



ENERGY STAR Residential Boilers Discussion Guide June 2023

Overview and Context

The U.S. Environmental Protection Agency (EPA) and Department of Energy (DOE) are sharing this ENERGY STAR Residential Boilers Discussion Guide to invite early stakeholder input as we evolve the ENERGY STAR program from its focus on traditional fossil fueled technologies to embrace emerging advances in efficiency. We propose two actions: sunsetting the ENERGY STAR Boilers specification and launching a new specification for air-to-water heat pumps.

The Version 3.0 ENERGY STAR Boilers specification took effect October 1, 2014. An EPA review in 2017 found that while market share of ENERGY STAR boilers was high, there were no opportunities to identify more energy efficient models. EPA chose to maintain the existing specification to continue to support the market movement to more efficient boilers, providing homeowners with significant savings. DOE finalized test method updates for boilers on February 21, 2023, with a compliance date of April 13, 2023. DOE determined that this update does not substantially impact measured efficiency, and therefore the revised test procedure does not provide further differentiation among boilers covered by the ENERGY STAR specification.

In recent years the context around boilers has changed in several ways leading EPA to now propose a sunset of the ENERGY STAR Boiler specification. First, with the passage of the Inflation Reduction Act, EPA sees an unprecedented opportunity for the ENERGY STAR program to support the national transition to the most energy efficient equipment available. The Agency recognizes an important responsibility to guide consumers to the choices that support the efficient electrification of residential space conditioning. Furthermore, market penetration of ENERGY STAR boilers remains high with no meaningful improvements in efficiency on the horizon. In 2020, we estimated 57% of gas boilers and 77% of oil boilers sold in the US were ENERGY STAR certified. Lastly, our analysis continues to show that there is no meaningful and cost-effective differentiation available among gas-powered products. Incentive programs that encourage consumers to purchase more efficient products, to the extent that they can be cost-justified, need not rely on ENERGY STAR certification. Further, the proposal to sunset the ENERGY STAR Boiler specification will in no way affect consumers' continued access to, or the availability of boilers.

In addition, new types of products have entered the market giving homeowners more choice than in the past. Air source heat pumps with excellent performance at low ambient temperatures are now widely available. Most of these are air-to-air heat pumps (covered in the ENERGY STAR CAC/HP specification), but an increasing number of air-to-water heat pumps consistent with hydronic distribution are also available. Additional products that can serve hydronic heating are expected to come to market soon. In the long term, as a larger proportion of electricity generation comes from intermittent renewable sources, the value of loads that can shift when they use energy will continue to rise. Hydronic heating offers the inherent advantage for load shifting of using an energy storage medium (water) as part of the system. EPA therefore expects hydronic systems may become more common in coming years, particularly in new construction.

EPA and DOE will host a webinar on **June 21, 2023, from 2:30-4:30pm Eastern Time** to engage with stakeholders on the content included in this discussion guide. Stakeholders are requested to share written feedback with EPA and DOE by July 7, 2023, to HVAC@energystar.gov. As always, stakeholder engagement is a vital ingredient in the success of the ENERGY STAR program and EPA and DOE look

forward to working with all parties to develop the new ENERGY STAR specification for air-to-water heat pumps.

Naming, Scope and Definitions

EPA seeks information on several issues to support the development of a draft 1 proposal. The first issue is the name of the new specification. EPA proposes “Heat Pump Boilers” instead of “Air-to-Water Heat Pumps” to make the connection to boilers more obvious to consumers, and to ensure searches for “ENERGY STAR Boilers” will find it.

Question 1: Is the name “ENERGY STAR Heat Pump Boilers” for the new specification preferable to “ENERGY STAR Air-to-Water Heat Pumps”? Is there another name that would better align with customer expectations of the product?

EPA intends for this new specification to focus on recognizing products that are now entering the market to serve hydronically heated homes - air-to-water heat pumps (ATWHP). Air-to-water heat pumps are electric appliances much like traditional air source heat pumps, except that they are designed to move heat from the surrounding air into water for distribution throughout the house, rather than into an air stream for distribution around a house. Heat pump water heaters are air-to-water heat pumps, but the temperatures, sizing, and controls are designed for heating domestic hot water, whereas air-to-water heat pumps are designed for use in hydronic heating systems. In some cases, a single product may be capable of both uses.

The Energy Policy Conservation Act (EPCA) includes boilers in the definition of “furnace”, which is codified by DOE in 10 CFR 430.2:

“Furnace” means a product which utilizes only single-phase electric current, or single-phase electric current or DC current in conjunction with natural gas, propane, or home heating oil, and which: (1) is designed to be the principal heating source for the living space of a residence; (2) is not contained within the same cabinet with a central air conditioner whose rated cooling capacity is above 65,000 Btu/h; (3) is an electric central furnace, electric boiler, forced-air central furnace, gravity central furnace, or low pressure steam or hot water boiler; and (4) has a heat input rate of less than 300,000 Btu/h for electric boilers and low pressure steam or hot water boilers and less than 225,000 Btu/h for forced-air central furnaces, gravity central furnaces, and electric central furnaces.

This definition includes combination products that provide domestic hot water as well as water for space heating and products that work with a hydronic coil in a forced air distribution system.

DOE has concluded that hydronic air-to-water and water-to-water heat pumps meet the definitional criteria to be classified as a consumer boiler. In this case, the appropriate subtype would be an electric boiler. EPA will adopt the below definition in Version 1.0. To specify that this only applies to hot water boilers, not steam boilers, we will include that “a hot water boiler operates at or below 160 psig water pressure and 250 °F water temperature.”

“Electric boiler” means an electrically powered furnace designed to supply low pressure steam or hot water for space heating application. A hot water boiler operates at or below 160 psig water pressure and 250 degrees Fahrenheit (°F) water temperature.

DOE has not provided a specific definition of a heat pump boiler or air-to-water heat pump, should that be needed to distinguish performance levels or test methods.

- Question 2:** Are there broadly accepted industry definitions of air-to-water heat pumps or heat pump boilers?
- Question 3:** Is there any need to distinguish boilers that are used with hydronic coils in a forced-air distribution system from those used with hydronic distribution? Are the same products used in both situations?
- Question 4:** EPA believes that products that can serve as domestic water heaters or as air-to-water heat pumps for space heating could simply be tested and rated for each use. Is there any need for a definitional distinction between heat pump water heaters and air-to-water heat pumps for space heating? If so, what would the distinction be?

There are two other product types just entering the market that can serve hydronically heated homes. EPA has heard discussion of dual fuel boilers, a single appliance containing an electric air-to-water heat pump and also a burner to provide backup heating capability.

Additionally, EPA has heard about gas powered heat pumps, which use a sorption-type or a thermal compression-type cycle which includes a step with direct heating of the refrigerant, done by a gas burner. On a site energy-basis, current gas-powered heat pump products and prototypes do not achieve as high efficiency as electrically powered alternatives. EPA is not aware of a clear path to cost-effectiveness for this product type.

- Question 5:** EPA is interested in additional information about dual fuel boilers particularly market, cost, and performance information.

Test Methods

In the March 2023 Final Rule, DOE relocated the test procedure for consumer boilers to a new appendix EE and made several updates to the definitions and referenced industry standards. These amendments are expected to have minimal impact on efficiency ratings. As of April 13, 2023, boilers are subject to the Federal test method found in 10CRF430 appendix EE. EPA reiterates that with the new ratings there is not enough difference in product performance to allow any further differentiation beyond current ENERGY STAR levels for gas-powered boilers.

DOE recognizes that hydronic heat pump products differ significantly from non-heat pump boilers, and that the current test procedure for consumer boilers (as well as the amended test procedure established by the recent final rule) would not provide test results that are representative of the energy use or energy efficiency of an air-to-water or water-to-water heat pump product. Because of these differences and uncertainty regarding the most representative approach to testing these products, DOE did not establish separate test procedures for hydronic heat pump products in the March 2023 final rule. Although air-to-water and water-to-water heat pump products meet all the definitional criteria to be considered a consumer boiler, the Department requires more information in order to determine a representative approach for testing these products. Since these products are the focus of the new specification, DOE and EPA will establish an ENERGY STAR test method for them. Both the [Efficiency Vermont rebate program](#) and the [ENERGY STAR Emerging Technology Award](#) tested them based on AHRI 550/590, which is intended for chillers but also defines tests in heating mode.

- Question 6:** As the evaporators are likely to be located outdoors, what range of outside air conditions are most representative to determine overall performance?
- Question 7:** At very low outside temperatures, the compressors for ATWHPs and dual fuel HPs may no longer provide useful efficient heat. We assume ATWHPs will include backup heating for this circumstance. Ideally, the test method would capture this behavior and incorporate it into an estimate of annual energy use. What is the best way to include backup heat in the test method? What other testing considerations should be evaluated for performance in cold climates?
- Question 8:** How often are air-to-water heat pumps applied in combination systems that also provide domestic hot water? For these applications, can they use the test and metric for

domestic hot water delivery efficiency found in 10CFR Part 430 Subpart B Appendix E? Would this test fully capture the performance of the product in space and water heating modes?

Question 9: Air-to-water heat pump systems can be designed to offer load shifting in addition to their other functions. Are there products offered that are specific to such applications? In other words, are systems that provide these functions designed and assembled on site using any air-to-water heat pump, or is there something specific about the product as it leaves the factory that enables this? Are there metrics appropriate for evaluating these capabilities in a product?

Question 10: Are there additional considerations for the test method for air-to-water heat pumps?

Specification Requirements

If the specification relies on AHRI 550/590, EPA could use the same criteria identified for the ENERGY STAR Emerging Technology Award from 2019-2020, which is $COP_H \geq 1.7$ at 5F outdoor dry bulb and leaving water temperature at 110F. In addition, a number of other quantities were reported including capacity in those conditions, COP and capacity at 47F and 17F, and Integrated Part Load Value (IPLV) for products with cooling. These efficiency criteria mimic that of the 2019 NEEP Cold Climate Heat Pump Specification. Since then, EPA has defined cold climate heat pumps in the ENERGY STAR heat pumps specification, including both COP at 5F and maximum capacity at that temperature compared to rated capacity at 47F. The intention of this requirement is to make sure that a unit selected for low ambient performance will also provide efficient, comfortable heat at low load conditions. In addition, DOE and EPA developed a Controls Verification Procedure that ensures that the performance measured in the laboratory with the fan and compressor speeds fixed will be achieved in the field when the fan and compressor speeds are controlled by the unit or its controller.

Question 11: Do air-to-water heat pumps generally use multiple speed, variable speed, or inverter-driven compressors? For these products, do part-load tests in AHRI 550/590 reflect field operation?

Question 12: If units are sized for design conditions, what does that mean for their part-load heating performance? What have users' experiences been in the field?

Question 13: This test defines performance with 110F leaving water temperature. This will not provide sufficient heat when used in legacy heat exchangers, typically designed for 160-180F water. Do manufacturers recommend using these products in retrofit situations? If so, is there anything special they recommend making sure residents have enough heat?

Question 14: Many hydronically-heated homes are located in cold climates in the US. Is there a need for separate criteria for cold climate ATWHs?

Question 15: Would it be useful for EPA to define connected criteria for air-to-water heat pumps, given that they can be deployed in systems that offer load shifting? How would the needed criteria compare to those in AHRI 1380 or AHRI 1430?

Question 16: What is the cost of air-to-water heat pump systems? Does this provide the same service (e.g., covers full heating load, provides cooling, etc.) as competing systems? What are the design and installation costs for these systems in new construction and in a replacement scenario?

Question 17: Are there any other considerations about the implementation of an air-to-water heat pumps specification that EPA should be aware of?

Next Steps

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EPA intends to release a draft of the new specification and of the test method in the third quarter of 2023. As always, stakeholder engagement is a vital ingredient in the success of the ENERGY STAR program and EPA and DOE look forward to working with all parties to develop the new ENERGY STAR specification for air-to-water heat pumps.