July 21, 2023

Abigail Daken
U.S. Environmental Protection Agency
ENERGY STAR HVAC Program
William Jefferson Clinton Building
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Topic: ENERGY STAR Residential Boilers Discussion Guide

Dear Ms. Daken:

This letter comprises the comments of the Pacific Gas and Electric Company (PG&E), San Diego Gas and Electric (SDG&E), and Southern California Edison (SCE), collectively referred to herein as the California Investor-Owned Utilities (CA IOUs), in response to the United States (U.S.) Environmental Protection Agency (EPA) Discussion Guide on Residential Boilers.

The CA IOUs comprise some of the largest utility companies in the nation, serving over 32 million customers in the Western U.S. We are committed to helping customers reduce energy costs and consumption while striving to meet their evolving needs and expectations. Therefore, we advocate for standards that accurately reflect the climate and conditions of our respective service areas. We respectfully submit the following comments to EPA:

General Comments

The CA IOUs commend EPA for inviting early stakeholder input to the discussion guide development process. The EPA notes limited pathways for further energy-efficiency improvements to the gas and oil-fired residential boilers' ENERGY STAR® specification, and we agree with EPA's assessment. Therefore, the CA IOUs support the proposed sunsetting of the gas and oil-fired residential boiler specification.

The CA IOUs also support the establishment of appropriate test procedures and efficiency specifications for consumer air-to-water heat pumps (AWHPs) towards the electrification of residential space conditioning and water heating. The proposed launch of the new ENERGY STAR specification for AWHPs is a positive step, and therefore, CA IOUs fully support it. Air-to-air heat pumps dominate the residential heat pump markets in Asia and the US while AWHPs dominate the residential heat pump market in Europe. However, recent ownership changes by major manufacturers in the global heat pump industry may make AWHP products more available in the US.[1] In addition, the range of potential applications for AWHP has increased due to technical innovations that have expanded the operating temperature range and the ability to shift electricity consumption away from times of peak electricity demand. The CA IOUs

[1] See response to Question 8.

expect that AWHP will become more popular in US homes, including as replacements for forced hot-air furnaces.

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?

As AWHP technology advances and AWHP-based HVAC systems integrate thermal energy storage (TES),[2] we expect AWHP will more easily replace gas and oil-fired boilers and also may find applications as replacements for gas- or oil-fired furnaces in forced-hot-air systems. From this perspective, the name "ENERGY STAR Heat Pump Boilers" is preferable to minimize market confusion. We recognize that AWHP residential applications may differ from those performed by gas- and oil-fired residential boilers as some AWHPs provide space cooling as well. Therefore, the CA IOUs endorse the name "ENERGY STAR Heat Pump Boilers" and clarify what functionalities are different from traditional gas- or oil-fired boilers.

Question 3: Is there any need to distinguish AWHP 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?

The CA IOUs recommend a standalone ENERGY STAR specification for AWHPs that differentiates between products intended for forced hot-air distribution systems, hydronic distribution, and for domestic water heating. The CA IOUs further suggest that the ENERGY STAR specification for AWHPs account for the fan energy associated with forced hot-air systems with hydronic coils. Further, the CA IOUs recommend ENERGY STAR separately consider AWHPs designed for domestic water heating because some of these systems cannot be used for space heating applications. AWHPs that provide domestic water heating require an entering water temperature under 70°F, which can be difficult to obtain in an AWHP system designed for space heating.

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?

The CA IOUs agree that AWHPs designed for multiple uses should be rated for each use because the efficiency in water heating mode as compared to space heating mode is impacted by the ambient conditions and return water temperature. AWHPs designed for domestic water heating, space cooling, and space heating are similar and manufacturers offer models designed for one, or up to all three functions. The CA IOUs assume that EPA will continue defining integrated heat pump water heaters separately but suggest including all "split system" AWHPs for water heating in the proposed new specification. Also, the CA IOUs suggest that rather than simply accepting test results for different

[2] PG&E's Emerging Technologies Program commissioned a study of AWHPs coupled with chilled water TES and radiant ceiling panels to demonstrate load-shifting potential. Additional research on fan coil delivery options and combined heat and hot water AWHP systems is pending. "Assessment of Residential Air-to-Water Heat Pumps Coupled with Thermal Energy Storage," Emerging Technologies Coordinating Council (ETCC), January 4, 2021, https://www.etcc-ca.com/reports/assessment-residential-air-water-heat-pumps-coupled-thermal-energy-storage.

applications as determined by manufacturers, ENERGY STAR could support comparability of products by requesting that manufacturers submit results for tests performed with air input and water output temperature that are representative of the different applications.

AWHPs typically have fan coil units located outdoors and AWHPs used for domestic water heating must draw heat from the full range of ambient air temperatures year-round. Regions within the U.S. and Canada may require AWHP cold climate performance metrics for the ENERGY STAR program, consistent with the EPA's approach to other product specifications. The domestic water heating AWHP installation includes a hot water storage tank configured to allow the water temperatures in the tank to stratify, i.e., the heat pump's heat sink temperature is close to the temperature of incoming water from the mains.

AWHPs intended for space heating applications operate when outdoor ambient temperatures drop below the zero load point temperature for a building. When using AWHPs in residential space heating systems, the return water temperature is often significantly warmer than the water from the mains. Therefore, while the same AWHP may serve both space heating and water heating applications it may have different levels of performance in space heating water heating modes, and the difference in performance between applications justifies a definitional distinction in the proposed ENERGY STAR specification.

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

Dual-fuel home heating systems that combine an AWHP with a natural gas or propane burner may be a near-term option for replacing fossil fuel-fired residential heating equipment in cold climates as currently available heat pumps may not be able to cost-effectively satisfy peak heating loads without improvements to the building thermal envelope or replacement of radiators in hydronic systems.

If EPA includes dual-fuel boilers in the proposed specification, we recommend optimizing the description to minimize fossil-fuel consumption and limit applications to colder climates. We also suggest incorporating controls-related provisions in the test method to lockout fossil-fuel heating except during the coldest periods and to maximize heat production from the AWHP. We also recommend that EPA plan to regularly revise the specification to reflect the improvements in AWHP performance which could eventually eliminate the need for dual-fuel systems.

Question 6: As the evaporators are likely to be located outdoors, what range of outside air conditions are most representative to determine overall performance?

The CA IOUs recommend that the ENERGY STAR for AWHP Boilers specification use the same outside air conditions included in DOE's test procedure for air-to-air heat pumps. Attachment 1 shows the fractional bin hours based on outdoor dry bulb temperatures applicable to AWHPs for California's 16 climate zones.

Question 7: At very low outside temperatures, the compressors for AWHPs and dual fuel HPs may no longer provide useful efficient heat. We assume AWHPs 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?

The Northwest Energy Efficiency Alliance's (NEEA's) advanced water heating specification (AWHS)[3] addresses the question of cold-climate efficiency for heat pump water heaters only. The CA IOUs suggest a similar approach to defining a test method for space conditioning AWHPs that also provide domestic hot water heating. We make the following recommendations based on Section 2.5.1 of the AWHS v 8.0, which states, "During the first draw of the U.S. Department of Energy (DOE) first-hour rating test,[4] the electric resistance heating element shall not be turned on until at least 66% of the tank's measured water volume has been withdrawn.":

- EPA should establish limits using easily measured operating parameters to lockout backup heating, e.g., when the outdoor air temperature is above the AWHP's ability to attain a specific temperature rise between water entering and leaving the condenser.
- The test procedure should also account for an AWHP system's potential to include TES as an alternative to backup heating.
- If the supplemental heat source uses electric resistance, AWHP manufacturers must state the maximum instantaneous electrical load of their product when backup heat is engaged.

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

Fossil-fuel boilers often provide both space and water heating in homes with hydronic heating systems. Residential AWHPs are available that are designed to provide both space and water heating. Efficiency Vermont provides incentives for residential installations of AWHP in a cold climate and some of the products on their qualified products list offer combined space and water heating (see the "US" column in Table 1).[5]

In Germany, over one million heat pumps provided residential space heating in 2020, with AWHPs making up approximately two-thirds of the residential heat pump fleet. German sales of AWHPs for residential applications reached about 130,000 units in 2021.[6] In Germany, homes are primarily heated by hydronic systems, AWHPs are the most common type of residential heat pump, and residential AWHPs usually provide both space and water heating.

Table 1 presents a sample of manufacturers offering AWHPs for combined residential space and water heating on the US and German markets:

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[3] Northwest Energy Efficiency Alliance, "Advanced Water Heating Specification." Northwest Energy Efficiency Alliance (NEEA), March 15, 2023, https://neea.org/our-work/advanced-water-heating-specification.

[4] "Appendix E to Subpart B of Part 430, Title 10 -- Uniform Test Method for Measuring the Energy Consumption of Water Heaters," Code of Federal Regulations, June 21, 2023, https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-B/appendix-Appendix%20E%20to%20Subpart%20B%20of%20Part%20430.

[5] Efficiency Vermont. Heat Pump Systems. https://www.efficiencyvermont.com/products-technologies/heating-cooling-ventilation/heat-pumps.

[6] All German residential AWHP market information from *Numbers, Dates, Facts: Climate Protection in the Building Sector*, the 2023 Buildings Report of the German Energy Agency (dena).

Table 1: Residential AWHP products that offer combined space and water heating (not exhaustive)

US	Germany
Aermec ANK series	Viessmann
Arctic Heat pump	Bosch Thermotechnik
Chiltrix	Vaillant
Mestek (SpacePak)	Lambda
MBtek Apollo EVI	Waermetec

(Note: US manufacturer Carrier purchased Viessmann's heat pump division in May 2023.)

The CA IOUs are not confident that the recently amended test procedure for water heaters in 10 CFR Part 430 Subpart B Appendix E would fully capture the performance of AWHP in space and water heating modes. AWHP are split system heat pumps with a air source heat pump unit installed outdoors subject to the full range of outdoor ambient temperatures and relative humidity as discussed above in the response to Question 6.

As DOE stated in 88 FR 40406 published on June 21, 2023 the amended test procedure "Explicitly states that the heat pump part of a split-system heat pump water heater is tested at the dry-bulb temperature and relative humidity conditions required for heat pump water heaters, and that the storage tank is tested at the ambient temperature and relative humidity conditions required for non-heat pump water heaters." The test procedure requires maintaining the dry-bulb temperature for heat pump water heaters within a range of 67.5 °F ± 5 °F, and with an average of 67.5 °F ± 1 °F during recoveries and an average of 67.5 °F ± 2.5 °F when not recovering. It also requires maintaining the relative humidity for heat pump water heaters within a range of 50 percent ±5 percent, and at an average of 50 percent ±2 percent during recoveries. An AWHP capable of operating in water heating and space heating modes will probably only operate in space heating mode when the outdoor temperature is below 67.5 °F and will likely spend most operating hours in heating mode when the outdoor temperatures are significantly colder.

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?

NEEA's AWHS v 8.0 covers integrated and split-system heat pump water heaters. The AWHS has five performance tiers, with Tiers 3 to 5 requiring demand response features.[7] However, NEEA's qualified product list does not include any split-system heat pump water heaters in Tiers 3 to 5.[8]

Harvest Thermal is an Oakland, California-based start-up that offers load shifting equipment designed for use with an AWHP and a hot water storage tank.[9] The California Load Flexibility Research and Development Hub (CalFlexHub) hosted by Lawrence Berkeley National Lab and the Stor4Build

[7] Alliance, "Advanced Water Heating Specification," AWHS v. 8.0 Section 2.6.4 https://neea.org/img/documents/Advanced-Water-Heating-Specification.pdf.
[8] Northwest Energy Efficiency Alliance, "Residential Heat Pump Water Heater Qualified Products List," Northwest Energy Efficiency Alliance (NEEA), March 14, 2023, https://neea.org/img/documents/residential-HPWH-qualified-products-list.pdf.
[9] Harvest Thermal https://www.harvest-thermal.com/product.

Consortium funded by DOE's Building Technology Office are actively researching demand and response heat pumps.[10] [11] We expect additional load-shifting capable AWHP-based systems to enter the market soon.

It is the CA IOUs understanding that AWHP systems that provide load shifting must be designed and assembled on site because no integrated AWHP with load shifting are currently available. To our knowledge there also are no widely accepted metrics to evaluate the ability of a AWHP to provide load shifting services.

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?

The CA IOUs emphasize the importance of having flexible demand capabilities and incorporation of emerging smart appliance functionalities even if the market penetration of the affected equipment is relatively small at this time. CA IOUs encourage ENERGY STAR to consider similar connectivity requirements in ENERGY STAR's various specifications, including HVAC and water heaters. The CA IOUs support open and secure connectivity that is cost-effective and can be used for managing electricity demands in granular intervals (e.g., hourly throughout the year).

The CA IOUs appreciate the opportunity to provide these comments regarding the Discussion Guide on Residential Boilers. We thank EPA for its consideration. We look forward to the next steps in the process.

[10] CalFlexHub https://calflexhub.lbl.gov/calflexhub-portfolio.
[11] Department of Energy Stor4build. https://www.energy.gov/eere/buildings/stor4build.

Sincerely,

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Attachment 1: Fractional cooling and heating bin hours applicable to AWHPs installed in California by Climate Zone

Representative temperature (°F)	Range Low	Range High	Arcata	Sonoma	Oakland	Paso Robles	Santa Maria	Los Angeles	San Diego	Fullerton	Hollywood Burbank	Riverside	Red Bluff	Sacramento	Fresno Yosemite	Palmdale	Palm Springs	Blue Canyon
67	65	69	0.019	0.067	0.104	0.083	0.105	0.248	0.270	0.183	0.146	0.117	0.102	0.101	0.100	0.088	0.076	0.108
72	70	74	0.003	0.057	0.044	0.066	0.070	0.133	0.146	0.137	0.119	0.125	0.089	0.074	0.099	0.090	0.107	0.086
77	75	79	0.001	0.044	0.014	0.045	0.024	0.039	0.045	0.088	0.081	0.080	0.073	0.054	0.076	0.077	0.099	0.059
82	80	84	0	0.029	0.007	0.041	0.009	0.015	0.014	0.063	0.059	0.062	0.056	0.039	0.063	0.064	0.101	0.013
87	85	89	0	0.021	0.004	0.032	0.003	0.003	0.004	0.025	0.040	0.041	0.040	0.033	0.053	0.052	0.082	0.002
92	90	94	0	0.009	0.001	0.025	0.002	0.001	0.001	0.013	0.018	0.037	0.040	0.028	0.044	0.044	0.083	0
97	95	99	0	0.004	0	0.019	0.001	0	0.001	0.004	0.006	0.018	0.036	0.016	0.037	0.036	0.066	0
102	100	104	0	0.001	0	0.011	0	0	0	0.002	0.002	0.005	0.018	0.004	0.018	0.012	0.049	0
107	105	109	0	0	0	0.002	0	0	0	0.001	0.002	0.001	0.004	0	0.002	0.003	0.030	0
112	110	114	0	0	0	0	0	0	0	0	0	0.001	0.001	0	0	0	0.010	0
117	115	119	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.002	0
122	120	124	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.001	0
62	60	64	0.087	0.101	0.199	0.105	0.140	0.232	0.233	0.174	0.173	0.159	0.097	0.134	0.094	0.095	0.100	0.092
57	55	59	0.231	0.159	0.282	0.139	0.235	0.206	0.177	0.142	0.142	0.123	0.098	0.141	0.092	0.087	0.077	0.105
52	50	54	0.312	0.220	0.189	0.164	0.226	0.098	0.090	0.097	0.119	0.119	0.110	0.143	0.122	0.092	0.065	0.124
47	45	49	0.192	0.150	0.110	0.118	0.109	0.022	0.017	0.058	0.067	0.080	0.112	0.112	0.100	0.093	0.038	0.115
42	40	44	0.097	0.074	0.034	0.080	0.052	0.002	0.002	0.012	0.019	0.020	0.070	0.071	0.065	0.068	0.012	0.092
37	35	39	0.044	0.048	0.012	0.043	0.019	0	0	0.002	0.007	0.010	0.041	0.040	0.028	0.056	0.003	0.074
32	30	34	0.012	0.014	0.001	0.021	0.004	0	0	0	0	0.001	0.010	0.007	0.007	0.031	0	0.085
27	25	29	0.001	0.003	0	0.006	0	0	0	0	0	0	0.002	0.001	0	0.011	0	0.042
22	20	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0.001	0	0.004
17	15	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	10	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	5	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-3	-5	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-8	-10	-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-13	-15	-11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-18	-20	-16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-23	-25	-21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: CA IOUs