hot water from warm air

The key to a heat pump's efficiency is that it doesn't create heat. Instead, it transfers heat from one place to another. There is nothing mysterious about how a HPWH works. Every refrigerator uses a heat pump to do its job. The difference is that a refrigerator pumps heat out of an insulated box (think of the warm air vented from the bottom of a refrigerator) while a HPWH sends heat into an insulated tank.

By compressing and expanding refrigerant in a closed loop, a HPWH extracts heat from surrounding air and delivers it to the tank. The neat thing about this process is that despite the fact that it's extracting heat from air that might be only 60°F, it can raise water temperatures as high as 140°F.

This multiplier effect is measured by something known as the coefficient of performance, or COP. HPWHs can achieve COP values between 3 and 5. That translates into 300% to 500% efficiency for every kilowatt of electricity used to power the fan and compressor. There's a catch, though: COP varies by climatic conditions. Heat pumps are most efficient when the surrounding air is warm and



Some HPWHs wrap the condenser coils around the tank to transfer heat to the water instead of pumping water out of the tank and past the coils.

**GE** [www.ge.com](http://www.ge.com)

- **Model:** GeoSpring Hybrid
- **Type:** integrated
- **Capacity:** 50 gal.
- **Energy factor (EF):** 2.35
- **First-hour rating (FHR):** 63 gal.
- **Cost:** \$1600
- **\$1500 tax-credit applicable:** yes

**Extra savings.** The GeoSpring includes demand-response capability for use with smart electric meters and can switch automatically between operating modes and change temperature settings to reduce electricity use during peak cost periods.





**A.O. Smith**  
www.etechnology.com

- **Model:** Voltex PHPT-80
- **Type:** integrated
- **Capacity:** 80 gal.
- **Energy factor (EF):** 2.3
- **First-hour rating (FHR):** 71 gal.
- **Cost:** \$2500
- **\$1500 tax-credit applicable:** yes



**Stiebel Eltron**  
www.stiebel-eltron-usa.com

- **Model:** Accelera 300
- **Type:** integrated
- **Capacity:** 80 gal.
- **Energy factor (EF):** 2.5
- **First-hour rating (FHR):** 78 gal.
- **Cost:** \$3500
- **\$1500 tax-credit applicable:** yes



**AirGenerate**  
www.airgenerate.com

- **Model:** AT166
- **Type:** integrated
- **Capacity:** 66 gal.  
50-gal. version to be released soon
- **Energy factor (EF):** 2.2
- **First-hour rating (FHR):** 60 gal.
- **Cost:** \$1499
- **\$1500 tax-credit applicable:** yes

**Improved maintenance.** Instead of using a sacrificial anode rod, Air-Generate's integrated units have a mesh sleeve that holds anode pellets. Simply unscrew a cap, and add more as needed.

humid. When comparing the efficiency of different models, be sure that COP is calculated under the same conditions. Usually, the manufacturer-listed COP is around 3 and is calculated with a temperature in the 60s and relative humidity in the 70% range.

**Payback dollars and recovery hours**

The water heater accounts for about 14% of the energy consumed in the typical home.

A HPWH dramatically reduces energy consumption compared to an electric water heater. And the higher the cost of electricity, the more dramatic the savings. In Connecticut, where I live, electricity costs 20¢ per kWh. For a HPWH, the payback period is less than two years, and federal tax credits for the HPWH will further reduce the payback period. (See the chart on the facing page for payback comparisons.)

If your existing tank-type water heater is fueled by natural gas, the payback period won't be as dramatic. In fact, you'll have to look hard at the relative costs of gas and electricity. Based on the current national average of electricity rates and gas rates, the lifetime ownership cost between an Energy Star gas-tank-style water heater and a HPWH is a wash. Also, you'll need to consider the difference in recovery times.



## Upgrade your existing tank

These small heat pumps allow you to upgrade your existing water heater to increase efficiency. Electric tank-style water heaters can be converted easily to heat-pump versions with one of three add-on products. Some of these products work with oil- or gas-fired water heaters, too, but installation may require a plumber's assistance. You'll need a tank of at least 40 gal., but larger tanks are better to maximize efficiency.

Integrated models bear the Energy Star label, but that doesn't mean that retrofit models are less efficient. They use identical technology; it's just that Energy Star doesn't rate retrofit models, and they don't qualify for a federal tax credit.

The heat pump is housed in a small box. Two retrofit models, the Geyser and the E-Tech, are installed next to the tank and use a circulating pump to draw water through the heat pump and then return hot water to the storage tank.

The AirTap lets you convert to a HPWH for about half the cost of the cheapest integrated models, but consider the age and condition of the tank so that you aren't stuck replacing it in a few years. Warranties for retrofits run between one and five years, but a heat pump should last about 12 to 15 years.



### AirGenerate

www.airgenerate.com

**Models:** AirTap A7 and AirTap A12

**Capacity:** 30 to 80 gal. for A7

**Energy factor (EF):** 2.11

**First-hour rating (FHR):** 43 gal. for A7; 60 gal. for A12

**Cost:** \$700 for A7; \$900 for A12

### Northroad Technologies

www.northrdt.com

**Models:** Geyser 6000-3.0

**Capacity:** 30 to 120 gal.

**Energy factor (EF):** 2.8

**First-hour rating (FHR):** 62.5 gal. (based on 50-gal. tank)

**Cost:** \$1300

### A.O. Smith

www.etechbyaosmith.com

**Models:** E-Tech R060

**Capacity:** 40 gal. and up

**Energy factor (EF):** 1.9

**First-hour rating (FHR):** 44 gal.

**Cost:** \$1300

As with any type of water heater, you need to consider how your household uses hot water. The first-hour rating and the recovery period determine the ability of a water heater to meet hot-water demand. The first-hour rating is the number of gallons of hot water the heater can deliver when starting with a fully heated tank. This is a function of tank size and the amount of additional hot water it can generate during that hour. The recovery period is the amount of time required to recharge the tank. This is important if you make multiple large hot-water demands that exceed the first-hour capacity over a two- or three-hour period. (See [www.energysavers.gov](http://www.energysavers.gov) for a worksheet to calculate your demand.) Although recovery times vary by specific conditions (incoming-water temperature, ambient air temperature, and so on), recovery time is typically faster with

a gas-fired unit. Generally, you might get 12 gal. to 20 gal. per hour with a heat pump and 35 gal. to 40 gal. per hour with gas.

### Keep these considerations in mind

In addition to planning for its sensitivity to air temperature, remember that a HPWH vents cool, dehumidified air, produces condensate, and has minimum airspace requirements. The heat pump should not be installed in a room or a garage where the temperature falls below the low 40s. In heating climates, it's usually placed in the basement. Some homeowners are concerned about the cooling characteristics of the water heater eating into their heating budget. Waste heat from the boiler or furnace during the winter generally is enough to offset the cooling effect of the heat pump. As a summertime bonus, a HPWH can replace the basement dehumidifier, and

it can reduce your cooling load. Depending on your heating and cooling situation, you can direct cool air to the outside, to another room, or to the central-air ducting. Some installations use a damper to direct cool air indoors or outdoors depending on the time of year; however, long runs of duct and/or dampers require a booster fan.

You'll need a place to drain condensate, which can be as much as 5 gal. a day. The HPWH should be somewhat isolated from living space because the fan and the compressor create about 50 db. of noise. Because the HPWH extracts heat from the surrounding air source and vents cool air, a heat pump needs at least 1000 cu. ft. of airspace to operate properly. □

Contributing editor Sean Groom is remodeling his house in Simsbury, Conn.

## Payback comparison

The purchase price of a water heater doesn't tell the whole cost story. Performance efficiency and the cost of different fuel types can erase purchase-price differences. For example, the GE GeoSpring costs \$1600 but uses only 1856kwh per year, for an average annual cost of \$210. The chart shows the payback when replacing GE's comparable gas or electric heaters with its HPWH.

Model	Price	Energy consumed	Annual cost at national average	HPWH payback period
GE electric (SE50M12AAH)	\$438	4879kwh per year	\$553 per year (11.33¢ per kwh)	3 years 4 months
GE natural gas (SG50T12AVG)	\$588	242 therms per year	\$290 per year (\$1.20 per therm)	12 years 8 months