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Additional submitted attachment is included below.

Commercial Steam Cookers

Codes and Standards Enhancement (CASE) Initiative

For PY 2024: Title 20 Standards Development

Analysis of Standards Proposal for

Commercial Steam Cookers

CEC Docket Number 23-AAER-01

May 21, 2024 DRAFT

Prepared for:

Pacific Gas and Electric Company® SDGE™ SOUTHERN CALIFORNIA EDISON® Energy for What's Ahead®

Prepared by:

George Chapman, Energy Solutions
Denis Livchak, Synergy-NRG
Grant Kelley, Energy Solutions
Rezvan Mohammadiziazi, Energy Solutions
Sean Steffensen, Energy Solutions
Tobyn Smith, Energy Solutions
Helen Davis, Energy Solutions

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1. Executive Summary

1.1. CASE Team Proposal Objective

The Codes and Standards Enhancement (CASE) Team, herein referred to as the CASE Team, presents recommendations to support the California Energy Commission's (CEC) efforts to update California's Appliance Efficiency Regulations (Title 20). Three California Investor-Owned Utilities (IOUs), Pacific Gas and Electric Company, San Diego Gas and Electric, and Southern California Edison sponsored this effort. The program prepares and submits proposals for cost-effective enhancements to improve the energy and water efficiency of appliances sold in California. The CASE Report provides a technical and cost-effective analysis of the standards for commercial steamer appliances.

The CEC will evaluate proposals submitted by the CASE Team and other stakeholders. They may choose to revise or reject these proposals. For more information about the rulemaking schedule and how to participate in the process, see the CEC's Appliance Efficiency Regulations – Title 20 website.

Sections 2 through 10 of this report cover the proposed appliance standards for commercial steamers and the supporting analysis. Section 11 responds to the questions in the Request for Information docketed by the CEC on November 14, 2023 (California Energy Commission 2023).

1.2. Commercial Steamer Types

Commercial steamers are appliances designed to cook various food products quickly and efficiently. Typically found in restaurants, hotels, cafeterias, and other foodservice locations, these devices handle large quantities of food over extended periods. While officially labeled as "steam cookers," they are commonly referred to as "steamers" by manufacturers and industry stakeholders. The CASE Team uses steamers throughout the report to describe these appliances.

Commercial steamers have two categories: atmospheric steam cookers, or "pressureless steam cookers," and pressure steam cookers. Atmospheric steam cookers heat water to generate steam at 212°F to cook food products. These steamers are praised for their adaptability and versatility in diverse commercial kitchen environments because they cook various food products rapidly and evenly. Pressure steam cookers superheat water to produce steam, reaching up to 250°F. This high heat enables quicker cooking of dense food products, such as pasta or large cuts of meat. The least common steamer heating technology is direct steam, typically used by large institutional settings like universities and hospitals, and relies on built-in steam systems to heat food products.

The commercial steamer classification has a category specific to atmospheric steam cookers, which can be subcategorized into boilerless and steam generator steamers. Boilerless steamers produce steam within the cooking cavity instead of inside a boiler or steamer. Steam generator products have a built-in steam boiler or generator that swiftly delivers high temperatures with quick recovery times.

Figure 1: Steam Generator Atmospheric Steamer (Left) and Pressure Steamer (Right)

Source: https://www.gofoodservice.com/p/market-forge-etp-10g (left), https://www.katom.com/learning-center/steamers-buyers-guide.html (right)

1.3. CASE Team Proposed Standards

The CASE Team proposes performance standards for most commercial steamers, including steam generator and boilerless product classes. The CASE Team recommends exempting certain product classes, such as pressure steamers, from standards due to the lack of available performance data to establish appropriate standard levels without compromising consumer utility. The CASE Team recommends test-and-list requirements for gas and electric pressure steamers and vacuum steamers to support consumer choice and provide the opportunity for future performance standards.

Specifically, the CASE Team proposes the scope and definitions aligned with the U.S. Environmental Protection Agency (US EPA) ENERGY STAR® Commercial Steam Cooker Specification V1.2 to provide a well-understood and consensus-based description. The CASE Team proposes adopting the most recent American Society for Testing and Materials (ASTM) test procedures, aligning them with the ENERGY STAR Specification, and ensuring performance levels are consistent with the ENERGY STAR Commercial Steam Cooker Specification V1.2 to harmonize with standards adopted by other states.

The proposed standards and the test-and-list requirements address water use, cooking energy, and idle energy for all product classes. This proposal covers products powered by electricity, natural gas, and propane. It includes definitions for multiple product classes, reflecting the diversity of commercial steam-cooking applications. Furthermore, the test procedures are grounded in those developed by the industry.

The following products would not be subject to the proposed standards or the test-and-list requirement:

- Steamers with less than three pans or using non-standard pan sizes.
- Steamers utilizing direct steam.
- Combination ovens.

- Humidified holding cabinets, steam kettles, and cook-and-holds.

Commercial steamers within the proposal's scope would be required to comply with existing CEC certification and marking requirements. Although the requirements are similar, participation in the ENERGY STAR program is not mandatory for compliance.

The proposed effective date is March 1, 2026, allowing sufficient time for pre-rulemaking and rulemaking activities and complying with the one-year required by California statute between adoption and effective dates.

1.4. Market Analysis

The CASE Team studied commercial steamers in the California marketplace and engaged in discussions with manufacturers and industry representatives. The CASE Team presents the results to demonstrate that the proposed standards are technically feasible.

The CASE Team reviewed the V1.2 ENERGY STAR qualified products list and the State Appliance Standards Database (SASD) to assess the availability of existing products from various manufacturers that comply with the proposed standards. Currently, ENERGY STAR estimates that V1.2 qualifying products represent 39% of the market for all steamer sales. Additionally, nine manufacturers make products recognized under the V1.2 criteria, representing most commercial steamer manufacturers and most steamer sales. The CASE Team concludes that the proposed standards would not cause any loss of consumer utility.

A significant factor influencing the adoption of these standards is that consumers might choose combination ovens as an alternative to meet their steam cooking needs. A combination oven has three different cooking modes in one appliance: convection, steam, and combination, i.e., convection and steam. This feature enables greater versatility in the kitchen, accommodating steaming, baking, stewing, and other cooking methods within a single appliance. The CASE Team estimates the market adoption rate for ENERGY STAR-certified combination ovens exceeds 70%. While consumer preference may drive the steam cooking market toward combination ovens, the CASE Team is confident the proposed standards are unlikely to accelerate this industry trend.

1.5. Per Unit Water and Energy Savings

The CASE Team used information from the California Electronic Technical Reference Manual (eTRM) to develop the appropriate inputs for the different types of steamers, including the number of operational days, operational hours per day, cooking efficiency, pounds of food cooked per day, and ASTM energy to food. Assumptions for preheating time and energy, idle energy rate, cooking efficiency, cooking water consumption, and idle water consumption vary from baseline to energy efficiency models. The CASE Team conducted the analysis using the widely adopted six-pan model.

The CASE Team calculated annual energy and water savings for a single-compartment four- to six-pan boilerless countertop unit or a freestanding six- to ten-pan dual-compartment steam generator unit. The table below presents the per unit energy savings by product class of commercial steamers.

Table 1 Annual Per Unit Water and Energy Savings

Product Class	Per unit savings Electricity (kWh/yr-unit)	Per unit savings Natural gas (therm/yr-unit)	Per unit savings Water (gal/yr-unit)
Electric Boilerless	4,358	-	6,257
Electric Steam Generator	4,811	-	15,377
Gas Boilerless	-	395	2,152
Gas Steam Generator	-	790	65,443

1.6. Cost Effectiveness

The CASE Team calculated the effectiveness and potential effects on consumers by comparing the benefits and costs of the proposed standards. All steamers studied by the CASE Team were assumed to have a 12-year useful life. The proposed standards are cost effective for steamers with electric or gas steam generators, as confirmed by the lifecycle benefit-cost ratio being greater than one for both product classes. The table below does not calculate paybacks or benefit-cost ratios for boilerless products due to the lack of incremental cost data. Efficient unit without a water connection have lower averaging costs and are inherently cost-effective. Electric and gas boilerless products are typically more efficient than steam generators because they generate steam directly in the cooking compartment. As a result, these units are less complex with less internal parts, thereby more affordable and cost-effective choice for consumers.

Table 2 Per Unit Lifetime Economic Impacts for Products Purchased in the First Year

Product Class	Design Life (years)	Present Value of Benefits (2024$)	Present Value of Incremental Costs (2024 $)	Net Present Value (2024 $)	Simple Payback Period (years)	Lifecycle Benefit-Cost Ratio
Electric Boilerless	12	13,372.10	-	13,372.10	-	Infinite
Electric Steam Generator	12	14,698.61	3,024.00	11,674.61	1.98	4.86
Gas Boilerless	12	9,604.18	-	9,604.18	-	Infinite

Product Class	Design Life (years)	Present Value of Benefits (2024$)	Present Value of Incremental Costs (2024 $)	Net Present Value (2024 $)	Simple Payback Period (years)	Lifecycle Benefit-Cost Ratio
Gas Steam Generator	12	17,228.29	805.00	16,423.29	0.45	21.40

1.7. Statewide Impacts

The CASE Team estimates 1,862 commercial steamer shipments to California annually. The CASE Team determined the number of units shipped for each product category using the CEC's total California inventory multiplied by the market share percentage of each product class. National American Association of Food Manufacturers (NAFEM) data analysis indicates that 55% of steamers sold in the US are boilerless, and the remaining 45% are steam generators (NAFEM 2002). The CASE Team assumes that the proportion of steam generator steamers to boilerless steamers is the same in California as it is nationally.

Commercial steamers meeting the proposed standards are widely available. The proposed standards do not pose any significant barriers to manufacturing compliant equipment as most manufacturers make both baseline and compliant equipment.

The proposed standards would result in a first-year statewide savings of 3.49 gigawatt hours (GWh) of electricity, 0.21 million therms of natural gas, and 19.32 million gallons of water. The statewide savings, which vary based on product class, are estimated to be 41.92 GWh of electricity, 2.55 million therms of natural gas, and 231.84 million gallons of water after a complete stock turnover that will not occur until 2038.

Table 3 Estimated California Statewide Savings in the Year of Stock Turnover

	Year of Stock Turnover	Electricity (GWh/yr)	Natural Gas (million therms/yr)	Water (million gallons/yr)	GHG Emissions (MT CO2e/yr)	Utility Bill Savings (million 2024 $/yr)
TOTAL	2038	41.92	2.55	231.84	19,077.07	11.58

The CASE Team calculated the embedded energy savings (savings from reduced water use) using the indoor energy factor of 5,440 kWh/million gallons of water included in Appendix A. With water savings of 232 million gallons per year at complete stock turnover, the embedded energy savings would be 1.3 GWh/yr. The incremental capital costs in the first full year of implementation are $0.4 million, and utility bill savings in the first year are $0.8 million.

2. Introduction

Manufacturers and industry stakeholders commonly refer to these appliances as steamers, although they are officially known as steam cookers. Restaurants, hotels, cafeterias, and other establishments serving large quantities of food use commercial steamers to cook vegetables, rice, potatoes, and seafood quickly. These products can consume substantial amounts of water and energy to reach the temperature required for steam cooking. Steamers are supplied with cold water, eliminating indirect energy usage from water heating equipment. Connectionless steamers are not attached to the building water or sewer system and require manual water filling. Steamers generate steam through two ways: heating water above 212˚F in the bottom of the cooking compartment, or heating water in a separate compartment and then injecting steam into the cooking cavity. Products providing the most speed and largest volumes rely on pressurized steam. Steamers vary in water consumption and intended use based on design and technology and serve diverse purposes or market applications.

Over the past two decades, developing and promoting more efficient products has drastically reduced commercial steamer water and energy consumption. Closed-system designs, improved gaskets, and increased insulation allow for more efficient use of steam without sacrificing speed or performance. As of 2022, ENERGY STAR® estimates that 39% of the commercial steamers sold in the United States meet the current V1.2 criteria. The 2022 California Green Building Code (California Green Building Standards Code 2022) requires connectionless or boilerless products and establishes water consumption requirements aligning with this proposal. Although some commercial steamer models comply with these voluntary codes, many models sold on the market greatly exceed these limits. In addition, the California Plumbing Code has requirements regarding water discharge temperatures to the sanitary sewer (California Code Regulations Title 17, § 30856).

California does not regulate the energy use of commercial steamers. Adopting mandatory water and energy efficiency criteria through Title 20 Codes and Standards Development would reduce water and energy waste for commercial steamers while maintaining consistency with related plumbing code requirements.

The CASE Team proposes a comprehensive approach to attaining water and energy savings by installing and using more efficient commercial steamers. This approach recommends:

- Mandatory appliance standards: In Title 20, establish energy and water performance standards for commercial steamers based on ENERGY STAR V1.2 and align with multiple other state standards for this product category. The proposal would also include maximum water consumption levels based on the LEED V4 requirements to capture significant water savings. The proposed standards would cover most commercial steamer categories, including boilerless and steam-generating products.
- Mandatory test-and-list requirements: In Title 20, establish energy and water performance test requirements based on industry-developed procedures. These test-and-list requirements provide consumers with additional information about product performance and enable the development of future standards for product categories that currently lack sufficient performance data. These proposed requirements would apply to pressure steamers outside the current scope of the ENERGY STAR program.
- Building codes: In Title 24, explore provisions to address drain water tempering and heat recovery requirements. These provisions could decrease the total energy used to produce steam by providing pre-heating and simultaneously reducing the amount of water lost to tempering.

Less-efficient steamers use more hot water and thus require greater tempering. The proposed standards would address some water waste associated with drain water tempering. However, building codes are uniquely suited to addressing interactive system effects between the steamer, drain, and domestic water systems.

This report provides supporting analysis for the first two components of the comprehensive approach, which focuses on performance standards for all commercial steamer types within the scope of the ENERGY STAR program. Pressure steamers would be required to test using industry-accepted procedures and list performance results to inform consumer purchases and create future performance standards.

3. Product and Technology Description

Commercial steamers fall into two major classifications. The first type is an atmospheric steamer, which typically operates around 212°F and provides the cooking temperature and speed to support most commercial food service applications, including restaurants and specific types of large-scale meal preparation institutions. Due to their versatile cooking applications, atmospheric steamers are the most common steamers on the market. Because this product circulates hot steam throughout the cooking compartment, it is also called a convection steamer.

Pressure steamers, the second category of commercial steamers, generate superheated steam and typically function within a 5-15 pounds per square inch (psi) range. This operational pressure facilitates cooking at temperatures as high as 250°F, shortening the cooking duration. Institutions with high-volume food service needs often prefer these products, as they efficiently handle large throughputs (WebstaurantStore Commercial Food Steamer Guide n.d.).

Commercial steamers generate steam through various technological approaches. However, atmospheric and pressure steamers use specific technologies to create steam. Direct steam products connect to a building's existing steam supply, but the supply must be potable for safe operation. Direct steam products can be pressure or atmospheric and found in large institutional settings like hospitals or other buildings with existing steam systems. These products are outside the scope of the proposed standards because the steam generation is separate from the appliance operation.

Steam generator products have a built-in steam boiler or generator that can quickly deliver high temperatures with fast recovery times. Electric resistance elements or natural gas burners heat the boiler or generator. The steam is injected into the cooking cavity from the boiler or steam generator by opening a valve. While atmospheric products can use either boilerless or boiler/steam-generator technologies, pressure steamers rely on boilers or steam generators to provide the temperature and heat necessary for pressure steaming.

Boilerless commercial steamers produce steam within the cooking cavity instead of inside a boiler or a steam generator. These products are unsuitable for consecutive cooking of multiple batches of fast-cooked items with less than a five-minute cooking time, as they take longer to regain steam when the door opens. Boilerless products generate steam in the bottom of the cooking compartment by heating water with an electric resistance heating element or a gas burner heat exchanger. These Steamers distribute steam evenly throughout the cooking compartment using perforated grates or a convection fan. These cookers generate atmospheric steam and are available in various sizes, from smaller countertop units to larger institutional designs. They are the most used type of steamers across all industries.

Commercial steamer capacity depends on the number of 12x20-inch food pans (commonly known as "hotel pans") that fit into its cooking compartment. Each pan can produce approximately 72 four-ounce portions of food per cooking cycle (WebstaurantStore Commercial Food Steamer Guide n.d.). The proposed standards cater to products that utilize three or more pans. They are categorized based on different capacities, which reflect the varying idle rates for compartments of proportional sizes. Larger compartments typically have higher idle energy usage, corresponding to the unit size.

The proposed standards and test-and-list requirements do not apply to application-specific or small countertop appliances like tortilla steamers due to their niche application and relatively low market share. The proposal does not include humidified holding cabinets, steam kettles, or cook-and-hold units.

These products offer distinct functionalities and are not comparable to those targeted by the proposed requirements.

The energy for steam generation can come from electricity, natural gas, or propane, excluding direct steam products that rely on building steam systems. Steam generators, boilers, and boilerless products are available in electric and gas. Both fuel types can be used for different throughputs and form factors, regardless of size. Smaller countertop steamers are usually electric. Consumers prefer electric steamers for countertop use because they take up less space than gas steamers, which have large burners and heat exchangers. The electric heating element is at the bottom of the cooking compartment, making it more compact.

Steamers can be plumbed directly into the building's water supply and drainage system. Others, known as connectionless products, depend on manual water filling into the cavity for steam generation. Plumbed steamers are the most common type of product used in commercial kitchens. They are connected directly to the water input lines and discharge water into the sanitary sewer after use. These products require professional installation, which can increase the cost. However, once installed, they do not need additional labor to fill or empty water from the machine. Plumbed steamers have a continuous water source, eliminating the potential for overheating due to lack of water. Larger capacity products like floor models and pressure steamers usually have plumbing connections to ensure the highest throughputs and automation. Plumbed products can be atmospheric or pressure and are available in all form factors. These products may require water filtration to reduce limescale buildup and may generally use more water than connectionless products.

Connectionless steamers generate steam from a water reservoir that requires regular refilling to prevent overheating. These products do not need a connection, offering greater flexibility when choosing an installation location. Connectionless steamers require additional labor to monitor and refill the water levels. However, connectionless steamers are designed to use less water overall (Austin 2024). Countertop models are typically connectionless, although some floor models with twelve or more pan capacities are also connectionless. Almost all connectionless products are atmospheric, and many of them are boilerless. However, a few boiler and pressure steamers on the market are also connectionless. The different types of steamers are depicted below and further described in this section:

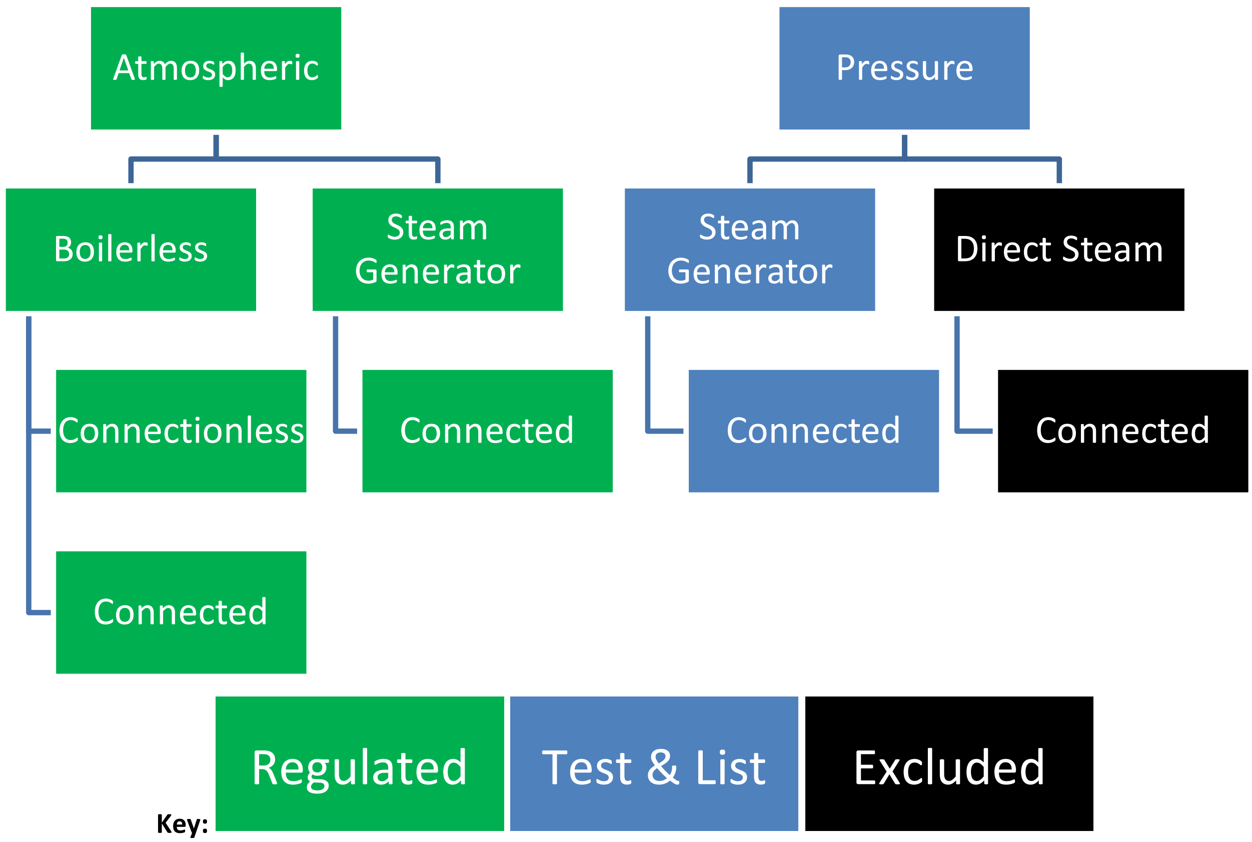

Figure 1 Steamer Types and Inclusion in Proposal

3.1. Cooking Technology Types

3.1.1. Atmospheric Steamers

Atmospheric steamers, also known as "pressureless steamers," are versatile appliances capable of cooking a wide variety of food products quickly and evenly. These steamers heat water to generate steam at 212°F for various cooking methods, including steaming, poaching, stewing, reheating, thawing, or par-cooking foods. Their adaptability makes them popular in diverse commercial kitchen environments, ranging from quick-service restaurants to large institutional settings. These steamers do not feature an integrated pressure gauge.

Atmospheric steamers, while slower than pressure steamers, offer several advantages. They allow operators to open and close the door at any time during cooking due to the lack of pressurization in the steamer compartment. This feature facilitates adding ingredients, stirring, or checking the cooking progress. These appliances are gentler on food, making them preferable for preparing delicate items like eggs or custards. They are also ideal for defrosting large frozen items, as they produce lower heat than pressure cookers. This lower heat setting prevents the exterior from cooking while the interior remains frozen, resulting in more effective defrosting. One significant advantage of atmospheric steamers is their ability to cook multiple types of food without transferring taste, a common issue in pressure steamers due to potential flavor cross-contamination (WebstaurantStore Commercial Food Steamer Guide n.d.).

As described in the previous section, atmospheric steamers can be subcategorized into boilerless and steam generator steamers. They cannot exceed pressures above 5 psi.

Figure 2 Steam Generator Atmospheric Steamer

Source: https://www.gofoodservice.com/p/market-forge-etp-10g

Figure 3 Boilerless Atmospheric Connectionless Steamer

Source: https://www.webstaurantstore.com/g/7000/accutemp-e64803e140-evolution-6-pan-countertop-electric-boilerless-steamer-480v

3.1.2. Pressure Steamers

Pressure steamers, also called non-atmospheric steamers, provide fast, high-output steam cooking and are most suited for large institutional settings. These cookers superheat water to produce steam reaching up to 250°F. This process makes drier food less prone to sogginess than food prepared in an atmospheric steamer. However, the high pressure generated by these cookers can adversely affect delicate foods such as eggs or green vegetables. Conversely, denser and more robust foods, like pasta, potatoes, rice, and large cuts of meat, are well-suited for pressure steamers. Pressure steamers produce high pressure, so operators cannot open the cooking compartment during steaming. These steamers may operate more effectively at high altitudes, while atmospheric steamers, which rely on lighter atmospheres, may struggle to reach typical cooking temperatures. A potential disadvantage of pressure steamers is the possibility of flavor transfer when cooking different types of food in the same compartment. Additionally, the need for these appliances to withstand high pressure often makes them larger, heavier, and more robust than atmospheric steamers (WebstaurantStore Commercial Food Steamer Guide n.d.). Pressure steamers have fail-safe features to provide safe operation by venting pressure.

The ASTM F1217 specification categorizes steamers into high- and low-pressure types. One suggested requirement in this test-and-list procedure is to specify the steamer's pressure level. This information lets consumers distinguish whether the steamers operate at high or low pressure.

Figure 4 Pressure Floor Steamer with a Boiler Base

Source: https://www.katom.com/learning-center/steamers-buyers-guide.html

Figure 5 Boiler Diagram Underneath the Cooking Compartments for a steamer

Source: https://assets.welbilt.com/m/5e481b807f1068e8/original/Pressure-Steamer-MAnaual.pdf

3.2. Steam Generation Technology

All commercial steamers use various technologies to produce high temperatures by combining water and heating technology for cooking with steam.

3.2.1. Steam Generator

Many steamers utilize steam generators to deliver on-demand steam essential for preparing large batches and consecutive à la carte cooking. This process involves preparing individual dishes from a menu instead of following a predetermined menu. Steam generator products include several different technologies to produce steam, including boilers, and are sometimes called boiler steamers instead of boilers. See Section 3.2.4 for more comparison. These appliances are popular in restaurant settings, as they rapidly recover heat, reducing the cooking time of frequently opened cooking compartments. Some products may have a built-in boiler in the cabinet, making them larger than other steamers. They heat the steam before it enters the cooking chamber, producing drier food than boilerless steamers. Steamers that use steam generators are usually larger floor models, as they employ a heating technology that is bulkier and suitable for high-volume cooking (see Section 3.3.3). Both pressure and atmospheric cookers use boiler and steam generator technology.

Steam cooking appliances can be powered by electricity, natural gas, or propane and require careful maintenance for optimal performance (WebstaurantStore Boiler Steamers n.d.). They use more water than boilerless products because they constantly generate and vent steam to provide rapid heat recovery when the compartment is opened. This increased water usage makes them more prone to limescale buildup, the extent of which can vary depending on the characteristics of the incoming water. While limescale buildup can affect all heat generation systems, it is especially harmful to steam generator systems due to the large buildup of water (Austin 2024).

Figure 6 Convection Steamer on a Cabinet Base

Source: https://www.webstaurantstore.com/documents/specsheets/vulcan_c24da6-10__specsheet.pdf

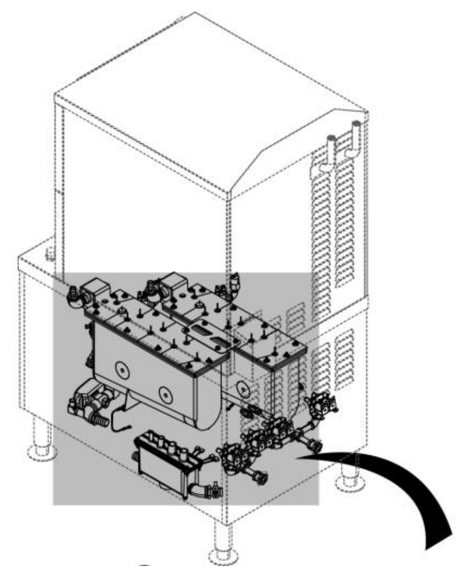

Figure 7 Diagram of Dual Steam Generators Underneath the Cooking Compartments for a Steamer

Source: https://www.webstaurantstore.com/documents/pdf/f45636.pdf

3.2.2. Boilerless

The most common steamer products rely on boilerless heating systems to generate steam. They generate steam directly in the cooking compartment by heating a pan of water with either gas or electric sources. Available in all form factors, boilerless products range from small single-pan units to large floor steamers that can accommodate nine or more pans. However, most models typically have three to six pans per compartment (The Editors n.d.). While boilerless systems take longer to heat up than boiler or steam generator products, they offer high flexibility in terms of application, including various food types, restaurant settings, and form factors. The boilerless steamer turns off the heating element once it reaches steam temperature, leading to slower recovery and less water use. The reduced water use leads to less limescale buildup, making boilerless products typically easier to clean and maintain than their boiler or steam generator counterparts.

Figure 8 Boilerless Steamer

Source: https://www.accutemp.net/wp-content/uploads/sites/25/2021/06/MM4214-2106-E6-Connected-DBL.pdf

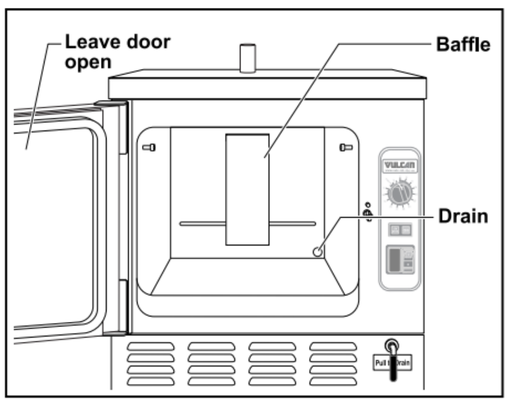

Figure 9 Diagram of Boilerless Steamer

Source: https://www.webstaurantstore.com/documents/pdf/c24e0series_manual.pdf

Figure 10 Electric Boilerless Connectionless Steamer

Source: https://www.webstaurantstore.com/documents/specsheets/vulcan_f37487_c24eo_series_electric_boilerless_connectionless_steamer_specsheet.pdf

Figure 11 Boilerless Steam Cavity

Source: https://www.webstaurantstore.com/documents/pdf/c24eo_steamer_service_man_f25386.pdf

3.2.3. Direct Steam

Direct steam products are the least common type of steamer heating technology. In these systems, steam is piped directly into the steamer. This setup is often found in institutional settings like universities and hospitals because they typically have existing steam systems. In these systems, steam is piped directly into the steamer from an external source. This setup is often found in such settings because they typically have existing steam systems. Direct steamers utilize excess steam, which would otherwise be vented, from the existing steam network. Most energy consumption in a commercial steamer is related to steam generation. These appliances can significantly improve energy efficiency by repurposing waste steam from a holistic energy perspective. Direct steamers using potable steam may require increased pressure for safe operation — building steam is often low pressure so any pressure steamers using direct steam may need to raise that pressure for operation. Direct steam products are outside the scope of the proposed standards as they have a lower market share, and building steam generation is decoupled from steamer efficiency.

Figure 12 Direct Steam Atmospheric Steamer

Source: https://www.webstaurantstore.com/documents/specsheets/390cem1648c_spec_sheet.pdf

Figure 13 Second Direct Steam Pressure Steamer

Source: https://www.middlebyadvantage.com/modelManual/CRWN-DC-2-DC-3_iom.pdf?v=1655839031065

3.3. Steamer Form Factors

Steamers are available in a variety of form factors. The proposed standards address steamers with capacities of three pans or more, representing most products on the market and an even greater percentage of the total energy use from this product category.

3.3.1. Portion Countertop Steamers

Portion steamers are smaller products designed to fit on a countertop and have small capacities for applications such as tortilla steaming. These products quickly heat or reheat small portions of food, are common in quick-service restaurants, and are typically designed to heat multiple orders consecutively. Portion steamers are almost exclusively electric due to portability and size considerations. Because these products cannot accommodate standardized hotel pans, they are outside the scope of industry test procedures and the proposed standards.

Figure 14 Portion Steamer

Source: https://www.webstaurantstore.com/nemco-6600-super-shot-countertop-tortilla-portion-steamer-120v/5916600A.html

3.3.2. Single Compartment Steamers

Single-compartment steamers are a popular form factor for steamers. They can be placed on casters, a table, or double stacked. Single-compartment steamer sizes range from three to as many as six pans (WebstaurantStore Commercial Countertop Steamers n.d.). These products can be electric, natural gas, or propane. While both boilerless and single-compartment steamers are on the market, boilerless are more common due to their size and cost (Interviews 2023–2024). A few single-compartment pressure products use boiler or steam generator technology, but these are uncommon. Boilerless single-compartment steamers are also offered as connectionless and do not need to connect to the water supply or drain.

Figure 15 Single Compartment Boilerless Convection Steamer Cooking Cavity

Source: https://www.webstaurantstore.com/cleveland-22cet6-1-steamchef-6-pan-electric-countertop-steamer-440-480v-3-phase/39022CET61PP.html?gclid=CjwKCAiAs6-sBhBmEiwA1Nl8s_81q-J9YOfCEP7L6koF1RfDcs8cslp30RKS3ljC-YuG9yFbeqN47hoCBbUQAvD_BwE

3.3.3. Floor Steamers

Floor steamers feature two cooking compartments equipped with six to sixteen pans, processing larger quantities of food. In electric and natural gas models, floor steamers come in atmospheric and pressure variants. They can be steam generators or boilerless models, with connectionless versions also available. In these dual-compartment models, the boiler or steam generator may be located next to the cooking cavity or in the base of the steamer. Most pressure steamers use a floor model design due to their high-volume food production capabilities.

Figure 16 Pressureless Steam Coil Boiler Steamer

Source: https://assets.katomcdn.com/raw/upload/v1677247210/products/109/109-24CSM120/109-24CSM120.pdf

Figure 17 Pressure Steam Generator Steamer

Source: https://www.webstaurantstore.com/documents/specsheets/39024cgp10.pdf

3.4. Steamer Energy Sources

Every steamer employs electricity to power controls, timers, and other electronic features. Steam generation is provided by electricity, natural gas, or propane. Direct steam products are also available in the market. However, these products fall outside the scope of the proposed standards.

3.4.1. Electric Steamers

Steamers use electricity for steam production at various voltages and applications. These can range from 120-volt (V) portion cookers to 480V floor models with capacities of 10 or more pans. Most countertop products rely on 208V or 240V connections to produce fast and efficient steam. The relatively high voltages for electric steamers may require upgrades to electrical service or panel capacity. Both atmospheric and pressure steamers can generate steam from electricity. Additionally, boiler and boilerless products may rely on electricity to generate steam.

3.4.2. Natural Gas and Propane Steamers

Natural gas is a popular choice for steamers in most commercial kitchens, accounting for 32.6% of annual steamer shipments in California (US EPA 2020). Both atmospheric and pressure steamers can use natural gas or propane. Additionally, boiler and boilerless products may rely on natural gas or propane to produce steam (Austin 2024).

3.5. Steamer Controls

Most steamers have simple controls with a mechanical timer that stops steam generation when the set time runs out. Other controls include a preheat light indicating when the steam compartment or generator has reached the desired temperature. Connectionless steamers have a light that turns on when the compartment needs manual refilling. Digital controls are less common but allow users to program cook times or hold a temperature. Some steamers also have an automatic setback mode that engages after a period of inactivity and cook cycle completion. A technician can adjust the automated setback time from half an hour to two hours after inactivity until the setback mode engages.

Almost all steamers have a constant steam mode, making the unit operate at maximum steam power. However, this can lead to energy waste, as most steamers cannot detect if food is inside the cavity and generate unnecessary steam. For more information on setback modes and controls, please refer to Section 5.1.

4. Proposed Standards

4.1. Proposal Description

The CASE Team proposes a comprehensive approach to achieving water and energy savings by selling and using more efficient commercial steamers.

This report provides a supporting analysis of the Title 20 proposal, focused on performance standards for all commercial steamer types within the scope of the ENERGY STAR program, as described in Section 3 of this report and with additional information provided in this section. The CASE Team proposes certain pressure steamers, which have low-market shares and limited testing data, be required to test-and-list to industry-accepted procedures to determine their energy and water performance. These products would have a certified performance, empowering consumers to make informed purchasing decisions and enabling potential future performance standards for these product categories. The proposed scope is as follows:

Table 4 Proposal Scope

Mandatory Standards	Test-and-list	Out of Scope
Electric atmospheric steamers: 3 pans and greater Gas atmospheric steamers: 3 pans and greater	Electric pressure steamers: 3 pans and greater Gas pressure steamers: 3 pans and greater Vacuum steamers	Steamers less than 3 pans or using non-standard pan sizes Steamers utilizing direct steam Combi-ovens Humidified holding cabinets, steam kettles and cook and holds

4.2. Proposed Changes to the Title 20 Code Language

4.2.1. Proposed Definitions

The CASE Team proposes a scope and definition similar to ENERGY STAR V1.2, as the industry has vetted these definitions based on twenty years of engagement with this market. The CASE Team proposes adding the following new definitions to Title 20:

- A definition for "Commercial Steam Cooker" to define the scope of the coverage and differentiate covered products from other product types, such as commercial steam kettles and portion steamers. This definition would be confined to products with a capacity for three or more full-size hotel pans consistent with the coverage of the ENERGY STAR scope.
- Definitions for steam cookers, including both pressure and atmospheric steam cookers. These definitions would explicitly exclude direct steam equipment from the scope of the proposed performance standards.
- Definitions for pan size to ensure consistent coverage for performance requirements based on pan capacity.

- Definitions for “Cooking Energy Efficiency,” “Idle Rate,” and “Water Consumption,” as required in the proposed performance standards.

The ENERGY STAR standard does not address the following commercial steamer types. The CASE Team proposes excluding these types of steamers from the scope of Title 20 regulations:

- Portion steamers,
- Steamers with capacities below three full-size hotel pans,
- Commercial steamers utilizing direct steam, and
- Combi ovens

Pressure steamers currently do not meet the ENERGY STAR program requirements. Therefore, the CASE Team recommends testing these products and listing them in the California database, which displays water consumption, cooking energy efficiency, idle energy, and pan capacity, as defined above. Steam cooking products that do not align with the covered standardized categories or those described above do not require a test-and-list because they are outside this regulation’s scope.

4.2.2. Proposed Test Procedure

ASTM Standard F1484 is a well-established test procedure that provides guidelines for measuring commercial steamer idle energy rates. The ENERGY STAR program used the 1999 version to determine commercial steamer energy efficiency, water consumption, and production capacity. However, the CEC should expect ENERGY STAR to update its test procedure within the next few years. The CASE Team recommends adopting the 2018 ASTM Standard test procedure for all steamer product classes under the proposed standards. To align with ENERGY STAR, the CASE Team recommends allowing certification based on testing using any test method version from 1999 or later, noting that 2018 is the most current version.

ASTM Standard F1484 uses red potatoes as the medium to determine commercial steamer energy efficiency, water consumption, and production capacity. Red potatoes have a relatively long cooking duration of approximately 20 minutes. Boilerless and steam generator steamers exhibit similar cooking times for this food item. However, some ASTM stakeholders have expressed concerns that these extended times may not accurately represent the performance of commercial steamers during à la carte cooking. This type of cooking involves short cooking times of 2-5 minutes and frequent door openings. Boilerless steamers often struggle with à la carte cooking due to their slower recovery times. Unlike systems with a steam generator or a boiler, they cannot inject steam on demand. Instead, the water at the bottom of the cooking compartment must reach boiling temperatures to regenerate steam, which can delay the cooking process. The ASTM committee considered testing with a secondary product like shrimp to show performance differences between boilerless and steam generator steamers. The additional proposed test procedure proved too complicated and costly for replicable test results. The committee is actively engaged in discussions to refine the test methods, aiming to better distinguish the performance of steamers during à la carte cooking. However, a quick consensus on an alternative test product seems unlikely. While future iterations of the procedure may ultimately resolve these challenges, the CASE Team recommends adopting the existing ASTM test procedure without modification.

Existing CEC regulations require the manufacturer to test units for each basic appliance. In the Title 20 Appliance Efficiency Regulations, the CEC defines a basic model as "all units of a given type of appliance (or class thereof) that are manufactured by one manufacturer that have the same primary energy source, and that do not have any differing electrical, hydraulic, physical, or functional characteristics that affect energy consumption, energy efficiency, water consumption, or water efficiency" (Section 1602). The CASE Team proposes using the existing basic model definition and testing requirements.

4.2.3. Proposed Standard Level

The proposed standard level for energy efficiency and idle energy rate is applicable to boilerless and steam generator products and equivalent to ENERGY STAR V1.2. The test procedure collects water consumption data, but the scope of ENERGY STAR criteria does not include water efficiency. These proposed standard levels align with existing standards in other states. This standard represents significant energy savings while providing clear guidance to the market. Market actor interviews with manufacturers have shown general support for these proposed levels and overall support for this alignment. Products are required to meet the idle rate for either gas or electricity depending on the fuel source used to generate steam:

Table 5 Requirements for Atmospheric Electric Steamers

Pan Capacity	Heavy Load Cooking Energy Efficiency	Maximum Standby Idle Energy Rate (watts)	Maximum Cooking Water Consumption
3-pan	≥ 50%	≤ 400	3 gal/pan/hour
4-pan	≥ 50%	≤ 530	3 gal/pan/hour
5-pan	≥ 50%	≤ 670	3 gal/pan/hour
6-pan and larger	≥ 50%	≤ 800	3 gal/pan/hour

Table 6 Requirements for Atmospheric Gas Steamers

Pan Capacity	Heavy Load Cooking Energy Efficiency	Maximum Standby Idle Energy Rate (Btu/h)	Maximum Cooking Water Consumption
3-pan	≥ 38%	≤ 6,250	3 gal/pan/hour
4-pan	≥ 38%	≤ 8,350	3 gal/pan/hour
5-pan	≥ 38%	≤ 10,400	3 gal/pan/hour
6-pan and larger	≥ 38%	≤ 12,500	3 gal/pan/hour

Tables 5 and 6 show that gas appliances have lower energy efficiency than electric efficiencies when measured at the appliance. The lower efficiency of gas appliances is due to their design. They require a combustion chamber open to the air and flue to expel combustion byproducts. This open system, where air plays a factor in the combustion, is less efficient than a resistance heating element. The latter can attain close to 100% efficiency under controlled conditions.

Conversations with steamer manufacturers revealed that the proposed water requirements are attainable for appliances meeting the ENERGY STAR V1.2 performance levels because an increase in water consumption leads to a corresponding increase in energy consumption. Steamers that meet energy standards are inherently water efficient. The CASE Team's analysis of the steamers meeting ENERGY STAR V1.2 revealed that the maximum cooking water consumption was 1.7 gallons per pan per hour (gal/hr/pan) for a batch (boilerless steamer) and 2.6 gal/hr/pan for a steam generator steamer. Baseline products consume more water as less efficient products generate excess steam, increasing water use. As boilerless and steam generator products are not always distinguishable, the team recommends the proposed level of 3 gal/pan/hour for all steamers to simplify the process. ASTM F1484 measures water consumption in gallons per hour (gal/hour). The team proposes a standard using gal/pan/hour to align with the Leadership in Energy and Environmental Design (LEED) Building Design and Construction Rating System rating system (USG) and California Reach Codes (International Code Council n.d.).

4.2.4. Proposed Reporting Requirements

The proposed reporting requirements for commercial gas or electric steamers accommodating three or more full size hotel pans include:

Table 7 Proposed Certification Requirements

Field	Source and Explanation	Example Values and Units
Brand Name	The company name	Steamco Steamers
Basic Model Number	Often an alphanumeric distinct model designation	GBC23
Individual Model Type	Usually the name of the model family	Steamtastic
Steam Generation Method (optional)	Separates boilerless steamers from steam generator steamers	Boilerless or Steam Generation
Pan Capacity per compartment	Number of pans per compartment	3,4,5,6
Primary Fuel Source	Direct steam steamers are out of scope	Gas or Electric
Cooking Efficiency	ASTM F1484 Section 10.9 Heavy Load Red Potatoes	%
Water Consumption while cooking	ASTM F1484 Section 10.9 Heavy Load Red Potatoes for connected steamers, Section 10.10 for connectionless steamers	Gallons/hour (Gallons/pan/hour can be calculated by dividing this field by Pan Capacity per compartment)
Ready To Cook Idle Energy Rate Gas*	ASTM F1484 Section 10.4	Btu/h
Ready To Cook Idle Energy Rate Electric*	ASTM F1484 Section 10.4	W
Standby Idle Energy Rate Gas*	ASTM F1484 Section 10.5, to be used for compliance	Btu/h
Standby Idle Energy Rate Electric*	ASTM F1484 Section 10.5, to be used for compliance	W
Water Consumption in idle*	Connected steamers only, not for connectionless steamers Measured during ready-to-cook idle test in ASTM F1484 Section 10.4	Gallons/hour
Steaming Pressure*	Separates atmospheric steamers (0 psi) from pressure steamers	-30 to 30 psi

Field	Source and Explanation	Example Values and Units
	(3psi+), vacuum steamers will report a negative value	
Number of Steaming Compartments*	Countertop steamers are single-compartment, and floor-standing units are dual-compartment. A 6-pan steamer can be a dual-compartment 3-pan or a single-compartment 6-pan steamer.	1 or 2
Production Capacity*	ASTM F1484 Section 10.9 Heavy Load Red Potatoes	Lb/h

*This information is not in the SASD.

These fields align with the State Appliance Standards Database (SASD) and ENERGY STAR V1.2. Manufacturers report to SASD to comply with Massachusetts, New Jersey, New York, and Rhode Island state appliance standards. The steam generation method is an optional reporting requirement consistent with the SASD. Allowing manufacturers to report this data would maintain consistency across ENERGY STAR and SASD. The CASE Team urges the CEC to adopt identical fields in the same sequence to streamline the compliance process.

The CASE Team intentionally proposes additional fields at the end of the table to maintain consistency between forms. SASD and ENERGY STAR require an Idle Energy Rate but do not specify if it is the ready-to-cook or Standby Idle Energy Rate; however, the ASTM F1484 test procedure has a distinction. The two idle rates are expected to be the same for steamers without advanced controls. For steamers with advanced controls, the standby idle energy rate is lower. The CASE Team recommends the standby idle energy rate be used to comply with the proposed T20 standard, which is likely the value collected by ENERGY STAR and SASD. The team recommends collecting both values to comply with the proposed Maximum Standby Idle Energy Rate. See Section 5.1 for more information on the idle rate. The additional required fields would provide consumers with information on unit specification, energy and water use, and production capacity.

4.2.5. Proposed Marking and Labeling Requirements

All appliances must be permanently marked with the manufacturer’s name, brand name or trademark, model number, and manufacturing date, clearly and prominently displayed in an easily accessible location on the unit. The CASE Team does not propose additional marking or labeling requirements for commercial steamers.

5. Market Analysis

5.1. Product Efficiency Opportunities

Commercial steamers enable users to efficiently and consistently prepare large quantities of food. These products prepare everything from continuous portions of steamed shellfish in a seafood restaurant to cooking large amounts of rice or pasta in an institutional setting. These applications require different heating technologies, capabilities, and form factors, as described in Section 3. For these products, the processes of generating steam for cooking and recovering it for quick preparation are the largest consumers of energy and water. Technologies that reduce steam usage and thus minimize the water required for production increase energy efficiency. Boilerless steamers produce and retain steam but do not consistently generate steam. This characteristic can slow recovery during frequent door openings, making them unsuitable for specific applications. However, it also inherently enhances their energy and water efficiency. While the design of boilerless steamers offers limited room for improvement, there are significant opportunities to improve the efficiency of steam generator steamers.

Improving the controls of steamers presents the most opportunities for enhancing energy and water efficiency. Many steamers use basic mechanical timers to control steam generation, which cannot detect if food is in the cooking cavity. Although steamers operate only for a few hours daily, they are usually turned on along with other cooking appliances in the morning and switched off when the facility closes at night, leading to significant energy waste during idle periods. A common feature in most steamers is the constant steam generation mode, which bypasses the cook timer. However, if an operator forgets to switch off this mode after cooking, it can result in considerable energy and water waste. Steam generator steamers in almost every kitchen consume more energy to generate steam than boilerless steamers because a separate compartment outside the cooking compartment needs to be heated and maintained at temperature.

Utilizing setback idle modes presents the greatest opportunity for energy efficiency. Steam generator products, used for rapid production and recovery, typically maintain the steam generation compartment at over 210°F in idle mode, consuming energy. Setback idle modes can reduce this temperature to below 180°F, allowing for a brief preheat period and saving energy without significantly impacting cooking times. Manufacturers employ various strategies to activate and deactivate these modes. Some use a timer that automatically triggers the setback idle mode after an hour of inactivity after the last cook cycle. Others may use sensors to detect the presence of food in the cavity or its placement in the pan, generating only the necessary steam. While this technology is not commonly used in steamers, several combi oven manufacturers have incorporated it in their steam mode.

All steam generator steamers that qualify for ENERGY STAR use setback idle modes to qualify for the idle energy criteria.

Advanced drain water tempering devices offer another opportunity for water conservation. Some local codes mandate that drain water above 140°F be tempered by blending it with a cold-water source. Steamers can leverage temperature controls and heat exchangers to reduce the amount of cold water needed. While most boilerless steamers, due to their minimal water flush, do not require drain water tempering, it is often necessary for steam generators and boiler-based steamers due to the larger volume of steam condensate they produce.

5.2. Technical Feasibility

Below is a list of steamers on the market that qualify for ENERGY STAR V1.2. The wide range of models from various manufacturers demonstrates the technical feasibility of the proposal.

Table 8 Steamers on market that qualify for Energy Star V1.2

Fuel Type	Steam Generation	Distinct Models	Manufacturers
Electric	Boilerless	24	7
Electric	Steam Generator	6	3
Gas	Boilerless	9	4
Gas	Steam Generator	3	2

5.2.1. Future Market Adoption of Qualifying Products

The CASE Team reviewed the V1.2 ENERGY STAR-qualified products list and SASD to assess the availability of qualifying products meeting the proposed standards. The results of that analysis are presented and discussed further in Section 8.2.

When ENERGY STAR adopted the V1.2 criteria in 2003 for evaluating energy-efficient products, the United States (U.S.) Environmental Protection Agency (EPA) thoroughly assessed the market to ensure the availability of qualified products from various manufacturers. The EPA sought to establish recognition criteria that do not rely on proprietary technology. After analyzing the market, the EPA determined that the proposed energy efficiency levels (V1.2) were well-represented. Additionally, they assessed the proposed standards across capacities and other performance features, concluding that the V1.2 levels provided good coverage across available features and product classes. ENERGY STAR estimates that V1.2 qualifying products accounted for 39% of the entire steamer market. Furthermore, nine manufacturers produced products recognized under the V1.2 criteria, representing most commercial steamer manufacturers and sales.

The following graphs display the difference in idle energy rates between boilerless and steam generator steamers, showcasing a range of sizes and performances of qualifying products available in the market. Steam generator steamers pass the ENERGY STAR idle energy threshold using setback idle mode. However, it is unclear from the ENERGY STAR data which boilerless models used this mode to pass the criteria. The orange line in the figures below represents the current ENERGY STAR V1.2 level and maximum proposed idle rate and only includes models compliant with ENERGY STAR.

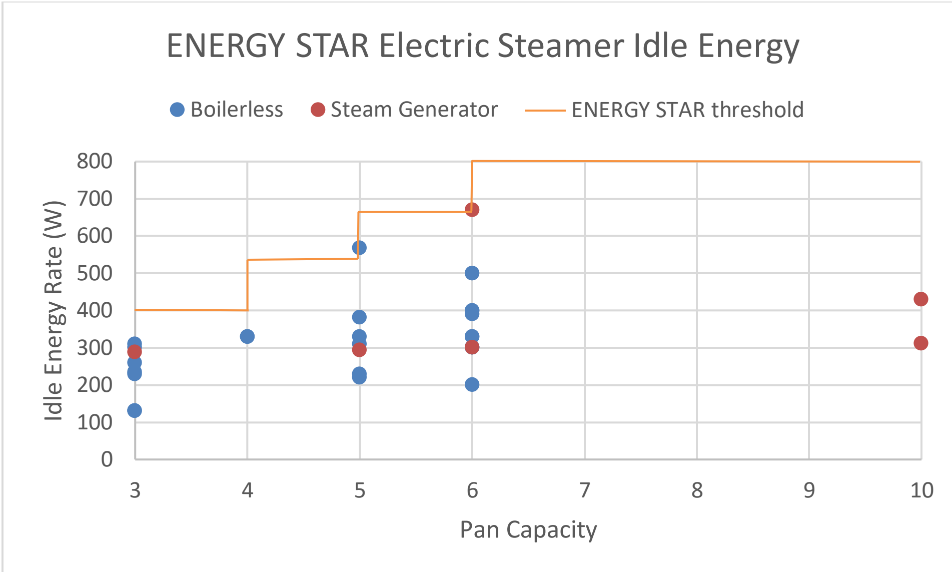

Figure 18 ENERGY STAR Electric Steamer Idle Energy

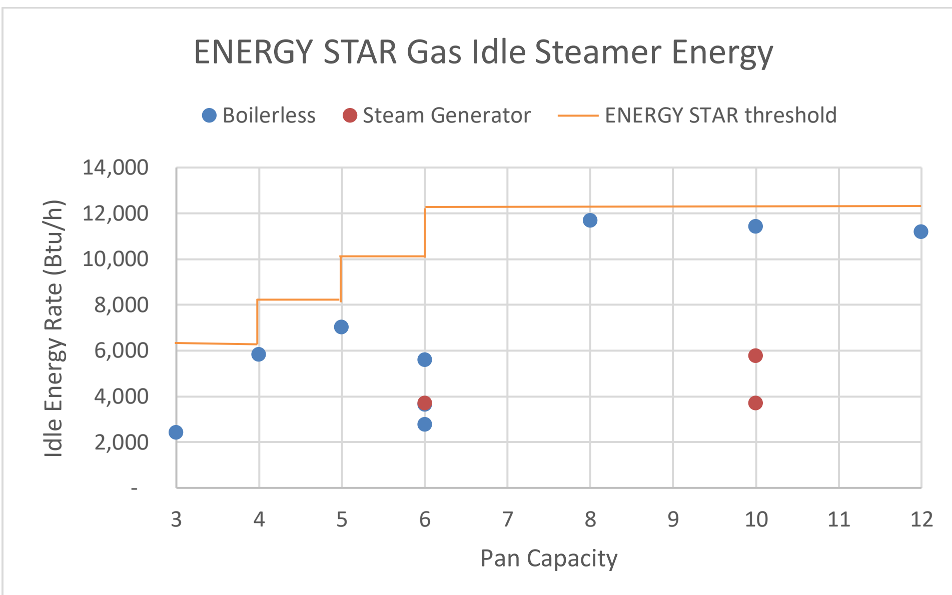

Figure 19 ENERGY STAR Gas Steamer Idle Energy

The chart below shows the difference in water consumption during cooking between boilerless and steam generator steamers. Steam generator steamers consume significantly more water than boilerless models, as highlighted in Section 5.1. One contributing factor to this disparity is integrated drain water tempering in steam generator steamers. However, ENERGY STAR data does not distinguish between potable water and drain water tempering consumption. The CASE Team does not suggest altering the test procedure and reporting to allow this differentiation.

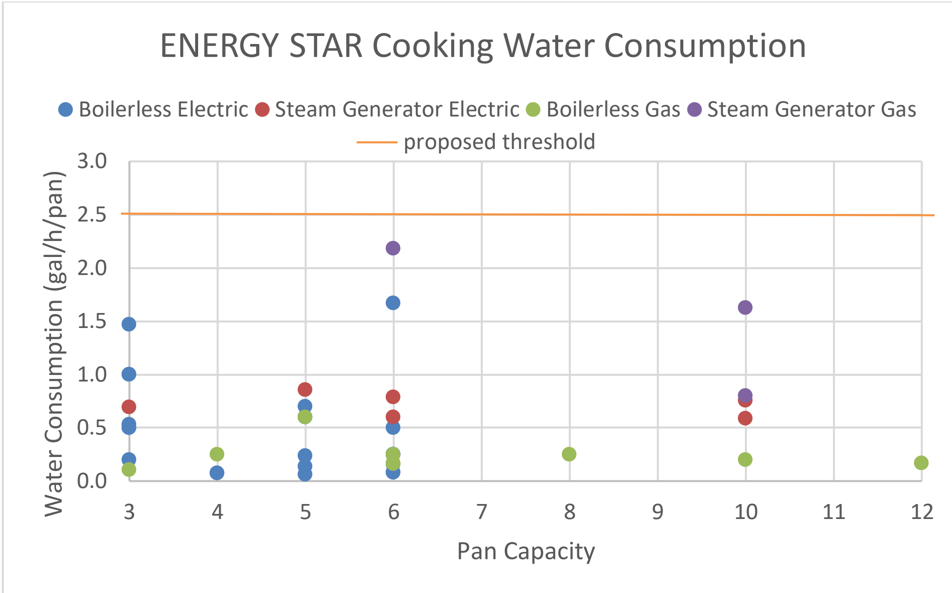

Figure 20 ENERGY STAR Cooking Water Consumption by Product Type

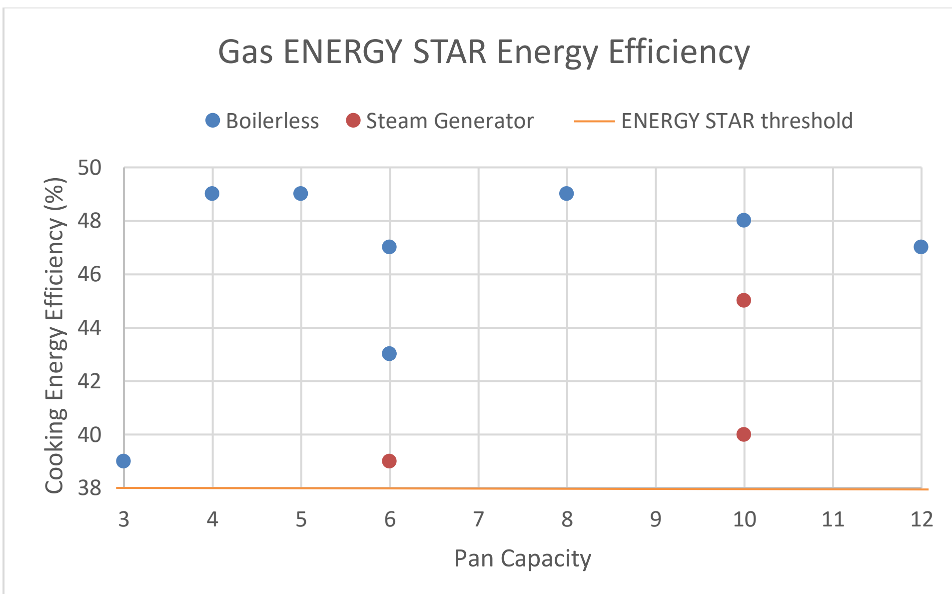

Figure 21 ENERGY STAR Gas Energy Efficiency

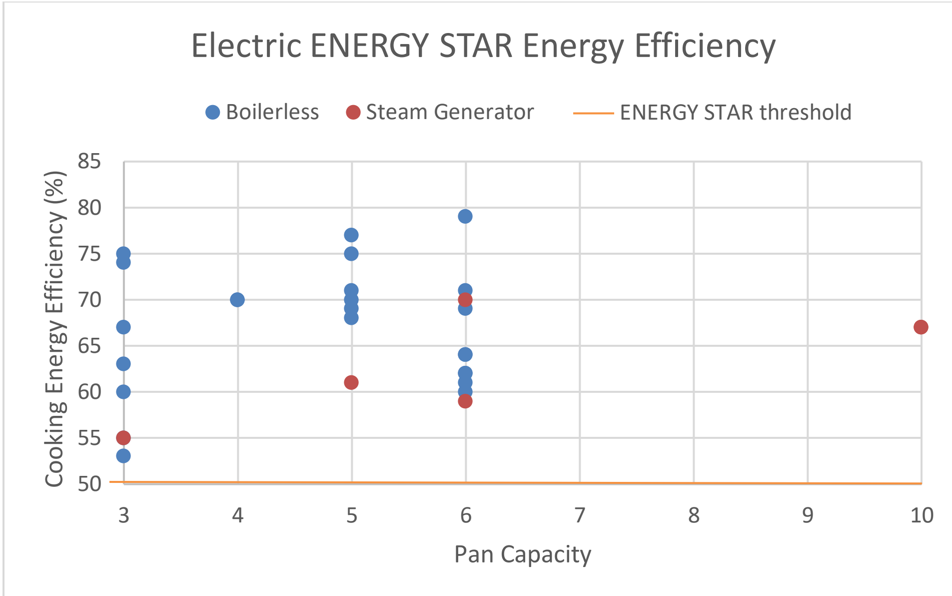

Figure 22 ENERGY STAR Electric Energy Efficiency

Limited data on water and energy consumption for pressure steamers is available. The ENERGY STAR data provided above pertains specifically to the most energy-efficient steamers. However, the CASE Team does not believe consumers will adopt pressure steamers if the CEC establishes a standard that eliminates atmospheric products because of the significant differences in the use and application of pressure steamers. Nevertheless, the test-and-list requirements for pressure steamers could enable future standards in this product category.

5.2.2. Consumer Utility and Acceptance

This section discusses consumer utility and acceptance of commercial steamers meeting the proposed standards level.

The proposed standards cover a range of commercial steamers meeting a spectrum of cooking needs, from countertop 3-pan products to large steam generator floor models. These products serve various purposes, from small seafood shacks to high-capacity settings like university dining halls and prisons.

Pressure steamers are subject to test-and-list requirements, while direct steam products fall outside the proposed standards' scope. Discussions with manufacturers showed that pressure steamers are only used in specialized applications, while a steam generator steamer can achieve a similar cooking performance. The CASE Team believes consumers are unlikely to switch to pressure steamers if the Energy Commission adopts standards for atmospheric products. Pressure steamers are generally expensive, less flexible, and have different applications than atmospheric products.

Consumers have widely adopted products that meet the proposed specification level, and many products sold already meet the criteria. During discussions, manufacturers did not identify consumer utility or acceptance concerns with products meeting the proposed performance standards. Most consumers are unaware of steamer efficiency levels and focus on the additional features and functionality of compliant products.

More efficient steamers include premium features like improved controls, timers, and pre-programmed settings to enhance the consumer experience. However, the test does not cover these additional features, and the energy required for these controls does not significantly impact energy and water efficiency. Only steamers with advanced controls have automatic setback idle modes, which reduce energy consumption during idle periods. Both compliant and non-compliant steamers deliver satisfactory cooking performance, but the compliant ones adhere to the proposed efficiency guidelines. The throughput and efficacy for efficient and less efficient products are generally the same, as demonstrated below.

- Electric baseline units had a range production capacity of 97-142lb/hr,
- Electric efficient units had a range production capacity of 63-266lb/hr,
- Gas baseline units had a range production capacity of 63-141lb/hr, and
- Gas efficient units had a range production capacity of 91-131lb/hr.

These numbers are based on California Electronic Technical Reference Manual (eTRM) datasets, which compare the ASTM production capacity of baseline and ENERGY STAR V1.2 models. Since capacity and speed are the primary motivations for consumer purchasing, all products meeting the proposed standards perform strongly in these areas and are comparable to less efficient products.

Setback idle mode is a popular energy-saving technique steamer manufacturers use to meet ENERGY STAR standards. However, it has a significant drawback: when the steam compartment or steam generator has been idle for a period (usually more than 30 minutes), it needs time to preheat before generating steam. Depending on the chosen setback idle temperature, this preheat time can be less than a minute while saving up to half of the idle energy. Fortunately, most steamed food products (with cooking times longer than 10 minutes) remain unaffected if placed into the cavity before the compartment is fully preheated. However, some operators may disable these short preheat times associated with setback idle energy mode.

One major consideration for adopting these standards is the potential for consumers to explore alternative products to meet their steam cooking needs. Combination (combi) ovens offer a convenient solution by combining a convection oven with a steamer. Restaurants equipped with combi ovens often no longer require a separate steamer, as they can steam vegetables and small portions of seafood in the oven’s steam mode. However, larger institutional operations may maintain separate steamers, and specialty establishments like seafood restaurants would continue relying on dedicated steamers. The primary obstacle to widespread combi oven adoption is its cost, which often exceeds the combined expense of purchasing a single-compartment steamer and a convection oven. Combi ovens come in two variants: spritzer (equivalent to boilerless steamers) and boiler (equivalent to steam generator steamers).

Title 20 proposed regulations do not include combi oven energy and water efficiency thresholds. Strict steamer regulations could push the market away from steamers toward combi ovens. Although older boiler-based combi ovens can use more water than boilerless steamers, newer combi ovens are very water and energy-efficient (California Foodservice Instant Rebates QPL n.d.). Three of the biggest combi oven manufacturers, Rational, Convotherm, and Unox, have certified most of their models (ENERGY STAR Certified Commercial Ovens n.d.) to the ENERGY STAR Commercial Ovens V3 specifications (US EPA n.d.). The CASE team estimated the market adoption rate for the ENERGY STAR combi oven exceeds 70%. The incremental costs between a qualifying steamer and one that is non-compliant are negligible in many circumstances, as described in Section 7.1. While the market may continue to shift toward combi ovens based on consumer preferences and versatility, the proposed standards are unlikely to impact that industry trend.

5.2.3. Commercial Steamer Market Structure

The market structure for commercial steamer sales aligns with the general market structure for commercial food service equipment and has been in place for decades. Prominent manufacturers of steamers include Cleveland, Vulcan, Market Forge, Crown, Groen, and Accutemp. Middleby Corporation and the Ali Group own most of these brands, while ITW owns Vulcan. While most manufacturers offer their customers either boilerless or steam generator steamers, Accutemp specializes in only boilerless steamers. Cleveland and Crown also provide pressure and direct steam models.

Of note, unlike commercial dishwashers, steamers are not typically leased. Below are the stakeholders within the commercial food service market:

- **Equipment Manufacturers:** Manufacturers of commercial food service equipment design, fabricate, and assemble equipment. Manufacturers seldom engage in direct sales to end customers. Instead, they collaborate with equipment representatives—such as manufacturers, vendors, or dealers—to distribute products, assist customers, and facilitate sales. Major restaurant chains purchase directly from equipment manufacturers and collaborate with a representative. These large restaurant chains and manufacturers typically have experience with existing state standards and integrate them into their sales process.
- **Manufacturer Representatives:** Manufacturer representatives work with equipment dealers, commercial kitchen designers, and consultants to promote and educate the market on the manufacturer's products, specify product in new kitchen designs and facilitate sales. Additionally, they can help demonstrate the operation and commissioning of equipment after the sale. Typically, manufacturer reps do not directly order or distribute equipment. They are paid commissions on equipment ordered through dealers in their territory.
- **Equipment Vendors/Dealers:** Vendors are brick-and-mortar stores or online retailers that sell equipment directly to consumers or through large regional retailers like Action Sales, Chef's Toys, Restaurant Depot, and Trimark. These retailers may have experience with streamer standards in other states. Consumers work with dealers to choose equipment from stocked items or order for specific requirements. Larger vendors offer design-build services where sales staff work with clients to specify products for new kitchens and extensive remodels. These vendors often participate in contract-bid activities where they propose a suite of kitchen equipment based on customer specifications and compete with other vendors for the equipment sales contract. Some restaurant operators will buy equipment from major online retailers like Webstaurant Store, Wasserstrom, and Katom. However, they are less popular and do not offer local support like equipment representatives. These resources generally provide search tools for consumers to identify more efficient products. Many online sales now provide details of compliance with other state standards that align with the proposed standards. Therefore, these systems have already adjusted to state standards and will not require significant changes to incorporate California standards into their sales processes.
- **Buying Groups:** Buying groups comprise various equipment vendors and dealers who sell a high enough volume of equipment to qualify for participation. Buying groups negotiate with manufacturers for the best prices for equipment vendors and dealers. Participating in a buying group can benefit equipment vendors as they can access lower prices, additional rebates, and promotions on specific equipment. However, customers may have a limited choice of brands when purchasing through a buying group.
- **Designers and Consultants:** Designers and consultants do not generally have a brick-and-mortar sales floor or offer online sales. However, they often have showrooms where they meet with

customers to design custom kitchens based on existing specifications or from scratch. A kitchen consultant will collaborate with an architect when building a new restaurant or dining facility. These consultants have brand loyalty and will specify equipment within a purchasing group unless the customer has specific requests.

- **Installers:** General contractors, plumbers, and electricians that install equipment, but generally do not purchase or sell equipment.

Given the variety of commercial steamers in each product class meeting the proposed standards, the CASE Team anticipates the continued market adoption of these models in both the baseline and compliant case.

The CASE Team does not anticipate that the standards proposal will significantly impact the existing manufacturer structure or supply, mainly because nearly half of all sales already meet the criteria. If the proposed standards are adopted, providing at least one year between the adoption and effective date would allow manufacturers and supply chains sufficient time to adjust their operations to comply with the changes.

6. Per Unit Water and Energy Savings

6.1. Key Assumptions

The CASE Team used the eTRM's findings and calculators to decide on the appropriate inputs for the number of operational days, operational hours per day, cooking efficiency, pounds of food cooked per day, and ASTM energy to food for various types of steamers. Preheat time and energy use, idle energy rate, cooking efficiency, cooking water consumption, and idle water consumption have different assumptions from baseline to energy-efficient models. These assumptions are also different from boilerless to steam generator models. The team conducted an analysis using the commonly used six-panel model.

Water temperature rise is based on the average temperature of operation minus average inlet water temperatures, as determined by EPA. The nationwide averages used for inlet water temperature are appropriate for approximating California's diversity of climate zones. Finally, the CASE Team relied on standardized metrics for water density and specific heat and approved methodologies for embedded electricity and load factors.

The CASE Team averaged the above assumptions for noncompliant baseline models that do not meet the criteria for ENERGY STAR V1.2 and compliant models that qualify for ENERGY STAR V1.2. The idle energy rate has the most significant impact on annual energy consumption. Section 5.1 (Product Efficiency Opportunities) contains several graphs related to idle energy rates and efficiencies of gas and electric steamers. Additionally, Table 24 in Appendix B (Steamers Energy and Water Use Assumptions) shows the average efficiencies and idle rates for each type of steamer analyzed.

Based on field data cited in the eTRM, 59% of idle time for baseline steam generator units is assumed to be spent in constant steam mode. The energy and water consumption rates during constant steam mode are equivalent to cooking rates when food in the cavity. In this mode, the food inside the steamer continues to cook without a predetermined end time. In contrast, boilerless steamers are designed to avoid constant steam, i.e., 0% steam output during downtime. This situation occurs when the unit generates steam without food due to user errors, such as excessively long timer settings or unintentional activation of constant steam mode. Many boilerless steamers are connectionless and automatically turn off if left unattended in continuous mode and run out of water.

6.2. Methodology

This section describes the CASE Team's methodology and approach for assessing the implications of the proposed standards on baseline and compliant steamer models in the same product category. The CASE Team conducted a comparative analysis of products meeting these standards and those that do not to determine the impact on water usage, energy consumption, and environmental factors. Customers can choose between the less expensive and less efficient baseline steamers and the more costly and more efficient alternatives with the same utility and production capacity.

These assumptions define the difference between compliant and baseline steamers, as described in Appendix B (Steamers Energy and Water Use Assumptions).

In situations where the baseline power of a given mode was already more efficient than the standard, the analysis assumes that power will not increase but rather remain the same. This analysis estimates the cooking efficiency as the average of all electric steamers that do not meet the standard.

The CASE Team conducted a secondary analysis of the energy savings and cost-effectiveness, assuming that the energy-efficient equipment performance is equal to the proposed standards for cooking efficiency and standby idle energy rate. The alternative method estimates the power consumption of compliant product that meets minimum performance required by the standard. This analysis where the compliant product just meets the “threshold” is further outlined in Appendix C (Alternative Steamer Savings Analysis).

Annual steamer energy and water consumption is calculated for the entire year by adding daily energy and water consumption for the following activities:

- **Preheat** in minutes for time to preheat kWh (electric boilerless, electric steam generator) and Btu (gas boilerless, gas steam generator).
- **Cooking** in cooking efficiency percent and gallons per hour for cooking water consumption.
- **Idle energy use i**n kW for electric boilerless, electric steam generator units, and Btu per hour for gas boilerless, gas steam generator units. Idle energy is measured for at least 3 hours of inactivity and normalized per hour. Therefore, it is expressed in kilowatt-hours per hour (kWh/h), simplifying to (kW).
- **Idle water use in constant steam mode** in gallons per hour for idle water consumption.

Operational assumptions are used to estimate the annual water and energy usage of typical facilities for baseline and energy-efficient steamers. These assumptions include:

- **Hours of Operation** per day assumed to be 9.6 hours.
- **Days operating per year** assumed to be 310 days of operation.
- **Quantity of food cooked per day** assumed to be 100 lb.
- **ASTM energy to food** assumed to be 105 Btu/lb.

Cooking energy is calculated by multiplying the amount of food cooked per day by the theoretical ASTM energy to cook food and dividing it by the cooking energy efficiency. Idle energy is calculated by multiplying the idle rate by the hours the unit is not cooking or in constant steam mode. Steamers with standby idle rates lower than ready-to-cook idle rates shall use the standby idle energy for idle energy calculations. The eTRM contains a more detailed calculation methodology.

6.3. Per Unit Water and Energy Saving Results

Energy and water savings were calculated by comparing compliant and baseline steamers, including gas, electric, boilerless, and steam generator steamers. The annual savings are shown for a single-compartment four- to six-pan boilerless countertop unit or a freestanding 6-10 pan dual-compartment steam generator unit. Embedded energy of water is not included in these calculations but is discussed further in Section 8.4.

Table 9 below represents the energy and water use for baseline steamers per unit per year. Non-qualifying gas models are estimated to use between 557 and 1,401 therms of natural gas per unit per year. Nonqualifying electric models are estimated to use 6,987–16,395 kWh per unit per year. Non-qualifying gas models are estimated to use 4,485–81,546 gallons of water per unit per year, depending on the product class. Non-qualifying electric models are estimated to use 7,133–24,067 gallons of water per unit per year, depending on the product class.

Table 9 Annual Per Unit Energy and Water Use for Base Case

Product Class	Base case per unit consumption Electricity (kWh/yr-unit)	Base case per unit consumption Natural gas (therms/yr-unit)	Base case per unit consumption Water (gal/yr-unit)
Electric Boilerless	6,987	-	7,133
Electric Steam Generator	16,395	-	24,067
Gas Boilerless	-	557	4,485
Gas Steam Generator	-	1,401	81,546

Table 10 shows the energy and water use for qualifying equipment per unit per year. Compliant gas models are estimated to use between 162 and 611 therms of natural gas per unit per year. Compliant electric models are estimated to use 2,629 kWh–11,584 kWh per unit per year. Compliant gas models use approximately 2,333–16,103 gallons of water per unit per year, depending on the product class. Compliant electric models use approximately 876–8,960 gallons of water per unit per year, depending on the product class.

Table 10 Annual Per Unit Energy and Water Use for Measure Case

Product Class	Measure case per unit consumption Electricity (kWh/yr-unit)	Measure case per unit consumption Natural gas (therms/yr-unit)	Measure case per unit consumption Water (gal/yr-unit)
Electric Boilerless	2,629	-	876
Electric Steam Generator	11,584	-	8,690
Gas Boilerless	-	162	2,333
Gas Steam Generator	-	611	16,103

Table 11 summarizes the water and energy savings for compliant equipment. Compliant gas models are estimated to save between 395 and 790 therms of natural gas per unit per year. Compliant electric models are estimated to save 4,358–4,811 kWh of electricity per unit per year. Compliant gas model steamers are approximated to save 2,152–65,443 gallons of water per unit per year, depending on the product class. Compliant electric steamers are approximated to save 6,257–15,377 gallons of water per unit per year, depending on the product class.

Table 11 Annual Per Unit Water and Energy Savings

Product Class	Per unit savings Electricity (kWh/yr-unit)	Per unit savings Natural gas (therm/yr-unit)	Per unit savings Water (gal/yr-unit)
Electric Boilerless	4,358	-	6,257
Electric Steam Generator	4,811	-	15,377
Gas Boilerless	-	395	2,152
Gas Steam Generator	-	790	65,443

7. Cost-Effectiveness

This section describes the methodology the CASE Team used to analyze the economic impacts of the proposed standards.

7.1. Incremental Cost

To determine the incremental cost, the CASE Team obtained price data from six major online retailers for purchasing commercial food service equipment.

- Webstaurant Store
- Sterling Steamers
- KaTom
- Chefs Deal
- ACityDiscount
- Go!Foodservice

An average price was attributed to compliant and baseline models by fuel type, generation type, and number of pans. These costs did not include maintenance and repair. Instead, the CASE Team assumed the costs to be the same for the base and measure cases. The incremental cost between measure and base equipment ranges from -$2,801 to $3,024 depending on the configuration of fuel type, generation type, and quantity of pans. The CASE Team believes the four- to six-pan model analysis accurately represents the relative pricing of 3-pan models.

Limited data on baseline steamers exists as most available data such as the ENERGY STAR qualified product list focus on compliant models. Baseline boilerless steamers are plumbed, which typically makes them a more expensive type of steamer. As noted in Section 3, connected and connectionless boilerless products provide consumers with the same cooking performance and capacity amenities. While efficient connected boilerless steamers are available, they were not considered in the compliant case because most efficient boilerless products are connectionless. Connectionless boilerless products are typically more efficient so that they do not require constant water refilling, making water efficiency essential for continuous operation. As a result, most boilerless products that comply with regulations are also connectionless. Because compliant products are more likely to be connectionless, and these products are less expensive, the incremental costs are -$2,801 for gas and -$512 for electric boilerless models.

Table 12 Equipment Per Unit Costs

Product Class	Base Case Equipment Cost (2024 $)	Measure Case Equipment Cost (2024 $)	Incremental Equipment Cost (2024 $)
Electric Boilerless	12,900.00	12,388.00	-512.00
Electric Steam Generator	29,376.00	32,400.00	3024.00
Gas Boilerless	16,297.00	13,496.00	-2,801.000
Gas Steam Generator	28,391.00	29,196.00	805.00

7.2. Design Life

According to the eTRM, the steamers the CASE Team studied have a 12-year useful life. Therefore, compliant and non-compliant equipment share the same Effective Useful Lifetime. The technological differences between compliant and baseline products support this finding.

Table 13 Effective Useful Lifetime by Product Class

Product Class	Effective Useful Life of Equipment (years)
Electric Boilerless	12
Electric Steam Generator	12
Gas Boilerless	12
Gas Steam Generator	12

7.3. Lifecycle Cost and Net Benefit

Table 14 contains the costs and benefits of the proposed standards per unit and total lifecycle. These standards are cost effective for steamers using electric and gas steam generators. The lifecycle benefit-cost ratio for both classes supports this conclusion, as it is greater than 1. Additionally, both boilerless classes demonstrate immediate cost effectiveness because they incur no incremental measure cost.

The incremental cost of the proposed standards ranges from -$2,801.00 to $3,024.00, depending on the product class. The analysis does not include additional costs, such as added maintenance or installation costs; however, the CASE Team will work with stakeholders to understand these costs. See Section 7.1 for a further cost breakdown. The electricity and natural gas prices were estimated using the latest U.S. Energy Information Administration (EIA) data to reflect California consumer's average price. The annual escalation rates were estimated using price forecasts. The electricity price forecast was derived from the CEC's 2022 California Energy Demand Forecast (California Energy Commission, n.d.). The natural gas price forecast was derived from "Utility Costs and Affordability of the Grid of the Future: An Evaluation of Electric Costs, Rates and Equity Issues" (California Public Utility Commission 2021). Electricity and gas prices were increased per the annual escalation rates. Finally, the price of water was derived from a CEC Staff Report on landscape irrigation controllers and was assumed to remain constant at $6.13 per thousand gallons (California Energy Commission, 2023).

The CASE Team estimates total lifecycle benefits per unit compliant with the proposed standards range from $9,604.18 to $17,228.29, depending on the equipment class, as shown in Table 14. The proposed standards are cost effective if the benefit-cost ratio, which ranges from 4.86 to infinite, is above 1. Table 14 does not calculate paybacks or benefit-cost ratios for boilerless products due to the absence of incremental costs. These products are inherently cost effective.

Table 14 Per Unit Lifetime Economic Impacts for Products Purchased in the First Year

Product Class	Design Life (years)	Present Value of Benefits (2024$)	Present Value of Incremental Costs (2024 $)	Net Present Value (2024 $)	Simple Payback Period (years)	Lifecycle Benefit-Cost Ratio
Electric Boilerless	12	13,372.10	-	13,372.10	-	Infinite
Electric Steam Generator	12	14,698.61	3,024.00	11,674.61	1.98	4.86
Gas Boilerless	12	9,604.18	-	9,604.18	-	Infinite
Gas Steam Generator	12	17,228.29	805.00	16,423.29	0.45	21.40

8. Statewide Impacts

8.1. Annual Sales and Stock Turnover

8.1.1. Total Inventory based on CEC data

The CASE Team's analysis of California restaurant count data (Spoor, Zabrowski, Mills, & Fisher-Nickel, 2014) subdivided by restaurant types most likely to use steamers revealed that there were 45,415 steam compartments in 2009. Many steam generator steamers are dual compartments, while boilerless steamers are almost exclusively single compartments. Independent full-service restaurants accounted for almost half of the steamer counts, followed by education and healthcare food service, which accounted for another quarter combined. Accounting for population growth, it is estimated that there will be 48,917 full-size steamer compartments in California in 2024.

The number of commercial steam cooking compartments (0.49) per food service facility is derived by dividing the 2023 stock of California steamer compartments (49,000) by the 2023 California food service facility count (100,000).

The CASE Team's analysis of California commercial steamer rebate data (California Foodservice Instant Rebates Program n.d.) showed that 67% of the steamer rebates were for electric steamers. Based on the CASE Team's analysis of NAFEM data (NAFEM 2002), along with assumptions about steamer prices, revealed that 55% of the steamers sold are boilerless, while the remaining 45% are steam generators. The figures below provide context on the national market for steamers.

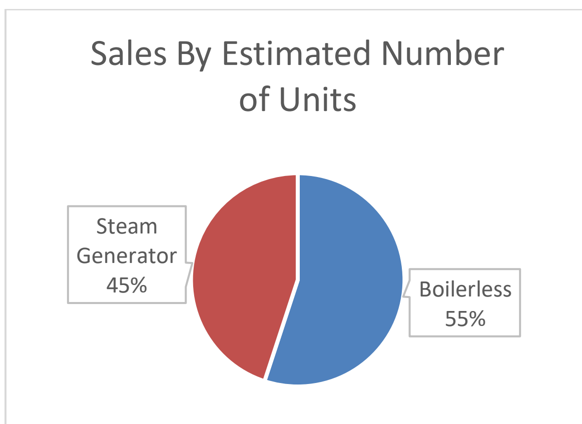

Figure 23 Sales by Estimated Number of Steamers

The total estimated California steamer compartment inventory of 49,000 was extrapolated for 67/33 electric/gas split and 45/55 steam generator/boilerless split and presented in Table 15 below.

Table 15 California Steamer Compartments Inventory (2022)

Product Class	CA Inventory	Share
Electric Boilerless	18,070	36.9%
Electric Steam Generator	14,890	30.4%
Gas Boilerless	8,748	17.9%
Gas Steam Generator	7,209	14.7%

8.1.2. Annual Shipments based on ENERGY STAR data

ENERGY STAR unit shipment data from 2022 (U.S. EPA ENERGY STAR 2022) showed 6,000 ENERGY STAR-certified commercial steamers sold in the United States. The CASE Team estimates that California accounted for 12.1% (California Foodservice Instant Rebates Program n.d.) of the nation's total restaurant count and applied this factor to calculate statewide savings.

Based on estimates, 726 ENERGY STAR-certified steamers are shipped to California per year. Assuming a market penetration rate of 39% (U.S. EPA ENERGY STAR 2022), the total number of steamers shipped to California is approximately 1,862 annually. Table 16 below shows the estimated number of steamers shipped to California each year, extrapolated by type based on percent of shipments from Table 15.

Table 16 California Steamer Annual Shipment Data

Product Class	CA Shipments	Percent of Shipments
Electric Boilerless	688	36.9%
Electric Steam Generator	567	30.4%
Gas Boilerless	333	17.9%
Gas Steam Generator	274	14.7%

The ENERGY STAR report on unit shipment data is the most accurate data available for shipments per year in California. ENERGY STAR reported these numbers in units shipped, and the CEC reported these numbers in terms of steam compartments. For the savings analysis the ENERGY STAR annual shipment data was extrapolated using useful life to arrive at California steamer inventory which is 22,000 steamers in the state.

8.2. Market Share of Qualifying Products

8.2.1. Current Market Share

The CASE Team gathered two commercial steamer sales market penetration estimates for units compliant with the proposed ENERGY STAR V1.2 standard levels.

According to an industry expert, the market penetration of ENERGY STAR-certified steamers varies by type. Steam generator steamers have a lower market penetration, representing less than 10% of sales.

ENERGY STAR-certified boilerless steamer models have a significantly higher market penetration, especially connectionless steamers, ranging from approximately 50% to over 70%.

ENERGY STAR unit shipment reports are based on data provided by commercial steamer manufacturers that participate in the program. The U.S. EPA ENERGY STAR 2022 report indicates a 39% compliance rate for the proposed ENERGY STAR V1.2 standard (U.S. EPA ENERGY STAR 2022). The CASE Team used this estimate and the total market data for boilerless versus steam generators to estimate the market penetration split.

8.2.2. Future Market Adoption of Qualifying Products

Commercial steamers meeting the proposed standards are widely available on the market. However, refurbished equipment on the secondary market presents a potential obstacle. A refurbished steamer is preowned and has undergone repairs and sometimes modifications from original manufacturer specifications. Given the small size of the refurbished market, its impact on the statewide savings outlined in this report would be negligible. The CASE Team is confident that a broad range of models from many manufacturers will meet the proposed standards and anticipates no significant obstacles for consumers in obtaining such models.

8.3. Statewide Water and Energy Savings – Methodology

The Case Team calculated statewide savings estimates using the per unit water and energy savings while factoring in the statewide stock and shipments forecast.

The CASE Team reviewed four categories: electric boilerless, electric with steam generator, gas boilerless, and gas with steam generator.

The CASE Team conducted separate analyses for each reviewed category and aggregated them to determine the statewide total. Section 8.1 of the report displays the market split of the four categories. The four groups used a shipment-weighted average (67/33 electric/gas split and 45/55 steam generator/boilerless split) for unit water and energy use for the relevant steamer categories.

The estimates presented in this report represent the savings achieved through implementing the ENERGY STAR V1.2 standards. As previously noted, these water and energy savings estimates pertain only to non-residential buildings. The CASE Team assumed when calculating statewide impacts that 39% of commercial steamers sold each year would meet the proposed standards, even if not adopted into Title 20 (U.S. EPA ENERGY STAR 2022).

8.4. Statewide Water and Energy Savings – Baseline and Compliant Case

Table 17 and Table 18 present the estimated first-year statewide water and energy use for baseline and compliant cases.

The proposed standard would have a first-year statewide savings of 3.49 GWh of electricity, 0.21 million therms of natural gas, and 19.32 million gallons of water.

Table 17 Estimated First-Year California Statewide Energy and Water Use for Baseline Case

Product Class	Electricity (GWh/yr)	Natural Gas (million therms/yr)	Water (million gallons/yr)
Electric Boilerless	3.64	0.00	3.23
Electric Steam Generator	8.23	0.00	10.25
Gas Boilerless	0.00	0.13	1.21
Gas Steam Generator	0.00	0.30	15.35
TOTAL	11.87	0.43	30.04

Table 18 Estimated First-Year California Statewide Energy and Water Use for Compliant Case

Product Class	Electricity (GWh/yr)	Natural Gas (million therms/yr)	Water (million gallons/yr)
Electric Boilerless	1.81	0.00	0.60
Electric Steam Generator	6.57	0.00	4.93
Gas Boilerless	0.00	0.05	0.78
Gas Steam Generator	0.00	0.17	4.41
TOTAL	8.38	0.22	10.72

Table 19 Estimated First-Year California Statewide Savings

Product Class	Electricity (GWh/yr)	Natural Gas (million therms/yr)	Water (million gallons/yr)	GHG Emissions (MT CO2e/yr)	Utility Bill Savings (million 2024 $/yr)
Electric Boilerless	1.83	0.00	2.63	164.94	0.32
Electric Steam Generator	1.66	0.00	5.32	150.06	0.29
Gas Boilerless	0.00	0.08	0.44	481.83	0.07
Gas Steam Generator	0.00	0.13	10.94	792.92	0.11
TOTAL	3.49	0.21	19.32	1,589.76	0.78

Table 20 summarizes the estimated statewide savings in the stock turnover year, which varies by equipment class based on effective useful lifetime. The CASE Team estimates these savings to be 41.92 GWh of electricity, 2.55 million therms of natural gas, and 231.84 million gallons of water.

Table 20 Estimated California Statewide Savings in the Year of Stock Turnover

Product Class	Year of Stock Turnover	Electricity (GWh/yr)	Natural Gas (million therms/yr)	Water (million gallons/yr)	GHG Emissions (MT CO2e/yr)	Utility Bill Savings (million 2024 $/yr)
Electric Boilerless	2038	21.95	0.00	31.51	1,979.31	4.13
Electric Steam Generator	2038	19.97	0.00	63.82	1,800.76	3.75
Gas Boilerless	2038	0.00	0.96	5.25	5,781.95	1.40
Gas Steam Generator	2038	0.00	1.58	131.26	9,515.05	2.30
TOTAL		41.92	2.55	231.84	19,077.07	11.58

The CASE Team calculated the embedded energy savings (savings from reduced water use) using the indoor energy factor of 5,440 kWh/million gallons of water included in Appendix A. With water savings of 232 million gallons per year at complete stock turnover, the embedded energy savings would be 1.3 GWh/yr. The incremental capital costs in the first full year of implementation are $0.4 million, and utility bill savings in the first year are $0.8 million.

8.5. Impact on California's Economy

Consumers most impacted by the proposed standards are owners and operators of commercial kitchens, including commercial food service establishments (e.g., restaurants and hotels) and institutional kitchens (e.g., hospitals, schools, and prisons). As noted in Section 8.1, California has approximately 100,000 food service facilities (76,750 commercial food service facilities and 20,110 institutional facilities). Most restaurants are considered small businesses because they employ fewer than 50 people, although this number includes many chain restaurants and those owned by larger firms. Additionally, in California, 58% of restaurants are minority-owned, and 32% are majority-owned by women. The most significant impact on owners and operators will likely be the increased upfront costs of purchasing a new commercial steamer. However, as indicated above, these owners and operators will experience considerable lifecycle cost benefits and rapid paybacks.

At least 147 commercial food service dealers sell to the state of California, not including online retailers.[1] Depending on the products they currently make, stock, and sell, manufacturers, retailers, and distributors would be impacted differently. As previously discussed, several manufacturers make compliant products, representing 39% of current sales, and the impact on manufacturers and distributors that sell these products would be relatively small. All parties must update stock and comply

[1] Based on statewide participation in foodservice incentive programs.

with the standards, resulting in increased administrative costs. For steam generator products, the increased incremental costs of compliant products will result in larger profit margins for these manufacturers and distributors, offsetting these compliance costs. However, boiler products with no incremental costs may experience reduced profit margins. The standards would likely adversely impact manufacturers that predominately make non-compliant products and the distributors that stock and sell these models. These manufacturers would shift distribution towards compliant product lines, develop new compliant products, or exit the California market. As noted, the proposed standards provide significant consumer choice from various manufacturers. These manufacturers have spent over two decades developing products aligned with the ENERGY STAR V1.2 specification. Distributors and other market actors who predominantly sell non-compliant products may have to change suppliers or alter current practices.

The CASE Team considered only the direct water and energy savings for consumers when calculating lifecycle benefits. This analysis does not incorporate savings related to reduced HVAC loads, water tempering, or other ancillary benefits from more efficient equipment.

To estimate the first-year statewide utility bill savings, the CASE Team multiplied the statewide electricity, fuel, and water savings in the standard's first effective year by the corresponding energy and water prices. Similarly, the team calculated the statewide savings for the stock turnover year by multiplying the year's fuel and water savings with the year's electricity, fuel, and water prices.

The incremental capital costs in Table 21 range from -$0.57 million to $1.05 million. Utility bill savings in the first year range from $0.07 million to $0.32 million, with the total utility bill savings being $0.78 million.

Table 21 Statewide Economic Impacts Occurring in the First Year

Product Class	Incremental Capital Costs (million 2024 $)	Utility Bill Savings (million 2024 $)
Electric Boilerless	-0.21	0.32
Electric Steam Generator	1.05	0.29
Gas Boilerless	-0.57	0.07
Gas Steam Generator	0.13	0.11
TOTAL	0.40	0.78

Table 21 presents the statewide lifetime economic impacts for products purchased in the first year, as opposed to per unit. The total value of benefits, realized by the end of the effective useful 12-year lifetime for steamers in each equipment class, is projected to be worth $25.45 million in the effective year (2024), with incremental costs amounting to $1.94 million, resulting in a net present value of $23.52 million.

Table 22 Statewide Lifetime Economic Impacts for Products Purchased in the First Year

Product Class	Present Value of Benefits (million 2024 $)	Present Value of Incremental Costs (million 2024 $)	Net Present Value (million 2024 $)
Electric Boilerless	9.20	-	9.20
Electric Steam Generator	8.33	1.71	6.62
Gas Boilerless	3.20	-	3.20
Gas Steam Generator	4.72	0.22	4.50
TOTAL	25.45	1.94	23.52

8.6. Environmental and Societal Impacts

A more efficient commercial steamer saves owners and operators significant energy and water. Most costs associated with building and operating a utility infrastructure are fixed. Thus, the overall utility and water agency costs are treated as relatively consistent, even if using more efficient steamers decreases the electric or gas demands and the volume of water treated and distributed daily. This proposal is unlikely to significantly impact the capacity of the electric or gas grid and wastewater conveyance and treatment systems.

The proposed standards will not change the types of materials used in commercial steamers or the number of materials used, nor will they make noteworthy modifications to the manufacturing process. The CASE Team does not expect these standards to have significant environmental impacts. This proposal should not impact aesthetics, biological resources, geology, hydrology, recreation, agriculture, cultural resources, land use, transportation, housing, mineral resources, public services, or tribal cultural resources.

9. Implementation Plan

The CASE Team foresees a straightforward implementation process for the proposal. The team anticipates active outreach and engagement from Energy Code Ace to help manufacturers understand the compliance process and support product certification. Furthermore, the MAEDbS system can work with SASD and ENERGY STAR to facilitate multi-jurisdictional compliance, reduce regulatory burdens, and enhance industry collaboration. Manufacturers have expressed a desire for this coordination in interviews conducted during the report's development. The team also encourages decision-makers to pursue the other components outlined in Section 2 (Introduction) of the comprehensive approach.

10. Other Legislative and Regulatory Considerations

10.1. Federal Legislative and Regulatory Background

Commercial steamers are currently not regulated by the United States (U.S.) Department of Energy (DOE). Furthermore, the DOE lacks the authority to regulate these products under current law (42 US Code). The proposed standards for commercial steamers are similar to the voluntary requirements set forth by the EPA for the ENERGY STAR program.

10.2. California Legislative and Regulatory Background

Title 20 does not have existing requirements for commercial steamers. The California Building Standards Commission (CBSC) has established voluntary commercial steamer standards for water usage, expecting that steamers be either connectionless or boilerless according to Section A5.303.3 of Title 24, Part 11 of the California Code of Regulations. Furthermore, the voluntary standards limit water use to 2 gallons/pan for “batch type” steamers and 5 gallons/pan for “cook to order” steamers. A “batch type” steamer is equivalent to a boilerless steamer, while a “cook to order” steamer reflects à la carte cooking typically undertaken by steam generator products.

California Title 24, Part 6 Section 140.9(b) contains specific prescriptive requirements for commercial kitchens, but these sections address ventilation, not steamer performance.

Commercial steamers may be required to lower the temperature of hot water discharge to below 140°F before it enters the sanitary sewer system, leading to increased water use due to the need for external cooling water. The water usage related to tempering with external cooling water is not measured in the recommended water use test methods for steamers, nor is it included in the analysis presented in this CASE Report. However, the proposed standards would likely reduce the amount of tempering water required as it uses less hot water. Overall, the proposed standards outlined in this report do not conflict with the California Plumbing Code.

The CASE Team could only find one direct reference to governing regulations related to commercial steamers in a California municipal code. In the Los Angeles Municipal Code, steamers are among several appliances, such as electric boilers and sprinkler tanks, that require annual inspection by the building’s superintendent (Section 97.0310 Pressure Vessels and Other Equipment to be Inspected Annually) (Los Angeles Municipal Code n.d.).

10.2.1. Utility and Other Incentive Programs

California IOUs offer $2,000 incentives for gas and $1,500 for electric per compartment for atmospheric commercial steamers that meet current ENERGY STAR requirements through the California Energy Wise point-of-sale commercial food service rebate program.

ENERGY STAR’s website lists 50 utilities outside of California that offer rebates for commercial steamers (US ENERGY STAR n.d.). The CASE Team has not independently verified this information and has not identified other municipal or regional water districts or utilities offering rebates for California commercial steamers.

10.3. Other State Standards

Commercial steamers are part of the Model Bill developed by the Appliance Standards Awareness Project (ASAP). More than ten states have adopted standards for these products and generally align with the ENERGY STAR V1.2 criteria for all product categories. The first standards for these products were adopted by Vermont in 2018, with several additional states following shortly after. However, many states lack a significant compliance and enforcement mechanism, so many manufacturers and market actors may not be aware of these existing standards. Several states, including New York and Massachusetts, use the SASD to determine compliance. The proposed standards align with those in other states and provide consistency across the industry.

10.4. Model Codes and Voluntary Standards

Both government and nongovernment organizations have made significant progress in creating model building codes and voluntary standards. These codes and standards were developed through a thorough process involving public review and the participation of industry stakeholders to enhance the efficiency of steamers. However, while providing efficiency guidelines, the voluntary standards may only apply to certain steamers, such as "connectionless" or "boilerless" models. The CASE Team concluded that it was not appropriate to mandate such a prohibition on other product types.

Moreover, some water requirements might disqualify a few products currently holding ENERGY STAR qualifications, leading to discrepancies between the ENERGY STAR program and other state standards, thereby complicating compliance. The proposed water efficiency standards are stricter than some codes, closely aligning with the most stringent voluntary codes, and result in only marginally fewer water savings. The CASE Team evaluated several model building codes and voluntary standards, which are listed below:

2021 International Association of Plumbing and Mechanical Officials Green Plumbing and Mechanical Code Supplement for use with all Codes (IAPMO GPMCS) and 2024 IAPMO GPMCS Proposed Changes for Public Comment: Developed by the International Association of Plumbing and Mechanical Officials through a public vetting process. The proposed changes for 2024 are currently undergoing public review. These standards require boilerless steamers to use no more than 2 gallons/compartment and steam generator products to use no more than 1.5 gallons/pan (International Association of Plumbing and Mechanical Officials Green Plumbing and Mechanical Code Supplement 2024). These provisions also require combi ovens to use no more than 1.5 gallons/pan. The anticipated release date for the final standards is the fall of 2024. More information is available at: www.iapmo.org.

International Green Construction Code 2021 (IgCC): Developed by the International Code Council through a public vetting process. This code requires the adoption of boilerless/connectionless steamers that use no more than 2 gallons/hour/pan.[2] More information is available at: http://www.iccsafe.org/CS/IGCC/Pages/default.aspx.

Leadership in Energy and Environmental Design (LEED) Building Design and Construction Rating System, Version 4.1: Developed by the U.S. Green Building Council through public vetting. LEED has both minimum requirements and credits available for more efficient steamers. The minimum requirements are 6 gallons/pan for batch (boilerless) steamers and 10 gallons/pan for cook-to-order

[2] Section 601.3.2.5(c)

(steam generator) steamers (US Green Building Council 2019). The credit eligibility is only for connectionless boilers and is 2 gallons/pan for batch (boilerless) and 5 gallons/pan for cook-to-order (steam generator). LEED is currently reviewing Version 5 Criteria. More information is available at: http://www.usgbc.org/leed.

ENERGY STAR is a program developed by the EPA through a process that relies on market, engineering, and pollution savings analyses and includes input from other EPA programs and industry and non-industry stakeholders. More information is available at: http://www.energystar.gov.

ENERGY STAR is considered the most influential among the model codes and voluntary standards mentioned above. Most model codes establish efficiency requirements that align with ENERGY STAR. The current recognition criteria have been in place since 2003 and were developed with input from the industry. Although ENERGY STAR has suggested revisiting the performance requirements for steamers, this process has yet to begin. The proposed standards for steamers are expected to align with the existing ENERGY STAR performance criteria.

National Model Commercial Energy Codes (ASHRAE 90.1-2022 and 2024 International Energy Conservation Code (IECC)): The most recent version of the national model commercial energy codes adopted by states includes a section (Chapter 11 in ASHRAE 90.1-2022 and Section C406 in the 2024 IECC) which requires commercial buildings following the prescriptive pathway to achieve a certain number of energy credits from a list of options. Choosing more efficient steamers is one of the options in the national model codes that will allow one to achieve energy credits and comply with the code through the prescriptive pathway. Although California does not adopt either ASHRAE 90.1 or the IECC, measures in the national model codes could be considered for adoption in California’s Title 24.

11. Response to Request for Information

This section is presented in a question-and-answer format and contains the 18 questions reprinted without modifications from the Request for Information docketed by the CEC on November 14, 2023, to Docket 23-AAER-01 (California Energy Commission, 2023). The CASE Team's answers are specific to steamer cookers, the technology addressed in this report. Future CASE Reports will cover other food service technologies separately.

1. Based on RFI Table 1, are there additional classifications that should be considered in scope or out-of-scope? Based on what factors?

Table 23 RFI Table 1 Commercial Food Service Equipment Scope from CEC

Commercial Food Service Equipment Appliance	Classifications
Commercial Steam Cookers	Natural Gas
Commercial Steam Cookers	Electric
Commercial Dishwashers	Electric
Commercial Convection Ovens	Natural Gas
Commercial Convection Ovens	Electric
Commercial Fryers	Natural Gas
Commercial Fryers	Electric

Source: California Energy Commission

For the equipment scope, the CASE Team suggests the CEC adjust its existing classifications with the following:

- Gas Boilerless
- Gas Steam Generator Atmospheric
- Electric Boilerless
- Electric Steam Generator Atmospheric
- Gas Steam Generator Pressure
- Electric Steam Generator Pressure

The first four of these product categories are within the scope of the CASE Report and the CASE Team's proposed standards, whereas the final two (i.e., Gas Steam Generator Pressure and Electric Steam Generator Pressure) are out of scope. All boilerless steamers are atmospheric.

The CASE Team has divided commercial steamers into two major categories: atmospheric and pressure steamers. Atmospheric steamers operate at around 212°F and provide cooking temperatures and speeds to support most commercial food service applications, including restaurants and specific institutional settings. Atmospheric steamers are the most common in the market due to the wide variety of cooking applications in commercial settings. Pressure steamers, the second category of commercial steamers, generate superheated steam and typically operate between 5-15 psi. This steamer is mainly used for high-volume cooking in institutional settings. It cooks at temperatures up to 250°F, resulting in shorter cook times.

For additional insight into these two classifications and the equipment subclassifications of steamers, the CASE Team refers to Section 3 (Product and Technology Description).

2. What definitions are useful to describe Steam Cookers, Dishwashers, Ovens, and Fryers? Are there distinct characteristics within Steam Cookers, Dishwashers, Ovens, and Fryers that would allow multiple uses?

The CASE Team has several proposed definitions for the CEC's review, including "Commercial Steam Cooker," "Steam Cooker," and pressure and atmospheric steam cookers.

The CASE Team refers readers to Section 4.2.1 (Proposed Definitions) for specific details on these definitions.

3. Steam Cookers, Dishwashers, Ovens, and Fryers are found in commercial and institutional settings such as hospitals, schools, etc., are there other unique settings that staff should investigate?

The CASE Team has no suggestions for any unique commercial and institutional settings that utilize steamers for the CEC to investigate.

4. Are there other efficient technologies available on the market for Steam Cookers, Dishwashers, Ovens, and Fryers? Are there new or upcoming technological developments for Steam Cookers, Dishwashers, Ovens, and Fryers?

The CASE Team is unaware of other available efficient technologies in the steamer marketplace.

5. Are there alternatives for Steam Cookers, Dishwashers, Ovens, and Fryers used by the food service industry that would achieve the same functions of those appliances? For example, are air fryers a viable efficient alternative to Fryers that use oil?

In its report, the CASE Team highlighted that with the proposed standards, customers could use combination (combi) ovens instead of steamers as a potential solution to meet large-scale food steaming needs for small-to-medium-sized restaurants and commercial kitchens. These ovens combine a convection oven and a steamer, can operate as steamers for vegetables and small amounts of seafood, and act as traditional baking appliances. The CASE Team's research report states that adversely strict regulations on steamers could push consumers toward combi ovens because of increasing market adoption and the overall cost-effectiveness of combi ovens. However, the CASE Team is confident its proposed standards will not impact this market trend. The CASE Team encourages CEC Staff to review Section 5.2.2 (Consumer Utility and Acceptance) for a more detailed explanation of combi ovens and their increasing utilization in the commercial kitchen marketplace.

6. The EnergyStar program provides a voluntary way to certify the efficiency of very efficient options on the listed appliances of RFI Table 1, are there other approaches available that CEC should be aware of? Please include references to publicly available sources.

The CASE Team would like to inform the CEC of alternative certification approaches for steamers beyond the Energy Star program. Manufacturers have three other voluntary methods to certify the efficiency of their appliances:

- 2021 International Association of Plumbing and Mechanical Officials Green Plumbing and Mechanical Code Supplement for use with all Codes (IAPMO GPMCS) and 2024 IAPMO GPMCS Proposed Changes for Public Comment
- International Green Construction Code 2021 (IgCC)
- Leadership in Energy and Environmental Design (LEED) Building Design and Construction Rating System, Version 4.1

The CASE Team refers readers to Section 10.4 (Model Codes and Voluntary Standards) for additional and more specific information on these voluntary methodologies.

7. What inspections or test methods should CEC staff use to verify compliance with each efficiency requirement?

The CASE Team suggests the CEC staff incorporate the ASTM Standard F1484-18 as the testing component for steamers in California. This well-established standard can effectively determine commercial steamers' energy efficiency, water consumption, and production capability. The test procedure involves using red potatoes as a test medium and outlines how to measure commercial steamers' idle energy rates and water consumption. ENERGY STAR references the F1484-99 for its V1.2 procedure. The CASE Team expects ENERGY STAR to update its specifications to the most recent (F1484-18) ASTM version within one to two years. For more information on the ASTM Standard F1484-18 test procedure, refer to Section 4.2.2 (Proposed Test Procedure).

8. Is there current research or advancement by industry to improve the efficiency of the appliances listed in Table 1?

Based on the CASE Team's research, after optimizing the cooking efficiency and standby idle energy rate, the most effective way to improve steamer efficiency is to refine the controls. Most steamers have simple mechanical timers that turn steam generation on and off and cannot determine whether food is in the cooking cavity. The most significant source of energy waste for steamer cookers is when the machine enters idle operation. Setback idle mode is the best opportunity for energy efficiency. This mode allows for a short preheat time but keeps the steam generation compartment temperature below 180°F to save energy. Currently, manufacturers use different control strategies to engage and disengage setback idle modes. After one hour of inactivity following the last cook cycle, some units idle in a setback mode. Some steamers have sensors to detect food and produce steam, but this is not typical. However, some combi ovens have this feature in steam mode. The CASE Team refers readers to Section 5.1 (Product Efficiency Opportunities) for additional information on this potential efficiency opportunity for steamers.

9. What is the market share of each identified classification of each appliance listed in RFI Table 1? Based on RFI Table 1, are there additional examples that should be considered in scope or out-of-scope? Based on what factors?

The CASE Team's analysis of California restaurant count data, subdivided by restaurant types more likely to use steamers, revealed 45,415 steam compartments in use in 2009. Independent full-service restaurants comprised nearly half of the steamer counts, followed by educational institutions and healthcare food services, constituting another quarter. California is estimated to have 48,917 full-size steamer compartments by 2023, accounting for population growth. The number of commercial steam cooking compartments (0.49) per food service facility is derived by dividing the 2023 California stock of steamers (49,000) by the 2023 California food service facilities count (100,000). Based on unpredictable sales growth in the food service industry due to the pandemic, the CASE Team projected a market growth rate of 0 percent for commercial steamers. For additional information, the CASE Team refers readers to Section 8.1 (Annual Sales and Stock Turnover).

10. What percent of the listed appliances in RFI Table 1 are leased or sold in California?

It is estimated that the leased steamer market is very small as this is a cooking appliance that can be easily damaged by poor water quality if improper water filtration is installed and maintained. It is estimated that almost all steamers in California are sold instead of leased.

In Section 8.1 (Annual Sales and Stock Turnover), the CASE Team analyzed steamer sales in California, estimating an annual figure of 726 units. Table 16 in the same section reveals that most of these are electric boilerless models (36.9%), followed by electric steam generators (30.4%). Both boilerless (17.9%) and steam generator (14.7%) gas models have a lower market share because electric steamers are compact and cost effective.

11. Please provide an estimate of the current installed stock in California for each of the appliances listed in RFI Table 1. What sources of information are available to estimate current and projected stock in California?

The CASE Team research estimates California has approximately 22,000 steamers with 49,000 steamer compartments installed. Electric boilerless steamer compartments constitute 36.9% (18,070), electric steam generator compartments 30.4% (14,890), gas boilerless 17.9% (8,748), and gas steam generator compartments 14.7% (7,209). Section 8.1 (Annual Sales and Stock Turnover) explains the CASE Team's methodology for determining this estimation. Note that appliances within the product classes may have one or more steamer compartments.

12. What is the retail cost per unit or differential within each appliance category for Steam Cookers, Dishwashers, Ovens, and Fryers?

According to the CASE Team's analysis of the California steamer marketplace, the per unit cost depends on the unit's relative size and the fuel used to generate energy. Boilerless steamers are typically less expensive than steam generators due to their smaller size and food volume requirements for preparation.

A boilerless gas steamer has a baseline cost of $16,297, while its electric counterpart costs $12,900. Similarly, a gas steam generator costs $28,391, and an electric steam generator costs $29,376. The team collected price data from six major online retailers that sell commercial food service equipment to determine each steamer's incremental cost. These online retailers are:

- Webstaurant Store
- Sterling Steamers
- KaTom
- Chefs Deal
- ACityDiscount
- Go!Foodservice

The CASE Team refers readers to Section 7.1 (Incremental Cost) for a more in-depth explanation of the team’s research analysis.

13. What is the installation cost per unit? What is the replacement cost per unit?

The CASE Team does not have data on the installation and replacement costs of electric or gas steamers.

14. What is the average lifetime of each appliance listed in RFI Table 1? What assumptions for product lifetime should staff consider for the listed appliances, and why? How do product lifetimes vary per product type within each appliance listed in RFI Table 1? Please provide published sources of information.

Based on the CASE Team's research and analysis of eTRM data, the average lifetime for all gas and electric steamers reviewed in this report is 12 years. The team found no significant differences between steamers that comply with current standards and those that do not. Section 7.2 (Design Life) details how the team reached the 12-year average lifespan metric.

15. What is the average run time for each of the appliances listed in RFI Table 1? Do they vary by product type?

The CASE Team estimates run time per assumptions in Sections 6.1 and 6.2. See also Appendix B for assumptions used to estimate steamer energy use.

16. Do manufacturers provide a broad product offering for the listed appliances?

Manufacturers provide customers with a broad list of steamers based on institution size, food volume, and preferred energy source, i.e., gas or electricity. The CASE Team reviewed products from six different online retailers to understand the variety of offerings by major market manufacturers. The team used this information to develop its analysis of California steamers.

17. How many small businesses are involved in the manufacturing, sale, or installation of the listed appliances in California? How might small businesses be affected by any changes to the listed appliances?

Most steamers are produced outside of California, the CASE team is unaware of steamers produced in California.

Businesses that specialize in steamer repair should be unaffected as customers will continue to need service for energy efficient steamers. Equipment distributors that sell steamers in California should not be affected as they can continue selling efficient steamers, which are available from most major manufacturing brands.

18. What are the potential impacts and benefits the proposed standards may have for consumers (i.e., users of these appliances)?

Based on the CASE Team's research methodology, the proposed standard would have a first-year statewide savings of 3.49 GWh of electricity, 0.21 million therms of natural gas, and 19.32 million gallons of water. More efficient commercial steamers provide significant energy and water savings for owners and operators of steamers.

The CASE Team refers readers to Section 0 (Statewide Impacts) for a complete list of the potential impacts and benefits of the proposed standards for consumers and businesses that use steamers.

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Appendix A: Embedded Electricity Usage Methodology

The CASE Team assumed the following embedded electricity in water values: 5,440 kWh/million gallons of water for indoor and 3,280 kWh/million gallons for outdoor water use.[3] Embedded electricity for indoor water use includes water extraction, conveyance, treatment to potable quality, water distribution, wastewater collection, and wastewater treatment. Embedded electricity for outdoor water use includes all energy uses upstream of the customer. It does not include wastewater collection or wastewater treatment. The embedded electricity values do not include on-site energy consumption associated with water use (e.g., the energy required for water heating or on-site pumping).

These embedded electricity values were derived from research conducted for CPUC Rulemaking 13-12-011. The CPUC study aimed to quantify the embedded electricity savings associated with IOU incentive programs that result in water savings. The findings represent the CPUC's most up-to-date research on embedded energy in water throughout California.[4] This study resulted in the Water-Energy (W-E) Calculator 1.0, updated to Version 2.0 (SBW Consulting, Inc. 2022) in February 2022. The CPUC analysis was limited to evaluating the embedded electricity in water and did not include embedded natural gas in water use. For this reason, this CASE Report does not include estimates of embedded natural gas savings associated with water reductions.

For the code change proposal presented in this report, the CASE Team used embedded electricity value for indoor water use only.

[3] SBW Consulting, Inc. 2022. Water-Energy Calculator 2.0 Project Report. Prox ject Report, San Francisco: California Public Utility Commission, February 22, 2022. https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/water-energy-nexus/we-calc20-project-report.pdf.

[4] Water/Energy Cost-Effectiveness Analysis: Revised Final Report. Prepared by Navigant Consulting, Inc. https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/energy-efficiency/water-energy-nexus-programs.

Appendix B: Steamers Energy and Water Use Assumptions

Section 6.2 of the report describes the methodology for calculating energy savings. The Table 25 shows the key assumptions for each baseline and compliant steamer subcategory. These assumptions include the preheat time, preheat energy, idle energy rate, cooking efficiency, and water consumption. Compliant steamers have lower idle rates and higher cooking efficiency than baseline steamers. The values for baseline steamers represent the average lab test data points for those that meet and do not meet energy-efficiency criteria. Most compliant steamers exceed the proposed efficiency threshold, so the average values of energy efficient steamers were used and presented below.

Table 24 CASE Report Energy Savings Methodology (Average)

Assumptions	Electric Boilerless	Electric Steam Generator	Gas Boilerless	Gas Steam Generator
Baseline	Average performance of units that do not meet ESTAR	Average performance of units that do not meet ESTAR	Average performance of units that do not meet ESTAR	Average performance of units that do not meet ESTAR
Efficient	Average performance of units that meet ESTAR	Average performance of units that meet ESTAR	Average performance of units that meet ESTAR	Average performance of units that meet ESTAR

Table 25 Efficiency Assumptions for Baseline and Compliant Steamers (average efficient)

Fuel	Steam generation type	Efficiency	Preheat time (min)	Preheat energy (kWh or Btu)	Idle energy rate (kW or Btu/h)	Idle water consumption (gal/h/pan)	Cooking efficien cy (%)	Cooking water consumption (gal/h/pan)	Production capacity (lb/h)
Electric	Boilerless	Baseline	11.0	1.56	1.74	0.33	51%*	0.95	114
Electric	Boilerless	Compliant	13.2	1.78	0.26	0.00	68%	0.40	111
Electric	Steam Generator	Baseline	11.0	1.56	2.94	0.22	51%*	1.98	114
Electric	Steam Generator	Compliant	13.2	1.78	0.30	0.00	64%	0.76	122
Gas	Boilerless	Baseline	11.8	27,614	11,485	0.22	20%	0.50	124
Gas	Boilerless	Compliant	13.4	9,778	2,291	0.12	46%	0.24	120
Gas	Steam Generator	Baseline	11.8	27,614	11,013	3.35	20%	3.73	124
Gas	Steam Generator	Compliant	13.4	9,778	4,395	0.21	41%	2.07	114

*The 51% energy-efficiency baseline is above the proposed 50% threshold because it represents the average efficiency of all steamers that did not qualify for the energy efficiency **and** idle criteria. The electric baseline dataset contained seven steamer models with efficiency ranging from 67% to 31%. Four of the seven models had energy efficiencies above 50%; however, they had idle rates above 900W, exceeding the proposed 800W energy efficiency threshold for 6-pan electric steamers.

Appendix C: Alternative Steamer Savings Analysis

The CASE Team conducted an alternate analysis of the energy savings and cost that the energy-efficient equipment performance is equal to the proposed standards for cooking efficiency and standby idle energy rate. The alternative method yields results consistent with CEC's energy savings and cost-effectiveness calculations from prior appliance efficiency rulemakings. Specifically, this method estimates the power consumption of compliant products based on minimum requirements to meet the proposed regulations. Products were assumed to consume the bare minimum power to accomplish the standard. In situations where the baseline power of a given mode was already more efficient than the standard, the report assumes that power will not increase but remain the same.

Table 26 CASE Report Energy Savings Methodology (Threshold)

Assumptions	Electric Boilerless	Electric Steam Generator	Gas Boilerless	Gas Steam Generator
Baseline	Average performance of units that do not meet ESTAR	Average performance of units that do not meet ESTAR	Average performance of units that do not meet ESTAR	Average performance of units that do not meet ESTAR
Compliant	ESTAR V1.2 threshold for idle energy, efficiency to match the baseline	ESTAR V1.2 threshold for idle energy for 6 pans, efficiency to match the baseline	ESTAR V1.2 threshold, 5 pan idle rate	ESTAR V1.2 threshold for efficiency, idle rate to match the baseline as it is below the 6 pan threshold

Table 27 Efficiency Assumptions for Baseline and Efficient Steamers (ESTAR threshold)

Fuel	Steam generation type	Efficiency	Preheat time (min)	Preheat energy (kWh or Btu)	Idle energy rate (kW or Btu/h)	Idle water consumption (gal/h/pan)	Cooking efficiency (%)	Cooking water consumption (gal/h/pan)	Production capacity (lb/h)
Electric	Boilerless	Baseline	11.0	1.56	1.74	0.40	51%*	1.14	114
Electric	Boilerless	Compliant	13.2	1.78	0.67	0.00	51%	1.14	111
Electric	Steam Generator	Baseline	11.0	1.56	2.94	0.22	51%*	1.98	114
Electric	Steam Generator	Compliant	13.2	1.78	0.80	0.00	51%	1.98	122
Gas	Boilerless	Baseline	11.8	27,614	11,485	0.27	20%	0.60	124
Gas	Boilerless	Compliant	13.4	9,778	10,400	0.14	38%	0.60	120
Gas	Steam Generator	Baseline	11.8	27,614	11,013	0.5	20%	6.88	124
Gas	Steam Generator	Compliant	13.4	9,778	11,013	0.32	38%	3.00	114

Table 28 shows the per unit energy and water savings per the alternative performance assumptions. Energy and water savings per unit are lower as the performance assumptions for the compliant products than those assumed for the CASE Report analysis.

Table 28 Annual Per Unit Water and Energy Savings

Product class	Per unit savings Electricity (kWh/yr-unit)	Per unit savings Natural gas (therm/yr-unit)	Per unit savings Water (gal/yr-unit)
Electric Boilerless	2,787	-	5,098
Electric Steam Generator	1,467	-	1,445
Gas Boilerless	-	164	1,635
Gas Steam Generator	-	672	45,115

The table below provides economic impacts and cost-effectiveness values for the alternative calculation. The cost effectiveness is lower as the increase in performance is less, while the incremental cost remains same as the CASE Report analysis.

Table 29 Per Unit Lifetime Economic Impacts for Products Purchased in the First Year

Product Class	Design Life (years)	Present Value of Benefits (2024$)	Present Value of Incremental Costs (2024 $)	Net Present Value (2024 $)	Simple Payback Period (years)	Lifecycle Benefit Cost Ratio
Electric Boilerless	12	8,801.17	-	8,801.17	-	Infinite
Electric Steam Generator	12	4,289.83	3,024.00	1,265.83	6.80	1.42
Gas Boilerless	12	5,669.54	-	5,669.54	-	Infinite
Gas Steam Generator	12	14,029.78	805.00	13,224.78	0.55	17.43

Table 30 shows the statewide savings in the stock turnover year for the alternative calculation method. The statewide savings are lower than the CASE Report savings due to the lower performance assumption of the compliant products. The compliance rate and stock numbers use the same assumptions as the CASE Report analysis.

Table 30 Estimated California Statewide Savings in the Year of Stock Turnover

Product Class	Year of Stock Turnover	Electricity (GWh/yr)	Natural Gas (million therms/yr)	Water (million gallons/yr)	GHG Emissions (MT CO2e/yr)	Utility Bill Savings (million 2024 $/yr)
Electric Boilerless	2,038	14.04	0.00	25.67	1,265.80	2.64
Electric Steam Generator	2,038	6.09	0.00	6.00	549.10	1.14
Gas Boilerless	2,038	0.00	0.40	3.99	2,400.61	0.58
Gas Steam Generator	2,038	0.00	1.35	90.49	8,093.81	1.96
TOTAL		20.12	1.75	126.14	12,309.32	6.32

Table 31 compares the simple payback period and lifecycle benefit-to-cost ratio of for different product classes when averaged assumptions/methodology (assumptions used in the CASE Report analysis) and threshold assumptions/methodology were used. As shown in Table 31, simple payback period increases, and lifecycle benefit-to-cost ratio reduces for electric steam generator and gas steam generator due to threshold methodology.

Table 31 Comparison of Per Unit Economic Impacts for Products Purchased in the First Year for Averaged Methodology and Threshold Methodology

	Averaged Assumption		Threshold Assumption	
Product Class	**Simple Payback Period (years)**	**Lifecycle Benefit Cost Ratio**	**Simple Payback Period (years)**	**Lifecycle Benefit Cost Ratio**
Electric Boilerless	-	Infinite	-	Infinite
Electric Steam Generator	1.98	4.86	6.80	1.42
Gas Boilerless	-	Infinite	-	Infinite
Gas Steam Generator	0.45	21.40	0.55	17.43

Appendix D: Electricity and Natural Gas Price Forecasts

Table 32 shows the electricity and natural gas price forecasts for 2022 to 2050. These prices were estimated using two sources from EIA: "Electric Power Monthly" (US Energy Information Administration (EIA), 2023) and "California Price of Natural Gas Sold to Commercial Consumers" (US Energy Information Administration (EIA), 2023) for the latest data on the average price California consumers paid for electricity and natural gas. The average electricity price was from August 2023 and the average natural gas price July 2023. The annual escalation rates were calculated using price forecasts. The electricity price forecast was derived from the CEC's 2022 California Energy Demand Forecast (California Energy Commission, n.d.).

The annual escalation rates were calculated for electricity and natural gas based on price forecasts. The electricity price forecast was derived from the California Energy Demand Forecast published by CEC in 2022 (California Energy Commission, n.d.) and the natural gas price forecast was derived from the California Public Utility Commission's 2021 report "Utility Costs and Affordability of the Grid of the Future: An Evaluation of Electric Costs, Rates and Equity Issues" (California Public Utility Commission, 2021). Because the sources used by the CASE Team for price forecasts were often less specific to California and/or less recent than the sources used for current marginal prices, the CASE Team forecasted actual future marginal electricity and natural gas prices by applying the calculated annual escalation rates to the current marginal prices. The CASE Team forecasted marginal prices in future years in 2024 dollars to make all years' marginal prices more comparable without needing to account for the effects of inflation. This also enabled the CASE Team to calculate the present value of utility bill savings in future years using the selected real discount rate.

Table 32 Electricity and Natural Gas Price Forecasts

Year	Electricity (Cents per kWh)	Natural Gas (Dollar per million Btu)
2022	19.74	11.24
2023	19.21	11.78
2024	19.01	12.35
2025	19.43	12.94
2026	19.51	13.56
2027	19.68	14.21
2028	19.96	14.89
2029	20.15	15.61
2030	20.22	16.36
2031	20.2	17.14
2032	20.31	17.96
2033	20.46	18.83
2034	20.61	19.73
2035	20.81	20.68

Year	Electricity (Cents per kWh)	Natural Gas (Dollar per million Btu)
2036	20.9	21.67
2037	20.98	22.71
2038	21.07	23.8
2039	21.16	24.94
2040	21.24	26.14
2041	21.33	27.39
2042	21.42	28.71
2043	21.51	30.09
2044	21.59	31.53
2045	21.68	33.04
2046	21.77	34.63
2047	21.86	36.29
2048	21.95	38.03
2049	22.04	39.86
2050	22.13	41.77