TECHNICAL BULLETIN

Heat Pump Plan Review for Food Facilities

Electric heat pump water heaters can comply with 2020 CCDEH Guidelines for Sizing Water Heaters

Figure 1: Hybrid heat pump in a small establishment

Purpose

Hot water is essential for food safety. Natural gas is the most common fuel for water heating, but its combustion is a major source of indoor air pollution and heat in commercial kitchens. In the Bay Area, burning natural gas in buildings is a larger source of outdoor air pollution and climate emissions than motor vehicles. Energy-efficient heat pump water heaters can eliminate on-site pollution, limit energy costs, and cool workspaces.

The purpose of this bulletin is to encourage health permit approval for heat pump water heaters (HPWH) in circumstances that meet CCDEH Guidelines for Sizing Water Heaters (revised February 2020). This bulletin is primarily a reference for health and safety officials; it may also be useful for design professionals and plumbing contractors. This bulletin is not a design guide, but it references resources that can improve cost-effectiveness and safety.

Requirements

Health Code

California Retail Food Code §114192(a) requires hot water to be supplied at a minimum of 120ºF as measured at the tap. The California Conference of Directors of Environmental Health (CCDEH) Guidelines for Sizing Water Heaters (2020) provide guidance on determining which systems satisfy State law and ensure sufficient hot water is available at all times. Under the guidelines, a proposed food facility must calculate maximum possible hot water consumption per hour and demonstrate minimum water heater storage capacity to obtain a health permit.

Building Codes

In addition to complying with health codes, food facility construction must comply with California Plumbing Code, Building Code, and Energy Standards. Plan review and inspection for compliance with building codes is a separate process from health inspection, and significantly affects food facility construction.

San Francisco Building Code 106A.1.17 requires new construction to be all-electric. In new buildings, gas is allowed for commercial cooking, but water heating must be electric.

New Requirement: BAAQMD Zero-NOx Rule 9-6

To mitigate the health impacts of air pollution, the Bay Area Air Quality Management District (BAAQMD) has adopted zero NOx requirements that will impact water heaters in the coming years. In 2027, gas-fired tank water heaters with input rating up to 75,000 BTU/hour will not comply with the zero NOx emissions limit and can no longer be sold or installed. By 2031, similar requirements will apply to water heaters with an input up to 2 million BTU/hr. The South Coast Air Quality Management District (serving much of the Los Angeles basin) is phasing in similar rules.

Related Requirements

The California Air Resources Board is proposing statewide Zero-Emission Space and Water Heating Standards, expected to be finalized in 2026, in order to meet State and federal air quality standards and benefit public health by reducing smog-forming NOx emissions.

Electric Water Heating Technologies

There are two common electric water heating technologies that could be used to meet zero-NOx and all-electric requirements:

Electric Resistance: In a common electric water heater, electric resistance elements emit heat when electric current is applied. Heating water with this technology is much more expensive than burning natural gas, significantly impacting business energy costs.

Heat Pump: A heat pump water heater transfers heat from air (or water[i]) into the storage tank. Heat pumps are very efficient: 1 kWh of electricity consumed will add between 1.5 to 4 kWh of heat to the water tank, reducing water heating energy cost 30% to 50% compared to electric resistance.

A food facility can achieve utility costs comparable to gas water heating if a heat pump water heater is combined with voluntary energy efficiency measures such as heat-recovery dish machines, high-performance pre-rinse spray valves, and eliminating long hot water plumbing lines with point-of-use hot water heaters for lavatories and bar sinks.

Heat Pump Options

Heat Pumps Alone Are Unlikely to Be Practical (Today)

While heat pumps could, on their own, provide enough hot water for food service establishments, *Formula 2 for electric water heaters* is based on input kW rather than heat output. Electric service equipment (panels, wiring, switchgear, etc.) is sized to safely meet a facility's peak load (e.g. maximum kW for the entire facility). This puts efficient heat pumps at a disadvantage in comparison to gas or electric resistance units because it encourages "oversizing", meaning installing equipment with more capacity than necessary. An oversized hot water system based on heat pumps alone would take up more space and be far more costly to construct than a right-sized heat pump system. Research is underway to inform revisions of the Guidelines that will better address heat pump performance characteristics.

"Hybrid" or "Integrated" Electric Heat Pump Water Heater

Some commercial and residential water heaters combine a storage tank, electric resistance heating element(s), and a heat pump. Such devices may be referred to as "integrated", "hybrid", or "unitary" heat pump water heater. The three terms are used interchangeably and refer to a single type of device. "Unitary" and "integrated" refer to the components being packed into a single unit. "Hybrid" refers to an operating mode where the device activates the electric resistance elements and/or the heat pump to maintain supply water temperature.[ii]

In hybrid heat pump water heaters, electric resistance elements and tanks are the same technology as any standard electric resistance water heater. In some models the heat pump can operate simultaneously with electric resistance elements, in which case the heat pump contributes to peak hot water production capacity.

There is another type of heat pump water heater: a "split system" where the heat pump and tank are installed as separate components. Split system configurations can be complex and are not addressed by this bulletin – but a split system can be designed with sufficient input kW to satisfy *Formula 2*.

Operating Modes

Hybrid mode: Hybrid heat pump water heaters will perform best in "hybrid" mode, where the more-efficient heat pump provides heat as often as possible, and the unit activates electric elements when maximum heat input is necessary to maintain supply temperature. For best combination of thermal performance and minimum energy cost, hybrid mode is recommended.

Ideally hybrid HPWH specified for a food service applications will be capable of activating the heat pump and electric resistance elements simultaneously. When both components activate simultaneously, the device can deliver more heat than a standard electric water heater with equivalent resistance element input kW.[iii]

However, features and functions vary by model and manufacturer. As of December 2024, in commercial models simultaneous activation of heat pump and resistance elements is a rare feature, and field performance data currently supports the conservative approach of limiting input kW to resistance element output only.

Electric-only: A hybrid water heater's "electric-only" mode turns off the heat pump and solely utilizes electric resistance elements. A water heater in electric-only mode may meet the minimum kW input required by CCDEH Guidelines, but the inefficiency of this mode will burden food facilities with significantly higher operating costs.

Heat pump-only: Digital controls on some units may include an "efficiency mode," which turns off the electric resistance elements and so that the heater relies solely on the more-efficient heat pump. If a hybrid HPWH is the sole source of hot water for a plumbing system, Environmental Health approval of a hybrid or integrated heat pump water heater should instruct the applicant to avoid use of any mode that deactivates or locks out resistance elements.

Review Procedure

If the kW Input proposed meets the minimum kW input required by CCDEH Guidelines *Formula 2 for Electric Water Heaters*, the device can be approved. To document kW Input, the applicant shall document the maximum electric input for proposed devices. Acceptable forms of documentation include manufacturer specifications, installation manual excerpts, device name plate, or written guidance provided by the manufacturer.

At the time of writing, hybrid HPWH on the market have limited Input kW, so larger facilities may require more than a single HPWH. Where multiple water heaters are installed, 2020 CCDEH Guidelines require water heaters to be piped in parallel. If multiple units are installed in parallel, the Input kW for *Formula 2 For Electric Water Heaters* is the sum of Input kW of all devices in combination.[iv]

Plan Check: Does a Proposal Satisfy Formula 2?

Formula 2 for Electric Water Heaters from CCDEH Guidelines

CCDEH Guidelines require electric water heaters to meet the following formula:

kW input = *GPH * Thermal Rise (°F) * 8.33 lb per gallon of water ÷ (0.98 Thermal Efficiency X 3312 BTU/kW)*

Thermal Rise is water heater output temperature – input temperature.

GPH is the maximum gallons of hot water that could be used by all fixtures and equipment in a plumbing system.

Example 1 – Café

Hourly Hot Water Demand: 50 GPH

(1) Calculate Minimum kW Input

Formula 2 required input:

Minimum kW input = 50 gph * 70 °F * 8.33 lb per gal water ÷ (0.98 Thermal Efficiency * 3412 BTU/kW) = 8.7 kW

The total input rating of electric resistance elements must be **8.7 kW or greater.**

(2) Verify kW Input of Proposed Equipment

The applicant proposes a hybrid HWPH with two elements, each with 6 kW rated input at 240V.

MODEL SPECIFICATIONS

Model Number	Nominal Capacity	COP	Number of Elements	Total Element Wattage (both elements at 240V)	First Hour Delivery at 100° Temperature Rise in Hybrid Mode (GPH)
CAHP 120	119	4.3*	2	12,000	194

*DOE test standard, 80°F ambient with 63% humidity, inlet water temperature at 70°F, outlet water temperature at 120° F

Figure 2: Manufacturer specifications of proposed equipment Resistance element input wattage and voltage are clearly indicated.

Technical Characteristics		
Model Type	Integrated Heat Pump Water Heater	
COP	4.3	
HP Rated Input Power	3.81 Horse Power (2.84kW)	
HP Rated Heating Output Capacity	12.21 kW	
Power Specification	208/240Vac ~ 60Hz 1Ph	
Maximum Operation Current	67 A	
Refrigerant	R134a	
Refrigerant Charge Quantity	3.3 Lbs (1.5 Kg)	
Electrical Heating Capacity	12.0 kW @ 240Vac and 9.0 kW @ 208Vac	
Operation Modes	Efficiency, Hybrid, Electric	
Max. Water Temperature	Efficiency/Hybrid	Electric
	150°F (66°C)	180°F (82°C)
Operating Ambient Temperature	20 - 110°F (4.4 - 43.3°C)	
Unit Operation Noise	59 dB (A)	
Approx. Heater Weight	498 Lbs (226 Kg)	
Approx. Shipping Weight	620 Lbs (281 Kg)	

Figure 3: Technical specification of proposed equipment indicates kW at 240V and 208V.

(3) Compare Proposed Input kW to *Formula 2* Minimum

12 kW proposed input **>** 8.7 kW minimum. The water heater satisfies *Formula 2* and can be approved.

CCDEH Guidelines Do Not Require Voltage Correction

2020 CCDEH Guidelines provide significant assurance that hot water systems will deliver 120F even in the unlikely event all taps are continuously at full output. Commercial water heaters are typically designed to operate at 240V or 208V, and a heating element receiving 208V will output 25% less heat than at 240V.[v] 2020 CCDEH Guidelines *Formula 2 for Electric Water Heaters* provide adequate heat output without adjustment for voltage, so the input kW of a HPWH at 240V should be utilized when completing *Formula 2* (Figure 3).

Future versions of CCDEH Guidelines may be more nuanced. For example, future guidelines may consider heat output from a heat pump (increasing calculated input kW) and voltage derating (decreasing calculated input kW).

Example 2: Ice creamery

Hourly Hot Water Demand: 25 GPH

(1) Calculate Minimum kW Input

Formula 2 required input: 4.4 kW

(2) Verify kW Input of Proposed Equipment

The applicant proposes a hybrid HPWH with one 4.5 kW element (Figure 4).

DESCRIPTION					ENERGY INFO		FEATURES						SHIPPING WEIGHTS	
NOMINAL GALLON CAPACITY	RATED GALLON CAPACITY	MODEL NUMBER	MODEL VARIANT	ELECTRIC BREAKER SIZE	UNIFORM ENERGY FACTOR (UEF)	EST. YEARLY ENERGY COST	COMPRESSOR BTU/H	FIRST HR. RATING (GALLONS)	RECOVERY IN G.P.H 90° F RISE	ELEMENT WATTAGE	TOTAL UNIT WATTAGE	MAX AMPS	UNIT WT. (LBS)	APPROX. SHIP WT. (LBS.)
40	36	HPLD40-1RU	701445	30	3.75	$104	4,200	60	27	4,500	5,000	21	157	174
50	45	HPLD50-1RU	701444	30	3.75	$104	4,200	67	27	4,500	5,000	21	178	218
65	59	HPLD65-1RU	701446	30	3.85	$155	4,200	75	27	4,500	5,000	21	225	262
80	72	HPLD80-1RU	701447	30	4.00	$149	4,200	87	27	4,500	5,000	21	244	281

Figure 4: Technical specification of appliance product line

(3) Compare Proposed Input kW to *Formula 2* Minimum

Proposed Input kW of 4.5 kW is greater than 4.4 kW minimum to meet 2020 CCDEH Guidelines. The proposed water heater satisfies *Formula 2*.

Applications

Common Applications

Hybrid heat pump water heaters will work best for smaller establishments with limited hot water needs such as ice cream shops, coffee bars, or quick-service sandwich shops. The best candidates will be sites where either (A) the project electrical contractor and Department of Building Inspection confirms the existing utility service panel has sufficient space and electric capacity for the proposed heat pump water heater, or (B) the proposed project scope of work includes a new electric service connection – and the new connection is sized to accommodate the proposed heat pump. If the Input kW of a single hybrid heat pump water heater is sufficient to satisfy *Formula 2,* the unit can be approved.

Less-Common Applications

The remainder of this section discusses other situations that may arise and examines the conditions necessary to satisfy CCDEH Guidelines in each case. For practical and financial reasons, these situations are not expected to be common because satisfying *Formula 2* with resistance elements can strongly impact electric service capacity and operating costs. As kW input rises, utility service capacity requirements increase. Studies underway at the time of writing will provide technical guidance to update CCDEH Guidelines to better reflect the performance of heat pumps to deliver hot water.

Simple Recirculation Loops

It is not a best practice to install HPWH in-line with a recirculation loop. The energy efficiency benefit of a heat pump requires a significant temperature rise (difference between input versus supply temperature), and a hybrid HPWH on a continuous recirculation loop would offer limited energy savings compared to a standard electric water heater. In addition, some manufacturers may not adequately test HPWH appliance controls for proper operation in a continuous recirculation loop, potentially impacting reliability.

Since locating a HPWH within a recirculation loop will compromise the efficiency benefit of HPWH, this approach is not expected to be common but is not prohibited by CCDEH Guidelines.

If a hot water recirculation loop is necessary, the designer is encouraged to review the *Technical Design Guide for Advanced Water Heating in the Foodservice Industry* for design best practices that improve efficiency, reduce energy cost, and may satisfy California Plumbing Code without recirculation. Common approaches to "trim" lengthy hot water piping include providing hot water to distant sinks with point-of-use hot water heating, adopting heat recovery dish machines, and disaggregating water heating into two or more separate systems that each comply with CCDEH Guidelines.

If an applicant proposes an all-electric system with recirculation, please recommend that they review the Design Guides at caenergywise.com or obtain an On-Site Energy Survey from the Food Service Technology Center.

Multiple Hybrid Heat Pump Water Heaters

It is possible for multiple hybrid heat pump water heaters to be piped in parallel. However, due to construction cost considerations hot water system disaggregation is expected to be a more common strategy than a single system with multiple HPWH's piped in parallel. In all circumstances, each hot water distribution system must comply with *Formula 2*.

Heat Pump-Assisted Hot Water System

Like a hybrid electric heat pump water heater, a heat pump-assisted hot water system would include a heat pump, storage tank, and electric resistance elements. In a heat pump-assisted system, electric resistance element(s) may be separate from the heat pump (a "split system"). A system where input kW satisfies CCDEH Guidelines *Formula 2* and *Appendix II* can be approved. Most commonly, the resistance coil will serve the recirculation loop, and the heat pump will be located upstream from the recirculation loop – heating incoming cold water. See the *Technical Design Guide for Advanced Water Heating in Food Service* ("fourth scenario") for details about heat pump-assisted systems.

Resources

California Energy Wise is a resource for energy efficiency in commercial kitchens of all types, sizes, and production capacities. CA Energy Wise resources include appliance rebates, live and on-demand classes to improve efficiency in design and operation, in-person commercial appliance demonstrations, energy cost calculators, and audits & expert consultation to tailor solutions to a facility's specific needs. caenergywise.com

Design Guides are available for all commercial kitchen systems. caenergywise.com/design-guides/

Relevant to this Bulletin:

- Technical Design Guide for Advanced Water Heating in Foodservice, 3rd Edition (2023)
- Operating Guidelines for Advanced Water Heater in Foodservice

Classes are offered live and on-demand caenergywise.com/seminars/

Rebates are available for the most efficient equipment in each category caenergywise.com/instant-rebates/

Financing is available to commercial tenants and owners:

- 0% interest from PG&E for businesses in operation >24 months pge.com/onbillfinancing
- Flexible terms from the State of California's *Go Green* Financing program gogreenfinancing.com

San Francisco Food Facility Plan Review: SF.gov/departments--food-safety

San Francisco Decarbonization Permit Streamlining: SFEnvironment.org

BayREN Codes Program: Helps local governments reduce energy and water use for a more sustainable and resilient future bayren.org/local-government-resources

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[i] Water-to-water heat pumps extract heat from one volume of water and deliver concentrated heat into a second volume of water or steam, to achieve performance characteristics such as higher supply water temperatures.

The most common uses of water-to-water heat pumps in buildings are either: (1) Extracting heat from a district loop serving multiple buildings such as a campus or neighborhood-scale development – such as the bay water heat exchange loop serving buildings in San Francisco's contemporary Mission Rock development. Or (2) A two-stage heat system that combines an air-to-water heat pump with a water-to-water heat pump. The two stages may be combined into a single device, where an air-to-water heat pump draws heat from ambient air, and a water-to-water heat pump concentrates that heat into a smaller volume of hotter water or steam.

At the time of writing, the authors are not aware of the use of water-to-water heat pumps in food service applications and are beyond the scope of this bulletin. We note them here because heat pump performance for sanitation purposes is an evolving field.

[ii] For background on split system designs, see the *Technical Design Guide for Advanced Water Heating in the Foodservice Industry* at: caenergywise.com/design-guides/

[iii] This approach is conservative to conform to 2020 CCDEH Guidelines. HPWH deliver more heat per input kW than resistance elements.

[iv] In some split systems, multiple heat pumps may be piped in series to maximize rise. This bulletin does not address split systems.

[v] Derating 25% at 208V is a reasonable approximation. More formally:

$$\text{Derated kW} = [\,(\text{actual voltage} / \text{nominal voltage})^2\,] \times \text{kW at nominal voltage}$$
$$(208V / 240V)^2 = .751, \text{ so Input kW is reduced 24.9\% at 208Vac.}$$

However, a heat pump designs vary and output from a heat pump output may not be impacted by voltage to the same degree.