



MEMORANDUM

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From: Peter Biermayer P.E., Utilities Engineer, EE Planning & Forecasting Section, Energy Division, CPUC

Subject: Guidance for Large Commercial Heat Pump Water Heater, Commercial and Multifamily, Fuel Substitution Measure Package SWWH028 for Capacity and Energy Savings claims

Summary

The purpose of this memo is to respond to the request for guidance on allowable capacity-based savings claims for heat pump water heating equipment. Specifically, this guidance seeks to clarify the claimable savings for the A.O. Smith CAHP-120 commercial heat pump water heater, referencing the Large Commercial Heat Pump Water Heater, Commercial and Multifamily, Fuel Substitution measure package SWWH028.

Guidance was requested on using a capacity of 176 kBtu/hr, based on a removed ENERGY STAR product listing through the end of March 2024. After March 2024, guidance was requested to alternatively use capacity based on manufacturer specifications, as discussed next.

The model (CAHP-120) can operate the heat pump and two electric heating elements simultaneously, thereby increasing its overall capacity. The unit's storage tank could possibly also provide extra persistent capacity. The measure package, SWWH028, was interpreted to permit using the highest capacity for an integrated unit based on manufacturer specification or the ENERGY STAR product listing. Based on manufacturer specifications, in the case of CAHP-120, it was suggested that the total claimable capacity would be the sum of:

- Heat pump capacity: 41,699 Btu/hr
- Heating element capacity: 40,946 Btu/hr
- Storage capacity: 79,703 Btu/hr

The current SWWH028 measure package allows for the use of all three capacity components using manufacturer's specifications for integrated heat pump water heaters like CAHP-120. However, CAHP-120 is not currently listed in the U.S. Department of Energy (DOE) Compliance Certification Management System (CCMS) database for commercial water heaters, therefore we are unable to use this independent source to verify ENERGY STAR or manufacturer-based capacity values.

A request was made that ex post evaluation teams not adopt a different capacity term for verification.

- **CPUC Limited Exception Allowed from January 1, 2024 – March 31, 2024:** CPUC Staff will allow Program Administrator's energy savings claims using a value based on the ENERGY STAR capacity value of 176 kBtu/hr. Upon review of the updated value of this heat pump, ENERGY STAR removed the product, A.O. Smith model CAHP-120, from the ENERGY STAR qualification list. The 176 kBtu/hr was a major calculation error within ENERGY STAR. While it should have been obvious if sufficient due diligence was performed by the program administrator (PA), staff will allow the Energy Star published value.
- **Allowed from April 1, 2024 – December 31, 2024:** CPUC will temporarily allow a capacity value based on the heat pump, electric resistance and storage. Based on the manufacturer specification the total capacity was determined to be 161 kBtu/hr, which is almost the sum of the following three capacities: heat pump capacity of 41,699 Btu/hr, heating element capacity of 40,946 Btu/hr, and storage capacity of 79,703 Btu/hr. This was based on an inlet water temperature of 40 F.
- **Beginning January 1, 2025:** CPUC will temporarily allow a capacity value based on the heat pump, electric resistance and storage, **but the storage value must be adjusted to the coldest inlet water temperature for**

the climate zone under consideration. Based on the manufacturer specification the total capacity was determined to be 161 kBtu/hr, which is almost the sum of the following three capacities: heat pump capacity of 41,699 Btu/hr, heating element capacity of 40,946 Btu/hr, and storage capacity of 79,703 Btu/hr. This was based on an inlet water temperature of 40 F. The 161 kBtu/hr capacity must be adjusted for each climate zone by setting the inlet water temperature to be no lower than the coldest inlet water temperature for the climate zone. Energy savings must be adjusted retroactively to January 1, 2025. The PA should do due diligence to make sure customer expectations of energy savings are realistic.

- Exceptions during this time period may result in a change of measure package values prior to a new measure package based on EnergyPlus models. These include:
 - The manufacturer specifications change (this would be considered remediating an error).
 - Change in the ENERGY STAR values (allowed in mid-cycle per resolution and would also be considered correcting an error).
 - Any other compelling reason the CPUC finds necessary to require a change, including a change in corrections to a water heater calculator or change to EnergyPlus to determine energy savings and capacity.
 - **Changes within this time period, due to the exceptions listed above are effective 90 days after a mandated change by CPUC staff.**
 - Additional heat pump water heater models meeting the capacity requirements may affect the measure package or may require adjustments for models having different efficiencies.
- **The program administrator must submit a revised measure package no later than May 31, 2025.** This will include EnergyPlus models with a heat pump performance curve. Input parameters to the EnergyPlus model must be specific to the building type.
- **Ninety days after a revised measure package is approved by CPUC staff:** A revised measure package based on EnergyPlus will be effective 90 days after CPUC staff approval. The capacity and energy savings will be determined by the revised measure package.
 - CPUC staff believes in many cases the allowed capacity discussed above could potentially overstate the energy savings, but it will depend on the application and sizing of the water heater.
 - Sizing guidance should be included in the measure package to maximize the heat pump-only performance (efficiency mode).
 - Southern California Edison should work with CPUC staff on details of the EnergyPlus model and input parameters. Potentially, current building prototypes may be adequate and just the inputs to the model may need to be vetted by the CPUC staff and entered into the model. Further improvements to the model and inputs may need to be made subsequently.
- Future EM&V studies will be encouraged to further adjust the measure package.

Background

The existing SWWH028 measure package does not explicitly address scenarios where both the heat pump and dual heating elements can operate simultaneously in response to hot water heating loads. Related to this, the measure package does not currently address the equipment installed capacity relative to hot water heating loads for participating installations. Depending on how the equipment is sized, equipment such as the AO Smith model CAHP-120 may run very efficiently using the heat pump to heat water or may rely more on the heating elements to

heat water which compromises the overall efficiency of the installed equipment and could lead to performance that does not align with the intended efficiency criteria. The efficiency of the water heater will also decrease when operating at temperatures lower than the test procedure specified ambient temperature.

Discussion

CPUC Guidance provides clarity on each of the issues identified in the background section of this memo and clarifies allowed savings claims.

Guidance for ENERGY STAR Capacity-Based Savings Claims – CPUC staff has concluded that while the capacity from the removed ENERGY STAR product listing should not be used as a basis for claims, staff will allow Program Administrator’s energy savings claims from January 1, 2024 – March 31, 2024, when it appears that ENERGY STAR used an incorrect heat pump input of 12 kW—rather than the actual 2.84 kW input—in the following formula, artificially inflating the capacity estimate:

Heat pump output (kBtu/hr) = Heat pump input (kW) * Heat pump COP * kW-to-Btu conversion factor

176= 12 * 4.3 * 3.412142

This approach clearly does not represent the true combined capacity of the heat pump, heating elements, and tank, and provides an erroneous estimate of heat pump-only capacity using an incorrect input kW.

Furthermore, the SWWH028 measure package does not explicitly allow for the use of the previously published capacity value from ENERGY STAR sources; the measure package allows the use of ENERGY STAR to obtain heat pump efficiency (coefficient of performance - COP).

Guidance for Manufacturer Capacity-Based Savings Claims Until Next Update - CPUC staff accept the approach of claiming the highest capacity based on manufacturer’s specifications and the combined output of the heat pump, heating elements and tank storage. However, staff do not approve using an inlet water temperature from the manufacturer of 40°F to calculate storage capacity for all climate zones starting in PY2025. According to the DEER Water Heater Calculator, the minimum observed temperature (taken from all days in the year) varies significantly across California climate zones (ranging from 40.4°F to 63.1°F). The A.O. Smith CAHP-120 specifications indicate different tank capacities depending on inlet temperature:

- 55,171 Btu/hr at 70°F
- 63,119 Btu/hr at 60°F
- 71,079 Btu/hr at 50°F
- 79,073 Btu/hr at 40°F

A unique climate zone capacity value should be determined using linear interpolation based on the observed minimum temperature taken from all days in a year, in each climate zone.

Savings claims for PY2025, and all savings claims leading up to the next measure package update, can use the resulting combined (heat pump, elements and storage tank) capacity by climate zone.

Note that per 10 CFR Part 431, commercial water heaters must be tested with an inlet water temperature of 58°F ± 2°F. It is not clear how this testing condition was met by the manufacturer.

Guidance for Updating SWWH028 Measure Package - CPUC staff requires that the PAs resubmit measure package SWWH028 – updated with the use of EnergyPlus models to replace the use of the DEER Water Heater Calculator in the current version of the measure package. Note that the current measure package has transitioned partially to EnergyPlus for multifamily building types. The work to be completed for this required measure package update will

be for similar updates for commercial building types.

The revised measure package update must be submitted by the end of May 2025. Including EnergyPlus models with a heat pump performance curve.

Guidance for Heat Pump Water Heater Sizing Requirements - CPUC staff requires that the PAs revise heat pump water heater sizing requirements for both the modeling updates and measure package update. PA modeling and measure package updates are to be completed in cooperation with and with guidance from CPUC staff. The measure package will explicitly address equipment sizing. Equipment sizing should be based on minimizing operation in a water heater mode using electric resistance heating.

This focus on equipment sizing is needed to address the potential of heat pump equipment efficiency degradation that can be introduced by heating elements. We recommend that the PAs perform additional research and collect independent testing data, including M&V, to improve our understanding of heat pump water heater performance in participating customer installations, and to help ensure robust 2025 claims based, in part, on a more accurate measure package. Due to time constraints, transitioning to an EnergyPlus model does not have to wait for data collection but it will be used for a future measure package.