Commercial Kitchen Hot Water System Decarbonization Market Needs Study

Final Report

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Executive Summary

Commercial kitchens depend heavily on hot water for various tasks, including hand washing, dishwashing, food preparation, and cleaning. As a result, water heating systems account for a significant portion of energy. California's broader push towards building decarbonization has increased interest in electrified water heating technologies. However, adoption in commercial kitchens has been slow.

This research examines how commercial kitchen stakeholders make decisions about hot water systems and related point-of-use equipment and presents the perspective from users' thought processes. The research team conducted interviews with restaurant owners, kitchen managers, contractors, and equipment vendors to better understand how equipment is selected and what barriers affect the adoption of efficient technologies.

Through these interviews with key market actors, the research team found that energy efficiency is not a factor in most equipment selection or replacement considerations. Maintaining operations is the highest priority for commercial kitchens. Due to tight profit margins in the foodservice sector, the priority is to restore operations quickly when equipment fails, which often leads to replacing the system with similar or exact equipment that fits existing infrastructure. As a result, many equipment changes are one-to-one replacements rather than opportunities to consider new technologies.

Cost also plays a key role. Many stakeholders focus on upfront price rather than long-term operating costs, particularly among small businesses with limited capital. Even when efficient technologies offer utility savings, the higher initial cost can discourage adoption.

The interviews also highlight the influence of intermediaries. Contractors, kitchen designers, and equipment suppliers often guide equipment selection, and contractors in particular can act as gatekeepers. If they are unfamiliar with technology or uncertain about installation requirements, they will not propose these options to customers.

Overall, increasing adoption of efficient and electrified water heating systems in commercial kitchens requires approaches that address the barrier of upfront costs, engage contractors and suppliers, improve the regulatory environment, and align with operational realities for foodservice businesses. The findings from this study point to several opportunities for utilities and program administrators to support the adoption of these technologies:

- **Offer point-of-sale incentives that lower the initial purchase price or related infrastructure costs (e.g., electric panel upgrades or plumbing redesign).** These incentives may support barriers created by the higher upfront costs of energy efficient equipment. Institutional kitchens, however, are the most likely to consider sustainability goals and lifecycle cost savings for equipment decision-making. As a result, early program efforts may benefit from focusing attention on the large institutions and campuses where these kitchens are located. Interviewees also noted that space for hot water equipment is often limited in commercial kitchens. Technologies designed for small footprints or outdoor installation may be more feasible.
- **Increase contractor familiarity and confidence with heat pump water heaters and other energy efficient systems to support greater adoption of this equipment.** Methods for

engaging contractors and suppliers could include expanding contractor training programs, providing technical assistance, supporting demonstration projects.

- **Create decision support tools and clear regulatory guidance, including quick comparison calculators, one-page equipment selection guides, and case studies on installations in similar facilities.** Kitchen operators could access these materials independently, or contractors and designers could share them with commercial kitchen staff during the planning process. Additionally, expanding awareness of CalNEXT's existing design guide and operational guide may be beneficial, given the positive feedback received on these guides during the market actor interviews.
- **Advocate for a clearer regulatory approval pathway for energy efficient equipment by collaborating with local health departments and the California Conference of Directors of Environmental Health to incorporate heat pump water heater sizing methods into official guidelines.**
- **Consider pilot programs or incentive structures that could address the misaligned incentives for distributors and leasing companies whose business models favor lower cost, less energy efficient equipment paired with chemical sales.**
- **Identify opportunities to make program participation easier for the small, minority-owned restaurants that comprise a notable portion of California's foodservice sector.** Strategies may include simplifying the application processes, making program materials available in multiple languages, creating targeted financing options for small businesses, and sharing information through trusted community networks in addition to formal program channels.

Abbreviations and Acronyms

Acronym	Meaning
ACEEE	American Council for an Energy-Efficient Economy
CCDEH	The California Conference of Directors of Environmental Health
HPWH	Heat pump water heaters
IOU	Investor-owned utility
kBtu	Thousand British thermal units
MEP	Mechanical-electrical-plumbing
NAICS	North American Industry Classification System
QSR	Quick-service restaurant
ft^2	Square foot

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Introduction

California's decarbonization goals depend on individual business 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.

This report starts by describing the commercial kitchen landscape in California, including different restaurant types, ownership structures, and operating contexts that affect hot water system decisions. It then looks at the roles of key market actors—such as restaurant owners, contractors, designers, vendors, leasing companies, and kitchen staff—and how their responsibilities and constraints shape choices around hot water systems during design, replacement, and day-to-day operations. The findings section summarizes insights from interviews about decision drivers and barriers to adopting decarbonized hot water systems. The report concludes by identifying opportunities for utilities and program administrators to better support kitchens through targeted engagement, clearer guidance, and tools that fit how equipment decisions are made.

Background

Hot water systems are integral to commercial kitchen operations. Restaurants primarily use hot water in the following scenarios: washing utensils in a three-compartment sink or dish machines, machine washing kitchen towels, cleaning floors at the end of the day, and operating hand and lavatory sinks for employees and customers. These systems are traditionally powered by natural gas, making them a prime candidate for decarbonization through electric alternatives like electric heat pump water heaters (HPWHs). However, implementing such upgrades in kitchens can be challenging due to space constraints, cost, electrical capacity requirements, equipment compatibility, and concerns around performance and reliability.

The current market landscape presents both barriers and opportunities. Decision-makers in the commercial kitchen space often face a lack of accessible information and high upfront costs—and have limited time or capacity to evaluate new technologies. However, 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 but stopped short of engaging directly with commercial kitchen operators to understand their preferences and informational needs (Fountain 2023), (Justus, Delagah and Slater 2023).

Objectives

This study seeks 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 centers on commercial kitchen 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 market actors prefer to receive information about equipment upgrades and how do they apply it?

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

Methodology and Approach

Prior CalNEXT research defines commercial kitchens as fast casual, fast food, and full-service restaurants (Justus, Delagah and Slater 2023). However, as research for this study progressed, the team recognized the need to include institutional kitchens—such as those in schools, hospitals, and corporate cafeterias—since institutional kitchens account for approximately 18 percent of the total foodservice market in California. To better capture this broader market perspective, the team expanded the scope of this study to include institutional kitchens in addition to restaurants.

The research team conducted secondary market research and interviews to address the 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 surrounding designing or retrofitting a commercial kitchen.

Using insights from this secondary research, the team developed market maps and personas to visualize key relationships across market actors, including equipment manufacturers, distributors, design consultants, foodservice operators, and others involved in equipment decision-making. The market map played a critical role in helping the team identify and prioritize which market actors to interview, while also ensuring diverse representation across the supply chain. These market maps are in Appendix A.

Primary research consisted of qualitative interviews with key market actors. The research team completed a total of 20 interviews with key market actors, detailed in Table 1. Among kitchen operators (i.e., restaurant owners, kitchen managers, and kitchen staff), the research team

interviewed representatives from 10 establishments, including 7 urban and 3 rural establishments. We conducted all but one interview in English, with a single interview conducted in Mandarin.

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, and institutional kitchens), as detailed in Table 1: Completed market actor interviews. The team sought to ensure different equipment categories (e.g., dish machine, hot water heaters) were represented and used by interviewees. While detailed interview guides for various stakeholders can be found in Appendix B, 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 factors influencing equipment selection and replacement.
- Technical, operational, and financial barriers to adoption.
- Opportunities for design improvements, training, and tool development.

Table 1: Completed market actor interviews.

Role	Facility Type	Total Complete
Kitchen Operators: Restaurant Owner, Kitchen Manager, or Staff	Full Service	6
	Fast Food	2
	Bar	1
	Institutional Kitchen	1
Commercial Kitchen Designer	All Facility Types	2
Equipment Vendor	All Facility Types	3
Contractor, Maintenance Professional	All Facility Types	3
Subject-Matter Expert	All Facility Types	2
Total	All Facility Types	20

Source: Project team.

Findings

The project team organized the findings to reflect decision-making related to hot water in commercial kitchens. The first section describes market-level findings for the commercial kitchen landscape and key ownership and operating characteristics that influence decision-making. The next section focuses on the roles and influence of different market actors, highlighting how responsibilities are distributed across owners, contractors, designers, vendors, leasing companies, and kitchen staff. Subsequent sections examine how these roles play out across the kitchen design process, daily operations, and equipment repair and replacement, with emphasis on common decision drivers and constraints. Throughout, these findings provide insight into the recurring challenges and implications for decarbonized hot water systems rather than providing an evaluation of specific technologies.

Commercial Kitchen Landscape

California's commercial kitchen market is large and diverse. Fast food restaurants, also known as quick-service restaurants (QSRs), represent the largest share of facilities and are some of the most energy-intensive establishments per square foot (ft^2) in the United States. Restaurants typically use about 250 thousand British thermal units per square foot ($kBtu/ft^2$) to 300 $kBtu/ft^2$ annually, compared to approximately 70 $kBtu/ft^2$ for the average commercial building (EIA 2023), which makes restaurants—and QSRs in particular—ideal for electrification. Ownership models include 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.

Understanding the structure and characteristics of California's commercial kitchen market helps explain why hot water system decisions vary widely across facilities, and why a one-size-fits-all approach to decarbonization is unlikely to be effective. Differences in restaurant type, ownership model, and operating context influence who makes equipment decisions, how quickly replacements occur, and which constraints matter most (e.g., cost, space, and standardization requirements). For program administrators, this context is critical for identifying which segments are more receptive to electrification efforts, which market actors they should engage, and where targeted strategies may be necessary to overcome specific barriers.

Ownership Landscape (Excluding Institutional Kitchens)

California's restaurant industry is marked by a diverse ownership structure, as shown in Table 2. Just over half of the restaurants (51 percent) are part of small chains, while independent single-location, full-service restaurants, and franchise-operated establishments make up 27 percent and 22 percent of the market, respectively (V. 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
Small Chains (Multi-Location)	44,323	51%
Single-Location, Full-Service	22,983	27%
Franchise-Operated	19,473	22%
Total	**86,779**	**100%**

Source: (V. Le 2025).

Broader Foodservice Market (Including Institutional Kitchens)

The commercial foodservice market in California is comprised of just over 100,000 facilities, segmented by restaurant type into several key categories detailed in Table 3. QSRs make up the largest share, followed by full-service restaurants, institutional kitchens, and snack bars (Monsur, Kuck and Honegger 2022). Among these facilities, QSRs—particularly cafes and 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, QSRs emerged as the top choice among participants[1] when asked to identify the foodservice business types that are most prepared to transition to all-electric operations (Coakley, et al. 2023). According to the North American Industry Classification System (NAICS) Association, quick-service kitchens fall under NAICS code 722513, which includes pizza delivery shops, takeout establishments, QSRs, and delicatessens (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%

[1] Participants at the February 2023 stakeholder meeting included manufacturers, energy consultants, and energy efficiency advocates.

Other	5%
Total	100%

Source: (Monsur, Kuck and Honegger 2022).

Restaurant Owner Demographics

A significant portion of California's commercial foodservice market is composed of minority-owned businesses (58 percent), as shown in Table 4. This figure underscores 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 Restaurant Owners
Asian-Owned	34%
Hispanic-Owned	22%
Black/African American-Owned	4%
All Minorities	**58%***

Source: (National Restaurant Association 2025).
*Percentages are reported as rounded values from the source. Minor discrepancies in the total reflect rounding.

Regional Restaurant Density and Per Capita Analysis

Urban centers have a greater geographic concentration of foodservice activity compared to rural areas, as illustrated in Figure 1: Geographic foodservice establishment density per square mile by county.. In dense urban areas, restaurants may be in mixed-use buildings, where multiple decision-makers can make electrification projects more complex. However, the greater availability of contractors in these areas presents strong opportunities for electrification and modernizing kitchen infrastructure. In addition to higher restaurant density and contractor availability, several of California's largest urban areas are subject to more stringent air quality regulations that create additional tailwinds for electrification.

The South Coast Air Quality Management District and the Bay Area Air Quality Management District are advancing zero-nitrogen-oxide water heater requirements that primarily affect coastal and urban counties. Although these districts cover a relatively small portion of California's geographic area, they include a majority of the state's population and foodservice facilities. As a result, restaurants in

these regions may face earlier and stronger regulatory pressure to move away from gas-fired water heating compared to kitchens in rural areas, where regulatory drivers are weaker.

While these markets can serve as early examples of adoption, it is also important to ensure that programs are designed to equitably serve customers across the state, including those in rural areas.

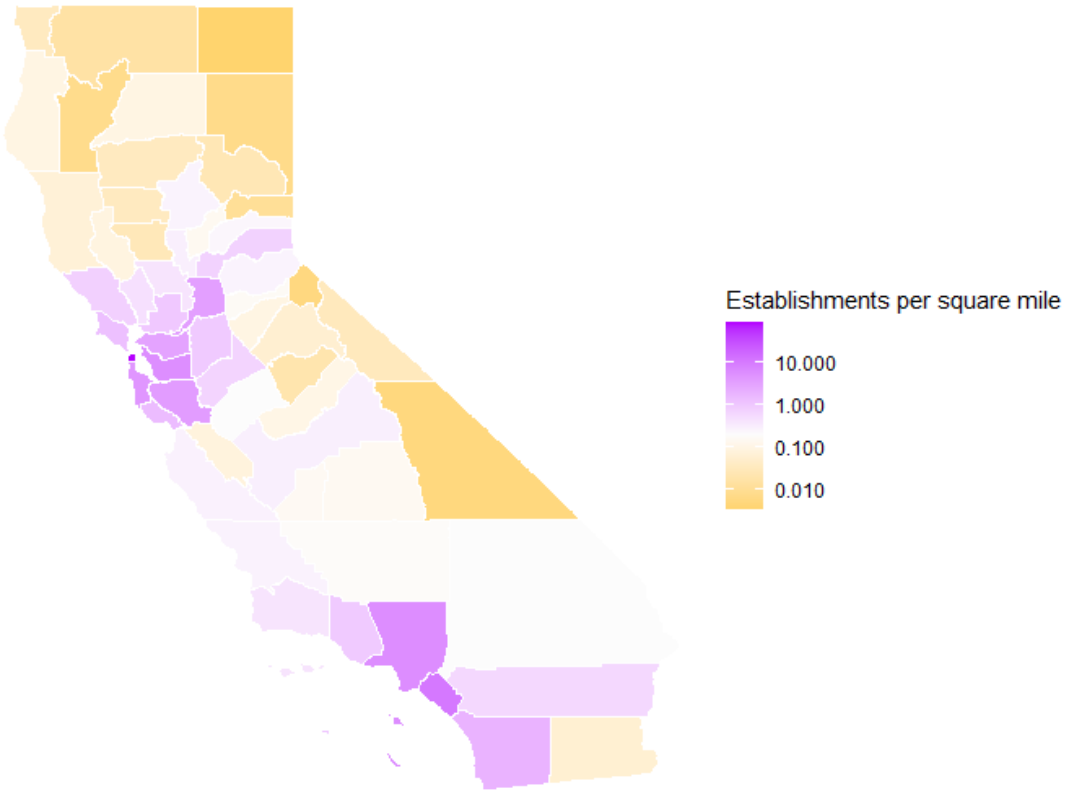

Figure 1: Geographic foodservice establishment density per square mile by county.
Note: Foodservice establishments include restaurants, bars, and special food services such as caterers and cafeterias.
Source: (Bureau 2023). Map created in R.

Market Actor Roles and Their Influence on Hot Water Systems

With the broader market context in mind, this section shifts focus to the specific roles and decision making of market actors involved in commercial kitchen hot water systems. Each subsection focuses on a specific actor and outlines their typical responsibilities, priorities, and involvement based on interview findings. The research team created personas to illustrate how these roles operate in practice and to show common decision-making patterns and constraints; we developed these personas based on direct interviews with individuals in each corresponding market actor role. Two roles—"equipment leasing company and maintenance technicians" and "building owners"—do not include personas because the research team was unable to secure interviews with individuals in those roles, despite multiple outreach attempts. Instead, findings related to these market actors reflect how other interviewees who regularly interact with these roles described them.

Taken together, this section highlights how multiple actors shape hot water decisions through their interactions, rather than a single decision-maker. A network of actors--including owners, contractors, chefs, and corporate stakeholders—shape decisions at various stages of planning and implementation. Based on both primary and secondary research, the research team identified two key contexts to examine these decision-making dynamics: (1) kitchen design, including new construction and retrofit scenarios, and (2) kitchen usage, including operations and maintenance. Table 5 summarizes key decision-making and operational responsibilities of different stakeholder roles, which are detailed in the following sections.

Table 5: Commercial kitchen market actor decisions and responsibilities.

Market Actor	Equipment Selection	Overall Responsibilities
Restaurant Owner/Head Chef	Cooking equipment, washing and sanitizing equipment, hot water system (if small business)	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
Contractor	Hot water system	Meeting equipment operational needs, sizing water system, designing plumbing layout
Equipment Manufacturer and Vendor	Cooking equipment, washing and sanitizing equipment, hot water system	Meeting operational needs, safety standards
Kitchen Manager/Staff	Cooking equipment, washing and sanitizing equipment	Meeting daily operational needs, food quality, operational safety, customer experience, staff training
Equipment Leasing Company and Maintenance Technician	Washing and sanitizing equipment	Sizing washing and sanitation system, maintenance on leased equipment, equipment installation and removal
Building Owner	Hot water system	Building integrity, building system operations

Source: Project team.

Restaurant Owner/Head Chef

Restaurant owners and head chefs are responsible for major kitchen decisions that influence food cooking and preparation, as well as overall kitchen organization. During day-to-day operations,

restaurant owners and head chefs interact with kitchen managers to ensure food quality and smooth operations. Owners may monitor equipment operation and coordinate equipment maintenance, repair, and replacement, or delegate some of these responsibilities to kitchen managers. During the initial design phase of a new restaurant, restaurant owners and head chefs dictate their operational needs to architects and kitchen designers. Chefs have significant influence over cooking and preparation equipment and may request specific systems but are typically not involved in washing and sanitization equipment choices. In smaller restaurants, owners may interact directly with equipment vendors or leasing companies to select washing and sanitation equipment. Owners typically communicate their expected dish throughput and sanitation requirements, and vendors or equipment leasing companies recommend system sizing based on these needs. In corporate-owned or franchise restaurants, owners may defer to corporate guidance for equipment selection. Restaurant owners are typically involved in hot water system selection at smaller, independently owned restaurants; otherwise, building owners are more likely to direct hot water equipment selection. Restaurant owners interact with maintenance professionals to service and replace both dishwashing and water heating equipment.

SMALL RESTAURANT OWNER PERSONA

Name: Carlos
Role: Owner-Operator
Business type: Small independent restaurant
Location: Small town in California
Years in business: 15 years
Building ownership: Owns building and equipment

Snapshot

Carlos is a long-time restaurant owner who manages nearly every aspect of his business, from kitchen operations to equipment maintenance. Operating in a small town with limited access to service technicians, he has learned to repair and maintain many systems on his own. His primary focus is keeping the restaurant running smoothly while controlling operating costs.

Key Priorities

Carlos's main objective is keeping the restaurant operating reliably while controlling costs. He needs to maintain profitability, avoid operational downtime caused by equipment failure, manage high utility costs, meet health department requirements, and extend the life of his existing equipment.

Pain Points

- **High energy costs:** Monthly electricity bills can exceed $3,000 to $4,000 during the summer due to air conditioning.
- **Limited access to technicians:** Service providers may be hours away, making repairs slow and expensive.
- **Aging equipment:** Some systems—such as heating, ventilation, and air conditioning units—are decades old and becoming less reliable.
- **Time constraints:** Running the restaurant leaves little time to research new technologies.

Decision-Making Process

Carlos makes equipment decisions carefully and pragmatically. His typical process involves asking other restaurant owners for recommendations through social media, checking online reviews and ratings of the equipment, comparing prices and product specifications, and requesting quotes from contractors. When replacing equipment, Carlos often prefers to purchase the same model as the previous unit so that installation is simple and he can reuse existing plumbing or electrical connections.

Attitudes toward Energy Efficiency

Carlos is interested in efficiency only when it reduces operating costs or improves reliability. For example, he replaced a tank water heater with a tankless system to reduce gas consumption. He is in the process of installing solar panels to offset electricity costs. However, he is cautious about electrification because electricity prices in California are high. Efficiency improvements must clearly reduce operational costs and not introduce operational risk.

Representative quote: *"Running a business means you have to control costs. If the equipment saves electricity or gas and works well, then I'll consider it."*

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 for equipment purchase and repair to franchise owners, while others have all major equipment-related decisions coordinated by a regional facilities manager

CORPORATE DIRECTOR PERSONA

Name: David
Role: Regional Operations Leader
Business type: National chain quick-service restaurant
Years in business: 10 years

Snapshot

David oversees operations and facility maintenance across multiple quick-service restaurant locations within a franchise network. His responsibilities include overseeing operational continuity, coordinating equipment repairs, and supporting purchasing decisions for kitchen and facility equipment.

Because restaurants operate under strict food safety regulations and tight operating schedules, David prioritizes equipment reliability, rapid repairs, and minimal operational disruption. Practicality, space constraints, and compatibility with existing building layouts drive decisions related to infrastructure, such as water heating systems.

Key Priorities

David's priority is maintaining uninterrupted restaurant operations.

Pain Points

- **Operational downtime risk:** Restaurants cannot legally operate without hot water for sanitation and handwashing, so system failures require immediate resolution.
- **High equipment usage:** Commercial kitchens operate for long hours and place heavy demand on equipment, leading to frequent maintenance or replacement cycles.
- **Space constraints:** Limited back-of-house space restricts equipment options and often requires the use of compact systems like tankless water heaters.

Decision-Making Process

David is pragmatic when it comes to equipment selection. In most cases, replacement equipment is the same model or type as the existing system, since switching technologies can require costly modifications to plumbing or building layout.

Attitudes toward Energy Efficiency

Energy efficiency is not a primary driver in equipment selection; instead, David focuses on operational reliability, compliance with heath codes, and cost of installation. Efficiency improvements may be considered if they do not increase operational risk or require major infrastructure change.

Representative quote: *"If the hot water system goes down, we have to fix it immediately. Without hot water, the restaurant can't operate."*

Kitchen Designer/Architects

Kitchen designers are responsible for the layout and design of kitchens during new construction. They are tasked with ensuring the kitchen can meet the operational demands of the restaurant, as defined by the kitchen owner or head chef, and they support equipment selection and implementation. Kitchen designers 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 construction 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 use a kitchen designer as part of the design process.

Architects are directly responsible for kitchen layout and design in new construction. They receive directions 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; additionally, they may coordinate design, construction, plumbing and mechanical engineering, and code compliance. Architects typically delegate decisions regarding water heater selection and plumbing (i.e., piping and water hookup design) to plumbing engineers.

KITCHEN DESIGNER PERSONA

Name: Alex
Role: Kitchen Designer
Business type: Food service design consultant
Location: Big city in California
Years in business: 10 years

Snapshot

Alex specializes in designing commercial kitchen layouts and specifying equipment based on operation requirements. He works closely with restaurant owners and contractors during new construction and renovation projects.

Key Priorities

Alex's main objective is designing functional and efficient kitchen layouts, making sure equipment meets the client's operational needs, and delivering projects within budget and schedule.

Pain Points

- Balancing budget constraints with performance requirements
- Limited owner engagements in energy performance discussions

Decision-Making Process

Alex usually recommends energy efficient equipment, such as ENERGY STAR® appliances and low-flow fixtures. However, final equipment decisions may change during construction due to budget constraints or contractor substitutions.

Attitudes toward Energy Efficiency

Alex considers energy efficiency during design, but it competes with cost, schedule, and operational requirements. He is more likely to suggest energy efficient options to his corporate clients, since they often prioritize sustainability more than small, independent restaurants due to their ability to consider long-term financial benefit alongside upfront costs. However, he will be less likely to suggest energy efficient options for time-sensitive projects that cannot absorb potential supply chain or regulatory delays.

Representative quote: *"We try to specify efficient equipment, but cost and construction constraints sometimes change those decisions."*

Contractor

Contractors play a central role in determining the type of hot water system installed in commercial kitchens. In many cases, building or kitchen owners either prefer not to make technical equipment

decisions or do not have the expertise to evaluate system options. As a result, they rely heavily on contractors' recommendations. At the same time, owners generally want to remain informed about the final selection and understand the rationale behind the equipment choice.

Contractors tend to recommend systems they are most familiar with. For example, contractors who have experience installing HPWHs, are comfortable navigating available incentives, or have established relationships with utility programs are more likely to prioritize HPWH systems. In contrast, contractors who are less familiar with technology are more likely to recommend conventional gas water heaters.

Interestingly, contractors interviewed describe very different experiences with HPWHs and generally fall into one of two groups. Contractors who regularly work with the technology report that HPWHs are often part of the discussion, whether through subsidized installations or simply as an option included in project quotes. The second group of contractors described HPWHs as becoming more common in residential and general commercial buildings but still rare in commercial kitchens. As one contractor noted, "I haven't had a kitchen yet ask me for it."

Despite these differences in familiarity, both groups identified several common barriers (discussed in the following section) to HPWH adoption, including higher upfront costs, longer maintenance timelines, and regulatory requirements.

System selection and sizing depend on several operational and site-specific factors. These include expected dishwashing throughput, sanitization requirements, and hot water demand from other sources such as restrooms. Contractors also consider equipment location, available space, upfront and operating costs, fuel availability, and ease of maintenance. In practice, contractors work closely with owners to understand the kitchen's operational needs and constraints. They also frequently consult equipment manufacturers during the sizing and selection process. As one contractor noted, manufacturers can be a "huge resource helping us figure out what system we need."

CONTRACTOR PERSONA

Name: Steve
Role: Installation Contractor
Business type: Mechanical contracting firm (water heating)
Client: Restaurants, commercial buildings, property managers, and utilities
Years in business: 20–35 years in commercial mechanical systems

Snapshot

Steve is an experienced mechanical contractor who designs and installs hot water systems in commercial buildings. His firm works with both gas and electric technologies and frequently advises customers on equipment replacement during renovations or system failures. In many projects, Steve plays a key role in recommending equipment options, sizing systems, and navigating permitting requirements. Restaurant owners typically rely heavily on his recommendations because they lack the technical expertise to evaluate different water heating technologies.

Key Priorities

Steve's priorities are delivering reliable hot water systems that meet operational demand, making sure installations comply with building and health codes.

Pain Points

- **High system cost:** Electrified systems—particularly heat pump water heating for commercial kitchens—can cost $60,000 to $120,000, far exceeding the cost of conventional gas systems.
- **Electrical infrastructure limitations:** Many buildings lack sufficient electrical capacity to support large electric water heating systems without costly upgrades.
- **Space and structural constraints:** Heat pump water heating systems often require additional storage tanks, condensers, and structural support for equipment weight.
- **Permitting and regulatory uncertainty:** Local building and health departments may be unfamiliar with new technologies such as heat pump water heating for commercial kitchens, causing delays or uncertainty during permitting.
- **System sizing complexity:** Commercial kitchens have extremely high and continuous hot water demand, making accurate system sizing critical. Many traditional sizing methods rely on outdated assumptions.

Decision-Making Process

Steve is often the primary technical decision-maker during equipment replacement or renovation projects. A typical decision chain in Steve's projects starts with a restaurant owner identifying the need for equipment replacement. Steve evaluates the business' system requirements and proposes solutions. Next, Steve works with manufacturers who provide technical guidance and support. Then, Steve submits the plans for review and approval to the building and health departments. Finally, the owner approves the final installation plan.

Attitudes toward Energy Efficiency

Steve generally supports higher-efficiency systems, but he is strategic about when he presents electrification options to his customers. Steve pays attention to which efficient technologies have rebates or other financial incentives available, since he understands that cost is the main driver for his customers. When full electrification is not feasible for a customer, Steve encourages them to upgrade to higher-efficiency gas systems over a lower-cost, less efficient option.

Representative quote: *"The biggest factor hasn't changed in the history of business—it's cost."*

Equipment Manufacturer and Vendor

Equipment manufacturers and vendors produce, supply, and install kitchen equipment and hot water systems. When kitchens choose to work directly with an equipment vendor, they may also provide initial training and ongoing technical support for kitchen equipment and hot water systems. 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 contractors, restaurant owners, and kitchen architects to provide guidance on equipment selection and availability.

EQUIPMENT VENDOR PERSONA

Name: Mike
Role: Commercial Kitchen Equipment Supplier
Business type: Foodservice equipment distributor
Years in business: 15+ years

Snapshot

Mike supplies commercial kitchen equipment for restaurants, schools, and institutional kitchens. He works directly with owners and chefs during equipment replacement or new installations.

Key Priorities

Mike's main objective is to sell equipment that meets client needs.

Pain Points

- Customers focused mainly on upfront cost
- Low awareness of efficiency benefits among small restaurants
- Supply chain constraints

Decision-Making Process

Mike often recommends equipment based on reliability, availability, and cost. Because he sells equipment directly, he also considers supplier relationships and inventory when making recommendations.

Attitudes toward Energy Efficiency

Efficiency features are typically secondary unless they are required by code or supported by rebates that reduce upfront cost. In these situations, customers often rely on Mike's expertise and will take his recommendations on which energy efficient equipment will best meet their needs.

Representative quote: *"If there's a rebate or code requirement, customers are more willing to consider efficient equipment."*

Kitchen Manager and Staff

Kitchen managers and staff are responsible for day-to-day operations, including food preparation, dish cleaning, front-of-house cleaning, and customer experience. Kitchen owners delegate daily operational responsibilities to kitchen managers, who oversee staff. This arrangement is most common at larger establishments and chain restaurants. In smaller and independent restaurants, an owner may fill the roles of a kitchen manager. As end users, kitchen staff experience firsthand challenges, such as insufficient hot water supply or long recovery times. They identify operational issues and alert kitchen managers, who then coordinate with maintenance technicians, equipment leasing companies, or vendors when repairs are needed. For substantial technical issues that may involve equipment replacement, kitchen managers alert owners, and while they may influence purchasing decisions, kitchen managers do not usually make the final selection.

Kitchen managers usually oversee training. New-hire training varies considerably between restaurants, but it typically involves basic safety overviews; training for back-of-house staff generally does not focus considerably on dish machine operation, in part because dishwashing is widely perceived as a simple task. As a result, staff are rarely trained on how operating practices such as loading patterns, cycle selection, or temperature settings affect performance. Proper operation of equipment is essential to realizing intended energy and performance benefits, which means this gap between perceived simplicity and actual system requirements may contribute to inefficient water and energy use in practice.

KITCHEN MANAGER PERSONA

Name: Samantha
Role: General Manager, Residential Dining Services
Business type: University dining system (large institutional campus)
Years in business: 15+ years

Snapshot

Samantha manages dining operations serving thousands of students daily. Her primary responsibility is making sure that dining facilities produce enough food to meet demand while maintaining food safety and service efficiency. Because institutional kitchens operate at a large scale, Samantha prioritizes operational reliability, production capacity, and compliance with health regulations. Infrastructure systems, such as hot water, only become a concern when failures disrupt kitchen operations.

Key Priorities

Samantha's main goal is to maintain uninterrupted food service for students and minimize operational downtime due to equipment failures.

Pain Points

- **Operational disruptions:** Hot water outages or equipment failures can stop kitchen operations entirely due to food safety regulations.
- **High-volume production requirements:** Campus dining facilities must prepare meals at scale, requiring robust equipment and reliable infrastructure.
- **Complex decision-making structures:** Operational managers do not control major equipment purchasing decisions, which are typically handled by administrators and finance teams.
- **Limited control over infrastructure:** Kitchen managers rely on campus maintenance teams and central administration for building system decisions.

Decision-Making Process

Typically, architects and designers determine equipment layouts, construction teams verify installation requirements, directors review operational needs, and finance leadership approves major expenditure. Samantha mainly influences equipment usability and replacement recommendations, rather than final purchasing decisions. She does this by interfacing with on-site maintenance staff and communicating operational needs to them and institutional directors.

Attitudes toward Energy Efficiency

Energy considerations are secondary to Samantha's key considerations: operational reliability, capacity to meet demand, and cost. Samantha communicates her operational and capacity needs to the construction team, who may have more freedom to consider energy efficient equipment when upgrading systems, since upfront cost is less of a constraint and these decisions align with the university's sustainability goals.

Representative quote: *"My job is to make sure we have enough food for the students every day. Equipment and hot water only become an issue if something breaks."*

Equipment Leasing Company and Maintenance Technicians

Equipment leasing companies play a significant role in the commercial kitchen ecosystem, particularly for supplying dishwashing and sanitization equipment. A significant portion of commercial kitchens lease their dishwashers from leasing companies, who are typically responsible for ongoing maintenance, cleaning, chemical replenishment, and troubleshooting when equipment malfunctions. Despite multiple attempts, the research team could not secure interviews with leasing companies. Other stakeholder interviews indicated that these companies play an influential role in equipment decisions. In one of the outreach calls, a leasing company owner responded that they were not sure how dishwashing equipment related to kitchen decarbonization. This lack of participation may itself suggest a degree of reluctance to engage with energy efficiency programs or research initiatives. As a result, the perspectives of leasing providers are not directly represented in the findings, even though they appear to influence equipment selection in many kitchens. Future research may benefit from additional efforts to engage this group to better understand their decision drivers and potential pathways for collaboration.

If present, maintenance technicians coordinate with kitchen staff to schedule downtime, perform repairs, and conduct preventative maintenance. This coordination is essential for minimizing disruptions during peak service periods and ensuring compliance with health regulations (Foodservice Equipment Reports 2024). Facility management research confirms that structured, preventative maintenance strategies significantly improve equipment reliability and long-term performance outcomes (West, et al. 2024).

Building Owner

Building owners coordinate and approve major equipment replacement and renovation decisions. Interactions between building owners and other restaurant equipment stakeholders (including restaurant owners, equipment vendors, and maintenance professionals) vary by restaurant management structure. For restaurants where the whole 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 can 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

There are two primary types of kitchen design projects: new kitchen construction and kitchen retrofits. New builds involve designing the entire kitchen layout, including cooking space, hot water systems, and service areas. Retrofit projects are typically smaller in scope and focus on replacing or upgrading a limited amount of equipment due to a new restaurant moving into an existing space or an existing kitchen expanding operations. Kitchen retrofits are more common than new builds because restaurants frequently move into existing kitchen spaces and the cost of retrofit is significantly lower than new builds.

In both new-build and retrofit cases, the research team found that owners and chefs drive the vision for kitchen layout and required equipment. Hot water needs are defined early during "programming," based on service volume, number of stations, and type of cuisine. Owners and chefs work with contractors, vendors, and leasing companies to select point-of-use equipment and ensure the layout meets the kitchen's operational needs—findings that are consistent with existing literature. Studies found that 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 newly built kitchens, the design process begins with the owner and the head chef or kitchen manager communicating operational needs and menu requirements to the architect and design team. If an owner consults kitchen designers, the kitchen designer will typically make recommendations related to cooking and preparation equipment (e.g., dish stations, prep sinks, and combination "combi" ovens), and support kitchens in finding contractors 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 directly with installation contractors, equipment manufacturers, and vendors, or leasing companies to select a water heating system, dishwasher, and other equipment

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

MEP engineers and plumbing subcontractors can function as the ultimate gatekeepers of the hot water equipment used in facilities. In new constructions, plumbing contractors 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. HPWHs face notable barriers related to regulatory guidelines and space constraints. The California Conference of Directors of Environmental Health (CCDEH) water heating sizing guidelines do not present HPWHs, adding uncertainty about regulatory compliance. 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 situated 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. As a result, MEP engineers or plumbing subcontractors may recommend against installing certain systems (e.g., heat pumps) by citing complexity and reliability concerns. In major renovations, restaurant operators typically inherit the existing water heating system and do not replace it if it is still operational.

Dishwashers are crucial for smooth kitchen operation in restaurants with high dish volume. Restaurant owners may work with designers or leasing companies to select dishwasher types and sizes based on operational needs and dish throughput. On rare occasions, a restaurant owner will independently purchase a dish machine, relying on internet research, discussions with vendors and manufacturers, and input from peer restaurant operators. Fast food restaurants typically do not use a dishwasher because they use disposable food packaging and utensils and thus have a lower dish volume than full-service restaurants; typically, they rely on three-compartment sinks for their dish cleaning. Bars may rely on smaller under-the-counter dishwashers to meet most of their dishwashing needs, while full-service restaurants are the primary users of dishwashing machines. Smaller establishments use door-type models, while larger restaurants use conveyor dishwashers. Dishwasher sizing dictates water temperature and flow rate requirements at the facility. Equipment considerations include speed (i.e., how fast it can clean dishes), perceptions of reliability (i.e., how likely it is to break down or require maintenance), and operational costs (e.g., required chemical supplies).

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 multitenant 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.

Barriers to Adopting Energy Efficient Hot Water Heaters and Dishwashing Machines

REGULATION

Operational efficiency is the top priority of restaurant owners, especially small businesses, who must meet regulatory requirements and turn a profit to continue operating. A study using US Bureau of Labor Statistics data found that approximately 17 percent of restaurants close within the first year of operation (Luo and Stark 2014). Over longer time horizons, fail rates increase substantially. About half of restaurants close within five years and about 65 percent within ten years, consistent with broader small-business survival statistics reported by the US Bureau of Labor Statistics’ Business Employment Dynamics database (Bureau of Labor Statistics 2023). In this context, the restaurant rarely prioritizes energy efficiency unless required by code or rebate programs. The lack of

involvement of the owner or chef in energy efficiency considerations reinforces the "minimum compliance" mindset, leading them to select equipment based on its ability to meet sanitary requirements without also considering how to optimize energy use.

Additionally, in both new construction and retrofit contexts, even when more efficient technology is technically market-ready, equipment regulations may constrain adoption. Specifically, many jurisdictions still use a 1990s-era food safety formula for sizing water heaters that only covers gas and electric resistance equipment (not heat pumps), which prevents plan reviewers from approving HPWHs in commercial kitchens.

AVAILABILITY

For new construction projects, equipment purchasing decisions are dependent on availability—i.e., whichever product contractors can install quickly to keep the project on schedule. In some cases, designers noted that they had 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, the availability of efficient equipment can be a deciding factor in the choice between standard and efficient options.

CONFIDENCE

Contractors 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 are not confident in the technology's ability to meet operational requirements, dislike its user experience, or are uncertain if it meets existing regulatory requirements. Additionally, if chefs and kitchen managers do not trust that the equipment meets performance standards, they will be hesitant to select the equipment. Demonstration of technology effectiveness through case study material or in-person demonstrations, as well as educational information and vendor outreach for heat pump and other electrified technologies remain an important step in building trust among key market actors.

EDUCATION AND AWARENESS

Education across all stakeholders—including chefs, managers, engineers, and maintenance contractors—is essential for market transformation. Energy efficiency is often a low priority for restaurant owners who are concerned with keeping the restaurant operating reliably while controlling costs. 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 does 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.

UPFRONT 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 a

centralized corporate office makes equipment decisions and long-term return on investment can be more effectively considered.

Equipment-Specific Considerations

DISHWASHING EQUIPMENT

There are two primary types of dishwashers that restaurants use: low water temperature (low-temp) and high water temperature (high-temp). Low-temp dishwashers intake hot water from the water heater—between 120°F to 140°F—and use chemical sanitizers and rinsing agents to clean dishes. High-temp dishwashers use hot water (160°F) to first rinse and clean the dishes, followed by a higher temperature sanitization rinse (180°F). They intake hot water and use an electric booster to increase the temperature to operating requirements. In US restaurants, most small door-style and under-the-counter dish machines are low-temp, and most large conveyor-style machines are high-temp.

The relevant differences for energy efficiency and decarbonization are complex. Under ideal operating conditions, low-temp dishwashers use more water and draw more hot water from the water heater, but the overall system uses less energy than high-temp dishwashers. However, operators can modify dishwasher functionality if they do not think the system is performing adequately. Field testing has shown low-temp dishwashers can use significantly more hot water in practice than specified (Gantley, et al. 2025).

High-temp dishwashers use less water and fewer chemical detergents to clean and sanitize dishes, resulting in decreased energy consumption at the water heater, but reduction in overall energy consumption is dependent on various design factors. Decreased hot water load at the water heater means there is potential to size down HPWH storage tanks, helping to reduce space constraints, but high-temp systems require an electric booster to bring water to the required temperature. This results in high-temp machines using more energy overall. A secondary barrier to high-temp machines is that they typically require a steam hood for proper ventilation. A heat recovery system can negate need for ventilation and further improve system efficiency. Using waste heat to preheat incoming water can, in many cases, almost entirely eliminate the need for a hot water hookup to the dishwasher. This could allow the water heater to be further downsized and reduce overall energy use to levels more in line with conventional low-temp equipment.

The synergies between high-temp dishwashers, heat recovery systems, and HPWHs present intriguing opportunities for energy efficiency and decarbonization. Further research into this topic can assess viability and practical barriers to implementation. Potential barriers to adoption can be upfront equipment and installation cost and availability to lease. Even though technology is viable for small door-style and under-the-counter high-temp dishwashers, leasing companies preferentially carry and lease low-temp dishwashers. Selling detergent is a key revenue stream for leasing companies, and low-temp machines require more chemical detergent to clean and sanitize. This may distort the market for dishwashers because of the other benefits restaurants receive from working with leasing companies, such as scheduled and emergency maintenance and lower upfront cost. None of the restaurant owners or kitchen staff interviewed for this project had experience with a high-temp dishwasher and HPWH combined configuration. Additionally, the associated market needs of this configuration were beyond the immediate scope of this project.

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, and include steamers, 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 as part of their cookline. As such, live technical demonstrations, videos, and informational materials are highly influential in encouraging technology adoption. The main barrier to the adoption of electrified and high efficiency 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 the restaurant requires additional capacity, 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. For example, internal modeling from manufacturers indicates that gas combi oven models 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.

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 food preparation and sanitation 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). Kitchen staff monitor equipment functionality, slowdowns, and breakdowns, and must act to coordinate workarounds, repair, and replacement to ensure kitchen operations continue to function smoothly.

Decision-Making Roles

The kitchen managerial structure and influence of actors vary between chain-affiliated and independently owned restaurants. In chain restaurants, local managers oversee daily small-scale maintenance and communicate maintenance needs to facilities managers, maintenance staff, or ownership. The managers themselves have limited authority to select or replace major systems. Facility managers are the primary stakeholders who interface with other maintenance staff, vendors, or equipment leasing companies and shape decisions around equipment repairs and replacement. Corporate decision-makers, such as regional directors, play a role in establishing protocols for equipment replacement or setting company-wide standards that may influence equipment selection, such as environmental, social, and governance goals. 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. Cost, reliability, and installation speed often drive equipment repair and replacement decision-making.

In independent restaurants, owners typically manage kitchen operations and service decisions more directly, drawing on their own experience and discretion (National Restaurant Association 2023). Independent restaurant owners more often draw from their network of friends and fellow restaurant owners to help make decisions around equipment selection and leasing. For example, the team interviewed one Mandarin-speaking Chinese restaurant owner who explained that he relies on a WeChat group of roughly 500 other Chinese restaurant owners for questions about kitchen equipment or repairs. According to him, that social media group is the first place he goes to ask for advice.

Because independent restaurants are less likely to have a dedicated maintenance team, independent restaurant owners more often interface directly with leasing companies, vendors, or even manufacturers to select equipment and coordinate contracts to install and maintain equipment. 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). Restaurants rarely prioritize energy efficiency or water-saving features in their water heaters or washing and sanitizing practices unless required by code or rebate programs. The lack of involvement by the owner or chef in energy efficiency considerations reinforces the mindset of "minimum compliance," in which they select equipment based on its ability to meet sanitary requirements without also considering how to optimize energy use.

Equipment Repair and Replacement

Interviews with restaurant management and staff suggested that a substantial portion of equipment replacement occurs on failure, when equipment breaks down and is no longer able to reliably meet the operational needs of a kitchen. When replacing equipment on failure, decision-makers consider several factors when selecting new equipment, including cost and installation speed. Independent restaurants or smaller franchise operators are typically more price-sensitive and risk-averse. They may also opt for known technologies, as there is a perceived lower likelihood that unknown issues and added costs will arise.

Prior to considering replacement, restaurants tolerate common hot water issues, such as intermittent low water temperature, running out of hot water, and slow recharge times. 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. A total failure event, where the water heater cannot generate any hot water, is seen as an emergency requiring immediate repair or replacement. Quick repair is a 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.

When replacing on failure, building owners, facility managers, and restaurant owners typically seek to install a water heater as identical to the old system as possible, prioritizing installation speed and cost. Space constraints and existing plumbing are barriers to altering the system; for instance, heat pumps often need more space than existing water heating systems and may require plumbing

redesign, electric panel upgrade, new electrical wiring, and new maintenance procedures. Because restaurants demand hot water, repairs occur quickly—and restaurants often prioritize installation speed over energy savings when the project would otherwise require building or plumbing alterations. Proactive energy-saving goals are not a common motivating factor in hot water equipment selection. At larger chain restaurants, corporate initiatives and division-wide planned upgrades can be a driver towards efficient or electrified water heating equipment.

When replacing dishwashers, restaurant owners and kitchen managers interviewed for this study said they typically seek out one-to-one replacements when dish machines become dysfunctional. Repeated breakdowns trigger replacements when maintenance teams and leasing company technicians find that continual repair would be more costly than system replacement. Small and independent restaurants were more likely to lease dishwashing equipment—leased equipment has a much lower upfront cost, and restaurants can lease it for a variable time period, ensuring that a restaurant will not be stuck with an expensive piece of equipment if the restaurant goes out of business. Upfront cost was typically less of a constraint for institutional kitchens and chain restaurants, where centralized corporate offices make equipment decisions and can more effectively consider long-term return on investment. However, these kitchens may still work with leasing companies for ease of dishwasher maintenance and coordinating the delivery of chemical cleaning supplies.

Conclusions and Recommendations

This study explored how commercial kitchen stakeholders make decisions about hot water systems and related equipment and identified the barriers of adopting energy efficient options. Despite growing policy effort in California, commercial kitchens have been slow to transition. In many cases, practical operational needs, tight budgets, and current equipment acquisition processes shape decision-making. The most effective electrification strategies should thoughtfully consider how to engage all levels of the design, operations, and ownership chain. The recommendations below reflect these realities and focus on approaches that align with how commercial kitchen stakeholders make decisions.

As part of the technology transfer process, the team shared the draft report with several stakeholders who participated in interviews for this study. Most did not have additional comments—in fact, one stakeholder responded that the report looked thorough and that they had nothing to add, providing additional confidence that the report represents the views gathered through the research.

Recommendations:

- **Offer financial incentives to lower the initial purchase price.** Most consistently, market actor interviews revealed that upfront costs outweigh operating expenses for most commercial kitchens. Several interviewees described situations where stakeholders selected lower-cost equipment, even when higher-efficiency options would reduce operating expenses over time. For example, a dish machine vendor noted that many customers first ask whether the equipment fits within their budget before considering water or energy savings. In independent restaurants, owners often prioritized what they could afford immediately rather than evaluating long-term cost, reflecting tight operating margins common in the foodservice sector. As a result, financial incentives that lower the initial purchase price can play a major role in encouraging adoption. Incentives applied at

the point of sale may be particularly effective because they influence purchasing decisions when selecting equipment. In addition, electrification programs may need to address related infrastructure costs. Several interviewees mentioned that electrical capacity can be a limiting factor for new equipment, suggesting that financial support for panel upgrades or related improvements could help remove an important barrier. Additionally, most interviewees had not seen the materials before the interview, suggesting that awareness remains limited. Interviewees also noted that commercial kitchens often have limited physical space for hot water equipment and frequently deprioritize this during facility design. As a result, equipment that can function in small footprints or be installed outside of kitchen space may be more feasible for many facilities.

- **Focus early electrification initiatives on institutional kitchens.** Institutional kitchens provide a notable exception to the prioritization of upfront costs over operating expenses. Interviews with these facilities suggested that large institutions and campuses are more likely to consider sustainability goals and lifecycle cost savings when making equipment decisions. Early program efforts may therefore benefit from focusing on institutional kitchens that are operationally and financially better suited for electrification. Successful installations in these settings can provide case studies and practical experience that support broader adoption across the foodservice sector.
- **Create practical support tools for complex—yet quick—decision-making.** Decision-making in a commercial kitchen is a complex process, suggesting that successful adoption of energy efficient options will likely require engagement with various market actors. While no market actor was the sole decision-maker for equipment installation, the owner usually had the final say on equipment decisions. Additionally, many interviewees said they make equipment decisions quickly, often when a system fails. Under these conditions, owners rarely have time to conduct detailed research on energy savings or technology alternatives. As a result, the research team recommends developing practical tools to help commercial kitchen owners efficiently evaluate equipment options. Potential decision-support tools could include quick comparison calculators that show estimated operating costs for different water heating technologies, one-page equipment selection guides designed for commercial kitchens, and case studies showing real installations in similar facilities. These resources may be especially useful for contractors and facility managers who regularly advise stakeholders on equipment choices. During the interviews, we shared CalNEXT's design guide and operational guide with some participants. Overall, the feedback was positive, and several interviewees said the guide was helpful.
- **Expand training and technical assistance opportunities for contractors.** Contractors often strongly influence the final equipment selection. One contractor suggested that the type of water heating system installed often depends on what the contractor is comfortable designing and installing rather than on stakeholder requests, indicating that contractor familiarity with HPWHs and other efficient systems may be a critical factor for adoption. Engaging contractors, designers, and distributors directly may therefore be an effective strategy for increasing the likelihood that efficient technologies are proposed during equipment replacement or renovation projects. Expanding contractor training programs, providing technical assistance, and supporting demonstration projects could help increase confidence with new energy efficiency technologies.

- **Advocate for a clearer regulatory approval pathway for energy efficient equipment.** Several market actors noted uncertainty during permitting or plan review during their interviews and shared how these uncertainties can discourage the use of unfamiliar technologies. Fortunately, the previous CalNEXT design guidance already began to address this issue. Interviewees found the design guide helpful for making the high-level decision—especially the calculations for the total cost per year—and also expressed an interest in seeing real-world data in the design guide versus calculated water and energy used. CalNEXT could consider a case study or field study that provides this real-world data. Additionally, the research team recommends working with the CCDEH and local health departments to incorporate HPWH sizing methods into official guidelines. A clear approval pathway could reduce design uncertainty and expand viable options during plan review. For example, incorporating HPWH sizing methods into official guidance used by CCDEH and local health departments could create a clearer approval pathway and reduce uncertainty during project planning.
- **Explore energy efficient incentive structures for equipment distributors and leasing companies.** Market actor interviews highlighted the role of equipment distributors and leasing companies in shaping technology adoption. In some cases, leasing arrangements can create misaligned incentives that favor lower-cost equipment or technologies that support chemical sales rather than energy or water efficiency. Collaborating with distributors and leasing companies could help improve the availability of efficient dishwashing and hot water systems; additionally, pilot programs or incentive structures that address these misaligned incentives may help encourage the promotion of higher efficiency equipment. One limitation of this study is that the research team was unable to interview equipment leasing companies. Several other interviewees indicated that leasing providers play an important role in equipment decisions, particularly for dishwashing systems, but none agreed to participate despite multiple outreach attempts. This lack of participation may also point to a broader hesitation among these market actors to engage with energy efficiency research or program discussions. Because leasing arrangements appear to influence equipment choices in many kitchens, future research would benefit from finding ways to better engage this group and understand the factors that shape their decisions and willingness to participate in efficient initiatives.
- **Identify opportunities to make program participation easier for small, minority-owned restaurants.** Finally, programs should look at ways to make participation easier for small businesses—especially minority-owned restaurants, which make up a large portion of California's foodservice sector. Language barriers and complicated application processes can make it difficult to take advantage of incentive programs. For many owners whose primary language is not English, information often comes through trusted community networks rather than formal program channels. These kinds of informal networks suggest that outreach through multilingual materials and community channels is important for reaching a broader range of businesses and communities. In addition, simplifying program applications and offering financing options designed for small businesses could also make it easier for restaurant owners to participate. Together, these steps could help improve access and support more equitable participation across California's diverse foodservice market.

Overall, the findings suggest that decisions about commercial kitchen equipment involve many different actors, each with their own priorities and constraints. Interest in energy efficient options varies, and practical considerations—such as cost, operations, and existing procurement processes—often shape equipment choices. Because of this, increasing adoption will likely require a multifaceted approach that engages multiple parts of the market and addresses the different needs and perspectives involved in equipment decisions.

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Appendix A: Market Maps

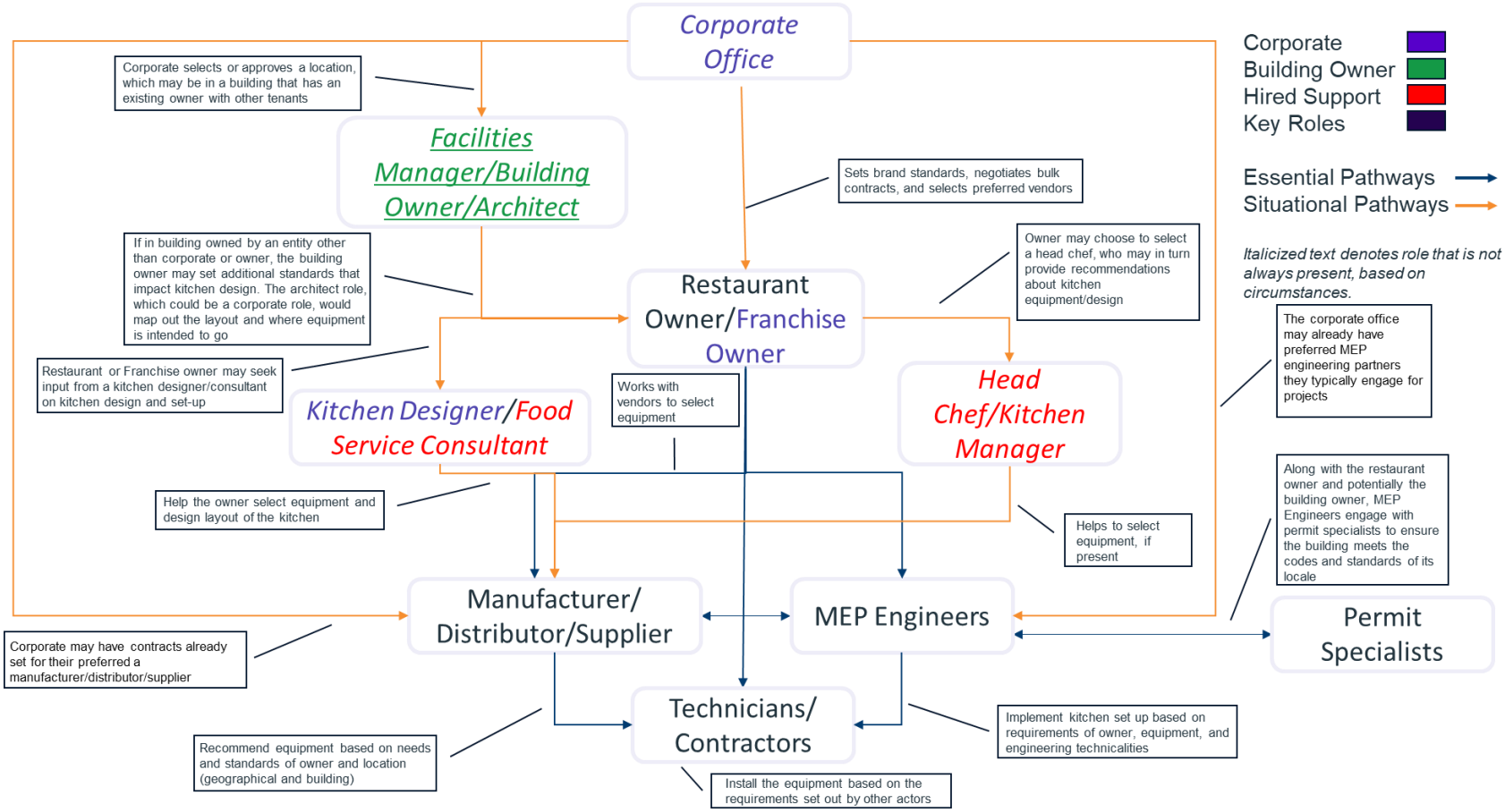

Figure 2: Map showing stakeholder relationships in commercial kitchen design for new construction and retrofit projects.

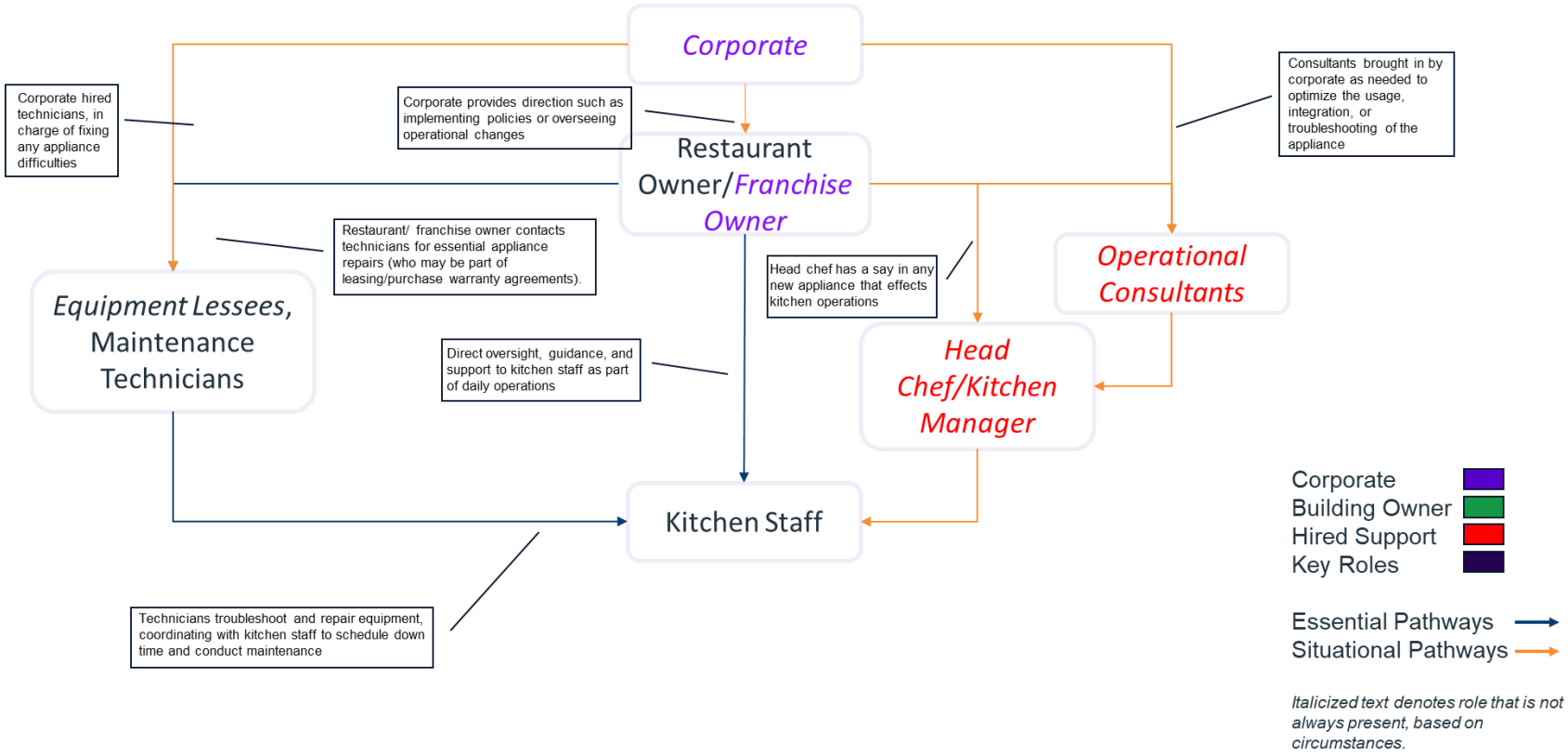

Figure 3: Map showing the stakeholder relationships involved in daily commercial kitchen equipment usage and maintenance coordination.

Appendix B: Interview Guides

A – Introduction

Thank you for taking the time to talk to me. As a reminder, we are working on a project to help understand opportunities and challenges to promoting kitchen decarbonization. We have reached out to several **[MARET SEGMENT MEMBERS]** and want to hear your perspectives on how we can serve the needs of kitchen operators and promote hot water decarbonization. Today we will be asking about we'll ask about two types of equipment in your kitchen:

- Hot water systems – things that generate and deliver hot water, like water heaters, storage tanks, recirculation lines, and plumbing that serves the kitchen.
- Point-of-use equipment – equipment in the kitchen that actually uses that hot water, like dishwashers, faucets, sprayers, sinks, and sanitization stations.

Do you have any questions before we begin? [Pause to answer any questions] Upon completion of the meeting today, you will receive an email with information on how to collect your $50 Tango gift card.

Is it okay with you if I record the interview to help with my own note taking?

Restaurant Owners, Kitchen Staff

1. Can you tell me a bit about yourself and your role, and also about your restaurant?
    A. Is your business minority owned?
    B. Who owns the building your restaurant is located in?
    C. Is your restaurant family owned? Franchised?
    D. Is the dishware you use in your restaurant primarily disposable or reusable?
2. To the best of your knowledge, can you briefly describe the hot water system in your kitchen, including water heaters, dish stations, and sanitizing practices?
3. Have you been involved with decisions to purchase hot water systems used in the kitchen?
    A. **[If NO]** Do you have familiarity with how these decisions are made and who makes them?

    [**Probe**: If restaurant is part of a chain: does corporate provide guidance or recommended specs?]

Design Professional, Vendor, Maintenance

1. Can you tell me a bit about yourself and your role, and also about your business?
2. Is your involvement primarily during the build phase, when the kitchen was initially designed, or renovation phase, when making upgrades to existing systems?

B – Point of Use Equipment [Restaurant Owner, Kitchen Staff]

1. Can you describe the dishwashing setup in your kitchen?

[Probe: machines, sprayers, sinks, sanitization practices, water-using cooking equipment]

2. Have you been involved in purchasing these systems?
3. How does management or staff share information about proper operation of washing equipment
   [Probe]: training, posted signs or documents?
   A. How closely are best practices followed? (temperature, time, loading, etc.)
4. What matters most when choosing dishwashing/sanitizing equipment? [Probe: cost, performance, reliability, space]
5. Have you used high-efficiency washing equipment? [Probe: high-temp dishwashers, heat recovery systems, efficient sprayer valves]
   A. If yes, what worked well / what were concerns?
   B. What would make it easier to adopt or evaluate these options? [Probe: guidance, calculators, training]
6. What day-to-day pain points do you experience with dishwashing systems? [Probe: inconsistent temperature, slow recovery, breakdowns]
7. What typically triggers replacement or upgrades? [Probe: planned vs. reactive maintenance]
   A. Are you involved in maintenance or replacement decisions?
8. Where do you see gaps in the information you need?

C – Hot Water Systems [Restaurant Owner, Kitchen Staff]

1. To the best of your knowledge, how is hot water supplied in your kitchen? [Probe: water heaters, tanks, pipe insulation]
2. Who was involved in selecting the system?
   [Probe]: engineers, designers, owners/managers, corporate if chain
3. What factors influenced the choice? [Probe: cost, performance, space, recommendations]
4. Have you used or considered high-efficiency/electric systems like tankless or heat pumps?
   A. If yes, what was your experience?
   B. If no, what are the barriers? [Probe: cost, infrastructure, reliability, permitting/codes, lack of spec sheets]
5. What resources would help you evaluate or adopt more efficient systems? [Probe: calculators, infographics, training]
6. What day-to-day pain points do you experience with hot water systems? [Probe: inconsistent temperature, slow recovery, breakdowns]
7. What typically triggers replacement or upgrades? [Probe: planned vs. reactive maintenance]
8. Where do you see gaps in the information you need?

D – Design and Build Phase [Designer Professional, Vendor, Maintenance]

1. Broadly speaking, what factors are most important during new kitchen builds or major renovations?
   [Probe]: Do designers think about hot water early on or does it come up later?
2. What factors are most important in the selection of a hot water system and/or point-of-use equipment during new builds or major renovations?
   [Probe]: cost, performance, space constraints, recommendations?
3. Who is involved in making the decision about what systems are selected?
   [Probe]: MEP engineers, kitchen designers, kitchen owners, managers?
4. Are high efficiency or electric hot water systems considered in designs?
   [Probe]: water heater efficiency? Dishwasher efficiency? Pipe insulation, sprayer valve, etc.?
5. Have you noticed any shifts in client demand for sustainability or energy efficiency in recent years compared to the past?
6. What kinds of technical or logistical challenges usually come up when people are thinking about decarbonized hot water systems in the design stage?
   [Probe]: cost, infrastructure, reliability concerns, lack of spec sheets?
7. Are there building codes, permitting processes, or specs that make it harder to choose electric options?
8. What information is most used when selecting hot water systems and equipment, such as guidance documents, design tools, and manufacturer specifications?
9. What information or resources do you wish you had but currently don't?
10. What tools or formats would make it easier to evaluate and adopt more efficient options for water heating systems and point of service equipment (e.g. dishwash machines)?
    [Probe]: calculators, infographics, training?
11. In your view, are you seeing an increase in demand from customers for high-efficiency or electric hot water systems compared to a few years ago? |
    [Probe]: What's driving/limiting that demand?

E – Operations Phase [Design Professionals]

Next I will ask a few questions about the day-to-day operation of commercial kitchens, focusing on the hot water system and what it is used for, such as dish washing and sanitization.

1. First, what are some of the day-to-day pain points you hear from customers about existing hot water systems?
   [Probe]: inconsistent temperature, slow recovery, breakdowns?
2. What typically triggers equipment replacement? Is it usually planned or more often reactive?
3. Have you designed kitchens that use **high-efficiency water heating systems**, like tankless systems or heat pump water heaters?
   A. What barriers are there to operating these kinds of systems in commercial kitchens?
   B. What kind of information or support would help increase the adoption of these systems?
      [Probe]: Install guidance, training, cost calculators?

4. Have you designed kitchens that use **high efficiency point of service equipment**, such as high temperature dishwashers, heat recovery systems, high efficiency sprayer valves or scrap collectors?
    A. What barriers are there to operating these kinds of systems in commercial kitchens?
    B. What kind of information or support would help increase the adoption of these systems?
    [Probe]: Install guidance, training, cost calculators?

F – Operations Phase [Vendor]

5. First, what are some of the day-to-day pain points you hear from customers about their hot water systems [or equipment VENDOR specializes in]?
    [Probe]: inconsistent temperature, slow recovery, breakdowns?
6. Are these problems linked to customer experience, food safety, or kitchen efficiency?
7. What typically triggers maintenance or replacement? Is it usually planned or more often reactive?
8. Does your company work with **high-efficiency water heating systems**, like tankless systems or heat pump water heaters?
    [If YES]: continue with A-E
    A. What benefits or challenges do you hear from customers?
    B. What kind of support do customers find most helpful when deciding to install water heating systems?
    [Probe]: Install guidance, training, cost calculators?
    C. What resources or training do you provide to your customers to ensure they use equipment properly?
    D. Do customers have problems following proper operating procedures?
    E. What if anything can be done to help ensure customers follow proper operating procedures?
9. Does your company work with **high efficiency point-of-use equipment**, such as high temperature dishwashers, heat recovery systems, high efficiency sprayer valves or scrap collectors?
    [If YES]: continue with A-E
    A. What benefits or challenges do you hear from customers?
    B. What kind of support do customers find most helpful when deciding point-of-use equipment?
    [Probe]: Install guidance, training, cost calculators?
    C. What resources or training do you provide to your customers to ensure they use equipment properly?
    D. Do customers have problems following proper operating procedures?
    E. What if anything can be done to help ensure customers follow proper operating procedures?

G – Operations Phase [Maintenance Staff]

10. First, what are some of the day-to-day pain points you notice with customers' hot water systems?
    [Probe]: inconsistent temperature, slow recovery, breakdowns?
11. Are these problems linked to customer experience, food safety, or kitchen efficiency?
12. What typically triggers maintenance or replacement? Is it usually planned or more often reactive?
13. Have you ever worked with **high-efficiency water heating systems**, like tankless systems or heat pump water heaters?
    [If YES]: continue with A-D
    A. What benefits or challenges do you hear from customers?
    B. What kind of support do customers find most helpful when deciding to install water heating systems?
       [Probe]: Install guidance, training, cost calculators?
    C. Do customers have problems following proper operating procedures?
    D. What if anything can be done to help ensure customers follow proper operating procedures?
14. Have you ever worked with **high efficiency point-of-use equipment**, such as high temperature dishwashers, heat recovery systems, high efficiency sprayer valves or scrap collectors?
    [If YES]: continue with A-D
    A. What benefits or challenges do you hear from customers?
    B. What kind of support do customers find most helpful when deciding point-of-use equipment?
       [Probe]: Install guidance, training, cost calculators?
    C. Do customers have problems following proper operating procedures?
    D. What if anything can be done to help ensure customers follow proper operating procedures?
15. What resources do you currently use when maintaining parts of the hot water system or recommending a new system?

CLOSE – Close Interview

Those are all the questions I have for you today.

16. Is there anything else you want to mention that you think we did not already address?
17. As a thank you for your input, we'd like to send you a $50 Tango gift card, which is an online card that can be applied to a wide variety of businesses or nonprofits of your choice. Alternately, we could also donate $50 to your local United Way in the name of your choice. Which would you prefer.

Thank you again for your input. Have a nice day. **[TERMINATE CALL]**