Commercial Foodservice Gas Fired Appliances Study

Project Number ET25SWG0004

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Executive Summary

The Commercial Foodservice Gas-Fired Appliances Study evaluates the energy efficiency potential of various gas-fired commercial foodservice (CFS) appliances. The study identifies equipment with significant energy savings, assesses market barriers, and recommends integrating them into energy efficiency incentive programs.

Through interviews with six subject matter experts (SMEs), and a review of past studies, the research examined gas-fired appliances that currently lack efficiency incentives. The study has focused on identifying high-potential technologies, market barriers to provide incentives, and the possibility of standardized efficiency testing to support future rebate programs.

Several appliances emerged as high-priority candidates for efficiency incentives. High-efficiency gas fryers, with over 70% efficiency, significantly outperform Energy Star Tier 2 models and offer substantial energy savings. Tilt skillets stand out for their versatility and ability to replace multiple appliances, reducing overall gas consumption. High-efficiency broilers provide up to 50% gas savings, better heat distribution, and fewer flare-ups, making them strong contenders for rebate programs and field trials.

Other equipment shows promise but requires further study before widespread adoption. High-efficiency steam kettles could offer significant energy reductions in institutional kitchens, but the lack of standardized efficiency benchmarks limits incentive feasibility. Infrared salamanders and cheese melters present potential savings, yet manufacturer engagement is low, and higher savings are not possible as thermostatic controls are lacking. Similarly, high-efficiency woks offer notable efficiency gains over traditional models but face market acceptance barriers, high costs, and operational concerns from chefs.

However, particle emissions regulations from the South Coast Air Quality Management District pose an additional challenge, particularly for gas-fired appliances. The possibility of a phase-out or stricter limits on particulate emissions could impact future adoption and regulatory feasibility of high-efficiency gas equipment.

The study recommends expanding lab and field testing, collaborating with manufacturers to refine efficiency standards, developing standardized test methods, and exploring tiered rebate structures to accelerate adoption. Training and educating the customer will also be crucial to increasing adoption in commercial kitchens.

High-efficiency gas-fired appliances present a significant opportunity for energy savings, but market acceptance and adaptability challenges, high costs, and testing gaps must be addressed. Future efforts should focus on high-impact technologies, regulatory alignment, and manufacturer collaboration to drive broader adoption of energy-efficient equipment in California's food service industry.

Introduction

The Midstream Foodservice program (SCG_SW_FS: COM-SW-Point of Sale Food Service) claimed 7,642,083 Net Lifecycle therms in 2024. In Q4 2024, a Gas Emerging Technologies (GET) representative spoke to two representatives from the Midstream Foodservice program. Those representatives suggested the need for several market, field, and lab studies. The market and field studies suggested would focus on a broad range of existing gas-fired CFS equipment that does not currently have a measure package.

The scope of the suggested studies was too broad for the GET program to initiate, and a more targeted scope was preferred. Therefore, this smaller project was initiated to gather early feedback from a handful of subject-matter experts (SMEs). The scope of this project was to interview six (6) subject matter experts (SMEs) to gather feedback on CFS measures that do not have incentives or measure packages and understand the barriers to their implementation. Barriers could include: not enough difference between efficient and non-efficient equipment, high initial cost making an incentive unlikely to impact decision-making, difficulty in establishing a test method, or difficulty in calculating energy savings. Only CFS equipment with medium to high potential to participate in EE programs would be investigated by the GET program in future studies.

This report summarizes the input from the CFS industry, obtained through interviews related to the energy efficiency of gas-fired CFS equipment.
The interviews were intended to:

- Identify gas-fired appliances with high energy savings potential.
- Identify obstacles in implementing energy efficiency (EE) incentives
- Understand market challenges and adoption resistance
- Propose recommendations for future incentive programs

Additionally, a representative from the Study Team attended the North American Association of Food Equipment Manufacturers (NAFEM) Conference that took place between February 26, 2025, and February 28, 2025, in Atlanta. Relevant findings from this conference have also been included in the report.

Assessment Objectives

Objectives

Below are the objectives of this study:

- Identify gas-fired CFS appliances with significant energy savings potential.

- Determine the key barriers to implementing energy efficiency (EE) incentives for gas-fired equipment.

Subject Matter Experts Interviewed

The panel of experts for this project came from different parts of the CFS industry; their roles are listed below.

Table 1: SME Experts and their positions/job titles

Number	Position
SME 1	Supervisor: Energy Efficiency WE&T (Foodservice)
SME 2	Vice President (Appliance Test Lab at the Foodservice Technology Center)
SME 3	Senior Staff Engineer - Foodservice
SME 4	Foodservice Tech & Design Center Program Manager
SME 5	Commercial Food Service Industry Specialist
SME 6	Institute Engineer II – Program Manager: Foodservice & Agriculture Program

Potential Equipment

This section lists the CFS equipment that has potential energy savings opportunities. For each piece of equipment, the report discusses previous studies, relative energy savings potential (High, Medium, or Low), barriers to providing incentives, test methods, additional SME comments and findings from the NAFEM Show, and recommendations for future work.

Custom Steam Tables

Brief Description and Function

These are stainless steel, heated serving stations that use steam to keep food at safe and consistent temperatures. Often found in buffets, cafeterias, and institutional kitchens, steam tables help maintain food quality by preventing drying out or uneven cooling. They come with compartments to hold pans of various sizes and can be customized to fit the workflow of a specific kitchen layout.

Previous Studies

Southern California Gas (SCG) submitted a measure package (MP) (SWFSO24-01) [1] on April 2, 2021, proposing the replacement of natural gas-fired wet well steam tables with more efficient dry well steam tables. The measure includes two measure application types (MATs): Accelerated Replacement (AR), which upgrades uninsulated, custom-built wet well tables to insulated, individually controlled dry well units, and New Construction/Normal Replacement (NC/NR), which assumes customers would have otherwise purchased wet well tables without program intervention. Savings estimates were based on case studies of (12) steam tables spread over three (3) sites that were documented in a report from Frontier Energy. [5] The EE savings consider reduced heat loss and improved heating control. The MP includes savings calculations for 3-, 4-, and 5-pan units across commercial, agricultural, and industrial sectors, with proposed delivery through upstream, downstream, and direct install methods. The Steam Table MP was rejected by CPUC primarily due to:

- **Lack of a Standard Baseline** – The study included custom-built steam tables, which varied too widely in design and efficiency. CPUC found it difficult to determine a standardized baseline for comparison.
- **Insufficient Field Data** – The study only monitored three (3) restaurants, whereas CPUC required at least ten (10) sites for reliable statistical analysis.
- **Unclear Efficiency Gains** – CPUC was not convinced that switching to high-efficiency models would yield consistent and verifiable energy savings, as restaurant operators misuse steam tables (e.g., reheating food instead of just holding it).
- **No Established ASTM Test Method** – There was no standardized lab testing procedure to validate the energy efficiency improvements claimed in the study.

Barriers to Incentives

- **Lack of Standard Baseline Data:** Custom steam table models vary widely in design. Therefore, CPUC rejected the measure package as no standard baseline was established.
- **Lack of Steam Table Energy Efficiency Data:** The experts mentioned that there is a lack of efficiency field and lab testing data available for this equipment, which makes it hard to determine which steam tables are in the high efficiency category.
- **Misuse of Steam Table:** Restaurants misuse steam tables by using them to reheat food instead of holding it, making energy savings unpredictable.
- **Limited field data:** Only three (3) customer sites were studied, while at least ten (10)

sites are required for CPUC approval of the Measure Package.

Testing Methodology

There is currently no ASTM test procedure for steam tables. The need for a verified and standardized testing technique has been stressed by experts. SME 3 pointed out that because there is currently no ASTM test method for steam tables, prior testing approaches presented a challenge in validating energy efficiency improvements or savings. Frontier's Study previous study was not able to create a performance testing protocol due to the lack of thermostatic control (units cannot be set to a specific temperature) and variation in sizes of custom-made steam tables. To provide a more uniform testing procedure, SME 2 and the CPUC proposed creating an efficiency benchmark like an industry standard practice (ISP) based on energy input and temperature stability which would help validate energy savings.

Additional SME Comments and Findings from NAFEM:

To minimize unnecessary energy loss, SME 4 recommended exploring wet-well steam tables from select manufacturers that utilize separate burners for each well. These models feature smaller burners and more efficient individual pilots, which have demonstrated energy savings in past studies. SME 4 emphasized that traditional custom-built steam tables, often made by steel fabricators with large, inefficient burners, are highly wasteful. Switching to manufacturer-designed steam tables with individual pilot controls can significantly reduce energy. enhancing efficiency. Discussions at NAFEM revealed that retrofitting key components presents an opportunity to enhance existing steam tables' performance and energy efficiency. Retrofits can include burner replacements, improved insulation or automatic lids to capture the heat flowing out of the system.

Energy Savings Potential:

Table 2 below summarizes the energy savings potential rankings given to steam tables by the six SMEs.

Table 2: Energy Savings potential for Steam Tables

Energy Savings Potential Ranking	Number of SMEs	Reasoning
High	1: SME 2	**Inefficient Legacy Units:** Many of these units are old, oversized, and inefficient, often lacking thermostatic controls. They continuously waste energy by overheating water, leading to significant standby losses.

Energy Savings Potential Ranking	Number of SMEs	Reasoning
		Early Replacement Savings Potential: Replacing outdated units with high-efficiency models could yield major energy savings, particularly when switching to factory-built steam tables with individual well controls instead of large-burner setups.
Medium	1: SME 1	**Widespread Use in Certain Restaurant Types**: Steam tables are a standard fixture in many food service operations, especially buffet-style restaurants. This provides a large potential user base for efficiency upgrades. **Lack of Market Demand for Efficiency**: Unlike ovens or fryers, operators do not actively seek high-efficiency steam tables, meaning manufacturers have little incentive to innovate in this category. **Cost Sensitivity of Customers**: Steam tables are considered a low-cost appliance. Many operators may hesitate to pay a premium for an energy-efficient model unless they see direct financial benefits. **Energy Savings Likely Exist but are Not Prioritized**: Theoretically, thermostatically controlled units and improved insulation could reduce waste heat, but without strong customer demand, adoption will be slow.
Low to Medium	1: SME 3	**CPUC Rejection & Baseline Challenges**: CPUC rejected a past attempt to establish an incentive for custom gas steam tables due to issues with defining the baseline (custom vs. factory-built units). This regulatory barrier limits the feasibility of a measure package. **Savings Potential Depends on the Baseline:** Switching from a custom unit to a factory-built unit could yield savings, but moving between factory-built models may not be significant enough to justify an incentive.
Low	2: SME 4 and SME 6	**Minimal Technological Innovation**: Gas steam tables have remained largely unchanged for

Energy Savings Potential Ranking	Number of SMEs	Reasoning
		decades, meaning there are no breakthrough high-efficiency models currently on the market. **Low Willingness to Change**: Many operators continue using inefficient units simply because they work. Unlike cooking appliances, which impact food quality, steam tables are passive holding devices, making them a low priority for upgrades. **Wasted Heat Energy:** The steam tables are usually operated with their lids open, which results in heat loss. Therefore, it is hard to analyze the actual heat requirement of the site.
No Response	1: SME 5	

Priority

The Study Team places the energy savings potential for steam tables in the Low to Medium range. While replacing legacy custom gas steam tables with factory-built models presents energy savings opportunities, several key barriers limit the potential for an efficiency incentive. The lack of thermostatic controls, continuous heat loss, and minimal technological innovation make it difficult to quantify savings and justify an incentive. Additionally, gas-fired steam tables are a niche product, with electric models dominating the market, especially in Northern California—further reducing the impact of a gas efficiency measure.

However, if manufacturers develop steam tables with individual well controls, improved insulation, or advanced burner designs, there could be a more compelling case for energy efficiency incentives. Targeting Southern California's ethnic restaurants, where gas-fired custom-built steam tables are more common, could yield higher savings. Despite this, adoption challenges persist, as steam tables are low-cost appliances with low operator interest in efficiency improvements. More field testing and baseline data would be needed to determine whether upgrading to energy-efficient models translates to cost savings that could drive adoption among restaurant owners.

Recommendations & Future Scope

While custom steam tables present some energy savings opportunities, further work should be limited due to market barriers, baseline challenges, and low prioritization among operators. Key reasons include:

- **Baseline and Regulatory Challenges**: CPUC rejected a previous attempt to

establish an incentive for gas steam tables, primarily due to difficulties defining the baseline (custom vs. factory-built models). The lack of clear baseline efficiency makes it difficult to justify incentives.

- **Minimal Technological Advancement**: Steam tables are a low-tech, low-cost appliance with few advancements in efficiency features. Unlike ovens, fryers, or grills, there is no strong demand for high-performance, energy-efficient models.
- **Low Customer Interest in Efficiency**: Operators prioritize reliability and food quality over energy savings. Since steam tables are holding equipment rather than cooking appliances, there is little incentive for food service businesses to replace functioning units for efficiency gains.
- **Field Data Limitations**: There is no standardized test method for gas steam tables, and previous field studies have been limited to a handful of sites. Without robust data, quantifying savings and establishing an incentive remains challenging.

Given these barriers, large-scale research, new incentives, and/or field studies should not be prioritized.

High Efficiency Infrared Salamander Broilers & Cheese Melters

Brief Description and Function

Compact broilers utilize high-intensity infrared heat for quick, even surface cooking. They are mounted on walls or above cooking ranges for easy access and are commonly used in commercial kitchens to brown, glaze, melt cheese, or add finishing touches to dishes without drying them out. Their fast-acting heat makes them perfect for a la carte kitchens where speed and appearance matter.

Previous Studies

The Study Team is unaware of any previous studies on this equipment.

Barriers to Incentives

- **Higher Cost and Availability:** While most existing models offer an infrared burner option, they are significantly more expensive and less readily available than traditional blue-flame burners. As a result, customers often choose the more affordable and widely available blue-flame option instead.
- **Most Infrared Burners Are Already Efficient**: It was described that many salamanders already use infrared technology, so switching to another "high-efficiency" infrared

burner (ceramic-based) might not yield significant savings

- **No standardized test method**: The lack of a standardized test procedure for evaluating efficiency benefits makes testing potential savings more difficult.
- **Hard to monitor equipment**: SME 2 mentioned that it is hard to test the salamander broilers and cheese melters as they are installed in corners or above gas stoves or integrated into kitchen setups, making it harder to access gas lines. This results in difficulty in testing or installing meters on the equipment.
- **Lack of Manufacturer Motivation**: Manufacturers are reluctant to invest in redesigning units due to the absence of clear incentives, business demand, or regulatory pressure. Without a compelling reason to modify existing designs, they see little value in pursuing efficiency improvements.
- **Market Adoption:** This equipment is left ON throughout service, leading to constant energy consumption. While control-based improvements could reduce energy waste, convincing customers to change their operating habits and invest in upfront costs for new technology remains a significant challenge**.**

Testing Methodology

There is no ASTM method available to test efficiency. However, SME 2 and SME 3 and their team are working on developing a test methodology.

Additional SME Comments and Findings from NAFEM

Experts suggested several possible solutions to increase the effective savings of highly efficient infrared burners over standard infrared burners. SME 2 proposed adding automatic burner shut-off sensors to current models to cut down on wasteful energy use. SME 3 mentioned a manufacturer installing a lever for better retaining of heat, but then the manufacturer was bought by another company and the project has been shelved. However, SME 3 recognized that restaurant owners are likely to object to this upgrade as it will affect their productivity. SME 6 suggested performing side-by-side testing in commercial kitchens to measure actual energy savings and confirm if efficiency gains result in genuine cost savings for restaurant owners; however, this is all dependent on the willingness of manufacturers to develop new upgrades as there is no such demand from the market or regulatory pressure.

Energy Savings Potential

Table 3 below summarizes the energy savings potential rankings given to Infrared Salamander & Cheese melters by the six SMEs.

Table 3: Energy Savings potential for Infrared Salamander & Cheese melters

Energy Savings Potential Ranking	Number of SMEs	Reasoning
High	3: SME 1, SME 2 and SME 3	**Faster Heat-Up and Recovery Times:** Infrared technology heats up quickly and provides direct, high-intensity heat, allowing operators to use the equipment only when needed rather than keeping it running constantly reducing gas usage **Past Innovation Efforts**: Some past manufacturer efforts explored sensor-activated burner systems that would turn ON only when a plate was placed inside. Another example mentioned was the manufacturer that had previously developed a lever-based heat retention system, but after the company was acquired, the project was shelved. Although both technologies were discontinued, experts believe they could be revived and optimized to improve efficiency.
Low to Medium	1; SME 4	**Thermostatic Setting and Flame Adjustment missing**: Gas salamanders and cheese melters in the current market do not have thermostatic control, compared to an electric alternative, which makes them less preferred. A thermostatic setting would reduce gas usage by lowering the flame power once the set temperature is reached. **Lack of Studies and Field Data:** The experts are not sure what this equipment's efficiency range is compared to the normal salamander broilers available in the market.
Low	2: SME 5 and SME 6	**Open Systems**: Both of these pieces of equipment are open making them highly inefficient due to significant heat loss. There are no alternative gas energy-efficient options available in the market; for example, something with a door would be a good option.

Priority

The Study Team places the energy savings potential in the Low to Medium range. While there is theoretical potential for efficiency improvements, barriers such as a lack of thermostatic controls, measurement challenges, and the presence of existing infrared technology limit the impact of highly efficient infrared burners to justify an incentive. Additionally, infrared salamanders and cheese melters serve a niche market, making them a lower-impact measure.

However, if manufacturers develop thermostatic-controlled gas-fired infrared models or revive lever covers or sensor-activated burner technology, there could be an opportunity for efficiency incentives. The study team feels that even after having potential upgrades, adaptability might be a barrier. More field testing in commercial kitchens would be needed to quantify savings and confirm whether efficiency gains translate to cost reductions for restaurant owners, which might convince them to adapt to the new broilers and cheese melters.

Recommendations & Future Scope

While infrared salamanders and cheese melters offer some energy savings potential, further work should be carefully assessed due to the following reasons:

- **Lack of Manufacturer Engagement**: Manufacturers have not prioritized improving the efficiency of these appliances. A past attempt at a lever-based heat retention system was discontinued after the company was acquired.
- **Minimal Efficiency Gains Over Existing Models**: Most infrared broilers and cheese melters already use infrared technology, meaning the difference between standard and "high-efficiency" versions is likely small unless additional controls (e.g., thermostatic settings) are introduced.
- **Potential for Sensor-Based Activation and Modulation**: A pressure sensor system could be reintroduced to automatically shut off burners when no plate is present, reducing standby losses. No current manufacturer has implemented this, but field testing could validate its impact**.**
- **Electric Alternatives May Offer Greater Efficiency:** Electric salamanders feature thermostatic controls and modular heat adjustment, potentially making them more efficient than gas models. Further research could compare gas vs. electric alternatives for efficiency incentives.

Based on the above reason, the study team recommends conducting a targeted study to assess the savings possible between standard infrared and high-efficiency infrared. If the savings potential is low, then no further studies should be done until new innovation or thermostatic controls are introduced in this gas-fired equipment.

High-Efficiency Deck-Type (Upright) Broilers (aka Steakhouse Broilers)

Brief Description and Function

Heavy-duty broilers are designed with multiple cooking decks, allowing chefs to cook large quantities of meat simultaneously at high temperatures. They are commonly used in steakhouses and high-volume restaurants to achieve the signature charred exterior and tender interior on steaks, poultry, and fish. They offer adjustable heat zones and allow for different levels of doneness.

Previous Studies

The Study Team is unaware of any previous studies on this equipment.

Barriers to Incentives

- **High upfront costs:** Due to their high upfront costs, that vary from $16,000 to $30,000, it is difficult to justify expenditures in these units, and substantial incentives would be necessary to promote efficient equipment purchases.
- **No defined testing method**: Even though ASTM F2237 offers a way to assess the performance of upright overfired broilers, there is no defined efficiency testing procedure for deck-type broilers.
- **Particle Emissions:** The matter is made more difficult by the possibility of a phase-out due to particle emissions limits from rules enforced by the South Coast Air Quality Management District.
- **Niche Market:** The product caters to a niche market and specific use case, making it less cost-effective to promote or test and resulting in low cumulative energy savings. Its impact on energy efficiency programs would be minimal and unlikely to justify investment.

Testing Methodology

No ASTM method is available to test the efficiency specifically for deck-type upright broilers. Although SME 3 and SME 6 mentioned that the ASTM F2237-03 (2020) Standard Test Method for Performance of Upright Overfired Broilers test method can be modified and used to test the performance of Deck-Type (Upright) Broilers

Additional SME Comments and Findings from NAFEM

SME 6 highlighted that emission concerns may drive the development of new technologies, such as low-emission infrared burners, to meet regulatory requirements while improving energy efficiency.

Energy Savings Potential

Table 4 below summarizes the energy savings potential rankings given to Steakhouse Broilers by the six SMEs.

Table 4: Energy Savings potential for Steakhouse Broilers

Energy Savings Potential Ranking	Number of SMEs	Reasoning
High/Medium to High	2; SME 3 and SME 6	• **Heat Loss in Traditional Models:** Traditional steakhouse broilers operate continuously without thermostatic controls, leading to significant heat loss. • **Efficiency of Infrared Burners:** Infrared burner technology provides direct, consistent heating, reducing fuel waste and excess kitchen heat. • **Potential of Pilot-Less Ignition:** Replacing traditional ignition systems with pilot-less ignition could lower standby energy losses.
Medium	1; SME 1	• **Niche Market with Some Efficiency Potential**: While not widely used, they still consume significant amounts of energy.
Low	2; SME 2 and SME 4	• **Lack of Field Data**: No field or lab data can determine potential efficiency savings. • **High Upfront Cost:** The expensive initial investment makes it difficult to justify switching without strong financial incentives. • **Niche Market**: Primarily used in steakhouses and select restaurants, limiting its adoption potential. • **Operational Adjustments:** Chefs may be reluctant to change their cooking techniques, which can hinder adoption of new technology.
No Rank	1; SME 5	

Priority

The study team places the priority in the low range. While traditional steakhouse broilers are inefficient, their niche market and high cost make widespread adoption unlikely. The financial barriers and the hesitancy of steakhouse operators to change equipment further reduce the feasibility of pursuing aggressive incentive programs. Given these challenges, this measure is a lower priority, and alternative efficiency strategies with broader impact should be explored.

Recommendations & Future Scope

No further work should be pursued on steakhouse broilers due to their niche market, high cost, and low feasibility for energy efficiency improvements. Key reasons include:

- **Limited Market Impact:** Used mainly in high-end steakhouses and hotels, making efficiency improvements low priority compared to widely used equipment.
- **High Cost, Low Savings**: Upfront costs range from $16,000 to $30,000, with minimal energy savings and an unattractive payback period, even with incentives.
- **Operator Resistance:** Steakhouse operators prioritize performance and quality over efficiency, making adoption unlikely.
- **No Industry or Regulatory Push**: Unlike other appliances, broilers lack efficiency mandates or market pressure for improvement.

Given these factors, further research, field studies, and/or incentives for steakhouse broilers should not be pursued. Efforts should focus on higher-priority commercial food service technologies with greater industry adoption and energy savings potential.

High-Efficiency Tilt Skillet

Brief Description and Function

A multifunctional cooking appliance featuring a wide, flat surface and a tilting mechanism for easy transfer of cooked food. It combines the benefits of a griddle, kettle, and sauté pan in one unit and is suitable for tasks like sautéing, browning, boiling, steaming, braising, and pan frying. Popular in institutional kitchens, it increases efficiency and reduces the need for multiple cooking tools.

Previous Studies

The Study Team is unaware of any previous studies on this equipment

Barriers to Incentives

- **High Upfront Cost:** The cost of high-efficiency tilt skillets can range from $12,000 to $25,000, making it difficult for food service operators to justify the investment without substantial incentives.
- **Lack of Field Study/Base Usage:** In a previous study for standard tilt skillet, it was hard to determine the hours of operation as it was used once or twice a week. This is due to the lack of adaptability by all the cooks/employees.
- **Operational Constraints:** Some high-efficiency models may alter cooking times, requiring chefs to adjust their workflow, leading to resistance to adoption.
- **Electric Competitor:** Most recent innovations in tilt skillets have been on the electric side, making it challenging to promote gas-fired high-efficiency models. Many new facilities are opting for electric tilt skillets due to efficiency gains and regulatory pressures
- **Training & Operational Challenges**: Operators are unfamiliar with how to fully utilize tilt skillets for multiple cooking processes (e.g., griddle, steamer, soup preparation). Without training, they may not experience the full benefits of efficiency improvements

Testing Methodology

ASTM F1047-95 Standard Specification for Frying and Braising Pans, Tilting Type.

Additional SME Comments and Findings from NAFEM

The manufacturers highlighted that zoned heating, which allows different sections of the skillet to operate at varying temperatures, could be a game-changer in energy efficiency as they can serve as multiple cooking processes (e.g., griddle, steamer, soup preparation). SME 6 suggested integrating smart thermostatic controls and enhanced heat distribution systems could significantly improve energy efficiency. SME 3 highlighted the importance of comparing different burner technologies, including infrared burners, to determine the best approach for improving performance. SME 2 highlighted that insulation improvements and lid design enhancements could make a significant difference in reducing heat loss. SME 2 suggested that efforts should be made to educate kitchen operators on how to use energy-efficient features effectively, as many users do not take full advantage of thermostatic controls and other efficiency mechanisms. Without a defined incentive or rebate procedure, manufacturers may hesitate to invest in high-efficiency designs, and incentive programs may struggle to gain regulatory approval.

Energy Savings Potential

Table 5 below summarizes the energy savings potential rankings given to High-Efficiency Tilt Skillet by the six SMEs.

Table 5: Energy Savings potential for Tilt Skillets

Energy Savings Potential Ranking	Number of SMEs	Reasoning
High	2; (SME 1 and SME 3)	**Versatility in Cooking Applications:** Tilt skillets can replace multiple appliances such as griddles, steam kettles, and fryers, making kitchens more energy-efficient by handling sautéing, steaming, frying, braising, and simmering in one unit, which is particularly beneficial for high-volume operations. **Manufacturers Introducing More Efficient Designs:** Newer models from manufacturers feature advanced burner systems, improved thermostat controls, and better insulation, reducing energy waste while maintaining precise cooking temperatures. **Lower Idle Energy Consumption**: Traditional tilt skillets remain heated for long periods, leading to unnecessary energy consumption, while modern high-efficiency models incorporate insulation and thermostatic controls that minimize heat loss and improve overall efficiency. **Lower Heat Emissions Reduce Kitchen HVAC Load:** By generating less excess heat than traditional models, high-efficiency tilt skillets contribute to lower cooling costs in commercial kitchens while creating a more comfortable working environment for staff.
Medium to High	2; (SME 4 and SME 6)	**Field Data on Energy Savings Still Limited:** While lab tests show promising results, real-world energy savings remain unverified due to the lack of long-term field data, making it harder to justify widespread adoption and incentive programs. **Higher Upfront Cost Slows Market Penetration:** The increased cost of high-efficiency models compared to traditional tilt skillets makes it difficult for small operators to justify the investment, even though rebates and incentives could offset some of the expense.

Energy Savings Potential Ranking	Number of SMEs	Reasoning
Medium	2; (SME 1 and SME 5)	**Variable Usage Hours Reduce Savings Consistency:** Unlike fryers and broilers that operate continuously, tilt skillets are often used only a few times per week in certain kitchens, reducing their overall energy-saving potential. **Adoption Challenges in Traditional Kitchens:** Many chefs and operators prefer familiar equipment like steam kettles or griddles, and without proper training, they may not fully utilize tilt skillets' efficiency features, reducing their potential energy savings.

Priority

The study team places high-efficiency tilt skillets in the medium-to-high potential range. Standard tilt skillets are inefficient, creating substantial energy savings opportunities. While their impact on gas consumption at small restaurants is minimal, their versatility in replacing multiple appliances—such as broilers, fryers, and griddles—makes them highly valuable in institutional settings like schools, hospitals, and correctional facilities, where large-scale cooking is required. However, higher upfront costs, limited market adoption for gas models, and operator resistance to change remain key challenges. Additionally, proper training is necessary to fully utilize their efficiency features, ensuring energy savings are realized in real-world applications.

Recommendations & Future Scope

Further work on high-efficiency tilt skillets should be pursued due to their potential for significant energy savings, versatility in commercial kitchens, and opportunity for broader market adoption. Key recommendations include:

- **Controlled Laboratory Testing and Field Testing in Real-restaurants**: Establish baseline efficiency metrics through lab testing, comparing energy performance between standard and high-efficiency models. Implement on-site testing in active commercial kitchens to measure actual energy consumption, identify operational barriers, and fine-tune efficiency improvements.
- **Manufacturer Collaboration**: Work with leading manufacturers to refine high-efficiency designs and integrate advanced energy-saving features into mainstream models.

- **Field Studies in Institutional Kitchens**: Conduct field studies in schools, hospitals, and large commercial kitchens to validate energy performance and drive adoption through real-world case studies.
- **Operator Training & Market Awareness**: Develop training programs, industry seminars, and educational initiatives to demonstrate cost savings and operational benefits and address operator resistance.

High-Efficiency Broiler

Brief Description and Function

A general term for a cooking device that applies direct heat from above (or sometimes below) to cook food quickly at high temperatures. Broilers are widely used for finishing, searing, or melting toppings, and are key in preparing dishes like steaks, kabobs, and gratins. They offer fast heat delivery for caramelization and browning, essential for flavor development.

Previous Studies

The Study Team is unaware of any previous studies on this equipment.

Barriers to Incentives

- **Limited Market Adoption**: The demand for high-efficiency broilers remains low due to their niche use in steakhouses and high-end kitchens.
- **High Cost:** Advanced broilers incorporating infrared technology can be 20-30% more expensive than traditional models**.**
- **Few High Efficiency Broiler Manufacturer Options:** Only one or two manufacturers in the market offer high-efficiency broilers.

Testing Methodology

F 1695-96 Standard Test Method for Performance of Underfired broilers

Additional SME Comments and Findings from NAFEM

At the NAFEM trade show, various manufacturers showcased high-efficiency broilers with advanced features aimed at reducing energy consumption. This indicates growing industry interest in more efficient cooking equipment, reinforcing the potential for energy savings in commercial kitchens. A high-efficiency manufacturer was previously studied as a potential Tier 2 category for the existing broiler measure package. However, due to its significantly

higher cost compared to alternatives, the Total Resource Cost (TRC) was below 1, and further progress on the measure was halted. After NAFEM, the Study Team connected with the high-efficiency underfired broiler manufacturer to find out more about the equipment costs which have decreased in the last two (2) years. This potential reduction in equipment cost could mean an improvement on the TRC and a Tier 2 can be created in the existing measure package. SME 4 stated that particular manufacturer's broiler has no cold spots. Additionally, this manufacturer's 36-inch broiler has an output at 54,000 Btu compared to 90,000-120,00 Btu traditionally available in the market. SME 4 also highlighted that manufacturers have explored infrared broiler designs, but widespread adoption remains limited due to cost and market resistance. SME 3 noted that manufacturers have hesitated to invest in efficiency improvements because most operators prioritize cooking performance over energy savings.

Energy Savings Potential

Table 6 below summaries the energy savings rankings given to high-efficiency boilers.

Table 6: Energy Savings Potential for High-Efficiency Broilers

Energy Savings Potential Ranking	Number of SMEs	Reasoning
High	2; (SME 2 and SME 4)	**Significant Energy Savings Compared to Standard Broilers:** A manufacturer's broiler consumes 54,000 BTU for a 36-inch model, compared to 90,000–120,000 BTU for standard char broilers, resulting in nearly 50% lower gas consumption while maintaining strong grilling performance. **Even Heat Distribution and Reduced Flare-Ups:** The design eliminates cold spots, ensuring consistent heat across the entire cooking surface, leading to better food quality and reduced food waste. The system also experiences fewer flare-ups, improving kitchen safety and reducing excess energy loss from uncontrolled combustion.
Medium	2; (SME 1 and SME 6)	**Moderate Efficiency Gains with Heat Retention Tradeoffs**: While energy savings exist, broilers do not retain heat as effectively as infrared broilers. Their large airflow gaps between grates and burners can lead to heat loss in high-ventilation kitchens, reducing overall efficiency in some environments. **High Upfront Cost**: The high upfront cost (~$11,000) compared to standard models ($3,000–$4,000)

Energy Savings Potential Ranking	Number of SMEs	Reasoning
		discourages investment, especially when cheaper alternatives exist with comparable performance.
Low to Medium	1; (SME 3)	**Limited Market Competition Raises Rebate Challenges:** Currently, there is only one manufacturer of this patented technology, making it difficult to secure incentives, as CPUC prefers multiple manufacturers in a product category to prevent pricing monopolies. Without broader industry competition, rebate programs are unlikely to expand.
Low	1; (SME 5)	**Operational Challenges**: Kitchen staff may struggle with heat retention issues for energy efficient boilers compared to other broilers, requiring adjustments to cooking methods that could disrupt workflow efficiency. **Infrared Burner Broilers:** These are less expensive alternatives and better than conventional under-fired broilers.

Priority

The Study Team places the priority in the medium range. It offers up to 50% gas savings (54,000 BTU vs. 90,000–120,000 BTU for standard charbroilers), even heat distribution, fewer flare-ups, and lower kitchen heat emissions, improving food quality and reducing cooling costs. However, high upfront costs, limited market adoption, and a lack of competition (single manufacturer) affect the adoption of energy efficiency incentive programs. Further heat retention concerns in high-ventilation kitchens and operator unfamiliarity reduce the market penetration.

Recommendations & Future Scope

Further work on High-Efficiency Broilers should be pursued due to its high energy savings potential, improved kitchen efficiency, and opportunity for increased adoption. Key recommendations include:

- **Field Testing in Real Kitchens**: Conduct on-site trials in commercial foodservice operations to measure actual energy savings, operator acceptance, and performance under varying kitchen conditions.
- **Exploring a Tier 2 Rebate Structure**: Evaluate higher incentive options to offset high

upfront costs and enhance market feasibility.

- **Manufacturer Expansion & Market Development**: Encourage broader industry competition to reduce costs, improve rebate possibilities, and drive innovation in high-efficiency boiler designs.
- **Operator Training & Education:** Develop targeted training, live demonstrations, and industry awareness campaigns to showcase cost savings, performance benefits, and proper usage techniques.

High-Efficiency Gas Fryer

Brief Description and Function

A commercial deep-frying appliance powered by natural gas or propane. It heats oil quickly and maintains steady temperatures, making it ideal for high-throughput kitchens such as fast-food chains and diners. Gas fryers are used to cook items like French fries, fried chicken, onion rings, and seafood with a crispy, golden exterior and tender inside.

Previous Studies

The Study Team is unaware of any previous studies on this equipment.

Barriers to Incentives

- **Higher Initial Costs:** High-efficiency fryers cost 30-50% more than standard models, making rebates critical for adoption and resistance from small operators who prioritize affordability over efficiency.
- **Resistance from Operators:** Many chefs and kitchen staff prefer familiar equipment, making them reluctant to switch unless they see substantial benefits.
- **Unclear Energy Savings & Data Gaps:** While immersion tube burners are known to improve heat transfer and reduce standby losses, there is limited field data on their real-world energy savings compared to standard fryers
- **Limited Manufacturer Competition:** Few manufacturers are producing these high-efficiency fryers (advanced immersion tube, convection-based fryer), which limit market competition and keep prices high.

Testing Methodology

ASTM F2144-17 Standard Test Method for Performance of Large Open Vat Fryers

ASTM F1361-21 Standard Test Method for Performance of Open Vat Fryers

Additional SME Comments and Findings from NAFEM

Experts agree that some new fryers are achieving gas efficiencies over 70%, significantly higher than the current Energy Star requirement of 50-60%. However, one SME also noted that many of these fryers are still in the early stages, and more field data is needed to validate their performance. The study team met SME 2 at NAFEM, where the SME pointed out that advanced heat exchangers and automated temperature controls could significantly improve efficiency. The SME also recommended checking out newly launched fryers by two manufacturers but did mention the high cost of the equipment. One of the manufacturers claims higher efficiency than tier 2 of the existing measure package. SME 3 emphasized that many manufacturers have not conducted ASTM tests on their fryers, and even if they have, they might not be willing to share the data. This makes it challenging to develop rebates or incentives for advanced fryer technologies At the NAFEM Show, multiple manufacturers claimed to have developed high-efficiency fryers that surpass the efficiency levels of those currently available in the market, utilizing various fryer designs and advanced heating technologies.

Energy Savings Potential

Table 7 below summarizes the energy savings potential rankings given to High-efficiency gas fryers by 4 SMEs. The study team did not get to ask SMEs 4 and 5 about the high-efficiency fryers.

Table 7: Energy Savings Potential for High Efficiency Fryers

Energy Savings Potential Ranking	Number of SMEs	Reasoning
High	4; (SME 1, SME 2 (Based on Conversation at NAFEM), SME 3 and SME 6)	**Significant Energy Savings:** High-efficiency fryers using advanced immersion tube burners or convection-based frying or metal fiber burners have been shown to reduce gas consumption compared to traditional fryers. These fryers improve heat transfer, maintain cooking consistency, and lower overall operating costs. **Fryers Are Essential in Commercial Kitchens**: Because fryers are one of the most commonly used appliances in restaurants, even modest efficiency improvements can lead to significant cumulative energy savings across the foodservice industry.

Energy Savings Potential Ranking	Number of SMEs	Reasoning
		Rebates and Incentives Could Drive Market Adoption: The high energy savings potential makes fryers strong candidates for rebate programs, provided real-world energy savings data supports incentive applications. However, field studies and additional research are necessary to validate their performance under actual cooking conditions.
Medium to High	2; (Based on Conversation at NAFEM) and SME 6))	**High Cost Is a Barrier for Small Operators:** While large chain restaurants can justify the investment, small independent restaurants struggle to afford high-efficiency fryers. Without substantial rebates or financing options, adoption may remain limited. **User Behavior Limits Potential Savings:** Many kitchen staff keep fryers running at full power even when low demand negates energy efficiency benefits. Operator training and automation (such as smart controls) could help ensure energy savings.

Priority

The Study team places this in the medium-high priority category. High-efficiency gas fryers offer substantial savings in high-volume kitchens, and at the NAFEM conference, multiple manufacturers claimed to have high-efficiency fryers surpassing the Energy Star Tier 2 requirement of 60–61% and have an efficiency of 70%. Adoption by small-scale restaurants remains limited due to operational resistance and high upfront cost concerns.

Recommendations & Future Scope

Further work on high-efficiency gas fryers should be pursued due to their high energy savings potential, significant market impact, and opportunity for increased adoption. Key recommendations include:

- **Lab Testing based on ASTM F2144-17/ASTM F1361-21 Test Method:** The highly efficient (convection-based/metal fiber burners) need to be lab tested to verify their claim. This is necessary as these are very new technologies with no test data to back the claims. before moving to field testing.

- **Field Testing in Real Kitchens:** Conduct on-site trials of newly introduced fryer technology in fast-food chains, hotels, and institutional kitchens to measure actual energy savings, operator acceptance, and performance under varying kitchen conditions.
- **Exploring a Tiered Rebate Structure:** Evaluate different efficiency tiers for rebate programs, considering new models that surpass Energy Star Tier 2 standards (60–61%) and claim to achieve 70% efficiency to incentivize broader adoption.
- **Promote Innovation Among Manufacturers:** This can be done by providing higher rebates for more efficient fryers. This would encourage everyone to have competitive pricing and indirectly help small restaurants and hotels afford it.

High-Efficiency Steam Kettles

Brief Description and Function

Steam kettles are large-capacity cooking vessels that use indirect steam heat between layers of metal to cook food gently and evenly. They're ideal for preparing large volumes of soups, stews, sauces, and pasta in hospitals, schools, and catering facilities. Steam kettles prevent scorching and allow precise temperature control, reducing manual labor and enhancing consistency.

Previous Studies

The Study Team is unaware of any previous studies on this equipment.

Barriers to Incentives

- **High Upfront Cost:** Institutional buyers, such as schools and hospitals, often operate on tight budgets, making it difficult to justify the higher price of high-efficiency models without rebates**.**
- **Limited Efficiency Gains:** While high-efficiency models exist, energy savings might not be big enough and making it difficult to justify financial incentives.
- **Niche Market**: Steam kettles are primarily used in institutional food service settings (e.g., hospitals, universities, correctional facilities), limiting the potential customer base for incentive programs.
- **Lack of Field Data:** There is insufficient real-world data on steam kettle energy use and savings, making it challenging to quantify efficiency benefits and develop a strong incentive case.

- **Low market adoption:** Steam Kettles are not widely used, so manufacturers are not interested in making them more efficient.

Testing Methodology

There is no standard ASTM test method for Steam Kettles. SME Expert 2 mentioned that ANSI Z83.11-2016 / CSA 1.8-2016 is a general safety and performance standard for gas food service equipment covering various appliances, including steam kettles, but it is not solely focused on them.

Additional SME Comments and Findings from NAFEM

SME 6 mentioned that Steam kettles would have higher savings potential replacing another equipment type (stock pot) over lower efficiency kettles. SME 3 proposed testing hybrid steam kettles that use both gas and electric heating elements to determine their efficiency improvements. SME 1 suggested that retrofitting existing steam kettles with better insulation and optimized burner technology could be a cost-effective alternative to full replacements. SME 4 and SME 6 highlighted the importance of monitoring real-world performance in high-use environments such as hospitals and school cafeterias to provide critical data for rebate programs.

Energy Savings Potential

Table 8 below summarizes the energy savings potential rankings given to Steam kettles by six SMEs.

Table 8: Energy Savings potential for Steam Kettles

Energy Savings Potential Ranking	Number of SMEs	Reasoning
High	1; (SME 3)	**Significant Savings in High-Volume Institutional Kitchens:** Steam kettles are extensively used in hospitals, universities, correctional facilities, and catering kitchens, where continuous operation and large batch cooking lead to high energy consumption. Upgrading to high-efficiency models could yield substantial savings in these environments. **Long Operating Hours Increase Cumulative Savings:** Unlike some commercial kitchen appliances that operate intermittently, steam kettles run for extended periods throughout the day. Even moderate efficiency improvements result in significant energy reductions over

Energy Savings Potential Ranking	Number of SMEs	Reasoning
		time, especially in institutions with daily meal preparation demands.
Medium to High	1; (SME 4)	**Potential for Gas and Water Savings:** Some high-efficiency steam kettles reduce both gas and water usage, optimizing boiling and steam circulation, which can lower operational costs and environmental impact.
Medium	3;(SME 2, SME 5 and SME 6)	**Limited Market Interest Slows Efficiency Innovation:** Steam kettles are a niche product, primarily found in large institutions rather than widespread restaurant use. Since demand is low, manufacturers have little motivation to invest in high-efficiency models, reducing the feasibility of efficiency-driven incentives. **Competing Technologies May Be More Cost-Effective:** Some institutions are switching to electric tilt skillets or other high-efficiency batch cooking solutions, potentially reducing the market for improved gas steam kettles. **Baseline and Testing Challenges:** Establishing a standardized efficiency baseline for steam kettles is difficult due to differences in size and operation. The lack of a dedicated ASTM test method makes measuring and verifying savings a barrier to incentive development.
Low	1;(SME 1)	**Minimal Efficiency Gains for Standard Kitchen Use**: In small- to mid-sized kitchens, steam kettles do not operate at the same intensity as in institutional settings, meaning energy savings would be negligible.

Priority

The Study Team assesses the potential of high-efficiency steam kettles in the low-to-medium range. While they offer considerable energy savings, particularly in high-use commercial and institutional settings, adoption barriers such as cost and a lack of operator awareness may limit their market penetration. Additionally, the savings potential for small restaurants is unknown, and there is no established efficiency range for products currently in the market. The lack of a standardized baseline and the absence of a dedicated testing method further complicate efforts to quantify efficiency gains and develop targeted incentive programs.

Recommendations & Future Scope

To maximize energy savings potential, further research and incentive programs for high-efficiency steam kettles should focus on targeted applications and alternative efficiency improvements rather than directly replacing existing models. The following recommendations outline key areas for further study and program development:

- **Prioritize Stock Pot Replacements:** Steam kettles offer significant efficiency improvements when replacing stock pots, which are less efficient and consume more energy. Incentive programs should focus on encouraging this transition rather than upgrading from lower-efficiency steam kettles.
- **Explore Advanced Insulation and Burner Technologies:** Research should investigate improved insulation materials and optimized burner designs to enhance heat retention and reduce standby losses. Retrofitting existing steam kettles with these improvements could provide a cost-effective alternative to complete replacements.
- **Conduct Field Testing in Institutional Settings:** Since hospitals, universities, correctional facilities, and catering operations are the primary users of steam kettles, field studies should focus on real-world performance testing in these environments. This would help validate energy savings claims and strengthen the case for potential rebate programs.
- **Develop Standardized Test Methods:** The absence of an ASTM test method makes quantifying efficiency gains difficult. Future efforts should focus on developing industry-accepted efficiency baselines to support measurement, verification, and incentive program design.

Implementing these recommendations could make high-efficiency steam kettles a viable energy-saving solution, particularly in institutional kitchens with high daily usage. However, due to limited market adoption and incremental efficiency gains, further research should only be pursued if significant efficiency improvements or broader market interest emerge.

High-Efficiency Woks

Brief Description and Function

Traditional, bowl-shaped cooking pans, typically made of carbon steel or cast iron, are known for their ability to withstand extremely high temperatures. Woks are used in stir-frying, steaming, deep-frying, and boiling, especially in Asian cuisine. Their shape allows for

fast cooking with minimal oil, making them a go-to for preparing vegetables, noodles, and proteins quickly while locking in flavor and nutrients.

Previous Studies

The study/testing **(SCGAT211301A [2], SCGAT202212A [3])** was mentioned by experts regarding high-efficiency woks involved a "National level Chinese food chain" testing a high efficiency burner prototype. The high efficiency burner was designed to significantly improve wok energy efficiency, achieving upwards of 35% efficiency compared to the 13-19% efficiency of traditional wok ranges. This "National level Chinese food chain" tested the highly efficient burner, but they ultimately did not adopt it because it altered the cooking process and required chefs to adjust their cooking techniques.

Similarly, a past study, **GTI Project No. 2057[4],** was done with a national-level Chinese food chain for high-efficiency woks. This study was done on GTI's improved and more efficient burner. The food chain rejected this Wok, citing high cost and the fact that the cooking won't be the same.

Barriers to Incentives

- **High Cost**: High-efficiency woks tend to be more expensive than traditional models. Operators may be unwilling to invest in them unless there are clear cost savings or incentives
- **Cooling Mechanism Concerns**: Traditional woks rely on water to cool the cooking surface and maintain operational efficiency. Without this feature, some chefs may worry about overheating or food sticking
- **Operational Resistance**: Many chefs resist changes to traditional wok designs, fearing performance loss.

Testing Methodology

ASTM F1991: Standard Test Method for Performance of Chinese (Wok) Ranges, used in [4].

Additional SME Comments and Findings from NAFEM

SME 6 and SME 2 consider the energy savings potential of high-efficiency woks to be very high, emphasizing that traditional gas woks operate at extremely low efficiency (~15%), leaving significant room for improvement. They believe that efficiency gains can be achieved through better burner design, insulation, and heat recovery systems. SME 2 also noted that past studies have tested prototype wok burners in lab settings, but these were never commercialized. More testing is required before establishing a standardized

efficiency benchmark. However, SME 4 and SME 5 are more skeptical about adoption, citing market resistance, higher upfront costs, and a lack of manufacturer support as key barriers. Ultimately, all experts agree that more field testing is necessary to validate efficiency claims and convince manufacturers and operators that high-efficiency woks can maintain the high heat output and performance expected in commercial kitchens.

Energy Savings Potential

Table 9 below summaries the energy savings potential rankings given to High-Efficiency and waterless Woks by the six SMEs.

Table 9: Energy Savings Potential for High Efficiency and Waterless wok

Energy Savings Potential Ranking	Number of SMEs	Reasoning
High	2; (SME 2 and SME 3)	**Significant Energy Savings Potential with Improved Efficiency Features**: Traditional gas-fired woks suffer from excessive heat loss due to their open burner design, leading to high gas consumption and energy waste. High-efficiency woks with burner shields, improved insulation, and better burner modulation can significantly reduce gas usage while maintaining high heat output. Waterless woks further eliminate energy waste by removing the need for continuous water cooling, reducing both gas and water consumption. **Market Demand & Regulatory Push**: Gas woks are widely used in commercial foodservice, particularly in Asian cuisine restaurants, where high-heat cooking is essential. Regulatory efforts to reduce gas consumption and emissions make high efficiency models an attractive alternative, driving potential for rebate programs and policy support**.**
Medium to High	1; (CFS 6)	**Potential for Savings, but Cost and Market Resistance Pose Challenges:** – While high-efficiency and waterless woks offer significant energy savings, the cost of upgrading remains a deterrent for many restaurant owners, making adoption dependent on strong financial incentives or rebates. **Technology Still in Early Stages:** Although some waterless gas woks exist, they have not yet seen widespread adoption, and further field testing is required to validate efficiency claims and prove their performance matches traditional woks.
Low to Medium	1; (CFS 4)	**Operational Adjustments Required for Adoption:** Some early tests of high-efficiency gas woks indicate reduced heat transfer,

Energy Savings Potential Ranking	Number of SMEs	Reasoning
		which impacts cooking speed and quality, discouraging adoption in fast-paced kitchens.
Low	1;(CFS 1)	**Limited Market Demand & Cost Concerns:** While traditional gas woks are energy-intensive, most restaurant owners are not actively looking for alternatives, making widespread adoption of high-efficiency models unlikely unless major cost savings can be demonstrated. **Difficult to Justify Cost vs. Savings:** Many kitchens prioritize high heat output and cooking speed over energy efficiency, making it difficult to convince operators to invest in expensive upgrades**.**
No Comment	1; (SME 5)	

Priority

The Study Team places high-efficiency woks in the medium potential range due to their significant energy and water savings, but adoption challenges and operational concerns limit widespread use. Traditional gas woks consume large amounts of energy and require continuous water cooling to prevent metal warping, leading to substantial gas and water waste. High-efficiency models with burner shields, improved insulation. However, chefs rely on traditional gas woks for their high heat output and fast response, making it difficult to switch to newer designs unless they maintain cooking performance. Additionally, high costs, limited manufacturer competition, and resistance to change make it challenging for restaurant owners to justify upgrading, particularly in retrofits where replacing existing woks is expensive. Rebates, field testing, and operator training will be essential to overcoming market hesitation and demonstrating real-world savings and performance benefits.

Recommendations & Future Scope

Given the high energy and water consumption of traditional gas woks, implementing high-efficiency models could lead to substantial savings. However, previous studies showed operator resistance due to changes in cooking performance and high costs. To reassess market readiness and technological advancements, the following steps should be taken:

- **Field Testing in Restaurant Kitchens:** Conduct on-site trials in commercial kitchens, where wok usage is highest, to measure real-world energy savings, performance, and operator acceptance.

- **Retrofitting Solutions:** Explore burner shields, improved insulation, and high-efficiency burners as cost-effective retrofitting options instead of full equipment replacement.
- **Reevaluate Previous Studies:** Revisit SCGAT211301A and SCGAT202212A, which tested a high-efficiency burner prototype with a national Chinese food chain but were rejected due to cooking process changes. Similarly, reassess the GTI Project No. 2057 [4], where cost and cooking differences led to rejection.
- **Lab Testing for New Technologies:** If newer high-efficiency wok technologies have emerged, lab testing should be conducted to evaluate efficiency gains, cooking performance, and compatibility with restaurant workflows before moving to field trials.
- **Awareness and Training Initiatives**: Educate restaurant owners and chefs on the cost savings and efficiency benefits of high-efficiency woks through awareness campaigns, live demonstrations, and training programs**.**

Potential CFS Components

High Efficiency Burner

Brief Description and Function

A fundamental part of any cooking range, burners provide direct heat through gas flames or electric coils. In commercial kitchens, burners can be customized with different configurations for boiling, sautéing, simmering, or pan-frying. They are essential for stove-top cooking and can be part of ranges, countertop units, or wok stations.

Previous Studies

A previous study/testing ([2],[3]) involved collaboration with a national-level Chinese food chain, testing a high-efficiency wok burner prototype. This advanced burner was specifically designed to improve wok cooking energy efficiency significantly, reaching efficiencies above **35%**, compared to traditional wok ranges which typically achieve only **13-19%** efficiency. However, the national-level Chinese food chain did not adopt the new high-efficiency burner despite its substantial efficiency gains, primarily due to the impact it had on cooking processes. The burner required chefs to adjust their cooking techniques, causing acceptance and usability challenges.

Currently, this high-efficiency burner technology is included in the California Energy Wise Rebate program (rated 50% efficient), which is under the cooktops category.

Priority

The Study Team recommends a comprehensive field study of these high-efficiency wok burners for the following reasons:

- **Calculation of Actual Energy Savings:** A field study will be able to determine actual energy savings achieved by restaurants in operational conditions and to compare these results directly with previous laboratory tests.
- **Assess customer acceptance and usability:** A field study would be able to asses real-world operator acceptance.
- **Understand Barriers:** A field study would help identify and understand potential barriers in field-testing solely the burner technology.

Additionally, the Study Team recommends evaluating the potential benefits of retrofitting this burner technology into various kitchen equipment. This approach would help determine energy savings potential when using the same high-efficiency burner across multiple appliances.

If substantial energy savings are verified, this burner technology could then become a standardized **burner replacement measure**, enabling customers to swap their existing burners with these new, highly efficient models.

The South Coast Air Quality Management District (SCAQMD) would be particularly interested in these burners due to their potential for emissions reductions.

Temperature Controls Retrofit

Brief Description and Function

A modern upgrade installed on older cooking equipment to improve the precision of temperature management. These retrofits enhance energy efficiency, improve food safety, and allow for better cooking consistency. By updating temperature controls, commercial kitchens can extend the lifespan of existing equipment while meeting current operational and regulatory standards.

Previous studies

No previous study has been done for this technology.

Priority

During a recent visit to NAFEM, a Study Team member identified a gas-fired fryer equipped with a thermostatic control system. The function of the temperature control system is to

shut off gas burners once the oil temperature reaches a set point. The manufacturer promotes just oil savings potential through the control system. The Study Team member-initiated discussions with the manufacturer's engineering team to determine if their temperature sensor and setpoint control system could be integrated into various commercial foodservice (CFS) equipment. If applicable across different equipment, the SME team believes a retrofit controls option would be worth testing to evaluate its potential for widespread energy savings by shutting off burners and user acceptance in CFS operations. The Study Team feels such control system retrofit options should be explored for CFS equipment.

Notable Equipment

The Study Team identified several equipment types discussed by SMEs during interviews that initially appeared promising. However, the Study Team decided not to pursue these due to reasons such as:

- Lack of available manufacturers
- Equipment is still in very early development or prototype stages
- Insufficient market availability or limited adoption potential
- Unclear or minimal energy savings data available

Thus, the following equipment will not be pursued further at this time.

Additionally, a few pieces of equipment were discussed during a Study Team member's visit to NAFEM, in collaboration with fellow SMEs outside of the interviews. Some of these pieces of equipment are listed in this section.

Note: The appendix provides an additional list of equipment discussed during SME interviews but deemed to have no significant potential, was too infeasible, or were purely conceptual ideas. Please refer to the appendix for more detailed information.

Gas Boosters for Warewashers

A gas-fired warewasher with a built-in booster heater improves efficiency by heating water to 180°F faster than electric models, making it ideal for high-volume dishwashing. SME 6 noted that gas booster warewashers with heat recovery systems show significant energy savings, while SME 2 found that gas models have lower operating costs but higher installation expenses. Adoption is limited in California, where electric dishwashers are the norm, and exhaust ventilation and fuel conversion requirements pose challenges. Experts suggest pilot programs to assess real-world performance. At the NAFEM conference, it was observed that out of the two manufacturers producing gas boosters, one discontinued

production and switched to electric boosters due to material sourcing issues. The second manufacturer only sells gas boosters to customers where high-voltage electricity is unavailable. Given the lack of suppliers and minimal market demand, gas boosters have no significant gas savings potential and are unlikely to be a viable energy efficiency measure.

Turbo Pot Finned Heat Exchanger

The Turbo Pot improves heat transfer efficiency with finned heat exchangers at the base, reducing cooking time and gas use. There used to be a rebate for this equipment but was retracted by CPUC as the turbo pot itself does not directly consume energy, as it is merely a cooking vessel rather than an actual appliance consuming gas or electricity directly. This creates difficulties in ensuring actual energy savings from use. SME 2 noted high energy savings, but kitchen misuse and burner modifications often negate efficiency gains. SME 3 found turbo pots ideal for slow cooking, but SME 5 pointed out that fin damage reduces efficiency over time. Adoption remains low, requiring education and proper burner settings to maximize benefits. A complete replacement would be too costly since most restaurants own multiple pans and pots. Gas savings potential is in question, as efficiency is highly dependent on usage habits and tracking energy savings is extremely difficult. So, no further testing of this equipment is recommended due to uncertain efficiency over time

Hydrogen Blend Natural Gas Compatible Equipment

SoCalGas along with three other California utilities, filed an application with the California Public Utilities Commission (CPUC) to develop a series of projects to demonstrate blending clean, renewable hydrogen into the natural gas system. This can also result in indirect reduction in consumption of natural gas. At the NAFEM conference, the Study Team met a California-based manufacturer who has started developing their product line to be compatible with hydrogen-blend natural gas. A hydrogen-blend natural gas-compatible product can be a potential GET Study topic as a market standard equipment would consume 100% natural, whereas these products would use a mixture of hydrogen and natural gas. This would result in indirect natural gas savings and reduce greenhouse gas emissions, improve air quality. The potential GET study would verify if the new equipment can provide the same level of service as the Hydrogen blend.

Hooded Broilers with Thermostat

SME 6 mentioned that two manufacturers introduced broilers with built-in hoods and thermostats, which had high gas-saving potential. However, discussions with one of the manufacturers at NAFEM revealed that the equipment was never granted a rebate, despite demonstrating energy savings. The rejection was because only two manufacturers produced this technology, and the utility required more manufacturers to offer similar equipment to prevent a monopoly before considering it for rebates.

Proposed Follow-work

The research and interviews on energy-efficient CFS equipment have provided a clear understanding of viable opportunities and limitations across different appliances. Key updates based on recent findings include:

- **Steam Tables**: Further work is **not recommended** due to market barriers, baseline issues, low customer interest, the lack of standardized test methods for custom steam tables, and previous CPUC rejection.
- **Infrared Salamander & Cheese melters**: While **potential savings exist**, manufacturer engagement remains low, and efficiency gains are minimal. A targeted study is recommended to evaluate sensor-based modulation and control features before further investments.
- **Steakhouse Broilers**: Due to their **high cost, niche market, and minimal efficiency improvements**, no further research should be pursued. The focus should shift to **widely adopted technologies** with greater industry impact.
- **Tilt Skillets**: These show **strong energy-saving potential** and market adoption. Further studies should focus on **lab and field testing, manufacturer collaboration, and targeted pilot programs in institutional kitchens**.
- **High-Efficiency Broilers**: Due to **high potential savings**, on-site field testing in real kitchens is recommended. Additional efforts should explore a **tiered rebate structure** and market development to enhance affordability and adoption.
- **Gas Fryers**: The potential for energy savings is **high**, making this a strong candidate for further work. **Lab testing based on ASTM standards is required before field testing**, and **a tiered rebate structure should be explored**.
- **Steam Kettles**: Future efforts should focus on **targeted applications**, such as replacing inefficient stock pots and improving burner insulation. **Developing standardized test methods** is crucial for validating energy savings.
- **High-Efficiency Woks**: Previous studies showed **operator resistance due to cooking performance changes**. A **comprehensive field study** is required to reassess new technologies, refine burner designs, and evaluate retrofitting options.
- **High-Efficiency Burners**: Despite **strong efficiency gains (35%-50%)**, past trials failed due to operational adjustments required by chefs. A new **field study should assess potential usability improvements** before reconsidering incentives.

- **Temperature Controls Retrofit**: No prior studies exist, but **recent industry interest suggests a strong opportunity**. Testing this retrofit across **multiple CFS appliances** could lead to **broad energy-saving applications**.

Conclusions

The California Statewide Gas Emerging Technologies (GET) Program has identified several high-efficiency gas-fired CFS equipment categories with strong potential for energy savings and incentive program integration. Through expert interviews, NAFEM observations, and industry research, this study has highlighted key equipment with high gas savings potential, including:

- **Tilt Skillets**: Their **versatility and widespread use in institutional kitchens** (schools, hospitals, catering operations) make them a prime candidate for **field testing and manufacturer collaboration** to refine energy-efficient designs.
- **Gas Fryers**: These fryers are highly adopted in fast-food chains, hotels, and commercial kitchens. They offer **significant efficiency gains** through **convection-based and MH burner technologies**. **ASTM-based lab testing** should validate these savings before field implementation and **tiered rebate programs**.
- **High-Efficiency Broilers**: These units present **notable energy savings and improved kitchen efficiency**, making them ideal for **on-site trials, incentive-based cost reductions, and market expansion initiatives**.

Moderate-priority technologies, such as **infrared salamanders, steam kettles, and high-efficiency woks**, require **targeted field studies** to determine real-world energy savings and overcome market barriers before incentives can be considered.

Conversely, **steakhouse broilers and custom steam tables** face **regulatory, cost, and market adoption challenges**, making them unsuitable for further research or incentive programs.

Emerging opportunities, such as **high-efficiency burners and temperature control retrofits**, could **impact multiple appliance categories**, but require **pilot testing** to quantify energy savings and assess market readiness.

Despite these promising technologies, common barriers persist across all equipment categories:

- **High Cost:** Many high-efficiency gas appliances are significantly more expensive than standard models, making it difficult for operators to justify the upfront investment.
- **Limited Market Acceptance**: Operators, particularly in independent restaurants, tend to resist changes due to concerns over cooking performance and reliability.
- **Lack of Equipment Efficiency Ranges**: Unlike electric alternatives, gas-fired appliances

do not have clear efficiency ratings, making it challenging to categorize products and create tiered incentives.

- **Testing Gaps & Standardization Challenges**: Many gas-fired equipment lacks industry-approved testing methodologies to verify energy savings, creating hurdles for rebate programs and regulatory acceptance.
- **Particle Emissions:** The matter is made more difficult by the possibility of a phase-out due to particle emissions limits from rules enforced by the South Coast Air Quality Management District.

Moving forward, the GET Program should focus on expanding lab and field-testing efforts, engaging manufacturers in efficiency validation, and developing standardized test procedures for high-potential equipment categories. By addressing market adoption challenges and refining efficiency benchmarks, this study can pave the way for scalable, real-world energy savings in California's commercial foodservice sector.

Appendix A – SME 1 Interview Notes

Interviewee(s) Names		Position
SME 1		Supervisor: Energy Efficiency WE&T (Foodservice)
Organization	**E-mail**	**Phone**
Hidden	Hidden	Hidden
Interview Date		1/31/2025

Introduction:

We are conducting these interviews to gather insights from subject matter experts on gas-fired appliances in the commercial food service sector. We aim to identify gas-fired measures/appliances that currently lack energy efficiency incentives from utilities in California. Your expertise will give us valuable insights into the current market challenges of introducing new incentives for gas-fired commercial kitchen equipment. This information will help inform future program development and strategies to enhance adoption.

Market Trends and Demand

1) Here is the list we have of gas-fired CFS equipment that does not have an energy efficiency incentive in California. Is there anything we are missing from this list?

There will never be an EE for appliances when there is no market need. For example, the demand for a Convection oven is driving EE possibilities. More efficiency is needed for better quality.
Big companies tend to push for EE where there is a large scale of customers looking for it.
Having an Energy Star should be a sign of market efficiency and performance in balance.
Customer Needs Performance: How quickly the food can be cooked from uncooked to ready to eat. and expects equal level of performance in multiple rounds.

CFS Measure	Energy Savings Potential [H/M/L]	Barriers to offer EE incentive	Comments
Custom Steam Tables	*Medium Priority*	*- Low-cost equipment; no market demand for EE versions* *- Customers prioritize affordability over efficiency*	*Extensively used, lunch buffet-style service.*

		- No prior incentives exist, making EE versions rare	
High-Efficiency Infrared Salamander Broiler (1)	*High*	*Traditionally inexpensive equipment and widely available but with Infrared Burner the Cost goes up.;* *Low demand for high-efficiency appliances.*	*Under counter broiler Measure package available, so add this to that measure* *Good potential, but cost barriers prevent wide adoption* *- Infrared broilers exist, but manufacturers struggle with high costs of components* *- a rebate program could help bridge the price gap easily available traditionally.*
High-Efficiency Cheese melter (1)	*High*	*Traditionally inexpensive.* *High Efficiency one $600-1200 dollars more expensive than the traditional one.* *Customer prefer cheaper readily available options*	*Same as above. It is Good for 2-3 years as TSB and TRC Standpoint but then it drops.* *Available spec sheet to check output Btus*
High-Efficiency Deck-Type Upright Broilers/Steakhouse Broilers	*Medium*	*Highly expensive and limited market size*	*No test method defined* *Some energy savings potential, but Low overall demand*
High Efficiency Tilt Skillet (2) –	*High*	*Lack of Manufacturer Interest and Investment for EE, The Market is resistant to switching from*	*People waiting on it* *No standard test method to access efficiency gain from tilt vs*

		Traditional skillets, Very expensive	*traditional, Maybe provide rebates to manufacturers to push them to develop better versions, High Volume Customers e.g. Hospitals, schools, hotels, universities*
Turbo Pot Finned Heat Exchanger	*Low*	*Highly expensive. Food service runs on a low margin, so no bandwidth is available for cost. Higher chances of it banging and damaging the product and returns*	*They need extra attention while cleaning to make sure the fins are cleaned and not blocked; not appreciated by the staff Requires Significant cost reductions to be widely accepted*
Synergy Grill Technology	*Medium*	*Heat distribution is good; gaps between the grates and the burner are high, resulting in a cooling effect through convection. Performance does not match traditional alternatives like infrared broilers in maintaining the heat - Requires specific use cases to justify adoption*	*Recently I tested. Highly efficient and well-made. It might affect performance over efficiency. Need to target specific customers or figure it out on performance levels.*
Smart Appliances	*Low*		*There are not a lot of options in gas. Options in electric appliances.*
High Efficiency Fryer	*High*	*High cost (E.g.: $28,000). Normal fryer is $ 3200-4800. Imported fryer 1200*	*One of the International Manufacturers, 50 pounds fired*

		Only large franchise businesses may justify the investment	*passed the Energy Star test. Waiting for 80 pounds results California-based fryers are on E.S. test today. price-sensitive Market makes it difficult to justify costs - Needs Significant price reduction to be viable*
High-Efficiency Wok	*Low*	*A limited set of customers. Hesitant to switch due to operational preferences - gas woks are deeply ingrained in restaurant operations - the cost of high-efficiency models is a deterrent*	*Talk about water usage reduction and tie-in with rebates.*
Steam Kettles	*Low (Medium maybe in manufacturing or industrial)*	*Primarily relevant for Institutional settings like hospitals, schools, and military bases - not widely adopted in commercial foodservice - high efficiency potential but requires further research and manufacturer engagement*	*No Commercial and but industrial sector potential. Soup manufacturer, meat and sausage manufacturer.*

- No incentives on reducing the usage/need of oil. Less emissions and reduce CHG.
Gas Wok: high in performance and cost-efficient with initial set up cost and running. Do manufacturers have customers ready to use?

2) On the list above, can you rank the energy savings potential of the equipment with low, medium, and high? If you don't know, what is the gap in knowledge that prevents you from answering?

3) On the list above, are there barriers you know of offering energy efficiency incentives for this equipment? Examples of barriers we know of are:

a) High first cost making an energy efficiency incentive inconsequential to equipment selection

b) Leased equipment meaning the leasing company makes the efficiency decisions rather than the customer

c) Lack of an ASTM test method to differentiate high efficiency and standard efficiency equipment.

d) Difficult to develop an ASTM test method to differentiate high efficiency and standard efficiency equipment.

e) Not large customer base/no need from customers.

f) Nomenclature; manufacturers sell similar tech. But their name and ad it differently. Convection ovens have different names under different companies. The function and the working principle are the same as a convection oven.

4) Are you observing any trends in the energy consumption or energy efficiency of gas-fired CFS equipment? For example, is gas-fired equipment getting more efficient, less efficient, staying the same? Does it depend upon the type of equipment or the manufacturer?
- National Brand– multi-million manuf. Lots of companies under there umbrella.
(California based): Focused on Energy efficiency
The labels are public or private depending on manuf. All the stuff on QPL. Frontier charge for testing.

5) What are the key factors driving demand for energy efficient gas-operated CFS equipment? What is the deciding factor to select between electric and natural gas equipment?
- Mom & pop Restaurant. It is preference; depends on legacy use case an availability of other options, availability of gas lines,
fear factors for policies/regulations come into factor for fully electric for big players.

6) What percent of CFS customers in California use Energy Star rated equipment? If you don't know about California specifically, do you know what percent nationwide use Energy Star-rated equipment?
- ES produces reported sales.

7) Are you aware of other rebate programs where a CFS owner would receive a higher incentive if they upgrade all their gas-fired systems to high-efficiency models, rather than upgrading only a portion of them?
Balance to gas and electric equipment. Look at all the equipment at the site.

Future Outlook

8) How do you see the role of gas-operated appliances evolving in the next 5–10 years?
Components need to be robust and cost efficient. E.g. Foam Insulation

9) Are there any emerging technologies or systems that you believe will significantly impact the gas appliance market? Like the High-Efficiency Deck-Type Upright Broilers or the High-Efficiency Tilt Skillet?
High/speed ovens hoodless ovens electric ovens have a high chance of disrupting the market due to space and efficiency. Function of the kitchen side.

10) Are there untapped opportunities for driving high efficiency CFS equipment with EE incentives? If so, could you list some specific equipment and potential barriers to providing an EE incentive?

11) Is there anything else you think we should know.

Optional Questions

Customer Thought Process

12) How educated are CFS customers regarding their gas usage and the efficiency of their equipment? Low, Medium or Highly educated?
60% of the restaurants aren't chain. The gas bill is the lowest of all the bills. Usually, the same across various sectors and markets.

13) How big of an influence are energy efficiency and sustainability in purchasing decisions for CFS equipment? Low, medium, high? Does it depend on the piece of equipment?

14) In general, are CFS customers aware of new and high-efficiency gas-fired equipment in the market which can reduce their operating costs and potentially cook a better product? (e.g., **high-efficiency tilt skillets**, **combination ovens, turbo pot heat exchangers or Synergy Grill Technology) ?**
- Customers are aware about. It is a reactive buy; when things break and need replacement

15) How do regional energy regulations and incentives impact the adoption of gas-operated versus electric appliances? Are electrification rebates causing customers to switch to electric CFS equipment?
- *People are talking about, goal should be GHG reduction and not electrification*.

Product Efficiency and Innovation

16) Are manufacturers in the industry adopting advanced technologies in their current line of products to reduce gas consumption? For example: Commercial gas Fryers using advanced immersion tube burners or automated smart *systems*

17) Are dealers and sellers pushing certain types of equipment due to their lower cost?
- *Yes ComED rebate*.

18) Are dealers and sellers pushing certain types of equipment due to their higher efficiency or EE incentives?

19) Are there any challenges in testing new high-efficiency CFS equipment due to customers' reluctancy to change their current workflow?

Gas Product Market Understanding

20) Are there specific appliance categories where gas still outperforms electric in terms of cost, performance, or reliability?

21) How do maintenance costs and lifespans compare between high-efficiency energy star rated gas systems and standard models?

22) Are there untapped opportunities for innovation in gas appliance technology that you believe the industry should focus on?

Appendix B – SME 2 Interview Notes

Interviewee(s) Names		Position
SME 2		Vice-President
Organization	E-mail	Phone
Hidden	Hidden	
Interview Date		02/06/2025

Introduction:

We are conducting these interviews to gather insights from subject matter experts on gas-fired appliances in the commercial food service sector. We aim to identify gas-fired measures/appliances that currently lack energy efficiency incentives from utilities in California. Your expertise will give us valuable insights into the current market challenges of introducing new incentives for gas-fired commercial kitchen equipment. This information will help inform future program development and strategies to enhance adoption.

Market Trends and Demand

1) Here is the list we have of gas-fired CFS equipment that does not have an energy efficiency incentive in California. Is there anything we are missing from this list?

CFS Measure	Energy Savings Potential [H/M/L]	Barriers to offer EE incentive	Comments
Custom Steam Tables	*Quite High for SoCal. Medium-Low for NorCal*	*3 manufacturers (2 major) for legacy equipment.* *The majority are electric equipment.* *Customers are usually from ethnic restaurants so Hard to Reach.* *The test method is an issue. (challenge to maintain the setting temperature as they do not have thermostats). This has been discussed in PGE and SoCal Gas.*	*Note: CPUC had rejected the previous measure for the custom Steam table. Reason and possibility to explore the appliance again.* *This is an early replacement measure. There are legacy units.* *CPUC was not happy with considering custom steam tables over legacy tables. And very*

			few field data and would like to have 10 sites.
High-Efficiency Infrared Salamander Broiler	*High*	*Untapped Market.* *No testing method (Frontier is working on it right now).* *Unknown Bandwidth for efficiency.* *Field Study: Mounted on wall or back so it is hard to monitor gas usage.*	*Grouped with Cheese melter and primary difference is infrared.* *Technology: They have a pressure sensor, to turn on and off when plates are placed.* *Different burner designs (blue and Radiant).* *ACC Project to preheat the air going into the pre-mix.* *Target: School, Catering Kitchen, Hospital.* *CEC study for advanced gas equipment for California restaurants.*
High-Efficiency Cheese melter	*High (lower than Broiler)*	*Combine with Broiler*	
High-Efficiency Deck-Type Upright Broilers/Steakhouse Broilers	*Low due to niche market.*	*Underfired is used instead and is used on the east coast to the west coast.* *Manufacturers don't have a dedicated engineering dept to test and provide the savings claim*	*Test Method available. (ASTM F2237) 2-3 units with lab data but no field data.* *Utilities across the USA offer rebates.*
High-Efficiency Tilt Skillet	*Medium (growing)*	*Tilt skillets have had innovations for electric in recent years.* *Expensive.*	*They are back in favor of kitchen design. High Volume usage institutional cost.*

		Field data (past data: very little usage; preference and new employee unwilling to adapt to it) *Schools biggest users but they have limited usage of hours so hard to justify or quantify savings*	*New built.* *There is a test method. F1786 Standard Test Method for Performance of Braising Pans. Can use operational data from electric skillet.*
Turbo Pot Finned Heat Exchanger	*It depends on the usability of the customer.*	*The customer would claim a rebate and not use the equipment.* *Huge swaps of pots can get overly expensive.* *Heat up too quickly and need learning.*	*ET study (maybe Navigant (2012)) for pots and a CEC study (2014) Old deemed measure and not sure about the measure package number.*
Synergy Grill Technology (XHP Chargrills)	*High (conditional to other use cases and cost)*	*Lower rate of adaption.* *Super expensive* *Need other moats (temperatures around the broilers, less cleaning) compared to standard broilers.* *Restricted sizes 36 and 48 inches. Some places would have 6 feet long.* *Does cook differently.*	*Demonstration: Its outcome has less heat in the kitchen and lower emissions due to less grease built up. His company would add an emission method.* *Food cooked quicker from ASTM test results.* *Possible lower labor cost to maintain.*
Smart Appliances	*Very Early (Low)*		*No product specific.*
High Efficiency Fryer	*Medium to High*	*Very Expensive* *Rebate tier 1 and 2 already present*	*We did not discuss this equipment in the SME interview, but a member of the study team met him at NAFEM and discussed it. The points here are*

			based on the conversation. New convection fryer have
High-Efficiency Wok + Water Less Wok	*Huge*	*Language and cultural practices. Lack of options*	*GTI did a prototype with a pre-mix burner that saves energy*
Steam Kettles	*Medium*	*The usage is in question and limited field data. The test method is a place used incredibly small data set* *The bandwidth of efficiencies or Steam kettles present in the market.*	*Note: The Highest market percentage is 3 gal and 40 gal. Super expensive. What would be a good rebate amount to push the customers and how big is Better for first-time buyers as replacing the existing Stock pot (50k kBtuH ANSI83.11 method for efficiency of ranges on different pots. ASTM single pot six but not same stock pot. Z2183 – more of*
Heat Exchanger for Pizza Deck	*Medium*	*Plumbing additional cost Use case of hot water*	*Adoption in the Pacific northwest capturing the waste heat out of the flue and using it to pre-heat water for domestic usage. Increase make-up temperature to 100+ This can be tested in the lab but it's hard to*

			verify in the field study. E.g. Manufacturer name hidden. No lab test, just a manufacturer Case study.
Gas Fired Dishwasher	*Medium*	*Baseline data is not available*	*(2) manufacturers. Replacing electric boosters with gas. Price to install twice but operational cost is 3 times lesser.*

- High efficiency burners Burner into different appliances
- Testing done on prototype burner and not a
- Field retrofit has an option of switching back to old burner. (Chinese restaurant chain option). Barriers to maintain same operational perspective.

2) On the list above, can you rank the energy savings potential of the equipment with low, medium, and high? If you don't know, what is the gap in knowledge that prevents you from answering?

3) On the list above, are there barriers you know of to offering energy efficiency incentives for this equipment? Examples of barriers we know of are:

a) High first cost making an energy efficiency incentive inconsequential to equipment selection

b) Leased equipment meaning the leasing company makes the efficiency decisions rather than the customer

c) Lack of an ASTM test method to differentiate high efficiency and standard efficiency equipment.

d) Difficult to develop an ASTM test method to differentiate high efficiency and standard efficiency equipment.

e) Not large customer base/no need from customer.

f) Nomenclature

4) Are you observing any trends in the energy consumption or energy efficiency of gas-fired CFS equipment? For example, is gas-fired equipment getting more efficient (Royal California Based manufacture), less efficient, staying the same? Does it depend upon the type of equipment or the manufacturer?

5) What are the key factors driving demand for energy efficient gas-operated CFS equipment? What is the deciding factor to select between electric and natural gas equipment?

6) What percent of CFS customers in California use Energy Star rated equipment? If you don't know about California specifically, do you know what percent nationwide use Energy Star-rated equipment?

7) Are you aware of other rebate programs where a CFS owner will receive a higher incentive if they upgrade all their gas-fired systems to high-efficiency models, rather than upgrading only a portion of them?

Future Outlook

8) How do you see the role of gas-operated appliances evolving in the next 5–10 years?

9) Are there any emerging technologies or systems that you believe will significantly impact the gas appliance market? Like the High-Efficiency Deck-Type Upright Broilers or the High-Efficiency Tilt Skillet?

10) Are there untapped opportunities for driving high efficiency CFS equipment with EE incentives? If so, could you list some specific equipment and potential barriers to providing an EE incentive?

11) Is there anything else you think we should know.

Optional Questions

Customer Thought Process

12) How educated are CFS customers regarding their gas usage and the efficiency of their equipment? Low, Medium or Highly educated?

13) How big of an influence are energy efficiency and sustainability in purchasing decisions for CFS equipment? Low, medium, high? Does it depend on the piece of equipment?

14) In general, are CFS customers aware of new and high-efficiency gas-fired equipment in the market which can reduce their operating costs and potentially cook a better product? (e.g., **high-efficiency tilt skillets**, **combination ovens, turbo pot heat exchangers or Synergy Grill Technology)?**

15) How do regional energy regulations and incentives impact the adoption of gas-operated versus electric appliances? Are electrification rebates causing customers to switch to electric CFS equipment?

Product Efficiency and Innovation

16) Are manufacturers in the industry adopting advanced technologies in their current line of products to reduce gas consumption? For example: Commercial gas Fryers using advanced immersion tube burners or automated smart systems

17) Are dealers and sellers pushing certain types of equipment due to their lower cost?

18) Are dealers and sellers pushing certain types of equipment due to their higher efficiency or EE incentives?

19) Are there any challenges in testing new high-efficiency CFS equipment due to customers' reluctancy to change their current workflow?

Gas Product Market Understanding

20) Are there specific appliance categories where gas still outperforms electric in terms of cost, performance, or reliability?

21) How do maintenance costs and lifespans compare between high-efficiency energy star rated gas systems and standard models?

22) Are there untapped opportunities for innovation in gas appliance technology that you believe the industry should focus on?

Appendix C – SME 3 Interview Notes

Interviewee(s) Names		Position
SME 3		Senior Staff Engineer
Organization	E-mail	Phone
Hidden	Hidden	Hidden
Interview Date		02/04/2025

Introduction:

We are conducting these interviews to gather insights from subject matter experts on gas-fired appliances in the commercial food service sector. We aim to identify gas-fired measures/appliances that currently lack energy efficiency incentives from utilities in California. Your expertise will give us valuable insights into the current market challenges of introducing new incentives for gas-fired commercial kitchen equipment. This information will help inform future program development and strategies to enhance adoption.

Market Trends and Demand

1) Here is the list we have of gas-fired CFS equipment that does not have an energy efficiency incentive in California. Is there anything we are missing from this list?

CFS Measure	Energy Savings Potential [H/M/L]	Barriers to offer EE incentive	Comments
Custom Steam Tables	*Low to Medium*	*Difficult to get savings, little to no data to test the custom steam table. No lab test is available for custom steam tables.* *Lab test need: Efficiency obtained, idle rate* *On-field study: hours of operation. Baseline determination (biggest hurdle).* *Not enough data for a range of efficiencies. To determine which is*	*SoCal Gas did a study and rejected it as the baseline was considered as custom. The follow-up was never finished.* *An alternate study for electric based was done last year. Had lab test by Edison and frontier. No standard measuring method.*

		high-efficiency category	
High-Efficiency Infrared Salamander Broiler	*High savings potential*	*No approved test method – SME 3 and the team working on the test method and are halfway there. Many of the broilers are Infrared burner fit already*	*Can add a thermostat to the system so that it does not run all the time. No manufacturer currently producing (lever turning gas on and off) Hidden named manufacturer was working on it. A demo device is present in some warehouses. Connect with the team at NAFEM*
High-Efficiency Cheese melter	*Same as above*		
High-Efficiency Deck-Type Upright Broilers/Steakhouse Broilers	*Medium to high*	*High Cost. $23k avg There is some data, SoCal Gas would have it (upright overfired broiler) The current system is 8k-10k.*	*Large, bulky appliances that use significant amounts of gas due to their design, which fire heat from both above and below. While they are likely to have high energy consumption, there is minimal available data on their efficiency.*
High Efficiency Tilt Skillet	*High Potential*	*Electric dominant (8 to 1). So, the current market size is small. National Brand (icombi) manufacturer. Electric skillet. Barriers to Adoption*	*Test method present. Need to find dealers to understand the market need The lack of sufficient test*

			data for gas tilt skillets suggested that future studies focus on usage profiles in schools, hospitals, and catering kitchens, where these appliances are more commonly used. Conducting a field study to collect real-world performance data would help validate efficiency claims
Turbo Pot Finned Heat Exchanger	*Low*	*Adaptation by the restaurant.*	*There was a rebate in the past and CPUC was hesitant on it. FE and SoCalGas have some white paper around. Use case: Carne roast and pasta restaurant. Turbo Port – only manufacturer.*
Synergy Grill Technology (XHP Chargrills)	*Low-medium (if multiple manufacturers come up)*	*It might end up with one manufacturer. Having the market share. $11k vs $900 to $10k*	*Already incentive in under fire broiler. Possibility to spilt measure package with higher efficiency. DO more market research on the need for the grill and justify the need of new tier. A new tier would affect the savings and rebate for Tier 1. In&Out, Fat*

			Burger, and Breweries are big buyers
Smart Appliances	*Unknown*	*Steep learning curve. California Based manufacturer had covered broiler, and the 24/7 restaurant would not accept it as*	*Radiant conveyor Toaster (electric) with huge savings. Need to push the manufacturer. To implement this system and the industry is also old school.*
High efficiency fryer	*High*	*Manufacturers were exploring technologies at industry expos, but they were not yet widespread in the commercial market*	*Almost present in the current energy star rated burner.* *Better options consist of better burner systems- Explore for multiple applications., (at NAFEM) – Promising efficiency the current fryers present introduced at NAFEM.*
High-Efficiency Wok	*High*		*Massive Opportunity. One burner Currently has 13-19% efficiency. They have the first manufacturer of the burner. To install their burner in the cooktop, two manufacturers were able to match it. They also have a 3-ring*

			wok design, which the Chinese food National brand did not pick up. The design efficiency is upwards of 30%. SoCalGas is working on it. We need a Lab test. Burners can be an easy retrofit measure. It is highly efficient that the same plug setting would have higher Btu output and higher temp. Maybe add a different orifice so the full blast output is the same BTU and temperature as before with lesser gas usage.
Steam Kettles	*High*	*No data available. There is an ASTM test method that needs to be explored. We don't have a baseline and savings. Very Expensive ($180K)*	*Found in an institution where huge amount of food is cooked. Prison, Crew ship, University.* *Range (2 gal to 200 gallon) testing would be needed to create a measure package. The most common sizes are 12 gal and 40 gal (30k-40k) (Manufacturer*

			names). We need significant rebates. Need to find the bandwidth of the efficiency. Present in the market. Testing can be hard as bulky and expensive. Field testing can be alternative.
Water Less Wok	*N/A*		*Testing waterless to see if they have less Btu than the current wok. Manuf. Town. A lot of them are overseas.*

- It is important to find the type of buyers to decide on the rebate. Avoid paying free money to big chains and tier 1 savings and rebates would be avoided.
- High Efficiency broiler has a much lower TRC, and SoCalGas is not worried about TRC. Programs are yet to fully transit to TSB. DNV (reviewer) would question doing the measure.
- Anything with TRC under that is gas, VEA (Viable Electric Alternative) and Phase out comes into picture and rebates for such measures are removed
- Provide Gift cards to the restaurants, customer to sweeten the deal.

2) On the list above, can you rank the energy savings potential of the equipment with low, medium, and high? If you don't know, what is the gap in knowledge that prevents you from answering?

3) On the list above, are there barriers you know of to offering energy efficiency incentives for this equipment? Examples of barriers we know of are:

a) High first cost making an energy efficiency incentive inconsequential to equipment selection

b) Leased equipment meaning the leasing company makes the efficiency decisions rather than the customer

c) Lack of an ASTM test method to differentiate high efficiency and standard efficiency equipment.

d) Difficult to develop an ASTM test method to differentiate high efficiency and standard efficiency equipment.

e) Not large customer base/no need from customer.

f) Nomenclature

4) Are you observing any trends in the energy consumption or energy efficiency of gas-fired CFS equipment? For example, is gas-fired equipment getting more efficient (Royal California Based manufacture), less efficient, staying the same? Does it depend upon the type of equipment or the manufacturer?

5) What are the key factors driving demand for energy efficient gas-operated CFS equipment? What is the deciding factor to select between electric and natural gas equipment?

6) What percent of CFS customers in California use Energy Star rated equipment? If you don't know about California specifically, do you know what percent nationwide use Energy Star-rated equipment?

7) Are you aware of other rebate programs where a CFS owner will receive a higher incentive if they upgrade all their gas-fired systems to high-efficiency models, rather than upgrading only a portion of them?

Future Outlook

8) How do you see the role of gas-operated appliances evolving in the next 5–10 years?

9) Are there any emerging technologies or systems that you believe will significantly impact the gas appliance market? Like the High-Efficiency Deck-Type Upright Broilers or the High-Efficiency Tilt Skillet?

10) Are there untapped opportunities for driving high efficiency CFS equipment with EE incentives? If so, could you list some specific equipment and potential barriers to providing an EE incentive?

11) Is there anything else you think we should know.

Optional Questions

Customer Thought Process

12) How educated are CFS customers regarding their gas usage and the efficiency of their equipment? Low, Medium or Highly educated?

13) How big of an influence are energy efficiency and sustainability in purchasing decisions for CFS equipment? Low, medium, high? Does it depend on the piece of equipment?

14) In general, are CFS customers aware of new and high-efficiency gas-fired equipment in the market which can reduce their operating costs and potentially cook a better product? (e.g., **high-efficiency tilt skillets**, **combination ovens, turbo pot heat exchangers or Synergy Grill Technology) ?**

15) How do regional energy regulations and incentives impact the adoption of gas-operated versus electric appliances? Are electrification rebates causing customers to switch to electric CFS equipment?

Product Efficiency and Innovation

16) Are manufacturers in the industry adopting advanced technologies in their current line of products to reduce gas consumption? For example: Commercial gas Fryers using advanced immersion tube burners or automated smart systems

17) Are dealers and sellers pushing certain types of equipment due to their lower cost?

18) Are dealers and sellers pushing certain types of equipment due to their higher efficiency or EE incentives?

19) Are there any challenges in testing new high-efficiency CFS equipment due to customers' reluctancy to change their current workflow?

Gas Product Market Understanding

20) Are there specific appliance categories where gas still outperforms electric in terms of cost, performance, or reliability?

21) How do maintenance costs and lifespans compare between high-efficiency energy star rated gas systems and standard models?

22) Are there untapped opportunities for innovation in gas appliance technology that you believe the industry should focus on?

Appendix D – SME 4 Interview Notes

Interviewee(s) Names		Position
SME 4		Foodservice Tech & Design Center Program Manager
Organization	**E-mail**	**Phone**
Hidden	Hidden	Hidden
Interview Date		02/07/2025

Introduction:

We are conducting these interviews to gather insights from subject matter experts on gas-fired appliances in the commercial food service sector. We aim to identify gas-fired measures/appliances that currently lack energy efficiency incentives from utilities in California. Your expertise will give us valuable insights into the current market challenges of introducing new incentives for gas-fired commercial kitchen equipment. This information will help inform future program development and strategies to enhance adoption.

Market Trends and Demand

1) Here is the list we have of gas-fired CFS equipment that does not have an energy efficiency incentive in California. Is there anything we are missing from this list?

CFS Measure	Energy Savings Potential [H/M/L]	Barriers to offer EE incentive	Comments
Custom Steam Tables	*Low*	*Convincing the operator to use. Use to reheat (even though it's not use case).* *Steam table are used with tops on so understanding end user is hard to understand.*	*Older Manufacturer ST or Custom Steam Table (Steel Manufacturer and add burner) switched to Steam Table manufacture by Duke Manufac. + APW Wyatt Burner better potential, smaller burner, individual pilot.* *Clear Path – Baseline old burners and not steam table.*
High-Efficiency Infrared Salamander Broiler Higher rank	*Low to Medium (to be determined)*	*Gas Broiler doesn't have a thermostatic setting and flame*	*Sal: Used to finish and cooking state, high temp and usage*

High-Efficiency Cheese melter		*adjustment as opposed to Electric. Not too many studies. Hard to figure out customer type*	*Cheese: Just used as a finishing High-end rest. And ethnic rest. Use them Maybe add door. No model avail. Currently Current market has metal mesh and ceramic majority. Maybe market broiler as an oven as broiler with a door.*
High-Efficiency Deck-Type Upright Broilers/Steakhouse Broilers	*Low*	*No current studies (gas or electric)*	*Maybe past studies but design have changed. It would have to be redesigned. Maybe fish restaurant. Use to grill them*
High Efficiency Tilt Skillet	*Medium to High*	*Expensive and new Acceptance and learning curve*	*More studies are coming up. Multiple manufacturers (better burners and insulation). Can potentially replace griddle. Use case – College University. The test case would be finalized by mid-year. Pressure braising pan (utilize as a griddle, a tilt skillet and essentially an instant pot to cook. Your braised meats at a faster rate.) Space saver. American restaurant chain has Tilt skillet High volume inst. Would use them. Maybe field study (Eric) and manuf.*

Turbo Pot Finned Heat Exchanger	*Low to Medium*	*Expensive than standard pots in the market*	*Break up the application the use case of turbo pot and test in various categories.* *Study done by SoCal Gas (2018) and Frontier.* *CEC study.* *Chipotle observed saving but hold off due to push electrification.* *20-30% Energy Savings and time.* *Check out turbo pot website for the chef study.*
Synergy Grill Technology (XHP Chargrills) (Very High on ranking)	*High*	*Double Cost.* *Educate and try it out for the customer.* *No other competitor to use this technology.*	*High heat reduction in the kitchen.* *The way that it cooks, the way that it holds the heat.* *The installation on it is.* *No cold spots 36 inch at 54,000 Btu compared to 90-120 kBtuH* *Good at holding heat and flare ups minimal*
High-Efficiency Wok + Water Less Wok	*Low to Medium (high energy output units)*	*Cost to acquire them for testing.* *Adoption : Customers would have to see some cost savings (rebate) + water at purchase.* *Focused group of restaurants.*	*GTI Study on Forced Air Wok (2012-13),* *The manufacturers see water savings but not on energy savings, the cost is higher due to insulation core. Sand and Ceramic. The savings would be the type of burners. High efficiency burner (Concerns reliability and functionality)* *. At NAFEM have a mesh/power burner.*

			Panda works with Frontier (some barrier) *Range tops + griddle plate can be considered as wok burner.* *Test method available F26.*
Steam Kettles	*Medium to High (range top or stock pot replacement)* *Low (stock kettles 40years +)*	*Steam Kettles (jacket) have a temperature range lower than Range top.* *Target customer: high volume usage.* *Ideal size 10-40 gallon* *100+ high volume places, soup houses or broth based.* *High cost.*	*Stock Pots: Are used for Pot cooking* *Range Top: Used for searing.* *There is a rough testing method. The efficiency maybe more or less the same due to similar working ideology.* *The burners insulation can increase the Efficiency.* *They are used on/off.* *20-30% market use it for long time.* *Cook time is reduced hence the savings.*
Water Heat Exchanger for Pizza Deck	*Low* *good if the ovens are redesigned for capturing the heat emitted.*	*Would need custom design based on the site and restaurant.* *Plumbing (dishwasher) system*	*Low interest.*
Gas Fired Dishwasher (Booster)	*Medium to high savings.*	*Insulation is challenging as exhaust.*	*Two Manuf. for Gas booster. Recently upgraded burner and insulation.* *Manuf. : Looking to push new Natural Gas dishwasher.* *Better heat output and easier to maintain as opposed electric.* *The gas booster has capacity to meet instantaneous higher hot water requirement.*

Smart Appliances			*No successful attempt yet.*
Power/Infrared Burner Multi-Deck Pizza ovens ()	*Medium to High*	*Need approval and finding for it.*	*There is a manufacture. Who might be interested in doing it. Better heat recovery, low Btu. Eric would be aware of potential proposal submitted to test this tech. (April 2023). Test method Available*

2) On the list above, can you rank the energy savings potential of the equipment with low, medium, and high? If you don't know, what is the gap in knowledge that prevents you from answering?

3) On the list above, are there barriers you know of to offering energy efficiency incentives for this equipment? Examples of barriers we know of are:

a) High first cost making an energy efficiency incentive inconsequential to equipment selection

b) Leased equipment meaning the leasing company makes the efficiency decisions rather than the customer

c) Lack of an ASTM test method to differentiate high efficiency and standard efficiency equipment.

d) Difficult to develop an ASTM test method to differentiate high efficiency and standard efficiency equipment.

e) Not large customer base/no need from customer.

f) Nomenclature

4) Are you observing any trends in the energy consumption or energy efficiency of gas-fired CFS equipment? For example, is gas-fired equipment getting more efficient (Royal California Based manufacture), less efficient, staying the same? Does it depend upon the type of equipment or the manufacturer?

5) What are the key factors driving demand for energy efficient gas-operated CFS equipment? What is the deciding factor to select between electric and natural gas equipment?

6) What percent of CFS customers in California use Energy Star rated equipment? If you don't know about California specifically, do you know what percent nationwide use Energy Star-rated equipment?

7) Are you aware of other rebate programs where a CFS owner will receive a higher incentive if they upgrade all their gas-fired systems to high-efficiency models, rather than upgrading only a portion of them?

Future Outlook

8) How do you see the role of gas-operated appliances evolving in the next 5–10 years?

9) Are there any emerging technologies or systems that you believe will significantly impact the gas appliance market? Like the High-Efficiency Deck-Type Upright Broilers or the High-Efficiency Tilt Skillet?

10) Are there untapped opportunities for driving high efficiency CFS equipment with EE incentives? If so, could you list some specific equipment and potential barriers to providing an EE incentive?

11) Is there anything else you think we should know.

Optional Questions

Customer Thought Process

12) How educated are CFS customers regarding their gas usage and the efficiency of their equipment? Low, Medium or Highly educated?

13) How big of an influence are energy efficiency and sustainability in purchasing decisions for CFS equipment? Low, medium, high? Does it depend on the piece of equipment?

14) In general, are CFS customers aware of new and high-efficiency gas-fired equipment in the market which can reduce their operating costs and potentially cook a better product? (e.g.,

high-efficiency tilt skillets, combination ovens, turbo pot heat exchangers or Synergy Grill Technology)?

15) How do regional energy regulations and incentives impact the adoption of gas-operated versus electric appliances? Are electrification rebates causing customers to switch to electric CFS equipment?

Product Efficiency and Innovation

16) Are manufacturers in the industry adopting advanced technologies in their current line of products to reduce gas consumption? For example: Commercial gas Fryers using advanced immersion tube burners or automated smart systems

17) Are dealers and sellers pushing certain types of equipment due to their lower cost?

18) Are dealers and sellers pushing certain types of equipment due to their higher efficiency or EE incentives?

19) Are there any challenges in testing new high-efficiency CFS equipment due to customers' reluctancy to change their current workflow?

Gas Product Market Understanding

20) Are there specific appliance categories where gas still outperforms electric in terms of cost, performance, or reliability?

21) How do maintenance costs and lifespans compare between high-efficiency energy star rated gas systems and standard models?

22) Are there untapped opportunities for innovation in gas appliance technology that you believe the industry should focus on?

Appendix E – SME 5 Interview Notes

Interviewee(s) Names		Position
SME 5		Commercial Food Service Industry Specialist
Organization	**E-mail**	**Phone**
Hidden	Hidden	Hidden
Interview Date		02/13/2025

Introduction:

We are conducting these interviews to gather insights from subject matter experts on gas-fired appliances in the commercial food service sector. We aim to identify gas-fired measures/appliances that currently lack energy efficiency incentives from utilities in California. Your expertise will give us valuable insights into the current market challenges of introducing new incentives for gas-fired commercial kitchen equipment. This information will help inform future program development and strategies to enhance adoption.

Market Trends and Demand

1) Here is the list we have of gas-fired CFS equipment that does not have an energy efficiency incentive in California. Is there anything we are missing from this list?

CFS Measure	Energy Savings Potential [H/M/L]	Barriers to offer EE incentive	Comments
Custom Steam Tables	*Not sure (not seen performance)*	*Competition with electrification*	*Biggest market in Southern California by Distributor (Reno).*
High-Efficiency Infrared Salamander Broiler	*Low*	*The efficiency range is small*	*They are mainly the same. Inefficient as they are open. The oven the high temp and door can do same thing.*
High-Efficiency Cheese melter			
High-Efficiency Deck-Type Upright Broilers/Steakhouse Broilers - Deck OVENs	*Not sure*		*IT is probably a deck oven. Deck term refers to flat ceramic or stone based. Testing method available for electric and gas ovens. Development by*

			Frontier and PG&E and current measure package available in the eTRM.
High Efficiency Tilt Skillet	*Medium*	*Niche market; needs a high volume of meals, likes universities and prison.* *Hours of operation depend on the menu or demand.*	*Opportunity in electric. – new manuf. In France – showcase in NRA show in Chicago in May.* *Performance data observed in Electric and good savings. The test method is available* *Reach out to manufac. For info on Effi.*
Turbo Pot Finned Heat Exchanger	*Medium to High (as New)* *M to L (worn)*	*Fins can be dinged, and the level of operation cannot be same.*	*Performance data available vs aluminum or steel – Testing firm did not approach it as it the vessel and not the main energy consumer.*
Synergy Grill Technology (XHP Chargrills)	*Low*	*Expensive*	*Few manufacturers have explored high-efficiency designs, and a lack of test data makes it difficult to quantify savings.*
High-Efficiency Wok +	*No comment as have not seen data*		*Performance data maybe available.* *Waterless wok would probably be electric.*
Steam Kettles	*Medium*		*Maybe Similar to a Tilt skillet.* *Universal. Prepare large volumes of food.*
Power/Infrared Burner Multi-Deck Pizza ovens Conveyor Ovens	*Medium to High*	*Not a big category.*	*There are differential terms of efficiency.* *Pepperoni Theory; impingement sucks it.*

Water Heat Exchanger for Pizza Deck			*Test methodology is not available or to verify claims*
Gas Fired Dishwasher (Booster)	*Low*	*Very niche category*	*The savings might not be high not*
Smart Appliances			*Maybe Thermostatic Griddles. Combination ovens. Low into Eco mode or energy save modes.*

2) On the list above, can you rank the energy savings potential of the equipment with low, medium, and high? If you don't know, what is the gap in knowledge that prevents you from answering?

3) On the list above, are there barriers you know of to offering energy efficiency incentives for this equipment? Examples of barriers we know of are:

a) High first cost making an energy efficiency incentive inconsequential to equipment selection

b) Leased equipment meaning the leasing company makes the efficiency decisions rather than the customer

c) Lack of an ASTM test method to differentiate high efficiency and standard efficiency equipment.

d) Difficult to develop an ASTM test method to differentiate high efficiency and standard efficiency equipment.

e) Not large customer base/no need from customer.

f) Nomenclature

4) Are you observing any trends in the energy consumption or energy efficiency of gas-fired CFS equipment? For example, is gas-fired equipment getting more efficient (Royal California Based manufacture), less efficient, staying the same? Does it depend upon the type of equipment or the manufacturer?

5) What are the key factors driving demand for energy efficient gas-operated CFS equipment? What is the deciding factor to select between electric and natural gas equipment?

6) What percent of CFS customers in California use Energy Star rated equipment? If you don't know about California specifically, do you know what percent nationwide use Energy Star-rated equipment?

7) Are you aware of other rebate programs where a CFS owner will receive a higher incentive if they upgrade all their gas-fired systems to high-efficiency models, rather than upgrading only a portion of them?

Future Outlook

8) How do you see the role of gas-operated appliances evolving in the next 5–10 years?

9) Are there any emerging technologies or systems that you believe will significantly impact the gas appliance market? Like the High-Efficiency Deck-Type Upright Broilers or the High-Efficiency Tilt Skillet?

10) Are there untapped opportunities for driving high efficiency CFS equipment with EE incentives? If so, could you list some specific equipment and potential barriers to providing an EE incentive?

11) Is there anything else you think we should know.

Optional Questions

Customer Thought Process

12) How educated are CFS customers regarding their gas usage and the efficiency of their equipment? Low, Medium or Highly educated?

13) How big of an influence are energy efficiency and sustainability in purchasing decisions for CFS equipment? Low, medium, high? Does it depend on the piece of equipment?

14) In general, are CFS customers aware of new and high-efficiency gas-fired equipment in the market which can reduce their operating costs and potentially cook a better product? (e.g.,

high-efficiency tilt skillets, combination ovens, turbo pot heat exchangers or Synergy Grill Technology) ?

15) How do regional energy regulations and incentives impact the adoption of gas-operated versus electric appliances? Are electrification rebates causing customers to switch to electric CFS equipment?

Product Efficiency and Innovation

16) Are manufacturers in the industry adopting advanced technologies in their current line of products to reduce gas consumption? For example: Commercial gas Fryers using advanced immersion tube burners or automated smart systems

17) Are dealers and sellers pushing certain types of equipment due to their lower cost?

18) Are dealers and sellers pushing certain types of equipment due to their higher efficiency or EE incentives?

19) Are there any challenges in testing new high-efficiency CFS equipment due to customers' reluctancy to change their current workflow?

Gas Product Market Understanding

20) Are there specific appliance categories where gas still outperforms electric in terms of cost, performance, or reliability?

21) How do maintenance costs and lifespans compare between high-efficiency energy star rated gas systems and standard models?

22) Are there untapped opportunities for innovation in gas appliance technology that you believe the industry should focus on?

Appendix F – SME 6 Interview Notes

Interviewee(s) Names		Position
SME 6		Institute Engineer II – Program Manager
Organization	E-mail	Phone
Hidden	Hidden	Hidden
Interview Date		02/21/2025

Introduction:

We are conducting these interviews to gather insights from subject matter experts on gas-fired appliances in the commercial food service sector. We aim to identify gas-fired measures/appliances that currently lack energy efficiency incentives from utilities in California. Your expertise will give us valuable insights into the current market challenges of introducing new incentives for gas-fired commercial kitchen equipment. This information will help inform future program development and strategies to enhance adoption.

Market Trends and Demand

1) Here is the list we have of gas-fired CFS equipment that does not have an energy efficiency incentive in California. Is there anything we are missing from this list?

CFS Measure	Energy Savings Potential [H/M/L]	Barriers to offer EE incentive	Comments
Custom Steam Tables	*High potential to improve. Low potential.*	*Small population of units that are efficient.*	*They are trending, customize hot Cold table probably electric. IT can be combination of gas and electric. Low technology progress. ASTM testing available*
High-Efficiency Infrared Salamander Broiler	*Low – Not a big energy user.*	*Small range of efficiencies. Need more study or results*	*Infrared Burner is the difference point. Need more data to compare.*
High-Efficiency Cheese melter			
High-Efficiency Deck-Type Upright Broilers/Steakhouse Broilers	*High – Niche market*	*They can be phased out due to emission. The particulate matter grease smoke little bits of things. Standard grill can be*	*High Energy Users. Good range of low and high efficient. Test method already present. They are expensive,*

		alternative. *Niche market.*	*but the alternatives are not that cheap.*
High Efficiency Tilt Skillet	*Medium to High.*	*Maybe more expensive.* *Combi oven when introduced; the adaptability would be issue so would skillet.* *Would need demos.*	*IT can replace a lot of appliances; Tilt Skillet manufacturer was awarded an innovation award. It is not a common appliance; people are not aware about it.* *Schools and Institutes, army, soup or gravies high volume food cooked.*
Turbo Pot Finned Heat Exchanger	*Very High. (30% efficiency)*	*Handling and sauting as heavy.* *expensive.*	*CEC report with Frontier.*
Synergy Grill Technology (XHP Chargrills)	*Medium*	*Cooking Performance might be barrier.*	*Not too expensive. It can be used in many places as grills.*
High-Efficiency Wok + Water Less Wok	*Medium to High*	*Cooking performance, convincing the customer.* *Too Expensive.*	*Big market and water savings are high. CEC study down.* *3-month payback*
Steam Kettles	*Medium(when replacing other appliance e.g. Stock Pot)* *Not sure about High Steam Kettle replacing less efficient Steam Kettle*	*Need more data of savings vs non efficient*	*Institutions usage/ Energy Savings is obtained by replacing other appliance* *Stock pot can be replaced but sauting can't be done*
Water Heat Exchanger for Pizza Deck		*Very tricky implementation.*	*More information need. Very early.* *They might exist. SME 3 might know.*
Gas Fired Dishwasher (Booster)	*High*	*Cost of the machine.*	*UTD study high at GTI. Chemical cleaning is reduced.*

Smart Appliances			*Pizza oven – Ideas. Lots of talks. Not mature idea.*
Power/Infrared Burner Multi-Deck Pizza ovens			*They are established but the range of efficiency. And testing needs to done to find out the savings potential and barrier.*
Commercial gas Fryers using advanced High-Production Fryers	*Medium to High.*	*Expensive. (2x-3x)*	*High labor and gas savings.*
Pilotless Ranges	*High*	*Adaption and Behavior*	*CEC study with study with Frontier*
Hooded Broilers with Thermostat		*Adaption and Behavior*	*(2) manufacturer made one but never took*
High-Efficiency Smart Convection Oven		*Getting a manuf. Partner, No incentive so*	*A prototype convention. There may be some manufacturer. Make the energy star oven more efficient.*

2) On the list above, can you rank the energy savings potential of the equipment with low, medium, and high? If you don't know, what is the gap in knowledge that prevents you from answering?

3) On the list above, are there barriers you know of to offering energy efficiency incentives for this equipment? Examples of barriers we know of are:

a) High first cost making an energy efficiency incentive inconsequential to equipment selection

b) Leased equipment meaning the leasing company makes the efficiency decisions rather than the customer

c) Lack of an ASTM test method to differentiate high efficiency and standard efficiency equipment.

d) Difficult to develop an ASTM test method to differentiate high efficiency and standard efficiency equipment.

e) Not large customer base/no need from customer.

f) Nomenclature

4) Are you observing any trends in the energy consumption or energy efficiency of gas-fired CFS equipment? For example, is gas-fired equipment getting more efficient (Royal California Based manufacture), less efficient, staying the same? Does it depend upon the type of equipment or the manufacturer?

5) What are the key factors driving demand for energy efficient gas-operated CFS equipment? What is the deciding factor to select between electric and natural gas equipment?

6) What percent of CFS customers in California use Energy Star rated equipment? If you don't know about California specifically, do you know what percent nationwide use Energy Star-rated equipment?

7) Are you aware of other rebate programs where a CFS owner will receive a higher incentive if they upgrade all their gas-fired systems to high-efficiency models, rather than upgrading only a portion of them?

Future Outlook

8) How do you see the role of gas-operated appliances evolving in the next 5–10 years?

9) Are there any emerging technologies or systems that you believe will significantly impact the gas appliance market? Like the High-Efficiency Deck-Type Upright Broilers or the High-Efficiency Tilt Skillet?

10) Are there untapped opportunities for driving high efficiency CFS equipment with EE incentives? If so, could you list some specific equipment and potential barriers to providing an EE incentive?

11) Is there anything else you think we should know.

Optional Questions

Customer Thought Process

12) How educated are CFS customers regarding their gas usage and the efficiency of their equipment? Low, Medium or Highly educated?

13) How big of an influence are energy efficiency and sustainability in purchasing decisions for CFS equipment? Low, medium, high? Does it depend on the piece of equipment?

14) In general, are CFS customers aware of new and high-efficiency gas-fired equipment in the market which can reduce their operating costs and potentially cook a better product? (e.g., **high-efficiency tilt skillets**, **combination ovens, turbo pot heat exchangers or Synergy Grill Technology) ?**

15) How do regional energy regulations and incentives impact the adoption of gas-operated versus electric appliances? Are electrification rebates causing customers to switch to electric CFS equipment?

Product Efficiency and Innovation

16) Are manufacturers in the industry adopting advanced technologies in their current line of products to reduce gas consumption? For example: Commercial gas Fryers using advanced immersion tube burners or automated smart systems

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19) Are there any challenges in testing new high-efficiency CFS equipment due to customers' reluctancy to change their current workflow?

Gas Product Market Understanding

20) Are there specific appliance categories where gas still outperforms electric in terms of cost, performance, or reliability?

21) How do maintenance costs and lifespans compare between high-efficiency energy star rated gas systems and standard models?

22) Are there untapped opportunities for innovation in gas appliance technology that you believe the industry should focus on?

References

[1] SWFS024-01_DryWellSteamTable_08-25-2021_Disposition
[2] SCGAT211301A VT Burner Wok Testing
[3] SCGAT202212A Normal Burner Wok Testing
[4] Wok Burner Improvements and Testing Final Report," GTI Project No. 2057
[5] (Steam Table Technology Assessment and Gas Energy Savings Demonstration, Frontier Energy Report # 50174.000-R0, July 2020).