ET Summit 2024

Presented by

ETCC
ENERGY TRANSITION
COORDINATING COUNCIL

Early Advocacy and Research with Heat Pumps in Commercial Kitchens

October 9, 2024

Amin Delagah
Associate Director
TRC

Code Readiness Activities to Prepare for Tomorrow

Research to overcome barriers for adoption of new technology

- **PG&E Code Readiness Program** conducts planning to set the stage for effective code development by gathering robust data on technologies and systems in advance of multi-year rulemaking at the state/federal level, and helps bring various agencies to the table
- Code Readiness can help **overcome code barriers**
  - Informs Codes and Standards Enhancement (CASE) Initiative Reports
  - CASE reports summarize the need and viability of proposed energy code measures and provide sample code language to inform Building Energy Efficiency Standards rulemaking

Project Funders

PG&E®

CalNEXT

Project Partners

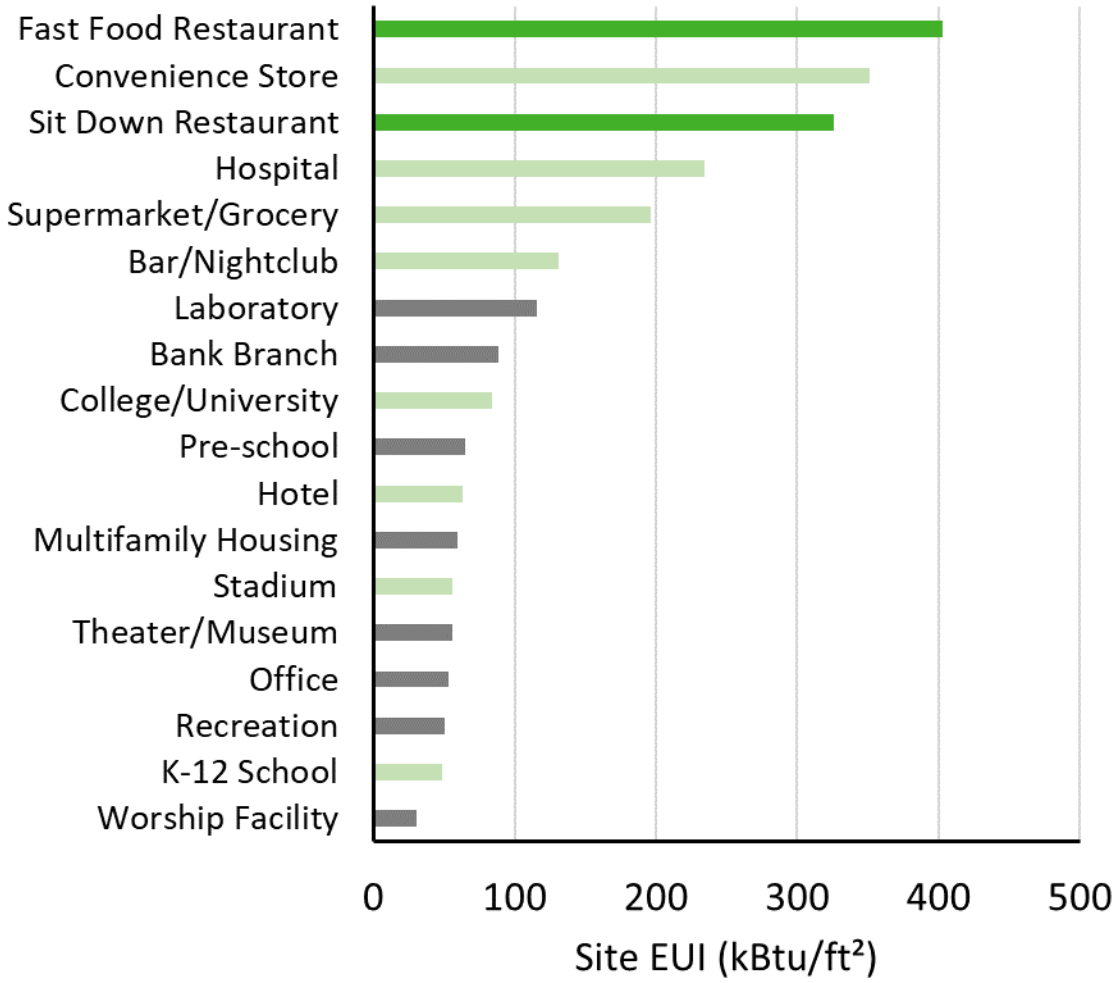
ATS Applied Technical Services

2050 PARTNERS

FRONTIER energy

The Importance of Foodservice and Decarbonization

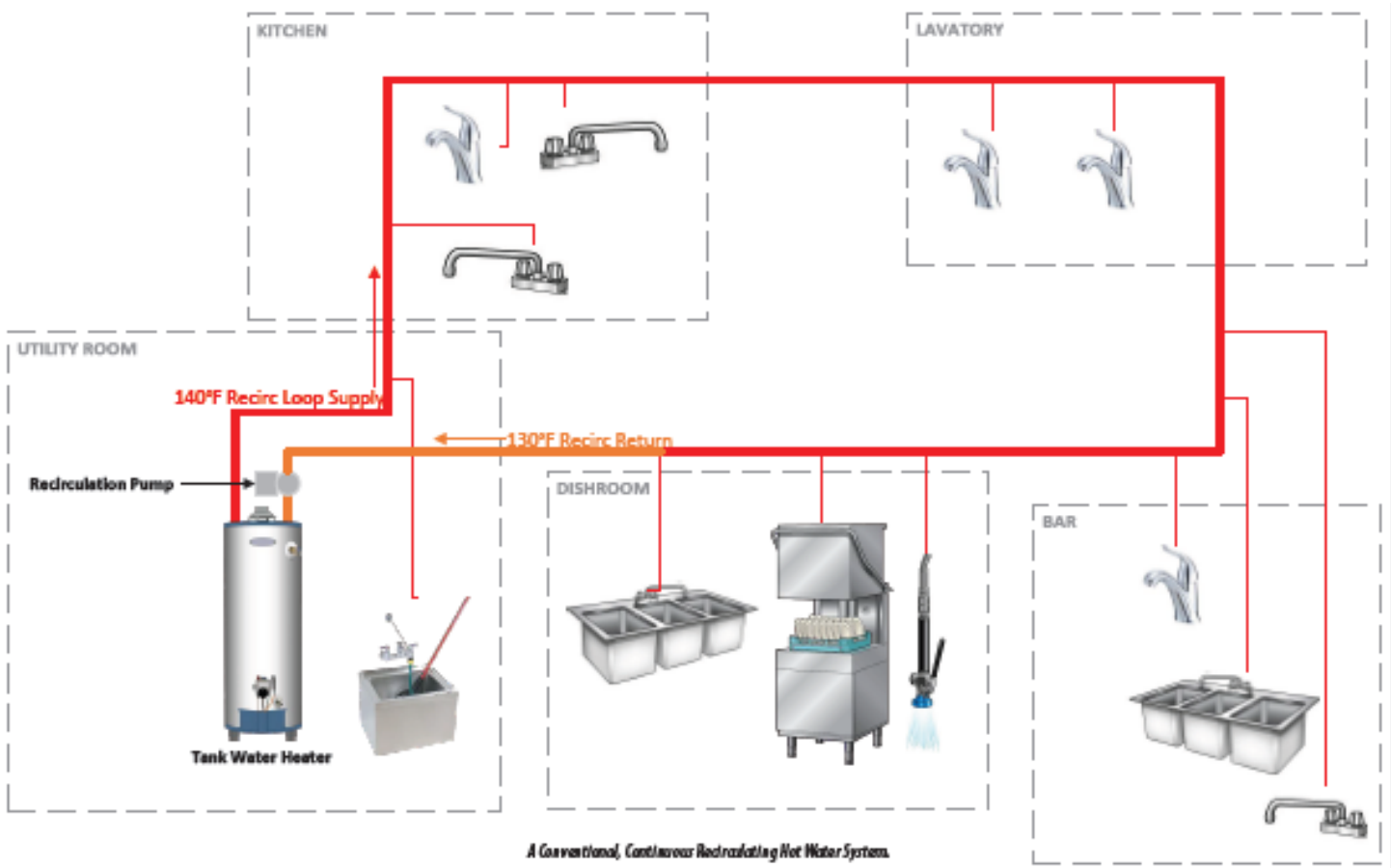
- Commercial foodservice facilities are among the **most energy- and emissions-intensive buildings**
- Segments with **light green bars** have commercial foodservice component
- **Huge segment barriers** with minimal profit margin, short payback focus, high business failure rates
- **Cooking, water heating, space heating, and patio heating** must be electrified to support California's decarbonization goals
- **Water heater is the single highest energy using appliance** in an average dedicated foodservice facility



Source: US Energy Use Intensity by Property Type (energystar.gov) 2024

Early Research and Motivation

- **Prior history of lab and field testing of water heaters conventional heaters** in commercial foodservice in SF Bay Area, 2000-2020
- **Identified heat pump (HP) barrier in 2021** with health department water heater sizing regulations
- **Health department rejection of HP in University Café** decarbonization project in 2022 **was a catalyst**
- **TRC utilized state efficiency programs to get ball rolling** with HPs in commercial foodservice by updating tools and conducting research and advocacy to increase familiarity in this segment



Source: Technical Design Guide

Early Work Builds Off CalNEXT Projects

Market Potential for HP Assisted Hot Water Systems in Foodservice Facilities

Project Team: TRC

HP Assisted Retrofit Study in Full-Service Restaurant

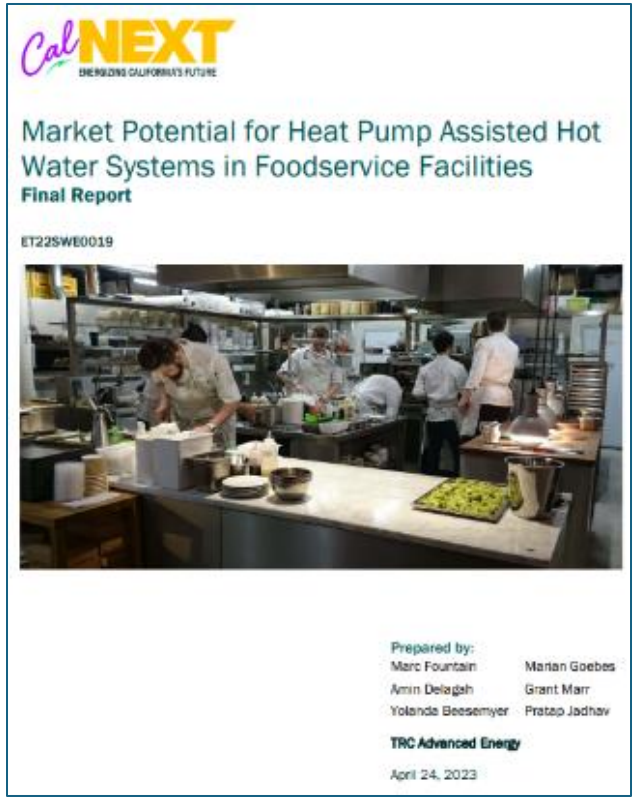
Project Team: TRC, Frontier Energy

Technical Design Guide for DHW System in Kitchens

Project Team: TRC, Frontier Energy

Master Mixing Valve Field Study

Project Team: TRC



Source: https://calnext.com/wp-content/uploads/2023/07/ET22SWE0019_Final_Report.pdf

Source: https://caenergywise.com/design-guides/

Market Potential of HP Assisted Systems

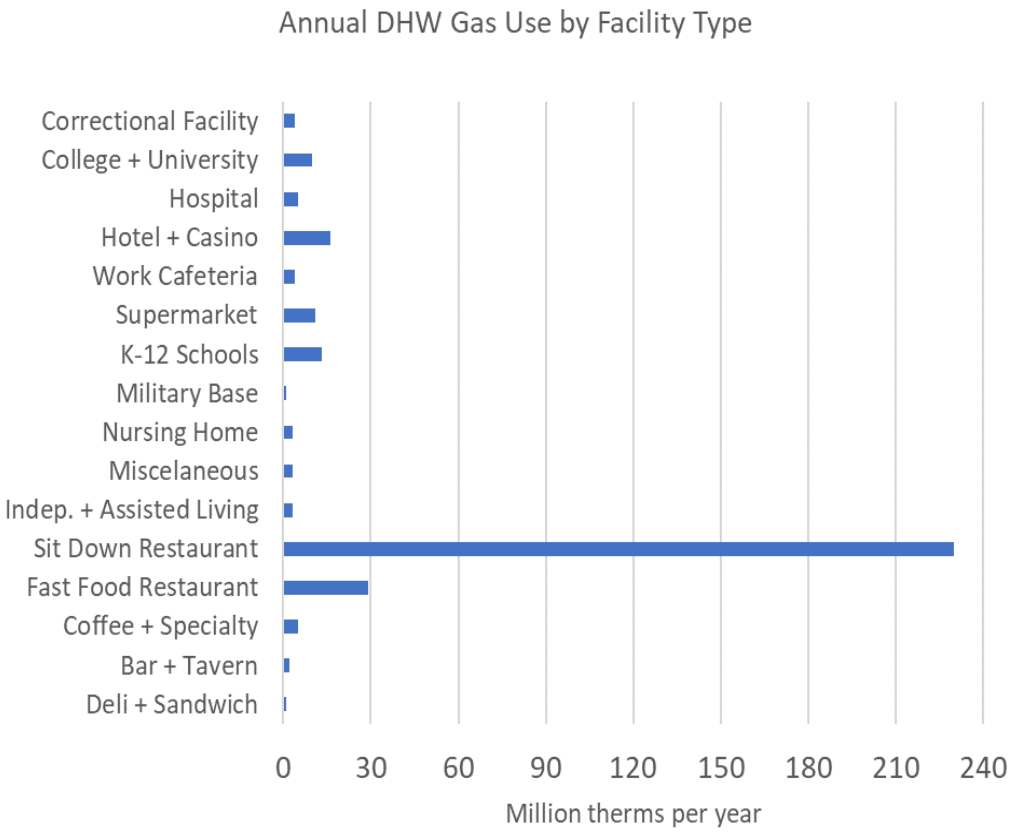
Study Results

Water heating in California is 90% gas, 10% electric resistance

No HP installations identified in restaurants

Multiple barriers identified including:

- **Larger upfront costs** (equipment, design, installation, electrical upgrades)
- **Higher space and water storage requirements** (indoor/outdoor footprint, weight on roof)
- **Broad lack of familiarity with technology** and application with owners/operators and health departments
- HP source and site **energy savings doesn't typically yield operating cost savings**
- **Demonstration of HPs in kitchens is a first step** to familiarize industry to work **towards updating the sizing guidelines**



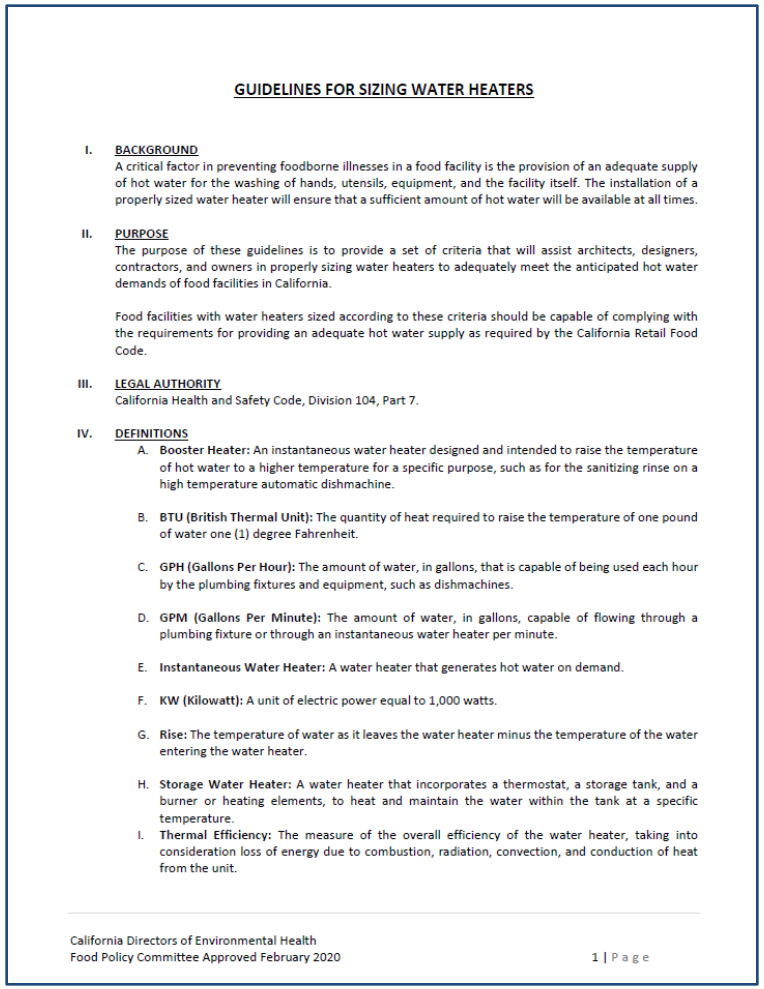
Source: 2010 CEC Report by Fisher-Nickel Inc.

https://hdl.handle.net/2027/uc1.31822039658588

California Retail Food Code & CCDEH

- The California Retail Food Code states: "**Hot water generation and distribution systems shall be sufficient to meet the peak hot water demands throughout the food facility**."
  - Assigns primary enforcement **responsibility to the local enforcement agency**
  - Nearly all California county enforcement agencies point to the **CCDEH Guidelines for Sizing Water Heaters**

- California Conference of Directors of Environmental Health, CCDEH
  - A non-profit organization whose membership is comprised of Environmental Health Directors from 62 jurisdictions, including all 58 California counties and 4 California cities
  - **Food Policy Committee developed guidelines to support jurisdiction review of water heater sizing**



GUIDELINES FOR SIZING WATER HEATERS

I. **BACKGROUND**
A critical factor in preventing foodborne illnesses in a food facility is the provision of an adequate supply of hot water for the washing of hands, utensils, equipment, and the facility itself. The installation of a properly sized water heater will ensure that a sufficient amount of hot water will be available at all times.

II. **PURPOSE**
The purpose of these guidelines is to provide a set of criteria that will assist architects, designers, contractors, and owners in properly sizing water heaters to adequately meet the anticipated hot water demands of food facilities in California.

Food facilities with water heaters sized according to these criteria should be capable of complying with the requirements for providing an adequate hot water supply as required by the California Retail Food Code.

III. **LEGAL AUTHORITY**
California Health and Safety Code, Division 104, Part 7.

IV. **DEFINITIONS**
A. **Booster Heater:** An instantaneous water heater designed and intended to raise the temperature of hot water to a higher temperature for a specific purpose, such as for the sanitizing rinse on a high temperature automatic dishmachine.

B. **BTU (British Thermal Unit):** The quantity of heat required to raise the temperature of one pound of water one (1) degree Fahrenheit.

C. **GPH (Gallons Per Hour):** The amount of water, in gallons, that is capable of being used each hour by the plumbing fixtures and equipment, such as dishmachines.

D. **GPM (Gallons Per Minute):** The amount of water, in gallons, capable of flowing through a plumbing fixture or through an instantaneous water heater per minute.

E. **Instantaneous Water Heater:** A water heater that generates hot water on demand.

F. **KW (Kilowatt):** A unit of electric power equal to 1,000 watts.

G. **Rise:** The temperature of water as it leaves the water heater minus the temperature of the water entering the water heater.

H. **Storage Water Heater:** A water heater that incorporates a thermostat, a storage tank, and a burner or heating elements, to heat and maintain the water within the tank at a specific temperature.

I. **Thermal Efficiency:** The measure of the overall efficiency of the water heater, taking into consideration loss of energy due to combustion, radiation, convection, and conduction of heat from the unit.

California Directors of Environmental Health
Food Policy Committee Approved February 2020 1 | Page

California Retail Food Code: Chapter 7, Article 1, Section 114194 (b)

ccdeh.com/ **Documents Tab:** Search for Water Heater Guidelines

HP Regulatory Barrier

Biggest barrier identified is CCDEH water heater sizing guidelines

- Currently, **no sizing guideline for heat pumps**, only gas-fired and electric resistance
- Thermal efficiency of **0.98 is fixed value used to calculate kW input** (power)

Formula 2 (for electric water heaters):

$$KW\ input = GPH\ X\ °F\ Rise\ X\ \frac{8.33lb}{gallon\ of\ water} \div Thermal\ Efficiency^{1}\ X\ 3412\frac{BTU}{KW}$$

KW input = 54 GPH X 50°F X 8.33 lbs / 0.98 X 3412 BTU/KW = 6.7 KW

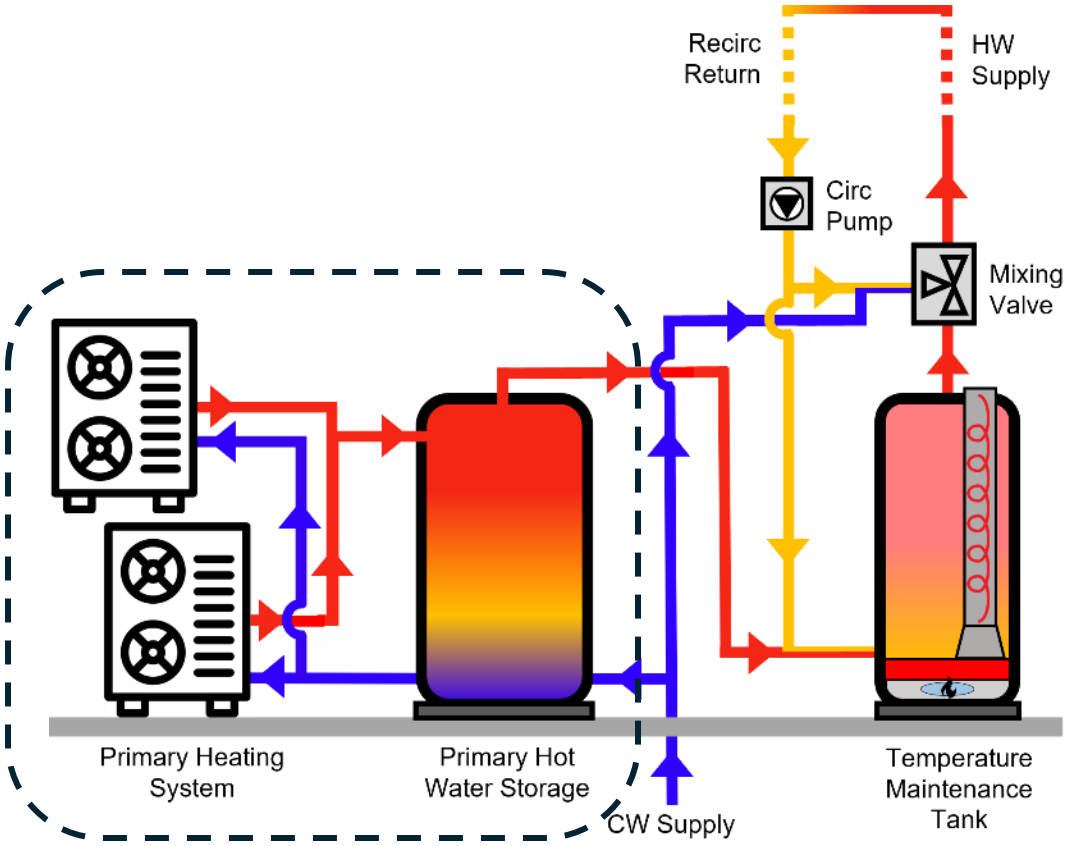
Source: CCDEH

Source: vernoncohd.com/food-service.php

- HP is **oversized by up to 400 percent** if allowed to use Formula 2 by local jurisdiction
- Existing sizing **guidelines don't account for hot water storage capacity**
- Report identified appropriate HP technologies for various sized kitchens
- **Heat Pump Assist concept developed to overcome existing barriers** with water heater sizing guidelines

Overcoming Barriers with HP Assist Configuration

- **Using a HP and storage tank upstream**, in series with the existing gas heater in an "assist" fashion, **is one way to overcome health dept. water heater sizing regulations**
- **Low risk opportunity to familiarize industry** on HP operation
- Demonstrate beneficial cooling and dehumidification
- Adds resiliency with dual fuel capability, no scrutiny on sizing
- **Mitigates other major barriers** including installed and operating costs, electrical capacity limitations, and space requirements
- **Lowest operating cost potential** when:
  - HP is load shifted to only operate during off-peak periods between 9pm to 4pm in California
  - Utility adds programs to power down HP when Flex Alerts or PSPS events occur (Summer AC Peak Use Days)



Overcoming Barriers with Unitary HPs in Café + Fast Food

In **facilities with small hot water loads**, there is a **path to use** light-commercial integrated HP/resistance **hybrid heaters** (11.3kW at 208V) to meet health dept. electrical input power requirements

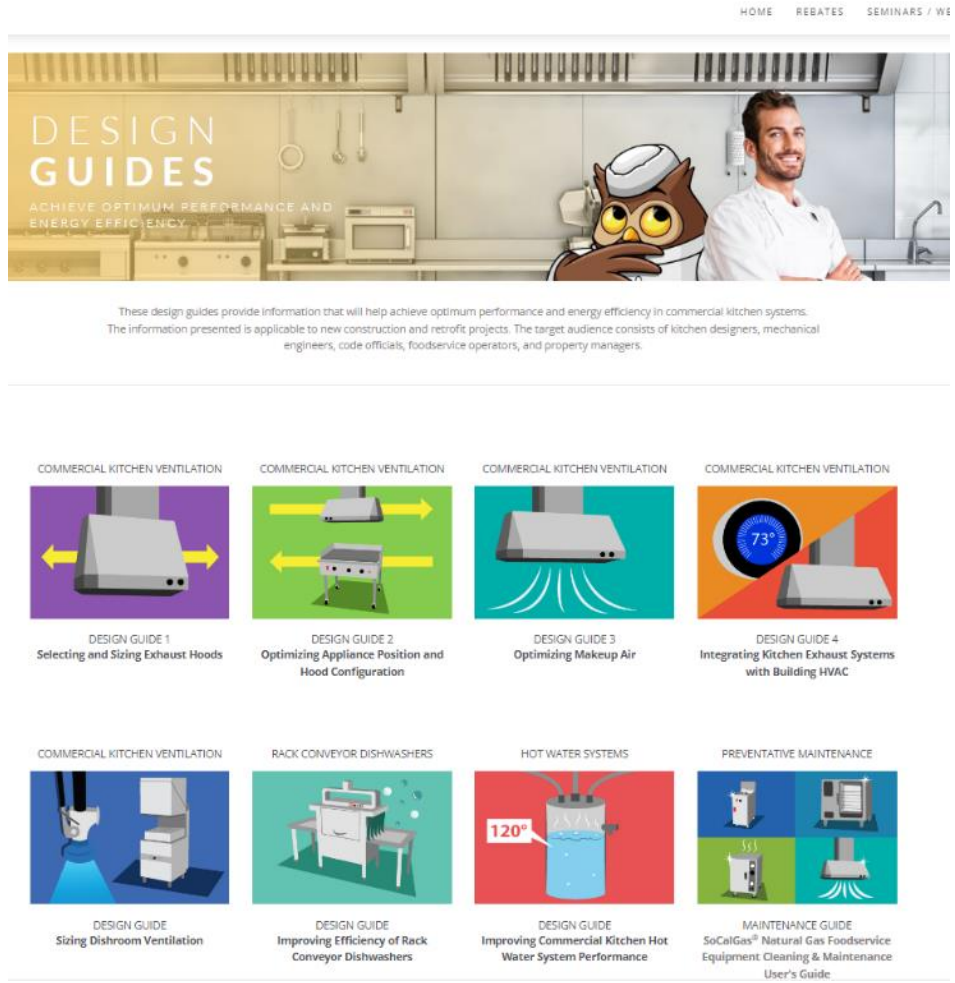
Hybrid heaters are best suited for systems without continuous recirculation

Overall, study shows there are two pathways to overcome sizing hurdles

Source: A.O. Smith

Commercial Kitchen DHW System Design Guides

- Expand on existing guide that had natural gas focus
- Split guide, **a technical design guide** and **operator's guide**
- Technical guide added sections on:
  - Mixing valves, water circulators and controls
  - **HP Assist concept**
  - **Electric HPs and HP installation and sizing considerations**
  - Load flexibility
  - **Water heater cost and footprint**
  - **DHW system design examples**
- Both guides translated into Spanish
- A slide deck accompanied by audio
- Design guides and slide decks with audio **posted on website for free download**



Source: https://caenergywise.com/design-guides/

HP Assist Field Demonstration Project

- CO2 based split system for HP Assist optimization
- **Study several optimization efforts** at fine dining restaurant
  - Add HP/tank to existing gas storage heater
  - Install master mixing valve
  - Load shift from 4-9 pm peak hours
  - Replace existing machine with heat recovery dishmachine

Photo Credit: Meiko

Photo Credit: SanCO2

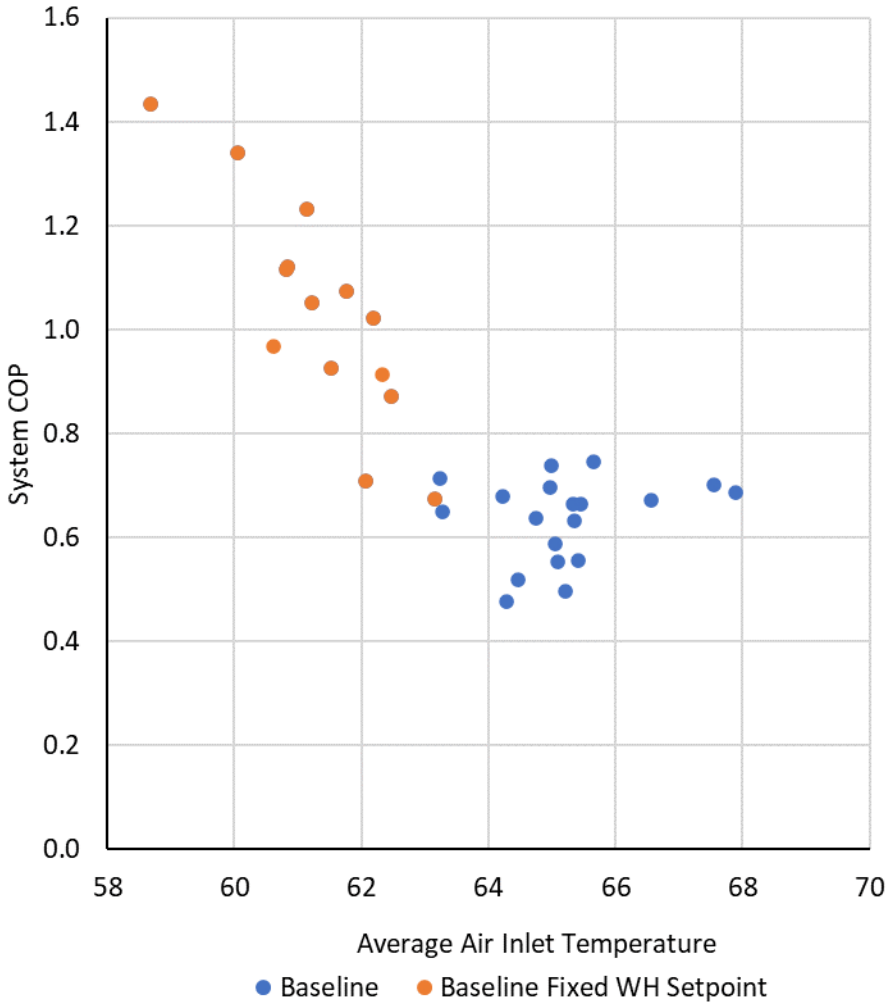
120-gallon HP/ER Hybrid Heater Monitoring

Study various optimization efforts at 3 sites that recently underwent retrofit from gas DHW systems

- 51-unit hotel installed 2 units in unventilated room
  - Ventilation improved in mechanical room by opening adjacent laundry room door
  - Site avoided having to add 3rd unit to meet load
- **Monitored system** with heaters in parallel **as found**
  - Unit #1 at 120°F, unit #2 at 140°F in **hybrid mode**
  - **System COP of 0.6**
- HP setpoint and operating mode optimization
  - Setpoints set to 130°F in **efficiency mode**
  - **System COP of 1.0, → 40% improvement**
- Other results
  - 1100 gal/d of hot water use
  - 4°F recirculation loop ΔT
  - Room temperature of 60°F

HP/ER Hybrid Heater Optimization

- Plan to **test DHW system optimizations where applicable** to
  - Optimize operating mode and temp. setpoints
  - Add pipe insulation in mechanical room
  - Balance water flows to parallel HPWHs
  - Look to increase room temperature
  - Add pump demand controller where applicable
  - Add and optimize digital mixing valve
  - Add ECM pump with constant return temp control
- **Monitor 3 commercial DHW sites** that underwent retrofits in hotel, supermarket and assisted living facility



Recap and Next Steps

- Started out with:
  - Industry advocacy and identification of decarbonization hurdles with **HP Assist Market Study**
  - Updated **Design Guides** benefit all stakeholders
- Projects in progress:
  - **HP Assist Field Retrofit Monitoring Project** to demonstrate HP technology and heat recovery dishmachines
  - **Master Mixing Valve Field Project** in 5 sites including one with HP/ER hybrid heater
- Next Steps are a trio of code readiness projects:
  - **HP/ER Hybrid Heater Field Monitoring Project** in 3 Non-Residential Buildings
  - **Commercial Kitchen HPWH System Lab Testing** at PG&E ATS (Mehdi)
  - **Overcoming Key Barriers to Electrification** of Full-Service Restaurant Hot Water (Maya)

Thank You!

Amin Delagah
Associate Director
Research & Consulting Group
adelagah@trccompanies.com
www.trcccompanies.com

TRC