FEMP
Federal Energy Management Program

Decarbonization Technology Snapshot

Heat Pump Water Heaters

Heat pump water heaters use electricity to move heat from one place to another instead of generating heat directly.[1] In many cases they replace gas-fired water heaters and are significantly more energy efficient, reducing on-site Scope 1 emissions and often resulting in reduced total emissions.

Technology Overview

A stand-alone air-source heat pump water heater pulls heat from the surrounding air and transfers it to heat water in a storage tank. Because it is drawing heat from the environment, it is often two to three times more energy efficient than conventional electric resistance and gas-fired water heaters. The technology is the same as used for a common refrigerator, a well-known heat pump already found in most homes and buildings, except that a refrigerator pulls heat from inside a box and sends it into the surrounding room.[2]

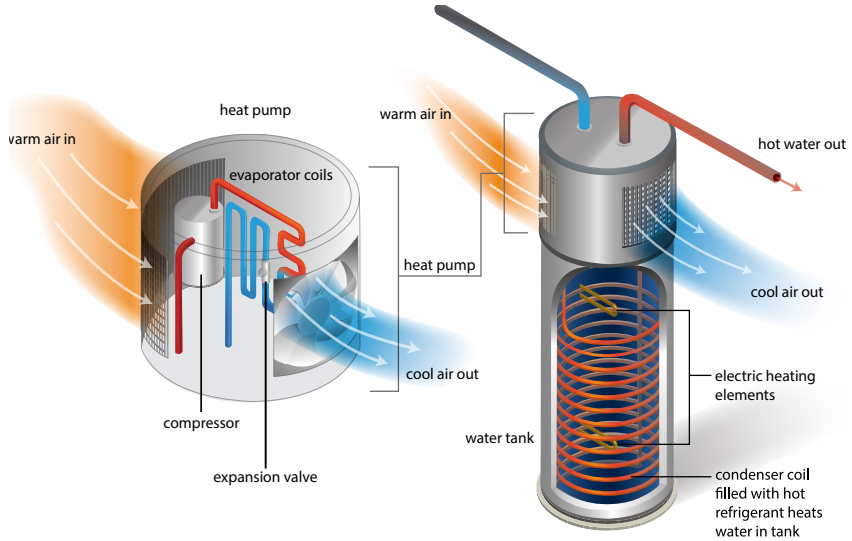

Figure 1. Heat pump water heater components. *Illustration by Marjorie Schott, NREL.*[3]

Installation Considerations

Heat pump water heaters operate most efficiently in locations that remain in the 40º–90ºF (4.4º–32.2ºC) range year-round and provide at least 1,000 ft^3 (28.3 m^3) of air space around the water heater. Air passing over the evaporator can be exhausted to the room or outdoors.[1]

Heat pump water heaters may not operate efficiently in a cold space because they tend to cool the space they are in. Installing them in a space with excess heat, such as a furnace room, can increase their efficiency and cool the room.[1]

How Do Heat Pump Water Heaters Support Decarbonization?

When replacing gas-fired water heaters, heat pump water heaters result in reduced Scope 1 (direct) emissions from facilities and fleet vehicles.

When replacing less-efficient electric water heaters, heat pump water heaters result in reduced Scope 2 (indirect) emissions from purchased electricity.

[1] Energy Saver. "Heat Pump Water Heaters." Accessed August 2024. https://www.energy.gov/energysaver/heat-pump-water-heaters.

[2] ENERGY STAR®. "How it Works — Heat Pump Water Heaters (HPWHs)." Accessed August 2024. https://www.energystar.gov/products/heat_pump_water_heaters/how-it-works.

[3] Maguire, Jeff, Jay Burch, Tim Merrigan, and Sean Ong. 2013. *Energy Savings and Breakeven Cost for Residential Heat Pump Water Heaters in the United States*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-5500-58594. https://www.nrel.gov/docs/fy13osti/58594.pdf.

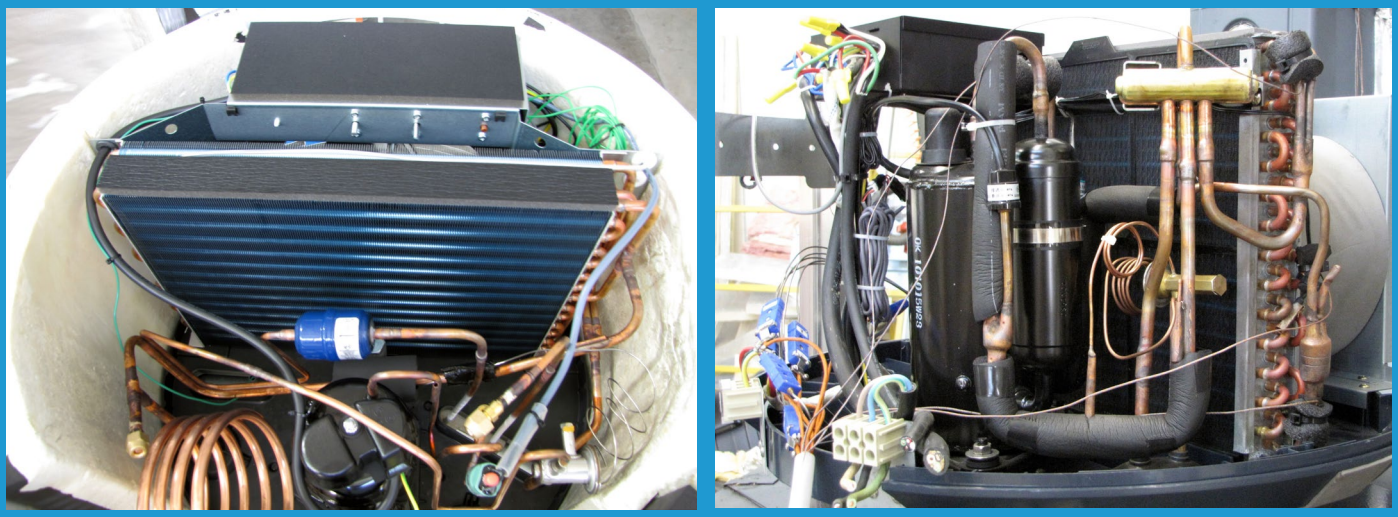

Figure 2. Photos show the inside of a heat pump, taken during the set-up of a heat pump water heater experiment at the National Renewable Energy Laboratory. Heat pump water heater technology has the potential to save twice as much energy when compared to an all-electric water heater because it utilizes the heat in the surrounding air instead of relying solely on electric resistance to heat the water. *Photos by Kate Hudon, NREL 19461 (left) and NREL 19462 (right).*

Costs and Savings

Heat pump water heater systems usually have higher initial costs than conventional water heaters. However, they typically have lower operating costs, which can offset higher purchase and installation costs.

Heat pump water heaters that have earned the ENERGY STAR certification are eligible for a tax credit of 30% of the installed cost, up to $2,000. Commercial buildings may also qualify for a federal tax credit.[4] Many states and utilities have additional incentives.[5,6] Heat pump water heaters in federal buildings are usually not eligible for federal tax credits.

All occupied buildings need electricity, but not all buildings need gas. Electricity can provide all the required heating and cooling in buildings. If more efficient electric equipment can replace gas-fired equipment in new buildings, the cost of gas piping, valves, and meters can also be eliminated. With similar replacements in existing buildings, the meter and the associated meter charge can be eliminated, providing additional savings. Reducing gas combustion in buildings can also reduce the associated air quality and explosion risks.

Sizing and Selection

To properly size a heat pump water heater, use the water heater's first hour rating. The first hour rating is the number of gallons of hot water the heater can supply per hour (starting with a tank full of hot water). The rating depends on the tank capacity and the size of the heat pump.

The Heat Pump Water Heater Installation Tool can guide you through the decision-making process for selecting a heat pump water heater and installing it properly.[7] After entering sizing and location information, the tool provides a recommended heat pump water heater size, a list of ENERGY STAR certified models matching the recommendation, and installation guidance. Federal agencies are required to purchase ENERGY STAR certified or FEMP-designated products as specified in 42 U.S. Code § 8259b, 42 U.S. Code § 8262g, and FAR Part 23. ■

Learn More

The Federal Energy Management Program provides technical assistance, resources, tools, and trainings to help federal agencies identify, procure, and deploy electrification and decarbonization strategies. Learn more at energy.gov/femp electrification-and-decarbonization-strategies-federal-agencies.

[4] Federal Energy Management Program. "Overview of Inflation Reduction Act Incentives for Federal Decarbonization." Accessed August 2024. https://www.energy.gov/femp/overview-inflation-reduction-act-incentives-federal-decarbonization.

[5] "ENERGY STAR Rebate Finder." Accessed August 2024. https://www.energystar.gov/rebate-finder.

[6] Office of State and Community Energy Programs. "State Energy Offices and Organizations." Accessed August 2024. https://www.energy.gov/scep/state-energy-offices-and-organizations.

[7] Building America Solution Center. "Heat Pump Water Heater Installation Tool." Accessed August 2024. https://basc.pnnl.gov/hpwh_installation_tool.