Commercial Kitchen Hot Water System Decarbonization Market Needs: California Perspectives

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ABSTRACT

California decarbonization goals depend on individual decision makers choosing to transition away from fossil fuel-dependent systems. Commercial kitchen owners and operators represent one of the most difficult segments to reach in this decarbonization effort due to their complex operational environments. Commercial foodservice (kitchen) water heating in California uses roughly 340 million therms of natural gas annually, representing about 16% of statewide commercial gas consumption (CalMTA, 2025). This study examines opportunities to advance decarbonization in California's commercial foodservice sector for hot water system.

Reliable hot water is essential for sanitation, food preparation, and daily operations in commercial kitchens. Many kitchens rely on gas-fueled systems that are replaced after failure. Training is scarce and most focus on basic operations, not energy saving. As the state moves toward broader electrification and carbon reduction goals, understanding how kitchen owners make equipment decisions is critical to identifying pathways for adopting electric and energy efficient technologies.

Secondary research and interviews with kitchen managers and staff, equipment distributors, and kitchen designers, suggest that reliability, cost, and operational continuity drive decision-making. Limited electrical capacity, space constraints, and uncertainty about energy efficient equipment performance and maintenance further inhibit adoption. However, there is interest in decarbonized solutions when framed around operational benefits, such as reduced downtime, compliance, and customer experience, rather than energy savings alone.

These findings suggest that accelerating commercial kitchen decarbonization will require updating health department sizing guidelines, contractor training, and marketing efforts that highlight non-energy benefits associated with kitchen upgrades. Together, these strategies can better support commercial kitchen stakeholders in making informed and practical decisions that contribute to California's broader decarbonization goal.

Introduction

California (CA) decarbonization goals depend on individual decision makers choosing to transition away from fossil fuel-dependent systems. Commercial kitchen owners and operators represent one of the most difficult segments to reach in this decarbonization effort due to their complex operational environments, which often include narrow margins, high staff turnover, and strict health and safety requirements. This market needs study presents findings focused on commercial kitchen hot water system decarbonization. It draws on secondary research, market actor mapping and stakeholder interviews.

Background

Hot water systems are integral to commercial kitchen operations. They are traditionally powered by natural gas, making them a prime candidate for decarbonization through electric alternatives like heat pump water heaters (HPWHs). However, implementing such upgrades in kitchens can be especially challenging due to space constraints, electrical capacity requirements, equipment compatibility, and concerns around performance and reliability.

The current market landscape presents both barriers and opportunities. On one hand, decision makers in the commercial kitchen space often face a lack of accessible information, face high upfront costs, and have limited time or capacity to evaluate new technologies. On the other hand, growing state-level energy policy support and regional air-quality rules, expanded incentive programs, and increasing sustainability expectations from institutions and consumers are driving interest in cleaner technologies. Previous CalNEXT-funded research provided detailed design and operational guides to support implementation (Fountain 2023, Justus, Delagah and Slater 2023), but stopped short of engaging directly with commercial kitchen operators to understand their preferences and informational needs.

California's regulatory landscape continues to evolve in support of electrification, with the state's goal of achieving economy-wide decarbonization by 2045. This study investigates the operational challenges commercial kitchens face and how energy efficiency technologies could help address them and identifies opportunities to better engage with commercial kitchens.

Objectives

The central objective of this study is to understand what resources and communication strategies would best support commercial kitchen stakeholders in making decisions that advance hot water system decarbonization. Rather than focusing on the technologies themselves, this research is centered on the purchasing decision makers and effective outreach strategies. Key research questions include: What roles do market actors, such as kitchen owners and operators, designers, contractors, and facility managers, play in the equipment selection decision-making process? What tools would help commercial kitchen operators better understand and act on decarbonization opportunities? How do they prefer to receive and apply information about equipment upgrades?

This study seeks to develop actionable insights and recommendations that enable utilities and program administrators to better support target appropriate decision makers and provide them with clear and practical tools.

Methodology and Approach

The research team conducted secondary market research and primary qualitative research to address research objectives. Secondary research involved reviewing prior studies and industry reports to understand California's commercial kitchen landscape, market actors, and the decision-making process when it comes to designing or retrofitting a commercial kitchen. The insights from this task informed the design of the primary research.

Using insights from this secondary research, the team developed a market map to visualize key relationships across market actors — including equipment manufacturers, distributors, design consultants, foodservice operators, and other in equipment decision making. The market

map played a critical role in helping the team identify and prioritize which market actors to engage in interviews, ensuring diverse representation across the supply chain.

Primary research consisted of qualitative interviews with key market actors to gather insights on awareness, adoption drivers, technical and economic barriers, and opportunities for innovation in commercial kitchen equipment design and program support. The research team completed a total of 19 interviews with key market actors, detailed in Table 1.

Table 1: Market actor sample table

Role	Total completed
Restaurant owner / kitchen manager	10
Commercial kitchen designer	2
Equipment vendor	3
Maintenance professional	2
Subject matter expert	2
Total	19

Interview recruitment leveraged existing CalNEXT networks, trade associations, and market data, with the aim of achieving representation across different facility types (e.g., fast service restaurants, full-service restaurants, institutional kitchens) and equipment categories (e.g., dish machine, hot water heater). The team conducted semi-structured interviews with open-ended questions focused on the following topics:

Awareness and perceptions of high-efficiency and electrified kitchen equipment
Key decision factors influencing equipment selection and replacement
Technical, operational, and financial barriers to adoption
Opportunities for design improvements, training, and tool development
Perspectives on current incentive programs and communication materials

The interview findings will inform actionable recommendations for utilities, program implementers, and manufacturers. Insights from these interviews will highlight how technology and program design can jointly address adoption barriers and support California's broader decarbonization and electrification goals.

Findings

Commercial Kitchen Characteristics

Prior CalNEXT research defines commercial kitchens include fast casual, fast food, and full-service restaurants (Justus, Delagah, and Slater 2023). As research for this study progressed, the research team recognized the need to include institutional kitchens such as those in schools, hospitals, and corporate cafeterias. Institutional kitchens account for approximately 18 percent of

the total food service market in California. To better capture this broader market perspective, this study expanded its scope to include institutional kitchens in addition to restaurants.

Findings show that California's commercial kitchen market is large and diverse. Quick-service restaurants represent the largest share of facilities and are some of the most energy-intensive establishments per square feet in the US, making them ideal for electrification (Goel, et al. 2018). Ownership is divided among single-location restaurants, franchises, and small chains, each with different operational structures and decision-making processes. The following sections explore these themes in greater detail, presenting results on restaurant ownership, market segmentation by kitchen type, ownership demographics, regional density, and regulatory and climate zone considerations.

Restaurant ownership landscape (excluding institutional kitchens). California's restaurant industry is marked by a diverse ownership structure, with details shown in Table 2. Just over half of the restaurants (51%) are part of small chains, while independent single-location, full-service restaurants and franchise-operated establishments make up 26 percent and 22 percent of the market, respectively (Le 2025). Decision-making processes and operational priorities differ across restaurant types, particularly between franchise and independent operators. Franchise restaurants may be more open to standardized programs, like electrification, due to the influence of corporate oversight and uniform operational practices. Small chains can share some characteristics with franchises (e.g., standardized equipment and menu) but retain a greater degree of local decision-making similar to independent restaurants.

Table 2. Commercial restaurant ownership landscape in California

Ownership type	Number of restaurants	Percentage of total
Single-location, full service	22,983	26.5%
Franchise-operated	19,473	22.4%
Small chains (multi-location)	44,323	51.1%

Source: Le 2025

Broader foodservice market segmentation by kitchen type (including institutional kitchens). The commercial foodservice market in California comprises just over 100,000 facilities, segmented by kitchen type into several key categories, detailed in Table 3. Quick-service restaurants (QSRs) make up the largest share, followed by full-service restaurants (FSRs), institutional kitchens, snack bars respectively (Monsur, Kuck and Honegger 2022). Among these, QSRs, particularly cafes or coffee shops, represent the most electrification-ready segment due to their relatively simple equipment requirements and extended operating hours. In a public stakeholder meeting held in February of 2023, participants, including manufacturers, energy consultants, and energy efficiency advocates, were asked to identify foodservice business types, most prepared to transition to all-electric operations. QSRs emerged as the top choice among stakeholders (Coakley, et al. 2023). According to the NAICS Association, quick-service kitchens fall under NAICS code 722513, which includes pizza delivery shops, takeout establishments, QSRs, and delicatessens (i.e., delis) (NAICS Association 2022). This classification underscores the operational characteristics that make QSRs particularly suitable for standardized electrification initiatives.

Table 3. Commercial foodservice facilities in California by kitchen type

Restaurant type	Percentage of restaurants
Quick service restaurants	37%
Full-service restaurants	27%
Institutional kitchens	18%
Snack bars	13%
Other	5%

Source: Monsur, Kuck and Honegger 2022

Restaurant ownership demographics. A significant portion of California's commercial foodservice market is composed of minority-owned businesses, as shown in Table 4. Minority ownership accounts for over two-thirds (68%) of the sector. In terms of gender ownership, over one-third (36%) of businesses are majority-owned by women, while just under half (49%) are at least 50 percent women-owned (National Restaurant Association 2025). These figures underscore the importance of equity-focused outreach in the design and implementation of commercial restaurant electrification programs. Tailoring initiatives to support minority- and women-owned businesses can help ensure inclusive participation and equitable access to the benefits of kitchen electrification.

Table 4. Minority owned restaurants in California

Ownership	Percentage of all restaurant owners
Asian-owned	35%
Hispanic-owned	26%
Black-owned	7%
All minorities	68%

Source: National Restaurant Association 2025

Regional restaurant density. Urban centers have concentrated foodservice activity per capita compared to rural areas (CITATION NEEDED). In dense urban areas, restaurants may be in mixed-use buildings, where multiple decision makers can make electrification projects more complex. However, greater availability of contractors in these areas presents strong opportunities for electrification efforts and modernizing kitchen infrastructure. While these markets can serve as early examples of adoption, it will also be important to ensure that programs are designed to equitably serve customers across the state, including those in rural areas.

Market Actor Roles and Influence

Commercial kitchen equipment decisions are rarely made by a single individual. Instead, decisions at various stages of planning and implementation are shaped by a network of actors, including owners, engineers, chefs, and corporate stakeholders. Based on secondary research, the

research team identified two key contexts to examine these decision making dynamics: kitchen design, including new construction and retrofit scenarios, and kitchen usage, including operations and maintenance. Electrification strategy can be most effective when all levels of the design, operations, and ownership chain are engaged. Table 6 summarizes key decision making and operational responsibilities of different stakeholder roles, which are detailed in the following sections.

Table 6. Commercial kitchen market actor decisions and responsibilities

Market actor role	**Equipment selection**	**Overall responsibilities**
Restaurant owner / head chef	Cooking equipment, washing and sanitizing equipment	Food quality, food safety, throughput, cooking preferences
Corporate / regional director	Cooking equipment, washing and sanitizing equipment, hot water system	General equipment selection, coordinating equipment repair, company-wide directives
Kitchen designer / architect	Sanitizing equipment	Code compliance, meeting operational needs, energy efficiency, kitchen organization efficiency
Plumbing engineer	Hot water system	Meeting equipment operational needs, sizing water system, designing plumbing layout
Equipment vendor	Cooking equipment, washing and sanitizing equipment, hot water system	Meeting operational needs, safety standards
Equipment leasing company	Washing and sanitizing equipment	Sizing washing and sanitation system, maintenance on leased equipment, equipment installation and removal
Kitchen manager / staff	Cooking equipment, washing and sanitizing equipment	Meeting daily operational needs, food quality, operational safety, customer experience, staff training
Building owner	Hot water system	Building integrity, building system operations

Restaurant owner / head chef. Restaurant owners and head chefs are responsible for major kitchen decisions that influence food cooking and preparation and overall kitchen organization. During the initial design phase of a restaurant and major renovation events, restaurant owners and head chefs dictate their operational needs to architects and kitchen designers. Chefs have significant influence over food cooking and preparation equipment but are typically not deeply involved in washing and sanitization equipment choices. Restaurant owners and head chefs interact with kitchen managers to ensure smooth day-to-day operations and may delegate some responsibility concerning equipment operation and coordinating equipment maintenance, repair, and replacement to kitchen managers. Restaurant owners can be more deeply involved which equipment selection in smaller, independent restaurants. However, they may defer to corporate

guidance in franchise and chain models. Restaurant owners interact with maintenance professionals to service or replace equipment.

Corporate and regional director. Large chains, including fast food and casual dining, and institutional kitchens include additional layers of decision-makers compared to independent and small chain restaurants. Roles that influence hot water equipment decisions can include corporate officers and directors, regional management, and facilities managers who oversee operations of several restaurants or kitchens. In management structures with these roles, kitchen managers typically alert facilities directors about equipment performance issues, and these directors coordinate equipment repair and replacement with maintenance companies, on-site maintenance teams, or equipment leasing companies. They also may coordinate directives from corporate or regional management, such as company-wide equipment upgrades. The division of responsibilities between kitchen management and facilities directors varies between different businesses. Some models give more responsibility to equipment purchase and repair to franchise owners, while others have all major equipment-related decisions to coordinated by a regional facilities manager.

Kitchen designer / architect. Kitchen designers and architects are responsible for the layout and design of the kitchen. They are tasked with meeting the operational needs of the kitchen, as defined by the kitchen owner or head chef, and supporting equipment selection and implementation. They serve an advisory role and support the architect in making design choices, equipment selection, and code compliance. They work with restaurant owners and architects to advise around operational questions or concerns. Not all restaurants hire a kitchen designer as part of their build or retrofit process; typically restaurants with access to more substantial capital, such as institutional kitchens within office buildings or upscale restaurants, are more likely to utilize a kitchen designer as part of the design process.

Architects are directly responsible for kitchen layout and design in new construction. They receive direction from restaurant owners and head chefs about operational needs, and in some cases may collaborate with restaurant owners to find design and cooking equipment solutions that meet their needs. Architects will typically select washing and sanitizing equipment that will be able to meet kitchen operational needs and dish throughput. They may coordinate design, construction, plumbing and mechanical engineering, and code compliance. Architects typically direct plumbing needs (i.e., piping and water hookup design) to plumbing engineers.

Plumbing engineer. Plumbing engineers are responsible for the sizing of hot water systems and hot water distribution design to meet the operational needs of a kitchen. System selection and sizing can depend on expected dish throughput, washing and sanitizing needs, and hot water loads from restrooms. Plumbing engineers also consider water heater location, space constraints, upfront and operational costs, fuel availability, and ease of system maintenance. Plumbing engineers interface with architects who inform them of kitchen operational needs.

Equipment vendor. Equipment vendors supply, install and may provide initial training and ongoing technical support for kitchen equipment and hot water systems when kitchens choose to work directly with an equipment vendor. In these instances, vendors play a critical role in making sure that the specified systems meet performance expectations and comply with energy and safety standards. They interface with restaurant owners and kitchen architects to provide guidance on equipment selection and availability.

Equipment leasing company. Equipment leasing companies play a significant role in the commercial kitchen ecosystem, particularly for supplying dishwashing and sanitization equipment. A significant portion of commercial kitchen lease their dishwash machines from leasing company, who are typically responsible for ongoing maintenance, cleaning, chemical replenishment, and troubleshooting when equipment malfunctions.

Kitchen manager / staff. Kitchen managers and staff are responsible for day-to-day kitchen operations. As end users, they experience firsthand challenges such as insufficient hot water supply or long recovery times. They identify operational issues and coordinate with maintenance technicians or vendors when repairs are needed. They may influence purchasing decisions but typically do not make the final selection. Their proper operation of equipment are essential to realizing intended energy and performance benefits.

Building owner. Building owners act as a point of coordination and approval for major equipment replacement and renovation decisions. Interaction between building owners and other restaurant equipment stakeholders (including restaurant owners, equipment vendors, and maintenance professionals) varies by restaurant management structure. For restaurants where the building is leased to a restaurant owner or company, the building owner is often principally involved in selecting hot water systems. They may consult with the restaurant tenant to ensure operational needs are met, but they often have final say on decisions to purchase new water heaters and coordinate repairs and equipment installation. For corporate owned chains, the building owner typically coordinates with a regional, purchasing, or operations director to select and coordinate repair and replacement of water heaters, ensuring that the system is able to meet operational needs. For these ownership models, building owners are typically not involved in day-to-day kitchen operations and cooking and sanitation equipment maintenance. When the restaurant owner and operator also owns the building, as is the case at some franchise restaurants, the owner may coordinate equipment selection, installation, and maintenance of water heater and sanitation systems.

The Kitchen Design Process

Kitchen design decisions in commercial foodservice settings follow a consistent core structure but vary in complexity depending on whether the project involves new construction or a retrofit. In both cases, we found that owners and chefs drive the vision for kitchen layout and required equipment. Kitchen designers translate that vision into equipment election and layout, with close collaboration with engineers to size hot water systems, handle technical constraints and confirm feasibility. Hot water needs are defined early during “programming,” based on service volume, number of stations and type of cuisine. Literature agrees with our findings. The central relationship in kitchen design is between the restaurant owner or franchisee coordinating closely with foodservice equipment manufacturers and distributors, mechanical-electrical-plumbing (MEP) engineers, permit specialists, and installation contractors (Clark, Doeschot and Fisher 2010). These stakeholders work together to select equipment, ensure regulatory compliance, and configure systems such as ventilation, drainage, gas, and electrical supply (Birchfield 2007). Regardless of whether the restaurant is part of a national chain or independently owned, this technical collaboration remains the foundation of kitchen buildout (Katsigris and Thomas 2013).

For new construction, the design process begins with the owner and the head chef or kitchen manager communicating needs for operation and menu requirements to the architect and design team. If an owner consults kitchen designers, the kitchen designer will typically make recommendations relating to cooking and preparation equipment (e.g., dish stations, prep sinks, combi ovens), and support kitchens in finding contracts and complying with health codes. Engineers are responsible for specifying and sizing the hot water system that they include as part of that functional kitchen layout. When not employing kitchen designers, owners typically interface with equipment vendors, leasing companies, or equipment manufacturers directly to select water heating and sanitizing equipment.

Retrofit projects introduce additional constraints and dependencies due to the limitations of existing infrastructure. Owners and engineers must adapt kitchen designs to preexisting floorplans, utility locations, ceiling heights, or code compliance issues, particularly when working in older buildings where systems and equipment need to be retrofitted around existing conditions (ACEEE 2024a). Alterations, particularly those affecting water heating systems, may require more extensive involvement from permit specialists, MEP engineers, or building owners or facilities managers compared to new construction, where design can proceed with fewer structural restrictions (Katsigris and Thomas 2013).

In both new construction and retrofit contexts, designers, engineers, vendors, and equipment manufacturers can play a key role in introducing restaurants to cutting-edge technologies because of their familiarity with the evolving technology landscape. However, even when more efficient technology is technically market-ready, its integration into new or retrofit projects may be constrained by economics, regulation, and space. A 1990-era food safety formula used by many jurisdictions only covers gas and electric resistance, not heat pumps. This prevents plan reviewers from approving heat pump water heaters (HPWHs) in commercial kitchens. With space challenges, MEP engineers and plumbing subcontractors become the ultimate gatekeepers of the equipment used in facilities. In one common scenario, large air-source heat pump systems or storage tanks simply cannot be accommodated without redesigning the mechanical rooms. As a result, if MEP engineers or plumbing subcontractors are either uncomfortable or untrained, they may recommend against installing certain system types of systems such as heat pumps, citing complexity and reliability concerns.

Additionally, the restaurant ownership structure can affect market actor roles and decision-making in both new and retrofit contexts. For example, chain-affiliated restaurants may receive guidance or requirements from a corporate design team, and when located in a multi-tenant facility, must also adhere to the specifications of building owners or facilities managers (Walker 2017). While the roles of “corporate design team” and “building architect” are not always present, they commonly layer onto the core design process and reflect the flexible but patterned nature of kitchen development.

Kitchen Operating Considerations

In the operational phase of a commercial kitchen, the core relationship centers on the restaurant owner or franchisee and the kitchen staff who interact with the equipment daily. These individuals are the primary actors responsible for executing workflows, managing safety, and ensuring that equipment meets service demands (Katsigris and Thomas 2013). Maintenance technicians play a critical role in sustaining equipment functionality and safety standards (Uzoigwe 2024).

The structure and influence of actors vary between chain-affiliated and independently owned restaurants. In chain restaurants, local managers oversee daily maintenance, yet they have limited authority to select or replace major systems. Corporate facility managers or a centralized corporate office often establish procedures and oversight mechanisms that shape daily kitchen operations, equipment repairs, and replacement. Cost, reliability, and installation speed often drive decision-making. Additionally, corporate entities may designate approved maintenance technicians and deploy operational consultants to monitor performance, troubleshoot equipment issues, or recommend usage improvements (ACEEE 2024b). Their involvement can constrain or support the autonomy of individual operators.

In contrast, independent restaurant owners typically manage kitchen operations and service decisions more directly, drawing on their own experience and discretion (National Restaurant Association 2023). Head chefs, when present, may also influence how appliances are used by overseeing equipment operation, staff performance, and kitchen routines (Bureau of Labor Statistics 2023).

Equipment Selection Considerations

Considerations for commercial kitchen equipment selection may take place as part of the design process (new construction or retrofit), or during kitchen operations as part of preventative or responsive maintenance. Equipment selection hinges on availability, awareness, trust, and cost.

Availability of efficient equipment. For new construction projects, equipment purchasing decisions are dependent on availability (i.e., whichever product can be installed quickly to keep the project on schedule). In some cases, designers noted that they have removed efficient or electric systems late in the process because the specified products were unavailable within the construction timeline. Even when efficient equipment is readily available, limited design and installation familiarity with new equipment may deter the designer from selecting these options to avoid potential delays. For kitchens leasing equipment sanitation equipment, the availability of efficient equipment can be a deciding factor in the choice between standard and efficient options.

Awareness of efficient equipment. Education across all stakeholders, including chefs, managers, engineers, and maintenance contractors, is essential for market transformation. However, decision makers may have limited awareness of electrified and efficient equipment options. Energy efficiency is often low priority for restaurant owners who instead are more concerned with food quality and customer experience and simply want systems to function adequately and meet operational needs. Equipment vendors and designers are often the market actors who push information about efficient options to restaurant owners and other decision makers. Beyond equipment selection, current staff training across all restaurant settings do not typically include content on energy efficiency. However, increasing awareness alone is likely to be an insufficient intervention approach. Even in cases where designers noted that owners were interested in electrifying their facility, often the cost of the equipment, supply chain, or regulatory levers discouraged teams from moving forward with an electric option.

Trust in new technology. Plumbing engineers and installers are particularly important to wider technology adoption. They are highly unlikely to recommend or install the technology for a commercial kitchen if they distrust the technology, dislike its user experience, or are uncertain if

it meets existing regulatory requirements. Additionally, if chefs and kitchen managers do not trust that equipment meets performance standards, they will be hesitant to select the equipment. Demonstration of technology effectiveness, though case study material or in person demonstrations, as well as educational information and vendor outreach for heat pump and other electrified technologies remains an important step in building trust among key market actors.

Equipment cost. Independent restaurants or smaller franchise operators are typically more price-sensitive and risk-averse. They may preferentially opt for known technologies, as there is a perceived lower likelihood that unknown issues and added costs will arise, or lease equipment, allowing for lower upfront costs. Upfront cost is typically less of a constraint for institutional kitchens and chain restaurants, where equipment decisions are made by a centralized corporate office and long term ROI can be more effectively considered.

The remainder of this section highlights equipment selection considerations for common commercial kitchen equipment, including water heaters and dishwashers, and food preparation equipment.

Hot water heaters. Hot water reliability and compliance are crucial for proper sanitation in commercial kitchens. In new construction, plumbing engineers select, size, and design water heating and distribution systems. Engineers typically default to gas water heating systems because they are familiar, widely available, and explicitly referred to in local building and health codes. In major renovations where a restaurant moves into an existing space, restaurant operators typically inherit the existing water heating system and do not replace it if it is still operational. Water heater replacement is typically pursued when equipment fails or has repeatedly broken down. When replacing on failure, building owners, facilities managers, and restaurant owners typically seek to install a water heater that is as identical to the old system as possible, prioritizing installation speed and cost. Planned upgrades to more efficient options are less common and can be driven by corporate initiatives. Proactive energy saving goals are not a common motivating factor in hot water equipment selection.

Common hot water issues include running out of hot water during peak business hours and slow recovery rates. Kitchen operators accept these issues as normal operating tradeoffs rather than triggers for system redesign because they are typically brief and do not result in business stoppage or significant impacts to customer experience. Kitchens temporarily shift operational duties to allow for water to heat back up. When water heating equipment fails and cannot produce hot water, quick repair is high priority because insufficient water temperature is a health code violation and prolonged lack of access to hot water can result in cessation of service.

HPWHs have been increasingly recognized for their efficiency, low cost, and reduced technological complexity. However, HPWHs still face two main barriers to broader uptake in the commercial kitchen sector. First, HPWH are not represented in the California Conference of Directors of Environmental Health (CCDEH) health department's water heating sizing guidelines. Designers explained that this absence creates significant permitting challenges. Often even when owners express interest in electrification, engineers tend to fall back on conventional systems when code compliance or project delays and equipment availability issues present barriers to selecting electric options. Second, space limitations also impede electrification potential. Designers prioritize front-of-house dining space in restaurant design, leaving little mechanical room for larger equipment footprints. HPWHs require storage tanks to meet hot water demand, which must either be housed in the back of house, requiring additional room for

the hot water system, or outside the building, potentially taking up parking space or requiring roof reinforcement depending on where the tank is located.

Dishwashing and sanitization equipment. Dishwashers are crucial for smooth kitchen operation in restaurants with high dish volume. When a dishwasher fails, staff often must hand-wash dishes, slowing down kitchen operations. Dishwasher sizing depends on the dish throughput needs of the restaurant and dictates water temperature and flow rate requirements at the facility. Equipment considerations include speed (how fast it can clean dishes), perceptions of reliability (how likely it is to break down or require maintenance), and operational costs including required chemical supplies.

Though energy efficient dishwashing and sanitization equipment can reduce operational costs and need for chemical detergents, several barriers exist for commercial kitchens when adopting energy efficient dishwash equipment. Firstly, few kitchen operators are familiar with energy or water efficiency features in dishwashing equipment. Secondly, many kitchens lease dish machines, which are serviced by the respective leasing companies. Leasing dishwashers is most common in smaller, independent, or non-institutional kitchens, though kitchens across the spectrum of size and operating structure may lease dishwashers. Leasing allows purchasers to avoid the significant upfront cost of dishwashing machines, instead paying a much lower monthly fee. Leasing, or even purchasing equipment through a leasing company, allows the kitchen easy access to maintenance services, which are included in leasing contracts. In such cases, replacement decisions are made primarily by those third party leasing companies. Typically, dishwasher leasing companies do not prioritize efficient high temperature equipment, instead mostly carrying standard equipment that uses more detergent. Most leasing companies derive a significant portion of their revenue not from leasing the equipment itself, but selling the chemical detergents used by standard efficiency dishwashing equipment. High efficiency dishwashers use higher temperature water and less detergent per cycle. This produces a misalignment of incentives, because leasing high efficiency dishwashers limits the amount of detergent the leasing company can sell. Thus it is more in their business interest to lease standard efficiency dishwashers that use more chemical detergent. This arrangement can limit transparency for end users as to which system efficiency metrics are used by the third party to determine equipment replacement.

Energy efficiency or water-saving features are rarely prioritized by the restaurant unless required by code or rebate programs. The lack of involvement of the owner or chef in energy efficiency considerations reinforces the mindset of "minimum compliance," in which equipment is selected purely based on its ability to meet sanitary requirements without also considering how to optimize energy use.

Hot water and food preparation equipment. Several kitchen equipment systems use hot water for food and beverage preparation. Typically, these systems intake cold water and heat the water according to food and beverage needs. These systems include steamers, combination ovens (“combi ovens”), kettles, sous-vide drawers, and coffee makers, among others. Although these systems do not use hot water from a central water heater, they can present opportunities for increased efficiency and electrification (Clark, Doeschot and Fisher 2010).

Combi ovens, steamers, and kettles are available in both gas and electric models. Boilerless combi ovens and steamers can present substantial energy and water savings because they eliminate the need for constant water heating and circulation. Because these systems are directly involved with food and beverage production, chefs are instrumental in choosing to adopt these

systems are part of their cookline. As such, live technical demonstrations, videos, and informational materials are highly influential in encouraging technology adoption.

The main barrier to adoption of electrified and highly efficient models is upfront cost. For most cooking equipment, lower cost alternatives produce similar outcomes, albeit less efficiently, slower, or at lower volume. Another barrier to adoption of electric options is existing electrical capacity; if additional capacity is required, choosing a gas-powered option in a kitchen with gas service can be easier and less expensive.

Manufacturers continue to advance the technological capabilities and efficiencies of food preparation equipment, offering more flexibility for kitchens with limited ventilation or floor space. However, cost differentials and high electricity rates in California slow adoption. Internal modeling from manufacturers indicates that gas combi oven models, for instance, achieve faster payback, often within a year, due to lower operating costs. But lack of awareness and sensitivity to upfront cost can be a barrier.

Conclusions

This study examined how commercial kitchen stakeholders make decisions about hot water systems and related equipment and identified the barriers that impede adoption of efficient and electrified options. Despite growing policy momentum for decarbonization in California, commercial kitchens face persistent operational, regulatory, and economic challenges that slow the transition. In addition to upfront costs and permitting barriers, concerns about utility costs, particularly because many kitchens operate during peak electricity demand periods are also important to address. Future research should evaluate the operating cost impacts of electrified hot water systems under different utility rate structures and compare them with conventional gas systems.

We recommend the following pathways: First, work with CCDEH and local health departments to incorporate HPWH sizing methods into official guidelines. A clear approval pathway will reduce design uncertainty and expand viable options during plan review. Programs should pair financial incentives with education and technical training for designers, engineers, and installers, and support code updates that streamline approval pathways for heat pump and other electrified technologies. Decarbonizing hot water systems will require collaboration between plumbing engineers, designers, and code authorities, as well as demonstrations of compact, code-compliant, and reliable electric alternatives.

Second, collaborate with distributors and leasing companies to improve availability of efficient dishwashing and hot water systems. Explore incentive structures or pilot partnerships that reduce the issues of misaligned incentives regarding leasing companies and efficient equipment and encourage adoption of high-efficiency systems. Messaging to restaurant owners and kitchen stakeholders related to energy efficiency should focus on their priorities: sanitization requirements, reliable operations, and minimal operational costs. Increased adoption of electrified kitchen equipment can be further aided by programs that help with electrical panel upgrades and rebates to lower upfront cost barriers to more efficient systems.

Third, offer multilingual materials, simplified application pathway, and small-business-friendly financing options to improve access and ensure equitable participation across California’s diverse foodservice market. Program administrators should also consider the potential impacts of electrification on peak electricity demand and encourage load-management strategies and time-of-use rate optimization where feasible to help control operating costs and reduce grid impacts. Finally, focus early program efforts on quick-service chained restaurants

and institutional kitchens that are operationally and financially suited for electrification, and user early successes to refine tolls for broader statewide adoption.

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