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NRDC Submission of Revised Draft Joint Appendix 13 on Water Heater Demand Management

Additional submitted attachment is included below.

August 9, 2019

Commissioner McAllister
California Energy Commission
1516 9th St, Sacramento, CA 95814

Re: NRDC Updated Submission of Draft Joint Appendix 13 on Water Heater Demand Management

Dear Commissioner McAllister:

The Natural Resources Defense Council (NRDC) appreciates the opportunity to submit to the California Energy Commission (CEC) a revised draft of a Heat Pump Water Heater (HPWH) Demand Management specification intended to be included in the 2019 Building Energy Efficiency Standards (Title 24 Part 6) as a new joint appendix, to support a compliance option in the 2019 code.

The draft specification included as an appendix to this comment letter is a revision of our April 26, 2019 submission. It adds a requirement designed to increase the ability for HPWH to store thermal energy during oversupply events, as well as minor language clarifications and improvements.

This proposal sets forth the requirements for a heat pump water heater to be eligible for a self-utilization credit under the 2019 building code, like battery storage.

The update, like the April 26, 2019 version, was developed in collaboration with the input from a broad group of stakeholders including AO Smith, Bradford-White, GE Appliances, HTP, Rheem, Sanden, Steffes, PG&E, SCE, Sempra, LADWP, SMUD, EPRI, Bonneville Power Administration, Portland General Electric, Northwest Energy Efficiency Alliance, Aquanta, Olivine, SkyCentrics, Virtual Peaker, Building Decarbonization Coalition, Consortium for Energy Efficiency, Ecotope, US EPA, LBNL, OpenADR Alliance, Redwood Energy.

Background on this HPWH Demand Management Specification

Heat pump water heaters can store energy in the form of hot water at times when electric demand is low and renewable electricity is abundant such as in the middle of the day and release that stored energy when needed by the customer without using electricity during grid peak demand times, helping balance the grid, integrate renewable energy, and reduce customer bills.[1]

NRDC strongly supports CEC's intention stated at multiple workshops to include a compliance credit for heat pump water heaters that utilize their thermal storage capacity to provide daily load shifting for the purpose of customer bill reductions, maximized solar self-utilization, and grid harmonization.

[1] Delforge P., Vukovich J., "Can Heat Pump Water Heaters Teach the California Duck to Fly," ACEEE Summer Study 2018.

Providing a compliance credit will encourage adoption of this technology by builders in new construction in California, creating market demand for load-shifting water heaters. The attached specification provides a clear set of requirements for manufacturers to design to, enabling them to bring products to market to meet the demand for demand-flexible heat pump water heaters and spur adoption of this technology in California and beyond.

Overview and Rationale for Revision

The 0.5 kWh load shift requirement in the April 26, 2019 draft can be achieved mostly by curtailing operation, without much or any load-up when there is enough energy stored in the tank. This is sufficient to support time-of-use control but does not provide utilities the ability to store extra thermal energy during oversupply events.

To address this gap, we propose to include an additional demand management function called "Advanced Load Up" that will enable the water heater to store additional energy on load-up, when in Advanced Demand Response Control mode as defined by JA-13.3.3.2. Even if the water heater is already fully loaded at user set point, Advanced Load Up will provide additional storage capacity by allowing the water heater to increase temperature higher than user set point (within safety limits).

As with the "Basic Load Up" function, the requirement is expressed in a performance-based manner as at least 0.5 kWh of electrical energy on Advanced Load Up, and 1 kWh on associated Light Shed event. This isn't cumulative, it means 1 kWh of load shift from Light Shed, including 0.5 kWh of electricity use on Advanced Load Up. 0.5 kWh represents approximately a 12-degree F uniform temperature increase in a 50-gallon tank (at a coefficient of performance of 3).

Given that the Advanced Load Up function may require loading up to a higher temperature than user set point, it will only be available in advanced control mode and therefore enabled only when users sign up for a remote demand management program. This will allow the utility to ensure upon enrollment that users understand that the water heater is set up with "Advanced Load Up" functionality which allows the user's set point temperature to be exceeded, and a mixing valve must be installed.

Respectfully submitted,

Pierre Delforge
Senior Scientist
Natural Resources Defense Council

Joint Appendix JA13

Appendix JA13 – Qualification Requirements for Heat Pump Water Heater Demand Management Systems

JA13.1 Purpose and Scope

Joint Appendix JA13 provides the qualification requirements for a heat pump water heater demand management system ("System") to meet the requirements for heat pump water heater demand management compliance credit available in the performance standards set forth in Title 24, Part 6, Sections 150.X(x). The primary function of the System is to serve the user's domestic hot water needs and provide daily load shifting, as applicable, for the purpose of user bill reductions, maximized solar self-utilization, and grid harmonization.

User interfaces referenced in these requirements should be designed for use by a typical residential user.

JA13.2 Definitions

Heat Pump Water Heater Demand Management System

The Heat Pump Water Heater Demand Management System is comprised of:

(a) Any hardware or software contained inside the water heater;

(b) Any hardware or software installed on premise (including a module); and

(c) Any software contained in applications or in the cloud;

which are necessary to fulfil the primary function of the System.

Local and remote methods

A local method means a method that can be performed from within the building and does not require the System to have a live connection to an off-premise source. A temporary connection **to a live off-premise source** such as via a smart phone, may be used for local setup and updates.

A remote method means a method that is performed via a live connection to an off-premise source, such as the internet, advanced metering infrastructure (AMI), or cellular.

JA13.3 Qualification Requirements

To qualify as a Heat Pump Water Heater Demand Management System for use for compliance with the applicable performance compliance credit, the System shall be certified to the Energy Commission to meet the following requirements:

JA13.3.1 Safety Requirements

The System shall comply with installation standards that are applicable in the California electrical, mechanical, and plumbing codes.

A thermostatic mixing valve conforming to ASSE 1017 shall be installed on the hot water supply line following all manufacturer installation instructions.

JA13.3.2 Minimum Performance Requirements

The installed System should meet or exceed the following performance specification:

(a) Efficiency: for heat pump water heaters, meet the requirements of the version 6.0 of the Northwest Energy Efficiency Alliance (NEEA) Advanced Water Heater Specification Tier 3 or higher.

(b) Thermal storage: comply with the first hour rating requirements in the following table (Chapter 5, Table 501.1 in 2018 Uniform Plumbing):

Number of bathrooms	1 to 1.5			2 to 2.5				3 to 3.5			
Number of bedrooms	1	2	3	2	3	4	5	3	4	5	6
First Hour Rating (gallons)	38	49	49	49	62	62	74	62	74	74	74

JA13.3.3 Control Requirements

The requirements below are applicable to all control strategies:

(a) **Time-of-use schedules:** The System shall have the capability of storing at a minimum five time-of-use schedule(s) locally, each supporting at a minimum five distinct time periods for both weekdays and weekends, at least three separate seasonal schedules, and daylight savings time changes. The System shall support both local and remote setup, selection, and update of time-of-use schedules. Local and remote setup, selection, and update shall be possible through a user interface (such as an app).

(b) **Demand management functionality**

Upon receiving a demand management price or dispatch signal, the System shall be capable of all the following automatic event responses:

1. **Basic Load Up**: The water heater will store extra thermal energy without exceeding the user set point temperature. It will avoid use of electric resistance elements unless user needs cannot be met;
2. **Advanced Load Up**: The water heater stores extra thermal energy, where some or all of the tank may exceed the set point temperature chosen by the user, within safe operating conditions. Advanced Load Up must only be enabled after agreement by the user and utility. It will avoid use of electric resistance elements unless user needs cannot be met. Advanced Load Up will only be available in Advanced Demand Response Control mode as defined in JA13.3.3.2;
3. **Return to Standard Operation**: The water heater terminates any demand management function and returns to user-selected standard operation mode until the next demand management function is activated;
4. **Light Shed**: The water heater will defer complete recovery for the duration of the shed event unless user needs cannot be met; The water heater shall avoid use of electric resistance elements during and immediately after the event unless user needs cannot be met;

5. **Deep Shed**: light shed, and completely avoid use of electric resistance elements during the event;
6. **Full Shed**: light shed, and completely avoid use of both compressor and electric resistance element during the event.

The demand management signals may be sent from a local utility, a remote aggregator, a local demand manager (e.g. local time-of-use demand manager or grid-edge such as smart inverter), or internal to the water heater (e.g. internal schedule- or price-based demand management).

The "Advanced Load Up" function shall only be enabled by a deliberate action of the user through the system's physical or remote interface upon enrolling in a utility's demand response program. The "Advanced Load Up" function shall be capable of being disabled deliberately by the user, or remotely by the utility or third-party service provider without deliberate action by the user.

For a water heater sized per JA13.3.2 guidelines and with the default set point as shipped from the manufacturer, the System shall be able to shift:

- A minimum of 0.5 kWh of user electrical energy per (Basic Load Up + Light Shed) event,
- A minimum of 1 kWh of user electrical energy per (Advanced Load Up + Light Shed) event, including at least 0.5 kWh on Advanced Load Up.

(c) **Non-standard mode exception:** The demand management functionality shall function in all user-selected modes except for vacation and off modes. The System shall return to the previous standard operation mode once the water heater exits from non-standard mode.

(d) **Local time management**: The System settings, including operating mode, time-of-use schedules, and local clock, shall be retained, or reacquired, in the event of a loss of power for at least three months. The local clock shall have a maximum drift of less than 5 minutes per year under standard operating conditions and without requiring remote connectivity.

(e) **Override and permanent disabling:** The System shall provide local and remote means for the user to override or permanently disable the demand management function. The override shall be temporary and have a maximum duration of 72 hours. Permanent disabling shall not be available as an operating mode or as an option in the primary menu.

(f) **User interface**: The System shall provide both a remote and local user interface, such as a web-based portal or a mobile device application, that at a minimum provide the dwelling occupants access to the following information: control strategy that is currently active, remote or local demand management mode, selected time-of-use schedule if applicable, and confirmation of any settings change.

(g) **Measurement and validation**: When connected remotely, the System shall make the following data available: Demand Management Override Status, Demand Management Disabled Status; power demand (watts); cumulative energy consumption (watt-hours); total energy storage capacity (watt-hours), available energy storage capacity (watt-hours).

The System shall be capable to use one of the following control strategies at the time of installation. The System also shall have the capability to switch to the other control strategies if available. The "Advanced Load Up" function shall not be enabled at time of installation.

JA13.3.3.1 Time-of-Use (TOU) Control

To qualify for the TOU Control, the System shall be installed in the default operation mode to serve domestic hot water user needs while optimizing water heater operation to reduce user bills under the selected time-of-use schedule. The System shall load up (charge) during the lowest priced TOU hours of the day and shed (minimize charging while serving user needs) during the highest priced TOU hours.

JA13.3.3.2 Advanced Demand Response Control

To qualify for the Advanced Demand Response Control, the System shall meet the demand responsive control requirements specified in Section 110.12(a). Additionally, the System shall be capable of changing the load-up and shed periods in response to real-time or day-ahead dispatch or price signals from the local utility, a remote aggregator, or a local demand manager. If remote communication is lost for more than 12 hours while the water heater is under Advanced Demand Response Control, the water heater shall revert to TOU Control until remote communication is reestablished, and then revert back to Advanced Demand Response Control.

JA13.3.3.3 Alternative Control Approved by the Executive Director

The Executive Director may, after stakeholder consultation, approve alternative control strategies that demonstrate equal or greater benefits to one of the JA13 control strategies. To qualify for Alternative Control, the System shall be operated in a manner that increases self-utilization of the PV array output, responds to utility rates, responds to demand response signals, and/or other strategies that achieve equal or greater benefits. This alternative control option shall be accompanied with well-documented algorithms for incorporation into the compliance software for compliance credit calculations.

JA13.4 Enforcement Agency

The local enforcement agency shall verify that all Certificate of Installations are valid. The System shall be verified as a model certified to the Energy Commission as qualified for a Heat Pump Water Heater Demand Management System Credit.