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Final CASE Report - Daylighting

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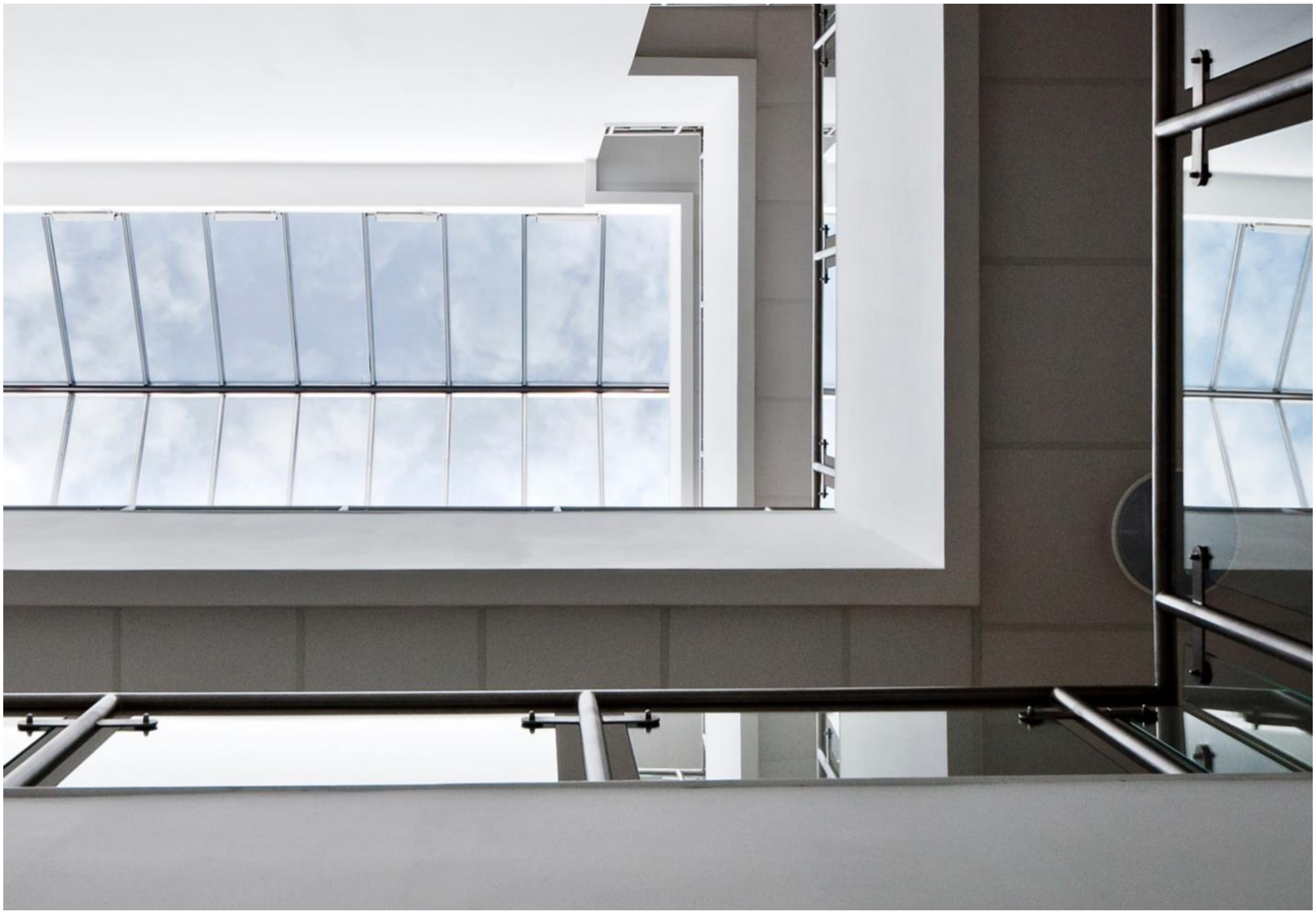
2025 California Energy Code

Daylighting



Nonresidential Lighting

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August 2023

Final CASE Report

CALIFORNIA ENERGY CODES & STANDARDS

A STATEWIDE UTILITY PROGRAM

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Table of Contents

Executive Summary vii

1. Introduction 1

2. Addressing Energy Equity and Environmental Justice 4

- 2.1 General Equity Impacts 4
- 2.2 Specific Impacts of the Proposal 10

3. Measure Description 11

- 3.1 Proposed Code Change 11
- 3.2 Justification and Background Information 11
- 3.3 Summary of Proposed Changes to Code Documents 13
- 3.4 Regulatory Context 14
- 3.5 Compliance and Enforcement 15

4. Market Analysis 17

- 4.1 Current Market Structure 17
- 4.2 Technical Feasibility and Market Availability 19
- 4.3 Market Impacts and Economic Assessments 20
- 4.4 Economic Impacts 25
- 4.5 Fiscal Impacts 30

5. Energy Savings 31

- 5.1 Energy Savings Methodology 31
- 5.2 Per-Unit Energy Impacts Results 46

6. Cost and Cost Effectiveness 52

- 6.1 Energy Cost Savings Methodology 52
- 6.2 Energy Cost Savings Results 52
- 6.3 Incremental First Cost 53
- 6.4 Incremental Maintenance and Replacement Costs 59
- 6.5 Cost Effectiveness 62

7. First-Year Statewide Impacts 67

- 7.1 Statewide Energy and Energy Cost Savings 67
- 7.2 Statewide Greenhouse Gas (GHG) Emissions Reductions 69
- 7.3 Statewide Water Use Impacts 70
- 7.4 Statewide Material Impacts 70
- 7.5 Other Non-Energy Impacts 72

8. Proposed Revisions to Code Language 73

- 8.1 Guide to Markup Language 73
- 8.2 Standards 73

8.3 Reference Appendices 78
8.4 ACM Reference Manual 80
8.5 Compliance Documents 81

9. Bibliography ____ 82

Appendix A: Statewide Savings Methodology ____ 89

Appendix B: Embedded Electricity in Water Methodology ____ 96

Appendix C: California Building Energy Code Compliance (CBECC) Software Specification ____ 97

Appendix D: Environmental Analysis ____ 99

Appendix E: Discussion of Impacts of Compliance Process on Market Actors ____ 103

Appendix F: Summary of Stakeholder Engagement ____ 107

Appendix G: Energy Cost Savings in Nominal Dollars ____ 110

Appendix H: ASHRAE Lighting Schedule ____ 111

List of Tables

Table 1: Scope of Code Change Proposal viii

Table 2: Lighting Distribution Chain 17

Table 3: Market Channels 18

Table 4: Distribution of Indoor Lamps by Control Type and EE/DR Participation 19

Table 5: California Construction Industry, Establishments, Employment, and Payroll in 2022 (Estimated) 20

Table 6: Specific Subsectors of the California Residential Building Industry by Subsector in 2022 (Estimated) 21

Table 7: Specific Subsectors of the California Commercial Building Industry Impacted by Proposed Change to Code/Standard by Subsector in 2022 (Estimated) 22

Table 8: California Building Designer and Energy Consultant Sectors in 2022 (Estimated) 23

Table 9: Employment in California State and Government Agencies with Building Inspectors in 2022 (Estimated) 24

Table 10: Estimated Impact that Adoption of the Proposed Measure would have on the California Commercial Construction 26

Table 11: Estimated Impact that Adoption of the Proposed Measure would have on the California Building Designers and Energy Consultants Sectors 27

Table 12: Estimated Impact that Adoption of the Proposed Measure would have on California Building Inspectors 27

Table 13: Net Domestic Private Investment and Corporate Profits, U.S. 28

Table 14: Space Types, General Lighting Design Illuminance and Power Density 33
Table 15: Estimated Floorspace Impacted and the Composition of Impacted Functional Space Types 43
Table 16: First-year Statewide Lighting Power in Daylit Zones by Climate Zone (kW) | New Construction and Additions 45
Table 17: First-year Statewide Lighting Power in Daylit Zones by Climate Zone (kW) | Alterations 46
Table 18: Full Load Hour (FLH) per Year Consumption of Base Case Lighting System and Lighting Systems in the PSDZ and SSDZ 48
Table 19: Annual Electricity Savings (kWh) and Demand Reductions per Watt of Controlled Lighting – New Construction and Alterations 50
Table 20: Annual Source Energy Savings (kBtu) per Watt of Controlled Lighting – New Construction, Additions and Alterations 51
Table 21: 2026 PV LSC Savings Over 30-Year Period of Analysis – Per Watt – New Construction, Additions and Alterations 53
Table 22: Control Solutions Considered for Implementing two-zone Automatic Daylighting Controls 54
Table 23: Estimated Labor Hours for Implementing the Proposed Code Change 55
Table 24: Estimated California Electrician Labor Rates 56
Table 25: Estimated Acceptance Testing Cost 57
Table 26: Estimated Costs for Implementing the Proposed Code Change – Two-Zone Systems 58
Table 27: Estimated Costs for Implementing the Proposed Code Change – Single-Zone Systems 59
Table 28: Estimated Labor Hours for Maintaining the Proposed Code Change 60
Table 29: Per-Unit Incremental Maintenance and Replacement Costs – Two-Zone Systems 61
Table 30: Per-Unit Incremental Maintenance and Replacement Costs – Single-Zone Systems 61
Table 31: 30-Year Present Value Incremental Costs for Two Zone Daylighting Controls – Controlling Both PSDZ and SSDZ 62
Table 32: 30-Year Present Value Incremental Costs for Single Zone Daylighting Control for – Controlling Either PSDZ Only or SSDZ Only 63
Table 33: 30-Year Cost-Effectiveness Summary Daylighting Controls Most Common Configurations – New Construction, Additions and Alterations 64
Table 34: 30-Year Cost Effectiveness Single Zone Daylighting Controls at 75 Watts, PSDZ only or SSDZ only – New Construction, Additions and Alterations 65

Table 35: 30-Year Cost Effectiveness Single Zone Daylighting Controls at 85 Watts, SSDZ only – New Construction, Additions and Alterations 66
Table 36: Statewide Energy and LSC Impacts – New Construction and Additions 68
Table 37: Statewide Energy and Energy Cost Impacts – Alterations 68
Table 38: Statewide Energy and LSC Impacts – New Construction, Additions, and Alterations..69
Table 39: First-Year Statewide GHG Emissions Impacts 70
Table 40: First-Year Statewide Impacts on Material Use..71
Table 41: Estimated New Nonresidential Construction in 2026 (Million Square Feet) by Climate Zone (CZ)...90
Table 42: Estimated Existing Floorspace in 2026 (Million Square Feet).........................91
Table 43: Estimated New Nonresidential Construction Impacted by Proposed Code Change in 2026, by Climate Zone and Building Type (Million Square Feet) 92
Table 44: Estimated Existing Nonresidential Floorspace Impacted by Proposed Code Change in 2026 (Alterations), by Climate Zone and Building Type (Million Square Feet)..93
Table 45: Percentage of Nonresidential Floorspace Impacted by Proposed Code Change in 2026, by Building Type..94
Table 46: Percentage of Nonresidential Floorspace Impacted by Proposed Measure, by Climate Zone 95
Table 47: First-Year Statewide Impacts on Material Use..102
Table 48: Roles of Market Actors in the Proposed Compliance Process......................104
Table 49: Utility-Sponsored Stakeholder Meetings 108
Table 50: Engaged Stakeholders..109
Table 51: Nominal LSC Savings Over 30-Year Period of Analysis – Per Watt – New Construction and Alterations –Offices, Conference Room, Corridors, Exercise Room, and Multipurpose Room. 110
Table 52: Nonresidential ACM Reference Manual Appendix 5.4B Office Lighting Schedule and Controlled Lighting Schedule With 5 Percent Night Lighting Stripped Off 112
Table 53: Lighting Schedule for ASHRAE 90.1 Office Prototype and Controlled Lighting Schedule with 5 Percent Night Lighting Stripped Off 114

List of Figures

Figure 1: The daylight model for modeling the spaces within the prototypical buildings that are affected by the proposed code change. 34

Figure 2: Daylighting control plot showing relationship between daylighting illuminance and electric lighting illuminance. 36
Figure 3: Electric Light Illuminance Fraction (ELIF) in the middle of acceptable range with 10 percent minimum dimming level versus interior daylight illuminance fraction. 37
Figure 4: Electric Power Fraction (ELPF) versus Electric Light Fraction (ELIF), 12 percent of rated power when dimmed to 10 percent of rated light output. 39

Executive Summary

This CASE Report presents a cost-effective code change proposal that revises automatic daylighting controls exceptions and builds on prior code changes to Title 24, Part 6 approved by the CEC. This report is part of an effort to develop technical and cost-effectiveness information for proposed requirements to create energy-efficient design practices and technologies. This proposal would implement the following changes:

- Adjust the wattage thresholds that apply to the Skylit Daylit Zones (SDZs), Primary Sidelit Daylit Zones (PSDZs), and Secondary Sidelit Daylit Zones (SSDZs).
- Modify Exception 3 of Section 130.1(d) and Section 160.5(b)4D, substituting 75W where 120W appears.
- Restructure the language and move the wattage criteria for triggering automatic daylighting controls to the main requirement, instead of as an exception.
- Require daylit zones with a connected general lighting load that is greater than or equal to 75 watts to implement automatic daylighting controls.

The proposed code changes would be cost effective over the 30-year period for spaces with one or more sidelit daylight zones. In the first year, this proposal is projected to save 27.81 GWh of electricity. The average present value incremental cost across all six control solution types would be $743.74 in total (or $2.50 per square foot) for the daylight model, which is applicable in both PSDZs and SSDZs, such as offices and conference rooms. For spaces with a single sidelit zone (typically a PSDZ without a SSDZ, such as a corridor), the average present value incremental cost is $362.34 in total (or $2.46 per square foot) across four single-zone systems. See Sections 6.3.1, 6.3.2, and 6.4 for a summary.

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's goal is to prepare and submit proposals that would result in cost-effective enhancements to improve energy efficiency and energy performance in California buildings.

The Statewide CASE Team submits code change proposals to the CEC, the state agency that has authority to adopt revisions to Title 24, Part 6. The CEC will evaluate proposals submitted by the Statewide CASE Team and other stakeholders. The CEC may revise or reject proposals. See the CEC's 2025 Title 24 website for information about the rulemaking schedule and how to participate in the process.

Proposal Description

This code change would revise the automatic daylighting controls exceptions. The measure adjusts the wattage thresholds that apply to skylit zones as well as both the Primary Sidelit Daylit Zones (PSDZs) and Secondary Sidelit Daylit Zones (SSDZs). The change rewrites the daylighting controls requirements in Section 130.1(d) and Section 160.5(b)4D. This action would transform the threshold wattage from an exception into a requirement and reduce the threshold for requiring automatic daylighting controls from 120 watts to 75 watts per space by daylit zone type. An exception is provided for the SSDZs when the corresponding PSDZs are not required to implement automatic daylighting controls; in such cases, the threshold for the SSDZs is 85 watts. This revision reflects the appropriate threshold wattage based on the cost of current daylight responsive controls cost of dimming LED (light emitting diode) light sources.

The 120-watt threshold for requiring automatic daylighting controls has been in place for multiple code cycles. It remained unchanged when the basis for indoor lighting power densities was changed to Light Emitting Diodes (LEDs) in the 2019 code cycle. This means the 120-watt threshold now represents significantly a larger daylit area is needed to trigger the requirement for photocontrols. The cost of daylighting controls has dropped, but the primary cost reduction is due to LED general lighting luminaires capable of dimming to 10 percent having no or negligible added costs.

Table 1 summarizes the scope of the proposed changes and which sections of standards, Reference Appendices, Alternative Calculation Method (ACM) Reference Manuals, and compliance documents that would be modified due to the proposed change.

Table 1: Scope of Code Change Proposal

Type of Requirement	Mandatory
Applicable Climate Zones	All
Modified Section(s) of Title 24, Part 6	Section 130.1.(d) and 160.5(b)4D
Modified Title 24, Part 6 Appendices	No proposed changes.
Would Compliance Software Be Modified	No
Modified Compliance Document(s)	No proposed changes.

Market Analysis

The control strategy involved in the proposed code change, automatic daylighting controls, is familiar to all market actors as the requirement has been in place for many code cycles. It has become a standard capability in most lighting control system offerings. In addition, most LED luminaires are already dimmable and can support automatic daylighting controls regardless of space size or connected lighting load. Connected lighting systems or networked lighting controls have further reduced the complexity of implementing the control strategy.

The proposed code change is technically feasible as there are multiple options for implementing automatic daylighting controls in smaller spaces with lower connected lighting power. The control solutions include a standalone daylight sensor, a daylight sensor as part of a room-based or building-wide control system, or luminaire-level lighting controls where a photosensor is integrated into each luminaire. And these options are available as wired, wireless, or a hybrid of wired and wireless systems.

The proposed code change would also align with the most recent revision to the daylight-responsive controls requirements in ASHRAE 90.1, also known as the Addendum O to ASHRAE 90.1-2019. The proposed code change would increase investment in California and result in a net positive impact on jobs. Refer to Section 4.4 for details of the estimated economic impacts.

The Statewide CASE Team discussed the proposed code language with different market actors, including manufacturers, lighting designers, electrical engineers, and members of the ASHRAE 90.1 Lighting Subcommittee, to ensure the requirements are clear and unambiguous. The Statewide CASE Team specifically consulted with manufacturers and manufacturers' sales representative agencies to understand the control solutions that can be used to implement this proposed code change and collect material cost data on those control solutions. The collected cost data played a key role in estimating the incremental cost of the proposed code change. See Appendix F for a summary of stakeholder engagement.

Cost Effectiveness

The proposed code change, based on the energy modeling and incremental cost estimates at the time this report was written, was found to be cost effective for all climate zones where it is proposed to be required. The benefit-to-cost (B/C) ratio of controlling 75 watts of general lighting power with daylighting controls in spaces with both Primary Sidelit Daylit Zones and Secondary Sidelit Daylit Zones as well as spaces with only Primary Sidelit Daylit zones over the 30-year period of analysis ranged between 1.11 and 1.70 depending on the climate zone. With the provided exception for the Secondary Sidelit Daylit Zones where daylighting controls are not required in the corresponding Primary Sidelit Daylit Zones, the B/C ratio of controlling 85 watts of general lighting power would be in the range between 1.03 and 1.47. California consumers and businesses would save more money on energy than they would spend to finance the efficiency measure. See more details in Section 6.

Statewide Energy Impacts: Energy, Water, and Greenhouse Gas (GHG) Emissions, and Embodied Carbon Impacts

The first-year statewide electricity savings for new construction, additions, and alterations combined was found to be 27.76 GWh, and the peak electrical demand reduction was estimated to be 0.114 MW. See Section 7 for more details on the first-year statewide impacts. Section 5.1 contains details on the per-unit energy savings.

Avoided GHG emissions are measured in metric tons of carbon dioxide equivalent (metric tons CO2e). Assumptions used in developing the GHG savings are provided in Section 7.2 and Appendix C of this report.

Compliance Process

The Statewide CASE Team worked with stakeholders to develop a recommended compliance and enforcement process and to identify the impacts this process would have on various market actors. The Statewide CASE Team did not identify any specific issues related to compliance and enforcement that the proposed code change would introduce. The issue common to all automatic daylighting controls remains to be end-users' unfamiliarity of the behaviors resulting from daylighting controls, causing complaints about the controls, and sometimes resulting in the controls being bypassed or disabled. The proposed code change would increase the number of spaces within a building that need to undergo field verification and acceptance testing. Refer to Section 3.5 and Appendix E for additional information.

Addressing Energy Equity and Environmental Justice

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. 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 but is open to receiving feedback and data that may prove otherwise. Please reach out to Yao-Jung Wen (ywen@energy-solution.com) and Marissa Lerner (mlerner@energy-solution.com) for further engagement. Full details addressing energy equity and environmental justice can be found in Section 2 of this report.

1. Introduction

The Codes and Standards Enhancement (CASE) initiative presents recommendations to support the 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's 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 with 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 CEC's 2025 Title 24 website for information about the rulemaking schedule and how to participate in the process.

The goal of this Final CASE Report is to present a code change proposal for revising automatic daylighting controls exceptions. 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 lighting designers, engineers, lighting distributors, lighting manufacturer's sales representative agencies, Title 24 acceptance test technicians and training organizations, building officials, manufacturers, builders, utility incentive program managers, Title 24 energy analysts, and others involved in the code compliance process. The proposal incorporates feedback received during a public stakeholder workshop that the Statewide CASE Team held on February 24, 2023, and May 16, 2023.

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

- Section 2 – Addressing Energy Equity and Environmental Justice presents the potential impacts of proposed code changes on disproportionately impacted populations (DIPs), as well as a summary of research and engagement methods.

- 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 lifecycle 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 Method (ACM) Reference Manual. Generalized proposed revisions to sections are included for the compliance manual and compliance documents.
- 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: ASHRAE Lighting Schedule presents lighting schedule used to model energy savings.

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 community (DAC) 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 Yao-Jung Wen (ywen@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 outreach with CBOs and EEEJ partners. The 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 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 engagement

[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.).

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 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) 6.2 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 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 desired in workplaces, schools, etc., it also has real world health impacts on people's health.

2.1.2.1 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
- Vehicle service

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

Strip Mall

Proposals for the strip mall building type have the potential to create disproportionate impacts. The benefits of strip malls are complex and vary based on factors such as location, economic conditions, and community needs. Rents in strip malls are often more affordable than they would be in heavily trafficked or more upscale areas. Strip malls often serve as affordable business centers for DIPs. Some shop owners indicate strip mall stores feel like “the center of social life” (Ramanathan 2017). 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 costs to secure business locations. Black entrepreneurs are almost three times more likely to lose profitability due to start-up costs compared to white entrepreneurs (Morelix 2016). Increases in cost could disrupt these DIP-owned businesses even more.

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 U.S. Areas 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.

Assembly

While proposals to most assembly buildings will not have a disproportionate impact, some of the buildings such as places of worship, community or recreation centers, homeless shelters used for temporary housing, and libraries, for example could more significantly affect DIPs. Places of worship can be valuable community fixtures for DIPs. Forty-seven percent of Black people and 39 percent of Latinx people report attending religious services weekly, compared to only 32 percent for White people (Pew Research Center 2023). Churches and other community assembly buildings serve as significant spaces for spiritual, cultural, and economic resources for DIPs. Specifically, building types that provide shelter in times of extreme weather events; aid in disaster preparedness; or provide shelter, food, or other resources to those in need would be more likely to result in disproportional impacts. Shelters and churches serve DIP populations. While the costs may increase for this nonresidential building type, the burden of that cost is unlikely to be disproportionate.

Hospital

Increased incremental costs for hospitals can present challenges to jurisdictions with lower income populations where the tax base, funding, and budgets may be more constrained. Proposed measures that impact health and resiliency have the potential to disproportionately impact those who attend or work in hospitals.

Restaurant

Proposals for restaurants could affect DIPs more significantly than the general population, particularly those who work in the foodservice industry, own a small business that is a restaurant, or rely on restaurants for food (especially those living in food deserts). An estimated 23.5 million Americans live in food deserts. Defined as an area with “limited access to a variety of healthy and affordable food” (Chapple n.d.). In these food deserts restaurants can play a role in providing access to more food for DIPs. Access to restaurants with healthy food is also limited for many DIPs in food deserts. In South Los Angeles, neighborhoods with a higher percentage of Black residents only 27 percent of restaurants provided 5 or more healthy options, while in the more affluent West Los Angeles, 40 percent of restaurants offered 5 or more healthy options (Lewis, et al. 2005). Many of California’s restaurants are owned by DIPs, and even more are staffed by DIPs. Of the 150,000 fast food employees in Los Angeles, 9 of 10 are people of color (UCLA Labor Center 2022). Proposals that have high incremental costs and health effects could have notable impacts on DIPs.

Grocery

Proposals for groceries could affect DIPs more significantly than the general population, particularly those who work in grocery buildings, own a small grocery business, or depend upon a specific grocery as a food source in a food desert. An estimated 23.5 million Americans live in food deserts (Chapple n.d.). Defined as an area with "limited access to a variety of healthy and affordable food," food deserts put a significant health burden on DIPs. In California, almost one million people live in food deserts (The Sarah Samuels Center for Public Health Research and Evaluation 2016). Living in a food desert can raise the price of living and cause people to travel further for food. Nearly two-thirds of Californians have reported feeling "very concerned" about paying for their rent with the rising cost of living (Public Policy Institute of California 2022). Even higher prices due to proposed measures and longer distances for food have the potential to harm DIPs. Proposals that impact incremental cost, health, resiliency, and comfort all have the potential to disproportionately impact those working in grocery buildings or relying on them as one of their only food sources in a food desert.

2.2 Specific Impacts of the Proposal

Based on a preliminary review, this proposal is unlikely to have significant negative or positive impacts on DIPs. The Statewide CASE Team does expect impacts on cost from the proposed code change. However, the costs are expected to be modest and outweighed by the benefits. Specifically, energy costs would decrease, which would result in lower utility bills for DIPs.

The Statewide CASE Team does not expect any impact on the health and safety of DIPs, or on their disaster preparedness. The comfort of DIPs is unlikely to be impacted by the proposed code changes.

3. Measure Description

3.1 Proposed Code Change

The proposed code change would adjust the wattage thresholds that apply to the Skylit Daylit Zones (SDZs) as well as the Primary Sidelit Daylit Zones (PSDZs) and Secondary Sidelit Daylit Zones (SSDZs). The key change would modify Exception 3 to Section 130.1(d) and Exception 3 to Section 160.5(b)4D, substituting 75W where 120W appears. In addition, to make the requirement clearer and more concise, this proposal also restructured the language and moved the wattage criteria for triggering automatic daylighting controls to the main requirement instead of as an exception. This change would effectively require daylit zones with a connected general lighting load that is greater than or equal to 75 watts to implement automatic daylighting controls. In SSDZs where automatic daylighting controls are not required in the corresponding PSDZs, i.e., PSDZs have a connected general lighting load less than 75 watts, an exception was provided to require automatic daylighting controls only when the connected lighting load in the SSDZs is 85 watts or greater.

3.2 Justification and Background Information

3.2.1 Justification

The California Energy Code has historically exempted small spaces with minor general lighting energy use from the requirement to use automatic daylighting controls. During the 2019 code cycle, the lighting power allowances have been adjusted to align with the luminous efficacies of LED technologies. However, the wattage criteria for exempting spaces from implementing automatic daylighting controls were not adjusted accordingly. This means the criteria originally designed to exempt small spaces from automatic daylighting control requirements have now been extended to include much larger spaces. Therefore, this measure proposes to recalibrate the wattage threshold for exempting spaces from implementing automatic daylighting controls to align with the underlying efficacies of LED light sources. The proposed measure also aims to align with ASHRAE 90.1 which already updated its wattage thresholds for automatic daylighting controls based on LED technology.

3.2.2 Background Information

Section 130.1(d) (and 160.5(b)4D) of Title 24, Part 6 includes a mandatory requirement that the general lighting in SDZs, PSDZs, and SSDZs must have automatic daylighting controls unless there is less than 120 watts of general lighting installed in these daylit zones. This wattage threshold links the lifecycle savings to the cost of the measure.

This 120-watt threshold has remained unchanged for multiple code cycles while the luminous efficacy of light sources (lumens per watt) has significantly increased since the threshold was established. The indoor lighting power densities (LPDs) were updated in the 2019 version of Title 24, Part 6 to be based on LED technology instead of legacy lighting technology (metal halide, fluorescent, or others), which resulted in LPD values being significantly reduced. In the 2022 code cycle, the Statewide CASE Team proposed to reduce the LPDs once again, but on a less dramatic scale, which was adopted by the CEC. The 120-watt threshold remained unchanged while LPDs were reduced in two consecutive code cycles.

The wattage thresholds for the daylighting controls requirement were developed based on the cost effectiveness of implementing daylighting controls that, under full daylight conditions, reduce lighting power to 35 percent of full power. In the 2022 code cycle, the Statewide CASE Team proposed to update the requirement so that lighting power must be reduced to 10 percent of full power, which aligns with the minimum required control step for LED lighting in accordance with existing mandatory multi-level lighting control requirements in Table 130.1-A. The CEC adopted this update and therefore, daylighting controls would save more energy (larger full load hours per year savings) under the 2022 code than they do when the current threshold was proposed in 2013, thereby making this measure more cost effective.

The National Electrical Manufacturers Association (NEMA) Daylight Management Council recommended alignment with ASHRAE 90.1 to improve compliance with both Title 24, Part 6 and ASHRAE 90.1. The ASHRAE 90.1 Lighting Subcommittee developed a proposal to revise the wattage thresholds for requiring daylight-responsive controls in Section 9.4.1.1. The proposed changes were released for public review in Summer 2020 as Addendum O to ASHRAE 90.1-2019 and were subsequently approved in June 2021. The Addendum O requires automatic daylight-responsive controls with the following wattage thresholds:

1. If the combined lighting power of all general lighting completely or partially within the primary sidelit area is 75 watts or greater, automatic daylight responsive controls are required in the primary sidelit area.
2. If the combined lighting power of all general lighting completely or partially within the primary sidelit area and the secondary sidelit area is 150 watts or greater, then automatic daylight responsive controls are required in the primary sidelit area and the secondary sidelit area.
3. If the combined input power of all general lighting completely or partially within daylight area under skylights and daylight area under roof monitors is 75 watts or greater, then automatic daylight-responsive controls are required in the daylight area.

This proposed code change largely aligns with the revised thresholds in the Addendum O to ASHRAE 90.1-2019. The main difference is the criteria for SSDZs. Instead of evaluating the combined general lighting power of PSDZs and SSDZs, the proposal raises the threshold to 85 watts for SSDZs when automatic daylighting controls are not required in the corresponding PSDZs.

3.3 Summary of Proposed Changes to Code Documents

The sections below summarize how the standards, Reference Appendices, Alternative Calculation Method (ACM) Reference Manuals, and compliance documents would be modified by the proposed change.[3] See Section 8 of this report for detailed proposed revisions to code language.

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: Section 130.1(d) and Exception 3 to Section 130.1(d) as well as Section 160.5(b)4D and Exception 3 to Section 160.5(b)4D.

Specific Purpose: The primary purpose of the changes is to lower the threshold for exempting spaces from requiring automatic daylighting controls. The secondary purpose of the changes is to make the requirements in the code language more concise, less confusing, and practical.

Necessity: These changes are necessary to increase energy efficiency via cost-effective lighting controls.

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

The purpose and necessity of proposed changes to the Nonresidential ACM Reference Manual are described below. See Section 7.4 of this report for the detailed proposed revisions to the text of the ACM Reference Manual.

Section: Section 5.4.5

Specific Purpose: The specific purpose of the changes is to lower the threshold for exempting spaces from requiring automatic daylighting controls.

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

Necessity: These changes are necessary to increase energy efficiency via cost-effective lighting controls.

3.3.3 Summary of Changes to the Nonresidential Compliance Manual

Chapter 5.4.4 of the Nonresidential Compliance Manual would need to be revised. The current threshold of 120 watts used to describe the exemption for automatic daylighting controls would need to be updated to the proposed 75 watts. Additionally, the new exception would need to be added to describe the raised threshold (85 watts) for the Secondary Sidelit Daylit Zones where automatic daylighting controls are not required in the corresponding Primary Sidelit Daylit Zones.

3.3.4 Summary of Changes to Compliance Documents

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

- NRCC-LTI-E – The verbiage of 120 watts in the sample notes provided as an example when the “exempt” options is selected needs to be updated.

3.4 Regulatory Context

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

The Mandatory Indoor Lighting Controls section of Title 24, Part 6 (Section 130.1 and 160.5) includes requirements for lighting control, including automatic daylighting controls in Section 130.1(d) (and 160.5(b)4D). Current requirements specify that general lighting luminaries in, or partially in, SDZs or PSDZs need to be controlled independently and lighting power be reduced to 10 percent when the area receives daylight that is 150 percent or greater than the designed lighting level. Currently, any spaces that have less than 120 watts of general lighting installed in the combined SDZs and PSDZs, or less than 120 watts of general lighting installed in the SSDZs are exempt from this requirement. This proposed measure would update the general lighting wattage threshold for a single daylit zone to 75 watts. Additionally, an exception is provided to raise the threshold to 85 watts for SSDZs when the corresponding PSDZs are not required to implement automatic daylighting controls.

There are no other relevant state or local laws or regulations.

3.4.2 Duplication or Conflicts with Federal Laws and Regulations

There are no relevant federal laws or regulations.

3.4.3 Difference From Existing Model Codes and Industry Standards

The proposed code change aligns with the most recent revision to the daylight-responsive controls requirements in Addendum O to ASHRAE 90.1-2019 Section 9.4.1.1.e.

The proposed code change would be more stringent than the daylight-responsive controls requirements in the 2021 IECC (International Energy Conservation Code), which has the same exception thresholds as ASHRAE 90.1-2019 before Addendum O was approved. The 2024 version of IECC is under development and includes a proposal to reduce the current 150-watt threshold to 75 watts for daylighting responsive controls.

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:

- **Design Phase:** Lighting designer or electrical engineer would design luminaire layout, specify luminaires, determine the daylit zones, and calculate the connected lighting load in each space. The lighting designer or electrical engineer, with the help of energy consultant, would identify automatic daylighting controls on the plans documents for daylit zones where the connected lighting load is 75 watts or greater (or 85 watts or greater in the secondary sidelit daylit zones where the connected lighting load in the corresponding primary sidelit daylit zones is less than 75 watts) and prepare the NRCC forms accordingly.
- **Permit Application Phase:** Plans examiner would check and confirm automatic daylighting controls are identified on the plans and NRCC forms for daylit zones with a connected lighting load of 75 watts or greater (or 85 watts or greater in the secondary sidelit daylit zones where the connected lighting load in the corresponding primary sidelit daylit zones is less than 75 watts).
- **Construction Phase:** Qualified design reviewer would review the plans documents and NRCC forms to make sure they are consistent and that automatic daylighting controls are identified for daylit zones with a connected lighting load of 75 watts or greater (or 85 watts or greater in the secondary sidelit daylit zones where the connected lighting load in the corresponding primary sidelit daylit zones is less than 75 watts). Electrical contractors or installer would

review the design documents and procure, install, and wire the photocontrols and other necessary hardware and accessories according to the design documents and fill out the NRCI forms. Commissioning provider would commission the photocontrols based on the design documents, specifically the control intent narratives, sequence of operations, and code requirements.

- **Inspection Phase:** Acceptance test technician would review the plans documents for daylit zones, perform automatic daylighting controls acceptance testing in daylit zones with a connected lighting load of 75 watts or greater (or 85 watts or greater in the secondary sidelit daylit zones where the connected lighting load in the corresponding primary sidelit daylit zones is less than 75 watts), and file the NRCA forms. Building inspector would verify automatic daylighting controls are identified for daylit zones with a connected lighting load of 75 watts or greater (or 85 watts or greater in the secondary sidelit daylit zones where the connected lighting load in the corresponding primary sidelit daylit zones is less than 75 watts) in approved drawings and documents.

Changes to the compliance process that has been in place for over a decade would be minimal. Instead of daylit zones with a connected lighting load of 120 watts or greater, there would be daylit zones with a connected lighting load of 75 watts or greater (or 85 watts or greater in the secondary sidelit daylit zones where the connected lighting load in the corresponding primary sidelit daylit zones is less than 75 watts).

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 held on February 24, 2023.

The market for automatic daylighting control solutions, including luminaire-level lighting controls (LLLCs), wired and wireless photocontrols, is well established in the United States (U.S.). Table 2 summarizes the market actors in the commercial lighting distribution chain.

Table 2: Lighting Distribution Chain

Market Actor	Core Function
Manufacturers	Production
Wholesale Distributors	Distribution of product, logistics, financing
Manufacturer Representatives	Sales generation
Lighting Designers and Electrical Engineers	Specification of control functionalities and sequence of operations for the projects and sometimes the exact product
Electrical Contractors	Product procurement and installation
Commercial End-Users	Decision maker

A 2015 study conducted by Bonneville Power Administration characterized four distribution channels used by manufacturers to sell lighting products to end-users. The four channels include wholesale distribution, retail, online only, and direct distribution. Furthermore, both independent and in-house manufacturing representatives act as brokers for deals, thus playing a key role in the distribution chain (Bonneville Power Authority 2015). Table 3 summarizes the key points about each distribution channel.

Table 3: Market Channels

Distribution Channel	Description
Wholesale Distribution	Dominant channel Not all inventory is physically stored at distributor site, some manufactures "drop-ship" directly from factory to project site
Retail	Selling products through traditional retail facilities
Online Only	Selling only through websites and shipping directly from a central warehouse Offering minimal customer service
Direct	Smallest channel used by large customers Product direct to consumer without use of third-party representatives

Companies that offer lighting control solutions that could be used to comply with the proposed requirements include, but are not limited to, Acuity Brands, Aleo Lighting, Autani, Avi-On Labs, Cooper Lighting Solutions, Crestron Electronics, Current, Digital Lumens, Enlighted, Keystone Technologies, Ledvance, Leviton, Litetronics, Legrand/WattStopper, Lutron, Maxlite, RAB Lighting, Signify, and Silvair. The U.S. Energy Information Administration (EIA) conducted the 2018 Commercial Buildings Energy Consumption Survey (CBECS). According to the survey, the adoption of daylighting controls is estimated at two percent of the U.S. buildings or seven percent of total floor area, since larger buildings are more likely to have daylighting controls.

In a U.S. Department of Energy (DOE) study released in 2016, 140 sources of published literature were reviewed to assess market penetration of and energy savings from lighting controls. This study estimated that for the 2015 installed lighting stock[9], daylighting controls were in less than one percent of installed fixtures in the U.S. commercial lighting stock.

The 2014 California Commercial Saturation (CSS) survey conducted by Itron and prepared for the California Public Utilities Commission, collected "information on the distribution of interior lamps by control type and the business's participation in Investor Owned Utility (IOU) Energy Efficiency (EE) lighting, EE lighting control, and Demand Response (DR) registration" (Itron, Inc. 2014). The study found that "participants have a statistically significant smaller share of their lamps manually controlled than non-participants and a higher share of their lamps controlled by Emergency Management Systems (EMS), occupancy sensors, motion sensors, photocells, and time clocks than non-participants" (Itron, Inc. 2014).

Table 4 describes the percentage of distribution of interior lamps with daylighting controls by business participants in IOU Energy Efficiency and Demand Response Programs. The data shows that few businesses utilize daylighting and other controls unless they participate in IOU Energy Efficiency and Demand Response Programs. Those businesses that utilize lighting control programs have the highest rate of adoption of daylighting and other controls. The data is based on an analysis of 1,730 surveyed sites.

Table 4: Distribution of Indoor Lamps by Control Type and EE/DR Participation

Control Type	Non-Participants	EE Lighting Participants	EE Lighting Control Participants	DR Participants
Daylighting and Other	0.1%	1.4%	2.9%	2.1%

Source: (Itron, Inc. 2014)

Although the 2018 CBECS, 2016 U.S. DOE study, and the 2014 CSS survey found various levels of adoption of daylighting controls, all studies demonstrate that daylighting controls have a low penetration rate across the U.S. and reveal an opportunity for energy savings by extending controls requirements to new spaces.

4.2 Technical Feasibility and Market Availability

The Statewide CASE Team evaluated the relationship between the area of a daylit zone and installed wattage using the 2016 lighting power density (LPD) values, which are based on legacy technology, and the 2022 LPD values, which have been based on LED technology since the 2019 code cycle. When LPDs were updated for the previous two code cycles, the 120-watt threshold was not updated to reflect new efficacies, and the size of daylit zones that are exempt from automatic daylighting controls effectively increased. Using legacy lighting technology LPDs, the 120-watt threshold corresponds to a lighting zone size in the range of 120 to 160 $feet^2$. Using 2022 LPDs, the 120-watt threshold corresponds to lighting zones that are in the range of 170 to 240 $feet^2$. The proposed 75-watt threshold will realign the daylighting control requirements, so controls are required in zone sizes similar to the 2016 code cycle.

Automatic daylighting controls have been a mandatory lighting control requirement for several code cycles, and market actors already have the knowledge on specifying, procuring, installing, commissioning, and testing them. The proposed measure would not require any of the market actors to acquire additional knowledge or meaningfully change practice. Occupants in daylit zones could still sometimes be confused about or dislike how the light level of overhead lighting is adjusted by the automatic daylighting controls in response to daylight. The Statewide CASE Team identified this as the result of lack of education and exposure like the use of occupant sensor in the early days, and this should be gradually resolved as automatic daylighting controls become a norm in all daylit spaces and LEDs are capable of smooth dimming.

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 5). 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 5: 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 revising automatic daylighting controls exceptions would likely affect commercial builders as well as builders of multifamily residential and industrial buildings but would not impact firms that focus on construction and retrofit of utility systems, public infrastructure, or other heavy construction. The effects on the residential, commercial, and industrial building industry would not be felt by all firms and workers, but rather would be concentrated in specific industry subsectors. Table 6 shows the residential building subsectors and Table 7 shows the commercial building subsectors the Statewide CASE Team expects to be impacted by the changes proposed in this report.

It is expected that builders would not be impacted significantly by any one proposed code change or the collective effect of all the proposed changes to Title 24, Part 6. Builders could be impacted by changes in demand for new buildings and construction costs. Demand for new buildings is driven more by factors such as the overall health of the economy and population growth than the cost of construction. The cost of complying with Title 24, Part 6 requirements represents a small portion of the total building value. Increasing the building cost by a fraction of a percent is not expected to have a significant impact on demand for new buildings or the builders' profits.

Builders would need to invest in training and education to ensure the workforce, including designers, acceptance technicians, engineers, and contractions know how to comply with the proposed requirements. Workforce training is not unique to the building industry and is common in many fields associated with the production of goods and services. Costs associated with workforce training are typically accounted for in long-term financial planning and spread out across the unit price of many units to avoid price spikes when changes in designs and/or processes are implemented.

The Statewide CASE Team's estimates of the magnitude of these impacts are shown in Section 4.4 Economic Impacts.

Table 6: Specific Subsectors of the California Residential Building Industry by Subsector in 2022 (Estimated)

Residential Building Subsector	Establishments	Employment	Annual Payroll (Billions $)
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 Electrical Contractors	7,857	48,366	3.3

Source: (State of California n.d.)

Table 7: 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 Electrical Contractors	3,137	74,277	7.0

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 8 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 of the Revise Automatic Daylighting Controls Exception measure to affect firms that focus on multifamily residential and nonresidential construction.

There is not a North American Industry Classification System (NAICS)[4] 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.[5] It is not possible to determine which business

[4] 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.

[5] 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.

establishments within the Building Inspection Services sector are focused on energy efficiency consulting. The information shown in Table 8 provides an upper bound indication of the size of this sector in California.

Table 8: 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

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

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 Estimating Impacts

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.

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

This measure would result in automatic daylighting controls implemented in more spaces. Consequently, manufacturers and distributors would sell more components necessary for implementing automatic daylighting controls, including photosensors, photocontrols, room controllers, gateways, and cables.

4.3.6 Impact on Building Inspectors

Table 9 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 9: 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, Employment Development Department n.d.)

- 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.
- 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 revising automatic daylighting controls exceptions 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 revising automatic daylighting controls exceptions 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,[6] 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

[6] 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.

codes. In all aspects 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.

Adoption of this code change proposal would result in relatively modest economic impacts through the additional direct spending by those in the commercial building industry, architects, energy consultants, and building inspectors. The economic impacts presented herein are based on the preliminary cost information for this proposed code change collected so far and will be updated in the Final CASE Report when the cost data collection and analyses are fully completed. Nevertheless, the Statewide CASE Team does not expect the final economic impacts to deviate from this preliminary estimate in any meaningful way. 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 10: Estimated Impact that Adoption of the Proposed Measure would have on the California Commercial Construction

Type of Economic Impact	Employment (Jobs)	Labor Income (Million)	Total Value Added (Million)	Output (Million)
Direct Effects (Additional spending by Commercial Builders)	204.1	$15.85	$18.32	$31.21
Indirect Effect (Additional spending by firms supporting Commercial Builders)	49.9	$4.32	$6.78	$12.48
Induced Effect (Spending by employees of firms experiencing "direct" or "indirect" effects)	84.9	$5.79	$10.37	$16.51
Total Economic Impacts	**338.9**	**$25.97**	**$35.47**	**$60.19**

Source: Statewide CASE Team analysis of data from the IMPLAN modeling software.[7]

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

Table 11: 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)	8.3	$0.91	$0.90	$1.43
Indirect Effect (Additional spending by firms supporting Bldg. Designers & Energy Consultants)	3.3	$0.27	$0.38	$0.61
Induced Effect (Spending by employees of firms experiencing "direct" or "indirect" effects)	5.0	$0.34	$0.61	$0.97
Total Economic Impacts	**16.7**	**$1.53**	**$1.89**	**$3.01**

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

Table 12: 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)	0.8	$0.09	$0.11	$0.13
Indirect Effect (Additional spending by firms supporting Building Inspectors)	0.1	$0.01	$0.01	$0.02
Induced Effect (Spending by employees of Building Inspection Bureaus and Departments)	0.4	$0.03	$0.05	$0.08
Total Economic Impacts	**1.3**	**$0.13**	**$0.17**	**$0.24**

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 increase in design, installation, commissioning, acceptance testing, and inspection effort, 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.[8] 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).[9] As Table 13 shows, 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 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 13: 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	**-**	**-**	**26**

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

[8] 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.

[9] 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.

The Statewide CASE Team estimates that the sum of proposed code changes in this report would increase in investment in California:

$$Change\ in\ Proprietor\ Income \times 0.26 = \$1{,}708{,}698$$

4.4.5 Incentives for Innovation in Products, Materials, or Processes

The proposed code changes are not expected to have a significant impact on the emerging trends within the lighting industry.

4.4.6 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 California's General Fund, any state special funds, or local government funds.

4.4.6.1 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. The proposed code change is not expected to have any significant impact on state buildings. Any impact that could occur due to new construction, additions, or alterations have been found to be cost effective.

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 an added 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 3.5 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.

4.4.7 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. The proposed changes are not known or expected to result in impacts on specific persons. Refer to Section 2 for more details addressing energy equity and environmental justice.

4.5 Fiscal Impacts

4.5.1 Mandates on Local Agencies or School Districts

There are no relevant mandates to local agencies or school districts. The proposed code change would not result in the creation of new jobs or revenue.

4.5.2 Costs to Local Agencies or School Districts

There are no costs to local agencies or school districts. The proposed code change would not result in the creation of new jobs or revenue.

4.5.3 Costs or Savings to Any State Agency

There are no costs or savings to any state agencies. The proposed code change would not result in the creation of new jobs or revenue.

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

There are no additional non-discretionary costs or savings to local agencies. The proposed code change would not result in the creation of new jobs or revenue.

4.5.5 Costs or Savings in Federal Funding to the State

There are no costs or savings to federal funding to the state. The proposed code change would not result in the creation of new jobs or revenue.

5. Energy Savings

The Statewide CASE Team gathered stakeholder input to inform the energy savings analysis. 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 developed energy use estimates for both the Standard Design and the Proposed Design. The Standard Design represents the geometry of the proposed design with a defined set of features that result in an energy budget that is minimally compliant with 2022 Title 24, Part 6 code requirements. Features used in the Standard Design are described in the 2022 Nonresidential ACM Reference Manual. The Proposed Design represents the same geometry as the Standard Design, but it assumes the energy features that conform with the proposed code change.

For both the Standard Design and Proposed Designs, the Statewide CASE Team used the lighting power densities (LPDs) specified in 2022 Title 24, Part 6 if using the area category method (Table 140.6-C) for the space types analyzed. In the Standard Design, it was assumed that there are no automatic daylighting controls. In the Proposed Design, it was assumed that there are automatic continuous daylighting dimming controls with minimum lighting and power factors of 0.1 for the PSDZ and SSDZ. This is equivalent to meeting the 2022 Title 24, Part 6 automatic daylighting controls requirement of dimming to 10 percent of the total design power when daylight is abundant.

Office areas, conference rooms, and corridors are the areas the Statewide CASE Team assume will be most affected by this measure. Other spaces that are associated with specific building types and are also likely to be impacted by the proposed code change include multipurpose rooms, lobbies, exercise areas, small dining areas, transaction areas, and retail areas. The Statewide CASE Team simulated the energy impacts in every climate zone and applied the climate-zone specific Long-term Systemwide Cost hourly factors when calculating energy and energy cost impacts.

5.1.2 Energy Savings Methodology per Prototypical Space

The Statewide CASE Team quantifies the per-unit energy savings expected from the proposed code change in several ways.

First, the site energy savings were calculated by fuel type. Electricity savings were measured in terms of both energy usage and peak demand reduction. This analysis considers only the lighting energy savings from expanded use of daylighting controls and does not calculate interaction effects with heating and cooling loads which are small.

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.[10] 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 CO2 emissions.

The Statewide CASE Team estimated LSC energy, source energy, electricity, natural gas, peak demand, and GHG impacts by simulating the proposed code change in Ray Tracing software and spreadsheet analysis.

5.1.2.1 Modeling of the Daylighting Condition for the Impacted Spaces within the Prototypical Buildings

The hourly energy savings from daylighting controls was calculated by simulating the hourly daylight illuminance values at the far side of the primary and secondary sidelit zones for all hours of the year in a prototypical space and calculating the energy consumption of the controlled luminaires using a spreadsheet model that calculates the electric lighting reduction in response to daylight and its corresponding reduction in electrical usage. The simulation of daylight illuminance in the interior of the prototypical space was accomplished using the LightStanza front end to Radiance – a backwards ray-tracing program that is considered to be one of the more accurate ways of simulating daylighting in buildings. This method was used instead of modelling the space with EnergyPlus whole building energy simulation which has a less accurate daylighting simulation (split-flux), but which also considers the interaction effects with Heating, Ventilation, and Air Conditioning (HVAC) heating and cooling loads. Reducing electric lighting energy consumption during the day in response to daylight reduces internal gains. This reduction in internal gains increases heating loads and decreases cooling loads. Work by Sezgen and Koomey (1998) found that the overall interaction

[10] See hourly factors for Source Energy, LSC, and GHG emissions at https://www.energy.ca.gov/files/2025-energy-code-hourly-factors

effects in large office buildings were small with a net 0.02 kWh reduction in HVAC energy per 1 kWh reduction in lighting energy. In comparison, the error associated with using the native split flux model in EnergyPlus as compared to Radiance has been reported to be around 20 percent. As a result, this analysis is based on a lighting energy only calculation with the understanding that HVAC interaction effects are small and would likely increase energy savings from daylighting controls, so the calculation method is slightly conservative.

The Statewide CASE Team developed a daylight model to evaluate the illuminance levels within a space from daylight. The model is intended to identify when there is sufficient daylight during each daytime hour that the electric lighting can be dimmed. The space characteristics are typical of those found in an office space, conference room, or medium size room with 75 watts to 120 watts of power in the daylit zones. The model consisted of a 16-foot wide by 18-foot-deep space with a 9-foot ceiling height as depicted in Figure 1. Standard interior reflectance was used for the ceiling (80 percent), walls (50 percent), and floor (20 percent). The daylight model is agnostic to space types, the energy impact from automatic daylighting controls for a specific space type can be derived by applying a calculation algorithm that is a function of simulated daylighting values relative to the general lighting design illuminance for the space type. This is multiplied by a lighting schedule that is a function of the occupancy of the space type and the assumed controls of the space (occupancy sensors, manual controls timeclocks etc.). The lower the design illuminance, the larger the daylighting controls savings fraction.

Table 14: Space Types, General Lighting Design Illuminance and Power Density

Space Types	General Lighting Design Illuminance (lux)	IES Reference Standard	General Lighting LPD (W/ft^2)
Office	300	RP-10	0.60
Conference Room	300	RP-10	0.75
Multipurpose Room	300	RP-3	0.80
Corridor	50, 100[a]	RP-10	0.40
Lobby	150	RP-10	0.50[b]
Exercise Room	400	DG-25	0.50

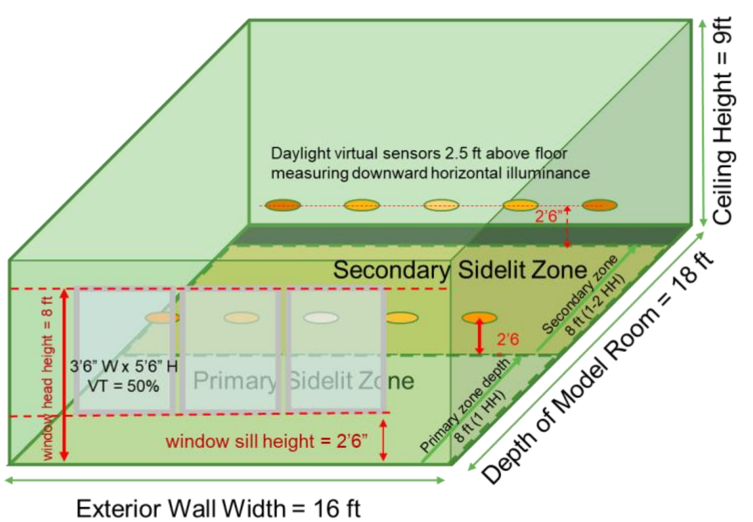
a. IES recommended illuminance for corridors is 50 lux, but 100 lux was used to minimize adaptation between corridor and other spaces.

b. The actual general lighting allowance is 0.7 W/ft^2, which accounts for focal and decorative lighting in addition to general lighting.

The simulated space was designed to be representative of many of the medium-sized spaces in nonresidential buildings where the connected lighting load in the daylit zones would be between 120 watts (the current threshold) and 75 watts (the proposed threshold). This daylight model includes three windows that are three feet and six inches wide by five feet and six inches tall. The windows are located adjacent to each other at the center of an exterior wall. The window head height is eight feet, and the windowsill height is placed at two feet and six inches. The window placement and dimensions are selected to maintain a 40 percent net window-to-wall ratio (not including wall area exterior to the plenum) to align with a typical office or commercial building envelope.[11]

The windows are assigned a 50 percent visible transmittance, a little higher than the 40 percent minimum prescriptive visible transmittance prescriptively required by Section 140.3 of Title 24, Part 6. For the purposes of this simulation, blinds were set to 100 percent open each day to minimize potential errors if the blind control interfered with the daylight analysis. Earlier studies have found that blinds are predominantly left open (Heschong Mahone Group 2012, Nezamdoost, Mahic and Van Den Wymelenberg 2018).

The PSDZ covered the entire width of the space and extended eight feet into the space from the window. The SSDZ also covered the entire width of the space and was located eight feet to 16 feet from the window. Calculation points were placed two feet and six inches above the floor – typical of a standard work plane – and spaced two feet apart. Two additional rows of calculation points were located at the back of each daylit zone. These additional rows were the key points utilized in the daylight analysis to determine if there was sufficient daylight within the entire PSDZ or SSDZ to dim the electric lighting.



- Daylight simulated with LightStanza front-end to Radiance ray tracing
- Daylight illuminance for control
  - Average of 5 sensors at rear of primary and secondary zone
  - 2.5 feet above finished floor
- Model configuration designed for spaces impacted by change from 120 W to 75 W threshold
  - 16' x 18' x 9' (288 ft^2)
- Surface reflectances: Ceiling 80%, Wall 50%, Floor 20%
- Ground reflectance: 0%
- Windows:
  - Three: 3'-6"W by 5'-6"H
  - Visible transmittance = 50%

Figure 1: The daylight model for modeling the spaces within the prototypical buildings that are affected by the proposed code change.

[11] With a 12-foot floor to floor height (3-foot plenum height) this design is representative of a 30% window to wall ratio. This analysis is conservative as designs with the prescriptive maximum WWR of 40% would be saving more energy with daylighting controls.

The daylight model was evaluated using LightStanza,[12] which is a calculation software that acts as a graphic user interface for Radiosity. This software uses raytracing to quantify the amount of daylight passing through a specific point (e.g., a window) in a specific direction. Raytracing considers reflection, refraction, and light scattering within a space to provide accurate daylight simulations. The ground plane outside of the simulated geometry was given a conservatively low reflectance of zero percent to offset the amount of shading that might occur from surrounding buildings. The LightStanza model used CEC weather files for each of the 16 Title 24 climate zones with hourly values of direct beam and diffuse illuminance to more accurately calculate hourly daylight illuminances based upon actual sky conditions in each climate zone.

The Statewide CASE Team performed a daylight analysis within the model for every daytime hour of the year. The daylighting condition in the daylight model was simulated with the window oriented in all four cardinal directions in each of the 16 climate zones, totaling 64 different scenarios. This allowed the Statewide CASE Team to identify the average hourly illuminance levels at the back of the primary and secondary sidelit zones to determine how much the electric lighting would be dimmed in response to daylight in each of these zones.

5.1.2.2 Electric Lighting Energy Savings Calculation for the Daylight Model

The response of the electric lighting controls to daylight illuminance levels in the rear of the primary and secondary sidelit zones is calculated to be representative of a daylighting control specified and installed in accordance with Section 130.1(d) *"Automatic daylighting controls"* of Title 24, Part 6, and the settings confirmed as meeting the code intent by successfully passing the Nonresidential Appendix NA7.6.1 *"Automatic Daylighting Controls Acceptance Test."*

Title 24, part 6 Section 130.1(d)3 requires:

> *B. For each space, ensure the combined illuminance from the controlled lighting and daylight is not less than the illuminance from controlled lighting when no daylight is available;*
>
> *C. For areas other than parking garages, ensure that, when the daylight illuminance is greater than 150 percent of the illuminance provided by the controlled lighting when no daylight is available, the controlled lighting power in that daylight zone shall be reduced by a minimum of 90 percent;*

These requirements are reflected in the control plot shown in Figure 2 below. The lighting system is given some leeway to implement daylighting controls. The requirements are designed to maintain amenity (light levels do not fall below the design illuminance of the electric lighting system) while saving energy. The leeway indicated by

[12] https://lightstanza.com/

the acceptable range is to ensure the requirements are achievable as no control works perfectly. So long as the system is not over-dimming and making the space too dark (combined daylight and electric light illuminance is not less than design illuminance) or under-dimming and being fully dimmed to 10 percent or lower when daylight is 150 percent of the design illuminance, the system complies.

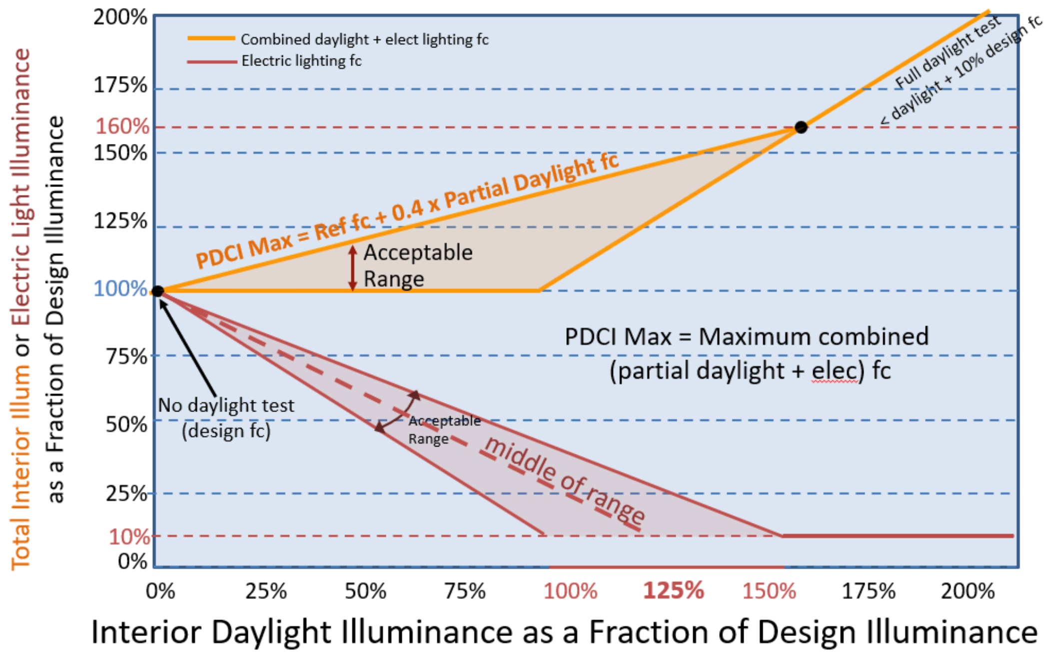


Figure 2: Daylighting control plot showing relationship between daylighting illuminance and electric lighting illuminance.

The safest approach to implement automatic daylighting controls would be to set the control response close to the middle of the acceptable dimming range (i.e., fully dimmed when daylight in the space is 125 percent of design illuminance). This typical control response is shown as the dashed red line in the middle of the red electric lighting control range. In this manner, if the control errs by slightly over-dimming or slightly under-dimming, the control will still pass the acceptance tests as the slight error will not cause the control to be outside of the acceptable range.

Thus, the Statewide CASE Team made use of the assumption that the controls would be linearly interpolating between 100 percent electric light output at 0 percent daylight contribution, and 10 percent electric light output when daylight in the space is 125 percent of the design illuminance. This would reflect customary practice and is halfway between a control that maximizes energy savings while the space does not drop below design illuminance and a minimally compliant control that is fully dimmed when daylight in the space is 150 percent of design illuminance.

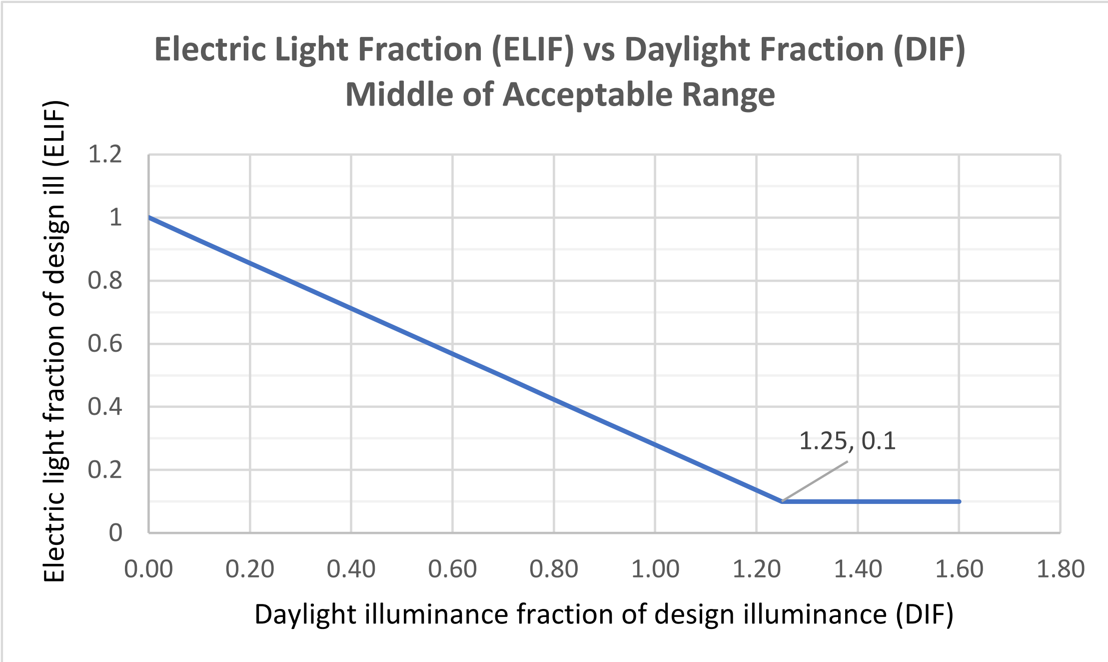


Figure 3: Electric Light Illuminance Fraction (ELIF) in the middle of acceptable range with 10 percent minimum dimming level versus interior daylight illuminance fraction.

Figure 3 illustrates the hourly electric light fraction of design illuminance, $ELIF_h$, with respect to daylight illuminance as a fraction of design illuminance, DIF_h. This relationship can be quantified as follows in Equation 1.

$$ELIF_h = max\left(1 - \frac{0.9}{1.25} DIF_h, 0.1\right)$$

Equation 1

Where:

DIF_h is the hourly interior daylight illuminance as a fraction of the design illuminance (Equation 2).

The slope of -0.9/1.25 reflects that electric lighting is dimmed by 90 percent when the interior daylight level is 125 percent of the design illuminance level.

The value of this equation never falls below 0.1 as the code requirement is to dim by at least 90 percent, thus when there is full daylighting in the space, electric lights can provide up to 10 percent of full light output.

$$DIF_h = \frac{Daylight\ Illuminance_h}{Design\ Illuminance}$$

Equation 2

Where:

Daylight $Illuminance_h$ is the hourly daylighting illuminance from the raytracing daylighting analyses averaged for the five virtual (simulated) light sensors at the opposite side of the primary and secondary sidelit zones from the windows.

Design Illuminance is the average illuminance provided by the general lighting system when there is no daylight in space.

It should be noted that the task illuminance values are used as a proxy for general lighting illuminance. Often the general lighting system is actually providing a mixture of the relatively low light levels needed for circulation lighting and some of the task lighting with the full task illuminance provided by a task lighting system. As a result, this analysis is conservative; actual general lighting design illuminance is often lower than the task illuminance, and a greater fraction of general lighting power will be reduced than calculated here.

The hourly electric light power fraction, $ELPF_h$, is determined based on $ELIF_h$ in Equation 1. ELPF represents the fraction or percentage of electric lighting power required to produce electric light level to result in the designed illuminance at the reference. This assumes a linear relationship between electric lighting power and electric light output – between the minimum power and light point when fully dimming, and the 100 percent power and 100 percent light output when the light is operating at its rated power and light.

$$ELPF_h = Min\ Power + (ELIF_h - Min\ Light) \times \frac{(1 - Min\ Power)}{(1 - Min\ Light)}$$

Equation 3

Where:

Min Power is the fraction of rated power at the minimum light output;

Min light is the fraction of rated light output at the minimum light output.

Typically, LEDs are assumed to consume power proportional to their light output. Thus, if a LED is dimmed to 40 percent of light output, it is assumed the LED consumes 40 percent of rated power. In other words, the LED is assumed to have a constant efficacy across its entire dimming range. To be slightly more conservative in calculating savings, the Statewide CASE Team assumed that the minimum fraction of lighting power is 12 percent for an LED luminaire capable of dimming to a minimum of 10 percent of light output. There is not much data available about this key performance characteristic, but the Statewide CASE Team did find a limited amount of data that indicated that there was approximately a 2 percent offset in lighting power at the minimum light output point for LED luminaires.

$$ELPF_h = 0.12 + (ELIF_h - 0.1) \times \frac{(1 - 0.12)}{(1 - 0.1)}$$

Equation 4

This linear interpolation of fraction of rated power to fraction of rated light is shown in Figure 4.

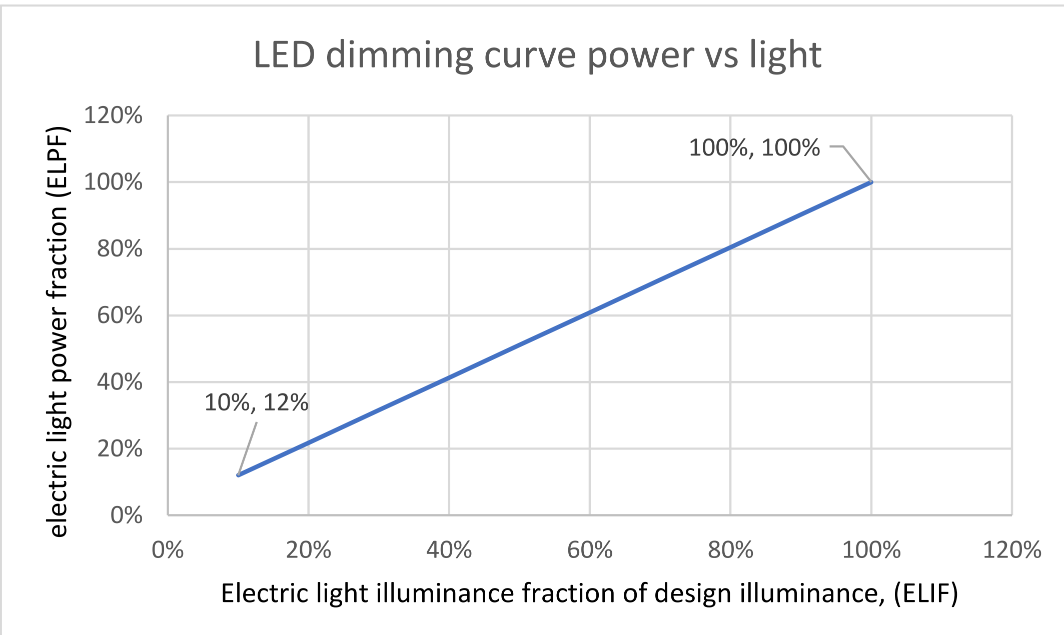


Figure 4: Electric Power Fraction (ELPF) versus Electric Light Fraction (ELIF), 12 percent of rated power when dimmed to 10 percent of rated light output.

By following Equation 1 through Equation 4, the hourly simulated daylight in the modeled space (DIF_h) is the basis of calculating the hourly fraction of light output of electric lighting in the daylight zones ($ELIF_h$) which in turn leads to the hourly fraction of electric power consumed by the controlled lighting ($ELPF_h$). However, electric lighting is not energized every daylit hour of the day. Spaces may be vacated during some portions of daytime hours and lights are turned off manually or by automatic controls. Thus, the savings from daylighting controls are multiplied by the probability that lights are on during that time.

The Statewide CASE Team modeled the effects of occupant sensing controls based on the lighting schedules provided in the ASHRAE 90.1 prototype score cards for the large office building prototype (see Appendix H for more details on the schedule and why it was utilized). In looking at the schedule, there is a background value of five percent lighting energy consumed even when the occupancy schedule is zero percent. This is likely representing “night lighting” or egress lighting for the space. As shown in Equation 5, the Statewide CASE Team subtracted five percent from the total lighting schedules to describe the probability of lighting that is controlled, CLS, based on the assumption that this five percent of lighting is uncontrolled.

$$CLS_h = ALS_h - 0.05$$

Equation 5

Where:

CLS_h is the hourly schedule of controlled lighting as a fraction of full occupancy;

ALS_h is the hourly schedule of all lighting as a fraction of full occupancy, including uncontrolled “night lighting” from ASHRAE prototype score cards.

After applying these reduced schedules to the lighting reduced by automatic daylighting controls, five percent of night lighting was added back onto to each hour’s energy consumption. This total normalized energy consumption is shown Table 18 as full load hours. Full load hours have units of Wh/year per watt or hours per year at rated power.

$$FLH = \sum_{h=1}^{8,760} [CLS_h \times ELPF_h + 0.05]$$

Equation 6

The base case with no daylighting controls has an electric lighting power fraction, ELPF in Equation 3, equal to one for all hours so that the full load hours is simply the lighting schedule of all lighting, ALS, including night lighting over the course of the year. The full load hours for the base case are, therefore, the summation expressed in Equation 7. The proposed daylighting controls case has a year’s worth of hourly electric lighting power fractions, $ELPF_h$, that are reduced based on the amount of daylight modelled into the rear of the primary and secondary zones.

$$FLH = \sum_{h=1}^{8,760} ALS_h$$

Equation 7

Since full load hours have units of Wh/year per watt, dividing them by 1,000 will represent energy savings in terms of kWh/year per watt of controlled lighting.

Full load hours of energy savings, and equivalently, annual energy savings per watt of lighting power, from automatic daylighting controls are the difference between the two summations above. The Statewide CASE Team has presented the normalized energy savings first in terms of full load hours per year as this is the format that is most recognizable to people who evaluate savings of daylighting controls. The full load hours savings fraction is not obscured by the wattage of the system, or the fraction of the building being controlled but is the fraction of lighting power reduction in the primary and secondary sidelit zones.

The equations for ELIF and ELPF are non-linear, and it would not be appropriate to average the illuminance results for various orientations prior to calculating the building energy savings. Therefore, the energy consumption was calculated by the daylit zones for each orientation and the PSDZ and SSDZ separately. To do otherwise would be to overestimate energy savings. The PSDZ would be saturated (above illuminance setpoint and thus dimmed to minimum) much of the time. If these zones with excess daylight were averaged either with the SSDZ or with other building orientations with less daylight, the average including the excess daylight would be applied to the other zones with less than full daylighting – something that does not actually happen. However, the energy results can be averaged for all four orientations as this is just an area weighted energy savings because the model has equal areas (corresponding to equal probabilities) in each orientation.

Savings for primary and secondary sidelit zones are reported separately because the incremental cost of adding a second control zone is less than the cost of adding the first control zone. There are fixed costs with adding any control zone to a room with a lesser amount of variable costs associated with adding additional control zones. This separation of primary and secondary energy savings and energy cost savings provides the detail needed to evaluate cost effectiveness for different combinations of primary and secondary zones.

Per-unit energy impacts are presented in full load hour savings, hence the annual energy savings per watt, separately for the primary sidelit zone, the secondary sidelit zone, and the combined primary and secondary sidelit zones for each space type affected by the proposed code change. The per-watt peak demand impacts, GHG impacts, and source energy impacts are subsequently derived from the per-watt energy impacts.

The per-watt impacts for the combined PSDZ and SSDZ would be most typical as most applications have both daylit zones. The per-watt impacts for the primary sidelit zones represent impacts in spaces with not much depth such as corridors. The per-watt impacts for the secondary sidelit zone would be a rare case but occasionally occurs depending on the lighting design.

The Statewide CASE Team applied the same schedule modified from the ASHRAE 90.1 scorecards for the large office building prototype to the primary space types that would be impacted by the code change, including offices, conference rooms and corridors, regardless of the building type.

5.1.2.3 Scaling the Electric Lighting Energy Savings for the Impacted Spaces within the Prototypical Buildings

The Statewide CASE Team estimated the portion of the floorspace within each prototype building that would be impacted by the proposed code change as listed in the second and third column of Table 15 for new constructions (NC) and existing buildings (Exist), respectively. These estimates were based on reviewing several recent building plans and identifying what fraction of floorspace were by windows and had lighting in the primary or secondary zone between 75 watts (proposed threshold) and 120 watts (existing daylighting control threshold). The corresponding square footage, in million square feet (M ft^2), based on the CEC 2026 Statewide Construction Forecast in Appendix A are listed in the third and fourth column of the table. For the impacted floorspaces within each prototype, the Statewide CASE Team further estimated the composition of different functional space types as the rest of the columns shown in Table 15. The base case and proposed case, energy savings per watt of controlled lighting were applied to the percent of floorspace impacted, the composition of the impacted functional space types and the LPDs of the space types to arrive at the savings for each prototype building in each of the 16 climate zones.

Table 15: Estimated Floorspace Impacted and the Composition of Impacted Functional Space Types

Prototype Building	New Construction	Existing Buildings	New Construction Daylit [a] (Million ft²)	Existing Building Daylit [b] (Million ft²)	Office (% Composition)	Conference Room (% Composition)	Corridor (% Composition)	Multipurpose Room (% Composition)	Exercise Room (% Composition)	Lobby (% Composition)
Large Office	7%	7%	0.93	5.06	50%	40%	10%	-	-	-
Medium Office	7%	7%	1.08	3.16	60%	20%	20%	-	-	-
Small Office	7%	7%	0.23	1.12	80%	-	20%	-	-	-
Large Retail	5%	5%	0.42	1.52	40%	50%	10%	-	-	-
Medium Retail	2%	2%	0.15	0.75	50%	40%	10%	-	-	-
Mixed-use Retail	0.5%	0.5%	0.03	0.00[c]	60%	20%	-	-	-	20%
Large School	7%	5%	0.51	1.39	40%	60%	-	-	-	-
Small School	2%	3%	0.09	0.66	50%	50%	-	-	-	-
Non-refrigerated Warehouse	1%	1%	0.17	0.82	70%	30%	-	-	-	-
Hotel	0.5%	0.5%	0.04	0.13	40%	30%	10%	-	20%	-
Assembly	5%	3%	0.55	1.51	50%	30%	10%	10%	-	-
Hospital	6%	6%	0.35	1.68	50%	50%	-	-	-	-
Laboratory	10%	10%	0.54	1.16	60%	40%	-	-	-	-
Restaurant	1%	1%	0.04	0.13	100%	-	-	-	-	-
Grocery	1%	1%	0.01	0.03	70%	20%	10%	-	-	-
Refrigerated Warehouse	1%	1%	0.00[c]	0.01	70%	30%	-	-	-	-
Controlled-environment Horticulture	1%	1%	0.02	0.03	70%	30%	-	-	-	-
Vehicle Service	10%	10%	0.60	2.74	20%	-	80%	-	-	-
New Construction Total Daylit Area (Million ft²)	**-**	**-**	**5.76**	**-**	**2.89**	**1.84**	**0.95**	**0.05**	**0.01**	**0.01**
Existing Buildings Total Daylit Areas (Million ft²)	**-**	**-**	**-**	**21.90**	**10.83**	**6.94**	**3.95**	**0.15**	**0.03**	**0.00**

a. New construction starts multiplied by fraction of building area which are newly covered by daylighting control requirements.

b. Retrofits occur every 15 years or 7 percent per year multiplied by fraction of building area which are newly covered by daylighting control requirements.

c. Impacted floorspace is rounded but is not zero.

Note that from Table 15, approximately half of the additional daylit areas that would be newly covered by the proposed code change are offices. The top three space types are offices, conference rooms, and corridors. Also, approximately 80 percent of newly covered areas would be for retrofits in existing buildings.

5.1.3 Statewide Energy Savings Methodology

The per-unit energy impacts were extrapolated to statewide impacts using the Statewide Construction Forecasts that the CEC provided (California Energy Commission 2022). The Statewide Construction Forecasts estimate new construction/additions that would occur in 2026, the first year that the 2025 Title 24, Part 6 requirements are in effect.[13] They also estimate the total existing building stock in 2026, which the Statewide CASE Team used to approximate savings from building alterations. The construction forecast provides construction (new construction/additions and existing building stock) by building type and climate zone, as shown in Appendix A.

For new construction and additions, the statewide installed lighting power for these applications by building are the product of 1) the statewide construction areas for new construction as presented in Appendix A, 2) the fraction of the impacted daylit areas per building, 3) the fraction of impacted space types per building, and 4) the lighting power densities per space type in Table 16. Combining these by climate zone across all building type yields a forecast of watts per space type per climate zone that are expected for the first year the requirements would be in effect. See Table 16 for results.

Note there is no wattage for the lobby space type as that space type is only in the mixed-use retail building type. This building type does not have a construction forecast yet but given only one space type is involved this will not change the statewide estimates significantly.

A similar approach was taken to estimate impacted building alterations, in this case a seven percent per year alteration rate corresponding to lighting being replaced once every 15 years is multiplied by the product of 1) the statewide construction areas for existing buildings as presented in Appendix A, 2) the fraction of the impacted daylit areas per building, 3) the fraction of impacted space types per building, and 4) the lighting power densities per space type. The results were then combined across all building types to yield a forecast of watts per space type per climate zone that are expected for the first year the requirements would be in effect. See Table 17 for results.

The first-year statewide energy savings per climate zone were derived by multiplying the per-watt energy savings discussed in the previous sections by the statewide lighting power in daylit zone in Table 16 and Table 17 for new constructions and existing

[13] Located in Appendix A of the CEC New Measure Proposal Template: https://www.energy.ca.gov/media/3538

buildings, respectively. Similarly, the statewide demand reductions and GHG reductions per climate zone are obtained by multiplying the per-watt demand reduction and per-watt GHG reduction by the statewide lighting power in daylit zone above.

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

Table 16: First-year Statewide Lighting Power in Daylit Zones by Climate Zone (kW) | New Construction and Additions

Climate Zone	Office LPD: 0.60	Conference Room LPD: 0.75	Corridor LPD: 0.40	Multi-purpose Room LPD: 0.80	Exercise Room LPD: 0.50	Lobby LPD: 0.50
1	6.5	3.9	1.0	0.0	0.0	0.0
2	52.0	28.1	8.7	1.6	0.1	0.1
3	242.0	210.7	40.6	6.3	0.5	0.3
4	119.6	105.2	22.4	2.2	0.3	0.1
5	22.4	14.9	3.9	0.2	0.1	0.0
6	134.6	108.2	32.3	3.1	0.3	0.3
7	101.6	83.3	21.5	3.2	0.2	0.2
8	190.1	154.6	46.8	5.7	0.4	0.5
9	338.5	267.9	96.5	7.3	0.6	0.5
10	141.7	109.3	32.6	4.6	0.3	0.7
11	36.8	33.1	4.1	0.7	0.1	0.0
12	214.1	161.7	38.7	5.7	0.4	0.3
13	67.7	50.2	15.0	1.2	0.1	0.2
14	34.3	26.2	9.9	1.0	0.1	0.2
15	23.1	16.0	4.6	0.5	0.1	0.1
16	11.8	9.1	2.8	0.3	0.0	0.0
All (kW)	**1,736.8**	**1,382.4**	**381.4**	**43.7**	**3.5**	**3.4**
All (Million ft^2)	**2.89**	**1.84**	**0.95**	**0.05**	**0.01**	**0.01**

Table 17: First-year Statewide Lighting Power in Daylit Zones by Climate Zone (kW) | Alterations

Climate Zone	Office LPD: 0.60	Conference Room LPD: 0.75	Corridor LPD: 0.40	Multi-purpose Room LPD: 0.80	Exercise Room LPD: 0.50	Lobby LPD: 0.50
1	27.3	13.6	5.6	0.7	0.1	0.0
2	165.6	104.4	35.3	3.1	0.4	0.0
3	794.6	653.0	161.6	15.3	1.7	0.0
4	425.0	343.4	80.4	7.6	0.9	0.0
5	78.2	45.7	16.7	1.1	0.2	0.0
6	517.5	422.4	131.3	9.6	1.1	0.0
7	414.5	343.5	95.9	6.9	1.1	0.0
8	738.0	625.5	189.2	15.0	1.5	0.0
9	1,211.5	1,046.8	311.2	20.2	2.3	0.0
10	657.1	508.5	193.4	15.4	1.3	0.0
11	133.9	95.2	29.1	2.7	0.3	0.0
12	774.8	579.5	176.4	11.7	1.4	0.0
13	270.8	201.4	68.2	5.1	0.5	0.0
14	151.8	119.7	49.1	3.2	0.3	0.0
15	90.6	65.0	24.1	2.0	0.2	0.0
16	47.7	36.2	12.8	1.1	0.1	0.0
All (kW)	**6,499.0**	**5,203.7**	**1,580.2**	**120.7**	**13.1**	**0.0**
All (Million ft^2)	**10.83**	**6.94**	**3.95**	**0.15**	**0.03**	**0.00**

5.2 Per-Unit Energy Impacts Results

Energy savings and peak demand reductions per unit are presented in Table 19. The per-unit energy savings figures do not account for naturally occurring market adoption or compliance rates.

As the methodology discussed in Section 5.1.3, the unit of interest is the savings per watt of lighting in the primary sidelit zone, the secondary sidelit, and the combined primary and secondary sidelit zone. And the primary metric in developing the per-watt energy savings is the full load hours of energy consumption in the base case without daylighting controls versus the full load hours of energy consumption by the lighting systems with automatic daylighting controls. Full load hours per year is the total energy consumption of the lighting system divided by its rated wattage. This evaluation is conducted for each of the 16 California climate zones.

The full load hours for spaces in an office building that would be impacted by this code change proposal are presented in Table 18. Only the full load hours savings in the

PSDZ are presented for corridors as it is typically a shallow space and does not have a SSDZ.

Table 18: Full Load Hour (FLH) per Year Consumption of Base Case Lighting System and Lighting Systems in the PSDZ and SSDZ

Climate Zone	No Daylighting Control Full Load Hours (FLH/year)	PSDZ (FLH/year)	PSDZ Savings (%)	SSDZ (FLH/year)	SSDZ Savings (%)	PSDZ (FLH/year)	PSDZ Savings (%)	PSDZ (FLH/year)	PSDZ Savings (%)	SSDZ (FLH/year)	SSDZ Savings (%)
Prototype(s)	All	Office, Conference Room, Multipurpose Room	Office, Conference Room, Multipurpose Room	Office, Conference Room, Multipurpose Room	Office, Conference Room, Multipurpose Room	Corridor	Corridor	Exercise Room	Exercise Room	Exercise Room	Exercise Room
1	2,949	1,228	58%	1,635	45%	1,066	64%	1,328	55%	1,861	37%
2	2,949	1,159	61%	1,562	47%	1,036	65%	1,253	58%	1,797	39%
3	2,949	1,147	61%	1,527	48%	1,033	65%	1,236	58%	1,767	40%
4	2,949	1,131	62%	1,496	49%	1,031	65%	1,214	59%	1,738	41%
5	2,949	1,132	62%	1,489	50%	1,031	65%	1,216	59%	1,733	41%
6	2,949	1,126	62%	1,475	50%	1,035	65%	1,203	59%	1,721	42%
7	2,949	1,132	62%	1,491	49%	1,039	65%	1,207	59%	1,744	41%
8	2,949	1,141	61%	1,502	49%	1,039	65%	1,221	59%	1,744	41%
9	2,949	1,140	61%	1,501	49%	1,041	65%	1,222	59%	1,744	41%
10	2,949	1,136	61%	1,490	49%	1,043	65%	1,215	59%	1,733	41%
11	2,949	1,193	60%	1,569	47%	1,053	64%	1,288	56%	1,799	39%
12	2,949	1,174	60%	1,557	47%	1,045	65%	1,268	57%	1,792	39%
13	2,949	1,181	60%	1,536	48%	1,072	64%	1,264	57%	1,774	40%
14	2,949	1,121	62%	1,465	50%	1,037	65%	1,197	59%	1,710	42%
15	2,949	1,131	62%	1,457	51%	1,046	65%	1,202	59%	1,700	42%
16	2,949	1,185	60%	1,577	47%	1,051	64%	1,286	56%	1,806	39%

Usually, the highest energy consumption for daylit spaces is in Climate Zone 1, which has the cloudiest days (least sunny days). However, since even on a cloudy day there is significant daylight available, the percentage savings relative to the base case with no daylighting control varies only slightly by climate zone. Also note that the daylighting controls on the primary sidelit zone lighting in the corridor saves a greater fraction of energy than these same controls applied to the primary sidelit zone lighting in the office space and conference room spaces. This is due to a lower design illuminance for the corridor (100 lux) than that for the office (300 lux), thus the lighting in the corridor is fully dimmed at daylight levels which would invoke only partial dimming in the office.

Based on the full load hours of energy consumption in Table 18, the per-unit (per-watt) electricity savings, demand reductions, and source energy savings for spaces that would be impacted by this code change proposal are calculated and presented in Table 19 and Table 20.

Table 19: Annual Electricity Savings (kWh) and Demand Reductions per Watt of Controlled Lighting – New Construction and Alterations

Climate Zone	PSDZ Energy Savings (kWh/year-W)	SSDZ Energy Savings (kWh/year-W)	PSDZ Energy Savings (kWh/year-W)	PSDZ Energy Savings (kWh/year-W)	SSDZ Exercise Energy Savings (kWh/year-W)	PSDZ Demand Reductions (W/W)	SSDZ Demand Reductions (W/W)	PSDZ Demand Reductions (W/W)	PSDZ Demand Reductions (W/W)	SSDZ Demand Reductions (W/W)
Prototype(s)	Office, Conference Room, Multipurpose Room	Office, Conference Room, Multipurpose Room	Corridor	Exercise Room	Exercise Room	Office, Conference Room, Multipurpose Room	Office, Conference Room, Multipurpose Room	Corridor	Exercise Room	Exercise Room
1	1.72	1.31	1.88	1.62	1.09	0.0060	0.0042	0.0082	0.0053	0.0036
2	1.79	1.39	1.91	1.70	1.15	0.0063	0.0042	0.0088	0.0054	0.0035
3	1.80	1.42	1.92	1.71	1.18	0.0069	0.0048	0.0091	0.0060	0.0041
4	1.82	1.45	1.92	1.73	1.21	0.0070	0.0048	0.0091	0.0061	0.0042
5	1.82	1.46	1.92	1.73	1.22	0.0075	0.0053	0.0096	0.0065	0.0047
6	1.82	1.47	1.91	1.75	1.23	0.0081	0.0058	0.0102	0.0072	0.0051
7	1.82	1.46	1.91	1.74	1.20	0.0084	0.0057	0.0107	0.0073	0.0049
8	1.81	1.45	1.91	1.73	1.20	0.0080	0.0057	0.0100	0.0070	0.0050
9	1.81	1.45	1.91	1.73	1.20	0.0083	0.0059	0.0102	0.0074	0.0052
10	1.81	1.46	1.91	1.73	1.22	0.0082	0.0059	0.0101	0.0072	0.0052
11	1.76	1.38	1.90	1.66	1.15	0.0060	0.0041	0.0086	0.0053	0.0035
12	1.77	1.39	1.90	1.68	1.16	0.0064	0.0041	0.0090	0.0056	0.0034
13	1.77	1.41	1.88	1.68	1.17	0.0064	0.0038	0.0093	0.0054	0.0031
14	1.83	1.48	1.91	1.75	1.24	0.0083	0.0059	0.0101	0.0073	0.0052
15	1.82	1.49	1.90	1.75	1.25	0.0082	0.0060	0.0099	0.0073	0.0052
16	1.76	1.37	1.90	1.66	1.14	0.0072	0.0051	0.0096	0.0063	0.0044

Table 20: Annual Source Energy Savings (kBtu) per Watt of Controlled Lighting – New Construction, Additions and Alterations

Climate Zone	PSDZ Source Energy Savings (kBtu/W)	SSDZ Source Energy Savings (kBtu/W)	PSDZ + SSDZ Source Energy Savings (kBtu/W)	PSDZ Source Energy Savings (kBtu/W)	PSDZ Source Energy (kBtu/W)	SSDZ Source Energy (kBtu/W)	PSDZ + SSDZ Source Energy (kBtu/W)
Prototype(s)	Office, Conference Room, Multipurpose Room	Office, Conference Room, Multipurpose Room	Office, Conference Room, Multipurpose Room	Corridor	Exercise Room	Exercise Room	Exercise Room
1	0.90	0.63	0.77	1.11	0.81	0.52	0.67
2	0.96	0.65	0.81	1.15	0.86	0.54	0.70
3	0.98	0.70	0.84	1.15	0.89	0.59	0.74
4	1.00	0.73	0.86	1.16	0.92	0.61	0.76
5	1.03	0.76	0.89	1.17	0.94	0.64	0.79
6	1.03	0.77	0.90	1.16	0.95	0.64	0.80
7	1.04	0.78	0.91	1.16	0.97	0.65	0.81
8	1.00	0.74	0.87	1.15	0.92	0.62	0.77
9	1.01	0.74	0.87	1.15	0.92	0.62	0.77
10	1.01	0.74	0.88	1.14	0.93	0.62	0.77
11	0.90	0.62	0.76	1.12	0.81	0.52	0.66
12	0.92	0.62	0.77	1.13	0.82	0.51	0.67
13	0.93	0.65	0.79	1.14	0.84	0.53	0.69
14	1.04	0.79	0.92	1.16	0.97	0.67	0.82
15	1.03	0.79	0.91	1.14	0.96	0.67	0.82
16	0.95	0.67	0.81	1.13	0.85	0.56	0.71

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 5.1.3. LSC hourly factors are a normalized metric to calculate energy cost savings that account 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 used in 2026 PV$ are presented in Section 6 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.

The proposed code change would apply to new constructions, additions, and alterations. The energy cost savings for additions and alterations were evaluated following the same approach as new constructions, as described above. There is no distinctive difference in per-unit savings among new construction, additions, and alterations for the proposed code change since the underlying assumptions are identical.

6.2 Energy Cost Savings Results

Per-unit energy cost savings for newly constructed buildings, additions, and alterations that are realized over the 30-year period of analysis are presented 2026 precent value dollars (2026 PV$) in Table 21.

The LSC hourly factors 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.

The lifecycle cost savings are derived from the per-unit energy savings analysis in Section 5.1. Since the Statewide CASE Team only completed the per-unit energy analysis for the spaces common in office buildings that would be impacted, the results presented herein represent only energy cost savings for those spaces.

Table 21: 2026 PV LSC Savings Over 30-Year Period of Analysis – Per Watt – New Construction, Additions and Alterations

Climate Zone	PSDZ 30-year LSC Savings (PV$/W)	SSDZ 30-year LSC Savings (PV$/W)	PSDZ + SSDZ 30-year LSC Savings (PV$/W)	PSDZ 30-year LSC Savings (PV$/W)	PSDZ 30-year LSC Savings (PV$/W)	SSDZ 30-year LSC Savings (PV$/W)	PSDZ + SSDZ 30-year LSC Savings (PV$/W)
Prototype(s)	Office, Conference Room, Multipurpose Room	Office, Conference Room, Multipurpose Room	Office, Conference Room, Multipurpose Room	Corridor	Exercise Room	Exercise Room	Exercise Room
1	$7.06	$5.31	$6.18	$7.86	$6.59	$4.40	$5.50
2	$7.40	$5.63	$6.52	$8.03	$6.96	$4.68	$5.82
3	$7.47	$5.80	$6.63	$8.05	$7.04	$4.83	$5.93
4	$7.53	$5.93	$6.73	$8.04	$7.14	$4.95	$6.04
5	$7.57	$6.01	$6.79	$8.07	$7.17	$5.01	$6.09
6	$7.74	$6.20	$6.97	$8.20	$7.38	$5.17	$6.28
7	$7.04	$5.61	$6.32	$7.46	$6.72	$4.64	$5.68
8	$7.65	$6.06	$6.85	$8.16	$7.27	$5.05	$6.16
9	$7.65	$6.07	$6.86	$8.15	$7.27	$5.05	$6.16
10	$7.67	$6.11	$6.89	$8.13	$7.30	$5.10	$6.20
11	$7.19	$5.55	$6.37	$7.91	$6.74	$4.62	$5.68
12	$7.29	$5.60	$6.44	$7.97	$6.84	$4.65	$5.74
13	$7.28	$5.70	$6.49	$7.88	$6.88	$4.74	$5.81
14	$7.74	$6.24	$6.99	$8.16	$7.39	$5.22	$6.30
15	$7.69	$6.26	$6.98	$8.11	$7.36	$5.25	$6.31
16	$7.43	$5.72	$6.57	$8.10	$6.96	$4.77	$5.86

6.3 Incremental First Cost

6.3.1 Incremental First Cost for Two-Zone Systems

The incremental first cost is estimated based on the daylight model used in the per-unit energy savings analysis. The Statewide CASE Team obtained quotes for the distributor net price from five manufacturer's sales representative agencies, each representing different manufacturers, for the material required to implement automatic daylighting controls in this daylight model. The quotes included systems with various levels of sophistication and configuration to cover a wide range of automatic daylighting control solutions for new constructions, additions, and alterations. These systems included both wired and wireless systems and include building management systems, room-based controls, and luminaire-level lighting controls. Since the daylight model has a PSDZ and a SSDZ, the hardware quoted for systems capable of controlling the light in each daylit zone separately per the code requirements. In total, the usable cost data included 22 photocontrols or systems from 11 manufacturers.

Table 22 shows the six types of control solutions the Statewide CASE Team considered for implementing the proposed code change. Cost data of multiple photocontrols or systems from different manufacturers were included for most of control solution types. The ease of installation and commissioning as well as maintenance access for these control solutions are divided into “easy,” “moderate,” and “difficult” categories. For installation and commissioning, control solutions in the “easy” category need simple wiring at the luminaire and minimum configuration, typically through a mobile app or handheld remote controller. Those in the “moderate” category require connecting wires among sensors, luminaires and the local controller and some programming to associate luminaires with sensors and controllers. Those in the “difficult” category involve laying wires and cables connecting to the central building management system with elaborate programming. For maintenance access, control solutions in the “easy” category need minimal to no routine setting modifications, and those in the “moderate” category require use of a ladder to replace batteries.

Table 22: Control Solutions Considered for Implementing two-zone Automatic Daylighting Controls

Code	Control Solution	Photocontrol Type	Ease of Installation and Commissioning	Maintenance Access
R-WL-C	Wireless room control	Closed loop	Easy	Moderate
R-WL-O	Wireless room control	Open loop	Easy	Moderate
R-WD-C	Wired room control	Closed loop	Difficult	Easy
R-WD-O	Wired room control	Open loop	Moderate	Moderate
LLLC	Luminaire-level control	Closed loop	Easy	Easy
BMS-O	Building management system	Open loop	Difficult	Easy

To arrive at the total incremental material cost, state and local sales tax, freight charge, and supply chain markup were applied to the net distributor price quotes. The Statewide CASE Team considered the highest, lowest, and average sales tax rate in 2023, which are 10.75 percent, 7.75 percent, and 8.62 percent, respectively. We assumed daylight sensors are shipped in carton boxes, and a freight charge of $1 would be attributed to each daylight sensor unit. Other necessary components, including keypads, networking devices, etc., were assumed to be in place due to other mandatory control requirements, and implementing automatic daylighting controls would not incur additional related hardware cost. A 45 percent markup throughout the supply chain is assumed for the daylight sensors. The cost of cables and connectors necessary to wire the daylight sensors to the controllers are also included and subject to the same sales tax rate. The second and third columns in Table 26 shows the pre-tax incremental material cost and material cost after tax, freight, and markup, respectively, for each control solution type. The values for each control solution type are the average costs across all systems that fall within the same control solution type.

The control solution “LLLC” typically comes with a sensor and control module factory-installed in each luminaire, and the modules typically include both an occupancy sensor and a photosensor. The Statewide CASE Team obtained quotes only for the sensor and control modules, exclusive of the luminaire cost. Since the hardware for occupant sensing and automatic daylight dimming within the sensor and control module is inseparable, the Statewide CASE Team assumed half of cost would be attributed to implementing automatic daylighting controls, while the other half of the cost is already required for occupancy controls. Similarly, the sensors in several other control solutions are a combo-sensor, including both an occupancy sensor and a photosensor. The Statewide CASE Team obtained the cost of the occupancy-only sensor of the same or similar sensor model, where available, and used the cost differential between the occupancy-only sensor and the combo-sensor as the incremental cost of the photosensor. If the occupancy-only sensor is not available, the Statewide CASE Team used the same assumption as the “LLLC” control solution and attributed half of the cost to implementing automatic daylighting controls.

The additional efforts required to implement the proposed code change, including installation and system startup and commissioning, were based on practitioner estimates, and presented in labor hours as shown in Table 23. For simplicity, the Statewide CASE Team used conservative estimates for the hours that would cover the average time required to perform installation and commissioning in both new construction and alteration. This would avoid the need to separately evaluate cost and cost effectiveness for new construction and alteration although, in general, such an approach would likely to be too conservative for new constructions.

Table 23: Estimated Labor Hours for Implementing the Proposed Code Change

	Easy	Moderate	Difficult
Installation hours (hr)	0.5	1.0	2.0
Startup and commissioning hours (hr)	0.5	0.5	1.0

The Statewide CASE Team assumed an electrician’s rate for labor. Two sources were consulted to estimate the labor rates: RSMeans and the prevailing wage published by

California Department of Industrial Relations (DIR) (State of California Department of Industrial Relations 2023).

The 2023 Quarter 1 RSMeans national average electrician rate is $80.00/hr and $100.10 (including overhead and profit) for non-union and union labors, respectively. The Statewide CASE Team used the 2023 Quarter 1 RSMeans City Cost Index for California, which ranges from 107.1 to 197.6 times the national average, as the scaling factors to arrive at the highest and lowest California labor rates as shown in Table 24. The Statewide CASE Team included overhead and profit in the cost estimate and decided on a California average scaling factor of 131.8 percent. Scaling the national average labor rate up 131.8 percent brings the labor rate to $105.44/hr and 131.93/hr for non-union and union California labors, respectively. The prevailing wages for workers employed on public works projects are published by county on the DIR website, The prevailing wages for the inside wireman classification under the electrician craft were used to estimate the labor rates. The average rate across all counties and climate zones weighed by the CEC 2026 construction forecast is $88.18/hr. The labor hours in Table 23 were then converted into labor costs using the hourly rate in Table 24.

The labor required for implementing the proposed code change typically does not involve the full skill set of a licensed electrician and may be largely performed by an electrician's apprentice. Therefore, the estimated labor cost using exclusively the electrician's rates would be on the conservative side.

Table 24: Estimated California Electrician Labor Rates

Rate	Highest	Lowest	Average
RSMeans Non-unionized ($/hr)	$158.08	$85.68	$105.44
RSMeans Unionized ($/hr)	$197.80	$107.21	$131.93
DIR Prevailing Wage ($/hr)	$127.99	$63.58	$88.18

The fourth and fifth columns in Table 26 show the installation and startup and commissioning labor costs, respectively, for implementing the proposed code change in the daylight model. The values for each control solution type are the average labor costs across all systems that fall within the same control solution type.

Additionally, acceptance testing will need to be performed on the automatic daylighting controls installed in the impacted spaces, and therefore, the cost of acceptance test was included as one of the components in the incremental first cost. The Statewide CASE Team assessed the hourly rate of an acceptance test technician (ATT) at $125-$150 and the time to perform automatic daylighting controls functional test at one hour per photocontrol per daylit zone based on information provided by state-certified Acceptance Test Technicians (ATTs). The code permits sampling of group of up to five photocontrols when performing automatic daylighting controls functional test as long as all photocontrols within the same sample group have the same characteristics, including cardinal direction, luminaire layout, etc.; if the photocontrol passes the test, all photocontrols within the same sample group pass. Utilizing the sampling approach, not every single additional photocontrol would incur acceptance testing cost. In the best-case scenario, only one out of every five photocontrols need to be tested when the ATT is able to identify and test the photocontrols in groups of five photocontrols. In this case, one-fifth of the cost on the acceptance test would be attributed to each photocontrol. Similarly, the Statewide CASE Team estimated the worst-case scenario where only one out of two photocontrols on average can be grouped for testing, and therefore, half of the cost on acceptance test would be attributed to each photocontrol. To take the sampling approach, the ATT also needs to spend time planning how to sample the photocontrols. The Statewide CASE Team conservatively assumed the planning time to be 0.1 to 0.5 hours per photocontrol when the overall planning time at the project level is distributed to each photocontrol. Table 25 shows the highest, lowest, and midpoint of each cost component considered in estimating cost associated with acceptance test. The Statewide CASE Team used the midpoint as the incremental cost on acceptance testing as summarized in the sixth column in Table 26 for each control solution type. Note that the acceptance cost in Table 26 doubles that in Table 25 because the two photocontrols, one for the PSDZ and one for the SSDZ, need to be tested separately for the two-zone system.

Table 25: Estimated Acceptance Testing Cost

Rate	Worst Case	Best Case	Midpoint
ATT Labor Rate ($/hr)	$150.00	$125.00	$138.00
Sampling Planning Time (hr)	0.5	0.1	0.3
Acceptance Test Time per Photocontrol per Daylit zone (hr)	1.0	1.0	1.0
Groupable Photocontrols	0.5 (one out of two tested)	0.2 (one out of five tested)	0.38
Average Acceptance Test Cost per Photocontrol ($)	$150.00	$37.50	$89.38

The total first cost for implementing the proposed code change in the daylight model is the summation of the material cost after tax, freight, and markup as well as the installation, startup, and commissioning labor costs. They are listed in the seven columns in Table 26 for each control solution type. The incremental cost per square foot for each control solution type is obtained by dividing the total first cost by the square footage of the 16ft-by-18ft-by-9ft daylight model (288 square feet) used for the raytracing analysis as described in Section 5.1.2.1.

Table 26: Estimated Costs for Implementing the Proposed Code Change – Two-Zone Systems

Control Solution Type Code	Pre-tax Material Cost	Material Cost after Tax, Freight and Markup	Installation Labor Cost	Startup and Commissioning Labor Cost	Acceptance Testing Labor Cost	Total First Cost	Total First Cost per Square Foot
R-WL-C	$131.29	$208.79	$54.26	$54.26	$178.75	$496.06	$1.72
R-WL-O	$111.63	$176.82	$54.26	$54.26	$178.75	$464.09	$1.61
R-WD-C	$197.34	$300.43	$108.52	$54.26	$178.75	$641.96	$2.23
R-WD-O	$177.60	$272.12	$217.03	$108.52	$178.75	$776.42	$2.70
Luminaire Level Lighting Controls (LLLC)	$90.76	$144.95	$54.26	$54.26	$178.75	$432.21	$1.50
BMS-O	$220.00	$347.50	$217.03	$108.52	$178.75	$851.80	$2.96

6.3.2 Incremental First Cost for Single-Zone Systems

The incremental first costs in Table 26 are based on control solutions that are installed, configured and commissioned to control a space that has both the PSDZ and SSDZ. For spaces that have only one daylit zone, such as corridors, the Statewide CASE Team collected additional cost data for systems implementing automatic daylighting controls in a single daylit zone. The cost data included four room-based systems from four manufacturers; two of the systems are wired control solutions (R-WD-C-SZ and R-WD-CO-SZ) while the other two are wireless control solutions utilizing battery-powered photosensors (R-WL-CO-SZ and R-WL-O-SZ). The photosensor for two of the systems (R-WL-CO-SZ and R-WD-CO-SZ) can be configured for either closed-loop or open-loop photocontrols, and the Statewide CASE Team assumed that they are configured for closed-loop photocontrols.

Table 27 shows the incremental first cost for the four room-based systems. For closed-loop control solutions, the key difference, compared to the two-zone solutions, is that the number of photosensors needed is half of that required for a two-zone implementation, and so are the associated wiring (for wired systems) and installation costs. For open-loop control solutions, the number of photosensor required for a single-zone and a two-zone implementation is the same, and there is no significant reduction in installation costs, especially for wireless systems. For both closed-loop and open-loop single-zone photocontrols, the startup and commissioning costs are assessed to be slightly more than half of what is required for a two-zone implementation to account for the base-level commissioning necessary regardless of how many photocontrols are being commissioned.

Table 27: Estimated Costs for Implementing the Proposed Code Change – Single-Zone Systems

Control Solution Code	Pre-tax Material Cost	Material Cost after Tax, Freight and Markup	Installation Labor Cost	Startup and Commissioning Labor Cost	Acceptance Testing Labor Cost	Total First Cost	Total First Cost per Square Foot
R-WD-C-SZ	$27.46	$39.62	$54.26	$35.27	$89.38	$218.52	$1.52
R-WL-CO-SZ	$150.00	$237.25	$27.13	$35.27	$89.38	$389.02	$3.07
R-WL-O-SZ	$75.00	$119.13	$54.26	$35.27	$89.38	$298.03	$2.62
R-WD-CO-SZ	$127.88	$198.54	$54.26	$35.27	$89.38	$377.44	$2.62

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 the periodic maintenance required to keep the equipment operating relative to current practices over the 30-year period of analysis. 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 Lifecycle Cost Hourly Factors. The present value of maintenance costs that occurs in the nth year is calculated as follows:

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

The energy savings related to the proposed measure are expected to persist throughout the 30-year measure's life. The Statewide CASE Team did not find any documented rated lifetime or maintenance requirements for photocontrols, including sensors and controls if they are physically separate, used for automatic daylighting controls. Outreach to manufacturers indicated that testing and assigning a rated lifetime to photocontrol products is not a standard practice, nor is there an established maintenance procedure. As a result, the Statewide CASE Team did not factor in photocontrol maintenance and replacement over the 30-year analysis period with the following two exceptions:

- Luminaire-based photocontrols (LLLC) are assumed to have a 15-year lifetime. Since luminaires have a 15-year typical lifespan, luminaire-based photocontrols, i.e., luminaire-level lighting controls, would need to be replaced along with the luminaires once during the 30-year measure life.
- For battery-powered wireless photocontrols, the battery would need to be replaced every 5 to 10 years based on manufacturer product specifications. Therefore, there would be multiple replacements during the 30-year measure life.

The incremental maintenance cost is estimated for each control solution type (shown in Table 22) based the same daylight model used in estimating per-unit energy savings using the following methodology:

- Estimate battery and labor costs for the daylight model for each maintenance and replacement occurrence.
- Calculate the incremental cost for each maintenance and replacement occurrence.
- Calculate the present value cost as per the equation above.

The Statewide CASE Team's research shows that the cost per battery, average across the same battery type, when bought in bulk, ranges from $0.69 to $7.37 per battery depending on the exact battery types[14]. The maximum price was $9.99 per item (1.5V AA lithium battery) and the minimum price was $0.25 per item (1.5V AA alkaline battery). The cost of battery was applied separately to each control solution, accounting for the number of batteries required, manufacturer-specified battery life, sales tax, and contractor markup, to estimate the battery replacement material cost during the 30-year period of analysis.

Table 28 shows the estimated labor hours for the level of maintenance access associated with each control solution type in Table 23, and the same electrician's labor rates in Table 24 were applied as the maintenance crew labor rates.

Table 28: Estimated Labor Hours for Maintaining the Proposed Code Change

	Easy	Moderate	Difficult
Maintenance staff hours	0.5	1.0	2.0

The Statewide CASE Team calculated the material and labor cost for an occurrence of maintenance and replacement event for each system. The average cost per maintenance and replacement occurrence across all systems that fall into the same control solution type was calculated for each of the six control solution types as shown in the second column of Table 29. The cost per maintenance and replacement occurrence per square foot for each control solution type, presented in the third column of Table 29, is then obtained by dividing the per-occurrence maintenance and replacement cost by the square footage of the 16ft-by-18ft-by-9ft daylight model (288 square feet) used for the raytracing analysis as described in Section 5.1.2.1. The above present value of maintenance cost equation was applied to each maintenance and

[14] The types of batteries required for the control solutions in Table 22 include 3.6V AA lithium, 1.5V AA lithium, 1.5V AAA lithium, 1.5V AA alkaline, CR123A, and CR2450. Each control solution also requires a different number of batteries.

replacement occurrence over the 30-year measure life to obtain the incremental maintenance cost in the last two columns of Table 29.

As with assuming an electrician's rate in the incremental first cost analysis in Section 6.3, maintenance, primarily battery replacement, does not command the full skill set of a licensed electrician and can be largely performed by an electrician's apprentice. Consequently, the estimated labor cost using exclusively the electrician's rates would be on the conservative side.

Table 29: Per-Unit Incremental Maintenance and Replacement Costs – Two-Zone Systems

Control Solution Type Code	Maintenance and Replacement Cost per Occurrence	Per-square-foot Maintenance and Replacement Cost per Occurrence	30-year Present Value Maintenance and Replacement Cost	30-year Present Value Maintenance and Replacement Cost per Square Foot
R-WL-C	$134.04	$0.47	$269.98	$0.60
R-WL-O	$95.59	$0.33	$137.37	$0.43
R-WD-C	$0	$0	$0	$0
R-WD-O	$0	$0	$0	$0
LLLC	$253.46	$0.88	$277.42	$0.96
BMS-O	$62.13	$0.22	$115.16	$0.28

The incremental maintenance and replacement costs in Table 29 are based on control solutions that control a space that has both the PSDZ and SSDZ. For spaces that have only a single daylit zone, such as corridors, the Statewide CASE Team separately estimated the maintenance and replacement costs for the four single-zone systems discussed in Section 6.3.2 using the same approach above, and the results are shown in Table 30.

Table 30: Per-Unit Incremental Maintenance and Replacement Costs – Single-Zone Systems

Control Solution Code	Maintenance and Replacement Cost per Occurrence	Per-square-foot Maintenance and Replacement Cost per Occurrence	30-year Present Value Maintenance and Replacement Cost	30-year Present Value Maintenance and Replacement Cost per Square Foot
R-WD-C-SZ	$0	$0	$0	$0
R-WL-CO-SZ	$41.38	$0.29	$53.70	$0.37
R-WL-O-SZ	$60.77	$0.42	$112.63	$0.55
R-WD-CO-SZ	$0	$0	$0	$0

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 Lifecycle Energy Cost 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.

The incremental present value cost for each of the six control solution types derived using the daylight model are summarized in Table 31. The average present value incremental cost across all six control solution types is $743.74 in total or $2.50 per square foot for the daylight model. This present value incremental cost is derived from the daylight model, and therefore, is most applicable to spaces with both PSDZs and SSDZs, such as offices and conference rooms. For spaces with only a single sidelit zone (most typically a PSDZ without a SSDZ like corridors), the average present value incremental cost is $362.34 in total or $2.46 per square foot for the additional four single-zone systems considered as summarized in Sections 6.3.2 and 6.4.

Table 31: 30-Year Present Value Incremental Costs for Two Zone Daylighting Controls – Controlling Both PSDZ and SSDZ

Control Solution Type Code	First Cost Total	First Cost Per Square Foot	30-year Present Value Maintenance and Replacement Cost Total	30-year Present Value Maintenance and Replacement Cost Per Square Foot	30-year Present Value Incremental Cost Total	30-year Present Value Incremental Cost Per Square Foot
R-WL-C	$496.06	$1.72	$269.98	$0.60	$766.04	$2.33
R-WL-O	$464.09	$1.61	$137.37	$0.43	$601.46	$2.04
R-WD-C	$641.96	$2.23	$0	$0	$641.96	$2.23
R-WD-O	$776.42	$2.70	$0	$0	$776.42	$2.70
LLLC	$432.21	$1.50	$277.42	$0.96	$709.64	$2.46
BMS-O	851.80	$2.96	$115.16	$0.28	$966.96	$3.24
Average	**$610.42**	**$2.12**	**$133.32**	**$0.38**	**$743.74**	**$2.50**

Table 32: 30-Year Present Value Incremental Costs for Single Zone Daylighting Control for – Controlling Either PSDZ Only or SSDZ Only

Control Solution Code	First Cost Total	First Cost Per Square Foot	30-year Present Value Maintenance and Replacement Cost Total	30-year Present Value Maintenance and Replacement Cost Per Square Foot	30-year Present Value Incremental Cost Total	30-year Present Value Incremental Cost Per Square Foot
R-WD-C-SZ	$218.52	$0.38	$0	$0	$218.52	$1.52
R-WL-CO-SZ	$389.02	$0.68	$53.70	$0.37	$442.73	$3.07
R-WL-O-SZ	$298.03	$0.52	$112.63	$0.55	$410.65	$2.62
R-WD-CO-SZ	$377.44	$0.66	$0	$0	$377.44	$2.62
Average	**$320.75**	**$0.56**	**$41.58**	**$0.23**	**$362.34**	**$2.46**

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 33 for the space types (offices, conference rooms, corridors, exercise rooms, and multipurpose rooms) that make up 98 percent of the expected installed wattage that would be newly controlled by automatic daylighting controls in PSDZs and SSDZs that contain lighting power between 75 watts and 120 watts. The Statewide CASE Team estimates that adding a two-zone automatic daylighting control to a space with 75 watts of controlled lighting in the primary zone and 75 watts of lighting in the secondary zone costs around $744 on a lifecycle basis. Similarly, adding a single-zone automatic daylighting control costs around $362 on a life cycle basis. The basis of these costs is presented in Table 31 and Table 32.

Table 33 shows that for the spaces controlled by automatic daylighting controls in both PSDZs and SSDZs as well as the PSDZ-only corridors, the benefit-to-cost ratios are greater than 1.0 for all climate zones. This means the proposed code change would be cost effective over the 30-year analyzed period.

Table 33: 30-Year Cost-Effectiveness Summary Daylighting Controls Most Common Configurations – New Construction, Additions and Alterations

Climate Zone	**PSDZ + SSDZ** 30-year LSC Savings (PV$/150 W)	**PSDZ + SSDZ** B/C Ratio [a]	**PSDZ** 30-year LSC Savings (PV$/75 W)	**PSDZ** B/C Ratio [b]	**PSDZ + SSDZ** 30-year LSC (PV$/150 W)	**PSDZ + SSDZ** B/C Ratio [a]
Prototype(s)	Office, Conference Room, Multipurpose Room	Office, Conference Room, Multipurpose Room	Corridor	Corridor	Exercise Room	Exercise Room
1	$928	1.25	$590	1.63	$824	1.11
2	$977	1.31	$603	1.66	$872	1.17
3	$995	1.34	$604	1.67	$890	1.20
4	$1,009	1.36	$603	1.66	$906	1.22
5	$1,018	1.37	$605	1.67	$914	1.23
6	$1,046	1.41	$615	1.70	$942	1.27
7	$949	1.28	$560	1.54	$853	1.15
8	$1,028	1.38	$612	1.69	$924	1.24
9	$1,029	1.38	$611	1.69	$924	1.24
10	$1,033	1.39	$610	1.68	$930	1.25
11	$955	1.28	$593	1.64	$852	1.15
12	$966	1.30	$598	1.65	$862	1.16
13	$973	1.31	$591	1.63	$871	1.17
14	$1,048	1.41	$612	1.69	$946	1.27
15	$1,047	1.41	$608	1.68	$946	1.27
16	$986	1.33	$608	1.68	$880	1.18

a. Assumes total incremental cost of $744.
b. Assumes total incremental cost of $362.

Table 34 considers rooms which are not deep and do not have a secondary sidelit zone or the less frequently encountered scenario, where the first row of lights starts in the secondary sidelit zone, and there is no primary sidelit zone. This table shows that implementing automatic daylighting controls in just PSDZs is cost effective with a benefit-to-cost ratio greater than 1.0 at a threshold of 75 watts. However, when implementing automatic daylighting controls in just SSDZs, the benefit-to-cost ratio can be slightly less than 1.0 for certain spaces in some climate zones.

The lowest benefit-to-cost ratios occur in SSDZs within spaces with a higher design illuminance, including exercise rooms at 400 lux. This is expected as higher levels of daylight would be needed to trigger automatic daylighting controls to dim the electric lights, hence resulting in lower overall energy savings. The threshold of 85W would ensure cost effectiveness in the worst case among the space types and climate zones analyzed when implementing automatic daylighting controls in SSDZs alone, as shown in Table 35. For this reason, an exception was created for the code change proposal to raise the threshold to 85 watts for SSDZs when automatic daylighting controls are not required in the corresponding PSDZs.

Table 34: 30-Year Cost Effectiveness Single Zone Daylighting Controls at 75 Watts, PSDZ only or SSDZ only – New Construction, Additions and Alterations

Climate Zone	PSDZ 30-year LSC Savings (PV$/75 W)	PSDZ B/C Ratio[a]	SSDZ 30-year LSC Savings (PV$/75 W)	SSDZ B/C Ratio[a]	PSDZ 30-year LSC Savings (PV$/75 W)	PSDZ B/C Ratio[a]	SSDZ 30-year LSC Savings (PV$/75 W)	SSDZ B/C Ratio[a]
Prototype(s)	Office, Conference Room, Multipurpose Room	Office, Conference Room, Multipurpose Room	Office, Conference Room, Multipurpose Room	Office, Conference Room, Multipurpose Room	Exercise Room	Exercise Room	Exercise Room	Exercise Room
1	$529	1.46	$398	1.10	$495	1.36	$330	0.91
2	$555	1.53	$422	1.17	$522	1.44	$351	0.97
3	$560	1.55	$435	1.20	$528	1.46	$362	1.00
4	$565	1.56	$445	1.23	$535	1.48	$371	1.02
5	$568	1.57	$450	1.24	$538	1.48	$376	1.04
6	$581	1.60	$465	1.28	$554	1.53	$388	1.07
7	$528	1.46	$420	1.16	$504	1.39	$348	0.96
8	$573	1.58	$454	1.25	$545	1.50	$379	1.05
9	$574	1.58	$455	1.26	$545	1.50	$379	1.05
10	$575	1.59	$458	1.26	$547	1.51	$382	1.06
11	$539	1.49	$416	1.15	$506	1.40	$347	0.96
12	$547	1.51	$420	1.16	$513	1.42	$349	0.96
13	$546	1.51	$427	1.18	$516	1.42	$355	0.98
14	$581	1.60	$468	1.29	$554	1.53	$392	1.08
15	$577	1.59	$470	1.30	$552	1.52	$394	1.09
16	$557	1.54	$429	1.18	$522	1.44	$357	0.99

a. Assumes total incremental cost of $362.

Table 35: 30-Year Cost Effectiveness Single Zone Daylighting Controls at 85 Watts, SSDZ only – New Construction, Additions and Alterations

Climate Zone	SSDZ 30-year LSC Savings (PV$/85 W)	SSDZ B/C Ratio[a]	SSDZ 30-year LSC Savings (PV$/85 W)	SSDZ B/C Ratio[a]
Prototype(s)	Office, Conference Room, Multipurpose Room	Office, Conference Room, Multipurpose Room	Exercise Room	Exercise Room
1	$451	1.25	$374	1.03
2	$478	1.32	$397	1.10
3	$493	1.36	$410	1.13
4	$504	1.39	$421	1.16
5	$510	1.41	$426	1.18
6	$527	1.45	$440	1.21
7	$476	1.31	$395	1.09
8	$515	1.42	$429	1.18
9	$516	1.42	$430	1.19
10	$519	1.43	$433	1.20
11	$472	1.30	$393	1.08
12	$476	1.31	$395	1.09
13	$484	1.34	$403	1.11
14	$530	1.46	$444	1.22
15	$532	1.47	$446	1.23
16	$486	1.34	$405	1.12

a. Assumes total incremental cost of $362.

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-unit savings, which are presented in Section 5.1, by assumptions about the percentage of newly constructed buildings that would be impacted by the proposed code. The statewide new construction forecast for 2026 is presented in Appendix A, as are the Statewide CASE Team's assumptions about the percentage of new construction that would be impacted by the proposal (by climate zone and building type).

For alterations, the Statewide CASE Team assumed that the existing building stock would be impacted by the proposed code change over the span of 15 years. In other words, one-fifteenth of the existing building stock would be impacted in the first year and each year thereafter. The statewide savings from alterations are thus determined by multiplying the per-unit savings by the estimated existing building stock in Appendix A and by the assumptions about the percentage of spaces within each building types that would be impacted by the proposed code change.

The first-year energy impacts represent the first-year annual savings from all buildings that were 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 do not take naturally occurring market adoption or compliance rates into account.

The tables below present the first-year statewide energy and energy cost savings from newly constructed buildings and additions (

Table 36) and alterations (Table 37) by climate zone. Table 38 presents first-year statewide savings from new construction, additions, and alterations. Values presented below represent the statewide forecasts or impacts associated with buildings that are built during the first year the requirements would be in effect. Energy impacts represent savings from buildings built in year one and achieved in one year only. LSC savings represent LSC savings from buildings built in year one but achieved over 30 years of operation.

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 36: Statewide Energy and LSC Impacts – New Construction and Additions

Climate Zone	Statewide New Construction and Additions Impacted (1,000 ft²)	Statewide New Construction Additions Impacted (kW)	Statewide Annual Electricity Savings (GWh/year)	Statewide Annual Peak Electrical Demand Reduction (MW)	Statewide Annual Source Energy Savings (Million kBtu)	Statewide 30-Year Present Value LSC (Million PV$)
1	18	11	0.02	0.000	0.01	$0.07
2	146	89	0.14	0.000	0.07	$0.59
3	786	493	0.81	0.003	0.43	$3.33
4	396	247	0.41	0.002	0.22	$1.69
5	67	41	0.07	0.000	0.04	$0.28
6	449	275	0.46	0.002	0.26	$1.96
7	334	206	0.34	0.002	0.19	$1.33
8	640	391	0.65	0.003	0.35	$2.74
9	1,163	703	1.17	0.005	0.64	$4.95
10	463	284	0.47	0.002	0.26	$1.99
11	116	74	0.12	0.000	0.06	$0.48
12	669	414	0.67	0.002	0.33	$2.73
13	217	133	0.22	0.001	0.11	$0.88
14	117	70	0.12	0.001	0.07	$0.50
15	71	44	0.07	0.000	0.04	$0.31
16	39	24	0.04	0.000	0.02	$0.16
Total	5,692	3,501	5.78	0.024	3.10	$24.01

Table 37: Statewide Energy and Energy Cost Impacts – Alterations

Climate Zone	Statewide Alterations Impacted (1,000 ft²)	Statewide Alterations Impacted (kW)	Statewide Annual Electricity Savings (GWh/year)	Statewide Annual Peak Electrical Demand Reduction (MW)	Statewide Annual Source Energy Savings (Million kBtu)	Statewide 30-Year Present Value LSC (Million PV$)
1	78	47	0.07	0.000	0.04	$0.30
2	503	305	0.50	0.002	0.26	$2.04
3	2,599	1,609	2.64	0.010	1.41	$10.90
4	1,367	849	1.41	0.005	0.76	$5.82
5	233	141	0.24	0.001	0.13	$0.98
6	1,754	1,071	1.80	0.008	1.00	$7.63
7	1,389	854	1.42	0.006	0.80	$5.51
8	2,537	1,553	2.58	0.011	1.40	$10.89
9	4,193	2,570	4.27	0.019	2.32	$18.02

10	2,257	1,359	2.27	0.010	1.24	$9.60
11	423	258	0.41	0.001	0.21	$1.69
12	2,505	1,531	2.48	0.009	1.24	$10.13
13	890	540	0.88	0.003	0.45	$3.60
14	535	321	0.54	0.002	0.31	$2.30
15	298	180	0.30	0.001	0.17	$1.28
16	160	97	0.16	0.001	0.08	$0.65
Total	**21,720**	**13,283**	**21.98**	**0.091**	**11.81**	**$91.34**

Table 38: Statewide Energy and LSC Impacts – New Construction, Additions, and Alterations

Construction Type	Statewide Annual Electricity Savings (GWh/year)	Statewide Annual Peak Electrical Demand Reduction (MW)	Statewide Annual Source Energy Savings (Million kBtu)	30-Year Present Value LSC (Million PV$)
New Construction & Additions	5.79	0.024	3.10	$24.05
Alterations	22.02	0.091	11.83	$91.51
Total	**27.81**	**0.114**	**14.94**	**$115.56**

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 LSC hourly factors and an assumed cost of $123.14 per metric tons of carbon dioxide equivalent emissions (metric tons CO2e).

The 2025 LSC hourly factors used in the lifecycle cost-effectiveness analysis include the monetary value of avoided GHG emissions based on a proxy for permit costs (not social costs).[15] 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. The authors used the same monetary values that are used in the Lifecycle Cost Hourly Factors.

Table 39 presents the estimated first-year avoided GHG emissions of the proposed code change. During the first year, GHG emissions of 782 (metric tons CO2e) would be

[15] 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.

avoided. It is worth noting that the average GHG reductions are approximately 20 Tons per GWH as compared to the average of 90 tons per GWh if the reductions occurred evenly over all hours of the year. This indicates that the daylighting savings occurs during the day when a greater fraction of electricity production is provided by renewable energy systems with lower GHG emission rates.

Table 39: First-Year Statewide GHG Emissions Impacts

Construction Type	Statewide Area with Added Daylight Controls (1,000 feet^2)	Statewide Lighting Wattage Newly Controlled (kW)	First-Year Statewide Electricity Savings [a] (GWh/year)	Reduced GHG Emissions [b] (Metric Tons CO2e)	Monetary Value of Reduced GHG Emissions ($)
New Construction & Additions	5,753	3,548	5.79	164	$20,219
Alterations	21,898	13,417	22.02	626	$77,109
Total	**27,651**	**16,965**	**27.81**	**790**	**$97,328**

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

b. GHG emissions factors are included in the LSC hourly factors published by CEC at 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 does not replace existing equipment or products with newer versions, as they are functional in the industry. However, the proposed mandatory code change would increase the usage of photosensors, control technology, and potentially cables and low voltage wires, depending upon implementation.

The Statewide CASE Team used the following approach to estimate material impacts:

- Estimate the material composition of each cost component for the daylight model used in deriving the per-unit energy impacts and incremental costs.
- Estimate the net change (from base case to proposed case) in units of cost component.
- Estimate the change in each material for the proposed code change per-unit (per watt).
- Apply the per-unit changes to new construction and alterations to develop statewide impact.

The Statewide CASE Team identified the material composition of the following cost components from a limited number of product environmental profiles or product safety datasheets published by the manufacturers.

- Photocontrol (Legrand North and Central America 2017)
- Cables, wires, and connectors (Legrand North America 2017, Belden 2013, Ideal Industries, Inc. 2003)
- Batteries (Duracell Industrial Operations, Inc 2022, Energizer Battery Manufacturing, Inc. 2017, Energizer Battery Manufacturing, Inc. 2017, Energizer Brands, LLC 2023)

The photocontrol material composition data identified above was for a product model different from those in Table 22. Therefore, the amount of each material used in the photocontrols considered in Table 22 was estimated by scaling that of the identified product model based on either weight or volume, whichever is available. The amount of material contained in the cables, wires and connectors were estimated based on the number and length needed to connect the photosensors to the controller in the daylight model. Similarly, the amount of each material contained in batteries were estimated based on the type and number of batteries required for the battery-powered photocontrols in the daylight model.

The amount of each material contained in all the cost components required to implement automatic daylighting controls in the daylight model would represent the amount of raw materials for 170 watts of controlled lighting power. The materials contained on a per-unit (per watt controlled) basis can then be derived by dividing the total amount of each material by 170. The statewide material impact is the product of the per-unit material amount and the first year statewide impacted wattage in the third columns of Table 36 and Table 37.

Table 40 shows the per-unit and first-year statewide impact of each material. Materials categories as “others” include a small number of other metals used in the printed circuit boards and electronic components in the photocontrols and cable connectors as well as small amount of other chemicals used in batteries.

Table 40: First-Year Statewide Impacts on Material Use

Material	Impact	Per-Unit Impacts (Pounds per Watt Controlled)	First-Year[a] Statewide Impacts (Pounds)
Mercury	No Change	0.000000	0.00
Lead	Increase	0.000002	29.82
Copper	Increase	0.000793	13,197.18
Steel	Increase	0.000946	15,734.51
Plastic	Increase	0.000980	16,306.19
Zinc	Increase	0.000007	109.18
Aluminum	Increase	0.000033	545.40

Lithium	Increase	0.000009	146.05
Manganese Dioxide	Increase	0.000021	351.30
Others	Increase	0.000103	1,716.37
TOTAL	-	-	48,135.99

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

7.5 Other Non-Energy Impacts

While automatic daylighting controls have been a mandatory requirement for many code cycles and a practice familiar to most market actors, it may be relatively new and unfamiliar to some building occupants. If offered an understanding of the system and how it functions, the occupants are likely to acclimate quickly to the control strategy and system behavior. If information is not offered to occupants, there could be confusion about the dimming behavior of the general lighting. If an occupant enters a space that is in dimmed due to ample daylight availability, such as an office or conference room, and turns on the luminaires on using manual controls but observes those in the daylit ones remain dim, there may be doubt that the lighting system is functioning as designed. Offering information on the system design and control plan can correct this.

Daylighting controls also have positive non-energy impacts. Daylight responsive controls reduce the amount of illuminance variability between the areas near windows and areas further away from windows. This reduced illuminance contrast can reduce discomfort glare in the space.

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).

8.2 Standards

SECTION 130.1 – MANDATORY INDOOR LIGHTING CONTROLS

…

d) **Automatic daylighting controls.** ~~The general lighting in skylit daylit zones, primary sidelit daylit zones and secondary sidelit daylit zones, as well as the general lighting in the combined primary and secondary sidelit daylit zones in parking garages, shall be provided with controls that automatically adjust the power of the installed lighting up and down to keep the total light level stable as the amount of incoming daylight changes.~~ In any enclosed space where the total installed wattage of general lighting luminaires completely or partially within skylit daylit zones is 75 W or greater, general lighting in skylit daylit zones shall be controlled by automatic daylighting controls. For skylights located in an atrium, the skylit daylit zone definition shall apply to the floor area directly under the atrium and the top floor area directly adjacent to the atrium.

In any enclosed space where the total installed wattage of general lighting luminaires completely or partially within primary sidelit daylit zones is 75 W or greater, the general lighting in the primary sidelit daylit zones shall be controlled by automatic daylighting controls.

In any enclosed space where the total installed wattage of general lighting luminaires in the secondary zones is 75 watts or greater, the general lighting in secondary sidelit daylit zones shall be controlled by automatic daylighting controls. General lighting in the secondary sidelit daylit zones shall be controlled independently of the general lighting in the primary sidelit daylit zones.

Parking garage areas where the total installed wattage of the general lighting in the primary and the secondary sidelit daylit zones is 60 watts or greater, the general lighting in the combined primary and secondary sidelit daylit zones shall be controlled by automatic daylighting controls. In parking garages, general lighting in the combined primary and secondary sidelit daylit zones shall be allowed to be controlled together.

General lighting luminaires longer than 8 feet shall be evaluated in segments of 8 feet or less for allocating luminaire power to the different daylit zones.

The general lighting in skylit daylit zones, primary sidelit daylit zones and secondary sidelit daylit zones, as well as the general lighting in the combined primary and secondary sidelit daylit zones in parking garages, shall be provided with controls that automatically adjust the power of the installed lighting in response to daylight availability in accordance with the following requirements.

1. All skylit daylit zones, primary sidelit daylit zones, secondary sidelit daylit zones, and the combined primary and secondary sidelit daylit zones in parking garages shall be shown on the plans.

   NOTE: Parking areas on the roof of a parking structure are outdoor hardscape, not skylit daylit areas.

2. General lighting in each type of daylit zone shall be controlled independently by automatic daylighting controls. ~~The automatic daylighting controls shall provide separate control for general lighting in each type of daylit zone.~~ General lighting in overlapping skylit daylit zone and sidelit daylit zone shall be controlled as part of the skylit daylit zone. General lighting in overlapping primary and secondary sidelit daylit zones shall be controlled as part of the primary sidelit daylit zone. ~~Linear LED luminaires and other solid state lighting (SSL) light sources in linear form may be treated as linear lamps in increments of 4 feet segment or smaller, and each segment is separately controlled based on~~ General lighting luminaires longer than 8 feet shall be controlled as segments of 8 feet or less and segments shall be controlled according to the type of the daylit zone in which the segment is primarily located.

3. The automatic daylighting controls shall:

   A. For spaces required to install multilevel controls under Section 130.1(b), adjust lighting via continuous dimming or the number of control steps provided by the multilevel controls;

   B. For each space, ensure the combined illuminance from the controlled lighting and daylight is not less than the illuminance from controlled lighting when no daylight is available;

   C. For areas other than parking garages, ensure that, when the daylight illuminance is greater than 150 percent of the illuminance provided by the controlled lighting when no daylight is available, the controlled lighting power in that daylight zone shall be reduced by a minimum of 90 percent; and

   D. For parking garages, ensure that when daylight illuminance levels measured at the farthest edge of the secondary sidelit zone away from the glazing or opening are greater than 150 percent of the illuminance provided by the controlled lighting when no daylight is available, the controlled lighting power in the combined primary and secondary sidelit daylit zones shall be reduced by 100 percent.

4. Photosensors should be located so that they are not readily accessible to unauthorized personnel.
5. The location where calibration adjustments are made to the automatic daylighting controls shall be readily accessible to authorized personnel but may be inside a locked case or under a cover which requires a tool for access.
6. Interactions with other lighting controls.
    A. Where area controls are required, area controls shall be capable of turning off or decreasing light levels to below the light levels set by the daylighting controls.
    B. Area controls shall be allowed to temporarily increase electric lighting light levels above the required levels in Section 130.1(d)3 if the controls are configured to reset electric lighting controls back to the Section 130.1(d)3 defaults after lights have been turned off or reduced by a manual control, occupancy sensor or timeclock.

Exception 1 to Section 130.1(d): Areas under skylights where it is documented that existing adjacent structures or natural objects block direct sunlight for more than 1,500 daytime hours per year between 8 a.m. and 4 p.m.

Exception 2 to Section 130.1(d): Areas adjacent to vertical glazing below an overhang, where the overhang covers the entire width of the vertical glazing, no vertical glazing is above the overhang, and the ratio of the overhang projection to the overhang rise is greater than 1.5 for South, East and West orientations or greater than 1 for North orientations.

Exception 3 to Section 130.1(d): Where automatic daylighting controls are not required for the primary sidelit daylit zones, and where the total wattage of general lighting luminaires in the secondary sidelit daylit zones is less than 85 watts, automatic daylighting controls are not required for the secondary sidelit zone. ~~Rooms where the combined total installed wattage of the general lighting in the skylit and primary sidelit zones is less than 120 watts are not required to have daylighting controls for those zones. Rooms where the total installed wattage of the general lighting in the secondary sidelit zones is less than 120 watts are not required to have daylighting controls for that zone.~~

~~**Exception 4 to Section 130.1(d):** Parking garage areas where the total installed wattage of the general lighting in the primary and the secondary sidelit daylit zones is less than 60 watts do not require automatic daylighting controls in the daylit zones.~~

Exception 4 ~~5~~ to Section 130.1(d): Rooms that have a total glazing area of less than 24 square feet, or parking garage areas with a combined total of less than 36 square feet of glazing or opening.

Exception 5 ~~6~~ to Section 130.1(d): For parking garages, luminaires located in the daylight adaptation zone.

EXCEPTION 6 ~~7~~ to Section 130.1(d): Luminaires in sidelit daylit zones in retail merchandise sales and wholesale showroom areas.

SECTION 160.5 – MANDATORY INDOOR REQUIREMENTS FOR INDOOR AND OUTDOOR SPACES

…

(b) **Common Services Area Lighting.** Lighting systems and equipment in multifamily common services areas shall comply with applicable provisions of Sections 160.5(b)1 through 160.5(b)4.

…

4. Mandatory Indoor Lighting Controls. Multifamily common use areas shall comply with the applicable requirements of Sections 160.5(b)4A through 160.5(b)4F, in addition to the applicable requirements of Sections 110.9.

…

D. **Automatic Daylighting Controls.** ~~The general lighting in skylit daylit zones, primary sidelit daylit zones, and secondary sidelit daylit zones, as well as the general lighting in the combined primary and secondary sidelit daylit zones in parking garages, shall be provided with controls that automatically adjust the power of the installed general lighting up and down to keep the total light level stable as the amount of incoming daylight changes.~~ In any enclosed space where the total installed wattage of general lighting luminaires completely or partially within skylit zones is 75 W or greater, general lighting in the skylit zone shall be controlled by automatic daylighting controls. For skylights located in an atrium, the skylit daylit zones shall apply to the floor area directly under the atrium and the top floor area directly adjacent to the atrium.

In any enclosed space where the total installed wattage of general lighting luminaires completely or partially within primary sidelit daylit zones is 75 W or greater, the general lighting in the primary sidelit daylit zones shall be controlled by automatic daylighting controls.

In any enclosed space where the total installed wattage of general lighting luminaires in the secondary sidelit daylit zones is 75 watts or greater, the general lighting in the secondary sidelit daylit zones shall be controlled by automatic daylighting controls. General lighting in the secondary sidelit daylit zones shall be controlled independently of the general lighting in the primary sidelit daylit zones.

Parking garage areas where the total installed wattage of the general lighting in the primary and the secondary sidelit daylit zones is 60 watts or greater, the general lighting in the combined primary and secondary sidelit daylit zones shall be controlled by automatic daylighting controls.

General lighting luminaires longer than 8 feet shall be evaluated in segments of 8 feet or less for allocating luminaire power to the different daylit zones.

The general lighting in skylit daylit zones, primary sidelit daylit zones and secondary sidelit daylit zones, as well as the general lighting in the combined primary and secondary sidelit daylit zones in parking garages, shall be provided with controls that automatically adjust the power of the installed lighting in response to daylight availability in accordance with the following requirements.

i. All skylit daylit zones, primary sidelit daylit zones, secondary sidelit daylit zones and the combined primary and secondary sidelit daylit zones in parking garages shall be shown on the plans.

Note: Parking areas on the roof of a parking structure are outdoor hardscape, not skylit daylit areas.

ii. General lighting in each type of daylit zone shall be controlled independently by automatic daylighting controls. The automatic daylighting controls shall provide separate control for general lighting in each type of daylit zone. General lighting in overlapping skylit daylit zone and sidelit daylit zone shall be controlled as part of the skylit daylit zone. General lighting in overlapping primary and secondary sidelit daylit zone shall be controlled as part of the primary sidelit daylit zone. Linear LED luminaires and other solid state lighting (SSL) light sources in linear form may be treated as linear lamps in increments of 4 feet segment or smaller, and each segment is separately controlled based on General lighting luminaires longer than 8 feet shall be controlled as segments of 8 feet or less and segments shall be controlled according to the type of the daylit zone the segment is primarily located.

iii. The automatic daylighting controls shall:

Appendix AFor spaces required to install multilevel controls under Section 160.5(b)4B, adjust lighting via continuous dimming or the number of control steps provided by the multilevel controls;

Appendix BFor each space, ensure the combined illuminance from the controlled lighting and daylight is not less than the illuminance from controlled lighting when no daylight is available;

Appendix CFor areas other than parking garages, ensure that when the daylight illuminance is greater than 150 percent of the illuminance provided by the controlled lighting system when no daylight is available, the controlled lighting power in that daylight zone shall be reduced by a minimum of 90 percent; and

Appendix DFor parking garages, ensure that when daylight illuminance levels measured at the farthest edge of the secondary sidelit zone away from the glazing or opening are greater than 150 percent of the illuminance provided by the controlled lighting when no daylight is available, the controlled lighting power in the combined primary and secondary sidelit daylight zones shall be reduced by 100 percent.

iv. Photosensor shall be located so that they are not readily accessible to unauthorized personnel.

v. The location where calibration adjustments are made to the automatic daylighting controls shall be readily accessible to authorized personnel but may be inside a locked case or under a cover that requires a tool for access.

vi. Interactions with other lighting controls.

a. Where area controls are required, area controls shall be capable of turning off or decreasing light levels to below the light levels set by the daylighting controls.

b. Area controls shall be allowed to temporarily increase electric lighting light levels above the required levels in 160.5(b)4Diii if the controls are configured to reset electric lighting controls back to the 160.5(b)4Diii defaults after lights have been turned off or reduced by a manual control, occupancy sensor or timeclock.

Exception 1 to Section 160.5(b)4D: Areas under skylights where it is documented that existing adjacent structures or natural objects block direct sunlight for more than 1,500 daytime hours per year between 8 a.m. and 4 p.m.

Exception 2 to Section 160.5(b)4D: Areas adjacent to vertical glazing below an overhang, where the overhang covers the entire width of the vertical glazing, no vertical glazing is above the overhang, and the ratio of the overhang projection to the overhang rise is greater than 1.5 for south, east, and west orientations or greater than 1 for north orientations.

Exception 3 to Section 160.5(b)4D: Where automatic daylighting controls are not required for the primary sidelit daylit zones, and where the total wattage of general lighting luminaires in the secondary sidelit daylit zones is less than 85 watts, automatic daylighting controls are not required for the secondary sidelit zone. ~~Rooms where the combined total installed wattage of the general lighting in the skylit and primary sidelit zones is less than 120 watts are not required to have daylighting controls for those zones. Rooms where the total installed wattage of the general lighting in the secondary sidelit zones is less than 120 watts are not required to have daylighting controls for that zone.~~

~~**Exception 4 to Section 160.5(b)4D:** Parking garage areas where the total installed wattage of the general lighting in the primary and the secondary sidelit daylit zones is less than 60 watts do not require automatic daylighting controls in the daylit zones.~~

Exception 4 ~~5~~ to Section 160.5(b)4D: Rooms that have a total glazing area of less than 24 square feet, or parking garage areas with a combined total of less than 36 square feet of glazing or opening.

Exception 5 ~~6~~ to Section 160.5(b)4D: For parking garages, luminaires located in the daylight adaptation zone and luminaires for only dedicated ramps. Daylight adaptation zone and dedicated ramps are defined in Section 100.1.

Exception 6 ~~7~~ to Section 160.5(b)4D: Luminaires in sidelit daylit zones in retail merchandise sales and wholesale showroom areas.

8.3 Reference Appendices

The following changes are proposed to NA 7.6 Indoor Lighting Controls Acceptance Tests, to exercise the interaction requirements between manual control and daylighting controls as described in Section 130.1(d)6 and Section 160.5(b)4Dvi.

NA 7.6 Indoor Lighting Controls Acceptance Tests

…

NA7.6.1.4 **Continuous Dimming Control Systems Functional Testing**

<Add new Section (f) to the acceptance test as follows:>

(f) Interaction with Area Controls.

Conduct this test under partial daylight conditions where the electric lighting is neither at full output nor at minimum light output. Where area controls are required in the enclosed space with electric lighting controlled by daylighting controls, verify and document the following.

1. Manual on/off control lighting reduction test
    a. Try to turn off controlled electric lighting with manual area controls. If manual control cannot turn off lighting, fix the system and retest again.
    b. After turning off the lighting with the manual control, turn the lights back on. If the lights do not return to their partially dimmed level in response to the daylighting controls, fix the system and retest again.
2. Manual dimmer control lighting reduction test
    a. If manual control is also a dimmer, try to dim lights. If dimmer cannot dim lights below light level set by daylighting controls, fix the system and retest again.
    b. After automatic shut-off controls turn off lights and turn on lights again evaluate dimming level. If the lights do not return to their partially dimmed level in response to the daylighting controls, fix the system and retest again.
3. Manual dimmer control lighting increase test. Manual dimmers do not have to have the capability to increase electric light levels above that set by the daylighting control. If manual dimmers do increase electric light levels above the values set by the daylighting control, the controls must also successfully pass this test.
    a. Use manual dimmer to increase electric light level above that set by automatic daylighting control. Record result.
    b. After automatic shut-off controls turn off lights and turn on lights again evaluate dimming level. If the lights do not return to their partially dimmed level in response to the daylighting controls, fix the system and retest again.

***NA7.6.1.5* Stepped Switching or Stepped Dimming Control Systems Functional Testing**

<Add new Section (e) to the acceptance test as follows:>

(f) Interaction with Area Controls.

Conduct this test under partial daylight conditions where the electric lighting is neither at full output nor at minimum light output. Where area controls are required in the enclosed space with electric lighting controlled by daylighting controls, verify and document the following.

1. Manual on/off control lighting reduction test

a. Try to turn off controlled electric lighting with manual area controls. If manual control cannot turn off lighting, fix the system and retest again.
b. After turning off the lighting with the manual control, turn the lights back on. If the lights do not return to their partial output level in response to the daylighting controls, fix the system and retest again.

8.4 ACM Reference Manual

5.4.5 Daylighting Control

This group of building descriptors is applicable for spaces that have daylighting controls or daylighting control requirements.

…

DAYLIGHT CONTROL REQUIREMENTS

Applicability: All spaces with exterior fenestration.

Definition: The extent of daylighting controls in skylit and sidelit areas of the space.

Units: List.

Input Restrictions: When the installed general lighting power in the primary sidelit daylit zone is ~~exceeds~~ 75W ~~120~~or greater, daylighting controls are required, per the Title 24 mandatory requirements.

Standard Design: For nonresidential spaces, when the installed general lighting power in the skylit, primary sidelit, or secondary sidelit daylit zone is ~~exceeds~~ 75W~~120~~ or greater, daylighting controls are required, per the Title 24 mandatory requirements. Controls are not required if total glazing area is less than 24 ft^2 or for luminaires in sidelit daylit zones in retail merchandise sales and wholesale showroom areas.

For parking garages, when the installed general lighting power in the primary sidelit and secondary sidelit daylit zone exceeds 60W, daylighting controls are required, per the Title 24 mandatory requirements. Luminaires located in daylit transition zones or dedicated ramps are exempt from this requirement. Controls are not required if total glazing and openings are less than 36 $feet^2$.

Appendix 5.4B: Schedules-24N

The office lighting schedule under the “Office” tab of Appendix 5.4B needs to be updated to reflect the occupancy schedule within the same tab. The lighting schedule currently has values which do not align with the occupancy schedule. See Appendix H for more details.

8.5 Compliance Documents

The lighting compliance form CEC-NRCC-LTI would be updated with the revised 75-Watt threshold for when daylight controls are required as well as the ruleset for the exception when there is no required primary zone control in the space resulting in an increased secondary sidelit zone threshold to 85 watts.

The daylighting controls acceptance test form 2022-CEC-NRCA-LTI-03 would be updated with a manual control/daylighting control interaction test that confirms the manual control can lower the light output of electric lighting. Additionally, if the manual control can increase electric lighting levels, the electric lighting levels shall be reset to the default levels as controlled by the daylighting controls after the lights are turned off and on by a manual control, occupancy control or timeclock control.

9. Bibliography

n.d. http://bees.archenergy.com/Documents/Software/CBECC-Com_2016.3.0_SP1_Prototypes.zip.

Abualsaud, Rana, Grigory Ostrovskiy, and Ziyad Mahfoud. 2019. "Ethnicity-Based Inequality in Heat-Related Illness Is on the Rise in California." *Wilderness & Environmental Medicine* 100-103.

ACEEE. n.d. "Energy Equity." *ACEEE.org.* Accessed 2023. https://www.aceee.org/topic/energy-equity.

Association, National Energy Assistance Directors. 2011. "2011 National Energy Assistance Survey Final Report."

Belden. 2013. "1624R Multi-Conductor - Category 5 Nonbonded-Pair ScTP Cable." August 14. Accessed June 3, 2023. https://www.belden.com/hubfs/resources/technical/technical-data/english/1624R.pdf.

Blankenship, Britney: J Renner, H Werner, M Lerner, K Cunningham. 2020. *Hand-in-Hand: Environmental and Social Justice Communities and California Energy Code.* ACEEE Summer Study on Energy Efficiency in Buildings.

Bonneville Power Authority. 2015. "2015 Non-Residential Lighting Market Characterization." October. https://www.bpa.gov/EE/Utility/research-archive/Documents/Momentum-Savings-Resources/2015_Non-Res_Lighting_Mkt_Characterization.pdf.

BW Research Partnership. 2016. *Advanced Energy Jobs in California: Results of the 2016 California Advanced Energy.* Advanced Energy Economy Institute.

California Air Resouces Board. 2019. "Global Warming Potentials." https://www.arb.ca.gov/cc/inventory/background/gwp.htm#transition.

California Department of Water Resources. 2016. "California Counties by Hydrologic Regions." Accessed April 3, 2016. http://www.water.ca.gov/landwateruse/images/maps/California-County.pdf.

California Energy Commission. 2015. *2016 Building Energy Efficiency Standards: Frequently Asked Questions.* http://www.energy.ca.gov/title24/2016standards/rulemaking/documents/2016_Building_Energy_Efficiency_Standards_FAQ.pdf.

—. 2022. "Energy Code Data for Measure Proposals." *energy.ca.gov.* https://www.energy.ca.gov/title24/documents/2022_Energy_Code_Data_for_Measure_Proposals.xlsx.

—. 2022. "Housing and Commercial Construction Data - Excel." https://ww2.energy.ca.gov/title24/documents/2022_Energy_Code_Data_for_Measure_Proposals.xlsx.

—. 2018. "Impact Analysis: 2019 Update to the California Energy Efficiency Standards for Residential and Non-Residential Buildings." *energy.ca.gov.* June 29. https://www.energy.ca.gov/title24/2019standards/post_adoption/documents/2019_Impact_Analysis_Final_Report_2018-06-29.pdf.

California Governer's Office of Emergency Services. 2021. *Cal OES News.* August 3. Accessed 2023. https://news.caloes.ca.gov/project-roomkey-impact-to-date-and-looking-ahead/.

California Public Utilities Commission (CPUC). 2015b. "Water/Energy Cost-Effectiveness Analysis: Revised Final Report." Prepared by Navigant Consulting, Inc. http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=5360.

California Public Utilities Commission. 2015a. "Water/Energy Cost-Effectiveness Analysis: Errata to the Revised Final Report." Prepared by Navigant Consulting, Inc. . http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=5350.

CEC. 2018. "Energy Equity Indicators Tracking Progress." *Energy.ca.gov.* June 25. Accessed 2023. https://www.energy.ca.gov/sites/default/files/2019-12/energy_equity_indicators_ada.pdf.

Chapple, Daniel. n.d. *Grocery Store Development in Recognized Food Deserts.* Sustainable Development Code . https://sustainablecitycode.org/brief/grocery-store-development-in-recognized-food-deserts/.

Cluett, Rachel, J Amann. 2015. "Multiple Benefits of Multifamily Energy Efficiency for Cost-Effectiveness Screening." *American Council for an Energy-Efficiency Economy.*

CPUC. n.d. "Disadvantaged Communities." Accessed 2023. https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/infrastructure/disadvantaged-communities#:~:text=What%20is%20a%20Disadvantaged%20Community,%2C%20health%2C%20and%20environmental%20burdens.

DC Fiscal Policy Institute. 2017. "Style Guide for Inclusive Language." *DCFPI.* December. https://www.dcfpi.org/wp-content/uploads/2017/12/Style-Guide-for-Inclusive-Language_Dec-2017.pdf.

Deng, Hengfang, Daniel P Aldrich, Michael M Danziger, Jianxi Gao, Nolan E Phillips, Sean P Cornelius, and Qi Ryan Wang. 2021. "High-resolution human mobility data reveal race and wealth disparities in disaster evacuation patterns." *Humanities & Social Sciences Communications.*

DOE. 2016. "Energy Savings Forecast of Solid-State Lighting in General Illumination Applications." https://energy.gov/sites/prod/files/2016/09/f33/energysavingsforecast16_2.pdf.

Drehobl, Ariel: L Ross: R Ayala. 2020. *How High are Household Energy Burdens? An Assessment of National and Metropolitan Energy Burden Across the United States.* American Council for an Energy-Efficiency Economy.

Duracell Industrial Operations, Inc. 2022. "Product Safety Data Sheet: Alkaline - Major and Specialty Cells and Batteries." January 17. Accessed June 9, 2023. https://www.procell.cn/wp-content/uploads/2022/04/2022-PSDS-Procell-Alkaline.pdf.

Energizer Battery Manufacturing, Inc. 2017. "Product Safety Data Sheet: Cylindrical Lithium Manganese Dioxide Batteries." January. Accessed June 9, 2023. https://data.energizer.com/pdfs/lithiummangdioxide_psds.pdf.

—. 2017. "Product Safety Data Sheet: Lithium Iron Disulfide Batteries." January. Accessed June 9, 2023. https://data.energizer.com/pdfs/lithiumirondisulfide_psds.pdf.

Energizer Brands, LLC. 2023. "Article Information Sheet/Safety Data Sheet (AIS/SDS): Alkaline Manganese Dioxide-Zinc Battery." January. Accessed June 9, 2023. https://data.energizer.com/wp-content/uploads/2023/01/alkaline-01-23-Energizer-1.pdf.

EPA. 2021. *Climate Change and Social Vulnerability in the United States: A Focus on Six Impacts.* U.S. Environmental Protection Agency, EPA.

Ettenson, Lara , and Christa Heavey. 2015. *California's Golden Energy Efficiency Opportunity: Ramping Up Success to Save Billions and Meet Climate Goals.* Natural Resources Defense Council & Environmental Entrepreneurs (E2).

Federal Reserve Economic Data (FRED). n.d. Accessed Sepember 14, 2022. https://fred.stlouisfed.org/release/tables?eid=258470&rid=144 .

—. n.d. *Data series relied on: Net Domestic Private Investment, Corporate Profits After Taxes.* Accessed September 18, 2022. https://fred.stlouisfed.org .

Goldman, Charles, Merrian C. Fuller, Elizabeth Stuart, Jane S Peters, Marjorie McRay, Nathaniel Albers, Susan Lutzenhiser, and Mersiha Spahic. 2010. *Energy*

Efficiency Services Sector: Workforce Size and Expectations for Growth. Lawrence Berkeley National Laboratory.

Goldsmith, Leo, and Michelle L. Bell. 2021. "Queering Environmental Justice: Unequal Environmental Health Burden on the LGBTQ+ Community." *American Journal of Public Health.* https://ajph.aphapublications.org/doi/10.2105/AJPH.2021.306406.

Heschong Mahone Group. 2012. "Daylight Metrics: PIER Daylighting Plus Research Program." https://www.researchgate.net/profile/Lisa-Heschong/publication/328965606_DAYLIGHT_METRICS_REPORT_for_the_CEC_PIER_Daylighting_Plus_Research_Program/links/5bed9e694585150b2bb9fcb3/DAYLIGHT-METRICS-REPORT-for-the-CEC-PIER-Daylighting-Plus-Research-Program.p.

Ideal Industries, Inc. 2003. "Wire-Nut Wire Connector Material Safety Data Sheet." October 9. Accessed June 8, 2023. https://cdn.cableorganizer.com/old-images/ideal/wire-nut/wire-nut-MSDS.pdf.

IEA. 2014. *Capturing the Multiple Benefits of Energy Efficiency.* International Energy Agency.

Itron, Inc. 2014. "California Commercial Saturation Survey." http://www.calmac.org/publications/California_Commercial_Saturation_Study_Report_Finalv2ES.pdf.

Kenney, Michael, Heather Bird, and Heriberto Rosales. 2019. *2019 California Energy Efficiency Action Plan.* Publication Number: CEC- 400-2019-010-CMF , California Energy Commission. Kenney, Michael, Heather Bird, and Heriberto Rosales. 2019. 2019 California Energy Efficiency Action Plan. California Energy Commission. Publication Number: CEC- 400-2019-010-CMF .

Laaidi, Karine: A Zeghnoun: B Dousset: P Bretin: S Vandentorren: E Giraudet: P Beaudeau. 2012. "The Impact of Heat Islands on Mortality in Paris during the August 2003 Heat Wave." *Environmental Health Perspectives.*

Legrand North America. 2017. "Product Environmental Profile: Wattstopper® - LMRJ-100." July. Accessed June 3, 2023. https://legrand.webdamdb.com/directdownload.php?ti=55645473&tok=LUyZG/VLPnU6sSey8OYNnwRR.

Legrand North and Central America. 2017. "Product Environmental Profile: Wattstopper® - LMLS-600 Dual Loop Photosensor." September. Accessed April 12, 2023. https://legrand.webdamdb.com/directdownload.php?ti=55645602&tok=bxbUHOxkdfGP3yq97nRZkARR.

Lewis, LaVonna Blair, David C Sloane, Lori Miller Nascimento, Allison L Diamant, Joyce Jones Guinyard, Antronette K Yancey, and Gwendolyn Flynn. 2005. "African Americans' Access to Healthy Food Options in South Los Angeles Restaurants." *American Journal of Public Health.*

Morelix, Alicia Robb and Arnobio. 2016. *Startup Financing Trends by Race: How Access to Capital Impacts Profitability.* Erwing Marion Kauffmann Foundation.

National Energy Assistance Directors' Association. 2011. *2011 National Energy Assistance Survey Final Report.* http://www.appriseinc.org/reports/Final%20NEADA%202011%20Report.pdf.

Nezamdoost, Amir, Alen Mahic, and Kevin Van Den Wymelenberg. 2018. "A Human Factors Study to Update a Recently Proposed Manual Blind Use Algorithm for Energy and Daylight Simulations." https://ieeexplore.ieee.org/document/8591835.

Norton, Ruth Ann, & B Brown. 2014. "Green & Healthy Homes Initiative: Improving Health, Economic, and Social Outcomes Through Integrated Housing Intervention." *Environmental Justice* Vol. 7 (Nbr. 6.).

Oh, Hyeon-Ju. 2020. "Exposure to respirable particles and TVOC in underground parking garages under different types of ventilation and their associated health effects." *Air Quality Atmosphere & Health.*

Pew Research Center. 2023. *Attendance at religious services by race/ethnicity.* Accessed 2023. https://www.pewresearch.org/religion/religious-landscape-study/compare/attendance-at-religious-services/by/racial-and-ethnic-composition/.

Ramanathan, Lavanya. 2017. "Mall outside DC has found a niche: immigrants." *AP News*, January 16. https://apnews.com/article/--9557e5da878b4328af8aab985167039d.

Rose, Erin: Hawkins, Beth. 2020. *Background Data and Statistics on Low- Income Energy Use and Burden for the Weatherization Assistance Program: Update for Fiscal Year 2020.* Oak Ridge National Laboratory.

SBW Consulting, Inc. 2022. *Water-Energy Calculator 2.0 Project Report.* Project Report, San Francisco: California Public Utility Commission.

Sezgen, Osman, and Jonathan G. Koomey. 1998. *Interactions Between Lighting and Space Conditioning Energy Use in U.S. Commercial Buildings.* Lawrence Berkeley National Laboratory.

Smargiassi, Audrey: M Fournier: C Griot: Y Baudouin: T Kosatsky. 2008. "Prediction of the indoor temperatures of an urban area with an in-time regression mapping approach." *Journal of Exposure Science and Environmental Epidemiology.*

State of California Department of Industrial Relations. 2023. *Director's General Prevailing Wage Determinations.* April. Accessed June 10, 2023. https://www.dir.ca.gov/oprl/DPreWageDetermination.htm.

State of California. n.d. *Employment Development Department, Quarterly Census of Employment and Wages (data search tool).* Accessed September 1, 2022. https://www.labormarketinfo.edd.ca.gov/cgi/dataanalysis/areaselection.asp?tablename=industry.

—. n.d. "Government Code Title 7 Division 1 Chapter 1.5 Article 4." *California Legislative Information.* Accessed 2023. https://leginfo.legislature.ca.gov/faces/codes_displaySection.xhtml?sectionNum=65040.12.&lawCode=GOV.

State of California, Employment Development Department. n.d. *Quarterly Census of Employment and Wages (data search tool).* Accessed September 1, 2022. https://www.labormarketinfo.edd.ca.gov/cgi/dataanalysis/areaselection.asp?tablename=industry.

Statewide CASE Team. 2011. *Measure Information Template - Indoor Lighting Controls.* Codes and Standards Enhancement Initiative.

Stone, Nehemiah, Jerry Nickelsburg, and William Yu. 2015. *Codes and Standards White Paper: Report - New Home Cost v. Price Study.* Pacific Gas and Electric Company. Accessed February 2, 2017. http://docketpublic.energy.ca.gov/PublicDocuments/Migration-12-22-2015/Non-Regulatory/15-BSTD-01/TN%2075594%20April%202015%20Codes%20and%20Standards%20White%20Paper%20-%20Report%20-%20New%20Home%20Cost%20v%20Price%20Study.pdf.

Tessum, Christopher W., Joshua S. Apte, Andrew L. Goodkind, Nicholas Z. Muller, Kimberley A. Mullins, David A. Paolella, Stephen Polasky, et al. 2019. "Inequity in consumption of goods and services adds to racial–ethnic disparities in air pollution exposure." *PNSA* 113 (13). https://doi.org/10.1073/pnas.1818859116.

The Sarah Samuels Center for Public Health Research and Evaluation. 2016. *California FreshWorks Food Access Report.* The California Endowment.

Thornberg, Christopher, Hoyu Chong, and Adam Fowler. 2016. *California Green Innovation Index - 8th Edition.* Next 10.

U.S. BUREAU OF LABOR STATISTICS. 2023. *U.S. Bureau of Labor Statistics.* January 25. Accessed 2023. https://www.bls.gov/cps/cpsaat18.htm.

U.S. Census Bureau, Population Division. 2014. "Annual Estimates of the Resident Population: April 1, 2010 to July 1, 2014."

http://factfinder2.census.gov/bkmk/table/1.0/en/PEP/2014/PEPANNRES/0400000US06.05000.

U.S. Energy Information Administration. 2016. *2012 CBECS Survey Data.* May 20. http://www.eia.gov/consumption/commercial/data/2012/.

U.S. EPA (United States Environmental Protection Agency). 2011. "Emission Factors for Greenhouse Gas Inventories." Accessed December 2, 2013. http://www.epa.gov/climateleadership/documents/emission-factors.pdf.

UCLA Labor Center. 2022. *Fast Food Frontline: COVID-19 and Working Conditions in Los Angeles.* Los Angeles: UCLA Labor Center.

United States Census Bureau. n.d. *Quick Facts 2019 and 2021.* Accessed September 12, 2022. United States Census Burhttps://data.census.gov/cedsci/table?t=Housing%20Units&g=0400000US06&tid=ACSCP5Y2020.CP04.

United States Environmental Protection Agency. 1995. "AP 42, Fifth Edition Compilation of Air Pollutant Emissions Factors, Volume 1: Stationary Point and Area Sources." https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors#5thed.

United States Environmental Protection Agency. 2018. "Emissions & Generation Resource Integrated Database (eGRID) 2016." https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid.

United States Government Accountability Office . 2018. *K-12 EDUCATION Public High Schools with More Students in Poverty and Smaller Schools Provide Fewer Academic Offerings to Prepare for College.* United States Government Accountability Office .

Zabin, Carol, and Karen Chapple. 2011. *California Workforce Education & Training Needs Assessment: For Energy Efficiency, Distributed Generation, and Demand Reponse.* University of California, Berkeley Donald Vial Center on Employment in the Green Economomy. Accessed February 3, 2017. http://laborcenter.berkeley.edu/pdf/2011/WET_Appendices_ALL.pdf.

Appendix A: Statewide Savings Methodology

The Statewide CASE Team estimated statewide impacts for the first year by multiplying per-unit savings estimates by statewide construction forecasts that the CEC provided (California Energy Commission 2022). On March 27, 2023, the CEC provided the construction estimates at the Staff Workshop on Triennial California Energy Code Measure Proposal Template.

To calculate first-year statewide savings, the Statewide CASE Team multiplied the per-unit savings by statewide construction estimates for the first year the standards would be in effect (2026). The nonresidential new construction forecast is presented in Table 41 and nonresidential existing statewide building stock is presented in Table 42. The projected nonresidential new construction that would be impacted by the proposed code change in 2026 is presented in Table 41. The projected nonresidential existing statewide building stock that would be impacted by the proposed code change as a result of alterations in 2026 is presented in Table 42. This section describes how the Statewide CASE Team developed these estimates.

The CEC Building Standards Office provided the nonresidential construction forecast, which is available for public review on the CEC's website: https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2025-building-energy-efficiency .

The construction forecast presents the total floorspace of newly constructed buildings in 2026 by building type and climate zone. The building types included in the CECs' forecast are summarized in Table 41.

The Statewide CASE Team made assumptions about the percentage of newly constructed floorspace that would be impacted by the proposed code change. Table 45 presents the assumed percentage of floorspace that would be impacted by the proposed code change by building type. If a proposed code change does not apply to a specific building type, it is assumed that zero percent of the floorspace would be impacted by the proposal. If the assumed percentage is non-zero, but less than 100 percent, it is an indication that some but not all buildings would be impacted by the proposal. Table 46 resents percentage of floorspace assumed to be impacted by the proposed change by climate zone. These assumptions were derived from the estimated composition of common space types that are likely to be impacted by the proposed code change based on the design experiences. And these space types include offices, conference rooms, multipurpose rooms, corridors, lobbies, exercise rooms, small dining areas, transaction spaces, and retail areas.

Table 41: Estimated New Nonresidential Construction in 2026 (Million Square Feet) by Climate Zone (CZ)

Building Type	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16	All CZs
Large Office	0.00	0.00	2.90	1.42	0.00	1.28	0.74	2.05	3.72	0.35	0.10	0.52	0.00	0.18	0.01	0.04	13.31
Medium Office	0.13	0.48	1.37	0.74	0.37	1.20	0.80	1.65	3.18	1.17	0.27	2.80	0.59	0.35	0.26	0.10	15.47
Small Office	0.01	0.43	0.19	0.02	0.06	0.15	0.23	0.16	0.36	0.41	0.09	0.54	0.38	0.04	0.10	0.03	3.22
Large Retail	0.00	0.00	1.10	0.55	0.15	0.70	0.37	0.83	1.66	0.63	0.30	1.30	0.36	0.14	0.18	0.06	8.34
Medium Retail	0.08	0.35	0.79	0.45	0.09	0.60	0.29	0.86	1.42	0.82	0.14	0.63	0.38	0.18	0.12	0.08	7.29
Strip Mall	0.00	0.15	0.50	0.23	0.01	0.56	0.49	0.99	1.07	1.35	0.07	0.59	0.33	0.32	0.10	0.06	6.81
Mixed-use Retail	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Large School	0.01	0.11	0.77	0.39	0.03	0.52	0.54	0.80	1.25	0.75	0.31	1.01	0.54	0.15	0.08	0.06	7.32
Small School	0.07	0.27	0.46	0.23	0.14	0.32	0.29	0.35	0.66	0.35	0.10	0.78	0.30	0.11	0.04	0.04	4.50
Non-refrigerated Warehouse	0.06	0.37	2.16	1.12	0.18	1.36	0.71	1.95	3.01	1.36	0.63	2.84	0.82	0.36	0.37	0.14	17.44
Hotel	0.04	0.22	1.03	0.53	0.11	0.55	0.48	0.78	1.18	0.57	0.15	0.80	0.26	0.14	0.12	0.04	7.02
Assembly	0.01	0.39	1.58	0.56	0.06	0.79	0.80	1.43	1.82	1.14	0.17	1.41	0.30	0.25	0.12	0.08	10.92
Hospital	0.03	0.17	0.81	0.42	0.08	0.32	0.53	0.43	0.76	0.79	0.14	0.80	0.26	0.14	0.11	0.05	5.83
Laboratory	0.01	0.19	1.29	0.71	0.07	0.42	0.27	0.46	0.84	0.35	0.13	0.43	0.12	0.08	0.04	0.03	5.44
Restaurant	0.01	0.08	0.33	0.17	0.03	0.34	0.20	0.49	0.82	0.41	0.07	0.31	0.14	0.10	0.05	0.03	3.59
Enclosed Parking Garage	0.00	0.01	1.83	1.25	0.00	2.59	0.71	2.27	1.53	0.05	0.00	0.04	0.00	0.02	0.00	0.01	10.29
Open Parking Garage	0.00	0.12	2.47	1.68	0.06	3.65	1.20	3.20	2.16	0.65	0.02	0.53	0.04	0.20	0.05	0.09	16.12
Grocery	0.01	0.05	0.10	0.06	0.01	0.05	0.02	0.05	0.09	0.05	0.01	0.04	0.02	0.01	0.01	0.01	0.58
Refrigerated Warehouse	0.00	0.00	0.06	0.05	0.01	0.02	0.00	0.01	0.01	0.04	0.00	0.07	0.12	0.01	0.01	0.01	0.41
Controlled-environment Horticulture	0.09	0.08	0.32	0.04	0.20	0.26	0.00	0.02	0.03	0.28	0.30	0.31	0.09	0.01	0.05	0.00	2.08
Vehicle Service	0.00	0.08	0.55	0.36	0.03	0.55	0.34	0.80	1.81	0.57	0.02	0.39	0.25	0.20	0.06	0.05	6.05
Manufacturing	0.00	0.02	0.21	0.07	0.02	0.01	0.05	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49
Unassigned	0.00	0.00	0.00	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.42
TOTAL	0.56	3.56	20.84	11.46	1.71	16.22	9.07	19.68	27.39	12.11	3.03	16.15	5.29	2.97	1.88	1.02	152.94

Table 42: Estimated Existing Floorspace in 2026 (Million Square Feet)

Building Type	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16	All CZs
Large Office	0.13	3.10	139.80	72.35	1.83	99.54	72.71	162.60	303.10	58.48	2.61	78.61	9.26	20.27	4.43	4.66	1,033
Medium Office	3.38	30.99	78.79	42.28	13.32	47.81	43.87	59.11	86.34	66.69	16.94	101.70	25.18	13.33	10.25	4.06	644
Small Office	4.18	12.75	22.19	11.33	7.50	13.22	8.52	13.28	20.88	24.43	10.60	43.94	21.47	4.99	6.18	2.68	228
Large Retail	1.00	8.67	58.68	26.90	4.20	31.96	25.34	43.46	66.53	53.31	11.40	58.16	22.51	10.91	9.40	3.21	436
Medium Retail	1.18	13.11	44.52	25.74	5.43	44.27	34.66	66.72	108.20	66.89	10.37	60.50	24.15	15.53	8.77	5.17	535
Strip Mall	3.34	9.84	37.42	18.43	5.10	40.23	28.29	55.76	83.70	66.92	12.25	48.37	24.18	15.27	8.70	4.59	462
Mixed-use Retail	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Large School	0.76	8.02	34.83	13.95	2.07	28.37	22.54	42.91	73.58	56.01	10.13	53.38	26.41	12.06	7.62	3.59	396
Small School	2.23	11.13	25.57	9.98	6.06	25.69	14.96	34.44	54.31	33.03	13.50	42.08	23.44	8.72	4.25	3.65	313
Non-refrigerated Warehouse	3.33	20.22	108.30	53.43	9.80	89.98	51.48	128.40	207.30	182.70	33.73	148.30	51.08	38.87	29.05	11.63	1,168
Hotel	1.77	10.52	48.10	24.73	5.01	30.49	32.66	41.97	66.01	37.09	7.22	40.53	13.08	8.01	5.88	2.44	376
Assembly	4.33	18.18	91.34	45.06	6.59	57.25	40.90	89.14	120.20	91.75	16.35	69.72	30.13	18.95	11.83	6.44	718
Hospital	1.87	11.09	48.33	24.67	5.06	28.25	27.15	40.77	69.88	39.60	11.11	53.18	22.49	8.80	5.03	3.23	401
Laboratory	0.18	4.01	36.93	28.06	1.53	12.21	17.19	15.61	19.31	10.81	0.68	12.14	4.40	1.72	0.39	0.57	166
Restaurant	0.61	3.62	14.72	7.49	1.55	16.46	10.73	23.78	40.00	32.41	3.52	16.95	7.74	6.86	3.45	1.90	192
Enclosed Parking Garage	0.02	0.54	40.71	30.94	0.30	29.15	20.67	58.41	72.53	2.67	0.35	3.09	0.49	0.85	0.17	0.43	261
Open Parking Garage	0.22	7.02	55.03	41.82	3.86	41.14	35.17	82.44	102.40	34.57	4.46	39.96	6.31	11.05	2.16	5.62	473
Grocery	0.10	1.70	5.87	3.56	0.75	3.42	2.08	4.01	6.95	4.02	0.65	3.74	1.45	0.93	0.54	0.38	40
Refrigerated Warehouse	0.00	0.46	0.91	0.21	0.39	0.46	0.02	0.42	0.79	0.65	0.26	2.15	3.91	0.18	0.19	0.14	11
Controlled-environment Horticulture	0.70	0.46	2.62	1.07	6.33	8.26	1.07	0.74	1.60	3.61	2.51	4.53	5.36	0.47	0.64	0.23	40
Vehicle Service	0.91	6.18	33.65	15.98	2.97	33.73	23.08	49.52	81.78	56.54	6.30	38.32	18.24	15.09	6.18	3.54	392
Manufacturing	4.11	16.89	61.93	79.55	5.59	73.33	33.27	122.70	168.10	49.58	12.86	57.01	25.97	16.98	5.15	9.27	742
Unassigned	0.36	6.58	9.03	6.32	0.22	2.58	0.77	3.78	7.87	2.55	3.37	14.35	2.94	0.77	0.40	1.03	63
Totals	34.68	205.07	999.26	583.86	95.46	757.79	547.13	1139.97	1761.35	974.31	191.16	990.71	370.19	230.62	130.66	78.47	9,091

Table 43: Estimated New Nonresidential Construction Impacted by Proposed Code Change in 2026, by Climate Zone and Building Type (Million Square Feet)

Building Type	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16	All CZs
Large Office	0.00	0.00	2.90	1.42	0.00	1.28	0.74	2.05	3.72	0.35	0.10	0.52	0.00	0.18	0.01	0.04	13.31
Medium Office	0.13	0.48	1.37	0.74	0.37	1.20	0.80	1.65	3.18	1.17	0.27	2.80	0.59	0.35	0.26	0.10	15.47
Small Office	0.01	0.43	0.19	0.02	0.06	0.15	0.23	0.16	0.36	0.41	0.09	0.54	0.38	0.04	0.10	0.03	3.22
Large Retail	0.00	0.00	1.10	0.55	0.15	0.70	0.37	0.83	1.66	0.63	0.30	1.30	0.36	0.14	0.18	0.06	8.34
Medium Retail	0.08	0.35	0.79	0.45	0.09	0.60	0.29	0.86	1.42	0.82	0.14	0.63	0.38	0.18	0.12	0.08	7.29
Strip Mall	0.00	0.15	0.50	0.23	0.01	0.56	0.49	0.99	1.07	1.35	0.07	0.59	0.33	0.32	0.10	0.06	6.81
Mixed-use Retail	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Large School	0.01	0.11	0.77	0.39	0.03	0.52	0.54	0.80	1.25	0.75	0.31	1.01	0.54	0.15	0.08	0.06	7.32
Small School	0.07	0.27	0.46	0.23	0.14	0.32	0.29	0.35	0.66	0.35	0.10	0.78	0.30	0.11	0.04	0.04	4.50
Non-refrigerated Warehouse	0.06	0.37	2.16	1.12	0.18	1.36	0.71	1.95	3.01	1.36	0.63	2.84	0.82	0.36	0.37	0.14	17.44
Hotel	0.04	0.22	1.03	0.53	0.11	0.55	0.48	0.78	1.18	0.57	0.15	0.80	0.26	0.14	0.12	0.04	7.02
Assembly	0.01	0.39	1.58	0.56	0.06	0.79	0.80	1.43	1.82	1.14	0.17	1.41	0.30	0.25	0.12	0.08	10.92
Hospital	0.03	0.17	0.81	0.42	0.08	0.32	0.53	0.43	0.76	0.79	0.14	0.80	0.26	0.14	0.11	0.05	5.83
Laboratory	0.01	0.19	1.29	0.71	0.07	0.42	0.27	0.46	0.84	0.35	0.13	0.43	0.12	0.08	0.04	0.03	5.44
Restaurant	0.01	0.08	0.33	0.17	0.03	0.34	0.20	0.49	0.82	0.41	0.07	0.31	0.14	0.10	0.05	0.03	3.59
Enclosed Parking Garage	0.00	0.01	1.83	1.25	0.00	2.59	0.71	2.27	1.53	0.05	0.00	0.04	0.00	0.02	0.00	0.01	10.29
Open Parking Garage	0.00	0.12	2.47	1.68	0.06	3.65	1.20	3.20	2.16	0.65	0.02	0.53	0.04	0.20	0.05	0.09	16.12
Grocery	0.01	0.05	0.10	0.06	0.01	0.05	0.02	0.05	0.09	0.05	0.01	0.04	0.02	0.01	0.01	0.01	0.58
Refrigerated Warehouse	0.00	0.00	0.06	0.05	0.01	0.02	0.00	0.01	0.01	0.04	0.00	0.07	0.12	0.01	0.01	0.01	0.41
Controlled-environment Horticulture	0.09	0.08	0.32	0.04	0.20	0.26	0.00	0.02	0.03	0.28	0.30	0.31	0.09	0.01	0.05	0.00	2.08
Vehicle Service	0.00	0.08	0.55	0.36	0.03	0.55	0.34	0.80	1.81	0.57	0.02	0.39	0.25	0.20	0.06	0.05	6.05
Manufacturing	0.00	0.02	0.21	0.07	0.02	0.01	0.05	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49
Unassigned	0.00	0.00	0.00	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.42
TOTAL	0.56	3.56	20.84	11.46	1.71	16.22	9.07	19.68	27.39	12.11	3.03	16.15	5.29	2.97	1.88	1.02	152.94

Table 44: Estimated Existing Nonresidential Floorspace Impacted by Proposed Code Change in 2026 (Alterations), by Climate Zone and Building Type (Million Square Feet)

Building Type	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16	All CZs
Large Office	0.13	3.10	139.80	72.35	1.83	99.54	72.71	162.60	303.10	58.48	2.61	78.61	9.26	20.27	4.43	4.66	1,033
Medium Office	3.38	30.99	78.79	42.28	13.32	47.81	43.87	59.11	86.34	66.69	16.94	101.70	25.18	13.33	10.25	4.06	644
Small Office	4.18	12.75	22.19	11.33	7.50	13.22	8.52	13.28	20.88	24.43	10.60	43.94	21.47	4.99	6.18	2.68	228
Large Retail	1.00	8.67	58.68	26.90	4.20	31.96	25.34	43.46	66.53	53.31	11.40	58.16	22.51	10.91	9.40	3.21	436
Medium Retail	1.18	13.11	44.52	25.74	5.43	44.27	34.66	66.72	108.20	66.89	10.37	60.50	24.15	15.53	8.77	5.17	535
Strip Mall	3.34	9.84	37.42	18.43	5.10	40.23	28.29	55.76	83.70	66.92	12.25	48.37	24.18	15.27	8.70	4.59	462
Mixed-use Retail	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Large School	0.76	8.02	34.83	13.95	2.07	28.37	22.54	42.91	73.58	56.01	10.13	53.38	26.41	12.06	7.62	3.59	396
Small School	2.23	11.13	25.57	9.98	6.06	25.69	14.96	34.44	54.31	33.03	13.50	42.08	23.44	8.72	4.25	3.65	313
Non-refrigerated Warehouse	3.33	20.22	108.30	53.43	9.80	89.98	51.48	128.40	207.30	182.70	33.73	148.30	51.08	38.87	29.05	11.63	1,168
Hotel	1.77	10.52	48.10	24.73	5.01	30.49	32.66	41.97	66.01	37.09	7.22	40.53	13.08	8.01	5.88	2.44	376
Assembly	4.33	18.18	91.34	45.06	6.59	57.25	40.90	89.14	120.20	91.75	16.35	69.72	30.13	18.95	11.83	6.44	718
Hospital	1.87	11.09	48.33	24.67	5.06	28.25	27.15	40.77	69.88	39.60	11.11	53.18	22.49	8.80	5.03	3.23	401
Laboratory	0.18	4.01	36.93	28.06	1.53	12.21	17.19	15.61	19.31	10.81	0.68	12.14	4.40	1.72	0.39	0.57	166
Restaurant	0.61	3.62	14.72	7.49	1.55	16.46	10.73	23.78	40.00	32.41	3.52	16.95	7.74	6.86	3.45	1.90	192
Enclosed Parking Garage	0.02	0.54	40.71	30.94	0.30	29.15	20.67	58.41	72.53	2.67	0.35	3.09	0.49	0.85	0.17	0.43	261
Open Parking Garage	0.22	7.02	55.03	41.82	3.86	41.14	35.17	82.44	102.40	34.57	4.46	39.96	6.31	11.05	2.16	5.62	473
Grocery	0.10	1.70	5.87	3.56	0.75	3.42	2.08	4.01	6.95	4.02	0.65	3.74	1.45	0.93	0.54	0.38	40
Refrigerated Warehouse	0.00	0.46	0.91	0.21	0.39	0.46	0.02	0.42	0.79	0.65	0.26	2.15	3.91	0.18	0.19	0.14	11
Controlled-environment Horticulture	0.70	0.46	2.62	1.07	6.33	8.26	1.07	0.74	1.60	3.61	2.51	4.53	5.36	0.47	0.64	0.23	40
Vehicle Service	0.91	6.18	33.65	15.98	2.97	33.73	23.08	49.52	81.78	56.54	6.30	38.32	18.24	15.09	6.18	3.54	392
Manufacturing	4.11	16.89	61.93	79.55	5.59	73.33	33.27	122.70	168.10	49.58	12.86	57.01	25.97	16.98	5.15	9.27	742
Unassigned	0.36	6.58	9.03	6.32	0.22	2.58	0.77	3.78	7.87	2.55	3.37	14.35	2.94	0.77	0.40	1.03	63
TOTAL	34.68	205.07	999.26	583.86	95.46	757.79	547.13	1139.97	1761.35	974.31	191.16	990.71	370.19	230.62	130.66	78.47	9,091

Table 45: Percentage of Nonresidential Floorspace Impacted by Proposed Code Change in 2026, by Building Type

Building Type	New Construction Impacted (Percent Square Footage)	Existing Building Stock (Alterations) Impacted (Percent Square Footage)
Large Office	7.00%	0.47%
Medium Office	7.00%	0.47%
Small Office	7.00%	0.47%
Large Retail	5.00%	0.33%
Medium Retail	2.00%	0.13%
Strip Mall	0.00%	0.00%
Mixed-use Retail	1.00%	0.07%
Large School	7.00%	0.33%
Small School	2.00%	0.20%
Non-refrigerated Warehouse	1.00%	0.07%
Hotel	< 1%	< 0.07%
Assembly	5.00%	0.20%
Hospital	7.00%	0.47%
Laboratory	10.00%	0.67%
Restaurant	1.00%	0.07%
Enclosed Parking Garage	0.00%	0.00%
Open Parking Garage	0.00%	0.00%
Grocery	1.00%	0.07%
Refrigerated Warehouse	1.00%	0.07%
Controlled-environment Horticulture	1.00%	0.07%
Vehicle Service	10.00%	0.67%
Manufacturing	3.00%	0.20%
Unassigned	1.00%	0.07%

Table 46: Percentage of Nonresidential Floorspace Impacted by Proposed Measure, by Climate Zone

Climate Zone	New Construction Impacted (Percent Square Footage)	Existing Building Stock (Alterations) Impacted (Percent Square Footage)
1	3.30%	0.25%
2	3.99%	0.26%
3	3.77%	0.27%
4	3.46%	0.26%
5	3.84%	0.25%
6	2.73%	0.25%
7	3.73%	0.26%
8	3.28%	0.24%
9	4.22%	0.25%
10	3.81%	0.24%
11	3.72%	0.23%
12	4.14%	0.26%
13	4.11%	0.25%
14	3.90%	0.24%
15	3.82%	0.23%
16	3.77%	0.22%

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

The CEC requires a beta version of CBECC software to be released at least one year prior to the effective date of the California Energy Code. The 2025 code will take effect January 1, 2026. Therefore, the beta version of the CBECC software must be released no later than January 1, 2025. The Statewide CASE Team would provide this appendix to the CBECC development teams at least 20 months prior to the anticipated effective date of the 2025 code to allow sufficient time for the development and testing of the software changes. Therefore, the Statewide CASE Team would provide this document to the CBECC development teams no later than May 1, 2024.

Introduction

The purpose of this appendix is to present proposed revisions to CBECC for commercial/ buildings (CBECC) along with the supporting documentation that the CEC staff and the technical support contractors would need to approve and implement the software revisions.

Technical Basis for Software Change

The change is expected to be minor and would require adjusting the inputs for the threshold for daylight dimming.

Description of Software Change

Background Information for Software Change

The change would involve updating the default settings of what are 100 percent daylight controls. Instead of 120W the threshold is 75W. This is in the building model data by currently active space.

Existing CBECC Building Energy Modeling Capabilities

Current compliance software unchecks 100 percent controlled.

Summary of Proposed Revisions to CBECC

There would need to be an allowance to account for the savings calculated using the ray -tracing methodology. The Statewide CASE team would discuss with NORESCO the possibility of an adjustment factor or adjustment to the schedule. The methodology used to find energy savings employs ray tracing. In contrast, The California Simulation Engine (CSE) utilizes the split-flux method for daylighting calculations. The split-flux method is faster and easier to use than ray tracing, especially for large buildings. It divides the light into two parts (direct and diffuse) and estimates how they interact with the surfaces in the building. However, ray tracing is more accurate and can handle complex geometries and materials, but it requires a lot of computer processing power which is not ideal for CBECC.

User Inputs to CBECC

EnergyPlus/California Simulation Engine Inputs

The Statewide CASE team would have a discussion with NORESCO on the optimum approach to translating the savings from the ray tracing methodology to a format compatible with CBECC.

Calculated Values, Fixed Values, and Limitations

Simulation Engine Output Variables

Compliance Report

The Statewide CASE Team does not anticipate any needed updates to the Compliance report.

Compliance Verification

The existing compliance verification processes are sufficient for the proposed measure. No changes are needed.

Testing and Confirming CBECC Building Energy Modeling

The Statewide CASE team would have a discussion with NORESCO regarding the appropriate testing and confirmation process for the model. Given that the methodology applied by the Statewide CASE relies on ray tracing for daylight calculation, while CBECC-Com employs split-flux, it is anticipated that some modifications may be necessary. It is imperative to address these discrepancies to ensure that the model produces accurate results and is validated through an appropriate testing and confirmation process.

Description of Changes to ACM Reference Manual

The Statewide CASE Team is not recommending changes to the standards or References Appendices.

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

There are significant energy savings and GHG emission reductions from this proposal. There are no water savings associated with this proposal. For more information on energy savings, see Section 5. For more information on the GHG emission reductions, see Section 7.2.

Direct Adverse Environmental Impacts

There are no identified direct adverse environmental impacts from this code change proposal.

Indirect Environmental Impacts

Indirect Environmental Benefits

There are no identified indirect environmental benefits from this code change proposal.

Indirect Adverse Environmental Impacts

The proposed code change is likely to lead to increased embodied carbon emissions from the likely increase in the usage of occupancy sensors, control technology, and potentially cables and low voltage wires, depending upon implementation. The proposed code change could result in a decrease in usage of time-switch controls. For more information on the material impacts see Section 7.4.

The Statewide CASE Team has determined that the operational emissions reductions from this proposal would likely far outweigh the potential increase in embodied carbon emissions.

Mitigation Measures

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.) The Statewide CASE Team did not determine that this measure would result in significant direct or indirect adverse environmental impacts and therefore did not develop any mitigation measures.

Reasonable Alternatives to Proposal

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 that no alternative achieves the purpose of the proposal with less environmental effect.

Water Use and Water Quality Impacts Methodology

There are no impacts to water quality or water use from the proposed code change.

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 initial 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 outlined in Section 7.4. See Section 7.4 for more details on the material impact analysis.

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).[16, 17] These industry-wide EPDs provide global warming potential (GWP) values per weight of specific materials.[18] The Statewide CASE Team chose the industry-wide average for GWP values in the EPDs because the materials accounted for in the statewide calculation would have a range of embodied carbon; i.e., 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 would 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). The total emissions reductions from this measure are the total GHG emissions reductions from Section 7.2 combined with emissions reductions (or additional emissions) from embodied carbon.

A comprehensive accounting of buildings' GHG emissions would include operational emissions (e.g., emissions from energy use) and embodied carbon. Title 24, Part 6 addresses energy use in buildings and results in reductions in operational GHG emissions. The Statewide CASE Team has provided embodied carbon impacts of the proposed code changes, which could support an informed dialogue on how operational emissions and embodied emissions be considered together in the future. The information provided in this report is an incomplete accounting of whole-building embodied carbon and does not account for interactive effects that the proposal may have on other elements of the building design or material use. There may be instances where a specific system or component may increase emissions through embodied

[16] 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.

[17] 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 Life Cycle 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.

[18] 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.

carbon but enable the building as a whole to have lower total emissions (operational plus building-wide embodied carbon).

Table 47: First-Year Statewide Impacts on Material Use

Material	Impact	First-Year[a] Statewide Impacts (Pounds)	Embodied GHG Emissions Saved (Metric Tons CO2e)[a]
Mercury	No Change	0.00	0
Lead	Increase	29.82	0.02
Copper	Increase	13,197.18	17
Steel	Increase	15,734.51	9
Plastic	Increase	16,306.19	14
Zinc	Increase	109.18	N/A
Aluminum	Increase	545.40	N/A
Lithium	Increase	146.05	N/A
Manganese Dioxide	Increase	351.30	N/A
Others	Increase	1,716.37	N/A
TOTAL		**48,135.99**	**39**

1. Zinc, aluminum, lithium, and manganese dioxide, the embodied carbon impacts appear as N/A because their impacts are negligible. The category “Others” appears as N/A because it is a mix of materials and therefore cannot be calculated.

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

This appendix discusses how the recommended compliance process, which is described in 3.5, could impact various market actors. Table 48 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. The information contained in Table 48 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.

Table 48 identifies the market actors who would play a role in complying with the proposed change, the tasks for which they would be responsible, their objectives in completing the tasks, how the proposed code change could impact their existing workflow, and ways negative impacts could be mitigated.

Table 48: 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
Lighting Designer and/or Electrical Engineer	• Design luminaire layout, specify luminaires, and determine connected lighting load in each space. • Determine the daylit zones within each space. • Specify automatic daylighting controls for daylit zones where the connected lighting load is greater than 120 watts. • Determine whether to specify automatic daylighting controls for the exempted daylit zones. • Determine whether to take advantage of Power Adjustment Factors (PAFs)	Instead of 120 watts, specify automatic daylighting controls for daylit zones where the connected lighting load is 75 watts or greater (or 85 watts or greater in the secondary sidelit daylit zones where the connected lighting load in the corresponding primary sidelit daylit zones is less than 75 watts).	On the NRCC (either NRCC-LTI or NRCC-PRF) form, if prepared by the lighting designer or electrical engineer, make sure automatic daylighting controls are included in spaces that are no longer exempted.	The proposed CASE measure is a simple extension of the existing practice, and no specific opportunity is identified for the market actor to minimize impacts of compliance requirement.
Energy Consultants	• Identify automatic daylighting controls on the plans where the connected lighting load is greater than 120 watts. • Determine whether to take advantage of PAFs • Prepare the NRCC forms, if not prepared by the lighting designer or electrical engineer.	Instead of 120 watts, identify automatic daylighting controls on the plan for daylit zones where the connected lighting load is 75 watts or greater (or 85 watts or greater in the secondary sidelit daylit zones where the connected lighting load in the corresponding primary sidelit daylit zones is less than 75 watts).	On the NRCC (either NRCC-LTI or NRCC-PRF) form, make sure automatic daylighting controls are included in spaces that are no longer exempted.	The proposed CASE measure is a simple extension of the existing practice, and no specific opportunity is identified for the market actor to minimize impacts of compliance requirement.
Plans Examiner	Check and confirm there are automatic daylighting controls for daylit zones with a connected lighting load greater than 120 watts on the NRCC forms and confirm the information is incorporated into the plan's documents.	Check and confirm there are automatic daylighting controls for daylit zones with a connected lighting load 75 watts or greater (or 85 watts or greater in the secondary sidelit daylit zones where the connected lighting load in the corresponding primary sidelit daylit zones is less than 75 watts) on the NRCC forms and confirm the information is incorporated into the plan's documents.	On the NRCC form, the plan examiner would need to make sure automatic daylighting controls are included in spaces that are no longer exempted.	The proposed CASE measure is a simple extension of the existing practice, and no specific opportunity is identified for the market actor to minimize impacts of compliance requirement.

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
Electrical Contractors or Installers	• Review the design documents, including the luminaire and control equipment schedules. • Procure, install, and wire the photocontrols and other necessary hardware and accessories according to the design documents.	The workflow is unchanged by the proposed CASE measure; however, the total number of photocontrols are increased due to the lowered threshold for requiring automatic daylighting controls. The overall time required to install and wire the photocontrols has increased as a result.	• The equipment schedules would have a higher number of equipment counts, and the drawings would show more spaces where equipment related to automatic daylighting controls is to be installed. • The overtime required to install and wire the equipment would be increased.	The proposed CASE measure is a simple extension of the existing practice, and no specific opportunity is identified for the market actor to minimize impacts of compliance requirement.
Qualified Design Reviewer	• Review NRCC forms and plans documents to ensure they are consistent and that automatic daylighting controls are identified for daylit zones with a connected lighting load greater than 120 watts. • Prepare NRCC-CXR forms.	Review NRCC forms and plans documents to ensure they are consistent and that automatic daylighting controls are identified for daylit zones with a connected lighting load 75 watts or greater (or 85 watts or greater in the secondary sidelit daylit zones where the connected lighting load in the corresponding primary sidelit daylit zones is less than 75 watts).	On the NRCC form and plan documents, make sure automatic daylighting controls are identified in spaces that are no longer exempted.	The proposed CASE measure is a simple extension of the existing practice, and no specific opportunity is identified for the market actor to minimize impacts of compliance requirement.
Commissioning Provider	• Review design documents, specifically, control intent narratives, sequence of operations, and code requirements. • Commission the photocontrols with the setpoints, ramp rate, and minimum dim level as specified in the design documents. • Confirm the photocontrols are functioning as intended.	The workflow is unchanged by the proposed CASE measure; however, the total number of photocontrols are increased due to the lowered threshold for requiring automatic daylighting controls. The overall time required to commission the lighting control system is increased as a result.	• The design documents would specify more spaces to be commissioned for automatic daylighting controls. • The overall time required to commission the lighting control system would be increased.	The proposed CASE measure is a simple extension of the existing practice, and no specific opportunity is identified for the market actor to minimize impacts of compliance requirement.

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
ATT	• Review the plans documents for the daylit zones. • Determine whether sampling of photocontrols is allowed and needed for the Functional Testing, and if so, strategize the sampling of group of five photocontrols. • Conduct the acceptance test on the sampled photocontrols.	• The total number of photocontrols are increased due to the lowered threshold for requiring automatic daylighting controls. • The workflow is unchanged by the proposed CASE measure; however, if sampling of photocontrols is allowed and needed, the total number of photocontrols that are sampled and tested are increased.	• The plans documents would show more spaces with photocontrols. • The overall time required to perform automatic daylighting controls Functional Testing increases as the number of sampled photocontrols increases. • The number of tested zones on the NRCA form would increase due to the increased number of photocontrols tested. ATT would also need to spend more time filling out the form.	Potential for using technologies to speed up acceptance testing process based on the increased number and sophistication of lighting controls.
Inspector	Review the approved drawings and documents and verify that automatic daylighting controls are included in all daylit zones with a connected lighting load greater than 120W.	The workflow is unchanged by the proposed CASE measure; however, the inspector needs to verify that automatic daylighting controls are included in all daylit zones with a connected lighting load 75W or greater (or 85 watts or greater in the secondary sidelit daylit zones where the connected lighting load in the corresponding primary sidelit daylit zones is less than 75 watts) instead of 120W.	On the NRCI and NRCA forms, the inspector would need to make sure automatic daylighting controls are included in spaces that are no longer exempted.	The proposed CASE measure is a simple extension of the existing practice, and no specific opportunity is identified for the market actor to minimize impacts of compliance requirement.

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 CASE Report are supported. 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 two stakeholder meetings for revising automatic daylighting controls exceptions via webinar described in Table 49. 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 49: Utility-Sponsored Stakeholder Meetings

Meeting Name	Meeting Date	Event Page from Title24stakeholders.com
First Round of Daylighting Utility-Sponsored Stakeholder Meeting	Friday, February 24, 2023	https://title24stakeholders.com/event/nonresidential-daylighting-lighting-language-clean-up-and-existing-buildings-utility-sponsored-stakeholder-meeting/
Second Round of Daylighting Utility-Sponsored Stakeholder Meeting	Tuesday, May 16, 2023	https://title24stakeholders.com/event/lighting-language-cleanup-controlled-environment-horticulture-and-nonresidential-daylighting-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 the initial draft code language for stakeholders to review.

The second round of utility-sponsored stakeholder meetings occurred in May 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 50. The Statewide CASE Team contacted the key stakeholders who had provided feedback on the lighting and daylighting measures during the previous code cycles in an attempt to

- Inform them about this proposed code change;
- Solicit their continuous engagement and participation in the stakeholder meetings;
- Collect data to inform energy modeling and cost estimates.

These stakeholders included manufacturers, lighting designers, industry associations, electrical engineering consultants, and other energy efficiency advocates. The Statewide CASE Team also engaged with the Chair and members of the ASHRAE 90.1 Lighting Subcommittee to ensure the proposed code change is well aligned with the requirements in ASHRAE 90.1. The Statewide CASE Team engaged with the manufacturers' sales representative agencies to collect cost data for various control solutions that can be used to meet the requirements in this code change proposal.

Table 50: Engaged Stakeholders

Organization/Individual Name	Market Role
Acuity Brands	Manufacturer
ASHRAE 90.1 Lighting Subcommittee	Standard Development Organization
Benya Burnett Consultancy	Lighting Designer
Building and Controls	Manufacturer's Sales Representative Agency
California Energy Alliance	Energy efficiency advocating organization
Crestron	Manufacturer
CT Lighting and Controls	Manufacturer's Sales Representative Agency
Current	Manufacturer
HLB	Lighting Designer
Legrand	Manufacturer
Lighting Design Alliance	Lighting Designer
Lutron	Manufacturer
MH Lighting	Manufacturer's Sales Representative Agency
National Electrical Manufacturers Association (NEMA)	Industry Association
NLCAA	Acceptance Test Technicians
The Engineering Enterprise	Electrical Engineering
The Lighting Agency	Manufacturer's Sales Representative Agency
Signify	Manufacturer
Visual Interest	Manufacturer's Sales Representative Agency

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 in 2026 PV$ are presented in Section 6 of this report. This appendix presents energy cost savings in nominal dollars.

Table 51: Nominal LSC Savings Over 30-Year Period of Analysis – Per Watt – New Construction and Alterations –Offices, Conference Room, Corridors, Exercise Room, and Multipurpose Room.

Climate Zone	PSDZ 30-year LSC Savings (Nominal $/W)	SSDZ 30-year LSC Savings (Nominal $/W)	PSDZ + SSDZ 30-year LSC Savings (Nominal $/W)	PSDZ 30-year LSC Savings (Nominal $/W)	PSDZ 30-year LSC Savings (Nominal $/W)	SSDZ 30-year LSC Savings (Nominal $/W)	PSDZ + SSDZ 30-year LSC Savings (Nominal $/W)
Prototype(s)	Office, Conference Room, Multipurpose Room	Office, Conference Room, Multipurpose Room	Office, Conference Room, Multipurpose Room	Corridor	Exercise Room	Exercise Room	Exercise Room
1	$15.94	$11.98	$13.96	$17.75	$14.89	$9.93	$12.41
2	$16.71	$12.71	$14.71	$18.14	$15.71	$10.56	$13.13
3	$16.85	$13.10	$14.98	$18.17	$15.90	$10.90	$13.40
4	$17.00	$13.39	$15.19	$18.16	$16.11	$11.18	$13.64
5	$17.08	$13.56	$15.32	$18.22	$16.19	$11.32	$13.75
6	$17.47	$13.99	$15.73	$18.50	$16.66	$11.68	$14.17
7	$15.89	$12.65	$14.27	$16.83	$15.17	$10.48	$12.82
8	$17.26	$13.68	$15.47	$18.42	$16.41	$11.40	$13.91
9	$17.27	$13.69	$15.48	$18.39	$16.41	$11.41	$13.91
10	$17.31	$13.78	$15.54	$18.36	$16.47	$11.51	$13.99
11	$16.24	$12.53	$14.38	$17.86	$15.22	$10.44	$12.83
12	$16.46	$12.63	$14.55	$17.99	$15.45	$10.49	$12.97
13	$16.44	$12.86	$14.65	$17.80	$15.53	$10.69	$13.11
14	$17.48	$14.07	$15.78	$18.43	$16.68	$11.78	$14.23
15	$17.37	$14.13	$15.75	$18.31	$16.62	$11.85	$14.23
16	$16.76	$12.90	$14.83	$18.29	$15.72	$10.76	$13.24

Appendix H: ASHRAE Lighting Schedule

Initially, the Statewide CASE Team considered using the Title 24, Part 6 ACM Reference Manual occupancy schedule which entailed converting into a lighting schedule based on occupancy interactions with lighting controls. It was noted that most of the hours during which the ACM occupancy for the office space was zero (such as weekday hour ending 1 am to 6 am) were hours when the lighting schedule was five percent. As a result, the Statewide CASE Team interpretated this to mean that five percent of the lighting schedule was dedicated to “night lighting” or lighting that was on all the time for egress, and that by removing five percent to account for egress lighting would reflect the fraction of lighting that could be controlled with daylighting controls. In this format, five percent of lighting would always be on, and the remaining controlled fraction would be the portion of lighting that was on after other controls were applied, such as timeclock or other occupancy controls. Table 52 below details the office lighting schedule and the updated version with the five percent night lighting removed.

Table 52: Nonresidential ACM Reference Manual Appendix 5.4B Office Lighting Schedule and Controlled Lighting Schedule With 5 Percent Night Lighting Stripped Off

Start and End Hours		Hourly lighting consumption profile from ACM Appendix 5.4B Schedules T-24-2022			Hourly lighting controls profile with 5% removed for egress lighting [a] (Converted values based on the ACM 5.4B Schedules of the 2022 Code)		
Start Hour	End Hour	Weekday	Saturday	Sunday	Weekday	Saturday	Sunday
0	1	0.05	0.05	0.05	0.00	0.00	0.00
1	2	0.05	0.05	0.05	0.00	0.00	0.00
2	3	0.05	0.05	0.05	0.00	0.00	0.00
3	4	0.05	0.05	0.05	0.00	0.00	0.00
4	5	0.05	0.05	0.05	0.00	0.00	0.00
5	6	0.10	0.05	0.05	0.05	0.00	0.00
6	7	0.10	0.10	0.05	0.05	0.05	0.00
7	8	0.30	0.10	0.05	0.25	0.05	0.00
8	9	0.65	0.30	0.05	0.60	0.25	0.00
9	10	0.65	0.30	0.05	0.60	0.25	0.00
10	11	0.65	0.30	0.05	0.60	0.25	0.00
11	12	0.65	0.30	0.05	0.60	0.25	0.00
12	13	0.65	0.15	0.05	0.60	0.10	0.00
13	14	0.65	0.15	0.05	0.60	0.10	0.00
14	15	0.65	0.15	0.05	0.60	0.10	0.00
15	16	0.65	0.15	0.05	0.60	0.10	0.00
16	17	0.65	0.15	0.05	0.60	0.10	0.00
17	18	0.35	0.05	0.05	0.30	0.00	0.00
18	19	0.30	0.05	0.05	0.25	0.00	0.00
19	20	0.30	0.05	0.05	0.25	0.00	0.00
20	21	0.20	0.05	0.05	0.15	0.00	0.00
21	22	0.20	0.05	0.05	0.15	0.00	0.00
22	23	0.10	0.05	0.05	0.05	0.00	0.00
23	24	0.05	0.05	0.05	0.00	0.00	0.00

The total lighting power of the general lighting system for any given hour is a combination of: the lighting power allowed by the daylighting controls to maintain appropriate combined electric lighting and daylighting light levels in the space multiplied by the hourly lighting profile with the 5 percent lighting (egress lighting) removed (representing the probability that daylight controlled lights would be on during that hour) and then five percent of lighting power would be added on to represent uncontrolled egress lighting that is continuously on all day and night in the daylit zone.

One inconsistency that the Statewide CASE Team noted with the ACM office lighting schedules is that weekdays for hours ending nine to 17, the people occupancy was 95 percent (except hour 13 when occupancy drops to 50 percent), but the office lighting schedule is only 65 percent during this same time period. This would imply that people are only operating their lights at little more than half power when they are in their offices or that the occupancy sensors are turning off their lights, which would represent a control failure. The control fraction (hourly profile fraction) with the five percent for egress removed was intended to represent the control fraction before daylighting controls are applied and thus should be reasonably close to the hourly occupancy fraction for the same hours.

As a result of this perceived inconsistency, the Statewide CASE Team used the ASHRAE 90.1 lighting schedule to represent all the other lighting controls besides daylighting controls. When this approach is taken, the lighting control fraction more closely approximates the occupancy profile of office spaces. Similar to the approach using the ACM Reference Manual occupancy schedule discussed earlier, the methodology using ASHRAE lighting schedule strips five percent off of the lighting profile values to account for egress lighting, multiplies the remaining control fraction by the calculated lighting fraction allowed by the daylighting controls, and then adds the five percent power fraction back on. See Table 53 below for the ASHRAE 90.1 lighting schedule with the five percent removed to account for night lighting. Using the nomenclature in Section 5.1.2 Energy Savings Methodology per Prototypical Space*,* the ASHRAE Lighting Schedule is the hourly lighting schedule for all lighting, ALS_h, and the lighting schedule with the five percent night lighting stripped off is the hourly controlled lighting schedule, CLS_h.

Table 53: Lighting Schedule for ASHRAE 90.1 Office Prototype and Controlled Lighting Schedule with 5 Percent Night Lighting Stripped Off

Start and End Hours		Hourly lighting consumption profile from PNNL Scorecard for ASHRAE 90.1 Prototypes			Hourly lighting controls profile with 5% stripped off for night lighting (Converted values based on the PNNL Scorecard for ASHRAE 90.1 Prototypes)		
Start Hour	End Hour	Weekday	Saturday	Sunday	Weekday	Saturday	Sunday
0	1	0.05	0.05	0.05	0.00	0.00	0.00
1	2	0.05	0.05	0.05	0.00	0.00	0.00
2	3	0.05	0.05	0.05	0.00	0.00	0.00
3	4	0.05	0.05	0.05	0.00	0.00	0.00
4	5	0.05	0.05	0.05	0.00	0.00	0.00
5	6	0.10	0.05	0.05	0.05	0.00	0.00
6	7	0.10	0.10	0.05	0.05	0.05	0.00
7	8	0.30	0.10	0.05	0.25	0.05	0.00
8	9	0.90	0.30	0.05	0.85	0.25	0.00
9	10	0.90	0.30	0.05	0.85	0.25	0.00
10	11	0.90	0.30	0.05	0.85	0.25	0.00
11	12	0.90	0.30	0.05	0.85	0.25	0.00
12	13	0.90	0.15	0.05	0.85	0.10	0.00
13	14	0.90	0.15	0.05	0.85	0.10	0.00
14	15	0.90	0.15	0.05	0.85	0.10	0.00
15	16	0.90	0.15	0.05	0.85	0.10	0.00
16	17	0.90	0.15	0.05	0.85	0.10	0.00
17	18	0.50	0.05	0.05	0.45	0.00	0.00
18	19	0.30	0.05	0.05	0.25	0.00	0.00
19	20	0.30	0.05	0.05	0.25	0.00	0.00
20	21	0.20	0.05	0.05	0.15	0.00	0.00
21	22	0.20	0.05	0.05	0.15	0.00	0.00
22	23	0.10	0.05	0.05	0.05	0.00	0.00
23	24	0.05	0.05	0.05	0.00	0.00	0.00