September 13, 2024

Environmental Protection Agency (EPA)
ENERGY STAR®
HVAC@energystar.gov

Topic: Central Heat Pump Water Heater System Discussion Guide and Draft Test Procedure

Dear Ms. Abigail 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's (EPA) discussion guide and draft test procedure on Central Heat Pump Water Heater (HPWH) Systems.

The CA IOUs comprise some of the largest utility companies in the nation, serving over 32 million customers in the Western United States. 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:

1. **CA IOU lab testing indicates CHPWH configurations significantly impact system efficiency.**

Since 2019, the CA IOUs have funded lab testing on numerous central heat pump water heater (CHPWH) systems. The primary objective was to better understand the impact of system configuration on efficiency. Lab testing included varying combinations of equipment (single-pass and multi-pass heat pumps), temperature maintenance heating options, primary and secondary storage tank sizes, piping configurations for recirculated water, a range of distribution system losses, and storage water temperatures.

Testing demonstrated that the configuration of a CHPWH system significantly impacts its energy use, potentially as much as, if not more so, than the heat pump's efficiency. Some design choices and configurations can lead to failed hot water delivery or low efficiency, even if configured with high heat pump coefficients of performance (COP). Results have indicated that intake water temperature, including recirculating hot water, and control points are important factors affecting CHPWH system efficiency. Designing a CHPWH system requires precise management of the intake water temperature and optimization of control settings to ensure heat pumps operate at peak efficiency. Different configurations can control the temperature of the water entering the heat pump. Since no "one size fits all" configuration exists, the system's efficiency and performance depend on effectively managing and maintaining this intake water temperature.

Once available, we will provide a copy of the report to the EPA. The report distills testing results into design recommendations for optimal performance and guides the selection of the overall system configuration. Moreover, by identifying trends that similarly impact system efficiency, the report can assist EPA in defining a product "family."

2. The CA IOUs recommend that the EPA include several system requirements and the proposed component metrics.

We encourage EPA to include initial system-level requirements in the CHPWH Version 1 specification. We acknowledge that CHPWHs currently have a low market share. Therefore, the market and industry may be unprepared for a minimum system efficiency specification. However, our research shows the importance of system configuration on efficiency. We recommend the EPA incorporate requirements in the CHPWH Version 1 specification to promote good engineering practices in designing and installing these systems. For example, specification requirements could include sensor wiring diagrams with designated installation locations on or within the storage tanks. Additionally, it may be beneficial to mandate plumbing diagrams and other pertinent information to facilitate successful system installation and operation.

Incorporating these system-level requirements from CHPWH Version 1 into the ENERGY STAR® program would also enable integrated system data collection and support the development of an appropriate and viable systems metric.

System-level requirements will educate designers and installers about the central systems, enabling them to recommend CHPWHs. Understanding the system's COP at various temperatures is crucial for successful installation.

The CA IOUs recommend the EPA consider adopting a similar approach developed by the ENERGY STAR Single-Family New Homes (SFNH) program, which evaluates and certifies the overall efficiency of custom homes. The program offers builders two certification options:

1. **Prescriptive Option:** Builders can meet the program's requirements by ensuring the home adheres to a specific list of criteria.
2. **Performance Option**: Builders have more design flexibility if they can demonstrate that the home is at least as efficient as one that meets the prescriptive option.

EPA could either require CHPWH systems to meet a list of prescriptive component requirements and design or have a third-party model of the system to demonstrate it is at least as efficient as one that meets the prescriptive requirements.

3. The CA IOUs support collecting test results at multiple temperature points with certain modifications.

We strongly support requiring product testing and results reporting at multiple temperature points, as detailed below, which will significantly advance the field, as detailed below. This data is crucial for designing a CHPWH system and modeling its energy use. We anticipate the standardizing testing and reporting data proposed in this CHPWH system specification will accelerate market adoption.

The CA IOUs support EPA's proposed evaporator testing conditions for air-source products at 5°F and 95°F dry bulb, and we recommend different intermediate points. The proposed EPA temperature points

are sometimes closely spaced (e.g., 5°F and 17°F, or 80.6°F and 95°F); however, at other temperatures, the gaps are wider (e.g., 17°F to 50°F). We recognize that one of the primary purposes of collecting the data is to calculate the output capacity and efficiency under design conditions. Therefore, engineers will need to interpolate between data points for their climates. Consequently, the CA IOUs suggest using an approach similar to the one outlined in the *Advanced Water Heating Specification v8.1* (AWHS) published by the Northwest Energy Efficiency Alliance.[1] This method uses conditions spaced approximately 30°F apart. See the table below for recommended dry and wet bulb conditions.

Label	Dry Bulb ˚F	Wet Bulb ˚F
Min	Mfr spec'd	Mfr spec'd DB minus 1
A	5	4 (maximum)
B	34	31
C	68	57
D	95	69

We acknowledge that minor changes may improve alignment with other industry standard test points and fully support those changes. For example, comparable standards typically set test condition B at 35°F dry bulb / 33°F wet bulb. Similarly, it may be logical for condition C to match the consumer water heater test conditions of 67.5°F and 50% relative humidity.[2] Additionally, the proposed conditions align with the optional test conditions specified by the U.S. Department of Energy (DOE) in its most recent test procedure for consumer water heaters. Therefore, aligning these conditions makes sense.

We recommend that the EPA adopt a minimum temperature condition labeled "Min," which manufacturers can select based on the equipment's capabilities. This value could be significantly below zero for some products. Further, if a product cannot function at the A and/or B conditions, we propose that manufacturers test and report performance at the lowest operating conditions (i.e. the "Min" test point). Therefore a "mild climate" product may test at points C, D, and a minimum ambient temperature (e.g., 47°F dry bulb and 43°F wet bulb). This approach would provide engineers and installers with critical information for accurately sizing heat pumps.

Lastly, we recommend that EPA collect and report the minimum and maximum operating ambient temperatures for the compressors, similar to its approach for residential water heaters.

4. **The CA IOUs recommend prioritizing a variety of ambient, entering, and leaving temperature conditions over a seasonal metric.**

The entering water temperature also strongly impacts performance. We support the EPA's proposal to differentiate condenser entering water temperature and temperature rise conditions for single-pass and multi-pass equipment.

Moreover, since municipal mains water supply temperatures correlate with seasonal air temperatures, we recommend varying supply water temperatures during test conditions.

[1] Northwest Energy Efficiency Alliance, Advanced Water Heater Specification," *Northwest Energy Efficiency Alliance,* July 15, 2024, https://neea.org/img/documents/Advanced-Water-Heating-Specification.pdf.
[2] Appendix E to Subpart B of Part 430, Title 10. https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-B/appendix-Appendix%20E%20to%20Subpart%20B%20of%20Part%20430.

In a typical CHPWH installation, the incoming mains water temperature will partially mix with hotter water in a tank or circulation loop. As a result, the water entering the heat pump is warmer than the mains. We recommend the approach taken by the Advanced Water Heater Specification (AWHS), as shown in the table below. Multi-pass systems generally operate differently from single-pass systems, which results in more consistent entering water temperatures. Therefore, a single entering water temperature is appropriate. We support EPA's proposal for the outlet water temperature of 140°F. However, we encourage EPA to consider an optional, higher temperature of 150-160°F, representing products with swing tank system designs.

Label	Single Pass Entering Water Temperature ˚F	Multi Pass Entering Water Temperature ˚F	All Systems Outlet Water Temperature ˚F
A	72	125	140
B	76	125	140
C	81	125	140
D	86	125	140

EPA asked for feedback on creating an integrated seasonal metric. Although the CA IOUs agree with EPA on the steps involved, we do not consider this metric a priority. Reporting and making the individual test points available would be more beneficial for advancing today's market.

5. **The CA IOUs recommend EPA add an ambient test in the mid-30s˚F range and capture performance changes during defrost.**

The CA IOUs encourage EPA to include an ambient test condition (for air-source products) at or near 34-35°F. Most of California's design temperature conditions range from 30-40°F. To adequately size the product, engineers and installers must know its output capacity and efficiency at these temperatures. We recognize that testing air-source products in this range will likely result in evaporator coil frosting and subsequent defrosting, which adds complexity to the test procedure. However, the test procedure for the 35°F condition in AHRI Standard 210/240, *Performance Rating of Unitary Air-conditioning and Air-source Heat Pump Equipment*, provides a template for conducting such a test and evaluating the results. We encourage EPA to leverage this and other existing procedures for space-heating heat pumps to include this test point. Although accounting for defrost adds complexity, it is crucial to determine to what extent the defrost reduces output capacity. This information is essential for installing a CHPWH system with sufficient water heating capability under design conditions that involve frosting and defrosting.

As previously stated, the exact temperature conditions can vary by a few degrees, with the most desirable outcome being alignment with other industry test points. Therefore, we encourage the EPA to consider the conditions of 35°F dry bulb / 33°F wet bulb.

6. **The CA IOUs recommend that EPA consider compliance and marketing.**

EPA's Central Heat Pump Water Heater Systems Discussion Guide does not address how ENERGY STAR plans to address component or system compliance with the final specification. The CA IOUs recommend that EPA structure the program to enable verification of system compliance. This verification will allow ENERGY STAR to maintain its high compliance rate, support its partners, and increase market adoption of efficient CHPWH systems. We also recommend that EPA consider and integrate a proposed

compliance approach into future drafts of the CHPWH specification. Outlining a compliance approach early in the specification development process provides transparency and ample time for stakeholder review, comment, and discussion.

We suggest that the EPA review and apply insights and experiences gained from the ENERGY STAR SFNH program by emulating its compliance process:

- **Provide education materials and a checklist** for third parties to verify or model whether the CHPWH system meets the ENERGY STAR specifications.
- **Partner with organizations** that train and certify the construction trades to accurately complete the checklist, verifying compliance through modeling or other approaches.
- **Submit the completed checklist** to the EPA or another third party for review before the system is deemed ENERGY STAR certified.

The CA IOUs also encourage the EPA to consider how building owners could market their CHPWH system as ENERGY STAR certified once verified. To maximize motivation for certification, owners need effective marketing, visible placement of the ENERGY STAR logo, and attractive incentives. Programs like Leadership in Energy and Environmental Design (LEED), ENERGY STAR for SFNH, and ENERGY STAR Certified Buildings have substantial marketing efforts to promote their certifications and the benefits of energy efficiency. We suggest EPA leverage insights from these programs to market the CHPWH system program effectively.

7. The CA IOUs recommend that EPA include connected criteria.

Although the capability of CHPWH systems to participate in demand response programs is still in its infancy, ENERGY STAR should consider requiring manufacturers to include connected capability reporting requirements, similar to those for residential HPWH manufacturers. In addition to the essential communications functions that enable a CHPWH to respond to demand response signals, ENERGY STAR should also consider requiring manufacturers to incorporate non-communications demand response functions. These features might include storing a user-supplied operating schedule or optimizing operations based on a time-of-use electricity rate schedule.

ENERGY STAR connected criteria for CHPWH should include a list of all the demand response functions the CHPWH can perform. Manufacturers could specify all the demand response protocols, standards, or regulations that their CHPWH system complies with, such as:

- AHRI Standard 1530[3]
- OpenADR[4]
- ANSI/CTA-2045 (EcoPort)[5]
- *California Energy Commission Title 24 JA 13 Heat Pump Water Heater Demand Management Systems*[6]

[3] We understand that the Demand-Flexible Commercial Electric Storage Water Heaters standard is in development.
[4] OpenADR Alliance. "Connecting Smart Energy to the Grid," n.d. https://www.openadr.org/
[5] "Customers and Installers Now Have a Choice." EcoPort, n.d. https://ecoport.openadr.org/
[6] California Energy Commission. "JA13 Heat Pump Water Heater Demand Management Systems," n.d. https://www.energy.ca.gov/rules-and-regulations/building-energy-efficiency/manufacturer-certification-building-equipment/ja13.

As noted above, system configuration is crucial for CHPWH energy efficiency, and the same applies to its configurations supporting demand response. Exploration is ongoing to determine the best CHPWH system configurations that support demand response. Sufficient hot water storage capacity is critical for a CHPWH system to shift electrical load. Adequate monitoring capability is also needed to allow accurate estimates of thermal energy storage. ENERGY STAR should consider requiring manufacturers to report all equipment added to a CHPWH system configuration to support demand response functions. Additionally, manufacturers could describe their system's load-shifting capability with different sizes of hot water storage tanks.

8. **The CA IOUs recommend miscellaneous changes to the proposed test procedure.**

Scope:
While the CA IOUs appreciate DOE's intent to include a range of heat pump equipment, such as ground-source products, we encourage DOE to focus on products with the most significant market potential. Currently, we are unaware of any direct geo-exchange or ground-source closed-loop CHPWH on the market.

We recommend defining CHPWH systems specifically as air-to-water and water-to-water heat pumps. Narrowing this specification would eliminate many of the proposed requirements in Section 4. This change will remove the ground coupling and its test requirements, allowing for the expansion of the system boundary to include essential hot water system components in multifamily buildings.

System Boundary:
The CA IOUs recommend reconsidering the CHPWH system boundary. In addition to the heat pump, hot water tank, and recirculation pump, we suggest including the following components:

- **A master mixing valve** before the risers and supply trunk, which directly impacts hot water distribution system performance.
- **A distribution system balancing method** is necessary to balance hot water distribution, limit the recirculation flow rate, and reduce heat losses.

Energy Efficiency Levels:
The CA IOUs recommend that the CHPWH Version 1 specification set a reasonable minimum efficiency level achievable by a minimally compliant CHPWH system but not by an electric resistance water heater. As CHPWHs are still in the early stages of adoption, overly ambitious efficiency requirements could hinder their market acceptance.

List Single- and Multi-pass Systems Separately:
The CA IOUs recommend EPA test and list each CHPWH separately for single- or multi-pass configurations, as the test conditions and efficiency vary. For example, the Northwest Energy Efficiency Alliance (NEEA) Commercial/Multifamily HPWH Systems Qualified Products List includes separate listings based on the configuration for the same model number.[7]

[7] Northwest Energy Efficiency Alliance. *Commercial Heat Pump Water Heater Qualified Products List*. Retrieved from https://neea.org/img/documents/commercial-HPWH-qualified-products-list.pdf.

The CA IOUs appreciate the opportunity to provide these comments regarding the specification development for CHPWH Systems. We thank EPA for its consideration and look forward to the next steps in the process.

Sincerely,

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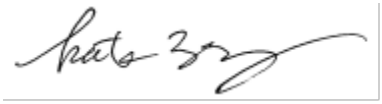

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