DOCKETED	
Docket Number:	22-BSTD-01
Project Title:	2025 Energy Code Pre-Rulemaking
TN #:	252582
Document Title:	CA Statewide Utility Codes and Standards Enhancement Team Comments - Final CASE Report- Revised October 12,2023, Swimming Pool and Spa Heating
Description:	N/A
Filer:	System
Organization:	CA Statewide Utility Codes and Standards Enhancement Team
Submitter Role:	Public
Submission Date:	10/12/2023 10:54:57 AM
Docketed Date:	10/12/2023

Comment Received From: CA Statewide Utility Codes and Standards Enhancement Team
Submitted On: 10/12/2023
Docket Number: 22-BSTD-01

Final CASE Report- Revised October 12,2023, Swimming Pool and Spa Heating

This document supersedes TN 251636, and contains the following revisions: 1. minor revisions and reorganization to address editorial issues; 2. added new Appendix H â€œHeat Pump Pool Heater Analysisâ€□.

Additional submitted attachment is included below.

Codes and Standards Enhancement (CASE) Initiative

2025 California Energy Code

Swimming Pool and Spa Heating

Single Family, Multifamily, and Nonresidential Pool and Spa Heating

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Revised October 2023
Original Version: August 2023
Final CASE Report

This report was prepared by the California Statewide Codes and Standards Enhancement (CASE) Program that is funded, in part, by California utility customers under the auspices of the California Public Utilities Commission.

Document Information

Category:	**Codes and Standards**
Keywords:	Statewide Codes and Standards Enhancement (CASE) Initiative; California Statewide Utility Codes and Standards Team; Codes and Standards Enhancements; 2025 California Energy Code; 2025 Title 24, Part 6; California Energy Commission; energy efficiency; mandatory; swimming pools and spas, solar thermal technologies, heat pump pool heaters, on-site renewable energy / site recovered energy for pools and spas
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Revisions as of 10/12/2023	This document contains the following revisions: 1. moved the embodied carbon results from the main body of the report to Appendix D; 2. added Appendix H, "Heat Pump Pool Heater Analysis"; and 3. revised language in the Executive Summary, Section 1, and Section 3.1 to reflect the addition of Appendix H.

Table of Contents

List of Tables

List of Figures

Executive Summary

This Codes and Standards Enhancement (CASE) Initiative presents justifications for code changes to pool and spa heating requirements that refine and build on prior code changes to the California Energy Code (Title 24, Part 6) approved by the California Energy Commission (CEC). These proposed code changes address the potential of solar and electric heat pump technology to drive increases in efficiency and significant greenhouse gas (GHG) emission reductions including:

a. Reduction of 10.9 million therms of natural gas in first year statewide impacts and roughly 819 million kBtu in long-term systemwide gas savings.
b. Cost-effective energy savings across all climate zones for non-residential and multi-family applications and across nearly all climate zones for single family applications.
c. Support for emerging electric heat pump pool heater and the established solar thermal technologies to support California's decarbonization goals.

To improve energy efficiency and energy performance in California buildings, simplify code structure and requirements, and streamline compliance and enforcement, this CASE Initiative presents justification for pool and spa heating code additions to support the CEC's updates of Title 24, Part 6.

This proposed measure would apply to newly constructed pools and existing pools planning to install a new gas or electric heater. Single family residential pools with an existing pool heater can be replaced with the same technology. Acceptance testing would not be required for this measure.

The proposed swimming pool and spa heating measure would require one of three alternatives to reduce GHG emissions and energy consumption: solar thermal heating, heat pump pool heating (HPPH), or waste heat recovery. Solar thermal energy is a commercially available technology that greatly reduces carbon emissions into the atmosphere by using the sun to heat water. Alternatively, heat pump pool heaters gather heat from the ambient air to heat pool water, while waste heat recovery gathers heat from other building energy uses such as dehumidification.

1. For the solar thermal option, the surface area of the solar collectors would be equal to or greater than a certain percentage of the surface area of the pool (65 percent for nonresidential and multifamily buildings, and 60 percent for single family buildings).
2. For the HPPH option, the heater would need to meet certain minimum coefficient of performance energy efficiency requirements.

3. The waste heat recovery option would require at least 60 percent of the annual pool heating load be provided by the on-site waste heat.

The proposal would except the heating of portable electric spas, pools and spas at single family homes with existing pool heaters, and pools and spas that would rely only on solar heating.

This report focuses on analysis and cost effectiveness of the solar thermal option for compliance. Notably, the report does not include analysis on the recovered energy option as it is an existing provision within Section 110.4(a)4 under the exception for prohibiting electric resistance heating. Appendix H provides an analysis of the HPPH option.

Proposal Description

Background

Solar thermal harnesses the sun's energy to generate heat for commercial and residential applications such as space heating, air conditioning, water heating, industrial process heat, drying, distillation and desalination, and even electrical power generation. There are several types of collectors that can be used for solar thermal systems, such as unglazed, transpired, flat-plate, evacuated tubes or concentrating collectors. In the case of swimming pool heating, unglazed collectors are often used due to their efficiency and affordability.

As one of the simplest and least expensive forms of solar thermal technology, unglazed collectors do not have a glass covering or “glazing” on the collector box and often use black plastic panels of aligned water tubes mounted on a roof or other support structure to absorb sunlight. A water pump circulates pool water directly through the water tubes, transferring energy to the water. The pump returns the water to the pool at a higher temperature, between 95 °F and 100 °F. Although primarily for pool heating, collectors can also preheat large volumes of water for other commercial and industrial applications.

For information on current market practices in California, see Section 4.1 and 4.2 of this report.

Scope of Code Change Proposal

Table 1 summarizes the scope of the proposed changes and sections of standards, Reference Appendices, Alternative Calculation Manual (ACM) Reference Manuals, and compliance documents that would be modified because of the proposed changes.

Table 1: Scope of Code Change Proposal

Type of Requirement	Mandatory
Applicable Climate Zones	All climate zones
Modified Section(s) of Title 24, Part 6	110.4: Mandatory Requirements for Pool and Spa Systems and Equipment 150.0(p) Pool Systems and equipment installation.
Modified Title 24, Part 6 Appendices	Joint Appendix 15: Eligibility Criteria for Energy Efficiency Measures on Solar Pool or Spa systems
Would Compliance Software Be Modified	No
Modified Compliance Document(s)	CEC-CF2R-PLB-03-E NRCC-PRC-E / NRCI-PRC-E LMCC-PRC-E

Statewide Energy, Water, Greenhouse Gas (GHG) Emissions

Table 2 estimates statewide first-year realized impacts of the proposed code change.

Relevant metrics for first-year statewide energy impacts are:

- Electric capacity in megawatts (MW)
- Natural gas savings in million therms per year (million therms/y)
- Source energy savings in millions of kilo British thermal units per year (million kBtu/y)
- Long-term systemwide energy savings in millions of kilo British thermal units per year (million kBtu/y)

Section 7 details first-year state impacts. Section 5.2 details energy savings per unit. Table 2 below summarizes the savings impacts for solar pool and spa heating.

Table 2: Summary of Impacts for Solar Pool and Spa Heating

Category	Metric	Nonresidential New Construction & Additions	Nonresidential Alterations	Residential New Construction & Additions	Residential Alterations
Cost Effectiveness	Benefit-Cost Ratio Range (varies by climate zone and building type)	1.22 – 10.6	1.22 – 10.6	0.54 – 3.93	0.54 –3.93
Statewide Impacts During First Year	Electricity Savings (GWh)	–	–	–	–
	Peak Electrical Demand Reduction (MW)	–	–	–	–
	Natural Gas Savings (Million Therms)	0.7	6.1	1.3	2.8
	Source Energy Savings (Million kBtu)	61	548	113	252
	Long-term Systemwide Electricity Savings (Million kBtu)	–	–	–	–
	Long-term Systemwide Gas Savings (Million kBtu)	36	322	143	318
	Total Long-term Systemwide Energy Savings (Million kBtu)	36	322	143	318
	Avoided GHG Emissions (Metric Tons CO_2e)	3,719	33,206	7,563	16,806
	Monetary Value of Avoided GHG Emissions ($2026)	457,992	4,089,211	931,315	2,069,589
	On-site Indoor Water Savings (Gallons)	–	–	–	–
	On-site Outdoor Water Savings (Gallons)	–	–	–	–
	Embedded Electricity in Water Savings (kWh)	–	–	–	–
Per Pool Impacts During First Year	Electricity Savings (kWh)	–	–	–	–
	Peak Electrical Demand Reduction (W)	–	–	–	–
	Natural Gas Savings (kBtu)	197,970	197,970	44,166	44,166
	Source Energy Savings (kBtu)	178,379	178,379	39,804	39,804
	Long-term Systemwide Energy Savings (kBtu)	104,743	104,743	50,189	50,189
	Avoided GHG Emissions (kg CO_2e)	10,816	10,816	2,652	2,652
	On-site Indoor Water Savings (Gallons)	–	–	–	–
	On-site Outdoor Water Savings (Gallons)	–	–	–	–
	Embedded Electricity in Water Savings (kWh)	–	–	–	–

Market Analysis and Regulatory Assessment

Based on a Pool and Hot Tub Alliance comment letter, the California swimming pool and spa market is one of the largest in the world (PHTA 2020), with gas-fired pool heaters being a popular system for heating pools. As gas prices continue to increase and demand for pools and pool heaters grows, sustainable pool heating options become more attractive.

While existing heating systems may serve as backup in existing buildings with pools or spas, solar thermal pool heating systems can drastically reduce operating costs. Low annual operating costs make solar thermal cost competitive with both gas-fired and heat pump pool heaters, yielding attractive payback periods.

The solar thermal pool heating market in California is well established, as the technology to implement the proposed code change is readily available from numerous solar thermal manufacturers who have operated in the state for over four decades. Technical barriers to consider with the adoption of this proposal are the high upfront installation costs and the impact of climate on heater performance.

This proposal is not intended to conflict with federal, state and local standards. The City of Santa Monica has a comparable requirement requiring pool heating with HPPH or solar heating for nonresidential, high-rise residential, and hotel and motels. Other communities in California are considering adopting a similar electric pool heating requirement.

There are federal appliance efficiency standards for pool heaters.

Cost Effectiveness

The code change was found to be cost-effective for all climate zones where requirements are proposed. The 30-year benefit-to-cost (B/C) ratio over the period of analysis varied based on climate zone and type of application. For nonresidential applications, the B/C ratio ranged between 1.2 and 10.3, and for residential applications the B/C ratio ranged between 0.5 and 3.9. Further details can be found in Section 6.5.

Over time California consumers and businesses would save more money on energy than they would spend to finance the efficiency measure, leaving money available for discretionary and investment purposes once the initial cost is paid off.

See Section 6 for the methodology, assumptions, and results of the cost-effectiveness analysis. Appendix H provides an analysis of the HPPH option.

Process

The Statewide CASE Team submits this proposal covering residential and nonresidential swimming pool and spa heating code changes for evaluation to the CEC, the state agency with authority to adopt revisions to Title 24, Part 6. Further information about the rulemaking schedule and process is detailed on the CEC website.

Stakeholders provided important insights into the analyses, justifications, and code compliance and enforcement process. Approximately 30 individuals, some of whom were members of eight different organizations, contributed data on costs, market, and energy assumptions. See Appendix F for a summary of stakeholder engagement.

Compliance and Enforcement

Overview of Compliance Process

The Statewide CASE Team developed a recommended compliance and enforcement process (Section 3.4.4) and worked with stakeholders to identify impacts on market actors (Section 4.3 and Appendix E). Compliance and enforcement issues concern:

- Building permits are not required to add a pool heater to an existing pool.
- A pool heater may be added to a pool during new construction even though construction plans did not include a pool heater.

The compliance methodology would be simplified by requiring a solar thermal area of 60 to 65 percent of the pool surface area and clarifying the code language to add an exception that pool owners with solar heating only do not have to meet this requirement, based on discussions with members of the California Solar and Storage Association (CALSSA) and its member manufacturers.

Field Verification and Acceptance Testing

The proposed measure would not require field verification or acceptance testing. Compliance would be determined upon review of plans and other documentation submitted for permit review, particularly by updating and expanding the residential Certificate of Installation from (CEC-CF2R-PLB-03-E) for residential applications, updating NRCC-PRC-E / NRCI-PRC-E for NR applications, and LMCC-PRC-E for MF applications. The nomenclature of the form may be further revised to clarify applicability to pools and spa and spa heating systems (i.e., revision of PLB to PAS).

Based on the building inspector's discretion, a field visit to verify the solar collectors were generally installed as designed could be included. The Statewide CASE Team is not recommending field verification, particularly not to the level of measuring area of installed solar panels.

Addressing Energy Equity and Environmental Justice

The Statewide CASE Team reviewed published studies that considered how disproportionately impacted populations (DIPs) would be impacted by the proposed measure. Pool heating tends to be household discretionary spending and is unlikely to impact DIPs more significantly than any pool-owning household. Residential Appliance Saturation Survey data does demonstrate that pool owners are concerned with the costs to heat their pools, however this data is not collected with DIPs in mind. A better understanding of the impacts of this measure could be reached with data from DIPs.

For nonresidential buildings like hotels, motels, and camps, spending for pool heating is less discretionary. For community centers that primarily serve DIPs, costs from the measure could be a higher burden.

1. Introduction

The Codes and Standards Enhancement (CASE) initiative presents recommendations to support the California Energy Commission's (CEC's) efforts to update California's Energy Code (Title 24, Part 6) to include new requirements or to upgrade existing requirements for various technologies. The three California Investor-Owned Utilities (IOUs) — Pacific Gas and Electric Company, San Diego Gas and Electric, and Southern California Edison – and two Publicly Owned Utilities — Los Angeles Department of Water and Power and Sacramento Municipal Utility District (herein referred to as the Statewide CASE Team when including the CASE Author) — sponsored this effort. The program goal is to prepare and submit proposals that would result in cost-effective enhancements to improve energy efficiency and energy performance in California buildings. This report and the code change proposal presented herein are a part of the effort to develop technical and cost-effectiveness information for proposed requirements on building energy-efficient design practices and technologies.

The CEC is the state agency that has authority to adopt revisions to Title 24, Part 6. One of the ways the Statewide CASE Team participates in the CEC's code development process is by submitting code change proposals to the CEC for consideration. CEC will evaluate proposals the Statewide CASE Team and other stakeholders submit and may revise or reject proposals. See the CECs 2025 Title 24 website for information about the rulemaking schedule and how to participate in the process.

The goal of this CASE Report is to present a code change proposal for pool and spa heating. The report contains pertinent information supporting the proposed code change.

When developing the code change proposal and associated technical information presented in this report, the Statewide CASE Team worked with many industry stakeholders including International Code Council - Solar Rating & Certification Corporation (ICC-SRCC), California Solar and Storage Association (CALSSA), Air Conditioning, Heating and Refrigeration Institute (AHRI), Pool and Hot Tub Alliance (PHTA), ASHRAE 90.2 Standing Standard Project Committee (SSPC) Chairs, ASHRAE 189.1 Committee Members, Rheem/Raypak, and several Subject Matter Experts such as Chad Worth. The proposal incorporates feedback received during several meetings between the Statewide CASE Team and stakeholders, and public stakeholder workshops that the Statewide CASE Team held on February 1, 2023 and May 18, 2023.

The following is a summary of the contents of this report:

- Section 2 – Addressing Energy Equity and Environmental Justice provides a review of the procedural equity and stakeholder engagement, potential impacts on disproportionately impacted populations, and specific impacts of the proposal.
- Section 3 – Measure Description of this CASE Report provides a description of the measure and its background. This section also presents a detailed description of how this code change is accomplished in the various sections and documents that make up the Title 24, Part 6 Standards.
- Section 4 – Market Analysis includes a review of the current market structure. Section 4.2 describes the feasibility issues associated with the code change, including whether the proposed measure overlaps or conflicts with other portions of the building standards, such as fire, seismic, and other safety standards, and whether technical, compliance, or enforceability challenges exist.
- Section 5 – Energy Savings presents the per-unit energy, demand reduction, and energy cost savings associated with the proposed code change. This section also describes the methodology that the Statewide CASE Team used to estimate per-unit energy, demand reduction, and energy cost savings.
- Section 6 – Cost and Cost Effectiveness presents the long-term systemwide cost and cost-effectiveness analysis. This includes a discussion of the materials and labor required to implement the measure and a quantification of the incremental cost. It also includes estimates of incremental maintenance costs, i.e., equipment lifetime and various periodic costs associated with replacement and maintenance during the period of analysis.
- Section 7 – First-Year Statewide Impacts presents the statewide energy savings and environmental impacts of the proposed code change for the first year after the 2025 code takes effect. This includes the amount of energy that would be saved by California building owners and tenants and impacts (increases or reductions) on material with emphasis placed on any materials that are considered toxic. Statewide water consumption impacts are also reported in this section.
- Section 8 – Proposed Revisions to Code Language concludes the report with specific recommendations with ~~strikeout~~ (deletions) and <u>underlined</u> (additions) language for the Standards, Reference Appendices, and Alternative Calculation Manual (ACM) Reference Manual. Generalized proposed revisions to sections are included for the Compliance Manual and compliance forms.
- Section 9 – Bibliography presents the resources that the Statewide CASE Team used when developing this report.
- Appendix A: Statewide Savings Methodology presents the methodology and assumptions used to calculate statewide energy impacts.

- Appendix B: Embedded Electricity in Water Methodology presents the methodology and assumptions used to calculate the electricity embedded in water use (e.g., electricity used to draw, move, or treat water) and the energy savings resulting from reduced water use.
- Appendix C: California Building Energy Code Compliance (CBECC) Software Specification presents relevant proposed changes to the compliance software (if any).
- Appendix D: Environmental Analysis presents the methodologies and assumptions used to calculate impacts on GHG emissions and water use and quality.
- Appendix E: Discussion of Impacts of Compliance Process on Market Actors presents how the recommended compliance process could impact identified market actors.
- Appendix F: Summary of Stakeholder Engagement documents the efforts made to engage and collaborate with market actors and experts.
- Appendix G: Energy Cost Savings in Nominal Dollars presents energy cost savings over the period of analysis in nominal dollars.
- Appendix H: Heat Pump Pool Heater Analysis provides a summary of energy savings and cost-effectiveness of the HPPH option.

The California IOUs offer free energy code training, tools, and resources for those who need to understand and meet the requirements of Title 24, Part 6. The program recognizes that building codes are one of the most effective pathways to achieve energy savings and GHG reductions from buildings – and that well-informed industry professionals and consumers are key to making codes effective. With that in mind, the California IOUs provide tools and resources to help both those who enforce the code, as well as those who must follow it. Visit EnergyCodeAce.com to learn more and to access content, including a glossary of terms.

2. Addressing Energy Equity and Environmental Justice

2.1 General Equity Impacts

The Statewide CASE Team recognizes, acknowledges, and accounts for a history of prejudice and inequality in disproportionately impacted populations (DIPs) and the role this history plays in the environmental justice issues that persist today. While the term disadvantaged communities (DACs) is often used in the energy industry and state agencies, the Statewide CASE Team chose to use terminology that is more acceptable to and less stigmatizing for those it seeks to describe (DC Fiscal Policy Institute 2017). Similar to the California Public Utilities Commission (CPUC) definition, DIPs refer to the populations throughout California that “most suffer from a combination of economic, health, and environmental burdens. These burdens include poverty, high unemployment, air and water pollution, presence of hazardous wastes, as well as high incidence of asthma and heart disease” (CPUC n.d.). DIPs also incorporate race, class, and gender since these intersecting identity factors affect how people frame issues, interpret, and experience the world.1

Including impacted communities in the decision-making process, ensuring that the benefits and burdens of the energy sector are evenly distributed, and facing the unjust legacies of the past all serve as critical steps to achieving energy equity. Recognizing the importance of engaging DIPs and gathering their input to inform the code change process and proposed measures, the Statewide CASE Team is working to build relationships with community-based organizations (CBOs) to facilitate meaningful engagement. A participatory approach allows individuals to address problems, develop innovative ideas, and bring forth a different perspective. Please reach out to Melissa Schellinger Gutierrez (mgutierrez@energy-solution.com) and Marissa Lerner (mlerner@energy-solution.com) for further engagement.

Energy equity and environmental justice (EEEJ) is a newly emphasized component of the Statewide CASE Team’s work and is an evolving dialogue within California and

[1] Environmental disparities have been shown to be associated with unequal harmful environmental exposure correlated with race/ethnicity, gender, and socioeconomic status. For example, chronic diseases, such as respiratory diseases, cardiovascular disease, and cancer, associated with environmental exposure have been shown to occur in higher rates in the LGBTQ+ population than in the cisgender, heterosexual population (Goldsmith and Bell 2021). Socioeconomic inequities, climate, energy, and other inequities are inextricably linked and often mutually reinforcing.

beyond.[2] To minimize the risk of perpetuating inequity, code change proposals are being developed with intentional consideration of the unintended consequences of proposals on DIPs. The Statewide CASE Team identified potential impacts via research and stakeholder input. While the listed potential impacts should be comprehensive, they may not yet be exhaustive. As the Statewide CASE Team continues to build relationships with CBOs, these partnerships will inform and further improve the identification of potential impacts. The Statewide CASE Team is open to additional peer-reviewed studies that contribute to or challenge the information on this topic presented in this report. The Statewide CASE Team is currently continuing general outreach with CBOs and EEEJ partners. Results of that outreach, as well as a summary of the 2025 code cycle EEEJ activities will be documented in the 2025 EEEJ Summary Report that is expected to be published on title24stakeholders.com by the end of 2023.

2.1.1 Procedural Equity and Stakeholder Engagement

As mentioned, representation from DIPs is crucial to considering factors and potential impacts that may otherwise be missed or misinterpreted. The Statewide CASE Team is committed to engaging with representatives from as many affected communities as possible. This code cycle, the Statewide CASE Team is focused on building relationships with CBOs and representatives of DIPs across California. To achieve this end, the Statewide CASE Team is prioritizing the following activities:

- Identification and outreach to relevant and interested CBOs
- Holding a series of working group meetings to solicit feedback from CBOs on code change proposals
- Developing a 2025 EEEJ Summary Report

In support of these efforts, the Statewide CASE team is also working to secure funds to provide fair compensation to those who engage with the Statewide CASE Team. While the 2025 code cycle will come to an end, the Statewide CASE Team's EEEJ efforts will continue, as this is not an effort that can be "completed" in a single or even multiple code cycles. In future code cycles, the Statewide CASE Team is committed to furthering relationships with CBOs and inviting feedback on proposed code changes with a goal of

[2] The CEC defines energy equity as "the quality of being fair or just in the availability and distribution of energy programs" (CEC 2018). American Council for an Energy-Efficient Economy (ACEEE) defines energy equity as that which "aims to ensure that disadvantaged communities have equal access to clean energy and are not disproportionately affected by pollution. It requires the fair and just distribution of benefits in the energy system through intentional design of systems, technology, procedures and policies" (ACEEE n.d.). Title 7, Planning and Land Use, of the California Government Code defines environmental justice as "the fair treatment and meaningful involvement of people of all races, cultures, incomes, and national origins, with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies" (State of California n.d.).

engagement with these organizations representing DIPs throughout the code cycle. Several strategies for future code cycles are being considered, including:

- Creating an advisory board of trusted CBOs that may provide consistent feedback on code change proposals throughout the development process.
- Establishing a robust compensation structure that enables participation from CBOs and DIPs in the Statewide CASE Team's code development process.
- Holding equity-focused stakeholder meetings to solicit feedback on code change proposals that seem more likely to have strong potential impacts.

2.1.2 Potential Impacts on DIPs in Single Family and Multifamily Buildings

2.1.2.1 Health Impacts

Understanding the influences that vary by demographics, location, or type of housing is critical to developing equitable code requirements. For example, residents in market rate apartments will have different air quality concerns than those in single family homes, or even those in subsidized multifamily housing (where smoking and other potential contaminants are closely regulated and monitored).

Several of the potential negative health impacts from buildings on DIPs are addressed by energy efficiency (Norton 2014., Cluett 2015, Rose 2020). For example, indoor air quality (IAQ) improvements through ventilation or removal of combustion appliances can lessen the incidents of asthma, chronic obstructive pulmonary disease (COPD), and some heart problems. Water heating and building shell improvements can lower stress levels associated with energy bills by lowering utility bill costs. Better insulation and tighter building envelopes can reduce the health impacts from intrusion of dampness and contaminants, as well as providing a measure of resilience during extreme conditions. Electrification can reduce the health consequences resulting from NOx, SO_2, and $PM_{2.5}$. Studies have shown that not only do the effects of urban heat islands lead to higher mortality during heat waves, but those in large buildings are disproportionately affected (Smargiassi 2008, Laaidi 2012). These residents tend to be the elderly, people of color, and low-income households (Drehobl 2020, Blankenship 2020, IEA 2014).

2.1.2.2 Energy Efficiency and Energy Burden

Because low-income households have a higher energy burden (percent of income spent on energy) than average households, energy efficiency alone can benefit them more acutely compared to the average. Numerous studies have shown that low-income households spend a much higher proportion of their income on energy (two to five times) than the average household (Power 2007, Norton 2014., Rose 2020). See section 5 for an estimate of energy cost savings from the current proposals. Moreover, utility cost stability is typically more important to these households compared to average households; for households living paycheck to paycheck, an unexpectedly high energy bill can keep that household cyclically impoverished (Drehobl 2020). Energy burdened households are 175 to 200 percent more likely to remain impoverished for longer than households not experiencing energy burden (Drehobl 2020).The impact of a rate increase or weather-related spike is more easily handled the greater the efficiency of the home. The cost impacts of efficiency and renewables can be significantly different for those in subsidized housing (where the total of rent plus utilities is controlled) versus those in single-family homes or market rate multifamily buildings.

2.1.2.3 First Cost and New Construction

One potential negative consequence to DIPs of code-based efficiency improvements is the potential for increased housing costs. However, a study found that increased construction costs do not have a statistically significant impact on home prices, as prices in the new home market are driven overwhelmingly by demand (Stone, Nickelsburg and Yu 2018). According to a peer-reviewed study done for the California Tax Credit Allocation Committee (CTCAC), land costs and developer characteristics (size, experience, and profit structure of the firm) have the most significant effect on affordable housing costs (CTCAC 2014). The 2014 study echoes the same findings in CTCAC's cost study prepared in 1996 as well as the 2015 study by Stone, et al (Stone, Nickelsburg and Yu 2015). Similarly, developers of market-rate apartments conduct studies to investigate rent history and other information for comparable multifamily properties, which informs rent levels for specific projects.[3]

2.1.3 Potential Impacts on DIPs in Nonresidential Buildings

To assess potential inequity of proposals for nonresidential buildings the Statewide CASE Team considered which building types are used by DIPs most frequently and evaluated the allocation of impacts related to the following areas among all populations.

- **Cost:** People historically impacted by poverty and other historic systems of wealth distribution can be affected more severely by the incremental first cost of proposed code changes. Costs can also create an economic burden for DIPs that does not similarly affect other populations. See section(s) 6 for an estimate of energy cost savings from the current proposals.
- **Health:** Any potential health burdens from proposals could more severely affect DIPs that can have limited access to healthcare and live in areas affected by environmental and other health burdens. Several of the potential negative health impacts from buildings on DIPs are addressed by energy efficiency (Norton

[3] Examples include Yardi-Matrix **Invalid source specified.**, HCA **Invalid source specified.**, and Foley & Puls **Invalid source specified.**, which all conduct market studies.

2014., Cluett 2015, Rose 2020). For example, indoor air quality (IAQ) improvements through ventilation or removal of combustion appliances can lessen the incidents of asthma, chronic obstructive pulmonary disease (COPD), and some heart problems. Black and Latinx people are 56 percent and 63 percent more likely to be exposed to dangerous air pollution than white people, respectively (Tessum, et al. 2019). Water heating and building shell improvements can reduce stress levels associated with energy bills by lowering utility bill costs. Electrification can reduce the health consequences resulting from NOx, SO_2, and $PM_{2.5}$.

- **Resiliency:** DIPs are more vulnerable to the negative consequences of natural disasters, extreme temperatures, and weather events due to climate change. Black Americans are 40 percent more likely to currently live in areas with the highest projected increases in extreme heat related mortality rates, compared to other groups (EPA 2021). Similarly, natural disasters affect DIPs differently. Race and wealth affect the ability to evacuate for a natural disaster, as evidenced during Hurricane Harvey wherein White and wealthy residents were overrepresented by 19.8 percent among evacuees (Deng, et al. 2021). Proposals that improve buildings' resiliency to natural disasters and extreme weather could positively impact DIPs. For example, buildings with more insulation and tighter envelopes can reduce the health impacts of infiltration of poor-quality air, reduce risk of moisture damage and related health impacts (mildew and mold), and help maintain thermal comfort during extreme weather events.
- **Comfort:** Thermal comfort and proper lighting are important considerations for any building where people work, though impacts are not proportional across all populations. Thermal comfort can also have serious health effects as heat related illness is on the rise in California. DIPs are at a greater risk for heat illness due in part to socioeconomic factors. From 2005 to 2015 the number of emergency room visits for heat related illness in California rose 67 percent for Black people, 53 percent for Asian-Americans, and 63 percent for Latinx people (Abualsaud, Ostrovskiy and Mahfoud 2019). Studies have shown that not only do the effects of urban heat islands lead to higher mortality during heat waves, but those in large buildings are disproportionately affected (Smargiassi 2008, Laaidi 2012). These residents tend to be the elderly, people of color, and low-income households (Drehobl 2020, Blankenship 2020, IEA 2014). Comfort is not only a nice quality to have in workplaces, schools, etc., but it also has real world health impacts on people's health.

2.1.3.1 Potential Impacts by Building Type

Proposals for the following building types would not have disproportionate impacts because all populations use the buildings with the same relative frequency. While there may be impacts on costs, health, resiliency, or comfort, DIPs would not be affected more or less than any other population. It is unlikely that DIPs would pay a disparate share of the incremental first costs.

- Office buildings of all sizes
- Retail buildings of all sizes
- Non-refrigerated buildings
- Laboratories
- Open air parking garage
- Vehicle service

Below is a description of how the proposed code changes might impact DIPs by building type.

Mixed-Use Retail

DIPs use mixed-use retail buildings more frequently than other populations, so there is a possibility of uneven impacts. Rents are often higher in mixed-use retail. Historically, small and minority owned businesses face challenges such as discrimination, difficulty in securing funding, and a lack of social capital that impact start-up costs and ability to secure business locations (Morelix 2016). Impacts on health, resiliency, or comfort are not anticipated to be disproportionate.

Schools (Small and Large)

Incremental costs could have a larger impact on DIPs than the general population because school funding is linked with race and income in the United States (U.S.). Jurisdictions with lower income populations where the tax base, funding, and capital improvement budgets may be more constrained may find it more challenging to accommodate the incremental first costs. Costs can affect educational quality, as incremental costs present a significant burden for schools with lower budgets. Analysis from the U.S. Government Accountability Office shows that students in poorer and smaller schools tend to have less access to college-prep courses and 80 percent of the students in these poorest schools were Black and Latinx (United States Government Accountability Office 2018). Incremental costs can deepen these educational inequalities by burdening schools with low budgets. Proposals will impact individuals attending and working at schools including those from DIPs. Proposals that impact health, resiliency, and comfort all have the potential to disproportionately impact those who attend or work in majority DIP schools, as those schools can less often afford considerations for those criteria.

Hotel

Proposals that impact health and resiliency have the potential to disproportionately impact those working or residing in hotels. California has used hotels for temporary housing, and many unhoused people rely on these buildings for shelter on a regular basis and during extreme weather events. California's Project Roomkey offered temporary hotel housing for more than 42,000 unhoused Californians in the COVID-19 crisis (California Governer's Office of Emergency Services 2021). More than 1.6 million people are employed year-round in accommodation and food services with more than 49 percent of that industry identifying as Black, Asian American, or Latinx (U.S. Bureau of Labor Statistics 2023). While the costs may increase for this nonresidential building type, the burden of that cost is unlikely to be disproportionate.

2.2 Specific Impacts of the Proposal

The Statewide CASE team has not identified any adverse impacts to DIPs based on this proposal for pool and spa heating.

Based on our research, pool heating tends to be discretionary spending for households. This measure is unlikely to impact DIPs more significantly than any pool-owning household. Freely available data (CEC RASS 2019) does demonstrate that pool owners are concerned with the costs to heat their pools, however this data is not collected with DIPs in mind. A better understanding of the impacts of this measure could be reached with data from DIPs. Spending for pool heating for non-residential buildings like hotels, motels, and camps is less discretionary. For community centers that primarily serve DIPs any costs from the measure could be a higher burden.

Breaking local noise ordinances is a potential risk involved in the proposed measure. Some California reporting has shown that electric pool heating can introduce noise to an area. For example, in Menlo Park, CA, noise above 50 dB has come from electric pool heating measures and required additional attention (Rebosio 2023). Pools can also be an important method for cooling down in the summer. Public pools can serve an important purpose to a community, and any incremental costs associated with pools could affect that resource (Lam 2023).

While these potential impacts are important, the Statewide CASE Team does not feel the proposal will significantly impact DIPs. The Statewide CASE Team is still in the process of investigating the potential impacts of the proposed code changes on DIPs and will include any additional findings in the 2025 EEEJ Summary Report.

3. Measure Description

3.1 Proposed Code Change

The proposed code change would require solar thermal pool and spa (except portable electric spas) heating systems, HPPH with certain COP, sizing and controls criteria, or on-site renewable energy or site recovered energy in nonresidential, multifamily, and newly constructed single-family buildings with heated swimming pools and spas. The surface area of the solar collectors installed would be equal to or greater than 65 percent of the surface area of the pool for residential pools and 60 percent of the surface area of the pool for multifamily and nonresidential pools. At least 60 percent of the annual heating energy would be required to come from on-site renewable energy or site recovered energy as an option.

This proposed measure would apply to newly constructed pools and existing pools installing a new gas or electric heater. Single family residential pools with an existing pool heater can replace with the same technology. Acceptance testing would not be required for this measure.

While we are modifying the requirements for pools and spas, the Statewide CASE Team will also explore opportunities to update language as needed based on advances in technology and standard design practices, and existing federal and state regulations applicable to pool heating products. The Statewide CASE Team is also proposing a cleanup of section 150.0(p) to harmonize Title 24, Part 6, with provisions in the federal regulations on dedicated-purpose pool pumps.

This report focuses on analysis and cost effectiveness of the solar thermal option for compliance. This report does not include analysis on the recovered energy option as it is an existing provision within Section 110.4(a)4 under the exception for prohibiting electric resistance heating. Appendix H provides an analysis of the HPPH option.

3.2 Justification and Background Information

3.2.1 Justification

The California swimming pool and spa market is one of the largest in the world (PHTA 2020), with gas-fired pool heaters remaining a popular system for heating pools today.

A solar thermal collector is a commercially available technology that heats water with solar energy, greatly reducing carbon emissions into the atmosphere. These systems can drastically reduce the operating cost of heating swimming pools and spas. The installation of solar thermal collectors in existing buildings with pools or spas, can render such systems to become the primary source of heating while enabling existing heating systems to serve as backup sources only when necessary. Furthermore, solar thermal heating is cost competitive with both gas-fired and heat pump pool heaters and has very low annual operating costs to yield attractive payback periods.

3.2.2 Background Information

3.2.2.1 Historical Context

Solar thermal technologies were subject to code changes in 2013. During the 2013 code cycle, the Statewide CASE Team proposed new solar water heater requirements for residential buildings and solar-ready requirements for both residential and nonresidential applications:

1. Required new low-rise nonresidential buildings to be designed such that it would be technically feasible to install, at a future date, a photovoltaic (PV) or solar water heating (SWH) system of the size specified in the code (Statewide CASE Team 2011a). It did not require solar equipment to be installed, nor did it propose a means of using renewable energy generation to reach a specified energy budget.
2. Examined the savings potential and opportunities for “solar oriented developments” (Statewide CASE Team 2011b).
3. Increased the prescriptive required minimum fraction of water heat to be provided by solar water heating systems for individual dwelling units (i.e., single family housing) with electric resistance (storage and instantaneous) water heaters using Package C (Statewide CASE Team 2011c).

These measures provided good insight into the market penetration for solar thermal water heaters. Furthermore, the Statewide CASE Team leveraged the cost-effectiveness report conducted by the Reach Code Team (consisting of the California IOUs, consultants, and engaged cities) in 2022, which compares single family and multifamily electric heat pump pool heaters and solar pool heating systems to gas-fired pool heaters.

The Statewide CASE Team initially considered pursuing a solar fraction requirement for swimming pools and spa heating. However, while the solar fraction approach has worked well for domestic solar thermal water heating, it may not be the best available solution for solar pool heating due to significant variations caused by key parameters, including but not limited to shading and swim activity related to pools. A simplistic yet effective idea is to consider associating the surface area of the pool to the surface area of the collectors. Performance differences such as peak efficiency or effective area were also considered for OG-100 certified collectors.

3.2.2.2 Technology

Solar thermal collectors are a renewable energy technology that harness the sun's energy to generate heat for various commercial and residential applications. These applications include space heating, air conditioning, hot water, industrial process heat, drying, distillation and desalination, and even electrical power generation. There are several types of collectors that can be used for solar thermal systems, such as unglazed, transpired, flat-plate, evacuated tube, and concentrating collectors. In the case of swimming pool heating, unglazed collectors are often used due to their efficiency and affordability.

Unglazed solar collectors operate at relatively low water temperatures (95°F - 100°F) and are one of the simplest and least expensive forms of solar thermal technology. These collectors are described as “unglazed” as they do not have a glass covering or “glazing” on the collector box to trap heat. Unglazed technologies often use black plastic tubular panels mounted on a roof or other support structure to absorb sunlight. A water pump circulates pool water directly through the tubular panels, transferring energy to the water, and returns the water to the pool at a higher temperature. Although used primarily for pool heating, these collectors can also pre-heat large volumes of water for other commercial and industrial applications. For information on current market practices in California, see Section 4.1 of this report.

The proposed solar pool and spa heating measure would propose a solar heating requirement to help reduce overall energy usage for pools and spas, while promoting the use of renewable energy sources.

3.3 Summary of Proposed Changes to Code Documents

The sections below summarize how the standards, Reference Appendices, and compliance forms would be modified by the proposed change.[4] See Section 8 of this report for detailed proposed revisions to code language.

Changes are proposed to Part 6, Section 110.4, Mandatory Requirements For Pool And Spa Systems And Equipment and Section 150.0(p) Mandatory Features and Devices. Joint Appendix 15– Eligibility Criteria for Energy Efficiency Measures on Solar Pool or Spa systems, is proposed to be added.

[4] Visit EnergyCodeAce.com for trainings, tools and resources to help people understand existing code requirements.

3.3.1 Specific Purpose and Necessity of Proposed Code Changes

Each proposed change to language in Title 24, Part 1 and Part 6 as well as the reference appendices to Part 6 are described below. See Section 8.2 of this report for marked-up code language.

Section: 110.4(a)1

Specific Purpose: The specific purpose of this measure is to ensure that all pool and spa heating systems or equipment installed comply with California's Appliance Efficiency Regulations except for commercial pool heaters. Such commercial equipment is outside the scope of California's Appliance Efficiency Regulations and cannot be currently certified.

Necessity: These changes are necessary to promote energy efficiency and safety in the use of pool and spa heating systems.

Section: 110.4(c)1

Specific Purpose: The specific purpose of the addition of this section is to require solar thermal pool heating for single family, multifamily and nonresidential hotel/ motel pool applications.

Necessity: These additions are necessary to reduce energy use via the use of cost-effective solar thermal swimming pool applications as the primary heating source.

Section: 110.4(c)2

Specific Purpose: The specific purpose of this addition is to allow pools or spas deriving at least 60 percent of the annual heating energy from on-site renewable energy or site recovered energy to avoid the mandatory solar requirement.

Necessity: This option allows the use of any pool heating system while simultaneously creating a pathway for other energy-efficient pool heating technologies to thrive in the market.

Section: 110.4(c)3

Specific Purpose: The specific purpose of this addition is to allow pools or spas being heated with a heat pump pool heater and meeting or exceeding the Coefficient of Performance improvement requirements by climate zone to avoid the mandatory solar requirement.

Necessity: These changes are necessary to allow cost-effective and properly sized heat pump pool heaters to be used as the primary heating source if other options are not deemed as viable.

Section: Exception 1 to Section 110.4(c)

Specific Purpose: The specific purpose is to provide an exemption for portable electric spas.

Necessity: These changes are necessary because portable electric spas are subject to regulation under California Appliance Efficiency Standards (Title 20) and are regulated separately as a package by the U.S. Department of Energy (DOE). This product has been optimized to perform efficiently through these rulemaking processes.

Section: Exception 2 to Section 110.4(c)

Specific Purpose: The specific purpose is to exempt pools replacing an existing heater.

Necessity: This is necessary because it is more effort to install solar in an existing residence, therefore single-family buildings with an existing heating system are able to replace equipment that has failed with the same type of equipment.

Section: Exception 3 to Section 110.4(c)

Specific Purpose: The specific purpose is to exempt pools that rely on solar heating only.

Necessity: This is necessary because a pool that relies only on solar heating does not consume any energy from utility sources.

Section: Section 150.0(p)

Specific Purpose: The specific purpose of this addition is to align Title 24 requirements with current federal appliance standards and California Appliance Efficiency Standards (Title 20). Specifically, Table 100.0-A of the 2022 edition of Title 24, Part 6, assigns mandatory provisions in section 150.0(p) to nonresidential, and hotel/motel occupancies.

Necessity: This addition is necessary to avoid confusion between different codes and standards, and ensure that Title 24, Part 6, is consistent with provisions in California's Appliance Efficiency Regulations and the federal regulations prescribed by DOE.

Section: Joint Appendix 15

Specific Purpose: The specific purpose of this addition is to require solar pool and spa heating equipment to be certified by the International Code Council – Solar Rating and Certification Corporation (ICC-SRCC), the International Association of Plumbing and Mechanical Officials, Research and Testing (IAPMO R&T), or by a listing agency that is approved by the Executive Director.

Necessity: This addition is necessary to ensure quality products are installed in the state of California. The performance of such products is third-party verified in accordance with industry test procedures and certification programs.

3.3.2 Specific Purpose and Necessity of Changes to the Residential ACM Reference Manual

The proposed code change would not modify the ACM Reference Manual.

3.3.3 Summary of Changes to the Residential and Nonresidential Compliance Manual

Section 4.8.5 of the 2022 Nonresidential and Multifamily Compliance Manual would need to be revised along with section 5.10.2 of the 2022 Single Family Residential Compliance Manual.

The 60 percent site solar or recovered energy provision set forth in Exception 2 to Section 110.4(a)(4) of the 2022 Title 24, Part 6, is reiterated in both sets of compliance manuals without any additional information prescribing how to apply or enforce this exception. Pool systems and equipment installation provisions set forth in section 150.0(p)2, 150.0(p)3 and 150.0(p)4 of Title 24, Part 6, are excluded from the 2022 Nonresidential and Multifamily Compliance Manual even though section 150.0(p) is mandatory for nonresidential hotels/motels per Table 100.0-A of 2022 Title 24, Part 6. The Single Family Residential Compliance Manual does not account for the pump flow rates provision set forth in Section 150.0(p)1.B. of Title 24, Part 6. The proposed revisions seek to align the compliance manuals with the existing code language while also ensuring new language aligning with the proposed code language is incorporated into the manuals.

Revisions to the above sections will be proposed after the development of the proposed code language. A reference to the current compliance form CEC-CF2R-PLB-03-E on Pool and Spa Heating Systems will be provided in the pertinent sections of the compliance manuals, and the nomenclature of the form may be further revised to clarify applicability to pools and spa and spa heating systems (i.e., revision of PLB to PAS).

3.3.4 Summary of Changes to Compliance Forms

The proposed code change would modify the compliance forms listed below. Discussion of the revised forms are presented in Section 8.5.

- CF2R-PLB-03-E: The proposed code change would require modifications to the residential form CEC-CF2R-PLB-03-E on Pool and Spa Heating Systems and would expand the applicable scope. The nomenclature of the form may be further revised to clarify applicability to pools and spa and spa heating systems.

- NRCC-PRC-E / NRCI-PRC-E and LMCC-PRC-E / LMCI-PRC-E: The proposed code change would require modifications to the nonresidential and multifamily compliance forms to ensure compliance with 110.4(c). A confirmation check box would need to be added to Section R - Pools & Spas) of the compliance forms for the proposed pool heating requirements.

3.4 Regulatory Context

3.4.1 Determination of Inconsistency or Incompatibility with Existing State Laws and Regulations

Title 24, Part 6 includes certification and installation requirements for pool and spa systems and equipment in section 110.4, with the following highlights:

- No electric resistance heating except (1) packaged units with R-6 insulation and tight covers or (2) where 60 percent of annual heating energy is from site solar energy or recovered energy.
- Piping provisions to allow for built-in / built-up connections for future addition of solar heating equipment.
- Covers are required for outdoor pools and spas that have a HPPH or gas heater.
- A time switch or a similar control mechanism to allow pumps to be programmed to run only during the off-peak electric demand period and for the minimum time necessary to maintain the water in the condition required by applicable public health standards.
- An on-off switch for the heater to allow shut off without adjusting the thermostat.

Section 150.0(p) of Title 24, Part 6 includes specific provisions for pump sizing and flow rate, system piping, and sizing of filters and valves. The California Department of Public Health requires minimum flow rates for turnover for public pools. 150(p)1 specifies maximum flow rates for turnover. The inconsistency is avoided by amending the scope of 150(p)1 to be applicable to only pools in single family buildings.

This proposal is not relevant to other parts of the California Building Standards Code, and thus changes outside of Title 24, Part 6, are not needed.

The proposal is not intended to conflict with any existing state or local laws and regulations. There are local regulations that are relevant to this proposal. As an example, in the City of Santa Monica building code per Section 8.106.080, *Non-residential, high-rise residential, hotel and motel solar and pool heating requirements*[5],

[5] Code language is available at: https://library.qcode.us/lib/santa_monica_ca/pub/municipal_code/item/article_8-chapter_8_106?view=all#article_8-chapter_8_106-8_106_080

Section 5.201 of the 2019 California Green Building Standards Code is amended to read as follows:

5.201.3 Pool Heating—Non-Residential, High-Rise Residential, and Hotel and Motel Buildings.

(a) For new pool construction, if the pool is to be heated, an electric heat pump water heater or a solar thermal system shall be used for such heating.

This was adopted in 2019.[6] Several additional local communities in California are considering adopting similar electric pool heating requirements.

A comprehensive summary on California's pertinent existing regulations was recently issued by CEC within the Draft Staff Report with the Analysis of Flexible Demand Standards for Pool Controls, (CEC 2022) and addressed the following aspects:

- Construction and operation of public swimming pools with turnover time and circulation volume provisions.
- Water quality and bather safety standards.
- Appliance efficiency standards.

California Code, Government Code - GOV § 65850.5 provides requirements for the permitting of solar energy systems including solar pool heaters by local code officials.

The Governor's Office of Planning and Research provides a solar permitting handbook. This handbook discusses Government Code 65850.5(b-c).

3.4.2 Duplication or Conflicts with Federal Laws and Regulations

There are two relevant federal standards which include regulations for dedicated-purpose pool pumps (DPPP), and pool heater efficiency standards.

DOE issued a Notice of Proposed Rulemaking (NOPR) for pool heater energy conservation standards on April 15, 2022 (DOE 2022) and the final rule was pre-published in March 2023 (DOE 2023). The final rule yielded a federal minimum efficiency standard for HPPHs for the first time and will go into effect 5 years after the final rule is published. The CA IOUs commented during the NOPR stage with recommendations for DOE to consider the maximum technology option (efficiency level (EL) 6) and supported an adjusted EL5 (CA IOUs 2022). The consumer pool heaters final rule set minimum standards based on ELs 2 and 4 for gas-fired and electric pool heaters respectively (HPPHs belong to DOE's electric pool heaters product class). EL2 for gas-fired pool heaters corresponds to an active mode thermal efficiency of 84 percent and EL4 for electric pool heaters corresponds to a heat pump incorporating a

[6] Record of adoption is available here: https://perma.cc/J42K-F4D5

twisted Titanium tube coil in concentric/counter flow Polyvinyl chloride pipe, and an increased evaporator surface area.

A Request for Information (RFI) on energy conservation standards for Dedicated-Purpose Pool Pumps (DPPPs) was published on January 24, 2022 (DOE 2022). The federal uniform test method is set forth in Appendix C to Subpart Y of 10 CFR Part 431 for dedicated-purpose pool pumps (DPPPs). Weighted energy factor levels for DPPPs are prescribed in 10 CFR 431.465(f), and are applicable to a variety of equipment classes typically up to a hydraulic horsepower (hhp) of 2.5. Labeling provisions for DPPPs are set forth in 10 CFR 431.466(b). These provisions have been incorporated in California's Appliance Efficiency Regulations in 20 CCR § 1604, 1605.1(g)(7), and 20 CCR § 1607(d).

Regarding DPPP motors, the federal test procedure is currently set forth in 10 CFR Part 431.484 of Subpart Z, but standards are yet to be established at the federal level. California's Appliance Efficiency Regulations prescribe efficiency requirements for replacement DPPP motors up to 5 hp in 20 CCR § 1605.3.

There are no preemption concerns with these standards in regard to the 2025 Title 24 swimming pool and spa heating measure. During a meeting with staff from a trade association representing manufacturers it was noted that on initial review preemption would not be a concern.

3.4.3 Difference From Existing Model Codes and Industry Standards

Section 7.4.4.3 of ASHRAE Standard 189.1-2020 prescriptively prescribes that spa pools heated to more than 90°F must have bottom and side surfaces insulated on the exterior with a minimum insulation of R-12.[7] Title 24, Part 6, does not currently prescribe any pool insulation provisions. Conduction can constitute about five percent heat loss from swimming pools (Office of Environment and Heritage 2019).

Section 7.4.5.2 of ASHRAE Standard 90.1-2019 prescribes a pool cover requirement for pools heated to more than 90°F. Pool covers must have a minimum insulation of R-12. Pool cover provisions have been in place in ASHRAE Standard 90.1 since its 1989 edition. Section 110.4(b)(2) of Title 24, Part 6, currently requires a cover for only outdoor pools or outdoor spas that have a heat pump or gas heater.

The Pool & Hot Tub Alliance (PHTA) has developed several standards in partnership with the International Code Council (ICC) on swimming pools, spas and hot tubs for

[7] The requirement is specified in prescriptive section 7.4.4.2 of both the 2020 and 2017 versions. Prior versions of ASHRAE Standard 189.1 do not include this language. Go to the following hyperlink to access the language: https://www.ashrae.org/technical-resources/standards-and-guidelines/read-only-versions-of-ashrae-standards

residential and commercial applications.[8] The International Swimming Pool and Spa Code (ISPSC) 2021, ANSI/APSP/ICC-15 2021, and ICC 902/APSP 902/SRCC 400 are some codes and standards relevant to the measures in this Final CASE Report.

The Solar Rating & Certification Corporation (ICC-SRCC), an ISO/IEC 17065-accredited third-party certification body and standard developer, addresses the certification and performance rating of solar heating and cooling products. ICC-SRCC noted the following on certain model codes and standards:

- ISPSC is currently adopted in several local jurisdictions in California, including Costa Mesa, Indian Wells, Pleasanton, Benicia, San Bernadino, Palo Alto, Newport Beach and Mission Viejo. Section 303 addresses energy consumption of residential and commercial swimming pools and spas, and prescribes the following provisions for pool heaters: switch, continuously burning ignition pilots, time switches, covers, and references to APSP 14 and APSP 15.
- Section C404.8 of the International Energy Conservation Code addresses energy consumption of pools and permanent spas, sets requirements for commercial pools and spas, addresses requirements for heaters (i.e., locations, switches, continuously burning ignition pilots), time switches, covers, and APSP 14 for portable electric spas. Section R403.10 Energy consumption of pools and spas, sets requirements for residential pools and spas. Addresses heaters (locations, switches, continuously burning ignition pilots), time switches, covers, APSP 14, APSP 15. Appendices CB and RB prescribe commercial and residential (specifically one-family dwellings, two-family dwellings, and townhouses) solar-ready provisions, and are intended to encourage the installation of renewable energy systems by preparing buildings for future installation of solar energy equipment, piping and wiring. The provisions in these appendices are not mandatory unless specifically referenced in the adopting ordinance.
- Water conservation measures are prescribed in the 2017 ANSI/APSP/ICC-13 Standard for Water Conversation Efficiency in Residential and Public Pools, Spas, Portable Spas and Swim Spas. Specifically, the measures serve to reduce energy loss due to evaporation and splashing via the provisions set forth in Splash-out (4.2), Evaporation (4.3) and Appendix A. Section 5.5.3 of the 2011 ANSI/APSP/ICC-15 Standard for Residential Swimming Pool & Spa Efficiency, prescribes that at least 18 inches (457 mm) of horizontal or vertical pipe shall be installed between the filter and the heater or dedicated suction and return lines, or built-in or built-up connections shall be installed to allow for the future addition of solar heating equipment.

[8] PHTA Standards available here: https://www.phta.org/standards-and-codes/phta-standards/industry-codes-and-standards/

Title 24, Part 6, currently prescribes the following requirements, and the Statewide CASE Team has requested industry stakeholders to provide any proposed changes that may be better aligned with other codes and standards. In addition, the Statewide CASE Team has requested cost-effectiveness and energy savings estimates associated with the proposed changes. The current provisions in Title 24, Part 6, are summarized below, and largely address some of the provisions suggested by industry stakeholders:

- Time switches – section 110.4(b)(3) specifies that a time switch or similar control mechanism must be installed as part of a pool water circulation control system that allows all pumps to be set or programmed to run only during off-peak electric demand period, and for the minimum time necessary to maintain the water in the condition required by applicable public health standards.
- A continuously burning pilot light is prohibited for a natural gas pool heater or spa heater per the provisions set forth in section 110.5.
- Section 110.4(b)(2) prescribes provisions for pool covers.
- Section 110.4(b) of Title 24, Part 6, currently requires that at least 36 inches of pipe be installed between the filter and the heater or dedicated suction and return lines, or built-in or built-up connections shall be installed to allow for the future addition of solar heating equipment.

Section 4.1 of ANSI/APSP/ICC-15 2021 requires dedicated-purpose pool pumps (DPPP) to comply with federal regulations prescribed by DOE. In comparison, section 4.1.2.1.3 of the ANSI/APSP/ICC-15 2011 specifies A, B and C curves with 0.0167, 0.050 and 0.0082 factors, some of which are currently prescribed in Section 150.0(p) of Title 24, Part 6. The proposed revisions to section 150.0(p) of Title 24, Part 6, seek to harmonize requirements with section 4.1 of ANSI/APSP/ICC-15 2021.

Section 4.2.2.3 of ANSI/APSP/ICC-15 2021 requires that HPPHs have a minimum coefficient of performance (COP) of 4.0 at low temperature conditions (i.e., at 50.0°F dry-bulb / 44.3°F wet-bulb surrounding air temperature) when tested in accordance with AHRI Standard 1160.

Upon further review of section 5.4.3 of ANSI/APSP/ICC-15 2021, the Statewide CASE Team concluded that the provisions align with ICC-SRCC's observations regarding section 5.5.3 of the 2011 edition of the standard. The minimum pipe length in Title 24, Part 6, is larger than the length prescribed in these sections of ANSI/APSP/ICC-15.

At least 11 of the 16 California climate zones have outdoor temperature fractional bin hours that are considered to be freezing conditions. The standard for Solar Pool and Spa Heating Systems, specifically 2020 ICC 902/PHTA 902/SRCC 400, requires freeze protection as outlined in section 302.12.3. The 2020 ICC 901/SRCC 100, a Solar Thermal Collector Standard, mandates in section 301.2.2 that where a collector is designated as “freeze tolerant,” it shall be designed to withstand freezing conditions without damaging the collector or reducing the design life of the collector while ensuring that verification is performed using a freeze-resistance test. The proposed revisions to Title 24, Part 6, seek to ensure that they are not in conflict with the freeze protection and freeze tolerance provisions prescribed in these standards.

3.4.4 Incentives for Innovation in Products, Materials, or Processes

The proposed measure has the potential to drive innovation in the pool heating industry. By promoting the use of on-site renewable energy or site-recovered energy, this measure incentivizes manufacturers to develop new, more efficient heating systems that can meet these requirements. For instance, this measure could drive solar innovation technology for pool heating, leading to the development of more efficient and cost-effective solar collectors. Moreover, manufacturers of heat pump pool heating systems could be incentivized to improve their systems' coefficient of performance (COP) to meet the sizing requirement and achieve compliance with this measure.

One advantage of the proposed measure is that it is designed to avoid stifling innovation by setting performance standards, rather than specifying particular technologies or solutions. Instead of mandating the use of specific technologies or solutions, the measure requires a certain percentage of the annual heating energy to come from on-site renewable energy or site-recovered energy. This approach creates a level playing field for all manufacturers and promotes healthy competition, which can drive innovation in the industry.

By encouraging manufacturers to develop new, innovative solutions that can meet these standards, the proposed measure can promote the development of more efficient, cost-effective, and sustainable pool heating systems. This could have far-reaching benefits for the industry, including lower energy costs, reduced carbon emissions, and increased energy independence.

3.5 Compliance and Enforcement

When developing this proposal, the Statewide CASE Team considered methods to streamline the compliance and enforcement process and how negative impacts on market actors who are involved in the process could be mitigated or reduced. This section describes how to comply with the proposed code change. It also describes the compliance verification process. Appendix E presents how the proposed changes could impact various market actors.

The compliance verification activities related to this measure that need to occur during each phase of the project are described below:

Appliable certificates of compliance (CF1R) are completed by the project proponent and submitted to the enforcement agency during the plan review phase. Applicable

Certificates of installation (CF2R) forms shall be completed by the installing technician or contractor if a pool heating system is implemented during the pool / in-ground spa construction phase, or if a new pool heating system is incorporated to an existing pool and in-ground spa. CF2R forms shall be submitted to the local building department as the enforcement agency during the project inspection phase.

- **Design Phase:** This phase would require a pool and spa industry professional to collaborate with a solar professional during a newly constructed project. Pool heaters are very often not installed during a newly constructed phase, but a pool owner may choose to install one later. Irrespective of when the pool heating system gets installed, a permit shall be obtained by the installer from the local building department and CEC-CF2R-PLB-03-E, the compliance form on Pool and Spa Heating Systems, shall be completed and signed by the responsible person, and be made available for inspection by the local building department. The nomenclature of the form may be further revised to clarify applicability to pools and spa and spa heating systems (i.e., revision of PLB to PAS).

  Title 24, Parts 1 and 6, have previously incorporated CF1R-STH-01-E, a Certificate of Compliance worksheet for OG-100 solar water heating systems. A new CF1R-PAS (with PAS serving as an acronym for pool and spa heating) worksheet similar to the approach taken in the previously issued CF1R-STH-01-E would be required for solar pool heating applications, and a declaration statement within the worksheet would address the following:

  1. The information provided on the Certificate of Compliance is true and correct.
  2. The responsible designer is eligible under Division 3 of the Business and Professions Code to accept responsibility for the building design or system design identified on the Certificate of Compliance.
  3. The energy features and performance specifications, materials, components, and manufactured devices for the building design or system design identified on this Certificate of Compliance conform to the requirements of Title 24, Part 1 and Part 6 of the California Code of Regulations.
  4. The building design features or system design features are consistent with the information provided on other applicable compliance documents, worksheets, calculations, plans and specifications submitted to the enforcement agency for approval with this building permit application.
  5. A copy of this Certificate of Compliance shall be made available with the building permit(s) issued for the building and made available to the enforcement agency for all applicable inspections. A copy of this

Certificate of Compliance is required to be included with the documentation the builder provides to the building owner at occupancy.

- **Permit Application Phase:** The installer of the pool heating system shall be responsible for obtaining the permit from the local building department. Plans may be reviewed by the building department along with field inspections performed by a building inspector.
- **Construction Phase:** The permit approval process may trigger an inspection by the local building department. Since CEC-CF2R-PLB-03-E is applicable to non-HERS registered projects, an approved HERS provider data registry approach is not needed for this form. Instead, the completed document shall be posted onsite for review by the local enforcement agency's inspector. The nomenclature of the form may be further revised to clarify applicability to pools and spa and spa heating systems (i.e., revision of PLB to PAS).
- **Inspection Phase:** The contractor responsible for the building permitting process shall complete the necessary sections of the certificate of installation. Inspectors should check that the number and types of pool heating systems indicated on the installation certificates match the approved certificate of compliance. The pool heating system shall correspond to plan specifications.

3.6 Addressing Energy Equity and Environmental Justice

The Statewide CASE Team assessed the potential impacts of the proposed measure, and based on a preliminary review, the measure is unlikely to have significant impacts on energy equity or environmental justice therefore reducing the impacts of disparities in DIPs. The Statewide CASE Team does not recommend further research or action at this time.

3.6.1 Research Methods and Engagement

Engagement is important because participatory approach allows individuals to address problems, develop innovative ideas, and bring forth a different perspective. The Statewide CASE Team conducted outreach to the California Low-Income Consumer Coalition (CLICC), Diversity in Aquatics, and spoke with representatives of the California Department of Housing and Community Development (HCD) to better understand the potential impact of a solar pool heating measure on low-income consumers. A response was not received from CLICC and only a template response was received from Diversity in Aquatics.

The Statewide CASE team reached out to Kyle Krause at the California Department of Housing and Community Development (HCD) in May 2023 and received a call back and discussed the proposal. HCD did not have concerns on the impact to DIPs. More details are included in Appendix F.

4. Market Analysis

4.1 Current Market Structure

The Statewide CASE Team performed a market analysis with the goals of identifying current technology availability, current product availability, and market trends. It then considered how the proposed standard may impact the market in general as well as individual market actors. Information was gathered about the incremental cost of complying with the proposed measure. Estimates of market size and measure applicability were identified through research and outreach with stakeholders including utility program staff, CEC staff, and a wide range of industry actors. In addition to conducting personalized outreach, the Statewide CASE Team discussed the current market structure and potential market barriers during a public stakeholder meeting that the Statewide CASE Team held on February 1, 2023 (Statewide CASE Team 2023c) and May 18, 2023 (Statewide CASE Team 2023d). Notes are available for both stakeholder meetings in the bibliography (Statewide CASE Team 2023a) (Statewide CASE Team 2023b).

The market for solar thermal pool heating is well established in the United States, with California being one of its leaders in pool installments and sales. The latest research conducted by PHTA (2020 Market Report) found California to have the highest number of commercial pool installments and sales out of all U.S. states. 19.6 percent of all commercial pools in California were installed in 2020 (513 of 10,034). This indicates a good opportunity for solar thermal pool heating.

The CSI-Thermal program provided rebates to utility customers who install solar thermal systems to replace water-heating systems powered by electricity or natural gas. In a 2020 report, CSI made market size assumptions using available datasets from the Residential Appliance Saturation Study (RASS) - most recent data dated 2009. Due to the age of the available data, the size of the water heating market was estimated; however, there is no conclusive evidence of the size of the solar thermal market. While RASS data is a good source for single family and multifamily applications; RASS-based data sets are not applicable to the scope of the nonresidential buildings being analyzed under this proposed measure.

Currently, the main market actors for residential and nonresidential swimming pool solar thermal water heating include system designers, architects, solar thermal contractors, distributors, manufacturers, and commissioning agents. For more information on the core functions of each market actor, see Appendix E.

4.2 Technical Feasibility and Market Availability

The technology to implement this code change is readily available in the California market. California has a long history of using solar thermal technology as a clean energy source, with numerous companies operating in the state for over 40 years. Currently, the production capacity of solar thermal manufacturers is greater than the current production levels. The three biggest manufacturers of solar thermal technologies are Aquatherm, UMA (Heliocol), and FAFCO. Others include Techno-Solis, Hot Sun Industries, Inc., Enerworks (Canada), Consolidated Manufacturers (CMI), Inc. The California Solar Initiative Thermal Program (CSI Thermal), as of late 2022, listed 48 different contractors with solar thermal pool heating projects in residential and commercial applications.

Although solar thermal technologies are well established in the market, there are several technical barriers that need to be considered with the adoption of this proposal. One such barrier is the high upfront costs of installing solar thermal pool heaters, particularly in pools without existing heating systems as it may require pool owners to install additional equipment (pumps and/or controls). The size and orientation of a pool can also impact the effectiveness of a solar pool water heater, with pools in areas with limited sunlight or poor orientation potentially unsuitable for solar heating.

Furthermore, the performance of solar pool water heaters can be affected by climate, particularly in climates with cloudy or overcast skies. Regular maintenance is required to ensure the proper functioning of solar pool water heaters, and technical expertise is needed for installation and maintenance, which can increase overall cost. Despite these technical barriers, solar pool water heaters can be a cost-effective and environmentally friendly way to heat pool water in areas with high levels of solar radiation.

4.3 Market Impacts and Economic Assessments

4.3.1 Impact on Builders

Builders of residential and commercial structures are directly impacted by many of the measures proposed by the Statewide CASE Team for the 2025 code cycle. It is within the normal practices of these businesses to adjust their building practices to changes in building codes. When necessary, builders engage in continuing education and training in order to remain compliant with changes to design practices and building codes.

California's construction industry comprises approximately 93,000 business establishments and 943,000 employees (see Table 3). For 2022, total estimated payroll will be about $78 billion. Nearly 72,000 of these business establishments and 473,000 employees are engaged in the residential building sector, while another 17,600 establishments and 369,000 employees focus on the commercial sector. The remainder of establishments and employees work in industrial, utilities, infrastructure, and other heavy construction roles (the industrial sector).

Table 3: California Construction Industry, Establishments, Employment, and Payroll in 2022 (Estimated)

Building Type	Construction Sectors	Establish-ments	Employ-ment	Annual Payroll (Billions $)
Residential	**All**	**71,889**	**472,974**	**31.2**
Residential	Building Construction Contractors	27,948	130,580	9.8
Residential	Foundation, Structure, & Building Exterior	7,891	83,575	5.0
Residential	Building Equipment Contractors	18,108	125,559	8.5
Residential	Building Finishing Contractors	17,942	133,260	8.0
Commercial	**All**	**17,621**	**368,810**	**35.0**
Commercial	Building Construction Contractors	4,919	83,028	9.0
Commercial	Foundation, Structure, & Building Exterior	2,194	59,110	5.0
Commercial	Building Equipment Contractors	6,039	139,442	13.5
Commercial	Building Finishing Contractors	4,469	87,230	7.4
Industrial, Utilities, Infrastructure, & Other (Industrial+)	**All**	**4,206**	**101,002**	**11.4**
Industrial+	Building Construction	288	3,995	0.4
Industrial+	Utility System Construction	1,761	50,126	5.5
Industrial+	Land Subdivision	907	6,550	1.0
Industrial+	Highway, Street, and Bridge Construction	799	28,726	3.1
Industrial+	Other Heavy Construction	451	11,605	1.4

Source: (State of California n.d.)

The proposed change to pool and spa heating would likely affect residential and commercial builders but would not impact firms that focus on construction and retrofit of industrial buildings, utility systems, public infrastructure, or other heavy construction. The effects on the residential and commercial building industry would not be felt by all firms and workers, but rather would be concentrated in specific industry subsectors. Table 4 shows the residential building subsectors and Table 5 shows the commercial building subsectors the Statewide CASE Team expects to be impacted by the changes proposed in this report. There would be a learning curve involved for all designers and installers impacted by the proposed measure. The Statewide CASE Team's estimates of the magnitude of these impacts are shown in Section 4.4 Economic Impacts.

Table 4: Specific Subsectors of the California Residential Building Industry by Subsector in 2022 (Estimated)

Residential Building Subsector	Establishments	Employment	Annual Payroll (Billions $)
New single family general contractors	12,671	58,367	4.4
New multifamily general contractors	421	6,344	0.7
New housing for-sale builders	189	3,969	0.5
Residential Remodelers	14,667	61,900	4.2
Residential poured foundation contractors	1,505	16,369	1.1
Residential Roofing Contractors	2,600	18,918	1.1
Other Residential Exterior Contractors	628	2,875	0.2
Residential Electrical Contractors	7,857	48,366	3.3
Residential plumbing and HVAC contractors	9,852	75,404	5.1
Other Residential Equipment Contractors	399	1,789	0.1

Source: (State of California n.d.)

Table 5: Specific Subsectors of the California Commercial Building Industry Impacted by Proposed Change to Code/Standard by Subsector in 2022 (Estimated)

Construction Subsector	Establishments	Employment	Annual Payroll (Billions $)
Commercial Building Construction	4,919	83,028	9.0
Nonresidential poured foundation contractors	529	18,159	1.6
Nonresidential Roofing Contractors	354	10,382	0.9
Nonresidential Siding Contractors	26	668	0.0
Other Nonresidential Exterior contractors	277	3,006	0.2
Nonresidential Electrical Contractors	3,137	74,277	7.0
Other Nonresidential equipment contractors	556	9,594	1.0
Nonresidential site preparation contractors	1,159	18,322	1.6
All other Nonresidential trade contractors	940	18,027	1.6

Source: (State of California n.d.)

4.3.2 Impact on Building Designers and Energy Consultants

Adjusting design practices to comply with changing building codes is within the normal practices of building designers. Building codes (including Title 24, Part 6) are typically updated on a three-year revision cycle, and building designers and energy consultants engage in continuing education and training in order to remain compliant with changes to design practices and building codes.

Businesses that focus on residential, commercial, institutional, and industrial building design are contained within the Architectural Services sector (North American Industry Classification System 541310). Table 6 shows the number of establishments, employment, and total annual payroll for Building Architectural Services. The proposed code changes would potentially impact all firms within the Architectural Services sector. The Statewide CASE Team anticipates the impacts for swimming pool and spa heating to affect firms that focus on single family, multifamily, nonresidential hotel and motel construction.

There is not a North American Industry Classification System (NAICS)[9] code specific to energy consultants. Instead, businesses that focus on consulting related to building energy efficiency are contained in the Building Inspection Services sector (NAICS 541350), which is comprised of firms primarily engaged in the physical inspection of residential and nonresidential buildings.[10] It is not possible to determine which business establishments within the Building Inspection Services sector are focused on energy efficiency consulting. The information shown in Table 6 provides an upper bound indication of the size of this sector in California.

Table 6: California Building Designer and Energy Consultant Sectors in 2022 (Estimated)

Sector	Establishments	Employment	Annual Payroll (Millions $)
Architectural Services [a]	4,134	31,478	3,623.3
Building Inspection Services [b]	1,035	3,567	280.7

Source: (State of California n.d.)

a. Architectural Services (NAICS 541310) comprises private-sector establishments primarily engaged in planning and designing residential, institutional, leisure, commercial, and industrial buildings and structures.

b. Building Inspection Services (NAICS 541350) comprises private-sector establishments primarily engaged in providing building (residential & nonresidential) inspection services encompassing all aspects of the building structure and component systems, including energy efficiency inspection services.

[9] NAICS is the standard used by federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy. NAICS was development jointly by the U.S. Economic Classification Policy Committee (ECPC), Statistics Canada, and Mexico's Instituto Nacional de Estadistica y Geografia, to allow for a high level of comparability in business statistics among the North American countries. NAICS replaced the Standard Industrial Classification (SIC) system in 1997.

[10] Establishments in this sector include businesses primarily engaged in evaluating a building's structure and component systems and includes energy efficiency inspection services and home inspection services. This sector does not include establishments primarily engaged in providing inspections for pests, hazardous wastes or other environmental contaminates, nor does it include state and local government entities that focus on building or energy code compliance/enforcement of building codes and regulations.

4.3.3 Impact on Occupational Safety and Health

The proposed code change does not alter any existing federal, state, or local regulations pertaining to safety and health, including rules enforced by the California Division of Occupational Safety and Health (DOSH). All existing health and safety rules would remain in place. Complying with the proposed code change is not anticipated to have adverse impacts on the safety or health of occupants or those involved with the construction, commissioning, and maintenance of the building.

4.3.4 Impact on Building Owners and Occupants, Including Homeowners and Potential First-Time Homeowners

4.3.4.1 Commercial Buildings

The commercial building sector includes a wide array of building types, including offices, restaurants and lodging, retail, and mixed-use establishments, and warehouses (including refrigerated) (Kenney 2019). Energy use by occupants of commercial buildings also varies considerably, with electricity used primarily for lighting, space cooling and conditioning, and refrigeration, while natural gas is used primarily for water heating and space heating. According to information published in the 2019 California Energy Efficiency Action Plan, there is more than 7.5 billion square feet of commercial floor space in California consuming 19 percent of California's total annual energy use (Kenney 2019). The diversity of building and business types within this sector creates a challenge for disseminating information on energy and water efficiency solutions, as does the variability in sophistication of building owners and the relationships between building owners and occupants.

4.3.4.2 Residential Buildings

According to data from the U.S. Census, American Community Survey (ACS), there were more than 14.5 million housing units in California in 2021 and nearly 13.3 million were occupied (see Table 7). Most housing units (nearly 9.42 million) were single family homes (either detached or attached), approximately 2 million homes were in buildings containing two to nine units, and 2.5 million homes were in multifamily buildings containing 10 or more units. The California Department of Revenue estimated that building permits for 67,300 single family and 54,900 multifamily homes will be issued in 2022, up from 66,000 single family and 53,500 multifamily permits issued in 2021.

Table 7: California Housing Characteristics in 2021[a]

Housing Measure	Estimate
Total housing units	14,512,281
Occupied housing units	13,291,541
Vacant housing units	1,220,740
Homeowner vacancy rate	0.7%
Rental vacancy rate	4.3%
Number of 1-unit, detached structures	8,388,099
Number of 1-unit, attached structures	1,030,372
Number of 2-unit structures	348,295
Number of 3- or 4-unit structures	783,663
Number of 5- to 9-unit structures	856,225
Number of 10- to 19-unit structures	740,126
Number of 20+ unit structures	1,828,547
Mobile home, RV, etc.	522,442

Sources: (United States Census Bureau n.d.), (Federal Reserve Economic Data (FRED) n.d.)

a. Total housing units as reported for 2021; all other housing measures estimated based on historical relationships.

Table 8 shows the distribution of California homes by vintage. About 15 percent of California homes were built in 2000 or later and another 11 percent built between 1990 and 1999. The majority of California's existing housing stock (8.5 million homes – 59 percent of the total) were built between 1950 and 1989, a period of rapid population and economic growth in California. Finally, about 2.1 million homes in California were built before 1950. According to Kenney et al, 2019, more than half of California's existing multifamily buildings (those with five or more units) were constructed before 1978 when there were no building energy efficiency standards (Kenney 2019).

Table 8: Distribution of California Housing by Vintage in 2021 (Estimated)

Home Vintage	Units	Percent	Cumulative Percent
Built 2014 or later	348,296	2.4	2.4
Built 2010 to 2013	261,221	1.8	4.2
Built 2000 to 2009	1,581,839	10.9	15.1
Built 1990 to 1999	1,596,351	11.0	26.1
Built 1980 to 1989	2,191,354	15.1	41.2
Built 1970 to 1979	2,539,649	17.5	58.7
Built 1960 to 1969	1,915,621	13.2	71.9
Built 1950 to 1959	1,930,133	13.3	85.2
Built 1940 to 1949	841,712	5.8	91.0
Built 1939 or earlier	1,306,105	9.0	100.0
Total housing units	**14,512,281**	**100.0**	**–**

Sources: (United States Census Bureau n.d.)

Table 9 shows the distribution of owner- and renter-occupied housing by household income. Overall, about 55 percent of California housing is owner-occupied and the rate of owner-occupancy generally increases with household income. The owner-occupancy rate for households with an income below $50,000 is only 37 percent, whereas the owner occupancy rate is 71 percent for households earning $100,000 or more.

Table 9: Owner- and Renter-Occupied Housing Units in California by Income in 2021 (Estimated)

Household Income	Total	Owner Occupied	Renter Occupied
Less than $5,000	353,493	113,315	240,178
$5,000 to $9,999	254,304	74,939	179,366
$10,000 to $14,999	495,287	134,633	360,654
$15,000 to $19,999	412,498	144,064	268,435
$20,000 to $24,999	467,694	169,431	298,264
$25,000 to $34,999	906,996	355,968	551,028
$35,000 to $49,999	1,319,892	560,453	759,438
$50,000 to $74,999	2,036,560	990,769	1,045,791
$75,000 to $99,999	1,662,032	920,607	741,425
$100,000 to $149,999	2,307,889	1,490,247	817,642
$150,000 or more	3,074,895	2,337,651	737,244
Total Housing Units	**13,291,541**	**7,292,076**	**5,999,465**

Source: (United States Census Bureau n.d.)

Understanding the distribution of California residents by home type, home vintage, and household income is critical for developing meaningful estimates of the economic impacts associated with proposed code changes affecting residents. Many proposed code changes specifically target single family or multifamily residences and so the counts of housing units by building type shown in Table 7. Table 9 provides the information necessary to quantify the magnitude of potential impacts. Likewise, impacts may differ for owners and renters, by home vintage, and by household income, information provided in Table 8 and Table 9.

4.3.4.3 Estimating Impacts

For California residents, the proposed code changes would result in lower energy bills. The Statewide CASE Team estimates that on average the proposed change to Title 24, Part 6 would increase construction cost by about $5,250 per single family home with a pool and a pool heater, but the measure would result in a savings of $8,030 in energy and maintenance cost savings over 30 years per home. This is roughly equivalent to a $14.58 per month increase in payments for a 30-year mortgage and a $22.31 per month reduction in energy costs. Overall, the Statewide CASE Team expects the 2025 Title 24, Part 6 Standards to save homeowners about $92.67 per year relative to homeowners whose single-family homes are minimally compliant with the 2022 Title 24, Part 6 requirements. As discussed in Section 4.3.4.1, when homeowners or building occupants save on energy bills, they tend to spend it elsewhere thereby creating jobs and economic growth for the California economy. Energy cost savings can be particularly beneficial to low-income homeowners who typically spend a higher portion of their income on energy bills, often have trouble paying energy bills, and sometimes go without other necessities to save money for energy bills (Association, National Energy Assistance Directors 2011).

Determining the number of pools that would have to comply with the proposed code requirement is complex. A small percentage of new single-family homes are built with a pool, and an even smaller percentage are built with a pool heater at the time of construction or first sale. There are also pools installed at existing homes and pool heating added to existing pools. We are assuming a total of about 13,000 new pools total built in CA each year which represents a 1 percent growth rate of all pools in California. Of those, about 1,000 pools are installed with new homes. It is assumed that 53 percent of pools are heated, based on the 2019 CEC Residential Appliance Saturation Survey (RASS) (CEC RASS 2019), more information is included in Appendix A.

Building owners and occupants would benefit from lower energy bills. As discussed in Section 4.4.1, when building occupants save on energy bills, they tend to spend it elsewhere in the economy thereby creating jobs and economic growth for the California economy. The Statewide CASE Team does not expect the proposed code change for the 2025 code cycle to impact building owners or occupants adversely. See Section 3.4.4 – Incentives for Innovation in Products, Materials, or Processes for a discussion on existing incentives that are relevant to this proposal.

4.3.5 Impact on Building Component Retailers (Including Manufacturers and Distributors)

The Statewide CASE Team anticipates the proposed measure would increase the sales of HPPHs and solar thermal systems while reducing the sales of gas-fired pool heaters. See Section 3.4.4 – Incentives for Innovation in Products, Materials, or Processes for a discussion on existing incentives that are relevant to this proposal.

4.3.6 Impact on Building Inspectors

Table 10 shows employment and payroll information for state and local government agencies in which many inspectors of residential and commercial buildings are employed. Building inspectors participate in continuing education and training to stay current on all aspects of building regulations, including energy efficiency. The Statewide CASE Team, therefore, anticipates the proposed change would have no impact on employment of building inspectors or the scope of their role conducting energy efficiency inspections.

Table 10: Employment in California State and Government Agencies with Building Inspectors in 2022 (Estimated)

Sector	Govt.	Establishments	Employment	Annual Payroll (Million $)
Administration of Housing Programs[a]	State	18	265	29.0
	Local	38	3,060	248.6
Urban and Rural Development Admin[b]	State	38	764	71.3
	Local	52	2,481	211.5

Source: (State of California n.d.)

a. Administration of Housing Programs (NAICS 925110) comprises government establishments primarily engaged in the administration and planning of housing programs, including building codes and standards, housing authorities, and housing programs, planning, and development.

b. Urban and Rural Development Administration (NAICS 925120) comprises government establishments primarily engaged in the administration and planning of the development of urban and rural areas. Included in this industry are government zoning boards and commissions.

4.3.7 Impact on Statewide Employment

As described in Sections 4.3.1 through 4.3.6, the Statewide CASE Team does not anticipate significant employment or financial impacts to any particular sector of the California economy. This is not to say that the proposed change would not have modest impacts on employment in California. In Section 4.4, the Statewide CASE Team estimated the proposed change in swimming pool and spa heating mandatory requirements would affect statewide employment and economic output directly and indirectly through its impact on builders, designers, energy consultants, and building inspectors. In addition, the Statewide CASE Team estimated how energy savings associated with the proposed change in swimming pool and spa heating mandatory requirements would lead to modest ongoing financial savings for California residents, which would then be available for other economic activities.

4.4 Economic Impacts

For the 2025 code cycle, the Statewide CASE Team used the IMPLAN model software[11], along with economic information from published sources, and professional judgement to develop estimates of the economic impacts associated with each of the proposed code changes. Conceptually, IMPLAN estimates jobs created as a function of incoming cash flow in different sectors of the economy, due to implementing a code or a standard. The jobs created are typically categorized into direct, indirect, and induced employment. For example, cash flow into a manufacturing plant captures direct employment (jobs created in the manufacturing plant), indirect employment (jobs created in the sectors that provide raw materials to the manufacturing plant) and induced employment (jobs created in the larger economy due to purchasing habits of people newly employed in the manufacturing plant). Eventually, IMPLAN computes the total number of jobs created due to a code. The assumptions of IMPLAN include constant returns to scale, fixed input structure, industry homogeneity, no supply constraints, fixed technology, and constant byproduct coefficients. The model is also static in nature and is a simplification of how jobs are created in the macro-economy.

The economic impacts developed for this report are only estimates and are based on limited and to some extent speculative information. The IMPLAN model provides a relatively simple representation of the California economy and, though the Statewide CASE Team is confident that the direction and approximate magnitude of the estimated economic impacts are reasonable, it is important to understand that the IMPLAN model is a simplification of extremely complex actions and interactions of individual, businesses, and other organizations as they respond to changes in energy efficiency codes. In all aspect of this economic analysis, the CASE Authors rely on conservative assumptions regarding the likely economic benefits associated with the proposed code change. By following this approach, the economic impacts presented below represent lower bound estimates of the actual benefits associated with this proposed code change.

[11] IMPLAN employs economic data and advanced economic impact modeling to estimate economic impacts for interventions like changes to the California Title 24, Part 6 code. For more information on the IMPLAN modeling process, see www.IMPLAN.com.

Adoption of this code change proposal would result in relatively modest economic impacts through the additional direct spending by those in the residential and commercial building industry, remodeling industry, architects, energy consultants, and building inspectors, as well as indirectly as residents spend all or some of the money saved through lower utility bills on other economic activities.[12] There may also be some nonresidential customers that are impacted by this proposed code change; however, the Statewide CASE Team does not anticipate such impacts to be materially important to the building owner and would have measurable economic impacts. Additionally, the Statewide CASE Team does not anticipate that money saved by commercial building owners or other organizations affected by the proposed 2025 code cycle regulations would result in additional spending by those businesses.

Table 11: Estimated Impact that Adoption of the Proposed Measure would have on the California Commercial Construction Sector

Type of Economic Impact	Employment (Jobs)	Labor Income (Million)	Total Value Added (Million)	Output (Million)
Direct Effects (Additional spending by Commercial Builders)	151.7	$12.1	$18.2	$39.3
Indirect Effect (Additional spending by firms supporting Commercial Builders)	88.5	$7.0	$12.0	$21.0
Induced Effect (Spending by employees of firms experiencing "direct" or "indirect" effects)	80.2	$5.5	$9.8	$15.6
Total Economic Impacts	**320.4**	**$24.5**	**$39.9**	**$75.9**

Source: Statewide CASE Team analysis of data from the IMPLAN modeling software.[13]

Table 12: Estimated Impact that Adoption of the Proposed Measure would have on the California Residential Construction Sector

Type of Economic Impact	Employment (Jobs)	Labor Income (Million)	Total Value Added (Million)	Output (Million)
Direct Effects (Additional spending by Residential Builders)	332.7	$25.0	$38.1	$81.7
Indirect Effect (Additional spending by firms supporting Residential Builders)	203.5	$15.0	$25.6	$43.5
Induced Effect (Spending by employees of firms experiencing "direct" or "indirect" effects)	169.2	$11.5	$20.6	$32.8
Total Economic Impacts	**705.4**	**$51.5**	**$84.3**	**$158.1**

[12] For example, for the lowest income group, we assume 100 percent of money saved through lower energy bills will be spent, while for the highest income group, we assume only 64 percent of additional income will be spent.

[13] IMPLAN® model, 2020 Data, IMPLAN Group LLC, IMPLAN System (data and software), 16905 Northcross Dr., Suite 120, Huntersville, NC 28078 www.IMPLAN.com

Source: Statewide CASE Team analysis of data from the IMPLAN modeling software.

Table 13: Estimated Impact that Adoption of the Proposed Measure would have on the California Building Designers and Energy Consultants Sectors

Type of Economic Impact	Employment (Jobs)	Labor Income (Million)	Total Value Added (Million)	Output (Million)
Direct Effects (Additional spending by Building Designers & Energy Consultants)	51	$5.5	$5.5	$8.7
Indirect Effect (Additional spending by firms supporting Bldg. Designers & Energy Consultants)	20	$1.7	$2.3	$3.7
Induced Effect (Spending by employees of firms experiencing "direct" or "indirect" effects)	30	$2.1	$3.7	$5.9
Total Economic Impacts	**101**	**$9.3**	**$11.5**	**$18.3**

Source: Statewide CASE Team analysis of data from the IMPLAN modeling software.

Table 14: Estimated Impact that Adoption of the Proposed Measure would have on California Building Inspectors

Type of Economic Impact	Employment (Jobs)	Labor Income (Million)	Total Value Added (Million)	Output (Million)
Direct Effects (Additional spending by Building Inspectors)	6	$0.70	$0.83	$1.01
Indirect Effect (Additional spending by firms supporting Building Inspectors)	1	$0.06	$0.10	$0.18
Induced Effect (Spending by employees of Building Inspection Bureaus and Departments)	3	$0.22	$0.39	$0.63
Total Economic Impacts	**10**	**$0.98**	**$1.33**	**$1.81**

Source: Statewide CASE Team analysis of data from the IMPLAN modeling software.

Table 15: Estimated Impact that Adoption of the Proposed Measure would have on Discretionary Spending by California Residents

Type of Economic Impact	Employment (Jobs)	Labor Income (Million)	Total Value Added (Million)	Output (Million)
Direct Effects (Additional spending by households)	0.0	$0	$0	$0
Indirect Effect (Purchases by businesses to meet additional household spending)	0.0	$0	$0	$0
Induced Effect (Spending by employees of businesses experiencing "indirect" effects)	752.9	51.3	92.6	147.3
Total Effect	**752.9**	**51.3**	**92.6**	**147.3**

Source: Statewide CASE Team analysis of data from the IMPLAN modeling software.

4.4.1 Creation or Elimination of Jobs

The Statewide CASE Team does not anticipate that the measures proposed for the 2025 code cycle regulation would lead to the creation of new *types* of jobs or the elimination of *existing* types of jobs. In other words, the Statewide CASE Team's proposed change would not result in economic disruption to any sector of the California economy. Rather, the estimates of economic impacts discussed in Section 4.4 would lead to modest changes in employment of existing jobs.

4.4.2 Creation or Elimination of Businesses in California

As stated in Section 4.4.1, the Statewide CASE Team's proposed change would not result in economic disruption to any sector of the California economy. The proposed change represents a modest change to solar pool water heating requirements, which would not excessively burden or competitively disadvantage California businesses – nor would it necessarily lead to a competitive advantage for California businesses. Therefore, the Statewide CASE Team does not foresee any new businesses being created, nor does the Statewide CASE Team think any existing businesses would be eliminated due to the proposed code changes.

4.4.3 Competitive Advantages or Disadvantages for Businesses in California

The proposed code changes would apply to all businesses incorporated in California, regardless of whether the business is located inside or outside of the state.[14] Therefore, the Statewide CASE Team does not anticipate that these measures proposed for the 2025 code cycle regulation would have an adverse effect on the competitiveness of California businesses. Likewise, the Statewide CASE Team does not anticipate businesses located outside of California would be advantaged or disadvantaged.

4.4.4 Increase or Decrease of Investments in the State of California

The Statewide CASE Team analyzed national data on corporate profits and capital investment by businesses that expand a firm's capital stock (referred to as net private domestic investment, or NPDI).[15] As shown in Table 16, between 2017 and 2021, NPDI as a percentage of corporate profits ranged from a low of 18 in 2020 due to the worldwide economic slowdowns associated with the COVID 19 pandemic to a high of 35 percent in 2019, with an average of 26 percent. While only an approximation of the

[14] Gov. Code, §§ 11346.3(c)(1)(C), 11346.3(a)(2); 1 CCR § 2003(a)(3) Competitive advantages or disadvantages for California businesses currently doing business in the state.

[15] Net private domestic investment is the total amount of investment in capital by the business sector that is used to expand the capital stock, rather than maintain or replace due to depreciation. Corporate profit is the money left after a corporation pays its expenses.

proportion of business income used for net capital investment, the Statewide CASE Team believes it provides a reasonable estimate of the proportion of proprietor income that would be reinvested by business owners into expanding their capital stock.

Table 16: Net Domestic Private Investment and Corporate Profits, U.S.

Year	Net Domestic Private Investment by Businesses, Billions of Dollars	Corporate Profits After Taxes, Billions of Dollars	Ratio of Net Private Investment to Corporate Profits (Percent)
2017	518.473	1882.460	28
2018	636.846	1977.478	32
2019	690.865	1952.432	35
2020	343.620	1908.433	18
2021	506.331	2619.977	19
5-Year Average	**Intentionally blank**	**Intentionally blank**	**26**

Source: (Federal Reserve Economic Data (FRED) n.d.)

4.4.5 Effects on the State General Fund, State Special Funds, and Local Governments

The Statewide CASE Team does not expect the proposed code changes would have a measurable impact on the California's General Fund, any state special funds, or local government funds.

4.4.5.1 Cost of Enforcement

Cost to the State: State government already has budget for code development, education, and compliance enforcement. While state government will be allocating resources to update the Title 24, Part 6 standards, including updating education and compliance materials and responding to questions about the revised requirements, these activities are already covered by existing state budgets. The costs to state government are small when compared to the overall costs savings and policy benefits associated with the code change proposals.

Cost to Local Governments: All proposed code changes to Title 24, Part 6 would result in changes to compliance determinations. Local governments would need to train building department staff on the revised Title 24, Part 6 Standards. While this re-training is an expense to local governments, it is not a new cost associated with the 2025 code change cycle. The building code is updated on a triennial basis, and local governments plan and budget for retraining every time the code is updated. There are numerous resources available to local governments to support compliance training that can help mitigate the cost of retraining, including tools, training and resources provided by the IOU Codes and Standards program (such as Energy Code Ace). As noted in Section

3.4.4 and Appendix E, the Statewide CASE Team considered how the proposed code change might impact various market actors involved in the compliance and enforcement process and aimed to minimize negative impacts on local governments.

4.4.6 Impacts on Specific Persons

While the objective of any of the Statewide CASE Team's proposal is to promote energy efficiency, the Statewide CASE Team recognizes that there is the potential that a proposed code change may result in unintended consequences. Refer to Section 2.2 for more details addressing energy equity and environmental justice.

4.5 Fiscal Impacts

The proposed regulations would increase the initial purchase cost of pool heating systems and save money through lower gas utility bills over the 25-year life of the solar collectors. For any applications, these incremental costs to purchases would most likely arise in the July 1, 2025–June 30, 2026, fiscal year. The incremental costs of the solar collectors are more than offset by the resulting reduced gas utility bills. These costs are not targeted specifically at state or local governments, but rather more broadly at which pool heating systems can be offered for sale to any entity in California.

4.5.1 Mandates on Local Agencies or School Districts

This proposed measure would impact various types of buildings and facilities, including schools with pools. It is possible that this proposed measure could impose a mandate on school districts that own or operate facilities with heated swimming pools and spas. However, the extent of the mandate would depend on the specific circumstances of each district. Therefore, there may be relevant mandates to local agencies or school districts.

4.5.2 Costs to Local Agencies or School Districts

There may be added costs to local agencies or school districts due to the proposed measure, which could potentially require reimbursement pursuant to California Constitution, Government Code sections 17500 et seq. If the school district owns or operates facilities with heated swimming pools and spas, they may incur costs to comply with the proposed measure. However, the extent of the costs would depend on the specific circumstances of each district.

4.5.3 Costs or Savings to Any State Agency

There are no added costs or savings imposed on any state agency by the proposed measure, as its provisions do not affect the operations or funding of any state agency.

4.5.4 Other Non-Discretionary Cost or Savings Imposed on Local Agencies

There may be added non-discretionary costs or savings imposed on local agencies due to the proposed measure. If school districts own or operate facilities with heated swimming pools and spas, they may incur added costs or savings to comply with the proposed measure. However, the extent of the costs or savings would depend on the specific circumstances of each district.

4.5.5 Costs or Savings in Federal Funding to the State

There are no costs or savings in federal funding to the state resulting from the proposed measure.

5. Energy Savings

The Statewide CASE Team gathered stakeholder input to inform the energy savings analysis. The Statewide CASE Team met with CALSSA and its members. See Appendix F for a summary of stakeholder engagement.

Energy savings benefits may have potential to disproportionately impact DIPs. Refer to Section 2 for more details addressing energy equity and environmental justice.

5.1 Energy Savings Methodology

5.1.1 Key Assumptions for Energy Savings Analysis

The Statewide CASE Team analyzed five pool applications to determine the energy savings of a solar pool heating code change. The pool applications cover residential, multifamily, and commercial locations. The Statewide CASE Team analyzed outdoor applications both with and without a pool cover to the sensitivity to savings for its use. The Statewide CASE Team assumed no pool cover for indoor pools since the controlled indoor environment prevents most evaporation from the pool.

The Statewide CASE Team selected two pool sizes for study among the various applications. For three applications, a 20,000-gallon pool is assumed with a 440 square feet surface area and gas-fired pool heater capacity of 110 thousand British thermal units per hour (kBtu/h). The solar collector size is 264 square feet to meet the minimum proposed requirement for residential pools and 286 square feet for nonresidential pools.

The other applications consider Olympic size pools with a volume of 660,000 gallons and a pool surface area of 13,450 square feet. A 2,200 MBtu/h gas-fired pool heater maintains the pool temperature. The solar collector size is 8,800 square feet to meet the minimum proposed requirement. All scenarios assume the pool is continuously heated.

The Statewide CASE Team assumed unglazed solar collectors for all since this is the most common collector for pool heating applications.

Table 17: Prototypical Pool Dimensions and Use Summary

Dimensions and Use	Scenario 1: **Residential Seasonal**	Scenario 2: **Multifamily/ Commercial Outdoor**	Scenario 3: **Multifamily/ Commercial Indoor**	Scenario 4: **Commercial Indoor Olympic**	Scenario 5: **Commercial Outdoor Olympic**
Pool Volume	20,000 gal	20,000 gal	20,000 gal	660,000 gal	660,000 gal
Pool Surface Area	440 ft^2	440 ft^2	440 ft^2	13,450 ft^2	13,450 ft^2
Pool Water Temp	80 °F	80 °F	80 °F	80 °F	80 °F
Pool Swim Season	Part-year	Year round	Year round	Year round	Year round
Pool Use	Weekends noon to 8 pm	Daily 10 am to 8 pm	Daily 10 am to 8 pm	Daily 6 am to 10 pm	Daily 10 am to 8 pm
Solar Collector Size	264 ft^2	286 ft^2	286 ft^2	8,800 ft^2	8,800 ft^2
Solar Collector Type	Unglazed	Unglazed	Unglazed	Unglazed	Unglazed

The Statewide CASE Team could not use the 2025 Research Version of the California Building Energy Code Compliance (CBECC) software like the other Title 24 measures since CBECC does not model the energy use of pools. Instead, the Statewide CASE Team evaluated several pool energy simulation software packages including Transient System Simulation Tool (TRNSYS), RETScreen Clean Energy Management Software and Enerpool Pro 3.0. The Statewide CASE Team determined that Enerpool Pro 3.0 Pool Heater Simulation Software developed by Natural Resources, Canada (NRCan) could provide results for the analysis.

The Enerpool Pro 3.0 software simulates the amount of heat that is lost through conduction, convection, radiation and evaporation of pool water. To simulate heat loss for a pool the software considers several key parameters while using it mathematical models:

1. Water temperature of the pool.
2. Ambient air temperature. The temperature of the air surrounding the pool was provided by the California Energy Commission's (CEC) 2025 Title 24 climate files.[16]
3. Wind Speed: The speed of the wind near the pool, which can affect heat transfer. The CEC 2025 Title 24 climate files contain hourly information on wind speed.

[16] California Energy Commission. Climate Zone tool, maps, and information supporting the California Energy Code. https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/climate-zone-tool-maps-and

4. Solar radiation: the amount of sun exposure the pool receives, which can impact water temperature.
5. Pool surface area: the size of the pool's surface area, which affects heat transfer.
6. Insulation properties: the rated effectiveness of the pool's shell to reduce heat loss.
7. Evaporation rate: the amount of water that evaporates from the pool. A pool cover may be used to control evaporation when the pool is not in use.
8. Convection: the movement of heat from water to the air through currents and mixing.

The software provides a detailed breakdown of key pool parameters and types of energy including:

1. Pool water temperature
2. Heat loss rate for conduction, convection, radiation and evaporation
3. Energy consumption by source to heat the pool.

Table 18 provides the schedule for when the residential pool is operated. The Statewide CASE Team estimated the beginning of the seasonal swim seasons by when the location had a sustained daily high temperature 70°F or greater. The end of the swim season was determined by the daily high temperature, the onset of inclement weather and the shortening of daylight due to the end of daylight savings time impacting the available hours for swimming.

Table 18: Climate Zone Residential Swim Season Assumptions

Climate Zone	Swim Season Start	Swim Season End
CZ1 Arcata	Jun 15	Sep 15
CZ2 Santa Rosa	May 1	Oct 31
CZ3 Oakland	June 1	Sep 30
CZ 4 San Jose	May 15	Oct 31
CZ 5 Santa Maria	June 1	Oct 15
CZ 6 Torrance	May 15	Oct 31
CZ 7 San Diego	June 1	Oct 15
CZ 8 Fullerton	April 15	Oct 31
CZ 9 Burbank	May 15	Oct 31
CZ 10 Riverside	Apr 1	Oct 31
CZ 11 Red Bluff	May 1	Oct 31
CZ 12 Sacramento	May 1	Oct 31
CZ 13 Fresno	April 1	Oct 31
CZ 14 Palmdale	April 15	Oct 31
CZ 15 Palm Springs	April 1	Oct 31
CZ 16 Blue Canyon	Jun 15	Sep 15

5.1.1.1 Key Assumptions of the Performance and Efficiency of Gas-fired Pool Heaters

Gas-fired pool heaters burn natural gas to heat pool water. The heat is transferred to the pool water as it pumped through the pool heater. Gas-fired pool heaters have high heating capacities and can quickly meet the heating demands of the pool owner. The heater capacity may range from 75,000 Btu/h to 450,000 Btu/h.

The efficiency of gas-fired pool heaters depends on several factors, including the size of the heater, the fuel type, and the thermal efficiency of the heat exchanger within the heater. The thermal efficiency of a pool heater is the ratio of the heat output to the energy input. The efficiency of gas fired pool heater is regulated by the U.S. DOE appliance standards that set a minimum 82 percent thermal efficiency. The DOE Final Rule (DOE 2023) will result in a standard based on Integrated Thermal Efficiency.

Manufacturers offer gas-fired pool heaters above the minimum thermal efficiency required by the U.S. DOE. Thermal efficiency may be improved by improving the heat exchanger and transitioning to condensing exhaust technologies.

For this analysis, the Statewide CASE Team assumed a thermal efficiency of 82 percent for gas powered pool heaters.

5.1.1.2 Key Assumptions of the Performance and Efficiency of HPPH

A HPPH uses electricity to transfer heat from the surrounding air to the pool water through a heat exchanger. HPPHs are rated on output capacity and are typically advertised at their high air temperature (80°F), high humidity (80 percent relative humidity), and 80°F water temperature test point (commonly denoted as 80/80/80). This is one of the test points required by the California Appliance Efficiency Standards (Title 20). This is unlike gas heaters which are typically advertised based on input capacity. HPPHs also are rated at other conditions such as 80°F/63 percent RH/80°F, 50°F/63 percent RH/80°F and 80°F/63 percent RH/104°F (spa conditions) as required by the CEC (California Energy Commission, 2022) and the Air-Conditioning and Refrigeration Institute (AHRI) equipment databases (AHRI, 2022). At each output capacity for these ratings, a Coefficient of Performance (COP) value is produced, which is a function of useful heat compared to work required, or a measurement of how efficient the heat pump is at the given conditions.

As noted in Section 3, there was a Notice of Proposed Rulemaking (NOPR) for pool heater efficiency published on April 15, 2022 (DOE 2022) and the final rule was published in May 2023 (DOE 2023). This rulemaking sets the federal minimum efficiency standard for HPPHs for the first time, which will go into effect 5 years after the final rule is published. Once standards are established for this equipment, manufacturers will only be permitted to publish ratings at the DOE test procedure rating condition, which is High Air Temperature—Mid Humidity (63 percent RH) level specified in Section 6 of AHRI Standard 1160.

COP data published at standard conditions by CEC is useful, however, because outside conditions are always changing determining the exact COP at any given temperature is challenging.

Some HPPHs may be operated below freezing if the freezing temperatures do not last longer than 8 hours. Many locations in California have temperate climates that would allow year-round operation without the need for electric resistance heating. HPPHs with the capability to operate in winter conditions may have reversible cycles to de-ice the HPPH. Data is limited on cold temperature performance of HPPH.

Figure 1 below plots the 231 models of HPPHs in the CEC database of October 2022. California has had an appliance standard for HPPHs since 2003 requiring the average of the standard (warm) and low temperature condition COP values to be greater than 3.5. Currently the database shows the lowest average COP at the warm and low temperature conditions to be 4.0, significantly higher than minimal compliance with the Title 20 standard. Furthermore, taking a simple average of the "average COPs" yields a COP of 4.8 (California Energy Commission 2022). As Figure 1 below shows, in warm conditions, COPs mostly range between 5 and 7.1.

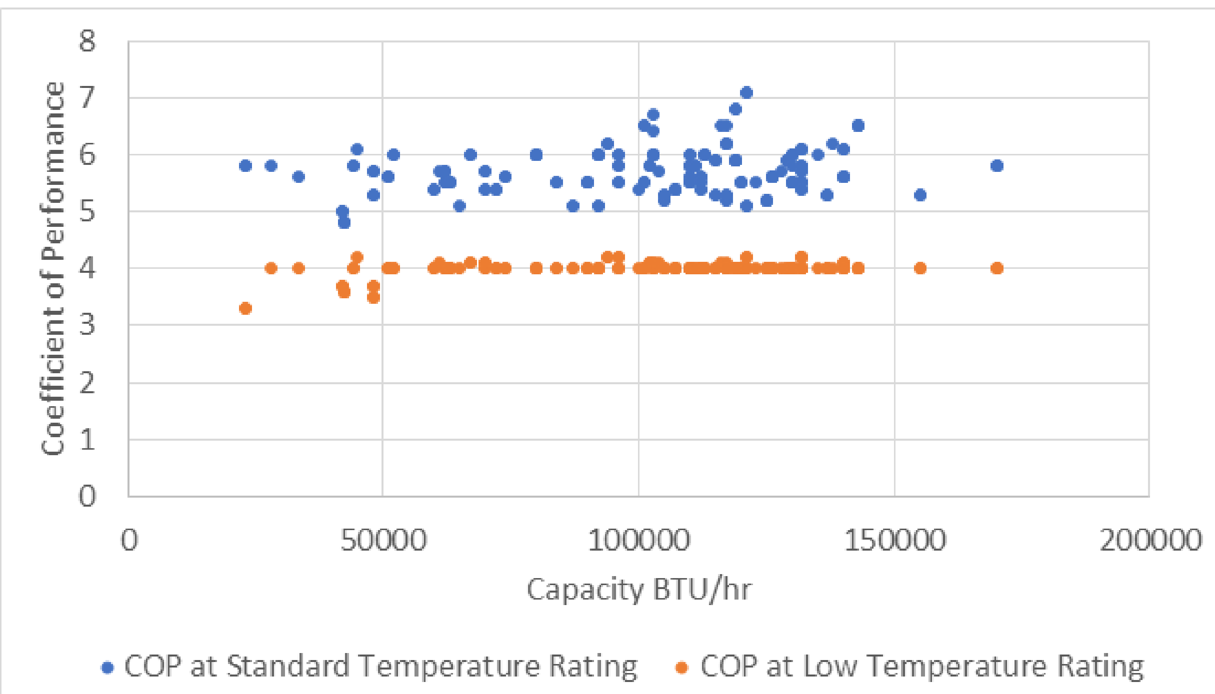

Figure 1: Heat pump pool heater performance

Source: (MAEDbS, 2022)

5.1.1.3 Solar Collector Performance and Efficiency Assumptions

Solar powered heating systems are devices that collect solar energy to heat the water in a swimming pool. The systems would have solar collectors that are usually installed on the roof of a single family, multifamily, or nonresidential building. The solar collectors gather heat from the sun and transfer the heat to the pool water as it is pumped through.

Pool and spa heating provide a low temperature solar thermal water heating opportunity. There are primarily three types of solar thermal collector equipment: unglazed, glazed and glycol systems. The analysis assumes unglazed solar thermal collector equipment.

Unglazed solar collectors are an efficient, low-cost system for heating swimming pools. They are made of a black plastic material that absorbs the sun's energy, converting it into heat. This heat is then transferred to the water in the pool. Unglazed solar collectors are popular for swimming pools because they are easy to install, require little to no maintenance, and are much less expensive than other pool heating systems. Unglazed solar collectors are more efficient than glazed solar collectors because they can absorb more of the sun's energy, but they also lose more heat to the environment.

Glazed collectors are made up of two main components: a glazed panel and an absorber plate. The glazed panel is made of tempered glass that protects the absorber plate from the elements. The absorber plate is coated with a dark, heat absorbent material (such as black chrome) that absorbs the sun's energy. The heat is transferred to the pool by circulating the pool water through the absorber plate.

Glycol solar collectors differ from the glazed and unglazed solar collectors in that a glycol solution is circulated through the collectors to gather the heat from the solar energy. The heat is transferred from the glycol solution to the pool water by a heat exchanger.

Design guides typically recommend sizing unglazed systems at 50 percent of the surface of the pool for seasonal pools and 100 percent to 125 percent for year-round applications. The collection efficiency of collectors can be described by the ability of the collector to collect the solar energy offset by losses due to wind and the temperature difference between the pool water and the ambient air temperature. The solar heating capacity of collectors is dependent on the weather and season, with the highest capacity attained during the summer months. Capacity may diminish drastically during periods of cooler weather. The SRCC offers ratings of solar collector efficiency through OG-100 and solar heating system ratings through OG-400 (ICC-SRCC 2022). There are no minimum performance requirements for solar collectors or solar powered heating systems.

The Enerpool software requires assumptions of three factors that determine the collector efficiency per the Hottel-Whillier-Bliss equation. These factors are the heat removal factor (FR) the effective transmittance-absorptance product (α) and the overall heat loss coefficient (UL). The values are based upon experimental data and depend upon the incident wind speed upon the collector. The Statewide CASE Team used values for a generic unglazed solar collector per NRCAN recommendations. Therefore, the following equations and performance coefficients were used for the simulation of the energy performance of the solar collectors:

$$FR\alpha = 0.85\text{-}0.04V$$

$$FRUL = 11.56+4.37V$$

Where V is equal to the incident wind speed per the Title 24 weather files.

Both unglazed and glazed systems must be winterized to prevent the freezing of pool water within when air temperatures drop below freezing. Pools that require heating during the winter months must size an auxiliary heating system to maintain pool temperatures.

5.1.2 Energy Savings Methodology per Prototypical Pool

The Statewide CASE Team measured per pool energy savings expected from the proposed code changes in several ways to quantify key impacts. First, savings are calculated by fuel type. Electricity savings are measured in terms of both energy usage and peak demand reduction. Natural gas savings are quantified in terms of energy usage. Second, the Statewide CASE Team calculated source energy savings. Source energy represents the total amount of raw fuel required to operate a building. In addition to all energy used from on-site production, source energy incorporates all transmission, delivery, and production losses. The hourly Source Energy values provided by CEC are strongly correlated with GHG emissions.[17] Finally, the Statewide CASE Team calculated Long-term Systemwide Cost (LSC) Savings, formerly known as Time Dependent Valuation (TDV) Energy Cost Savings. LSC Savings are calculated using hourly LSC factors for both electricity and natural gas provided by the CEC. These LSC hourly factors are projected over the 30-year life of the building and incorporate the hourly cost of marginal generation, transmission and distribution, fuel, capacity, losses, and cap-and-trade-based CO_2 emissions.[18]

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[18] See Hourly Factors for Source Energy, Long-term Systemwide Cost, and Greenhouse Gas Emissions at https://www.energy.ca.gov/files/2025-energy-code-hourly-factors

More information on source energy and LSC is available in the March 2020 CEC Staff Workshop on Energy Code Compliance Metrics and the July 2022 CEC Staff Workshop on Energy Code Accounting for the 2025 Building Energy Efficiency Standards.

The CEC directed the Statewide CASE Team to model the energy impacts using specific prototypical pool models that represent typical pools for different types of buildings. The prototype pools that the Statewide CASE Team used in the analysis are presented in Table 19.

Table 19: Prototype Pools Used for Energy, Demand, Cost, and Environmental Impacts Analysis

Prototype Name	Pool Surface Area (sq. ft)	Pool Volume (gal)	Baseline Heat Source	Measure Heat Source	Description
NR Motel Outdoor Pool Covered Gas	440	20,000	Gas	Solar Thermal with Gas Backup	Outdoor pool typical of commercial application with pool cover in use outside of business hours
NR Motel Outdoor Pool Uncovered Gas	440	20,000	Gas	Solar Thermal with Gas Backup	Outdoor pool typical of commercial application with no pool cover
NR Motel Indoor Pool Uncovered Gas	440	20,000	Gas	Solar Thermal with Gas Backup	Indoor pool typical of commercial application with no pool cover
NR Olympic Outdoor Pool Covered Gas	13,455	660,000	Gas	Solar Thermal with Gas Backup	Outdoor pool typical of commercial application with pool cover in use outside of business hours
NR Olympic Outdoor Pool Uncovered Gas	13,455	660,000	Gas	Solar Thermal with Gas Backup	Outdoor pool typical of commercial application with no pool cover
NR Olympic Indoor Pool Uncovered Gas	13,455	660,000	Gas	Solar Thermal with Gas Backup	Indoor pool typical of commercial application with no pool cover
Residential Outdoor Pool Covered Gas	440	20,000	Gas	Solar Thermal with Gas Backup	Residential outdoor pool covered
Residential Outdoor Pool Uncovered Gas	440	20,000	Gas	Solar Thermal with Gas Backup	Residential outdoor pool uncovered

The Statewide CASE Team analyzed each gas prototype listed Table 19 for a standard and baseline design. The electric prototypes have been analyzed, and results appear as appendix H of the Final CASE Report. The Standard Design represents the geometry and use of the prototypical pool uses a set of features that result in a Long-term Systemwide energy budget and source energy budget that is minimally compliant with 2022 Title 24, Part 6 code requirements. The Proposed Design represents the same geometry as the Standard Design, but it assumes the sources of energy required by the proposed code change. To develop savings estimates for the proposed code changes, the Statewide CASE Team created a Standard Design and Proposed Design for each prototypical pool with the Standard Design representing compliance with 2022 code and the Proposed Design representing compliance with the proposed requirements. Comparing the energy impacts of the Standard Design to the Proposed Design reveals the impacts of the proposed code change relative to a pool that is minimally compliant with the 2022 Title 24, Part 6 requirements / that follows industry typical practices.

The Proposed Design was identical to the Standard Design in all ways except for the source of pool heating.

The energy impacts of the proposed code change vary by climate zone. The Statewide CASE Team simulated the energy impacts in every climate zone and applied the climate-zone specific LSC hourly factors when calculating energy and energy cost impacts. Per unit energy impacts are presented in savings per prototype pool. The savings are presented per pool regardless of single family, multifamily, or nonresidential location. The analysis approach differs from the other code change proposals because there is not a strong correlation between the building size and size or energy use of the pool.

5.1.3 Statewide Energy Savings Methodology

The per-pool energy impacts were extrapolated to statewide impacts using estimates developed by the Statewide CASE Team that relied upon industry and regulatory sources to estimate the quantity of existing pools and forecasted pools in California. The Statewide CASE Team estimates new construction of pools that would occur in 2026, the first year that the 2025 Title 24, Part 6 requirements are in effect. They also estimate the amount of total pool stock in 2026, which the Statewide CASE Team used to approximate savings from pool retrofits to existing.

The team assumed for pool heater retrofits the retrofit would occur at the end of useful life assumed to be 11.2 years per the recent U.S. DOE commercial pool heater proposed regulation. The Statewide CASE Team calculated the number of pools retrofit by the dividing the existing pool stock by the estimated useful life.

The Statewide CASE Team estimated there were approximately 2,000 Olympic-sized nonresidential pools in California based upon listings in a national guide to large pools. The Statewide CASE Team assumed California has about 25 percent of the 7,698 pools in the nationwide listing (SwimmersGuide n.d.).

In 2020, the Pool and Hot Tub Alliance commented to the CEC on building decarbonization. In the letter they provided an estimate of 41,000 commercial pools in California. The Statewide CASE Team used that estimate and the previous Olympic pool estimate to calculate that there would be 39,000 smaller pools in California (PHTA 2020).

The Solar Energy Industries Association published an estimate of the number of commercial pools which showed that 39 percent are indoor and 61 percent are outdoor pools (SEIA 2011). The Statewide CASE Team used this estimate to assign nonresidential stock quantities.

The Residential Appliance Saturation Survey surveyed pool owners in California about the types of appliances and their use. The survey describes that about half of pools have no heater and that only 11 percent of those pools are continuously heated. Most other pools with a heater are rarely or never heated (CEC RASS 2019). The Statewide CASE Team chose to study those pools that are continuously heated as pools that are rarely or never heated will not have much energy use that can be displaced through the proposed solar collector requirements. A 1998 National Renewables Laboratory Report, Report on Solar Pool Heating Quantitative Survey, found similar pool owner pool heating habits for California (NREL 1999).

Appendix A presents additional information about the methodology and assumptions used to calculate statewide energy impacts.

5.2 Per-Unit Energy Impacts Results

Natural gas and energy savings per prototypical residential and nonresidential pools are presented in Table 20 through Table 25 for new construction, additions, and alterations. The per-unit energy savings figures do not account for naturally occurring market adoption or compliance rates. Based on the analysis of using a gas-fired pool heater baseline, there are no first year for electricity savings, or peak demand reductions. The solar thermal collector analysis found a wide range of natural gas savings from 64 therms/yr for a residential pool to 45,000 therms/yr for an Olympic pool.

Table 20: Natural Gas Savings (kBtu/yr) For Solar Pool Heating Per Prototypical Pool (Climate Zones 1 - 8)

Prototype	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8
NR Motel Indoor Pool Uncovered Gas	17,000	69,000	34,000	84,000	42,000	48,000	52,000	88,000
NR Motel Outdoor Pool Covered Gas	19,000	70,000	36,000	88,000	44,000	48,000	52,000	86,000
NR Motel Outdoor Pool Uncovered Gas	20,000	72,000	37,000	93,000	46,000	50,000	54,000	88,000
NR Olympic Indoor Pool Uncovered Gas	490,000	2,000,000	960,000	2,400,000	1,200,000	1,400,000	1,500,000	2,500,000
NR Olympic Outdoor Pool Covered Gas	950,000	2,300,000	1,400,000	3,200,000	1,700,000	1,500,000	1,600,000	2,600,000
NR Olympic Outdoor Pool Uncovered Gas	1,400,000	3,000,000	2,300,000	3,900,000	2,500,000	2,300,000	2,300,000	3,200,000
Residential Outdoor Pool Covered Gas	6,400	44,000	19,000	48,000	18,000	23,000	21,000	39,000
Residential Outdoor Pool Uncovered Gas	6,400	44,000	19,000	52,000	19,000	23,000	22,000	45,000

Table 21: Natural Gas Savings (kBtu/yr) for Solar Thermal Per Prototypical Pool (Climate Zones 9 – 16)

Prototype	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16
NR Motel Indoor Pool Uncovered Gas	84,000	88,000	78,000	75,000	87,000	78,000	110,000	52,000
NR Motel Outdoor Pool Covered Gas	84,000	87,000	79,000	76,000	85,000	86,000	88,000	59,000
NR Motel Outdoor Pool Uncovered Gas	88,000	93,000	87,000	79,000	93,000	110,000	120,000	78,000
NR Olympic Indoor Pool Uncovered Gas	2,400,000	2,500,000	2,300,000	2,200,000	2,500,000	2,300,000	3,200,000	1,500,000
NR Olympic Outdoor Pool Covered Gas	2,700,000	2,800,000	2,700,000	2,400,000	2,600,000	3,500,000	2,800,000	2,700,000
NR Olympic Outdoor Pool Uncovered Gas	3,500,000	3,600,000	3,500,000	3,200,000	3,500,000	4,500,000	4,400,000	3,700,000
Residential Outdoor Pool Covered Gas	39,000	48,000	42,000	48,000	45,000	45,000	29,000	22,000
Residential Outdoor Pool Uncovered Gas	45,000	59,000	62,000	54,000	69,000	63,000	70,000	23,000

Table 22: Source Energy Savings (kBtu/yr) for Solar Thermal Per Prototypical Pool (Climate Zones 1 - 8)

Prototype	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8
NR Motel Indoor Pool Uncovered Gas	16,000	62,000	31,000	76,000	38,000	43,000	47,000	79,000
NR Motel Outdoor Pool Covered Gas	18,000	63,000	33,000	79,000	40,000	43,000	47,000	77,000
NR Motel Outdoor Pool Uncovered Gas	18,000	65,000	34,000	84,000	42,000	45,000	48,000	79,000
NR Olympic Indoor Pool Uncovered Gas	450,000	1,800,000	870,000	2,200,000	1,100,000	1,200,000	1,300,000	2,300,000
NR Olympic Outdoor Pool Covered Gas	860,000	2,100,000	1,300,000	2,900,000	1,500,000	1,300,000	1,400,000	2,300,000
NR Olympic Outdoor Pool Uncovered Gas	1,300,000	2,800,000	2,100,000	3,600,000	2,200,000	2,000,000	2,000,000	2,800,000
Residential Outdoor Pool Covered Gas	5,800	40,000	17,000	44,000	16,000	21,000	19,000	36,000
Residential Outdoor Pool Uncovered Gas	5,800	40,000	18,000	47,000	17,000	21,000	19,000	40,000

Table 23: Source Energy Savings (kBtu/yr) for Solar Thermal Per Prototypical Pool (Climate Zones 9 – 16)

Prototype	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16
NR Motel Indoor Pool Uncovered Gas	76,000	79,000	70,000	68,000	79,000	70,000	96,000	47,000
NR Motel Outdoor Pool Covered Gas	76,000	78,000	71,000	68,000	77,000	77,000	79,000	53,000
NR Motel Outdoor Pool Uncovered Gas	79,000	83,000	79,000	71,000	84,000	95,000	100,000	71,000
NR Olympic Indoor Pool Uncovered Gas	2,200,000	2,300,000	2,000,000	2,000,000	2,300,000	2,100,000	2,900,000	1,300,000
NR Olympic Outdoor Pool Covered Gas	2,400,000	2,500,000	2,400,000	2,200,000	2,400,000	3,100,000	2,500,000	2,500,000
NR Olympic Outdoor Pool Uncovered Gas	3,100,000	3,200,000	3,100,000	2,900,000	3,200,000	4,000,000	4,000,000	3,300,000
Residential Outdoor Pool Covered Gas	35,000	43,000	38,000	44,000	41,000	41,000	26,000	20,000
Residential Outdoor Pool Uncovered Gas	40,000	53,000	56,000	49,000	63,000	56,000	63,000	20,000

Table 24: LSC Savings ($PV 2026) for Solar Thermal Per Prototypical Pool (Climate Zones 1 - 8)

Prototype	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8
NR Motel Indoor Pool Uncovered Gas	8,900	35,000	17,000	43,000	22,000	25,000	28,000	46,000
NR Motel Outdoor Pool Covered Gas	10,000	36,000	19,000	45,000	23,000	26,000	28,000	45,000
NR Motel Outdoor Pool Uncovered Gas	11,000	37,000	20,000	48,000	25,000	27,000	29,000	47,000
NR Olympic Indoor Pool Uncovered Gas	250,000	1,000,000	500,000	1,200,000	640,000	730,000	790,000	1,300,000
NR Olympic Outdoor Pool Covered Gas	530,000	1,200,000	790,000	1,700,000	950,000	810,000	860,000	1,400,000
NR Olympic Outdoor Pool Uncovered Gas	780,000	1,600,000	1,300,000	2,100,000	1,400,000	1,300,000	1,300,000	1,700,000
Residential Outdoor Pool Covered Gas	7,300	50,000	22,000	55,000	21,000	26,000	24,000	45,000
Residential Outdoor Pool Uncovered Gas	7,300	50,000	22,000	59,000	21,000	27,000	25,000	51,000

Table 25: LSC Savings ($PV 2026) for Solar Thermal Per Prototypical Pool (Climate Zones 9 - 16)

Prototype Climate Zone	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16
NR Motel Indoor Pool Uncovered Gas	44,000	45,000	38,000	37,000	44,000	39,000	55,000	26,000
NR Motel Outdoor Pool Covered Gas	44,000	45,000	39,000	38,000	43,000	44,000	47,000	30,000
NR Motel Outdoor Pool Uncovered Gas	47,000	49,000	44,000	40,000	47,000	55,000	60,000	42,000
NR Olympic Indoor Pool Uncovered Gas	1,300,000	1,300,000	1,100,000	1,100,000	1,300,000	1,200,000	1,600,000	750,000
NR Olympic Outdoor Pool Covered Gas	1,400,000	1,500,000	1,400,000	1,300,000	1,300,000	1,900,000	1,500,000	1,500,000
NR Olympic Outdoor Pool Uncovered Gas	1,900,000	1,900,000	1,800,000	1,700,000	1,800,000	2,400,000	2,400,000	2,000,000
Residential Outdoor Pool Covered Gas	44,000	55,000	48,000	55,000	52,000	51,000	32,000	25,000
Residential Outdoor Pool Uncovered Gas	51,000	68,000	70,000	61,000	79,000	71,000	80,000	26,000

6. Cost and Cost Effectiveness

6.1 Energy Cost Savings Methodology

Energy cost savings were calculated by applying the LSC hourly factors to the energy savings estimates that were derived using the methodology described in Section 5.1. LSC hourly factors are a normalized metric to calculate energy cost savings that accounts for the variable cost of electricity and natural gas for each hour of the year, along with how costs are expected to change over the period of analysis. In this case, the period of analysis used is 30 years.

The CEC requested energy cost savings over the 30-year period of analysis in both 2026 present value dollars (2026 PV$) and nominal dollars. The cost effectiveness analysis uses energy cost values in 2026 PV$. Costs and cost-effectiveness using and 2026 PV$ are presented in Section 6.5 of this report. CEC uses results in nominal dollars to complete the Economic and Fiscal Impacts Statement (From 399) for the entire package of proposed change to Title 24, Part 6. Appendix G presents energy cost savings results in nominal dollars.

6.2 Energy Cost Savings Results

Per-unit energy cost savings for newly constructed pools and retrofitted pools that are realized over the 30-year period of analysis are presented 2026 precent value dollars (2026 PV$) in Table 26 through Table 32. The savings presented are for those pools that are heated continuous while in operation. For nonresidential pools, all pools are assumed to be heated continuously to meet customer amenity for heated water for swimming. The Reach Code team reviewed CEC RASS data,[19] as well as an NREL survey of pool heating behavior.[20] The surveys revealed that many pool owners with heaters heat their pools either never or occasionally. The Reach Code team for the analysis used the RASS data to adjust the energy use of the as modeled continuously heated pool to reflect the lower number of pool owners that heat their pool in this way. The results in Table 33 through Table 35 represent the average costs and average energy savings for the SF pools. Although the measure is cost-effective on average, most savings accrue to those pool owners that would have continuously heated their pools. Pool owners that would have not used their pool heater often would not find much natural gas use offset by the solar thermal powered pool heater.

[19] https://webtools.dnv.com/CA_RASS/Uploads/CEC-200-2021-005-MTHLGY.pdf

[20] https://www.nrel.gov/docs/fy99osti/26485.pdf

The LSC methodology allows peak electricity savings to be valued more than electricity savings during non-peak periods.

Any time code changes impact cost, there is potential to disproportionately impact DIPs. Refer to Section 2 for more details addressing energy equity and environmental justice.

Table 26: 2026 Present Value LSC Savings Over 30-Year Period of Analysis – Nonresidential Motel Indoor Pool Uncovered Gas Prototype – New Construction, Additions and Alterations

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Savings (2026 PV$)
1	N/A	8,919	8,919
2	N/A	34,947	34,947
3	N/A	17,438	17,438
4	N/A	42,839	42,839
5	N/A	22,274	22,274
6	N/A	25,436	25,436
7	N/A	27,512	27,512
8	N/A	45,643	45,643
9	N/A	43,961	43,961
10	N/A	45,048	45,048
11	N/A	38,203	38,203
12	N/A	37,388	37,388
13	N/A	43,619	43,619
14	N/A	39,402	39,402
15	N/A	55,158	55,158
16	N/A	26,398	26,398

Table 27: 2026 Present Value LSC Savings Over 30-Year Period of Analysis – Nonresidential Motel Outdoor Pool Covered Gas Prototype – New Construction, Additions and Alterations

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Savings (2026 PV$)
1	N/A	10,153	10,153
2	N/A	35,794	35,794
3	N/A	18,930	18,930
4	N/A	45,028	45,028
5	N/A	23,352	23,352
6	N/A	25,679	25,679
7	N/A	28,029	28,029
8	N/A	45,224	45,224
9	N/A	44,278	44,278
10	N/A	45,006	45,006
11	N/A	39,023	39,023
12	N/A	37,900	37,900
13	N/A	43,125	43,125
14	N/A	43,697	43,697
15	N/A	46,869	46,869
16	N/A	30,162	30,162

Table 28: 2026 Present Value LSC Savings Over 30-Year Period of Analysis – Nonresidential Motel Outdoor Pool Uncovered Gas Prototype – New Construction, Additions and Alterations

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Savings (2026 PV$)
1	N/A	10,635	10,635
2	N/A	37,003	37,003
3	N/A	19,659	19,659
4	N/A	47,991	47,991
5	N/A	24,638	24,638
6	N/A	26,730	26,730
7	N/A	28,916	28,916
8	N/A	46,555	46,555
9	N/A	46,626	46,626
10	N/A	48,539	48,539
11	N/A	43,552	43,552
12	N/A	39,616	39,616
13	N/A	46,521	46,521
14	N/A	55,358	55,358
15	N/A	60,383	60,383
16	N/A	42,167	42,167

Table 29: 2026 Present Value LSC Savings Over 30-Year Period of Analysis – Nonresidential Olympic Indoor Pool Uncovered Gas Prototype – New Construction, Additions and Alterations

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Savings (2026 PV$)
1	N/A	254,186	254,186
2	N/A	1,000,304	1,000,304
3	N/A	496,592	496,592
4	N/A	1,235,879	1,235,879
5	N/A	636,119	636,119
6	N/A	726,612	726,612
7	N/A	785,612	785,612
8	N/A	1,312,805	1,312,805
9	N/A	1,264,486	1,264,486
10	N/A	1,300,441	1,300,441
11	N/A	1,110,946	1,110,946
12	N/A	1,079,356	1,079,356
13	N/A	1,274,818	1,274,818
14	N/A	1,155,809	1,155,809
15	N/A	1,637,488	1,637,488
16	N/A	752,883	752,883

Table 30: 2026 Present Value LSC Savings Over 30-Year Period of Analysis – Nonresidential Olympic Outdoor Pool Covered Gas Prototype – New Construction, Additions and Alterations

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Savings (2026 PV$)
1	N/A	527,142	527,142
2	N/A	1,216,580	1,216,580
3	N/A	791,322	791,322
4	N/A	1,706,417	1,706,417
5	N/A	945,276	945,276
6	N/A	809,476	809,476
7	N/A	859,791	859,791
8	N/A	1,370,993	1,370,993
9	N/A	1,446,958	1,446,958
10	N/A	1,508,488	1,508,488
11	N/A	1,373,767	1,373,767
12	N/A	1,260,820	1,260,820
13	N/A	1,344,934	1,344,934
14	N/A	1,863,598	1,863,598
15	N/A	1,511,747	1,511,747
16	N/A	1,489,643	1,489,643

Table 31: 2026 Present Value LSC Savings Over 30-Year Period of Analysis – Nonresidential Olympic Outdoor Pool Uncovered Gas Prototype – New Construction, Additions and Alterations

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Savings (2026 PV$)
1	N/A	777,398	777,398
2	N/A	1,642,683	1,642,683
3	N/A	1,266,356	1,266,356
4	N/A	2,100,552	2,100,552
5	N/A	1,380,443	1,380,443
6	N/A	1,284,602	1,284,602
7	N/A	1,290,279	1,290,279
8	N/A	1,727,260	1,727,260
9	N/A	1,916,930	1,916,930
10	N/A	1,936,807	1,936,807
11	N/A	1,810,727	1,810,727
12	N/A	1,679,248	1,679,248
13	N/A	1,825,777	1,825,777
14	N/A	2,384,031	2,384,031
15	N/A	2,403,039	2,403,039
16	N/A	1,952,465	1,952,465

Table 32: Average 2026 PV LSC Savings Over 30-Year Period of Analysis – Per Pool Over 30-Year Period of Analysis – New Construction, Additions and Alterations – All Nonresidential Prototypes

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Savings (2026 PV$)
1	N/A	34,553	34,553
2	N/A	96,009	96,009
3	N/A	59,950	59,950
4	N/A	122,144	122,144
5	N/A	70,369	70,369
6	N/A	71,589	71,589
7	N/A	75,008	75,008
8	N/A	113,655	113,655
9	N/A	116,972	116,972
10	N/A	119,735	119,735
11	N/A	107,343	107,343
12	N/A	100,836	100,836
13	N/A	114,328	114,328
14	N/A	130,461	130,461
15	N/A	146,818	146,818
16	N/A	99,073	99,073

Table 33: 2026 Present Value LSC Savings Over 30-Year Period of Analysis – Residential Outdoor Pool Covered Gas Prototype – New Construction, Additions and Alterations

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Savings (2026 PV$)
1	N/A	1,209	1,209
2	N/A	8,241	8,241
3	N/A	3,563	3,563
4	N/A	9,041	9,041
5	N/A	3,414	3,414
6	N/A	4,308	4,308
7	N/A	3,903	3,903
8	N/A	7,431	7,431
9	N/A	7,330	7,330
10	N/A	9,041	9,041
11	N/A	7,902	7,902
12	N/A	9,067	9,067
13	N/A	8,539	8,539
14	N/A	8,491	8,491
15	N/A	5,383	5,383
16	N/A	4,125	4,125

Table 34: 2026 Present Value LSC Savings Over 30-Year Period of Analysis – Residential Outdoor Pool Uncovered Gas Prototype – New Construction, Additions and Alterations

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Savings (2026 PV$)
1	N/A	1,205	1205
2	N/A	8,268	8268
3	N/A	3,667	3667
4	N/A	9,781	9781
5	N/A	3,502	3502
6	N/A	4,417	4417
7	N/A	4,064	4064
8	N/A	8,377	8377
9	N/A	8,431	8431
10	N/A	11,198	11198
11	N/A	11,589	11589
12	N/A	10,084	10084
13	N/A	13,004	13004
14	N/A	11,817	11817
15	N/A	13,222	13222
16	N/A	4,272	4272

Table 35: Average 2026 PV LSC Savings Over 30-Year Period of Analysis – Per Pool Over 30-Year Period of Analysis – New Construction, Additions and Alterations – All Residential Prototypes

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Savings (2026 PV$)
1	N/A	1206	1206
2	N/A	8264	8264
3	N/A	3654	3654
4	N/A	9684	9684
5	N/A	3490	3490
6	N/A	4403	4403
7	N/A	4043	4043
8	N/A	8254	8254
9	N/A	8288	8288
10	N/A	10918	10918
11	N/A	11110	11110
12	N/A	9952	9952
13	N/A	12423	12423
14	N/A	11385	11385
15	N/A	12203	12203
16	N/A	4253	4253

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6.3 Incremental First Cost

The Statewide CASE Team estimated the incremental first cost of the measure depending upon the pool prototype. For analysis where the Statewide CASE Team assumed the pool would have a solar collector with a backup gas heater the incremental cost was assumed to be the solar collector. The cost of the backup gas heater was assumed to be the same but there could be a potential benefit to install a smaller gas heater with the solar collector to reduce cost.

Incremental costs were based on the costs of the entire system, rather than individual components. For residential and nonresidential pools with a capacity of 20,000 gallons, the assumed incremental cost was $5,250, while for nonresidential Olympic-size pools (660,000 gallons), the assumed incremental cost was $139,214. The cost of the solar collectors was estimated from a database of installation cost values from the California Solar Initiative Commercial Pool Solar Thermal Rebate program. The database contains over 1,100 commercial pool solar thermal projects with data on the collector size and total project cost. The Statewide CASE Team estimated the costs of the solar thermal collectors from this data.

6.4 Incremental Maintenance and Replacement Costs

Incremental maintenance cost is the incremental cost of replacing the equipment or parts of the equipment, as well as periodic maintenance required to keep the equipment operating relative to current practices over the 30-year period of analysis.

Routine upkeep for a solar pool heating system should include clearing the collector surface, examining for leaks, and ensuring foliage has not obstructed the collectors. The tasks could be performed by the property owner. Other less common tasks would be altering the system to correct design and installation errors, repairing leaks, or replacing components (Moezzi 2020).

The Statewide CASE Team assumed that the incremental maintenance cost would be one percent of the first cost of the system.

The present value of equipment maintenance costs (or savings) was calculated using a three percent discount rate (d), which is consistent with the discount rate used when developing the 2025 LSC hourly factors. The present value of maintenance costs that occurs in the n^{th} year is calculated as follows:

$$Present\ Value\ of\ Maintenance\ Cost\ =\ Maintenance\ Cost\ \times \left[\frac{1}{1+d}\right]^n$$

6.5 Cost Effectiveness

This measure proposes a mandatory requirement. As such, a cost analysis is required to demonstrate that the measure is cost effective over the 30-year period of analysis.

The CEC establishes the procedures for calculating cost effectiveness. The Statewide CASE Team collaborated with CEC staff to confirm that the methodology in this report is consistent with their guidelines, including which costs were included in the analysis. The incremental first cost and incremental maintenance costs over the 30-year period of analysis were included. The LSC savings from electricity and natural gas savings were also included in the evaluation. Design costs were not included nor were the incremental costs of code compliance verification.

According to the CEC's definitions, a measure is cost effective if the benefit-to-cost (B/C) ratio is greater than 1.0. The B/C ratio is calculated by dividing the cost benefits realized over 30 years by the total incremental costs, which includes maintenance costs for 30 years. The B/C ratio was calculated using 2026 PV costs and cost savings.

Results of the per-unit cost-effectiveness analyses are presented in Table 36 for nonresidential and residential new construction/additions and alterations.

The proposed measure saves money over the 30-year period of analysis relative to the existing conditions and is cost effective in every climate zone.

Appendix H provides the energy savings and cost-effectiveness analysis for the HPPH option.

Table 36: 30-Year Cost-Effectiveness Summary Per Pool – New Construction, Additions and Alterations – Nonresidential (NR) and Residential (R) Prototypes

Climate Zone	*NR* **Benefits** Long-term Systemwide Energy Cost Savings + Other PV Savings [a] (2026 PV$)	*NR* **Costs** Total Incremental PV Costs [b] (2026 PV$)	*NR* **Benefit-to-Cost Ratio**	*R* **Benefits** Long-term Systemwide Energy Cost Savings + Other PV Savings [a] (2026 PV$)	*R* **Costs** Total Incremental PV Costs [b] (2026 PV$)	*R* **Benefit-to-Cost Ratio**
1	38,284	18,786	2.0	4,692	8,713	0.5
2	99,740	18,786	5.3	22,036	8,713	2.5
3	63,681	18,786	3.4	10,707	8,713	1.2
4	125,875	18,786	6.7	25,525	8,713	2.9
5	74,100	18,786	3.9	10,306	8,713	1.2
6	75,320	18,786	4.0	12,547	8,713	1.4
7	78,738	18,786	4.2	11,665	8,713	1.3
8	117,385	18,786	6.2	22,011	8,713	2.5
9	120,703	18,786	6.4	22,093	8,713	2.5
10	123,466	18,786	6.6	28,555	8,713	3.3
11	111,074	18,786	5.9	29,028	8,713	3.3
12	104,567	18,786	5.6	26,181	8,713	3.0
13	118,059	18,786	6.3	32,254	8,713	3.7
14	134,192	18,786	7.1	29,703	8,713	3.4
15	150,548	18,786	8.0	31,713	8,713	3.6
16	102,804	18,786	5.5	12,179	8,713	1.4

a. **Benefits: Long-term Systemwide Energy Cost Savings + Other PV Savings:** Benefits include Long-term Systemwide Energy Cost Savings over the period of analysis (California Energy Commission 2022, 51-53). Other savings are discounted at a real (nominal – inflation) three percent rate. Other PV savings include incremental first-cost savings if proposed first cost is less than current first cost, incremental PV maintenance cost savings if PV of proposed maintenance costs is less than PV of current maintenance costs, and incremental residual value if proposed residual value is greater than current residual value at end of CASE analysis period.

b. **Costs: Total Incremental Present Valued Costs:** Costs include incremental equipment, replacement, and maintenance costs over the period of analysis. Costs are discounted at a real (inflation-adjusted) three percent rate and if PV of proposed maintenance costs is greater than PV of current maintenance costs. If incremental maintenance cost is negative, it is treated as a positive benefit. If there are no total incremental PV costs, the B/C ratio is infinite.

7. First-Year Statewide Impacts

7.1 Statewide Energy and Energy Cost Savings

The Statewide CASE Team calculated the first-year statewide savings for new construction and additions by multiplying the per-pool savings, which are presented in Section 5.2, by assumptions about the percentage of newly constructed pool that would be impacted by the proposed code. The statewide new pool forecast for 2026 is presented in Appendix A, as are the Statewide CASE Team's assumptions about the percentage of pools that would be impacted by the proposal (by climate zone).

The first-year energy impacts represent the first-year annual savings from all pools that are estimated to be completed in 2026. The 30-year energy cost savings represent the energy cost savings over the entire 30-year analysis period. The statewide savings estimates apply assumption on naturally occurring market adoption or compliance rates.

Table 37 through Table 41 below present the first-year statewide energy and energy cost savings from newly constructed pools and alterations by climate zone and building type.

While a statewide analysis is crucial to understanding broader effects of code change proposals, there is potential to disproportionately impact DIPs that needs to be considered. Refer to Section 2 for more details addressing energy equity and environmental justice.

Table 37: Statewide Energy and Energy Cost Impacts – Nonresidential New Construction and Additions

Climate Zone	Statewide New Construction & Additions Impacted by Proposed Change in 2026 (# of Pools)	First-Year[a] Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year Present Valued Energy Cost Savings (Million 2026 PV$)
1	1	N/A	N/A	0	0.06	$0.04
2	8	N/A	N/A	0.01	1.08	$0.62
3	33	N/A	N/A	0.03	2.67	$1.59
4	17	N/A	N/A	0.03	2.85	$1.65
5	4	N/A	N/A	0	0.33	$0.20
6	37	N/A	N/A	0.04	3.48	$2.12
7	24	N/A	N/A	0.03	2.32	$1.41
8	54	N/A	N/A	0.09	8.22	$4.87
9	89	N/A	N/A	0.15	13.91	$8.27
10	74	N/A	N/A	0.13	11.98	$7.03
11	8	N/A	N/A	0.01	1.21	$0.68
12	38	N/A	N/A	0.06	5.41	$3.06
13	18	N/A	N/A	0.03	2.89	$1.63
14	16	N/A	N/A	0.03	2.82	$1.63
15	8	N/A	N/A	0.02	1.53	$0.90
16	4	N/A	N/A	0.01	0.59	$0.34
Total	434	N/A	N/A	0.68	61.34	$36.02

a. First-year savings from all pools completed statewide in 2026.

Table 38: Statewide Energy and Energy Cost Impacts – Nonresidential Alterations

Climate Zone	Statewide New Construction & Additions Impacted by Proposed Change in 2026 (# of Pools)	First-Year[a] Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year Present Valued Energy Cost Savings (Million 2026 PV$)
1	12	N/A	N/A	0.01	0.57	$0.34
2	73	N/A	N/A	0.11	9.64	$5.57
3	298	N/A	N/A	0.26	23.86	$14.17
4	152	N/A	N/A	0.28	25.46	$14.71
5	31	N/A	N/A	0.03	2.91	$1.75
6	334	N/A	N/A	0.35	31.11	$18.94
7	212	N/A	N/A	0.23	20.67	$12.57
8	483	N/A	N/A	0.82	73.42	$43.45
9	797	N/A	N/A	1.38	124.21	$73.83
10	662	N/A	N/A	1.19	106.97	$62.74
11	71	N/A	N/A	0.12	10.80	$6.04
12	342	N/A	N/A	0.53	48.27	$27.28
13	160	N/A	N/A	0.28	25.78	$14.52
14	141	N/A	N/A	0.28	25.14	$14.60
15	69	N/A	N/A	0.15	13.63	$8.03
16	39	N/A	N/A	0.06	5.22	$3.06
Total	3,877	N/A	N/A	6.08	547.65	$321.58

c. First-year savings from all pools completed statewide in 2026.

Table 39: Statewide Energy and Energy Cost Impacts – Residential New Construction and Additions

Climate Zone	Statewide New Construction & Additions Impacted by Proposed Change in 2026 (# of Pools)	First-Year[a] Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year Present Valued Energy Cost Savings (Million 2026 PV$)
1	27	-	-	0.00	0.05	$0.07
2	158	-	-	0.02	2.14	$2.69
3	642	-	-	0.04	3.86	$4.84
4	327	-	-	0.06	5.21	$6.54
5	67	-	-	0.00	0.39	$0.49
6	719	-	-	0.06	5.17	$6.53
7	455	-	-	0.03	3.00	$3.80
8	1,039	-	-	0.16	14.01	$17.69
9	1,715	-	-	0.26	23.23	$29.33
10	1,423	-	-	0.28	25.38	$32.08
11	153	-	-	0.03	2.79	$3.50
12	735	-	-	0.13	12.03	$15.10
13	345	-	-	0.08	7.05	$8.85
14	304	-	-	0.06	5.65	$7.14
15	149	-	-	0.03	2.96	$3.74
16	84	-	-	0.01	0.58	$0.74
Total	**8,340**	**-**	**-**	1.26	113.50	$143.11

a. First-year savings from all pools completed statewide in 2026.

Table 40: Statewide Energy and Energy Cost Impacts – Residential Alterations

Climate Zone	Statewide New Construction & Additions Impacted by Proposed Change in 2026 (# of Pools)	First-Year[a] Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year Present Valued Energy Cost Savings (Million 2026 PV$)
1	59	-	-	0.00	0.12	$0.15
2	350	-	-	0.05	4.76	$5.98
3	1,427	-	-	0.09	8.58	$10.76
4	727	-	-	0.13	11.58	$14.53
5	150	-	-	0.01	0.86	$1.08
6	1,597	-	-	0.13	11.49	$14.51
7	1,012	-	-	0.07	6.66	$8.44
8	2,308	-	-	0.35	31.14	$39.32
9	3,810	-	-	0.57	51.61	$65.18
10	3,163	-	-	0.63	56.40	$71.28
11	339	-	-	0.07	6.20	$7.78
12	1,633	-	-	0.30	26.73	$33.55
13	767	-	-	0.17	15.66	$19.66
14	675	-	-	0.14	12.56	$15.87
15	330	-	-	0.07	6.57	$8.31
16	186	-	-	0.01	1.30	$1.63
Total	**18,534**	**-**	**-**	2.80	252.22	$318.02

a. First-year savings from all pools completed statewide in 2026.

Table 41: Statewide Energy and Energy Cost Impacts – New Construction, Additions, and Alterations

Application Type	Construction Type	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First - Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year Present Valued Energy Cost Savings (PV$ Million)
Nonresidential	New Construction & Additions	N/A	N/A	0.7	61.3	36
	Alterations	N/A	N/A	6.1	547.7	322
	Total	N/A	N/A	6.8	609	358
Residential	New Construction & Additions	N/A	N/A	1.3	113.5	143
	Alterations	N/A	N/A	2.8	252.2	318
	Total	N/A	N/A	4.1	365.7	461
All	Total	N/A	N/A	10.9	974.7	818.6

a. First-year savings from all alterations completed statewide in 2026.

7.2 Statewide Greenhouse Gas (GHG) Emissions Reductions

The Statewide CASE Team calculated avoided GHG emissions associated with energy consumption using the hourly GHG emissions factors that CEC developed along with the 2025 hourly factors and an assumed cost of $123.15 per metric tons of carbon dioxide equivalent emissions (metric tons CO2e).

The monetary value of avoided GHG emissions is based on a proxy for permit costs (not social costs).[21] The cost effectiveness analysis presented in Section 6 of this report does not include the cost savings from avoided GHG emissions. To demonstrate the cost savings of avoided GHG emissions, the Statewide CASE Team disaggregated the value of avoided GHG emissions from the other economic impacts.

Table 42 presents the estimated first-year avoided GHG emissions of the proposed code change. During the first year, GHG emissions of 95,855 (metric tons CO2e) would be avoided.

[21] The permit cost of carbon is equivalent to the market value of a unit of GHG emissions in the California Cap-and-Trade program, while social cost of carbon is an estimate of the total economic value of damage done per unit of GHG emissions. Social costs tend to be greater than permit costs. See more on the Cap-and-Trade Program on the California Air Resources Board website: https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program.

Table 42: First-Year Statewide GHG Emissions Impacts

Measure	Electricity Savings[a] (GWh/yr)	Reduced GHG Emissions from Electricity Savings[a] (Metric Tons CO2e)	Natural Gas Savings[a] (Million Therms/yr)	Reduced GHG Emissions from Natural Gas Savings[a] (Metric Tons CO2e)	Total Reduced GHG Emissions[a] (Metric Tons CO2e)	Total Monetary Value of Reduced GHG Emissions[b] ($)
Nonresidential Solar Pools	0	0	6.76	36,925	36,925	4,547,203
Residential Solar Pools	0	0	4.06	24,368	24,368	3,000,904
TOTAL	0	0	10.82	61,293	61,293	7,548,107

a. First-year savings from all buildings completed statewide in 2026.

b. GHG emissions factors are included in the LSC cost hourly factors published by CEC at this link: https://www.energy.ca.gov/files/2025-energy-code-hourly-factors.

7.3 Statewide Water Use Impacts

The proposed code change would not result in water savings.

7.4 Statewide Material Impacts

The proposed code change requiring solar thermal pool and spa heating systems, HPPH, or waste heat recovery would increase the use and production of copper and plastic in both residential and nonresidential applications. See Appendix D for more details.

Table 43: First-Year Statewide Impacts on Material Use

Material	Impact	Nonresidential Per-Unit Impacts (Pounds per Square Foot)	Nonresidential First-Year [a] Statewide Impacts (Pounds)	Residential Per-Unit Impacts (Pounds per Square Foot)	Residential First-Year [a] Statewide Impacts (Pounds)
Mercury	No Change	0	0	0	0
Lead	No Change	0	0	0	0
Copper	Increase	10	40,643	10	268,746
Concrete	No Change	0	0	0	0
Steel	No Change	0	0	0	0
Insulation	No Change	0	0	0	0
Wood	No Change	0	0	0	0
Plastic	Increase	378.7	1,539,148	126.8	3,407,695
Refrigerants	No Change	0	0	0	0
TOTAL	N/A	388.7	1,579,791	136.8	3,676,441

a. First-year savings from all buildings completed statewide in 2026.

7.5 Other Non-Energy Impacts

The proposed code change also has the potential to increase property valuation as well as reduce on-site emissions. The installation of renewable energy systems such as solar thermal and waste heat recovery could increase the property value of buildings with indoor swimming pools and spas.

The use of renewable energy sources such as solar thermal and waste heat recovery would reduce on-site emissions of pollutants from gas and electric heating systems. This would help improve air quality and reduce the negative health impacts associated with such emissions.

The CEC and California Air Resources Board (CARB) have previously indicated that electricity generation from combustion sources emits GHGs and criteria air pollutants such as particulate matter, sulfur oxides, carbon monoxide, nitrogen oxides, and volatile organic compounds, and the latter two of which are also precursors of ground-level ozone (Nicholaus Struven 2022). CEC has previously paraphrased the following:

- Per the American Lung Association, people of color are more than three times more likely to be breathing more polluted air than white people (American Lung Association 2021).
- People living in poverty are most likely to live near sources of pollution and more likely to be vulnerable to the health impacts of air pollution, including asthma, diabetes, and heat disease (PSE Healthy Energy 2020).
- The CPUC has previously raised issues in its Environmental & Social Justice Action Plan (California Public Utility Comission 2022) about the lack of community involvement. Community members are not participating in transition to solar and electrification. Requirements are coming from the top down and not from collaboration with the community. It is necessary to look at grassroots efforts and engage in education on the benefits.
- On solar issues, 80 percent of people are disqualified because they their roofs are unsuitable because roofs need to be repaired. The Title 24 Pool and Spa Heating proposal provides an exception to pools with an existing pool heating system. Therefore, a homeowner needed to replace a broken pool heater could replace the pool heater in kind without first needing to repair their roof if they had had to install a solar thermal pool heating system.

The Statewide CASE Team notes that CPUC's Action Plan did not specifically address solar thermal pool heating systems. CPUC's Action Plan included some commentary on solar water heating but did so from the perspective of incentive levels. The code language proposed in Section 8 of this report incorporates exception 2 to the proposed subsection, and the Statewide CASE Team expects the exception would exempt most the homeowners addressed in CPUC's Action Plan.

Including impacted communities in the decision-making process, ensuring that the benefits and burdens of the energy sector are evenly distributed, and facing the unjust legacies of the past serve as critical steps to achieving energy equity. To minimize the risk of perpetuating inequity, code change proposals are being developed with intentional consideration of the unintended consequences of proposals on DIPs.

The Statewide CASE Team recognizes the importance of engaging DIPs and gathering their input to inform the code change process and proposed measures. A participatory approach allows individuals to address problems, develop innovative ideas, and bring forth a different perspective. The Statewide CASE Team is working to build relationships with community-based organizations (CBOs) to facilitate meaningful engagement with stakeholders and gather feedback on the proposed measures. The Statewide CASE Team is still investigating the potential impacts of the proposal and seeks input from CBOs and members of DIPs. Please reach out to Helen Davis (hdavis@energy-solution.com), Nancy Metayer (nmetayer@energy-solution.com) and Marissa Lerner (mlerner@energy-solution.com) for further engagement.

The Statewide CASE Team considered the impacts of the proposal on DIPs using five criteria: cost, health, disaster preparedness, safety, and comfort. Proposals for nonresidential and residential code changes may impact DIPs differently. The Statewide CASE Team considered which building types are used most frequently by DIPs and evaluated the social and economic well-being of DIPs. A goal is to identify barriers DIPs face that could lead to inequitable allocation of social and economic benefits and burdens among all individuals.

The Statewide CASE Team began conducting outreach with the California Low-Income Consumer Coalition, which has prior experience in building broad coalitions with a variety of organizations, involvement with Property Assessed Clean Energy (PACE) legislation, and based on this history, could be a possible liaison for reviewing and providing feedback on the proposed code change from a DIP perspective.

A preliminary review indicates that this proposal is unlikely to have significant impacts on energy equity or environmental justice.

8. Proposed Revisions to Code Language

8.1 Guide to Markup Language

The proposed changes to the standards, Reference Appendices, and the ACM Reference Manuals are provided below. Changes to the 2022 documents are marked with red underlining (new language) and ~~strikethroughs~~ (deletions).

Some of the proposed revisions to section 110.4 clarify that requirements are applicable to pools, spas, and pool and spa combinations with certain exceptions (e.g., portable electric spas).

The proposed provision to derive at least 60 percent of the annual heating energy from on-site renewable energy or site recovered energy would require calculations and source of annual energy use estimate when this provision is invoked during the installation of the heating system. ASHRAE has previously issued an interpretation stating that in the case of ASHRAE Standard 90.1, heat may be recovered from any site source such as an air-conditioning system condenser heat, boiler stack heat recovery, natatorium dehumidification / heat recovery units (ASHRAE 1992).

Table 100.0-A *Application or Standards* would be updated. Rather than recreate the entire table, revisions to the applicable row are provided below.

Occupancies	Application	Mandatory	Prescriptive	Performance	Additions/ Alterations
Nonresidential, And Hotels/Motels	Pool and Spa Systems	110.4, 110.5, ~~160.7~~	N. A.	N.A.	141.0

8.2 Standards

SECTION 100.1 – DEFINITIONS AND RULES OF CONSTRUCTION

DEDICATED-PURPOSE POOL PUMP comprises self-priming pool filter pumps, non-self-priming pool filter pumps, waterfall pumps, pressure cleaner booster pumps, integral sand-filter pool pumps, integral-cartridge filter pool pumps, storable electric spa pumps, and rigid electric spa pumps. See 20 CCR § 1602(g)(4) of the Appliance Efficiency Regulations for additional definitions.

ON-SITE RENEWABLE ENERGY is energy from renewable energy sources harvested at the building site.

POOLS, ANSI/APSP/ICC-5 is the American National Standards Institute and National Spa and Pool Institute document titled “American National Standard for Residential Inground Swimming Pools” 2011 (ANSI/APSP/ICC-5 2011 (R2022)) ~~with Addenda A~~.

POOL, PUBLIC is a pool other than a residential pool, that is intended to be used for swimming or bathing and is operated by an owner, lessee, operator, licensee, or concessionaire, regardless of whether a fee is charged for use. Public pools include pools installed in private settings such as multifamily residential buildings or hotels that are available exclusively for use by tenants or guests.

POOLS, RESIDENTIAL are permanently installed residential in-ground swimming pools intended for use by a single- family home for noncommercial purposes and with dimensions as defined within the scope of ANSI/NSPI-5 ANSI/APSP/ICC-5 2011 (R2022).

PORTABLE ELECTRIC SPA is a factory-built electric spa or hot tub, supplied with equipment for heating and circulating water at the time of sale or sold separately for subsequent attachment. See 20 CCR § 1602(g)(2) of the Appliance Efficiency Regulations for additional definitions.

RENEWABLE ENERGY RESOURCES are energy from solar, wind, biomass or hydro, or extracted from hot fluid or steam heated within the earth.

SITE-RECOVERED ENERGY is waste energy recovered at the building site that is used to offset consumption of purchased fuel or electrical energy supplies.

SOLAR SWIMMING POOL OR SPA HEATING SYSTEM is an assembly of components designed to heat water for swimming pools or spas by solar thermal means, excluding pool recirculation components.

SECTION 110.4 – MANDATORY REQUIREMENTS FOR POOL AND SPA SYSTEMS AND EQUIPMENT

(a) **Certification by Manufacturers.** Any pool heater or spa heating system or equipment for a pool, spa, or a pool and spa combination may shall be installed only if the manufacturer has certified that the system or equipment has all of the following:

1. **Efficiency.** For eEquipment subject to State or federal appliance efficiency standards, listings in the Commission's directory of certified equipment showing compliance with applicable standards; shall comply with the applicable provisions of Sections 110.1; and
2. **On-off switch.** A readily accessible on-off switch, mounted on the outside of the heater that allows shutting off the heater without adjusting the thermostat setting; and
3. **Instructions.** A permanent, easily readable, and weatherproof plate or card that gives instruction for the energy efficient operation of the pool and/or spa heater, and for the proper care of pool and/or spa water, when a and to cover the pool and/or spa when not in is used; and
4. **Electric resistance heating.** No electric resistance heating.

Exception 1 to Section 110.4(a)4: ~~Listed package units with fully insulated enclosures, and with tight- fitting covers that are insulated to at least R-6~~ Portable electric spas compliant with the Appliance Efficiency Regulations.

Exception 2 to Section 110.4(a)4: Pool and/or spas deriving at least 60 percent of the annual heating energy from on-site renewable ~~solar~~ energy or site recovered energy.

(b) **Installation.** Any pool and/or spa system or equipment shall be installed with all of the following:

1. **Heating Equipment.** Equipment installed to heat water for pools and/or spas shall be selected from equipment meeting the standards shown in Table 110.4-A.

Table 110.4-A HEATING EQUIPMENT STANDARD

Heating Energy Source	**Standard**
Electric Resistance	UL 1261
Gas-fired	ANSI Z21.56/CSA 4.7a
Heat Pump	AHRI 1160 and one of the following: CSA C22.2 No. 236, UL 1995, or UL/CSA 60335-2-40
Solar	ICC/APSP 902/SRCC 400 for solar pool heaters, ICC 901/SRCC 100 for solar collectors

Footnote for Table 110.4.A. PHTA is formerly APSP.

2. ~~1.~~**Piping.** At least 36 inches of pipe shall be installed between the filter and the heater or dedicated suction and return lines, or built-in or built-up connections shall be installed to allow for the future addition of solar heating equipment;
3. ~~2.~~**Covers.** A cover for outdoor pools and/or outdoor spas that have a heat pump or gas heater; ~~and~~
4. ~~3.~~**Directional inlets and time switches for pools.** If the system or equipment is for a pool:
   i. The pool shall have directional inlets that adequately mix the pool water; and
   ii. A time switch or similar control mechanism shall be installed as part of a pool water circulation control system that will allow all pumps to be set or programmed to run only during the off-peak electric demand period and for the minimum time necessary to maintain the water in the condition required by applicable public health standards.

(c) **Heating Source Sizing.** Installed heating systems or equipment for pool and/or spa, shall meet the requirements of 1., 2., or 3. below.

1. Solar swimming pool or spa heating system with a solar collector surface area that is equivalent to the following:

i. For nonresidential and multifamily buildings at least 65 percent of the pool and/or spa surface area, or
ii. For single family buildings at least 60 percent of the pool and/or spa surface area.

2. A heat pump pool heater as the primary heating system shall meet the efficiency requirements in Table 110.4-B. The heat pump pool heater shall meet the sizing requirements of Reference Joint Appendix JA15, Section JA15.3. The heat pump pool heater's control shall meet the criteria set forth in section 110.2(b).

Table 110.4-B HEAT PUMP POOL HEATER MINIMUM EFFICIENCY REQUIREMENTS

Equipment Type	**Efficiency**	**Compliance Date**	**Test Procedure**
Heat Pump Pool Heater	Coefficient of Performance (COP) of not less than 5.5 at the High Air Temperature-Mid Humidity rating condition.	Manufactured prior to May 31, 2028	10 C.F.R. section 430.23(p) (Appendix P to subpart B of part 430)
Heat Pump Pool Heater	Integrated Thermal Efficiency, TE_I, not less than the following: $\frac{600(PE)}{PE + 1{,}619}$ Where PE is the active electrical power, in Btu/h.	Manufactured on or after May 31, 2028	10 C.F.R. section 430.23(p) (Appendix P to subpart B of part 430)

3. Systems that do not use solar collectors or heat pump pool heaters as their primary heat source shall derive at least 60 percent of the annual heating energy from on-site renewable energy or site recovered energy.

Exception 1 to Section 110.4(c): Portable electric spas compliant with the Appliance Efficiency Regulations.

Exception 2 to Section 110.4(c): A pool and/or spa at single family buildings with existing heating systems or equipment for pools and/or spas.

Exception 3 to Section 110.4(c): A pool/and or spa that is heated solely by a solar swimming pool or spa heating system.

Section 150.0(p) Mandatory Features and Devices

(p) Pool Systems and equipment installation. Any residential pool system or equipment installed shall comply with the applicable requirements of Section 110.4, as well as the requirements listed in this section.

1. **Pump sizing and flow rate for single family buildings.**
   - A. All installed Dedicated-Purpose Pool ~~p~~Pumps and Replacement Dedicated-Purpose Pool ~~p~~Pump motors ~~subject to State or federal appliance standards~~ shall be listed in the Commission's directory of certified equipment and shall comply with the Appliance Efficiency Regulations.
   - B. All pump flow rates shall be calculated using the following system equation:

     $$H = C \times F^2$$

     WHERE:

     H is the total system head in feet of water.

     F is the flow rate in gallons per minute (gpm).

     C is a coefficient based on the volume of the pool:
     0.0167 for pools less than or equal to 17,000 gallons.
     0.0082 for pools greater than 17,000 gallons.
   - C. Filtration pumps shall be sized, or if programmable, shall be programmed, so that the filtration flow rate is not greater than the rate needed to turn over the pool water volume in 6 hours or 36 gpm, whichever is greater; and
   - D. Replacement Dedicated-Purpose Pool Pump ~~m~~Motors used for filtration ~~with a capacity of 1 hp or more shall be multispeed~~ shall meet the applicable standards set forth in 20 CCR § 1605.3 of the Appliance Efficiency Regulations; and
   - ~~E.~~ Dedicated-Purpose Pool Pumps shall meet the applicable standards set forth in 20 CCR § 1605.1(g)(7) of the Appliance Efficiency Regulations. ~~Each auxiliary pool load shall be served by either separate pumps or the system shall be served by a multispeed pump; and~~

     ~~EXCEPTION to Section 150.0(p)1E: Pumps less than 1 hp may be single speed.~~
   - F. ~~Multi-speed~~ Dedicated-Purpose Pool ~~p~~Pumps with more than one speed shall have controls which default to the filtration flow rate when no auxiliary pool loads are operating; and
   - G. For ~~multi-speed~~ Dedicated-Purpose Pool ~~p~~Pumps with more than one speed, the controls shall default to the filtration flow rate setting within 24 hours and shall have an override capability for servicing.
2. **System piping.**

A. A length of straight pipe that is greater than or equal to at least 4 pipe diameters shall be installed before the pump; and
B. Pool piping shall be sized so that the velocity of the water at maximum flow for auxiliary pool loads does not exceed 8 feet per second in the return line and 6 feet per second in the suction line; and
C. All elbows shall be sweep elbows or of an elbow-type that has a pressure drop of less than the pressure drop of straight pipe with a length of 30 pipe diameters.

3. **Filters.** Filters shall be at least the size specified in NSF/ANSI 50 for public pool intended applications.
4. **Valves.** Minimum diameter of backwash valves shall be 2 inches or the diameter of the return pipe, whichever is greater.

SECTION 160.7 – MANDATORY REQUIREMENTS FOR COVERED PROCESSES

(a) **Elevators.** Elevators shall meet the requirements of **Section** 120.6(f).

(b) **Pool and spa systems.** Pool and spa systems available to multiple tenants or to the public shall comply with the applicable requirements of Section 110.4. Pool and spa systems installed for exclusive use by a single tenant shall comply with the applicable requirements of Section 150.0(p). Pool and spa systems installed for public use shall comply with Section 150(p)2, Section 150.0(p)3, and Section 150.0(p)4.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8 and 25943, Public Resources Code.

8.3 Reference Appendices

Appendix JA15 – Criteria for Solar Swimming Pool or Spa Heating System, Heat Pump Pool Heaters, and On-Site Renewable Energy or Site Recovered Energy

JA15.1 Purpose and Scope

Joint Appendix JA15 provides the eligibility criteria for energy efficiency measures for solar swimming pool or spa heating systems, and sizing for heat pump pool heaters.

JA15.2 Solar Pool or Spa Heating Systems

Solar swimming pool and/or spa heating systems shall be certified and rated by the Solar Rating and Certification Corporation (ICC-SRCC), the International Association of Plumbing and Mechanical Officials, Research and Testing (IAPMO R&T), or by a listing agency that is approved by the Executive Director.

Solar thermal collectors shall be listed and labeled in accordance with Table 110.4-A. The installed system shall meet the following eligibility criteria:

a. The system shall be installed according to manufacturer's instructions.
b. The system shall be installed in the exact configuration for which it was rated. The system shall have the same collector(s), piping, pump, vacuu

relief valve, controls, and other components used to establish the rated condition.

JA15.3 Heat Pump Pool Heater Sizing

A heat pump pool heater shall be sized using the heat pump pool heater manufacturer's specifications. The following sizing provisions shall be applicable if the heat pump pool heater manufacturer's specifications do not include information on heat pump pool heater sizing:

(a) Determine desired pool temperature in °F.
(b) Determine average temperature for the coldest month of pool use in °F.
(c) Determine temperature rise in °F by subtracting the average temperature for the coldest month from the desired pool temperature.
(d) Calculate the pool volume in gallons.
(e) Use equation JA15-1 to determine the Btu/h output requirement of the heat pump pool heater.

Equation JA15-1

$$Q_{out} = V_p \times 8.33 \times \Delta T \div t$$

Where:

Q_{out} is the output heating capacity of the heat pump pool heater

V_p is the pool volume in gallons

8.33 is the weight of a gallon of water at 62°F in lbs/gal

ΔT is the pool temperature rise in °F, and shall not exceed 10°F

t is the time in hours and shall not exceed 17.5 hours

8.4 ACM Reference Manual

There are no proposed changes to the ACM Reference Manual.

8.5 Compliance Forms

The compliance document CEC-CF2R-PLB-03-E for residential applications would need to be revised and possibly renamed to transition from a plumbing-specific document to a pool and spa version. the nomenclature of the form may be further revised to clarify applicability to pools and spa and spa heating systems (i.e., revision of PLB to PAS). The current compliance form does not account for the pump flow rates provision set forth in Section 150.0(p)1.B. of Title 24, Part 6. The proposed revisions to this compliance form seeks to align the compliance form with the existing code language while also ensuring new language aligning with the proposed code language is incorporated into the compliance form.

Here are some examples pertaining to the compliance manual revisions that would be reflected in compliance form CEC-CF2R-PLB-03-E:

a. The 60 percent site solar or recovered energy provision set forth in Exception 2 to Section 110.4(a)(4) of the 2022 Title 24, Part 6, is reiterated in both sets of compliance manuals without any additional information prescribing how to apply or enforce this exception, so compliance form CEC-CF2R-PLB-03-E would be revised to address this matter.

b. Pool systems and equipment installation provisions set forth in section 150.0(p)1.B of Title 24, Part 6, are excluded from the 2022 Nonresidential and Multifamily Compliance Manual even though section 150.0(p) is mandatory for nonresidential hotels/motels per Table 100.0-A of 2022 Title 24, Part 6.

c. The Single Family Residential Compliance Manual does not account for the pump flow rates provision set forth in Section 150.0(p)1.B. of Title 24, Part 6. The proposed revisions seek to align the compliance manuals with the existing code language while also ensuring new language aligning with the proposed code language is incorporated into the manuals.

Impacted line items within compliance form CEC-CF2R-PLB-03-E would be revised to meet the intent of the 2025 edition of Title 24, Part 6. The nomenclature of form CEC-CF2R-PLB-03-E may be further revised to clarify applicability to pools and spa and spa heating systems (i.e., revision of PLB to PAS). Provisions in the previously-issued compliance form CF1R-STH-01-E for solar water heaters would be adapted to develop new CF1R-PAS provisions for solar pool heating equipment, and compliance for market actors would be aligned with requirements they already have to meet for existing solar water heating provisions in Title 24, Part 6.Additionally, compliance forms NRCC-PRC-E and LMCC-PRC-E would need to be revised for nonresidential and multifamily applications to ensure projects comply with the new requirements. The current compliance forms do not account for the proposed code language in Section 110.4(c) of Title 24, Part 6. A check box would need to be added where the applicant could confirm compliance with that section, or mark as “not applicable” if the pool is not proposed to be heated.

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Appendix A: Statewide Savings Methodology

The Statewide CASE Team estimated statewide impacts for the first year by multiplying per-pool savings estimates by statewide pool forecasts that the Statewide CASE Team developed. Details of the pool forecast are in Section 7.

Single Family Pools

The Statewide CASE Team followed assumptions on pool heating to be consistent with survey results from the 2019 Residential Appliance Saturation Study (RASS) study and the 1999 National Renewable Energy Laboratory Report on Solar Pool Heating Quantitative Survey. The 2019 Residential Appliance Saturation Study (RASS) study (CEC RASS 2019) shows that 53 percent of pools in California have some form of pool heating (natural gas, solar thermal, electricity or propane) and the vast majority of those with heaters (90 percent) use natural gas. The RASS data also shows how heating varies among pool owners. Figure 2 shows the frequency of heating among those pool owners with a heater that provided a response. Most single-family pool owners with a heater do not heat the pool.

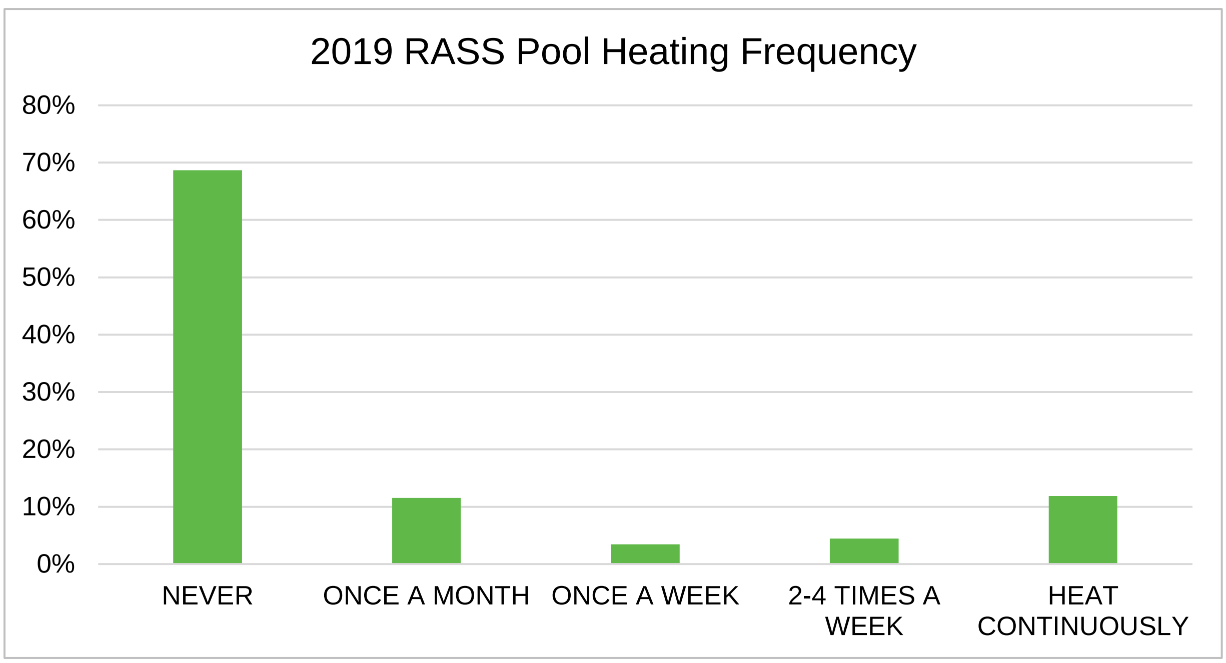

Figure 2: Frequency of heating pool among California pool owners with heater

Source: (CEC RASS 2019)

The 1999 Report on Solar Pool Heating Quantitative Survey (NREL 1999) surveyed pool owners who had either or solar thermal pool heating system or a gas-fired pool heater The survey questions covered topics such as pool usage patterns, energy costs, and attitudes towards solar pool heating. The results of the survey were analyzed to provide insights into consumer behavior and preferences related to solar pool heating. Figure 3 provides the results of the pool heating frequency of solar thermal heated pools and gas-fired pools. The results show a statistically significant increase in pool heating by solar thermal heated pools compared to gas-fired pools. The Statewide CASE Team used the information on frequency of pool heating from the NREL study for energy calculations.

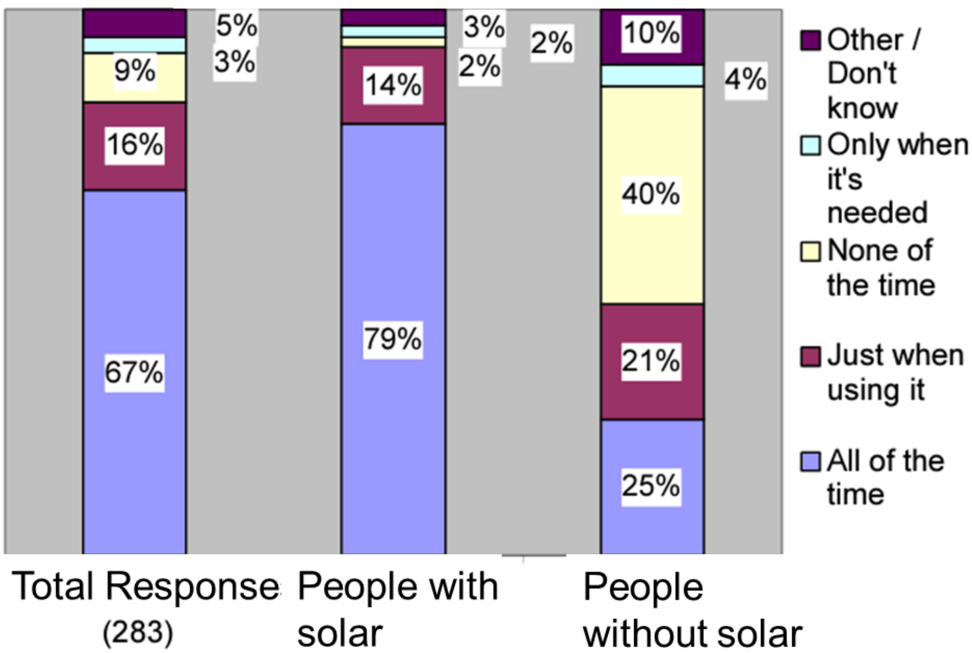

Figure 3: Frequency of heating pool

Source: NREL (1999)

The Statewide CASE Team estimated statewide impacts for the first year by multiplying per-pool savings estimates by the fraction of pools that have heaters and are heated continuously. The Statewide CASE Team made assumptions about the percentage of pools that would be impacted yearly by reviewing information provided by stakeholders for new pool construction and assuming that pool heaters at end of life would require replacement and trigger the new requirements. The yearly number of existing pools impacted was assumed to be the total stock divided by the estimated useful life of 11.2 years for the pool gas-fired heater. The total number of pools in CA was estimated from PKdata (Pkdata n.d.). 2019 RASS data provided the percentage that were gas heated or electric heated. The U.S. EPA WaterSense Pool Cover Notice of Intent (WaterSense 2018) provided an estimate of the number of pools where covers are used.

The Statewide CASE Team distributed the number of pools to the climate zones by taking a construction weighted average from the CEC construction forecast[22] and multiplying it by the total number of single-family pools. The following tables have the estimated residential pools for 2026.

The Statewide CASE Team assumed a pool growth rate of one percent to estimate new pools in California. The one percent growth rate is consistent with published sources. The Statewide CASE Team used the one percent growth rate to also estimate the number of pools in the future year 2026 from the PKdata data from 2014 (Adler 2015).

[22] CEC provided the construction estimates on 2/7/2023 to the Statewide CASE Team.

Table 44: Residential Outdoor Covered Gas Heated Pools

Climate Zone	Name	New Pools with Heating 2026	Pool Heating Retrofits 2026
1	Arcata	3	28
2	Sonoma	18	165
3	Oakland	75	671
4	Paso Robles	38	342
5	Santa Maria	8	71
6	Los Angeles	84	751
7	San Diego	53	476
8	Fullerton	122	1,085
9	Hollywood Burbank	201	1,791
10	Riverside	167	1,487
11	Red Bluff	18	160
12	Sacramento	86	768
13	Fresno Yosemite	40	360
14	Palmdale	36	317
15	Palm Springs	17	155
16	Blue Canyon Nyack	10	88

Table 45: Residential Outdoor Uncovered Gas Heated Pools

Climate Zone	Name	New Pools with Heating 2026	Pool Heating Retrofits 2026
1	Arcata	21	186
2	Sonoma	123	1,102
3	Oakland	503	4,489
4	Paso Robles	256	2,286
5	Santa Maria	53	472
6	Los Angeles	563	5,024
7	San Diego	356	3,182
8	Fullerton	813	7,261
9	Hollywood Burbank	1,343	11,987
10	Riverside	1,115	9,952
11	Red Bluff	120	1,068
12	Sacramento	575	5,138
13	Fresno Yosemite	270	2,412
14	Palmdale	238	2,125
15	Palm Springs	116	1,038
16	Blue Canyon Nyack	66	586

Table 46: Residential Outdoor Covered Electric Heated Pools

Climate Zone	Name	New Pools with Heating 2026	Pool Heating Retrofits 2026
1	Arcata	0	3
2	Sonoma	2	18
3	Oakland	8	75
4	Paso Robles	4	38
5	Santa Maria	1	8
6	Los Angeles	9	83
7	San Diego	6	53
8	Fullerton	14	121
9	Hollywood Burbank	22	199
10	Riverside	19	165
11	Red Bluff	2	18
12	Sacramento	10	85
13	Fresno Yosemite	4	40
14	Palmdale	4	35
15	Palm Springs	2	17
16	Blue Canyon Nyack	1	10

Table 47: Residential Outdoor Uncovered Electric Heated Pools

Climate Zone	Name	New Pools with Heating 2026	Pool Heating Retrofits 2026
1	Arcata	3	28
2	Sonoma	18	165
3	Oakland	75	671
4	Paso Robles	38	342
5	Santa Maria	8	71
6	Los Angeles	84	751
7	San Diego	53	476
8	Fullerton	122	1,085
9	Hollywood Burbank	201	1,791
10	Riverside	167	1,487
11	Red Bluff	18	160
12	Sacramento	86	768
13	Fresno Yosemite	40	360
14	Palmdale	36	317
15	Palm Springs	17	155
16	Blue Canyon Nyack	10	88

Multifamily Pools

The Statewide CASE Team followed assumptions for nonresidential pools since they are similar in size, heating, and use patterns. The Statewide CASE Team seeks an estimate of pools at multifamily locations that is separate from an estimate at commercial locations. For this analysis, the number of multifamily pools was assumed to be included within the estimate for NR pools.

Nonresidential Buildings

The Statewide CASE Team used PKdata and listing of large pools at the Swimmer Guide (SwimmersGuide n.d.) to estimate the number of nonresidential pools in California. The PKdata was assumed to have all nonresidential pools and the Swimmers Guide provided data to estimate the number of large pools within the PKdata. A one percent growth rate was assumed for both new pools in 2026 and to estimate the stock of pools from number of pools provided by PKdata in 2014 (Adler 2015) and Swimmers Guide in 2023. The Statewide CASE Team assumed that nonresidential pools would be heated by gas or electricity in equal proportions as was provided by the 2019 RASS data. Cover use was also assumed to be consistent with the assumptions from the single-family pools. All nonresidential pools were assumed to be heated continuously per information provided by the Solar Energy Industries Association (Solar Energy Industries Association 2011).

Table 48: Nonresidential Motel Outdoor Covered Gas Heated Average Size Pools

Climate Zone	Name	New Pools with Heating 2026	Pool Heating Retrofits 2026
1	Arcata	0	1
2	Sonoma	1	5
3	Oakland	2	21
4	Paso Robles	1	11
5	Santa Maria	0	2
6	Los Angeles	3	24
7	San Diego	2	15
8	Fullerton	4	34
9	Hollywood Burbank	6	57
10	Riverside	5	47
11	Red Bluff	1	5
12	Sacramento	3	24
13	Fresno Yosemite	1	11
14	Palmdale	1	10
15	Palm Springs	1	5
16	Blue Canyon Nyack	0	3

Table 49: Nonresidential Motel Outdoor Uncovered Gas Heated Average Size Pools

Climate Zone	Name	New Pools with Heating 2026	Pool Heating Retrofits 2026
1	Arcata	1	6
2	Sonoma	4	35
3	Oakland	16	143
4	Paso Robles	8	73
5	Santa Maria	2	15
6	Los Angeles	18	160
7	San Diego	11	101
8	Fullerton	26	231
9	Hollywood Burbank	43	381
10	Riverside	35	316
11	Red Bluff	4	34
12	Sacramento	18	163
13	Fresno Yosemite	9	77
14	Palmdale	8	67
15	Palm Springs	4	33
16	Blue Canyon Nyack	2	19

Table 50: Nonresidential Motel Outdoor Covered Electric Heated Average Size Pools

Climate Zone	Name	New Pools with Heating 2026	Pool Heating Retrofits 2026
1	Arcata	0	0
2	Sonoma	0	1
3	Oakland	0	2
4	Paso Robles	0	1
5	Santa Maria	0	0
6	Los Angeles	0	3
7	San Diego	0	2
8	Fullerton	0	4
9	Hollywood Burbank	1	6
10	Riverside	1	5
11	Red Bluff	0	1
12	Sacramento	0	3
13	Fresno Yosemite	0	1
14	Palmdale	0	1
15	Palm Springs	0	1
16	Blue Canyon Nyack	0	0

Table 51: Nonresidential Motel Outdoor Uncovered Electric Heated Average Pools

Climate Zone	Name	New Pools with Heating 2026	Pool Heating Retrofits 2026
1	Arcata	0	1
2	Sonoma	0	4
3	Oakland	2	16
4	Paso Robles	1	8
5	Santa Maria	0	2
6	Los Angeles	2	18
7	San Diego	1	11
8	Fullerton	3	26
9	Hollywood Burbank	5	42
10	Riverside	4	35
11	Red Bluff	0	4
12	Sacramento	2	18
13	Fresno Yosemite	1	9
14	Palmdale	1	7
15	Palm Springs	0	4
16	Blue Canyon Nyack	0	2

Table 52: Nonresidential Motel Indoor Uncovered Gas Heated Average Size Pools

Climate Zone	Name	New Pools with Heating 2026	Pool Heating Retrofits 2026
1	Arcata	0	4
2	Sonoma	3	26
3	Oakland	12	105
4	Paso Robles	6	53
5	Santa Maria	1	11
6	Los Angeles	13	117
7	San Diego	8	74
8	Fullerton	19	169
9	Hollywood Burbank	31	280
10	Riverside	26	232
11	Red Bluff	3	25
12	Sacramento	13	120
13	Fresno Yosemite	6	56
14	Palmdale	6	50
15	Palm Springs	3	24
16	Blue Canyon Nyack	2	14

Table 53: Nonresidential Motel Indoor Uncovered Electric Heated Average Size Pools

Climate Zone	Name	New Pools with Heating 2026	Pool Heating Retrofits 2026
1	Arcata	0	0
2	Sonoma	0	3
3	Oakland	1	12
4	Paso Robles	1	6
5	Santa Maria	0	1
6	Los Angeles	1	13
7	San Diego	1	8
8	Fullerton	2	19
9	Hollywood Burbank	3	31
10	Riverside	3	26
11	Red Bluff	0	3
12	Sacramento	1	13
13	Fresno Yosemite	1	6
14	Palmdale	1	6
15	Palm Springs	0	3
16	Blue Canyon Nyack	0	2

Table 54: Nonresidential Olympic Outdoor Uncovered Gas Heated Average Size Pools

Climate Zone	Name	New Pools with Heating 2026	Pool Heating Retrofits 2026
1	Arcata	0	0
2	Sonoma	0	2
3	Oakland	1	7
4	Paso Robles	0	3
5	Santa Maria	0	1
6	Los Angeles	1	8
7	San Diego	1	5
8	Fullerton	1	11
9	Hollywood Burbank	2	18
10	Riverside	2	15
11	Red Bluff	0	2
12	Sacramento	1	8
13	Fresno Yosemite	0	4
14	Palmdale	0	3
15	Palm Springs	0	2
16	Blue Canyon Nyack	0	1

Table 55: Nonresidential Olympic Indoor Uncovered Electric Heated Average Size Pools

Climate Zone	Name	New Pools with Heating 2026	Pool Heating Retrofits 2026
1	Arcata	0	0
2	Sonoma	0	0
3	Oakland	0	1
4	Paso Robles	0	0
5	Santa Maria	0	0
6	Los Angeles	0	1
7	San Diego	0	0
8	Fullerton	0	1
9	Hollywood Burbank	0	1
10	Riverside	0	1
11	Red Bluff	0	0
12	Sacramento	0	1
13	Fresno Yosemite	0	0
14	Palmdale	0	0
15	Palm Springs	0	0
16	Blue Canyon Nyack	0	0

Table 56: Nonresidential Olympic Outdoor Covered Gas Heated Large Size Pools

Climate Zone	Name	New Pools with Heating 2026	Pool Heating Retrofits 2026
1	Arcata	0	0
2	Sonoma	0	0
3	Oakland	0	1
4	Paso Robles	0	1
5	Santa Maria	0	0
6	Los Angeles	0	1
7	San Diego	0	1
8	Fullerton	0	2
9	Hollywood Burbank	0	3
10	Riverside	0	2
11	Red Bluff	0	0
12	Sacramento	0	1
13	Fresno Yosemite	0	1
14	Palmdale	0	0
15	Palm Springs	0	0
16	Blue Canyon Nyack	0	0

Table 57: Nonresidential Olympic Indoor Uncovered Gas Heated Large Size Pools

Climate Zone	Name	New Pools with Heating 2026	Pool Heating Retrofits 2026
1	Arcata	0	0
2	Sonoma	0	1
3	Oakland	1	5
4	Paso Robles	0	3
5	Santa Maria	0	1
6	Los Angeles	1	6
7	San Diego	0	4
8	Fullerton	1	8
9	Hollywood Burbank	1	13
10	Riverside	1	11
11	Red Bluff	0	1
12	Sacramento	1	6
13	Fresno Yosemite	0	3
14	Palmdale	0	2
15	Palm Springs	0	1
16	Blue Canyon Nyack	0	1

Table 58: Nonresidential Olympic Outdoor Covered Electric Heated Large Size Pools

Climate Zone	Name	New Pools with Heating 2026	Pool Heating Retrofits 2026
1	Arcata	0	0
2	Sonoma	0	0
3	Oakland	0	0
4	Paso Robles	0	0
5	Santa Maria	0	0
6	Los Angeles	0	0
7	San Diego	0	0
8	Fullerton	0	0
9	Hollywood Burbank	0	0
10	Riverside	0	0
11	Red Bluff	0	0
12	Sacramento	0	0
13	Fresno Yosemite	0	0
14	Palmdale	0	0
15	Palm Springs	0	0
16	Blue Canyon Nyack	0	0

Table 59: Nonresidential Olympic Outdoor Uncovered Electric Heated Large Pools

Climate Zone	Name	New Pools with Heating 2026	Pool Heating Retrofits 2026
1	Arcata	0	0
2	Sonoma	0	0
3	Oakland	0	1
4	Paso Robles	0	0
5	Santa Maria	0	0
6	Los Angeles	0	1
7	San Diego	0	1
8	Fullerton	0	1
9	Hollywood Burbank	0	2
10	Riverside	0	2
11	Red Bluff	0	0
12	Sacramento	0	1
13	Fresno Yosemite	0	0
14	Palmdale	0	0
15	Palm Springs	0	0
16	Blue Canyon Nyack	0	0

Appendix B: Embedded Electricity in Water Methodology

There are no on-site water savings associated with the proposed code change.

Appendix C: California Building Energy Code Compliance (CBECC) Software Specification

There are no recommended revisions to the compliance software because of this code change proposal.

Appendix D: Environmental Analysis

Potential Significant Environmental Effect of Proposal

The CEC is the lead agency under the California Environmental Quality Act (CEQA) for the 2025 Energy Code and must evaluate any potential significant environmental effects resulting from the proposed standards. A “significant effect on the environment” is “a substantial adverse change in the physical conditions which exist in the area affected by the proposed project.” (Cal. Code Regs., tit. 14, § 15002(g)).

The Statewide CASE Team has considered the environmental benefits and adverse impacts of its proposal including, but not limited to, an evaluation of factors contained in the California Code of Regulations, Title 14, section 15064 and determined that the proposal would not result in a significant effect on the environment.

Direct Environmental Impacts

Direct Environmental Benefits

The proposed measure has the potential to yield various direct environmental benefits. Foremost, the measure can significantly reduce greenhouse gas emissions by decreasing the dependence on nonrenewable energy sources, such as natural gas, which generate harmful pollutants and contributes to poor air quality. By mandating solar thermal pool and spa heating systems in nonresidential, multifamily, and newly constructed single-family buildings with heated swimming pools and spas, it can contribute to a cleaner, healthier environment for humans and wildlife.

Direct Adverse Environmental Impacts

Although the proposed measure focuses on mitigating the adverse environmental impacts associated with traditional gas or electric pool heating systems, there may still be some direct adverse environmental impacts associated with the manufacture and disposal of solar collectors.

The manufacturing of solar collectors requires the use of materials such as glass, aluminum, and copper, which can have negative environmental impacts if not sourced sustainably. Additionally, the manufacturing process can produce greenhouse gas emissions and other air pollutants. However, the impact of these negative environmental impacts is generally small when compared to the greenhouse gas emissions that are avoided through the use of solar collectors.

When it comes to the disposal of solar collectors, the materials used in their construction can be recycled or reused, which can minimize the environmental impact. However, improper disposal of these materials can lead to environmental pollution and harm to wildlife and ecosystems. To mitigate this risk, it is important to ensure that the disposal of solar collectors is done in accordance with local regulations and best practices to minimize negative environmental impacts. The following issues were raised in an article published by the Los Angeles Times in 2022 (Kisela 2022):

1. Lack of recycling initiatives and end of life ending up in major landfill problems;
2. Lack of cost effectiveness associated with recouping elements of value during the recycling process from these panels. More cost effective to just dispose them; and
3. Lack of extended producer responsibility obligations on manufacturers and installers of these panels.

On October 1, 2015, SB 489 was enacted to add section 25259 to Health and Safety Code, Division 20, Chapter 6.5, Article 17, which authorizes the Department of Toxic Substances Control (DTSC) to adopt regulations to designate end-of-life photovoltaic modules that are identified as hazardous waste as a universal waste and subject those modules to universal waste management. Starting January 1, 2021, businesses that intend to manage waste photovoltaic modules as universal waste must notify DTSC of the universal waste management activities.[23]

Washington State's SB 5939 requires manufacturers to provide the public a convenient and environmentally sound way to recycle all modules.[24] New Jersey and North Carolina, passed laws in 2020 to require the study of end-of-life PV management options to help develop options for legislative or regulatory considerations (NREL 2021).

Indirect Environmental Impacts

An increase in HPPH installs is likely to yield increased GHG emissions. Low-GWP refrigerant measures should be considered by CARB for these products like the steps previously taken by CARB for other space-conditioning heat pumps using refrigerants. In addition, leak mitigation measures should be continued to be evaluated for products containing refrigerants.

Indirect Environmental Benefits

Per the U.S. Energy Information Administration, the use of solar energy can replace or reduce the use of other energy sources that have larger effects on the environment (EIA 2022).

[23] Per the notice here: https://dtsc.ca.gov/photovoltaic-modules-pv-modules-universal-waste-management-regulations/

[24] Policy available here: https://ecology.wa.gov/Waste-Toxics/Reducing-recycling-waste/Our-recycling-programs/Solar-panels

Indirect Adverse Environmental Impacts

Lack of appropriate end-of-life management of solar products can strain valuable resources. DTSC's ongoing leadership in this matter through its regulations and enforcement levers will help mitigate this issue.

Mitigation Measures

DOE's Solar Energy Technologies Office (SETO) has funded research to develop new materials and designs that can make PV products longer-lasting, less energy-intensive to produce, easier to recycle, and even less polluting at the end of life.[25] SETO's Photovoltaics End-Of-Life Action Plan outlines a five-year strategy to establish safe, responsible, and economic end-of-life practices (DOE EERE 2022).

Per a fact sheet issued by the Solar Energy Industries Association®, PV panels typically consist of glass, aluminum, copper, silver, and semiconductor materials that can be successfully recovered and reused, and by weight, more than 80 percent of a typical PV panel is comprised of glass and aluminum, and both are easy to recycle. SEIA's partners in its National Recycling Program have processed over 4 million pounds of PV modules and related equipment since the program's launch (SEIA 2020).

The U.S. Environmental Protection Agency has raised the following in lieu of solar panels being disposed in landfills: a) commercialization of recycling of solar panels to economically recover most components, b) solar panel reuse and refurbishment.[26]

A report issued by the International Renewable Energy Agency and the International Energy Agency Photovoltaic Power Systems Programme, projects PV panel waste volumes to the year 2050., and states that recycling or repurposing solar PV panels at the end of their roughly 30-year lifetime can unlock an estimated stock of 78 million tons of raw materials and other valuable components globally by 2050. If fully injected back into the economy, the value of the recovered material could exceed $15 billion by 2050.[27]

The Statewide CASE Team has considered opportunities to minimize the environmental impact of the proposal, including an evaluation of "specific economic, environmental, legal, social, and technological factors." (Cal. Code Regs., tit. 14, § 15021). In the context of the past or upcoming actions undertaken by federal and state regulatory agencies, and trade associations, the Statewide CASE Team did not determine this

[25] Information available here: https://www.energy.gov/eere/solar/end-life-management-solar-photovoltaics

[26] Information available here: https://www.epa.gov/hw/solar-panel-recycling

[27] Information available here: https://www.irena.org/publications/2016/Jun/End-of-life-management-Solar-Photovoltaic-Panels

measure would result in significant direct or indirect adverse environmental impacts and therefore, did not develop any mitigation measures.

Reasonable Alternatives to Proposal

The pathways prescribed in the proposed section 110.4(c) continue to allow the use of pool heating systems that allowed by the current edition of Title 24, Part 6, so the alternatives to the solar approach prescribed in subsection 110.4(c)(1) place no incremental adverse effect on the environment relative to the current burden.

If an EIR is developed, CEQA requires a lead agency to evaluate reasonable alternatives to proposals that would have a significant adverse effect on the environment, including a “no project” alternative (Cal. Code Regs. Tit. 14, §§ 15002(h)(4) and 15126.6).

The Statewide CASE Team has considered alternatives to the proposal and believes the available alternatives do not increase adverse effect on the environment.

Water Use and Water Quality Impacts Methodology

There are no impacts to water quality or water use.

Embodied Carbon in Materials

Accounting for embodied carbon emissions is important for understanding the full picture of a proposed code change’s environmental impacts. The embodied carbon in materials analysis accounts specifically for emissions produced during the “cradle-to-gate” phase: emissions produced from material extraction, manufacturing, and transportation. Understanding these emissions ensures the proposed measure considers these early stages of materials production and manufacturing instead of emissions reductions from energy efficiency alone.

The Statewide CASE Team calculated emissions impacts associated with embodied carbon from the change in materials as a result of the proposed measure. The calculation builds off the materials impacts described in Section 7.4.

After calculating the materials impacts, the Statewide CASE Team applied average embodied carbon emissions for each material. The embodied carbon emissions are based on industry-wide environmental product declarations (EPDs).[28, 29] These industry-wide EPDs provide global warming potential (GWP) values per weight of specific materials.[30] The Statewide CASE Team chose the industry-wide average for GWP values in the EPDs because the materials accounted for in the statewide calculation have a range of embodied carbon. That is, some materials like concrete have a wide range of embodied carbon depending on the manufacturer's processes, source of the materials, etc. The Statewide CASE Team assumes that most building projects will not specify low embodied carbon products. Therefore, an average is appropriate for a statewide estimate.

First year statewide impacts per material (in pounds) were multiplied by the GWP impacts for each material. This provides the total statewide embodied carbon impact for each material. If a material's use is increased, then there is an increase in embodied carbon impacts (additional emissions). If a material's use is decreased, then there is a decrease in embodied carbon impacts (emissions reduced). Table 60 presents estimated first-year GHG emissions impacts associated with embodied carbon. The increased GHG emissions from embodied carbon are modest when compared to the 61,293 metric tons CO2e GHG emissions reductions from reduced natural gas use as presented in Section 7.2.

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[28] EPDs are documents which disclose a variety of environmental impacts, including embodied carbon emissions. These documents are based on lifecycle assessments on specific products and materials. Industry-wide EPDs disclose environmental impacts for one product for all (or most) manufacturers in a specified area and are often developed through the coordination of multiple manufacturers and/or associations. A manufacturer specific EPD only examines one product from one manufacturer. Therefore, an industry wide EPD discloses all the environmental impacts from the entire industry (for a specific product/material) but a manufacturer specific EPD only factors one manufacturer.

[29] An industry wide EPD was not used for mercury, lead, copper, plastics, and refrigerants. Global warming potential values of mercury, lead and copper are based on data provided in a lifecycle assessment (LCA) conducted by Yale University in 2014. The GWP value for plastic is based on a LCA conducted by Franklin Associates, which capture roughly 59 percent of the U.S.' total production of PVC and HDPE production. The GWP values for refrigerants are based on data provided by the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report.

[30] GWP values for concrete and wood were in units of kg CO2 equivalent by volume of the material rather than by weight. An average density of each material was used to convert volume to weight.

Table 60: First-Year Embodied Carbon Emissions Impacts

Material	Impact	Nonresidential First-Year [a] Statewide Impacts (Pounds)	Nonresidential Embodied GHG Emissions Reductions (Metric Tons CO2e)	Residential First-Year [a] Statewide Impacts (Pounds)	Residential Embodied GHG Emissions Reductions (Metric Tons CO2e)
Copper	Increase	40,643	-52	268,746	-341
Plastic	Increase	1,539,148	-1,293	3,407,695	-2,862
TOTAL	**N/A**	**1,579,791**	**-1,345**	**3,676,441**	**-3,204**

a. First-year savings from all buildings completed statewide in 2026.

Appendix E: Discussion of Impacts of Compliance Process on Market Actors

This appendix discusses how the recommended compliance process, which is described in Section 3.5, could impact various market actors. Table 61 identifies the market actors who would play a role in complying with the proposed change, the tasks for which they are responsible, how the proposed code change could impact their existing workflow, and ways negative impacts could be mitigated. Please refer to Section 3.5 on details pertaining to the market actors from the standpoint of the design phase, permit application phase, construction phase, and inspection phase. The information contained in Table 61 is a summary of key feedback the Statewide CASE Team received when speaking to market actors about the compliance implications of the proposed code changes. Appendix F summarizes the stakeholder engagement that the Statewide CASE Team conducted when developing and refining the code change proposal, including gathering information on the compliance process.

To ensure compliance is achievable as straightforward and effortless as possible, the proposed revisions to the code language would culminate into revisions to an existing compliance form. Section 4.8.5 of the 2022 Nonresidential and Multifamily Compliance Manual would be revised along with section 5.10.2 of the 2022 Single Family Residential Compliance Manual. The proposed revisions to existing compliance forms are intended to be simple and not place additional burden on market actors.

Table 61: Roles of Market Actors in the Proposed Compliance Process

Market Actor	Task(s) in current compliance process relating to the CASE measure	How would the proposed measure impact the current task(s) or workflow?	How would the proposed code change impact compliance and enforcement?	Opportunities to minimize negative impacts of compliance requirement
Swimming Pool and Spa Heating System Contractor	• Perform required calculations to confirm that provisions set forth in the proposed section 110.4(c) are met. • Coordinate with swimming pool design and construction team if pool and spa heating system is being installed in conjunction with the swimming pool's installation. • Apply for a building permit when a new pool and spa heating system is being installed in newly constructed pools and spas, or in additions and alterations (except for single family pools with existing pool and spa heating systems). • Place a copy of compliance documentation with the building permit(s) issued for the building, and make them available to the local enforcement agency for all applicable inspections. A copy of the compliance documentation must be included with the documentation provided to the building owner at occupancy.	• Document compliance of the new requirements in revised form CEC-CF2R-PLB-03-E, and when applicable, the new CF1R-PAS worksheet for solar pool and spa heating system. • The installer of the pool and spa heating system shall be responsible for obtaining the permit from the local building department. Plans may be reviewed by the building department along with field inspections performed by a building inspector.	• The local building department shall be responsible for reviewing the signed compliance forms since both sets of compliance forms pertain to non-HERS registered projects. • Permit approval shall be contingent upon the completion of the relevant compliance documentation.	• Increased coordination between swimming pool and spa designers / installers, and pool and spa heating equipment installers with building owners. In certain instances, swimming pool installers may either offer to install the pool and spa heating systems themselves, or enter into subcontracts with other pool and spa heating system contractors as part of consolidated projects. • In many instances, the installation of a pool heating system is foregone at the time a swimming pool is installed. No additional documentation would be necessary in such scenarios from the perspective of the applicable compliance forms.

Market Actor	Task(s) in current compliance process relating to the CASE measure	How would the proposed measure impact the current task(s) or workflow?	How would the proposed code change impact compliance and enforcement?	Opportunities to minimize negative impacts of compliance requirement
Swimming Pool and Spa Designer, and Swimming Pool and Spa Contractor	• Perform the above listed tasks if a pool heating system is scheduled to be installed at the same time as a new swimming pool; or • Coordinate pool heating system installation with a swimming pool and spa heating equipment contractor.	• Perform the above listed tasks if a pool heating system is scheduled to be installed at the same time as a new swimming pool; or • Coordinate pool heating system installation with a swimming pool and spa heating equipment contractor.	• Perform the above listed tasks if a pool heating system is scheduled to be installed at the same time as a new swimming pool; or • Coordinate pool heating system installation with a swimming pool and spa heating equipment contractor.	• Perform the above listed tasks if a pool heating system is scheduled to be installed at the same time as a new swimming pool; or • Coordinate pool heating system installation with a swimming pool and spa heating equipment contractor.
Local Building Department and Building Inspector	• Responsible for approving permit application.	• Trigger a site inspection to review new or revised compliance forms prior to permit approval.	• Impact is expected to be minimal relative to current processes. • Requiring the review of the new form CF1R-PAS when solar pool and/or spa heating system is installed, and the CF2R-PLB-03-E by the building inspector when provisions set forth in the proposed section 110.4(c) and 150.0(p) are invoked.	• Consolidation of all new tasks (i.e., new fields in existing form) with existing inspection and approval practices. • Increased awareness and enforcement of pool and spa requirements.
Building owner	• Responsible for ensuring that responsible contractor secures a building permit prior to the install of a pool and spa heating system.	• None.	• Responsible for ensuring that responsible contractor secures permit approval during the inspection phase.	• Consolidation of all new tasks into existing compliance form.

Market Actor	Task(s) in current compliance process relating to the CASE measure	How would the proposed measure impact the current task(s) or workflow?	How would the proposed code change impact compliance and enforcement?	Opportunities to minimize negative impacts of compliance requirement
CEC	• Issuance of revised compliance documentation such as manuals and forms.	• Intended to fit into CEC's existing practices.	• Impact is expected to be minimal relative to current processes. • Additional efforts are required to develop or modify the CF1R and CF2R forms, but CEC also has the option of invoking the Statewide CASE Team's assistance on this scope of work.	• Consolidation of all new tasks into existing compliance form.
Pool Heating System Manufacturer	• Ensure that all pool and spa heating systems or equipment subject to State or federal appliance efficiency standards, are listed on CEC's directory of certified equipment, and are compliant with the Appliance Efficiency Regulations.	• None.	• Ensure that only compliant pool and spa heating systems are installed in California.	• Ensure that training resources for installers reinforce that pool heating systems not meeting the definitions set forth in section 20 CCR § 1602 of the Appliance Efficiency Regulations, are prohibited from being installed for all pool heating applications.

Appendix F: Summary of Stakeholder Engagement

Collaborating with stakeholders that might be impacted by proposed changes is a critical aspect of the Statewide CASE Team's efforts. The Statewide CASE Team aims to work with interested parties to identify and address issues associated with the proposed code changes so that the proposals presented to the CEC in this Final CASE Report are generally supported. Public stakeholders provide valuable feedback on draft analyses and help identify and address challenges to adoption including cost effectiveness, market barriers, technical barriers, compliance and enforcement challenges, or potential impacts on human health or the environment. Some stakeholders also provide data that the Statewide CASE Team uses to support analyses.

This appendix summarizes the stakeholder engagement that the Statewide CASE Team conducted when developing and refining the recommendations presented in this report.

Utility-Sponsored Stakeholder Meetings

Utility-sponsored stakeholder meetings provide an opportunity to learn about the Statewide CASE Team's role in the advocacy effort and to hear about specific code change proposals that the Statewide CASE Team is pursuing for the 2025 code cycle. The goal of stakeholder meetings is to solicit input on proposals from stakeholders early enough to ensure the proposals and the supporting analyses are vetted and have as few outstanding issues as possible. To provide transparency in what the Statewide CASE Team is considering for code change proposals, during these meetings the Statewide CASE Team asks for feedback on:

- Proposed code changes
- Draft code language
- Draft assumptions and results for analyses
- Data to support assumptions
- Compliance and enforcement, and
- Technical and market feasibility

The Statewide CASE Team hosted stakeholder meetings for Solar Pool and Spa Heating via webinar described in Table 62. Please see below for dates and links to event pages on Title24Stakeholders.com. Materials from each meeting, such as slide presentations, proposal summaries with code language, and meeting notes, are included in the bibliography section of this report.

Table 62: Utility-Sponsored Stakeholder Meetings

Meeting Name	Meeting Date	Event Page from Title24stakeholders.com
First Round of Nonresidential, Multifamily and Single Family Solar Pool Heating Utility-Sponsored Stakeholder Meeting	Wednesday, February 1, 2023	https://title24stakeholders.com/event/nonresidential-multifamily-and-single family-solar-pool-heating-utility-sponsored-stakeholder-meeting/
Second Round of Nonresidential, Multifamily and Single Family Solar Pool Heating Utility-Sponsored Stakeholder Meeting	Thursday, May 18, 2023	https://title24stakeholders.com/event/pools-nonresidential-space-heating-and-commercial-kitchens-utility-sponsored-stakeholder-meeting/

The first round of utility-sponsored stakeholder meetings occurred from January to February 2023 and were important for providing transparency and an early forum for stakeholders to offer feedback on measures being pursued by the Statewide CASE Team. The objectives of the first round of stakeholder meetings were to solicit input on the scope of the 2025 code cycle proposals; request data and feedback on the specific approaches, assumptions, and methodologies for the energy impacts and cost-effectiveness analyses; and understand potential technical and market barriers. The Statewide CASE Team also presented initial draft code language for stakeholders to review.

The second round of utility-sponsored stakeholder meetings occurred in May of 2023 and provided updated details on proposed code changes. The second round of meetings introduced early results of energy, cost-effectiveness, and incremental cost analyses, and solicited feedback on refined draft code language.

Utility-sponsored stakeholder meetings were open to the public. For each stakeholder meeting, two promotional emails were distributed from info@title24stakeholders.com. One email was sent to the entire Title 24 Stakeholders listserv, totaling over 3,000 individuals, and a second email was sent to a targeted list of individuals on the listserv depending on their subscription preferences. The Title 24 Stakeholders' website listserv is an opt-in service and includes individuals from a wide variety of industries and trades, including manufacturers, advocacy groups, local government, and building and energy professionals. Each meeting was posted on the Title 24 Stakeholders' LinkedIn page (and cross-promoted on the CEC LinkedIn page) two weeks before each meeting to reach out to individuals and larger organizations and channels outside of the listserv. The Statewide CASE Team conducted extensive personal outreach to stakeholders identified in initial work plans who had not yet opted into the listserv. Exported webinar meeting data captured attendance numbers and individual comments, and recorded outcomes of live attendee polls to evaluate stakeholder participation and support.

Statewide CASE Team Communications

The Statewide CASE Team held personal communications over email and phone with numerous stakeholders when developing this report, listed in Table 63.

Table 63: Engaged Stakeholders

Organization/ Event/ Individual Name	Market Role	Notes from Meeting and CASE Report Sections
International Code Council - Solar Rating & Certification Corporation (ICC-SRCC)	Industry Association	Met with staff in December 2022 and members in January and May 2023. Helped to understand the history of solar fraction suggesting a simplistic approach with percentage of pool surface area.
California Solar and Storage Association (CALSSA)	Industry Association	Meet with membership twice in January 2023, in May 2023, and had ongoing dialog with several members. Prefer measure to apply broadly. See Section 2.3. During the May meeting members suggested clarification to the code language with an exception to meeting the surface area requirement when not using backup heat.
Chad Worth	Academics	Held several meetings to discuss proposed measure and other ideas such as variable speed and prescriptive design guidelines for NR pools similar to SF provisions.
Air Conditioning, Heating and Refrigeration Institute (AHRI)	Trade Association	Met with Staff in February and May 2023. Generally, membership is not concerned. Provided written comments.
Pool and Hot Tub Association (PHTA)	Trade Association	Included in the meeting with ASHRAE 189.1 discussed below. Met with PHTA staff and several PHTA members on May 2, 2023, and responded to the written comments originally filed to the Statewide CASE Team after the round 1 stakeholder sessions. Responded to written comments after the round 2 stakeholder session through email.
Fluidra	Manufacturer	Participated in PHTA and meetings and submitted comments after each stakeholder meeting. Responded to the first set of comments in the May conversation with PHTA and through email for their second set of comments. They provided responses to stakeholder questions and suggestions for improving the code language.
California Low-Income Consumer Coalition	Consumer Advocacy Group	No response.
Diversity in Aquatics	Consumer Advocacy Group	Received an automated response.
National Consumer Law Center	Consumer Advocacy Group	Expressed appreciation in the Statewide CASE Team's interest in ensuring that low-income households are not harmed by the proposed code changes. However, did not have feedback to offer from the standpoint of swimming pools and spas in single family buildings or community pools. Stated that some amount of work has been performed in California, but the work was unrelated to pools and spas. Close engagement exists with low-income households based in Massachusetts.

Organization/ Event/ Individual Name	Market Role	Notes from Meeting and CASE Report Sections
ASHRAE 90.2 Standing Standard Project Committee (SSPC) Chairs	Standard development committee	Met in March 2022. Committee is focused on zero carbon with immediate goal to address rating index. Concept may be best introduced in the Winter of 2024, would need an analytical approach for ASHRAE 90.2.
ASHRAE 189.1 Committee Members	Standard development committee	Met in November 2022 with PHTA and Cadeo Group. Beginning modeling work related to pool insulation due to existing insulation requirement in ASHRAE 189.1.
Rheem / Raypak	Manufacturer	Met with the Statewide CASE Team in November 2022 and April 2023. Noted it is challenging to switch from gas-fired pool heating to HPPH with restrictions on electric resistance or other forms of auxiliary heating. Air to Water (ATW) Heat pumps are an option, development is ongoing. See Section 1. Also provided feedback on HPPH sizing.
ASHRAE 90.1 Committee Members	Standard development committee	Engaged with multiple voting members part of an hoc committee of ASHRAE 90.1 on Indoor Pool & Spa. The Statewide CASE Team was invited to summarize the measures at this ad hoc committee level. The Statewide CASE Team has invited voting members of this ad hoc committee to participate at the stakeholder meetings.
AHR 2023 Expo	Major HVAC&R trade show co-sponsored by AHRI and ASHRAE, and endorsed by several organizations	The Statewide CASE Team identified at least 19 exhibitors potentially interested in this CASE measure activity.[31] The Statewide CASE Team paraphrased the questions on the Title 24 stakeholder's website for this measure as part of the key talking points. The Statewide CASE Team was informed that gas-fired technologies are mostly used in pool and spa heating applications. The Statewide CASE Team was also informed about the following products during the AHR Expo: • A pool collector example.[32] • Incorporation of a major compressor manufacturer's models into heat pump pool heaters.[33] • Gas-fired boilers can be used in pool and spa heating applications.

[31] Full list of exhibitors was accessed here: https://ahr23.mapyourshow.com/8_0/explore/exhibitor-gallery.cfm?featured=false

[32] https://sunearthinc.com/oasis-pp/

[33] https://climate.emerson.com/en-us/shop/1/copeland-scroll-for-pool-heating?fetchFacets=true#facet:&partsFacet:&facetLimit:&searchTerm:&partsSearchTerm:&productBeginIndex:0&partsBeginIndex:0&orderBy:2&partsOrderBy:&pageView:list&minPrice:&maxPrice:&pageSize:&facetRange:&

Organization/ Event/ Individual Name	Market Role	Notes from Meeting and CASE Report Sections
Aquatherm Industries, Inc.	Manufacturer	Used Polysun simulation to demonstrate the GHG emissions reductions potential associated with a baseline gas-fired pool heating system. Provided heat pump pool heater sizing calculations based on pool volume in lieu of using pool surface area, as originally proposed in the Statewide CASE Team's measure description. Sizing based on pool volume is typical industry practice for heat pump pool heaters.
Hot Sun Industries, Inc.	Manufacturer	Ongoing conversations and met in May 2023. Suggested that all new pools be pre-plumbed for solar, such that barriers to solar adoption are minimal in the future. The cost to do so is low and the opportunity is the greatest at the permitting / construction phase. In regard to solar pool heating in newly constructed buildings, suggested the installation of a motorized three-way valve, solar sensor wire and piping up the wall but not through or around the soffit. Options like heat pumps to heat the spa using the pool as a source would be fine but these types of solutions would not work without a several inch thick insulating cover. See Section 2.2.2. Expressed concerns with the HPPH options.
FAFCO, Inc.	Manufacturer	In regard to solar pool heating provisions, a balance should be struck between the collector area as a function of the pool surface area, and the proposed requirements in the new joint appendix 15, so as to avoid over constraining installation of such systems. The proposed revisions to efficiency requirements in section 110.4(a)(1) may necessitate further clarification of what types of equipment are eligible for heating pools and spas. See Section 2.2.2
Western Pool and Spa Show	Trade and education involving pool and spa service and construction professionals, and manufacturers and distributors	Engaged with 3 solar thermal manufacturers and 2 contractors. The Statewide CASE Team paraphrased the questions on the Title 24 stakeholder's website for this measure as part of the key talking points, and raised awareness about the second utility-sponsored stakeholder meeting scheduled for May of 2023. During these engagements, the Statewide CASE Team was made aware of potential issues that could arise from proposing a solar collector surface area requirement of 70 percent for single family homes. Based on the feedback received, the requirement was reduced.
Natural Resources Defense Council	Environmental advocacy group	Provided emailed comments after each stakeholder meeting. NRDC supports the proposed measure and would also support further steps to explore the requirements for variable speed pool pumps and pool insulation for pools heated to more than 90 degrees that were considered early in the measure development process. NRDC supports the proposed code language, including restating the requirement for variable speed from T20.

Engagement with DIPs

The Statewide CASE Team conducted outreach to the California Low-Income Consumer Coalition (CLICC) and Diversity in Aquatics to better understand the potential impact of a mandatory solar pool heating measure on low-income consumers.

An email was forwarded to invite the CLICC to the February 1 stakeholder meeting and follow-up emails were sent on February 8 and March 16, 2023. A response was not received from CLICC.

An email was sent to Diversity in Aquatics on April 27, 2023, and a response was received on May 3, 2023 that appeared to be a template response indicating their mission was to promote diversity, inclusion, and access to aquatics by educating, engaging, and empowering communities of color and offering to join their newsletter. No further communication was received.

The Statewide CASE team also reached out to Kyle Krause at the California Department of Housing and Community Development (HCD) on May 11, 2023, and received a call back and discussed the proposal. HCD did not have concerns on the impact to DIPs.

Appendix G: Energy Cost Savings in Nominal Dollars

The CEC requested energy cost savings over the 30-year period of analysis in both 2026 present value dollars (2026 PV$) and nominal dollars. The cost effectiveness analysis uses energy cost values in 2026 PV$. Costs and cost effectiveness using and 2026 PV$ are presented in Section 6 of this report. This appendix presents energy cost savings in nominal dollars.

Table 64: Nominal LSC Savings Over 30-Year Period of Analysis – Per Pool – New Construction and Alterations – Nonresidential Motel Outdoor Pool Covered Gas Prototype

Climate Zone	30-Year LSC Electricity Cost Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Energy Savings (Nominal $)
1	-	25,566	25,566
2	-	90,135	90,135
3	-	47,668	47,668
4	-	113,388	113,388
5	-	58,804	58,804
6	-	64,609	64,609
7	-	70,491	70,491
8	-	113,786	113,786
9	-	111,404	111,404
10	-	113,237	113,237
11	-	98,264	98,264
12	-	95,438	95,438
13	-	108,595	108,595
14	-	109,943	109,943
15	-	117,923	117,923
16	-	75,890	75,890

Table 65: Nominal LSC Savings Over 30-Year Period of Analysis – Per Pool –New Construction and Alterations – Nonresidential Motel Outdoor Pool Uncovered Gas Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Energy Savings (Nominal $)
1	-	26,781	26,781
2	-	93,180	93,180
3	-	49,506	49,506
4	-	120,847	120,847
5	-	62,043	62,043
6	-	67,255	67,255
7	-	72,724	72,724
8	-	117,136	117,136
9	-	117,313	117,313
10	-	122,125	122,125
11	-	109,670	109,670
12		99,760	99,760
13		117,147	117,147
14		139,283	139,283
15		151,925	151,925
16		106,094	106,094

Table 66: Nominal LSC Savings Over 30-Year Period of Analysis – Per Pool – New Construction and Alterations – Nonresidential Motel Indoor Pool Uncovered Gas Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	0.00	22,458	22,458
2	0.00	88,001	88,001
3	0.00	43,911	43,911
4	0.00	107,875	107,875
5	0.00	56,090	56,090
6	0.00	63,998	63,998
7	0.00	69,192	69,192
8	0.00	114,839	114,839
9	0.00	110,606	110,606
10	0.00	113,341	113,341
11	0.00	96,199	96,199
12	0.00	94,147	94,147
13	0.00	109,838	109,838
14	0.00	99,136	99,136
15	0.00	138,779	138,779
16	0.00	66,419	66,419

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Table 67: Nominal LSC Over 30-Year Period of Analysis – Per Pool – New Construction and Additions – Nonresidential Olympic Outdoor Pool Uncovered Gas Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Energy Savings (Nominal $)
1	-	1,957,586	1,957,586
2	-	4,136,484	4,136,484
3	-	3,188,844	3,188,844
4	-	5,289,455	5,289,455
5	-	3,476,129	3,476,129
6	-	3,232,086	3,232,086
7	-	3,244,975	3,244,975
8	-	4,345,823	4,345,823
9	-	4,823,036	4,823,036
10	-	4,873,047	4,873,047
11	-	4,559,639	4,559,639
12	-	4,228,558	4,228,558
13	-	4,597,538	4,597,538
14	-	5,998,271	5,998,271
15	-	6,046,097	6,046,097
16	-	4,912,444	4,912,444

Table 68: Nominal LSC Over 30-Year Period of Analysis – Per Pool – New Construction and Additions – Nonresidential Olympic Outdoor Pool Covered Gas Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	0.00	1,327,411	1,327,411
2	0.00	3,063,502	3,063,502
3	0.00	1,992,650	1,992,650
4	0.00	4,296,973	4,296,973
5	0.00	2,380,326	2,380,326
6	0.00	2,036,658	2,036,658
7	0.00	2,162,324	2,162,324
8	0.00	3,449,449	3,449,449
9	0.00	3,640,578	3,640,578
10	0.00	3,795,388	3,795,388
11	0.00	3,459,319	3,459,319
12	0.00	3,174,905	3,174,905
13	0.00	3,386,713	3,386,713
14	0.00	4,688,853	4,688,853
15	0.00	3,803,586	3,803,586
16	0.00	3,747,973	3,747,973

Table 69: Nominal LSC Over 30-Year Period of Analysis – Per Pool – New Construction and Additions – Nonresidential Olympic Indoor Pool Uncovered Gas Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	0.00	640,072	640,072
2	0.00	2,518,892	2,518,892
3	0.00	1,250,482	1,250,482
4	0.00	3,112,100	3,112,100
5	0.00	1,601,828	1,601,828
6	0.00	1,828,173	1,828,173
7	0.00	1,975,766	1,975,766
8	0.00	3,303,047	3,303,047
9	0.00	3,181,473	3,181,473
10	0.00	3,271,937	3,271,937
11	0.00	2,797,502	2,797,502
12	0.00	2,717,956	2,717,956
13	0.00	3,210,154	3,210,154
14	0.00	2,908,040	2,908,040
15	0.00	4,119,955	4,119,955
16	0.00	1,894,270	1,894,270

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Table 70: Nominal LSC Over 30-Year Period of Analysis – Per Pool – New Construction and Additions – Residential Outdoor Pool Covered Gas Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	0.00	3,223	3,223
2	0.00	21,966	21,966
3	0.00	9,496	9,496
4	0.00	24,099	24,099
5	0.00	9,101	9,101
6	0.00	11,479	11,479
7	0.00	10,398	10,398
8	0.00	19,802	19,802
9	0.00	19,533	19,533
10	0.00	24,092	24,092
11	0.00	21,063	21,063
12	0.00	24,166	24,166
13	0.00	22,761	22,761
14	0.00	22,625	22,625
15	0.00	14,345	14,345
16	0.00	10,993	10,993

Table 71: Nominal LSC Over 30-Year Period of Analysis – Per Pool – New Construction and Additions – Residential Outdoor Pool Uncovered Gas Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	0.00	3,212	3,212
2	0.00	22,037	22,037
3	0.00	9,774	9,774
4	0.00	26,069	26,069
5	0.00	9,333	9,333
6	0.00	11,770	11,770
7	0.00	10,827	10,827
8	0.00	22,324	22,324
9	0.00	22,466	22,466
10	0.00	29,840	29,840
11	0.00	30,890	30,890
12	0.00	26,877	26,877
13	0.00	34,659	34,659
14	0.00	31,490	31,490
15	0.00	35,234	35,234
16	0.00	11,383	11,383

Appendix H: Heat Pump Pool Heater Analysis

The Statewide CASE Team docketed the Swimming Pool and Spa Heating Final CASE Report in August 2023. Shortly after this report was made publicly available, the Energy Commission reached out to the Statewide CASE Team to request additional details on the cost effectiveness of the proposed alternative measure for heat pump pool heaters (HPPH). The Energy Commission requested investigation into pools heated by HPPH scenarios in addition to the solar thermal heated pool scenarios originally analyzed for the Final CASE Report. At the request of the Energy Commission, the Statewide CASE Team developed a supplementary cost effectiveness analysis for pools heated by HPPH to show the proposed alternative requirement would be cost effective. The additional analysis was needed to mitigate concerns that the proposed alternative requirement would only be cost effective for some climate zones. The Statewide CASE Team modeled both residential and non-residential pools heated by HPPH as a supplementary analysis. In August 2023, the Statewide CASE Team presented the additional analysis to the Energy Commission showing the pool heated by HPPH were cost effective in all climate zones except for the indoor Olympic pool in climate zone 16. As a result, the Statewide CASE Team did not make any updates to the proposed requirement. The addendum presents the additional analysis on the supplementary cost effectiveness calculations.

Heat Pump Pool Heater Analysis

The Statewide CASE Team modeled pools heated by HPPH to show cost effectiveness at the request of the Energy Commission. The purpose of this investigation was to verify that the proposed code change would be cost effective for the proposed alternative requirements for pool heating.

Assumptions:

- Pools that were identical in size and use as were assumed for the solar thermal analysis (The pool dimensions are provided in Table 17 of section 5.1.1).
- The use of a HPPH as the primary source of pool heating with a gas backup heater to provide heat only when cold weather conditions prevented the HPPH from operating. The Olympic size pool was served by 13 140 kbtu/h capacity HPPH. The coefficient of performance of 5.5 matches the value proposed for 2025 effective date for the HPPH alternative.
- The pool heating transitions from HPPH heating to natural gas heating at an air temperature of 45 ˚F to prevent damage to the HPPH from freezing.
- The incremental cost is assumed to be the cost of the HPPH. The baseline scenario has a gas heater. The measure scenario has the gas heater as a

backup with a HPPH as the primary source of heat. Therefore, the incremental cost due to the proposal is the addition of the HPPH.

The coefficient of performance was modeled as a function of air temperature to match trends in performance found in models certified to the CEC MAEDbS Database. The coefficient of performance declines with air temperature as there is less heat in the air for the HPPH to gather. The coefficient of performance would likely improve above 80 ˚F but the CASE Team assumes a constant value to be conservative. Figure 4. provides a plot of the coefficient of performance vs air temperature. The backup gas heater had the same 82% thermal efficiency as assumed for the solar thermal analysis. Table 72 below provides a description of the HPPH assumed for the scenarios analyzed. Figure 5 shows a bank of HPPH providing heat to a large aquatic center.

Table 72: Prototypical HPPH Analysis Summary

Scenario	HPPH Capacity (kbtu/h output)	Coefficient of Performance at 80 ˚F	Low Temperature Transition Point to Gas Heater Backup	Backup Gas Heater Thermal Efficiency
NR motel pool	90	5.5	45 ˚F	82%
NR Olympic pool	1,800	5.5	45 ˚F	82%
Residential pool	90	5.5	45 ˚F	82%

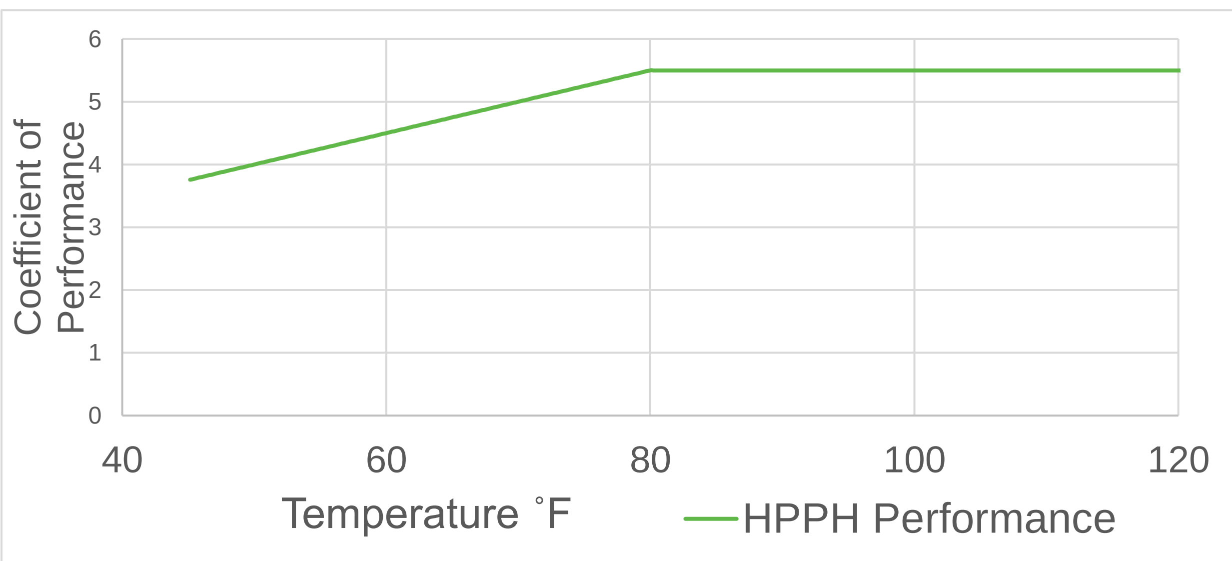

Figure 4: HPPH Coefficient of Performance vs. Air Temperature

Source: CASE Team

Figure 5: Bank of HPPH for Large Aquatic Center

Source: Lex Pools

Updated Energy Savings

The Statewide CASE Team calculated the energy savings for pools heated by HPPH using the same method as described in Section 5.1 and Section 5.2 of the Final CASE Report. The Statewide CASE Team presents the savings in the table below.

Table 73: Prototype Buildings Used for Energy, Demand, Cost, and Environmental Impacts Analysis

Prototype Name	Pool Surface Area (sq. ft)	Pool Volume (gal)	Baseline Heat Source	Measure Heat Source	Description
NR Motel Outdoor Pool Covered Electric	440	20,000	Gas	HPPH with Gas Backup	Outdoor pool typical of commercial application with pool cover in use outside of business hours
NR Motel Outdoor Pool Uncovered Electric	440	20,000	Gas	HPPH with Gas Backup	Outdoor pool typical of commercial application with no pool cover
NR Motel Indoor Pool Uncovered Electric	440	20,000	Gas	HPPH with Gas Backup	Indoor pool typical of commercial application with no pool cover
NR Olympic Outdoor Pool Covered Electric	13,455	660,000	Gas	HPPH with Gas Backup	Outdoor pool typical of commercial application with pool cover in use outside of business hours
NR Olympic Outdoor Pool Uncovered Electric	13,455	660,000	Gas	HPPH with Gas Backup	Outdoor pool typical of commercial application with no pool cover
NR Olympic Indoor Pool Uncovered Electric	13,455	660,000	Gas	HPPH with Gas Backup	Indoor pool typical of commercial application with no pool cover
Residential Outdoor Pool Covered Electric	440	20,000	Gas	HPPH with Gas Backup	Residential outdoor pool covered
Residential Outdoor Pool Uncovered Electric	440	20,000	Gas	HPPH with Gas Backup	Residential outdoor pool uncovered

Per Unit Energy Impact Results

The natural gas and energy savings per prototypical residential and nonresidential pools are presented in Table 74 through Table 83 for new construction, additions, and alterations. The electricity use increases are because of the use of electricity by the HPPH to provide heat rather than the gas heater used for the baseline measure.

Table 74: Electricity Savings (kWh/yr) For HPPH Per Prototypical Pool (Climate Zones 1 - 8)

Prototype	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8
NR Motel Indoor Pool Uncovered Electric	(4,100)	(3,700)	(5,100)	(3,000)	(5,000)	(6,600)	(7,200)	(6,900)
NR Motel Outdoor Pool Covered Electric	(13,000)	(10,000)	(17,000)	(7,700)	(16,000)	(19,000)	(20,000)	(18,000)
NR Motel Outdoor Pool Uncovered Electric	(16,000)	(13,000)	(21,000)	(10,000)	(20,000)	(25,000)	(26,000)	(23,000)
NR Olympic Indoor Pool Uncovered Electric	(120,000)	(110,000)	(150,000)	(89,000)	(150,000)	(200,000)	(220,000)	(210,000)
NR Olympic Outdoor Pool Covered Electric	(390,000)	(310,000)	(500,000)	(230,000)	(480,000)	(580,000)	(600,000)	(540,000)
NR Olympic Outdoor Pool Uncovered Electric	(470,000)	(380,000)	(600,000)	(300,000)	(570,000)	(700,000)	(750,000)	(660,000)
Residential Outdoor Pool Covered Electric	(4,800)	(7,400)	(7,200)	(4,300)	(5,800)	(4,700)	(3,100)	(3,300)
Residential Outdoor Pool Uncovered Electric	(7,000)	(12,000)	(12,000)	(8,200)	(8,900)	(8,200)	(5,600)	(6,200)

Table 75: Electricity Savings (kWh/yr) For HPPH Prototypical Pool (Climate Zones 9 – 16)

Prototype	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16
NR Motel Indoor Pool Uncovered Electric	(5,200)	(5,100)	(4,000)	(4,100)	(4,500)	(3,200)	(5,200)	(1,900)
NR Motel Outdoor Pool Covered Electric	(13,000)	(13,000)	(9,400)	(10,000)	(9,900)	(9,200)	(11,000)	(4,800)
NR Motel Outdoor Pool Uncovered Electric	(17,000)	(17,000)	(13,000)	(14,000)	(14,000)	(13,000)	(16,000)	(6,500)
NR Olympic Indoor Pool Uncovered Electric	(160,000)	(150,000)	(120,000)	(120,000)	(140,000)	(99,000)	(160,000)	(54,000)
NR Olympic Outdoor Pool Covered Electric	(390,000)	(380,000)	(270,000)	(310,000)	(290,000)	(270,000)	(320,000)	(140,000)
NR Olympic Outdoor Pool Uncovered Electric	(500,000)	(480,000)	(370,000)	(410,000)	(410,000)	(370,000)	(460,000)	(190,000)
Residential Outdoor Pool Covered Electric	(3,800)	(5,100)	(4,100)	(5,300)	(4,700)	(5,000)	(2,300)	(2,700)
Residential Outdoor Pool Uncovered Electric	(7,300)	(9,600)	(9,100)	(9,800)	(10,000)	(12,000)	(7,100)	(4,800)

Table 76: Peak Demand Reduction (Watt/unit) For HPPH Per Prototypical Pool (Climate Zones 1 - 8)

Prototype	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8
NR Motel Indoor Pool Uncovered Electric	(250)	(240)	(230)	(200)	(230)	(330)	(740)	(670)
NR Motel Outdoor Pool Covered Electric	(880)	(890)	(740)	(720)	(790)	(1,000)	(2,400)	(2,300)
NR Motel Outdoor Pool Uncovered Electric	(1,200)	(1,200)	(1,100)	(1,100)	(1,100)	(1,600)	(3,600)	(3,400)
NR Olympic Indoor Pool Uncovered Electric	(7,400)	(7,200)	(6,800)	(6,000)	(6,900)	(10,000)	(22,000)	(20,000)
NR Olympic Outdoor Pool Covered Electric	(30,000)	(29,000)	(25,000)	(24,000)	(25,000)	(35,000)	(83,000)	(77,000)
NR Olympic Outdoor Pool Uncovered Electric	(37,000)	(36,000)	(33,000)	(31,000)	(33,000)	(45,000)	(100,000)	(94,000)
Residential Outdoor Pool Covered Electric	(450)	(800)	(700)	(590)	(750)	(430)	(350)	(270)
Residential Outdoor Pool Uncovered Electric	(620)	(1,200)	(1,100)	(1,000)	(1,100)	(790)	(690)	(690)

Table 77: Peak Demand Reduction (Watt/unit) For HPPH Prototypical Pool (Climate Zones 9 – 16)

Prototype	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16
NR Motel Indoor Pool Uncovered Electric	(290)	(290)	(210)	(220)	(200)	(200)	(200)	(200)
NR Motel Outdoor Pool Covered Electric	(870)	(920)	(560)	(680)	(480)	(640)	(420)	(690)
NR Motel Outdoor Pool Uncovered Electric	(1,300)	(1,400)	(930)	(1,000)	(830)	(1,100)	(890)	(1,000)
NR Olympic Indoor Pool Uncovered Electric	(8,600)	(8,800)	(6,200)	(6,600)	(5,900)	(6,000)	(6,300)	(5,900)
NR Olympic Outdoor Pool Covered Electric	(28,000)	(29,000)	(17,000)	(21,000)	(15,000)	(22,000)	(13,000)	(23,000)
NR Olympic Outdoor Pool Uncovered Electric	(38,000)	(38,000)	(27,000)	(31,000)	(25,000)	(31,000)	(26,000)	(29,000)
Residential Outdoor Pool Covered Electric	(320)	(250)	(330)	(500)	(240)	(480)	(69)	(400)
Residential Outdoor Pool Uncovered Electric	(810)	(760)	(920)	(1,000)	(820)	(1,100)	(660)	(600)

Table 78: Natural Gas Savings (kBtu/yr) For HPPH Per Prototypical Pool (Climate Zones 1 - 8)

Prototype	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8
NR Motel Indoor Pool Uncovered Electric	73,000	73,000	97,000	61,000	94,000	130,000	140,000	140,000
NR Motel Outdoor Pool Covered Electric	240,000	190,000	320,000	150,000	300,000	370,000	390,000	350,000
NR Motel Outdoor Pool Uncovered Electric	290,000	240,000	400,000	200,000	370,000	470,000	490,000	440,000
NR Olympic Indoor Pool Uncovered Electric	2,200,000	2,200,000	2,900,000	1,800,000	2,800,000	3,900,000	4,200,000	4,200,000
NR Olympic Outdoor Pool Covered Electric	7,000,000	5,700,000	9,400,000	4,500,000	8,900,000	11,000,000	12,000,000	10,000,000
NR Olympic Outdoor Pool Uncovered Electric	8,300,000	7,100,000	11,000,000	5,900,000	10,000,000	14,000,000	14,000,000	13,000,000
Residential Outdoor Pool Covered Electric	85,000	130,000	140,000	81,000	110,000	93,000	62,000	67,000
Residential Outdoor Pool Uncovered Electric	120,000	210,000	230,000	160,000	160,000	160,000	110,000	120,000

Table 79: Natural Gas Savings (kBtu/yr) for HPPH Per Prototypical Pool (Climate Zones 9 – 16)

Prototype	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16
NR Motel Indoor Pool Uncovered Electric	100,000	100,000	84,000	84,000	95,000	69,000	110,000	38,000
NR Motel Outdoor Pool Covered Electric	260,000	250,000	190,000	200,000	200,000	190,000	230,000	100,000
NR Motel Outdoor Pool Uncovered Electric	340,000	320,000	260,000	270,000	290,000	280,000	330,000	130,000
NR Olympic Indoor Pool Uncovered Electric	3,200,000	3,200,000	2,500,000	2,500,000	2,800,000	2,100,000	3,400,000	1,100,000
NR Olympic Outdoor Pool Covered Electric	7,700,000	7,400,000	5,500,000	6,000,000	5,900,000	5,600,000	6,700,000	2,900,000
NR Olympic Outdoor Pool Uncovered Electric	9,800,000	9,300,000	7,400,000	7,800,000	8,300,000	7,700,000	9,600,000	3,800,000
Residential Outdoor Pool Covered Electric	76,000	99,000	81,000	100,000	92,000	99,000	48,000	53,000
Residential Outdoor Pool Uncovered Electric	150,000	190,000	180,000	190,000	210,000	240,000	150,000	95,000

Table 80: Source Energy Savings (kBtu/yr) for HPPH Per Prototypical Pool (Climate Zones 1 - 8)

Prototype	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8
NR Motel Indoor Pool Uncovered Electric	61,000	61,000	82,000	51,000	79,000	110,000	110,000	110,000
NR Motel Outdoor Pool Covered Electric	190,000	160,000	260,000	120,000	250,000	300,000	300,000	270,000
NR Motel Outdoor Pool Uncovered Electric	230,000	190,000	330,000	170,000	300,000	370,000	380,000	340,000
NR Olympic Indoor Pool Uncovered Electric	1,800,000	1,800,000	2,400,000	1,500,000	2,400,000	3,200,000	3,400,000	3,400,000
NR Olympic Outdoor Pool Covered Electric	5,700,000	4,600,000	7,700,000	3,700,000	7,300,000	8,800,000	9,000,000	8,000,000
NR Olympic Outdoor Pool Uncovered Electric	6,800,000	5,800,000	9,400,000	4,900,000	8,700,000	11,000,000	11,000,000	9,900,000
Residential Outdoor Pool Covered Electric	70,000	110,000	110,000	67,000	86,000	76,000	51,000	54,000
Residential Outdoor Pool Uncovered Electric	100,000	170,000	190,000	130,000	130,000	130,000	93,000	100,000

Table 81: Source Energy Savings (kBtu/yr) for HPPH Per Prototypical Pool (Climate Zones 9 – 16)

Prototype	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16
NR Motel Indoor Pool Uncovered Electric	87,000	87,000	71,000	70,000	80,000	58,000	93,000	31,000
NR Motel Outdoor Pool Covered Electric	210,000	200,000	150,000	160,000	160,000	160,000	180,000	78,000
NR Motel Outdoor Pool Uncovered Electric	270,000	260,000	210,000	220,000	230,000	220,000	270,000	100,000
NR Olympic Indoor Pool Uncovered Electric	2,600,000	2,600,000	2,100,000	2,100,000	2,400,000	1,800,000	2,900,000	910,000
NR Olympic Outdoor Pool Covered Electric	6,100,000	5,900,000	4,400,000	4,800,000	4,800,000	4,600,000	5,300,000	2,300,000
NR Olympic Outdoor Pool Uncovered Electric	7,800,000	7,500,000	6,100,000	6,400,000	6,900,000	6,300,000	7,700,000	3,000,000
Residential Outdoor Pool Covered Electric	62,000	82,000	67,000	83,000	77,000	81,000	40,000	43,000
Residential Outdoor Pool Uncovered Electric	120,000	160,000	150,000	160,000	170,000	200,000	130,000	78,000

Table 82: Long-term Systemwide Energy Savings (kBtu) for HPPH Per Prototypical Pool (Climate Zones 1 - 8)

Prototype	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8
NR Motel Indoor Pool Uncovered Electric	15,000	16,000	23,000	13,000	21,000	33,000	35,000	35,000
NR Motel Outdoor Pool Covered Electric	45,000	36,000	72,000	28,000	64,000	93,000	93,000	86,000
NR Motel Outdoor Pool Uncovered Electric	53,000	44,000	90,000	36,000	77,000	120,000	120,000	100,000
NR Olympic Indoor Pool Uncovered Electric	430,000	480,000	680,000	390,000	630,000	990,000	1,100,000	1,100,000
NR Olympic Outdoor Pool Covered Electric	1,300,000	1,000,000	2,100,000	790,000	1,900,000	2,700,000	2,800,000	2,500,000
NR Olympic Outdoor Pool Uncovered Electric	1,500,000	1,300,000	2,500,000	1,100,000	2,200,000	3,300,000	3,500,000	3,100,000
Residential Outdoor Pool Covered Electric	65,000	100,000	110,000	63,000	79,000	73,000	49,000	53,000
Residential Outdoor Pool Uncovered Electric	97,000	160,000	180,000	120,000	120,000	130,000	90,000	98,000

Table 83: First Year Long-term Systemwide Energy Savings (kBtu) for HPPH Per Prototypical Pool (Climate Zones 9 - 16)

Prototype Climate Zone	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16
NR Motel Indoor Pool Uncovered Electric	26,000	26,000	20,000	20,000	24,000	16,000	31,000	8,100
NR Motel Outdoor Pool Covered Electric	61,000	59,000	45,000	44,000	48,000	39,000	65,000	20,000
NR Motel Outdoor Pool Uncovered Electric	77,000	74,000	61,000	57,000	67,000	54,000	92,000	24,000
NR Olympic Indoor Pool Uncovered Electric	780,000	780,000	610,000	590,000	710,000	480,000	950,000	240,000
NR Olympic Outdoor Pool Covered Electric	1,800,000	1,700,000	1,300,000	1,300,000	1,400,000	1,100,000	1,900,000	530,000
NR Olympic Outdoor Pool Uncovered Electric	2,200,000	2,100,000	1,700,000	1,700,000	2,000,000	1,600,000	2,700,000	710,000
Residential Outdoor Pool Covered Electric	60,000	80,000	66,000	81,000	76,000	78,000	40,000	41,000
Residential Outdoor Pool Uncovered Electric	110,000	150,000	150,000	150,000	170,000	190,000	130,000	75,000

Cost and Cost-Effectiveness

Incremental First Cost

The Statewide CASE Team used the same cost-effectiveness calculation methodology and assumptions as described in Section 6.1 of the Final CASE Report. The following tables show the cost-estimates for the pools heated by HPPH.

The incremental cost is assumed to be the cost of the HPPH. The baseline scenario has a gas heater. The measure scenario has the gas heater as a backup with a HPPH as the primary source of heat. Therefore, the incremental cost due to the proposal is the addition of the HPPH.

Table 84: 2026 Present Value LSC Savings Over 30-Year Period of Analysis – Nonresidential Motel Outdoor Pool Covered HPPH Prototype – New Construction, Additions and Alterations

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Savings (2026 PV$)
1	-66,620	111,906	45,286
2	-54,958	90,862	35,904
3	-85,606	157,341	71,735
4	-44,882	72,463	27,582
5	-85,721	149,491	63,770
6	-109,696	202,981	93,285
7	-123,414	216,029	92,615
8	-108,088	194,457	86,368
9	-74,981	136,022	61,041
10	-73,160	132,619	59,459
11	-50,736	95,789	45,053
12	-57,900	101,903	44,003
13	-52,463	100,921	48,458
14	-52,330	90,937	38,607
15	-59,523	124,792	65,268
16	-28,054	47,647	19,594

Table 85: 2026 Present Value LSC Savings Over 30-Year Period of Analysis – Nonresidential Motel Outdoor Pool Uncovered HPPH Prototype – New Construction, Additions and Alterations

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Savings (2026 PV$)
1	-81,805	135,143	53,338
2	-69,128	112,941	43,813
3	-110,000	199,534	89,533
4	-60,622	96,309	35,687
5	-104,913	181,835	76,921
6	-140,679	256,381	115,703
7	-154,069	272,430	118,361
8	-137,654	242,590	104,936
9	-98,469	175,159	76,691
10	-95,413	169,576	74,163
11	-71,940	132,896	60,956
12	-78,244	135,237	56,994
13	-76,641	143,725	67,084
14	-76,596	130,850	54,253
15	-89,740	181,555	91,815
16	-38,346	62,723	24,376

Table 86: 2026 Present Value LSC Savings Over 30-Year Period of Analysis – Nonresidential Motel Indoor Pool Uncovered HPPH Prototype – New Construction, Additions and Alterations

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Savings (2026 PV$)
1	-19,814	34,470	14,656
2	-18,273	34,304	16,031
3	-24,809	47,666	22,857
4	-15,460	28,681	13,221
5	-24,809	45,925	21,116
6	-35,180	67,894	32,714
7	-40,151	75,560	35,408
8	-38,428	73,864	35,436
9	-27,315	53,036	25,721
10	-27,144	52,975	25,831
11	-20,716	41,066	20,350
12	-21,560	41,091	19,532
13	-22,809	46,366	23,557
14	-17,172	32,779	15,606
15	-27,092	58,008	30,916
16	-9,934	17,997	8,062

Table 87: 2026 Present Value LSC Savings Over 30-Year Period of Analysis – Nonresidential Olympic Outdoor Pool Covered HPPH Prototype – New Construction, Additions and Alterations

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Savings (2026 PV$)
1	-1,998,914	3,290,233	1,291,319
2	-1,652,911	2,701,231	1,048,320
3	-2,554,429	4,645,100	2,090,672
4	-1,352,166	2,140,443	788,277
5	-2,544,631	4,396,585	1,851,954
6	-3,281,951	6,015,775	2,733,824
7	-3,661,942	6,432,086	2,770,144
8	-3,241,582	5,764,399	2,522,818
9	-2,236,693	4,024,727	1,788,034
10	-2,174,838	3,914,429	1,739,591
11	-1,478,178	2,760,770	1,282,592
12	-1,718,615	3,003,971	1,285,355
13	-1,554,356	2,972,521	1,418,166
14	-1,567,222	2,663,488	1,096,266
15	-1,772,295	3,685,102	1,912,807
16	-841,699	1,373,535	531,835

Table 88: 2026 Present Value LSC Savings Over 30-Year Period of Analysis – Nonresidential Olympic Outdoor Pool Uncovered HPPH Prototype – New Construction, Additions and Alterations

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Savings (2026 PV$)
1	-2,373,163	3,912,656	1,539,493
2	-2,031,522	3,346,569	1,315,047
3	-3,053,894	5,587,868	2,533,974
4	-1,735,116	2,799,290	1,064,174
5	-2,974,371	5,159,824	2,185,452
6	-3,969,222	7,291,994	3,322,771
7	-4,428,499	7,948,419	3,519,920
8	-3,967,340	7,059,821	3,092,482
9	-2,833,784	5,066,047	2,232,263
10	-2,708,335	4,853,595	2,145,260
11	-1,999,529	3,690,250	1,690,721
12	-2,251,202	3,911,230	1,660,027
13	-2,208,147	4,165,570	1,957,423
14	-2,088,632	3,639,409	1,550,777
15	-2,530,460	5,191,653	2,661,193
16	-1,084,279	1,794,270	709,990

Table 89: 2026 Present Value LSC Savings Over 30-Year Period of Analysis – Nonresidential Olympic Indoor Pool Uncovered HPPH Prototype – New Construction, Additions and Alterations

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Savings (2026 PV$)
1	-584,950	1,018,710	433,760
2	-544,666	1,023,575	478,910
3	-739,602	1,422,112	682,510
4	-462,001	855,845	393,844
5	-744,887	1,379,375	634,488
6	-1,060,705	2,048,603	987,898
7	-1,205,717	2,279,670	1,073,953
8	-1,159,360	2,228,982	1,069,622
9	-824,027	1,600,121	776,094
10	-818,986	1,598,936	779,950
11	-618,743	1,225,164	606,421
12	-647,934	1,233,295	585,360
13	-687,680	1,397,608	709,928
14	-523,287	999,189	475,902
15	-830,366	1,780,576	950,211
16	-289,769	526,107	236,338

Table 90: Average 2026 PV LSC Savings Over 30-Year Period of Analysis – Per Pool Over 30-Year Period of Analysis – New Construction, Additions and Alterations – All Nonresidential Prototypes

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Savings (2026 PV$)
1	-133,246.84	221,577.31	88,330.48
2	-114,702.37	192,450.50	77,748.13
3	-173,454.92	318,542.40	145,087.48
4	-98,471.10	161,495.19	63,024.09
5	-168,679.54	295,281.66	126,602.12
6	-227,109.57	419,269.35	192,159.78
7	-252,602.30	454,179.81	201,577.51
8	-228,428.98	410,547.16	182,118.18
9	-162,796.65	294,772.04	131,975.39
10	-157,466.33	285,730.86	128,264.53
11	-117,106.76	219,053.27	101,946.52
12	-128,922.94	227,187.75	98,264.82
13	-127,533.46	243,532.63	115,999.17
14	-119,069.27	208,594.63	89,525.35
15	-148,344.31	305,591.47	157,247.16
16	-59,463.92	99,456.27	39,992.35

Table 91: 2026 Present Value LSC Savings Over 30-Year Period of Analysis – Residential Outdoor Uncovered Pool HPPH Prototype – New Construction, Additions and Alterations

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Savings (2026 PV$)
1	-7,345	23,440	16,095
2	-12,585	39,491	26,906
3	-12,858	42,455	29,597
4	-9,712	29,455	19,743
5	-10,285	30,865	20,580
6	-9,550	30,588	21,038
7	-6,665	21,508	14,842
8	-7,245	23,475	16,231
9	-8,654	27,586	18,933
10	-10,743	35,880	25,137
11	-10,136	34,518	24,382
12	-11,065	35,658	24,594
13	-10,987	39,058	28,070
14	-13,547	44,988	31,441
15	-7,873	29,179	21,307
16	-5,466	17,893	12,427

Table 92: Present Value LSC Savings Over 30-Year Period of Analysis – Residential Outdoor Covered Pool HPPH Per Pool Prototype - New Construction, Additions and Alterations

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Savings (2026 PV$)
1	-5,083	15,912	10,828
2	-8,052	25,060	17,007
3	-7,705	25,483	17,778
4	-4,793	15,295	10,502
5	-6,771	19,936	13,165
6	-5,408	17,519	12,111
7	-3,621	11,693	8,072
8	-3,766	12,535	8,768
9	-4,290	14,225	9,935
10	-5,458	18,746	13,289
11	-4,434	15,299	10,865
12	-5,747	19,100	13,354
13	-4,790	17,342	12,552
14	-5,655	18,639	12,984
15	-2,347	9,052	6,705
16	-3,176	10,049	6,874

Table 93: Average LSC Savings Over 30-Year Period of Analysis – Residential All Prototypes - New Construction, Additions and Alterations

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Savings (2026 PV$)
1	-7,051	22,461	15,410
2	-11,996	37,615	25,619
3	-12,188	40,249	28,061
4	-9,072	27,614	18,542
5	-9,828	29,444	19,616
6	-9,011	28,889	19,878
7	-6,270	20,232	13,962
8	-6,793	22,053	15,261
9	-8,086	25,849	17,763
10	-10,056	33,653	23,596
11	-9,394	32,019	22,625
12	-10,373	33,506	23,132
13	-10,182	36,235	26,053
14	-12,521	41,562	29,042
15	-7,154	26,563	19,408
16	-5,168	16,874	11,705

Intentionally blank

Incremental Maintenance and Equipment Costs

The Statewide CASE Team estimated the annual incremental maintenance cost using values calculated during the 2022 U.S. DOE consumer pool heater standards rulemaking. The values were chosen from the table 8.3.4 of the U.S. DOE Consumer Pool Heater Technical Support Document (DOE 2022). The incremental maintenance cost for the 20,000-gallon scenarios as $95 per year and 660,000-gallon pool as $1,236. The larger maintenance cost for the 660,000-gallon pool was due to maintaining more HPPH than the 20,000-gallon pool. The HPPH was assumed to have a design life of 11 years. The HPPH was replaced in year 11 and year 22.

Residual Value

The HPPH residual value was calculated at the end of the 30-year period of evaluation assuming a straight-line depreciation of its cost. The residual value represents the value of the HPPH in year 30 of the analysis assuming it had been installed in year 22. The residual value is a benefit for the cost-effectiveness analysis.

Cost-Effectiveness

The table below presents the cost effectiveness using the same methodology as in the Final CASE Report.

The proposed measure saves money over the 30-year period of analysis relative to the existing conditions and is cost effective in every climate zone.

Table 94: 30-Year Cost-Effectiveness Summary Per Pool – New Construction, Additions and Alterations – Nonresidential (NR) and Residential (R) Prototypes

Climate Zone	*NR* **Benefits Long-term Systemwide** Energy Cost Savings + Other PV Savings [a] (2026 PV$)	*NR* **Costs** Total Incremental PV Costs [b] (2026 PV$)	*NR* **Benefit-to-Cost Ratio**	*R* **Benefits Long-term Systemwide** Energy Cost Savings + Other PV Savings [a] (2026 PV$)	*R* **Costs** Total Incremental PV Costs [b] (2026 PV$)	*R* **Benefit-to-Cost Ratio**
1	89,054	17,416	5.1	38,319	10,982	3.5
2	78,472	17,416	4.5	63,402	10,982	5.8
3	145,811	17,416	8.4	69,401	10,982	6.3
4	63,748	17,416	3.7	46,013	10,982	4.2
5	127,326	17,416	7.3	48,652	10,982	4.4
6	192,883	17,416	11.1	49,295	10,982	4.5
7	202,301	17,416	11.6	34,761	10,982	3.2
8	182,842	17,416	10.5	37,951	10,982	3.5
9	132,699	17,416	7.6	44,100	10,982	4.0
10	128,988	17,416	7.4	58,433	10,982	5.3
11	102,670	17,416	5.9	56,045	10,982	5.1
12	98,988	17,416	5.7	57,292	10,982	5.2
13	116,723	17,416	6.7	64,468	10,982	5.9
14	90,249	17,416	5.2	71,812	10,982	6.5
15	157,971	17,416	9.1	48,143	10,982	4.4
16	40,697	17,416	2.3	29,216	10,982	2.7

a. **Benefits: Long-term Systemwide Energy Cost Savings + Other PV Savings:** Benefits include Long-term Systemwide Energy Cost Savings over the period of analysis (California Energy Commission 2022, 51-53). Other savings are discounted at a real (nominal – inflation) three percent rate. Other PV savings include incremental first-cost savings if proposed first cost is less than current first cost, incremental PV maintenance cost savings if PV of proposed maintenance costs is less than PV of current maintenance costs, and incremental residual value if proposed residual value is greater than current residual value at end of CASE analysis period.

b. **Costs: Total Incremental Present Valued Costs:** Costs include incremental equipment, replacement, and maintenance costs over the period of analysis. Costs are discounted at a real (inflation-adjusted) three percent rate and if PV of proposed maintenance costs is greater than PV of current maintenance costs. If incremental maintenance cost is negative, it is treated as a positive benefit. If there are no total incremental PV costs, the B/C ratio is infinite.