Technology Brief: Water Heaters Meeting the Proposed DOE Standards

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The U.S. Department of Energy (DOE) recently proposed updated efficiency standards for residential water heaters. The standards would improve the efficiency of both electric and gas water heaters and deliver some of the largest energy bill savings and greenhouse gas reductions of any appliance standard to date. If finalized, the new standards would take effect in 2029, giving manufacturers ample time to update their product lines. Here's what to know about water heaters that would meet the new standards.

MORE-EFFICIENT ELECTRIC TANK MODELS

Most electric water heaters sold today consume large amounts of electricity to heat water by using decades-old electric resistance technology. The proposed standards would shift most of the market for electric storage ("tank") water heaters to heat pump technology, which cuts energy use in half. Some small water heaters (i.e., units designed to provide relatively small amounts of hot water including those designed for installation in small spaces) could continue to use electric resistance technology.

WHAT IS A HEAT PUMP WATER HEATER?

Heat pumps are a proven technology for moving heat from a cooler place to a warmer place: they are what enable refrigerators to keep our food cold and air conditioners to keep our homes comfortable. With refrigerators and ACs, they move heat from a relatively cool space to the warmer room or to the outdoors. With heat pump water heaters (HPWHs), the same technology works in reverse—moving heat from ambient air into a tank of water. This technology has been around for decades. Typical HPWHs (sometimes referred to as "hybrid water heaters") also include backup electric resistance elements for periods of high hot water demand.

ARE HPWHS COST-EFFECTIVE?

DOE's analysis found that at the proposed efficiency level, a HPWH's incremental installed cost would be paid back in three years through dramatically reduced energy bills. Additionally, new tax incentives and rebates under the Inflation Reduction Act would let many households save money on up-front costs and see even quicker paybacks. Over the lifetime of the product, households would save more than $1,800 on average, not accounting for rebates or tax breaks.

DO HPWHS WORK IN COLD CLIMATES?

Since HPWHs transfer heat from the ambient air to heat water, some might wonder if they work when the ambient air is very cold. Today's HPWHs are efficient and effective even in cold climates. HPWHs can operate optimally in temperatures down to 40°F, and most water heaters are placed indoors, where surrounding air temperatures typically do not drop significantly below 40°F. Even on a very cold day, a HPWH placed in an unconditioned area (e.g., a garage) can still supply hot water by using the backup heating element—all while still using less energy on average than a conventional electric resistance

water heater. In addition, split system HPWHs, which typically have an indoor storage tank coupled with an outdoor compressor, can operate in temperatures as low as -25°F.

Will households have the hot water they need with a HPWH?

Typical HPWHs have backup electric resistance elements that help ensure that the availability of hot water, especially during periods of high hot water use, remains uninterrupted. When the heat pump and electric resistance elements are running simultaneously, HPWHs can actually deliver more hot water compared to a conventional electric resistance water heater. The overwhelming majority of HPWH consumers report being satisfied with their water heater, even when installed in colder climates like Maine and Michigan.[1,2]

Can HPWHs be placed anywhere in a home?

Similar to other water heaters, HPWHs can be installed in various locations, such as basements, utility rooms, or garages. Installers generally prefer to place HPWHs in basements or garages (in milder climates) because these locations can provide adequate space and airflow around the water heater. However, HPWHs can also be installed in constrained spaces like closets with proper ventilation (e.g., louvered door, exhaust ducting, or wall vents) to prevent cold air from building up.[3]

Are HPWHs noisy?

HPWHs have a fan and a compressor that make a light humming noise. When surveyed about their HPWH satisfaction, the vast majority of consumers expressed no issues with the sound level of their water heater. Most HPWHs emit sound at levels between 40 and 80 decibels (noise levels similar to a box fan or window air-conditioning unit). Since water heaters are typically located in basements, utility rooms, or garages, the noise that reaches living spaces is usually much lower.

Do HPWHs take away conditioned air?

HPWHs draw heat from the space in which they are located to heat up the water in the tank, then exhaust cooled air to the surrounding space.[4] This means that if the HPWH is installed in a conditioned space, in the winter the space-heating system may have to replace some of the heat that the HPWH absorbs. However, the electricity bill savings from a HPWH significantly outweigh any potential increases in heating costs. If there is a significant effect on the space heating, options are available to install a venting system to exhaust the cooled air into an attic/crawlspace or outdoors. DOE's analysis for the proposed rule takes into account increased costs due to space heating and/or exhaust venting, if applicable.

In the summer, HPWHs, if placed indoors, can decrease a home's cooling load because the exhaust air helps cool the space. Additionally, if located in basements or unconditioned spaces like garages,

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[1] Efficiency Maine Trust Heat Pump Water Heater Initiatives Impact Evaluation. www.efficiencymaine.com/docs/WHEC_EMT_HPWH_Impact_Evaluation_Full_Report_with_Appendices_12_11_2019.pdf.

[2] Installed Performance of Heat Pump Water Heaters in a Cold Climate. slipstreaminc.org/publications/installed-performance-heat-pump-water-heaters-cold-climate.

[3] Heat Pump Water Heaters in Small Spaces Lab Testing: "The Amazing Shrinking Room". neea.org/resources/heat-pump-water-heaters-in-small-spaces-lab-testing-the-amazing-shrinking-room.

[4] For split system HPWHs where the heat pump is located outdoors, no cool air is exhausted indoors.

HPWHs can be advantageous because of their dehumidification benefits, potentially eliminating the need to own and operate a dehumidifier.

How long will a HPWH last?

DOE estimates that all electric storage water heaters, including HPWHs, last about 15 years on average. While most electric resistance water heaters come with 5- or 6-year warranties, many HPWHs sold today come with a 10-year manufacturer warranty on the tank and parts. Like with all appliances, proper maintenance can help extend the water heater's life and minimize loss of efficiency.

Can HPWHs be used in demand response programs?

Electricity usage reaches "peak demand" during certain times of the day when consumer demand for electricity is at its highest. Increasing power generation to meet these high demands can have a significant impact on energy costs. HPWHs provide significant reductions to peak demand because they consume much less energy than electric resistance water heaters. In addition, like electric resistance water heaters, HPWHs can be used as part of voluntary demand response programs, which are used to help divert or reduce power from certain appliances during peak demand periods. HPWHs already have most, if not all, of the electronic components (communications port and internal controls) needed for demand flexibility built in. Studies have shown that demand response programs with connected HPWHs can offer valuable load-shifting opportunities and yield significant cost savings.[5,6]

MORE-EFFICIENT GAS MODELS

A gas storage water heater uses a gas burner to heat water in a large tank. A tankless (or "instantaneous") water heater does not have a large storage tank and instead heats water as it moves through a heat exchanger on the way to the plumbing fixture or appliance drawing hot water. The proposed standards would reduce energy use by about 9% and 13% for gas storage and gas tankless water heaters, respectively, relative to models just meeting the current standards.

How would the efficiency of gas storage water heaters be improved?

For gas storage water heaters, manufacturers would be able to meet the proposed standards by adding a non-powered flue damper. A flue damper seals off the flue when a gas-fired water heater is not firing, thereby reducing heat losses during standby mode. Powered flue dampers require electricity, which can significantly increase installation costs if an electrical outlet is not available. Non-powered dampers are instead powered by gas pressure or by a water heater's standing pilot light, eliminating the need to provide electricity to the water heater. They are an inexpensive, readily available technology for cutting energy waste from gas storage water heaters.

How would the efficiency of gas tankless water heaters be improved?

For gas tankless water heaters, the proposed standards would effectively require models to use condensing technology. Condensing gas water heaters have higher efficiencies because they extract additional heat from the exhaust gases that otherwise would be vented outdoors. Condensing technology has been in use for decades; about half of tankless water heaters sold today already use it.

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[5] CTA-2045 Water Heater Demonstration Report. www.e-radioinc.com/files/bpa_smart_waterheater_final_report.pdf.

[6] www.energy.gov/sites/default/files/2020/03/f72/bbrn-peer-022720.pdf.