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Foodservice Water Heating Systems Technical Overview and Findings

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List of Abbreviations

Acronym	Definition
AWHI	Advanced Water Heater Initiative
BAAQMD	Bay Area Air Quality Management District
BESS	Battery energy storage system
Btu/hr	British Thermal Units per hour
CARB	California Air Resources Board
CCDEH	California Conference of Directors of Environmental Health
CEC	California Energy Commission
COP	Coefficient of performance
DEER	Database for Energy Efficiency Resources
DOE	Department of Energy
ER	Electric resistance
FDAS	Flexible Demand Appliance Standards
HPWH	Heat pump water heater
IOU	Investor-owned utility
kWh	Kilowatt hour
MIDAS	Market Informed Demand Automation Server
NBI	New Buildings Institute
PG&E	Pacific Gas & Electric
PV	Photovoltaic
RFF	Restaurant – Fast-Food
RSD	Restaurant – Sit-Down
SCE	Southern California Edison
SDG&E	San Diego Gas & Electric
TE	Thermal efficiency
TOU	Time-of-use
UEF	Uniform energy factor

1 Executive summary

This document summarizes the technical overview and research findings for the Foodservice Water Heating Systems Market Transformation Initiative. The feasibility, performance, and customer impacts of using commercial heat pump water heaters (HPWHs) were evaluated across the California foodservice industry. The research included a review of applicable codes and standards, a restaurant on-site survey of 16 facilities, laboratory testing of HPWH configurations and load shifting strategies, field studies documenting operating HPWH installations and performance, and building energy modeling across California climate zones and commercial electric utility rate impacts.

The results indicate that HPWHs can serve a range of foodservice hot water applications, but successful implementation is highly site-specific. Space, ventilation, electrical capacity, and the specifics of hot water usage all affect system selection, performance, and ultimately the impact to customer operational costs. Generally, split-system HPWH equipment shows higher observed system efficiency compared to integrated systems with today's available equipment, and systems with recirculation and higher hot water demands show reduced performance. Laboratory testing demonstrated that load shifting is technically feasible, but effective operation requires appropriate equipment sizing, hydraulic balancing, controls, and management of recirculation losses where applicable.

Building energy modeling showed lower annual energy consumption for the modeled HPWH cases compared to existing gas and electric resistance (ER) baseline equipment. However, the energy savings did not consistently translate into lower customer utility bills. Bill impacts varied substantially by utility territory, rate structure, facility type, and HPWH system configuration. The results indicate that electricity and gas rate structures – including time-of-use (TOU) periods and demand charges – are the primary drivers of customer economics. Load shifting produced limited and variable bill impacts in the modeled cases, although it may still provide value for demand response and other grid service applications.

Overall, the findings support continued consideration of HPWHs for foodservice applications, particularly where site conditions are favorable and system design is carefully integrated into the facility's hot water distribution system. Future market efforts should continue to address electrical and space constraints, improve sizing guidance, evaluate utility rate structures as they evolve over time, and develop installation and controls strategies that reflect the operating conditions of foodservice facilities.

2 Product overview

2.1 General product overview

Foodservice facilities use hot water for food preparation, handwashing, dishware washing, and cleaning. Foodservice facilities are energy-intensive operations in which hot water-related energy consumption often amounts to between 20% and 25% of total facility energy use. In California, water heating accounts for 23% of total natural gas consumed in restaurants.[1]

HPWHs use heat from the surrounding air to heat water, offering a highly energy-efficient alternative to conventional electric resistance water heaters and a decarbonization alternative to conventional gas-fired water heaters. HPWH systems operate using a refrigeration cycle in which a fan draws ambient air over an evaporator coil containing refrigerant to extract heat. The refrigerant absorbs the heat and is compressed to change its thermodynamic properties, allowing the heat to be transferred to the water stored in a tank via a heat exchanger. When an HPWH unit is properly installed and operating at ideal temperature conditions, it consumes 3 to 4 times less energy than conventional ER and gas-fired equipment, depending on specific equipment conditions. Removing natural gas combustion equipment from kitchen areas also improves comfort and air quality for restaurant workers.[2]

HPWHs are generally offered as either integrated units, which combine the heat pump and storage tank, or split systems, which separate the compressor and evaporator from the storage tank. Products evaluated as part of this research included commercially rated 208 V/240 V equipment in integrated and split configurations, with efficiency or performance requirements based on ENERGY STAR Version 2, requiring a rated coefficient of performance (COP) of at least 3.0.[3]

Most HPWHs include supplemental ER heating capabilities in addition to the heat pump. Supplemental ER heat can be used to more quickly heat water under high hot water demand conditions. Manufacturers often provide various equipment mode configurations that allow or restrict the supplemental ER heat operation at the user's discretion.

Load shifting enables customers to use the thermal storage available in the stored hot water to adjust equipment operation to take advantage of lower, off-peak electric rates. Load-shifting

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[1] Itron, Inc. (2006). *California Commercial End-Use Survey: Executive Summary*. Prepared for the California Energy Commission. CEC-400-2006-005. CALMAC Study ID CEC0023.01. https://www.calmac.org/publications/CEC_CEUS_Executive_Summary_03012006.pdf

[2] Briscoe, T. (2026 October 6). Restaurant workers face hidden dangers from gas stoves, including pollution and extreme heat. *Los Angeles Times*. https://www.latimes.com/environment/story/2026-10-06/restaurant-workers-face-hidden-dangers-from-gas-stoves-including-pollution-extreme-heat

[3] ENERGY STAR. (n.d.). *Commercial water heaters for partners*. U.S. Environmental Protection Agency. Retrieved October 7, 2026, from https://www.energystar.gov/products/commercial_water_heaters/partners

capabilities were assessed through laboratory evaluation and building energy modeling. Thermostatic mixing valves allow higher tank temperatures and pre-charging to elevated tank temperatures before peak electric-demand periods. Pre-charging storage tanks to elevated temperatures and equipment mode adjustments were evaluated in a laboratory setting to validate load-shifting capabilities under representative restaurant hot water draw profiles. Findings were further applied to building energy modeling scenarios to quantify impacts to customer utility bills.

The research summarized in this report focuses primarily on water heater equipment. Successful adoption of electrified technologies across the California foodservice industry requires evaluation of the complete hot water system, which also includes storage, distribution, recirculation, controls, and fixtures. These broader system design considerations have been documented in California's CalNEXT guidance.[4]

3 Research objectives and methodology

This section summarizes the research objectives and methods used to assess the technologies and products summarized in Section 2. Research was guided by these key objectives:

- Assess the technical feasibility and challenges of decarbonizing water heating in existing foodservice facilities across California.
- Identify barriers to and opportunities for widespread adoption of HPWHs related to codes, standards, and other regulations and policies.
- Quantify the energy benefits, including peak electrical load impacts, for customers switching from natural gas equipment to HPWH technologies.
- Assess the operational cost impacts for customers switching from natural gas equipment to HPWH technologies.

3.1 Codes and standards review

We reviewed federal and California codes and standards requirements that affect commercial water heating. Reviews included Department of Energy (DOE) water heater requirements, California Title 20 appliance standards and Title 24 building requirements, the California Retail Food Code, air quality regulations, and California Conference of Directors of Environmental Health (CCDEH) water heater sizing guidance.

[4] Frontier Energy, Inc., and TRC Companies. (2023). *Technical design guide for advanced water heating within the foodservice industry*. Prepared for CalNEXT. https://calnext.com/wp-content/uploads/2024/10/Technical-Design-Guide.pdf. The guide describes foodservice hot water systems as comprising water heaters and storage, distribution piping, and hot water-using equipment and fixtures and provides guidance on system efficiency, recirculation, controls, and electrification strategies.

3.2 Site surveys

Site surveys were designed to characterize existing restaurant water heating equipment, operating conditions, end-use fixtures, space constraints, ventilation, maintenance practices, hot water use, and utility service. On behalf of CalMTA, TRC Companies surveyed 16 foodservice facilities. The surveyed sites were geographically dispersed across Northern and Southern California and included cafes, quick-service, and full-service restaurant types. The survey objectives included characterizing the hot water system, identifying retrofit feasibility and barriers, and identifying hot water system-specific efficiency opportunities such as pipe insulation.

3.3 Laboratory testing

Lab testing was designed and performed to analyze the feasibility of load shifting using commercially rated integrated HPWHs and foodservice facility hot water draw profiles. Performance data was collected by TRC Companies to evaluate system performance across various draw profiles representing cafes, quick-service, and full-service restaurant facilities. System configurations were tested with and without recirculation loops to evaluate corresponding impacts on performance and load-shifting feasibility.

3.4 Field studies

CalMTA partnered with New Buildings Institute (NBI), which is conducting a select set of field studies of HPWH installations in foodservice facilities in California. The broader study remains ongoing, although interim findings were available to support CalMTA's assessment of foodservice HPWH installations.[5] NBI documented installation conditions, system configurations, and operating experience and collected field data on system performance. Findings were used to inform the technology assessment and building energy modeling and are further discussed in Section 4.

3.5 Energy modeling and bill impact analysis

Building energy modeling served as the primary tool for assessing technology performance and customer bill impacts across the state of California. Simulations were performed using EnergyPlus, an open-source DOE physics-based building simulation engine,[6] with California-specific Database for Energy Efficiency Resources (DEER) reference prototype restaurant buildings.[7] Two reference building prototypes are used in this analysis: Restaurant – Fast-Food

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[5] Advanced Water Heating Initiative. *Small commercial heat pump water heater field study*. New Buildings Institute. Retrieved November 2, 2026 from https://www.advancedwaterheatinginitiative.org/small-commercial-field-study

[6] U.S. Department of Energy. (n.d.). *EnergyPlus documentation*. Retrieved October 7, 2026, from https://energyplus.readthedocs.io/en/latest/. This site describes EnergyPlus as an open-source, whole-building energy simulation program used to model building energy consumption and water use.

[7] California Energy Data and Reporting System. (n.d.). *EnergyPlus – DEER resources*. California Public Utilities Commission. Retrieved October 7, 2026 from https://cedars.cpuc.ca.gov/deer-resources/tools/energy-plus/. This site provides access to commercial and residential DEER prototype EnergyPlus models.

(RFF), representing quick-service facilities; and Restaurant – Sit-Down (RSD), representing full-service facilities.

Modeled existing, or baseline, water heating systems included natural gas equipment, both storage tank-style and instantaneous systems, along with electric resistance storage tank-style equipment. HPWH simulated cases included integrated and split-system equipment types meeting ENERGY STAR performance minimums. Table 1 summarizes the various simulated cases.

Table 1. Summary of Modeled Baseline and Proposed Water Heating Equipment

Case	Equipment Type	Representative Equipment Details
Baseline	Gas – tank	50 gal, 76,000 Btu/h, UEF[a] >= 0.62 for RFF; 80 gal, 120,000 Btu/h, TE[b] >= 0.80 for RSD
Baseline	Gas – instantaneous	200,000 Btu/h, TE >= 0.80 for RFF and RSD
Baseline	Electric – tank	50 gal, 24 kW, UEF >= 0.95 for RFF; 80 gal, 48 kW, TE >= 0.98 for RSD
Proposed	Integrated HPWH[c]	120 gal, 42,000 Btu/h + 18 kW ER, COP >=3.0 for RFF; (2) 120 gal, 42,000 Btu/h + 18 kW ER, COP >=3.0 for RSD
Proposed	Split-system HPWH[d]	80 gal, 67,000 Btu/h + 6kW ER, COP >=3.0 for RFF; 160 gal, 67,000 Btu/h + 6 kW ER, COP >=3.0 for RSD

[a] Uniform Energy Factor (UEF)
[b] Thermal Efficiency (TE)
[c] Integrated HPWH systems modeled with equipment inside the building and outside ambient air ducted directly to the evaporator
[d] Split-system HPWH systems modeled with evaporator and compressor located outdoors, with storage tank and condensing coils inside the building

The analysis performed annual energy simulations for all cases across the 16 California climate zones, and proposed HPWH technologies were compared against the various baseline cases to evaluate energy performance and utility bill impacts across a suite of scenarios. Load-shifting strategies were also simulated, limiting HPWH equipment to HP-only mode during the five-hour peak pricing window while preventing hot water runout. Foodservice facilities are required to provide hot water at all fixtures at or above 120 degrees F, [8] and this threshold was a direct requirement in the energy simulations for preventing hot water runout.

The bill impact analysis that was conducted assessed commercial electric rate structures for the investor-owned utility (IOU) applicable to restaurant facilities across California, including multiple

[8] California Retail Food Code, Cal. Health and Safety Code § 114192(a) (2006). https://leginfo.legislature.ca.gov/faces/codes_displaySection.xhtml?lawCode=HSC&sectionNum=114192

rates within each utility territory. All applicable commercial rate structures for the three electric IOUs are represented based on tariff price structures acquired through the Market Informed Demand Automation Server (MIDAS) reporting system for June 2025 through May 2026.[9]

Bill impacts were evaluated based on the simulated annual consumption profiles, comparing existing systems to proposed cases where a positive impact indicated an increase to annual operating costs and a negative value indicated savings. Results were further weighted to create summaries of bill impacts that included both favorable and unfavorable customer outcomes. Results emphasize that fuel substitution depends heavily on the specific electricity-to-gas price relationship. All relevant findings are detailed in Section 4.

4 Results

4.1 Codes and standards summary

4.1.1 Federal requirements

Many foodservice facilities use commercial water heater equipment categorized under federal standards, although consumer products may be used in smaller restaurants or restaurants with lower hot water demands. The DOE sets the standards in the Code of Federal Regulations at Section 10 CFR 431[10] for commercial equipment and 10 CFR 430[11] for consumer equipment. A subset of commercial units are classified as residential-duty commercial water heaters regulated under 10 CFR 431 but use 10 CRF 430 for test procedures and efficiency metrics.

For commercial water heater equipment, a new rule was published on December 5, 2023, with compliance required on or after October 6, 2026.[12] In the most recent rulemaking, the DOE did not adopt thermal efficiency standards for electric storage water heaters, including HPWH. DOE also did not consider HPWH a technology option for meeting efficiency standards, noting that the only model available on the market was not suitable for all applications. As a result, electric storage water heaters are required to meet standby efficiency requirements only, leaving a significant opportunity for increased stringency in future standards. The next opportunity to

[9] California Energy Commission. (n.d.). Market informed demand automation server (MIDAS). Retrieved October 7, 2026 from https://midasapi.energy.ca.gov/. This site describes MIDAS as a database and API for accessing electric utility price schedules and other time-varying electricity data; rate schedules used in this analysis were retrieved for June 2025 through May 2026.

[10] Energy Efficiency Program for Certain Commercial and Industrial Equipment,10 C.F.R. §§ 431.102, 431.106, 431.110 (2026). https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-431

[11] Energy Conservation Program for Consumer Products,10 C.F.R. §§ 430.2, 430.32(d) (2026). https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430

[12] Energy Efficiency Program for Certain Commercial and Industrial Equipment, Energy Conservation Program: Energy Conservation Standards for Commercial Water Heating Equipment, Final Rule, 10 C.F.R. § 431 (2023). https://www.regulations.gov/document/EERE-2021-BT-STD-0027-0042

influence federal rulemaking will be in the 2035 standard, with negotiations beginning in the next few years.

DOE has also adopted amended energy conservation standards for consumer water heaters under 10 CFR Part 430, with compliance required for products manufactured on or after May 6, 2029.[13] The new requirements raise efficiency levels for many common-size electric storage water heaters to levels generally associated with heat pump technology, while smaller product classes with lower delivery requirements may continue to meet the standards using electric resistance. These changes have relevant implications for foodservice facilities: Smaller facilities with lower hot water demand may use consumer-grade equipment affected by this new standard. The rule is less directly applicable to larger restaurant facilities.

4.1.2 California code requirements

Due to federal preemption, California Title 20[14] does not establish unique efficiency standards for commercial or consumer-grade water heaters. However, the California Energy Commission (CEC) plans to develop Flexible Demand Appliance Standards (FDAS) that would require water heaters to include demand-responsive features.[15] CEC initiated a rulemaking in 2023 to consider Title 20 efficiency standards for commercial dishwashers, which could result in regulation affecting booster water heaters and further reduce hot water demand. As of November 2026, the CEC's commercial dishwasher standards remain in the pre-rulemaking phase. CEC released a draft analysis in March 2026 and held a public workshop in April 2026 but has not announced a formal proposed action or adoption date. Under the draft proposal, manufacturers would have one year from the effective date of the regulation to comply.[16]

For both new construction and retrofits, neither mandatory nor prescriptive requirements restrict water heater types based on fuel source. Prescriptive requirements for service water heating systems require a heat pump water heating system in school buildings less than 25,000 square feet and less than four stories in climate zones 2-15. This requirement applies to the school building's service water heating system and is not limited specifically to the school's cafeteria. For

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[13] U.S. Department of Energy. Energy Conservation Program: Energy Conservation Standards for Consumer Water Heaters. 89 Federal Register 37,778 (May 6, 2024). https://www.govinfo.gov/content/pkg/FR-2024-05-06/pdf/2024-09209.pdf. Effective July 5, 2024, with compliance required on or after May 6, 2029; see also U.S. Department of Energy, "Consumer Water Heaters," describing the scope of consumer water heaters under 10 CFR § 430.2, https://www.energy.gov/cmei/buildings/consumer-water-heaters

[14] California Energy Commission. Appliance Efficiency Regulations - Title 20, Cal. Code of Regulations, Title 20, §§ 1601–1609. https://www.energy.ca.gov/rules-and-regulations/appliance-efficiency-regulations-title-20

[15] California Energy Commission. (n.d.). *Flexible demand appliance standards*. https://www.energy.ca.gov/proceedings/active-proceedings/flexible-demand-appliances/flexible-demand-appliance-standards

[16] California Energy Commission. (2026). *Analysis of proposed efficiency standards for commercial dishwashers*. CEC-400-2026-001. https://www.energy.ca.gov/publications/2026/analysis-proposed-efficiency-standards-commercial-dishwashers

other nonresidential occupancies, the prescriptive requirements generally do not mandate a particular water heater fuel type, although gas service water heating systems with total installed heating input capacity of 1 MMBtu/h or greater must meet a minimum thermal efficiency of 90%. There are no water heating prescriptive measures or trade-offs against other building efficiency features if the performance compliance approach is used.

Electric-ready requirements were adopted in the 2025 update of Title 24[17] for all commercial kitchens constructed after January 1, 2026. These mandatory requirements include a dedicated branch circuit wiring and outlet that are accessible to cookline appliances, with conductors rated at a minimum of 50 amps; an electrical service panel with a minimum capacity of 800 connected amps; an electrical service panel sized to accommodate an additional 208 V or 240 V; and a 50-amp breaker (with exemptions for hospitals and all-electric commercial kitchens).[18]

The 2025 Title 24 updates also include prescriptive solar photovoltaic (PV) and battery energy storage system (BESS) changes for restaurants. Prescriptive PV system size is determined based on conditioned floor area, climate zone, and available room area. BESS is also determined by floor area. These updates primarily affect new construction restaurants and generally do not apply to alterations or retrofit projects. As a result, Title 24 requirements will change the economics of newly constructed restaurants, which could impact future considerations around HPWHs but do not specifically impact the existing market today.

4.1.3 California air quality regulations

In December 2025, the California Air Resources Board (CARB) proposed a market-based approach (like a cap-and-trade system) to limit sales of GHG- and NOx-emissive space heating, water heating, and pool heating equipment in California.[19] The approach would establish declining limits on emissive equipment sales and allow compliance flexibility through credits. The 60% water heater emissive sales limit, which begins in 2030 and declines by 1% annually until it reaches 50%, should be described as a proposed concept presented during the December 2025 workshop — not as an adopted requirement. As of October 2026, CARB states that the regulation has not been finalized and that a formal regulatory proposal has not been submitted to the CARB board for consideration.

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[17] California Energy Commission. (2025). *2025 Building energy efficiency standards for residential and nonresidential buildings*. CEC-400-2025-010-F. https://www.energy.ca.gov/sites/default/files/2025-07/CEC-400-2025-010-F_0.pdf. See California Code of Regulations, Title 24, Parts 1 and 6, effective January 1, 2026.

[18] California Energy Commission. (n.d.). *2025 Electric readiness for new commercial kitchens FAQs*. Retrieved October 7, 2026 from https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/energy-code-support-center-8-0. This addresses the requirements in California Code of Regulations, Title 24, Part 6, Section 120.6(k).

[19] California Air Resources Board. (2025 December 11). *Zero-emission space and water heater standards*. https://ww2.arb.ca.gov/sites/default/files/2025-12/December_2025_Workshop_Slides_2.pdf

The Bay Area Air Quality Management District (BAAQMD) adopted amendments to Rule 9-6 establishing zero-NOx requirements for newly manufactured natural gas water heaters with rated heat input below 75,000 Btu/h beginning January 1, 2027, and for water heaters between 75,000 and 2 million Btu/h beginning January 1, 2031.[20] The requirements generally become relevant when existing equipment is replaced or reaches its end of life. In 2026, the BAAQMD proposed flexibility amendments that could provide exemptions and delay the compliance date for smaller units by one year.[21] As of October 2026, those amendments had not yet been adopted; the board is scheduled to convene on this in November of 2026.

In Rinnai America Corp. v. SCAQMD, the federal district court for the Central District of California upheld Rule 1146.2, determining that it fell outside the scope of Energy Policy and Conservation Act preemption.[22] This rule remains enforceable, subject to any further judicial review.

4.1.4 California health code requirements

California's foodservice hot water requirements are primarily created for sanitation, delivery temperature, and peak demand service; they are not based on the characteristics of a particular technology. California Retail Food Code Section114192(a) requires hot water to be supplied at a minimum of 120 degrees F[23] as measured at the faucet, and foodservice facilities must provide sufficient water heating capacity for these fixtures and sanitation equipment.[24] The CCDEH publishes guidance commonly used by local environmental health departments, and these recommendations include an additional requirement that recirculation systems be used when any fixture is located more than 60 feet from the water heater, unless an alternative distribution approach is approved.[25]

These requirements create challenges for HPWH applications because conventional sizing methods emphasize the water heater's input or recovery heating rate and do not explicitly account for the effects of a heat pump, the interaction of storage volume, implications of supplemental electric resistance elements, mixing valves, or considerations around recirculation

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[20] Bay Area Air District. (n.d.). *Building Appliances Rule Implementation*. https://www.baaqmd.gov/en/community-health/building-appliances-rule-implementation

[21] South Coast Air Quality Management District. (2024, June 7). Rule 1146.2. Emissions of Oxides of Nitrogen From Large Water Heaters and Small Boilers and Process Heaters. https://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1146-2.pdf

[22] Rinnai America Corp. v. South Coast Air Quality Management District, 25-5129 (9th Cir. 2025). https://www.climatecasechart.com/collections/rinnai-america-corp-v-south-coast-air-quality-management-district_4199ea

[23] California Retail Food Code, Cal. Health and Safety Code § 114192(a). (2007). https://leginfo.legislature.ca.gov/faces/codes_displaySection.xhtml?lawCode=HSC&sectionNum=114192

[24] California Retail Food Code, Cal. Health and Safety Code § 114195(a)–(b) (2007). https://leginfo.legislature.ca.gov/faces/codes_displaySection.xhtml?lawCode=HSC&sectionNum=114195

[25] California Conference of Directors of Environmental Health, Food Policy Committee. (2020). *Guidelines for sizing water heaters*. https://ochealthinfo.com/sites/hca/files/2021-06/Water_Heater_Guidelines_Updated_2-6-2020.pdf

systems and losses. CalNEXT research found that health department sizing guidance does not provide a dedicated method for HPWHs, which can result in systems being oversized by three to four times.[26] The issue is also affected by recirculation; continuous recirculation is common in larger restaurants, creating an ongoing heat maintenance load. Additional CalNEXT guidance clearly identifies strategies for hot water systems that better match HPWH performance for foodservice loads,[27] clearly pointing to the need to realign the CCDEH sizing guidance with updated methods, including HPWH technology.

Several recent California activities have begun to address these gaps, including a study identifying heat pump-assist systems – in which a heat pump operates in series with existing water heating equipment – as a pathway for medium and large hot water demand foodservice facilities to satisfy sizing interpretations of environmental health departments and still invest in decarbonization strategies.[28] More recently, CalNEXT also completed a study documenting findings from restaurant stakeholders and recommending improved regulatory guidance, contractor training, and program designs that reflect the operating conditions of small commercial kitchens.[29] These activities indicate that California stakeholders are actively developing the technical and market knowledge needed to support broader adoption of HPWHs; however, they do not themselves constitute a change to health code sizing standards. Until such guidance is formally adopted, local environmental health departments may continue to interpret the existing CCDEH requirements as written.

4.2 Site survey results

On behalf of CalMTA, TRC Companies surveyed 16 California restaurant facilities that included cafe, quick-service, and full-service restaurants across Northern and Southern California. This activity produced a technical summary prepared for CalMTA. The present summary memo incorporates key findings from this activity. The complete reports are internal project deliverables and are not publicly available.

The surveys documented existing water heating equipment and system information, hot water end uses, operating conditions, recirculation system information, ventilation and space constraints around the existing water heating equipment, and electrical service panel total service amperage. Nearly all surveyed sites used larger commercial gas water heating equipment, while

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[26] CalNEXT. (2023). *Market potential for heat pump assisted hot water systems in food service facilities*. Project ET22SWE0019. https://calnext.com/wp-content/uploads/2023/07/ET22SWE0019_Final_Report.pdf

[27] CalNEXT. (2024). *Commercial kitchen hot water system design guide*. https://calnext.com/wp-content/uploads/2024/10/Technical-Design-Guide.pdf

[28] Statewide Electric Emerging Technologies Program. (2025). *Restaurant field monitoring*. Project ET22SWE0046. https://www.etcc-ca.com/reports/restaurant-field-monitoring

[29] CalNEXT. (n.d.). *Commercial kitchen hot water system decarbonization market needs study*. Project ET25SWE0010. Retrieved October 7, 2026 from https://calnext.com/approved-projects/

some of the cafe and quick-service sites used smaller storage and tank-style equipment, including four sites with consumer-grade equipment.

Findings varied by facility type and operating considerations. Full-service restaurants commonly had dishwashing machines and were the only sites with recirculation systems; however, this finding should not be considered representative, due to the small sample size of the survey. Water heater setpoints ranged from 120-145 degrees F, while measured temperatures and flow rates at end-use fixtures varied considerably depending on hot water system and building layout. This finding suggests that equipment sizing, recirculation requirements, and other design considerations will need to be evaluated on a site-specific basis. Recirculation was reported at about one-third of the facilities.

Space constraints and sufficient ventilation requirements for HPWH systems were evaluated at each facility. The majority of sites (14 of 16) were considered to have suitable space for split-system configurations based on proximity to outdoor locations. Interior space constraints for integrated HPWHs were more frequently observed, assuming that the HPWH would be exactly located where existing equipment presides. Generally, if a single integrated HPWH tank could serve the facility hot water demand, then sufficient space was available, assuming an existing tank-style system. Sites with existing instantaneous systems and sites where multiple integrated HPWHs might be needed to serve a load requiring larger hot water draws were more commonly reported to be space-constrained.

Electrical infrastructure was also evaluated as a potential barrier to broad HPWH adoption; however, surveys were limited to reviewing the panel service amperage ratings and did not include a full engineered evaluation for available capacity and electrical headroom. Panel service amperage ratings ranged from 125 to 800 amps, with most facilities reporting 208 V/120 V service. At the surveyed facilities, 208 V service was more common than 240 V service, which may reduce available capacity of supplemental electric resistance elements.

Overall, these findings indicate that restaurants offer meaningful opportunities for HPWH adoption, but the most appropriate system configuration will depend on the hot water demand, hot water delivery system configuration, and space and electrical constraints specific to each facility.

4.3 Laboratory testing results

Laboratory testing conducted by TRC Companies evaluated configurations with one to three A.O. Smith CHP-120[30] commercial heat pump water heaters across several plumbing configurations under different hot water draw profiles representing cafes, quick-service, and full-service

[30] A. O. Smith. (n.d.). *CHP-120 fully integrated heat pump*. Retrieved November 2, 2026 from https://www.hotwater.com/product-literature/AOS1006.html. The detailed ENERGY STAR model designation is CAHP-120 100.

restaurants. The tests focused on assessing the technical feasibility of applying various load shifting strategies to reduce energy consumption across a representative five-hour peak pricing window consistent with California IOU commercial electric rate structures. This activity also produced a technical summary prepared for CalMTA. The present summary incorporates key findings from this activity. The complete reports are internal project deliverables and are not publicly available.

The primary strategies for load shifting included manually switching each unit to heat pump-only mode during the five-hour window, essentially forcing each unit to rely only on the heat pump, and disabling the supplemental electric resistance coils. Strategies included a pre-charging period before the load-shifting window to elevate the tank temperature. Table 2 summarizes key scenarios tested, important configuration details, and summary performance metrics.

Table 2. Summarized Laboratory Load-Shifting Scenario Results

Representative Hot Water Draw	Scenario Configuration and Strategy	Hot-Water Load-Shifted[a]	Total Energy Use	System COP
Cafe	1 CHP-120, no recirculation, HP-only pre-charge	64.4 gal/100%	8.3 kWh	2.7
Cafe	1 CHP-120, variable recirculation, HP-only pre-charge	38.9 gal/71%	25.5 kWh	0.7[b]
Quick-Service	2 CHP-120s, no recirculation, HP-only pre-charge	104 gal/100%	13.7-14.0 kWh[c]	2.5-2.6
Full-Service	2 CHP-120s, no recirculation, HP-only pre-charge	27-28 gal/6%	41.8-43.3 kWh[c]	2.9-3.0
Full-Service	3 CHP-120s, no recirculation, HP-only pre-charge	62.9 gal/14%	46.3 kWh	2.7
Full-Service	3 CHP-120s, no recirculation, HP + ER pre-charge	236.7 gal/52%	70.7 kWh	1.8

[a] Total hot water draw volume and percentage of hot water volume served by pre-charge before heating needed from heat pump during the prescribed load-shifting window

[b] For this testing, system COP is approximately useful thermal energy delivered by the system divided by energy use of the heating plant. The calculation uses the mixing valve output as the delivered thermal output. Consequently, energy use for temperature maintenance within the recirculation loop increases relative to delivered thermal fixture demand, resulting in a system COP less than one.

[c] Multiple tests conducted under this configuration

Load shifting was successfully dispatched across the spectrum of hot water draw profiles and system configurations. The impact of recirculation was observed by comparing the two cafe scenarios. Switching from HP-only pre-charge to HP-plus electric resistance increased the load shifted, but an overall increase in energy consumption was observed, as expected. Recirculation contributed to the lowest measured COP tested. This finding aligns with reported information from field studies discussed in Section 4.4.

The testing also found that flow balancing among multiple HPWHs and the interaction between elevated pre-charge tank temperatures, mixing valves, and aquastat controls were important sources of observed variation. These results indicate that successful foodservice hot water load shifting will require coordinated equipment sizing, hydraulic balancing, careful control sequencing, and management of recirculation losses.

4.4 Field studies results

Field study results were collected and compiled by NBI. The field studies summarized here were conducted as part of a broader Advanced Water Heating Initiative (AWHI) study of small commercial HPWH applications. The larger study includes approximately 26 sites across several building types or segments, with each site monitored for six to 12 months at minute-level resolution.[31]

The CalMTA-supported sites focused on foodservice facilities. Operating data compiled from multiple California sites with commercial HPWHs included one quick-service facility, multiple grocery stores, and one full-service restaurant. There were various hot water delivery system configurations, and average daily hot water demand ranged from just over 250 gallons per day to nearly 500.

System performance varied considerably between sites. The quick-service facility, served by an integrated HPWH with continuous recirculation, observed monthly average system COP between 1.3 and 1.5, where approximately one-third of the energy use came from the supplemental electric resistance elements. The grocery sites, each served by integrated HPWHs as well, achieved average monthly system COPs ranging between 1.7 to 2.1. Here, only 2% of energy consumption was observed from the supplemental electric resistance elements. The full-service restaurant hot water load was served by an outdoor split-system HPWH and indoor storage tanks and able to achieve the highest observed monthly COP range, between 3.5 and 4.1.

In addition, the analysis team suggested that higher daily hot water draw was generally associated with improved COP; however, this was more likely due to the system type: The full-service

[31] Advanced Water Heating Initiative. (2026, October 16). *Small commercial heat pump water heater field study*. New Buildings Institute. Retrieved October 16, 2026 from https://www.advancedwaterheatinginitiative.org/small-commercial-field-study

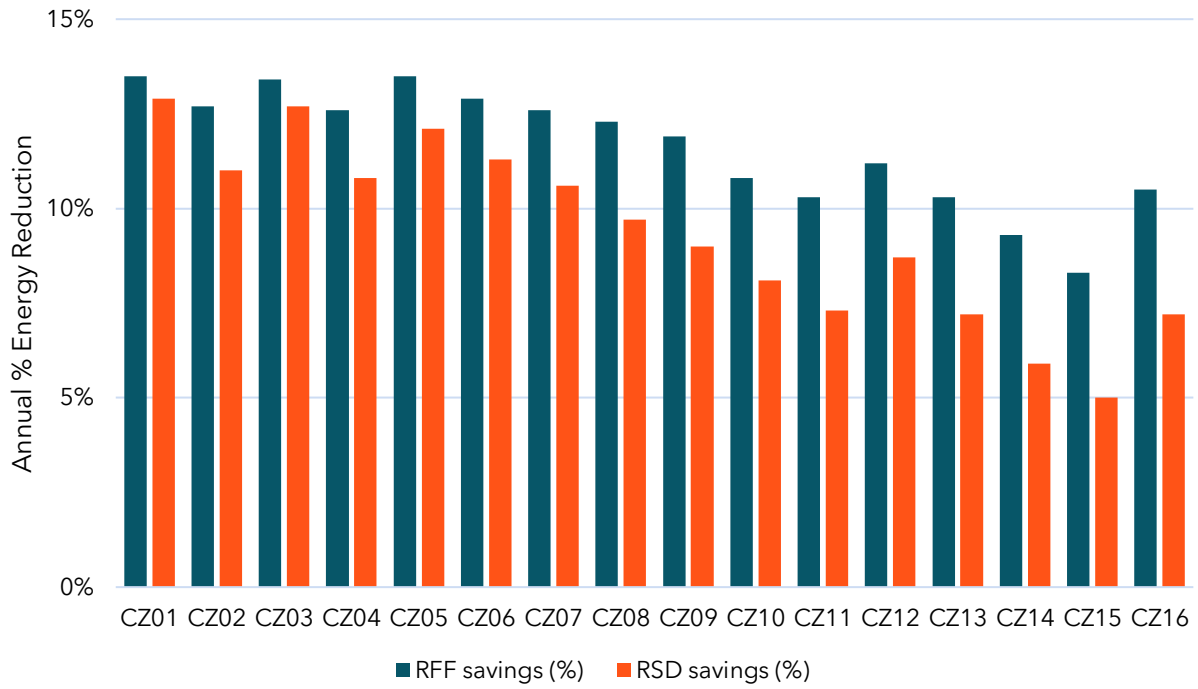
restaurant with the highest hot water draw also had a split-system HPWH. With the site excluded from the analysis, this correlation is not as clearly quantified. Ambient temperature impacted performance of the split-system HPWH as expected, with observed daily COPs exceeding five where elevated outdoor temperatures approached 80 degrees F. The results indicate that system type, recirculation, and hot water demand are all important considerations for designing an effective system. The findings here should not be considered comprehensive, but they point to the importance of careful design of hot water delivery systems to maximize system efficiency. NBI has published more comprehensive preliminary foodservice findings from the broader study.[32]

4.5 Energy modeling and bill impact assessment results

Energy modeling and bill impact results are summarized in this section.

In all modeled scenarios, proposed HPWH cases show annual energy consumption savings compared to both natural gas and electric resistance baselines. Figure 1 summarizes the average modeling facility level energy consumption savings for RFF and RSD across all proposed and baseline comparisons, summarized by climate zone.

Figure 1. Average Facility-Level Annual Percentage Reduction in Energy Consumption Between Each Baseline and Proposed Paired Case, Summarized by Climate Zone

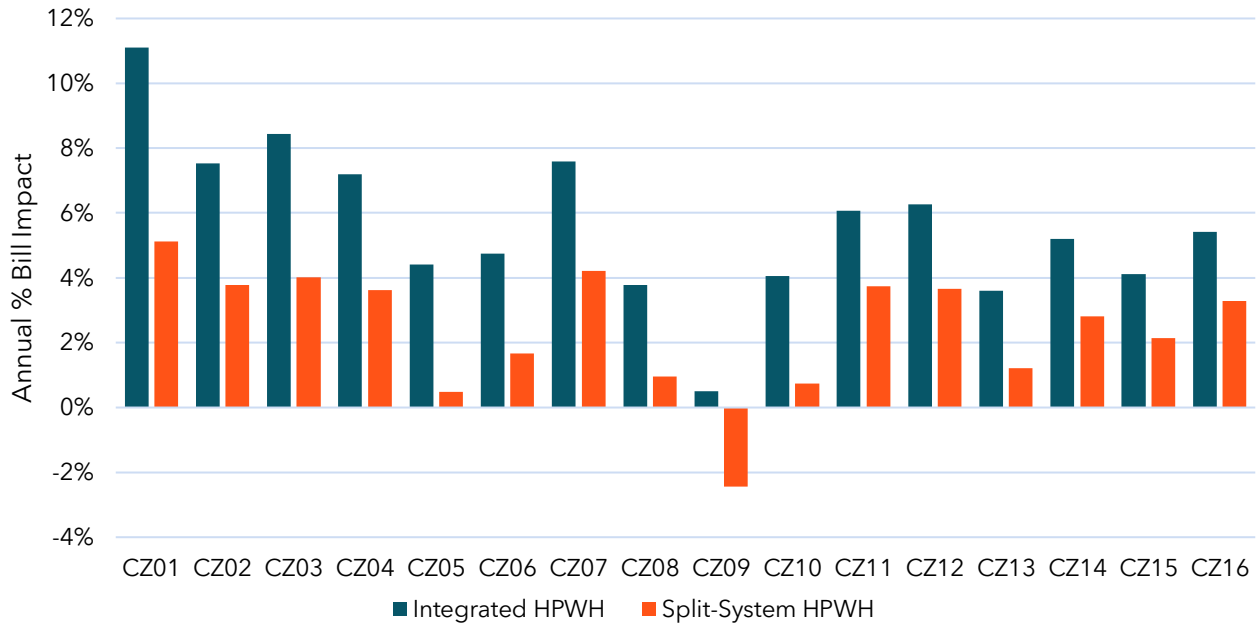


[32] Gabriel, N. (2026, April 2). *H.O.T.T.O.G.O. – 3 key factors influencing heat pump water heater performance in food service*. CleanTechnica. https://cleantechnica.com/2026/04/02/h-o-t-t-o-g-o-3-key-factors-influencing-heat-pump-water-heater-performance-in-food-service/

Percentage savings shown in Figure 1 are aggregated annual electricity and natural gas converted to a common site energy metric and represent whole-building energy consumption differences between each baseline and proposed case modeled. Savings are shown at the facility level and are not weighted to show segment-wide implications. In general, differences between RFF and RSD annual percent reductions represent differences in whole-building prototype models reflecting the impact of other building systems' energy consumption relative to the modeled hot water system. Both integrated and split-system HPWH equipment were modeled using outdoor ambient temperature as the evaporator inlet condition. For integrated systems, this modeling simplification was necessary to avoid numerical instability in EnergyPlus, because the models are not set up with validated HVAC system and control sequences capable of handling simultaneous heat extraction by the HPWH and HVAC system response. In addition, commercial kitchen airflow is governed primarily by exhaust requirements and 100% outdoor air makeup units, with little to no recirculated air. As a result, the analysis did not assign a separate building HVAC cooling benefit of the extracted heat by the HPWH. The modeled results therefore do not capture potential performance benefits or localized comfort improvements, but they also avoid claiming HVAC systems that could not be reliably represented by the model.

Bill impacts are assessed across the simulated baseline and proposed cases individually and then across proposed and baseline pairs constructed for bill impact comparisons. This analysis explores only published rate structures and is not forward-looking with estimates for rate escalation over time. Figure 2 summarizes average facility-level bill impacts for integrated and split-system HPWHs across all proposed and baseline comparisons, summarized by climate zone.

Figure 2. Average Facility-Level Annual Bill Impact Percentage Between Each Baseline and Proposed Paired Case Across All Applicable Utility Rates Structures, Summarized by Climate Zone

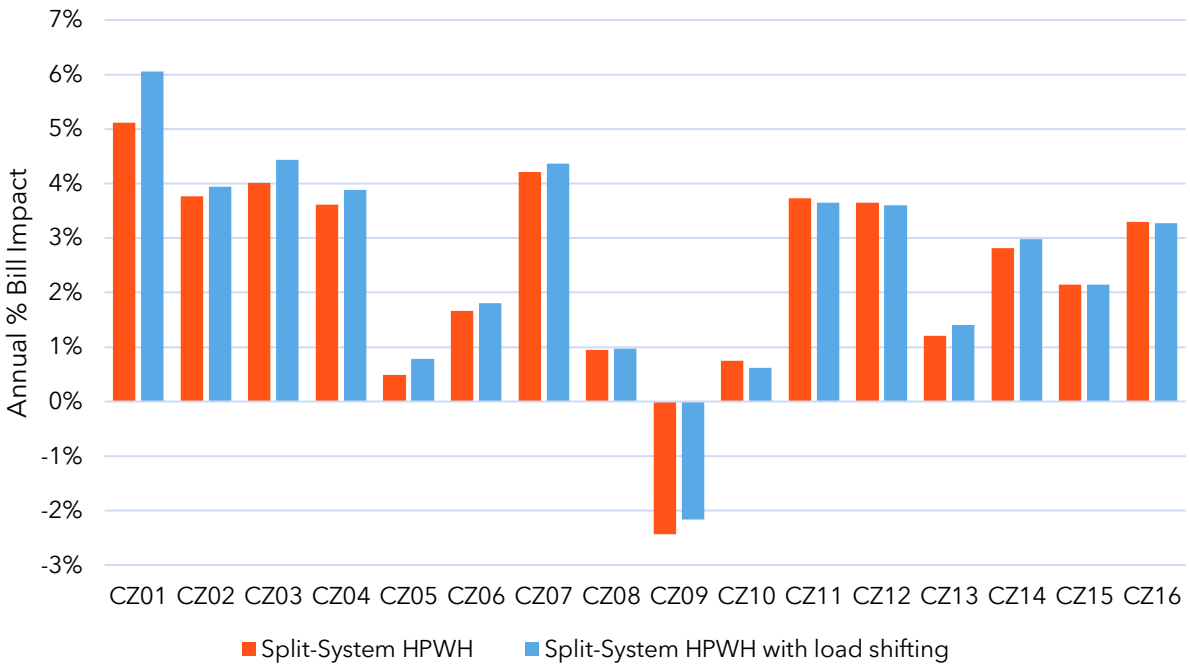


Average facility-level annual bill impacts shown in Figure 2 comprise positive and negative bill impacts, are averaged across applicable rate structures in each climate zone, and are unweighted. These results include cases with electric baselines.

The observable difference between integrated and split-system HPWHs is due to modeled COP differences and align with results reported through field studies discussed in Section 4.4 where split-system HPWHs have reported higher COPs compared to integrated systems. Also, the sole average annual facility-level bill impact savings reported in climate zone 9 is driven by more favorable rate structures in Southern California Edison (SCE) service territory in combination with split-system performance considerations. Since there are obvious bill impact savings for scenarios with baseline electric resistance equipment, further assessment of bill impacts focuses on fuel-switching scenarios only.

Load shifting, which was confirmed as technically feasible through lab testing, as discussed in Section 4.3, was also applied to simulations to determine aggregated impacts on annual energy use and bill impacts. In particular, building energy models were simulated where HP-only mode is forced on the simulated heat pump water heating equipment during the five-hour peak pricing window up to the point where the system may experience hot water runout, and then the electric resistance elements were allowed to energize to meet health code requirements. Figure 3 compares average facility-level bill impacts for split-system HPWHs, with and without load shifting, compared against natural gas baseline scenarios, and summarized by climate zone.

Figure 3. Average Facility-Level Annual Bill Impact Percentage Between Natural Gas Baseline and Split-System HPWH Proposed Scenarios With and Without Load Shifting, Summarized by Climate Zone



Results in Figure 3 show that load shifting for the purpose of mitigating bill impacts has limited and variable modeled impact across the state of California. Average facility-level bills increase for some climate zones and decrease for others. This is largely a function of the specific rate structures for the electric IOUs with territory in those climate zones, some of which include a facility demand charge that may or may not be reduced due to operating mode changes at the water heating equipment. Comparing the rate structures across IOUs reveals this variability in more detail. Table 3 summarizes the percentage of annual bill impacts that are due to an increase in operating costs for each IOU during the peak time-of-use pricing window. In other words, Table 3 summarizes whether or not the bill impact results are primarily due to peak pricing window rates or not.

Table 3. Summary of Percentage of Bill Impacts Due to Peak Pricing for Each IOU

IOU	Average Facility-Level Percentage of Annual Bill Impacts Occurring During Peak TOU Pricing Window (4 -9 p.m.)
PG&E	38%
SCE	61%
SDG&E	8%

Table 3 shows that for SCE rates applied to the modeled scenarios, 61% of the annual bill impacts are coming from operational cost changes during the peak pricing window. For SCE territory, it means that considerations for reducing consumption during the peak pricing window will have a larger impact compared to Pacific Gas and Electric (PG&E) and San Diego Gas and Electric (SDG&E), but it also confirms that nearly 40% of annual bill impacts are due to operational changes outside of the peak pricing window. PG&E and SDG&E rate structures show that peak pricing is not a major reason for the reported annual bill impact. Therefore, load shifting can impact annual operating costs, but shifting consumption outside of the peak pricing window will not in and of itself provide relief from operational cost increases, and these resulting impacts vary significantly by IOU and rate structure.

The important takeaway is that load shifting is not a broadly applicable strategy for mitigating bill impacts associated with electrifying foodservice water heating systems across California; however, restaurants with specific characteristics and hot water system designs may be able to leverage this approach. Load-shifting capabilities can broadly serve other beneficial purposes for the grid, but customers using them purely for a utility bill benefit will have marginal impacts and, in some cases, could increase operational costs. Although not explicitly displayed, results for integrated HPWHs with load shifting applied are similar.

Bill impacts for fuel-switching scenarios are further assessed and weighted by estimates for the number of restaurant facilities in each climate zone and by CEC-reported commercial customer meter count for each rate structure[33] to generate a representative bill impact for each IOU territory. Figure 4 summarizes these results.

[33] California Energy Commission. Docket No. 23-LMS-01, including Pacific Gas and Electric Company, *PG&E Rate Modifier Exclusion Data*; Southern California Edison Company, *SCE Appendix D Rate Modifier Exclusion Data*; and San Diego Gas and Electric Company, *SDG&E LMS Compliance Plan – Appendix B: Rate Modifier Exclusion Data*, (2025 April 1). https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=23-LMS-01. Meter counts and rate-modifier data were obtained from these utility filings. The RFF and RSD demand-category assignments described here are project-team assumptions based on the available data and are not classifications reported by the CEC.

Figure 4. Weighted Average Annual Bill Impact by Restaurant Type, Climate Zone, and Utility Rate Summarized by IOU With Estimated Representative Number of Individual Facilities



The weighted bill impacts presented here include both positive and negative estimated changes in annual operating costs from the simulated cases and should not be interpreted as the expected outcomes for every restaurant in California.

For SCE, specific rates show more favorable impacts to customer bills when switching from natural gas equipment to HPWHs. PG&E and SDG&E show few situations with favorable bill impact results. The primary drivers for this are the rate structures themselves and the relative difference between electricity and natural gas rates for a given facility load shape. Climate-related impacts and equipment efficiency have secondary impacts.

Key findings associated with the energy modeling and bill impacts analysis are as follows:

- HPWH technology consumes substantially less energy than gas water heater technology, but the energy efficiency advantage does not necessarily translate into lower customer operational costs. Generally, HPWHs are three to four times more energy efficient than gas systems, while electricity may cost five to eight times more than natural gas on an energy-equivalent basis for commercial electric IOU customers across California.
- Estimated bill impacts from the simulations varied substantially by utility territory and rate structure within that territory. Climate zone and HPWH system performance showed secondary impacts compared to utility tariffs.
- We would expect some customers to experience bill impact savings when switching from gas water heating to HPWHs. The modeled SCE results estimated that approximately 60% of quick-service facilities could see bill savings, but these are estimates based on the prototypical energy modeling load shapes and general commercial customer rate

information. These results use reported customer participation in each rate across all commercial customers and are not specific to restaurants.

- Electricity and gas rate structures were identified as the primary drivers for the modeled results. Time-of-use periods and rates, demand charges, and other commercial rate characteristics of both electricity and gas can materially change the economic outcome.
- Modeling scenarios leveraging load-shifting strategies to mitigate bill impacts showed generally minimal changes to energy and bill impact results. This analysis therefore did not support load shifting as a viable strategy for bill impact mitigation; however, this technology should not be excluded from consideration for load shifting and its potential value for participation in demand response to provide grid services.

5 Conclusion

The research demonstrates that HPWH adoption in foodservice facilities across the state of California is technically feasible, but the results do not support treating HPWHs as a direct, one-to-one replacement for conventional water heating equipment in every application. The most appropriate solution depends on the facility's hot water demand profile, storage and recovery design considerations and requirements, recirculation system details where applicable, available space and electrical service, and equipment performance details. Split systems may offer an advantage where interior space is constrained, while integrated systems may be appropriate where sufficient dedicated space is available and hot water demand aligns with equipment capacity.

The site surveys and field studies showed that system performance depends on more than the rated efficiency of the HPWH unit itself. Recirculation losses, supplemental electric resistance operation, flow balancing across multiple tanks, and control settings can materially affect observed performance. These findings also suggest that installation guidance and technical support should address the complete hot water system rather than focus only on equipment selection.

The laboratory and modeling results indicate that load shifting can be implemented technically, but its value should be considered carefully against the intended objective. Operating HPWHs in heat pump-only mode during peak pricing periods in California can shift some facility electric load, but the modeled bill impacts show that the overall value was limited, variable, and highly correlated to the specifics of the electric rate structure and site-specific water heating system needs. Load shifting may therefore be more valuable as a demand response or grid flexibility service rather than as a standalone customer-dispatched resource for bill savings.

The bill impact analysis results highlight a central challenge to electrifying water heating systems: Improved equipment efficiency does not necessarily produce lower annual operating costs for current commercial electricity and gas prices. Customer economics are strongly influenced by utility territory and associated rate structures, with some rates producing favorable outcomes and

many others producing unfavorable outcomes. Any market or incentive strategy should therefore account for rate-specific bill impacts and should avoid presenting a single statewide result as representative of every facility.

The findings support targeting implementation of HPWHs in foodservice facilities where site conditions, system design, and utility rates are favorable and aligned. Additional research could include pilot electrification rate designs coupled with field demonstrations across a broader range of restaurant types and geographies and continued improvement around sizing guidance that accounts for HPWH performance. The results presented here should be interpreted as a technical market assessment based on the evaluated sites, prototypes, and rate structures, not as a prediction of outcomes for every California foodservice facility.

6 About CalMTA

CalMTA is a program of the California Public Utilities Commission and is administered by Resource Innovations. We work to deliver cost-effective energy efficiency and decarbonization benefits to Californians through market transformation. CalMTA-developed market transformation initiatives also aim to advance the State's goals on demand flexibility, workforce development, and equity. CalMTA is a program of the California Public Utilities Commission (CPUC) and is administered by Resource Innovations. Learn more at www.calmta.org.