Codes and Standards Enhancement (CASE) Initiative

2025 California Energy Code

Nonresidential Envelope

Nonresidential Envelope
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August 2023
Final CASE Report

CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

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

Pacific Gas and Electric Company

Southern California Edison — Energy for What's Ahead

SDGE

LA DWP Los Angeles Department of Water & Power

SMUD

Document Information

Category:	**Codes and Standards**
Keywords:	Statewide Codes and Standards Enhancement (CASE) Initiative; California Statewide Utility Codes and Standards Team; Codes and Standards Enhancements; 2025 California Energy Code; 2025 Title 24, Part 6; California Energy Commission (CEC); energy efficiency; mandatory; prescriptive; Opaque Assemblies; vestibules; Fenestration; Windows; Alterations; Additions; U-factor
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Executive Summary

“The building envelope, which includes the walls, windows, roof, and foundation, forms the primary thermal barrier between the interior and exterior environments. With envelope technologies accounting for approximately 30% of the primary energy consumed in residential and commercial buildings, it plays a key role in determining levels of comfort, natural lighting, ventilation, and how much energy is required to heat and cool a building,” (U.S. Department of Energy n.d.). This report presents three cost-effective code change proposals that will improve the envelope performance in nonresidential buildings: opaque assemblies, vestibules, and windows. The report contains pertinent information supporting the code change.

Statewide, over 30 years, the total projected Long-term Systemwide Cost (LSC) savings in millions of present value dollars per year (million 2026 PV$) for each measure are:

- **Opaque assemblies:** 16.63 million 2026 PV$
- **Vestibules:** 64.44 million 2026 PV$
- **Windows:** 66.24 million 2026 PV$

Projected electric savings in gigawatt-hours per year (GWh/y) include:

- **Opaque assemblies:** 1.49 GWh/y
- **Vestibules:** 10.41 GWh/y
- **Windows:** 12.29 GWh/y

Projected natural gas savings in million therms per year (million therms/y) include:

- **Opaque assemblies:** 0.123 million therms/y
- **Vestibules:** 0.04 million therms/y
- **Windows:** 0.1 million therms/y

The Codes and Standards Enhancement (CASE) Initiative presents recommendations to support the California Energy Commission’s (CEC’s) efforts to update the California Energy Code (Title 24, Part 6) to include new requirements or to upgrade existing requirements for various technologies. Three California Investor-Owned Utilities (IOUs) — Pacific Gas and Electric Company, San Diego Gas and Electric, and Southern California Edison – and two Publicly Owned Utilities — Los Angeles Department of Water and Power, and Sacramento Municipal Utility District (herein referred to as the Statewide CASE Team when including the CASE Author) — sponsored this effort. The program goal is to prepare and submit proposals that would result in cost-effective enhancements to improve energy efficiency and energy performance in California buildings. This report and the code change proposals 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 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: https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2025-building-energy-efficiency.

The Statewide CASE Team reached out to approximately 20 individuals and organizations with specific expertise in building envelope design and construction to gather information on costs, market assumptions, and technical feasibility. In response to several of these meetings, the Statewide CASE Team has modified the envelope proposals incrementally, but stakeholders have generally indicated support.

Proposal Description – Opaque Assemblies

The opaque assemblies of the building envelope are all those that are not transparent. This proposal would make the prescriptive U-factors more stringent for new wall and roof/ceiling assemblies, by climate zone. All assemblies would be affected except metal-framed walls, for which the U-factors were revised during the 2022 Title 24, Part 6 code cycle. This proposal would not apply to alterations. Also, it would not add or modify field verification or acceptance tests or require any technology not previously regulated.

Table 1 summarizes the scope of the proposed changes.

Table 1: Scope of Code Change Proposal – Opaque Assemblies

Proposal Scope	Opaque Assemblies
Type of Requirement	Prescriptive
Applicable Climate Zones*	All
Modified Section(s) of Title 24, Part 6	Prescriptive:140.3
Modified Title 24, Part 6 Appendices	N/A
Would Compliance Software Be Modified	Yes
Modified/New Compliance Document(s)	Yes

Table 2 through Table 7 present summarized information on the impacts of the opaque assemblies proposal for each assembly type analyzed.

Table 2: Summary of Impacts for Opaque Assemblies – Prescriptive Wood-Framed and Other Roof

Category	Metric	New Construction & Additions
Cost Effectiveness	Benefit-to-Cost Ratio Range (varies by climate zone and building type)	-2.74 to 4.43
Statewide Impacts During First Year	First-Year Electricity Savings (GWh)	0.86
	First-Year Peak Electrical Demand Reduction (MW)	0.12
	First-Year Natural Gas Savings (Million Therms)	0.03
	First-Year Source Energy Savings (Million kBtu)	2.36
	30-Year LSC Electricity Savings (Million 2026 PV$)	5.09
	30-Year LSC Gas Savings (Million 2026 PV$)	1.54
	30-Year Total LSC Savings (Million 2026 PV$)	6.63
	First-Year Avoided GHG Emissions (Metric Tons CO2e)	235.14
	Monetary Value of Avoided GHG Emissions during First Year ($2026)	28,957
	First-Year On-site Indoor Water Savings (Gallons)	N/A
	First-Year On-site Outdoor Water Savings (Gallons)	N/A
	First-Year Embedded Electricity in Water Savings (kWh)	N/A
Per Square Foot Impacts During First Year (weighted average for all prototypes and climate zones)	First-Year Electricity Savings (kWh)	0.0167
	First-Year Peak Electrical Demand Reduction (W)	0.0024
	First-Year Natural Gas Savings (kBtu)	0.0505
	First-Year Source Energy Savings (kBtu)	0.0456
	LSC Savings (2026 PV$)	0.1282
	First-Year Avoided GHG Emissions (kg CO2e)	0.0045
	First-Year On-site Indoor Water Savings (Gallons)	N/A
	First-Year On-site Outdoor Water Savings (Gallons)	N/A
	First-Year Embedded Electricity in Water Savings (kWh)	0.00

Table 3: Summary of Impacts for Opaque Assemblies – Prescriptive Metal Building Roof

Category	Metric	New Construction & Additions
Cost Effectiveness	Benefit-to-Cost Ratio Range (varies by climate zone and building type)	-0.69 – 3.04
Statewide Impacts During First Year	First-Year Electricity Savings (GWh)	0.07
	First-Year Peak Electrical Demand Reduction (MW)	0.03
	First-Year Natural Gas Savings (Million Therms)	0.02
	First-Year Source Energy Savings (Million kBtu)	1.60
	30-Year LSC Electricity Savings (Million 2026 PV$)	0.51
	30-Year LSC Gas Savings (Million 2026 PV$)	1.07
	30-Year Total LSC Savings (Million 2026 PV$)	1.57
	First-Year Avoided GHG Emissions (Metric Tons CO2e)	108.80
	Monetary Value of Avoided GHG Emissions during First Year ($2026)	13,399
	First-Year On-site Indoor Water Savings (Gallons)	N/A
	First-Year On-site Outdoor Water Savings (Gallons)	N/A
	First-Year Embedded Electricity in Water Savings (kWh)	0.00
Per Square Foot Impacts During First Year (weighted average for all prototypes and climate zones)	First-Year Electricity Savings (kWh)	0.0045
	First-Year Peak Electrical Demand Reduction (W)	0.0017
	First-Year Natural Gas Savings (kBtu)	0.1149
	First-Year Source Energy Savings (kBtu)	0.1038
	LSC Savings (2026 PV$)	0.1022
	First-Year Avoided GHG Emissions (kg CO2e)	0.0071
	First-Year On-site Indoor Water Savings (Gallons)	N/A
	First-Year On-site Outdoor Water Savings (Gallons)	N/A
	First-Year Embedded Electricity in Water Savings (kWh)	0.00

Table 4: Summary of Impacts for Opaque Assemblies – Prescriptive Metal Building Walls

Category	Metric	New Construction & Additions
Cost Effectiveness	Benefit-to-Cost Ratio Range (varies by climate zone and building type)	0.61 - 6.55
Statewide Impacts During First Year	First-Year Electricity Savings (GWh)	0.05
	First-Year Peak Electrical Demand Reduction (MW)	0.03
	First-Year Natural Gas Savings (Million Therms)	0.02
	First-Year Source Energy Savings (Million kBtu)	1.72
	30-Year LSC Electricity Savings (Million 2026 PV$)	0.40
	30-Year LSC Gas Savings (Million 2026 PV$)	1.13
	30-Year Total LSC Savings (Million 2026 PV$)	1.54
	First-Year Avoided GHG Emissions (Metric Tons CO2e)	114.44
	Monetary Value of Avoided GHG Emissions during First Year ($2026)	14,092
	First-Year On-site Indoor Water Savings (Gallons)	N/A
	First-Year On-site Outdoor Water Savings (Gallons)	N/A
	First-Year Embedded Electricity in Water Savings (kWh)	0.00
Per Square Foot Impacts During First Year (weighted average for all prototypes and climate zones)	First-Year Electricity Savings (kWh)	0.0037
	First-Year Peak Electrical Demand Reduction (W)	0.0024
	First-Year Natural Gas Savings (kBtu)	0.1559
	First-Year Source Energy Savings (kBtu)	0.1408
	LSC Savings (2026 PV$)	0.1259
	First-Year Avoided GHG Emissions (kg CO2e)	0.0094
	First-Year On-site Indoor Water Savings (Gallons)	N/A
	First-Year On-site Outdoor Water Savings (Gallons)	N/A
	First-Year Embedded Electricity in Water Savings (kWh)	0.00

Table 5: Summary of Impacts for Opaque Assemblies – Prescriptive Light Mass Walls

Category	Metric	New Construction & Additions
Cost Effectiveness	Benefit-to-Cost Ratio Range (varies by climate zone and building type)	0 - 48.07
Statewide Impacts During First Year	First-Year Electricity Savings (GWh)	0.22
	First-Year Peak Electrical Demand Reduction (MW)	0.04
	First-Year Natural Gas Savings (Million Therms)	0.04
	First-Year Source Energy Savings (Million kBtu)	3.67
	30-Year LSC Electricity Savings (Million 2026 PV$)	1.53
	30-Year LSC Gas Savings (Million 2026 PV$)	2.45
	30-Year Total LSC Savings (Million 2026 PV$)	3.98
	First-Year Avoided GHG Emissions (Metric Tons CO2e)	247.0
	Monetary Value of Avoided GHG Emissions during First Year ($2026)	30,417
	First-Year On-site Indoor Water Savings (Gallons)	N/A
	First-Year On-site Outdoor Water Savings (Gallons)	N/A
	First-Year Embedded Electricity in Water Savings (kWh)	0.00
Per Square Foot Impacts During First Year (weighted average for all prototypes and climate zones)	First-Year Electricity Savings (kWh)	0.0167
	First-Year Peak Electrical Demand Reduction (W)	0.0034
	First-Year Natural Gas Savings (kBtu)	0.3018
	First-Year Source Energy Savings (kBtu)	0.2760
	LSC Savings (2026 PV$)	0.2987
	First-Year Avoided GHG Emissions (kg CO2e)	0.0186
	First-Year On-site Indoor Water Savings (Gallons)	N/A
	First-Year On-site Outdoor Water Savings (Gallons)	N/A
	First-Year Embedded Electricity in Water Savings (kWh)	0.00

Table 6: Summary of Impacts for Opaque Assemblies – Prescriptive Heavy Mass Walls

Category	Metric	New Construction & Additions
Cost Effectiveness	Benefit-to-Cost Ratio Range (varies by climate zone and building type)	0 – 19.32
Statewide Impacts During First Year	First-Year Electricity Savings (GWh)	0.15
	First-Year Peak Electrical Demand Reduction (MW)	0.01
	First-Year Natural Gas Savings (Million Therms)	0.003
	First-Year Source Energy Savings (Million kBtu)	0.25
	30-Year LSC Electricity Savings (Million 2026 PV$)	0.99
	30-Year LSC Gas Savings (Million 2026 PV$)	0.17
	30-Year Total LSC Savings (Million 2026 PV$)	1.15
	First-Year Avoided GHG Emissions (Metric Tons CO2e)	30.84
	Monetary Value of Avoided GHG Emissions during First Year ($2026)	3,798
	First-Year On-site Indoor Water Savings (Gallons)	N/A
	First-Year On-site Outdoor Water Savings (Gallons)	N/A
	First-Year Embedded Electricity in Water Savings (kWh)	0.00
Per Square Foot Impacts During First Year (weighted average for all prototypes and climate zones)	First-Year Electricity Savings (kWh)	0.023
	First-Year Peak Electrical Demand Reduction (W)	0.002
	First-Year Natural Gas Savings (kBtu)	0.043
	First-Year Source Energy Savings (kBtu)	0.039
	LSC Savings (2026 PV$)	0.179
	First-Year Avoided GHG Emissions (kg CO2e)	0.005
	First-Year On-site Indoor Water Savings (Gallons)	N/A
	First-Year On-site Outdoor Water Savings (Gallons)	N/A
	First-Year Embedded Electricity in Water Savings (kWh)	0.00

Table 7: Summary of Impacts for Opaque Assemblies – Prescriptive Wood-Framed and Other Walls

Category	Metric	New Construction & Additions
Cost Effectiveness	Benefit-to-Cost Ratio Range (varies by climate zone and building type)	0.21 - 7.54
Statewide Impacts During First Year	First-Year Electricity Savings (GWh)	0.14
	First-Year Peak Electrical Demand Reduction (MW)	0.02
	First-Year Natural Gas Savings (Million Therms)	0.01
	First-Year Source Energy Savings (Million kBtu)	0.90
	30-Year LSC Electricity Savings (Million 2026 PV$)	0.81
	30-Year LSC Gas Savings (Million 2026 PV$)	0.59
	30-Year Total LSC Savings (Million 2026 PV$)	1.40
	First-Year Avoided GHG Emissions (Metric Tons CO2e)	70.50
	Monetary Value of Avoided GHG Emissions during First Year ($2026)	8,682
	First-Year On-site Indoor Water Savings (Gallons)	N/A
	First-Year On-site Outdoor Water Savings (Gallons)	N/A
	First-Year Embedded Electricity in Water Savings (kWh)	0.00
Per Square Foot Impacts During First Year (weighted average for all prototypes and climate zones)	First-Year Electricity Savings (kWh)	0.009
	First-Year Peak Electrical Demand Reduction (W)	0.001
	First-Year Natural Gas Savings (kBtu)	0.067
	First-Year Source Energy Savings (kBtu)	0.060
	LSC Savings (2026 PV$)	0.094
	First-Year Avoided GHG Emissions (kg CO2e)	0.005
	First-Year On-site Indoor Water Savings (Gallons)	N/A
	First-Year On-site Outdoor Water Savings (Gallons)	N/A
	First-Year Embedded Electricity in Water Savings (kWh)	0.00

Proposal Description – Vestibules

The proposed code change would establish a new mandatory requirement for vestibules in nonresidential buildings with high-traffic main entrances. The affected building types would be assembly, business, education, institutional, and mercantile. The vestibule requirement would be applicable to main entrances in new construction and additions. It would not apply to alterations. Exceptions to the requirement would parallel those identified in ASHRAE 90.1 and in IECC, including the option of using a revolving door[1] or air curtain in some applications. See Section 5.1.4.3 for more details.

The proposed code change would require small changes to the compliance software.

Table 8 summarizes the scope of the proposed changes. Table 9 presents the summarized impacts of the vestibules proposal.

Table 8: Scope of Code Change Proposal – Vestibules

Proposal Scope	Vestibules
Type of Requirement	Mandatory
Applicable Climate Zones*	All
Modified Section(s) of Title 24, Part 6	120.7
Modified Title 24, Part 6 Appendices	JA1
Would Compliance Software Be Modified	no
Modified/New Compliance Document(s)	Yes

Table 9: Summary of Impacts for Vestibules

[1] California Title 24, Part 2 provides restrictions on when a revolving door can be used a part of a means of egress.

Category	Metric	New Construction & Additions
Cost Effectiveness	Benefit-to-Cost Ratio Range (varies by climate zone and building type)	0.0 – 33.3
Statewide Impacts During First Year	First-Year Electricity Savings (GWh)	10.41
	First-Year Peak Electrical Demand Reduction (MW)	0.19
	First-Year Natural Gas Savings (Million Therms)	0.04
	First-Year Source Energy Savings (Million kBtu)	3.24
	30-Year LSC Electricity Savings (Million 2026 PV$)	62.32
	30-Year LSC Gas Savings (Million 2026 PV$)	2.12
	30-Year Total LSC Savings (Million 2026 PV$)	64.44
	First-Year Avoided GHG Emissions (Metric Tons CO2e)	887.19
	Monetary Value of Avoided GHG Emissions during First Year ($2026)	109,255
	First-Year On-site Indoor Water Savings (Gallons)	N/A
	First-Year On-site Outdoor Water Savings (Gallons)	N/A
	First-Year Embedded Electricity in Water Savings (kWh)	0.00
Per square foot/ Impacts During First Year	First-Year Electricity Savings (kWh)	0.4070
	First-Year Peak Electrical Demand Reduction (W)	0.0075
	First-Year Natural Gas Savings (kBtu)	0.1399
	First-Year Source Energy Savings (kBtu)	0.1266
	30-Year LSC Savings (2026 PV$)	2.5197
	First-Year Avoided GHG Emissions (kg CO2e)	0.0347
	First-Year On-site Indoor Water Savings (Gallons)	N/A
	First-Year On-site Outdoor Water Savings (Gallons)	N/A
	First-Year Embedded Electricity in Water Savings (kWh)	0.00

Proposal Description – Windows

This proposal would set a new mandatory requirement establishing U-factor values for vertical fenestration assemblies for alterations, additions, and new construction. The proposed mandatory requirements would apply to all vertical fenestration including fixed windows, curtainwall or storefront, and operable windows.

Currently, Title 24, Part 6 includes prescriptive U-factor and RSHGC requirements for exterior vertical fenestration, but these values can be traded away for higher efficiency HVAC equipment or other building systems when a designer uses the performance path to achieve code compliance. This measure, by establishing maximum mandatory U-factor for vertical fenestration, would ensure that there is a minimum level of window efficiency that cannot be replaced by a non-envelope system that typically has a much shorter lifespan.

This proposal would not add or modify acceptance tests or require any technology not previously regulated. Compliance would be verified through the existing verification process and would only require light modifications to the compliance documents.

The proposed mandatory requirement is less stringent than the existing prescriptive requirement, which has already proven to be cost effective. Therefore, a cost-effectiveness analysis is not included.

Table 10 summarizes the scope of the proposed changes. Table 11 presents the summarized impacts of the windows proposal.

Table 10: Scope of Code Change Proposal – Windows

Proposal Scope	Windows
Type of Requirement	Mandatory
Applicable Climate Zones*	All
Modified Section(s) of Title 24, Part 6	120.7, 141.0
Modified Title 24, Part 6 Appendices	N/A
Would Compliance Software Be Modified	Yes
Modified/New Compliance Document(s)	Yes

Table 11: Summary of Impacts for Windows

Category	Metric	New Construction & Additions	Alterations
Cost Effectiveness	Benefit-to-Cost Ratio Range (varies by climate zone and building type)	-4.49 – 5.08	-1.09 – 9.95
Statewide Impacts During First Year	First-Year Electricity Savings (GWh)	0.61	11.68
	First-Year Peak Electrical Demand Reduction (MW)	0.01	0.26
	First-Year Natural Gas Savings (Million Therms)	0.00	0.10
	First-Year Source Energy Savings (Million kBtu)	0.34	8.72
	30-Year LSC Electricity Savings (Million 2026 PV$)	2.98	57.39
	30-Year LSC Gas Savings (Million 2026 PV$)	0.22	5.64
	30-Year Total LSC Savings (Million 2026 PV$)	3.20	63.04
	First-Year Avoided GHG Emissions (Metric Tons CO2e)	46.47	1036.01
	Monetary Value of Avoided GHG Emissions during First Year ($2026)	5,723	127,582
	First-Year On-site Indoor Water Savings (Gallons)	N/A	N/A
	First-Year On-site Outdoor Water Savings (Gallons)	N/A	N/A
	First-Year Embedded Electricity in Water Savings (kWh)	N/A	N/A
Per square foot/ Impacts During First Year	First-Year Electricity Savings (kWh)	0.0776	0.2026
	First-Year Peak Electrical Demand Reduction (W)	0.0014	0.0045
	First-Year Natural Gas Savings (kBtu)	0.0477	0.1676
	First-Year Source Energy Savings (kBtu)	0.0430	0.1512
	30-Year LSC Savings (2026 PV$)	0.4084	1.0933
	First-Year Avoided GHG Emissions (kg CO2e)	0.0059	0.0180
	First-Year On-site Indoor Water Savings (Gallons)	N/A	N/A
	First-Year On-site Outdoor Water Savings (Gallons)	N/A	N/A
	First-Year Embedded Electricity in Water Savings (kWh)	N/A	N/A

Addressing Energy Equity and Environmental Justice

Based on the nature of these measures, the Statewide CASE Team has determined they would be unlikely to have significant impacts on energy equity or environmental justice. 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 Maureen Guttman (mguttman@energy-solution.com) and Marissa Lerner (mlerner@energy-solution.com) for further engagement.

1. Introduction

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

The CEC is the state agency that has authority to adopt revisions to Title 24, Part 6. One of the ways the Statewide CASE Team participates in the CEC's code development process is by submitting code change proposals to the CEC for consideration. The 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 cost-effective code change proposal for nonresidential opaque assemblies, vestibules, and windows. 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 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 public stakeholder workshops that the Statewide CASE Team held on February 14, 2023, and May 22, 2023, as well as follow-up discussions with the stakeholders at large.

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

- Section 2 – Addressing Energy Equity and Environmental Justice
- Section 3 – Market Analysis for Nonresidential Envelope

- Sections 4 through 6 of the report describe in detail each of the nonresidential envelope measure categories. Section 4 addresses Opaque Assemblies, Section 5 addresses Vestibules, and Section 6 addresses Windows. The following is a summary of the contents within each Section:
    - Sections 4.1, 5.1 and 6.1 – Measure Description sections providing a description of the measure and its background. These sections also present a detailed description of how this code change is accomplished in the various sections and documents that make up Title 24, Part 6 Standards.
    - Sections 4.2, 5.2 and 6.2 – Energy Savings sections presenting the per-unit energy, demand reduction, and Long-term Systemwide Cost (LSC) savings associated with the proposed code change. These sections also describe the methodology that the Statewide CASE Team used to estimate per-unit energy, demand reduction, and LSC savings.
    - Sections 4.3, 5.3, and 6.3 – Cost and Cost Effectiveness sections presenting lifecycle cost and cost-effectiveness analysis. These include a discussion of the materials and labor required to implement the measure and a quantification of the incremental cost.
    - Sections 4.4, 5.4 and 6.4 – First-Year Statewide Impacts sections presenting the statewide energy savings and environmental impacts of the proposed code change for the first year after the 2025 code takes effect. These include 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 these sections.
    - Sections 4.5, 5.5 and 6.5 – Addressing Energy Equity and Environmental Justice sections presenting the potential impacts of proposed code changes on disproportionately impacted populations (DIPs).
- Section 7 concludes the report with specific recommendations for all measures with ~~strikeout~~ (deletions) and underlined (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 8 – 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 LSC savings over the period of analysis in nominal dollars.
- Appendix H: Per-Unit Energy Impacts Results for additional analyses not included in the body of the report.
- Appendix I: Energy Cost Savings Results additional analyses not included in the body of the report.
- Appendix J: Statewide Energy and Energy Cost Savings for additional analyses not included in the body of the report.

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

2. Addressing Energy Equity and Environmental Justice

2.1 General Equity Impacts

The Statewide CASE Team recognizes, acknowledges, and accounts for a history of prejudice and inequality in disproportionately impacted populations (DIPs) and the role this history plays in the environmental justice issues that persist today. While the term disadvantaged communities (DACs) is often used in the energy industry and state agencies, the Statewide CASE Team chose to use terminology that is more acceptable 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). DIPs also incorporate race, class, and gender since these intersecting identity factors affect how people frame issues, interpret, and experience the world.[2]

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 Maureen Guttman (mguttman@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

[2] 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 Bell 2021). Socioeconomic inequities, climate, energy, and other inequities are inextricably linked and often mutually reinforcing.

beyond.[3] To minimize the risk of perpetuating inequity, code change proposals were 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. Results of that outreach and a summary of the 2025 code cycle EEEJ activities will be documented in the 2025 EEEJ Summary Report which 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. For 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

[3] 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. 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.

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 sections 4.3.2, 5.3.2 and 6.3.2 for estimates of energy cost savings from the current proposals.
- **Health:** Any potential health burdens from proposals could more severely affect DIPs with 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 (Tessum, et al 2019). Water heating and building shell improvements can lower stress levels associated with energy bills by lowering utility bill costs. Electrification can reduce the health consequences of NOx, SO2, and PM2.5.
- **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 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 during 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 the 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 rising 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 illnesses in California rose 67 percent for Black people, 53 percent for Asian-Americans, and 63 percent for Latinx people (Abualsaud, Ostrovskiy 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 are the elderly, people of color, and low-income households (Drehobl 2020 Blankenship 2020 IEA 2014). Comfort is not only a nice quality to have in workplaces, schools, and other facilities, but it also has real-world health impacts on people's health.

Potential impacts by building type will be published in the 2025 EEEJ Summary Report.

2.2 Specific Impacts of the Proposal

This proposal is unlikely to have significant negative impacts on DIPs. As explained in Section 2.1.2 energy efficiency measures such as insulation and tighter building envelopes can reduce the health impacts from the intrusion of dampness and contaminants. Therefore, this proposal has the potential to impact DIPs in relation to health positively. This proposal also has the potential to positively impact DIPs in relation to resiliency and comfort as tighter building envelopes would result in reduced air infiltration and improved indoor air quality. There are no expected impacts on DIPs regarding cost.

3. Market Analysis for Nonresidential Envelope

3.1 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 and 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 public stakeholder meetings that the Statewide CASE Team held on February 14, 2023, and May 22, 2023.

The nonresidential building envelope market involves many market actors in a variety of roles. This includes designers, architects, component manufacturers (shell, insulation, etc.), installers, construction companies, and certification/compliance specialists.

Opaque Assemblies

The opaque envelope measure would have some impact on all these market actors. Designers and architects would have to be aware of the new code changes and then design to those requirements. Plans examiners would need to verify that the project meets new envelope U-factor requirements; builders would need to build to the correct specifications; and inspectors would need to verify that the assembly U-factor meets what is listed in the specifications.

The market actors most impacted by this measure would likely be designers and architects. This measure does not introduce new technologies, so component manufacturers would not be greatly impacted. This proposal would necessitate that designers learn the new U-factor requirements and factor those into their designs. This could be accomplished with current techniques and materials. Compliance specialists would need to learn the new standards and verify building compliance for mandatory and prescriptive requirements. In comparison to Title 24 Part 6 2022, updated U-factor requirements typically do not correspond to changes in the framing size or entail the addition of continuous insulation where previously there were none. The only exceptions are for prescriptive wood framed wall assemblies in Climate Zones 1 and 3. In those cases, a stakeholder who is an insulation contractor informed the team that 2x6 framing is commonly employed compared to the 2x4 reference assembly from the Title 24, Part 6, 2022 Energy Code. This common use of 2x6 framing was further supported by data from permits submitted in prior years indicating that over 90 percent of project

submitting for prescriptive compliance used 2x6 framing even though the typical framing size required for the climate zones are 2x4 framing. Therefore, in Climate Zones 1 and 3 the Statewide CASE Team has increased the framing size for the reference assembly from 2x4 studs to 2x6 studs.

Component manufacturers, design-build consultants, and industry organizations have been the most vocal actors in this code cycle. The most common feedback for the opaque envelope measure highlights the need for cost effectiveness. The Statewide CASE Team understands these concerns, and while this measure has a broad impact on first cost, the potential for significant energy savings allows this measure to be cost effective.

Vestibules

In typical high-trafficked buildings and healthcare facilities, architects add vestibules and/or air barriers in the entrance lobby as a common practice. Vestibules typically include fenestration materials that are available in the market. Within the current market, vestibules are well-known and common in high-traffic buildings, where they are cost effective. There are no existing incentives or utility programs to encourage the usage of vestibules. There has been an increase in the use of air barriers in main entrances since the early 2000s, due to codes and regulations requiring their use in larger buildings.

Windows

Within the current market, there has been an increase of façade engineering in the design consulting world – which implies an increased appreciation of energy-efficient fenestration systems. The production of double-glazed windows has become the norm for top window manufacturers. Real estate owners are putting new efforts into improving building asset values to gain back occupancy in the post-pandemic era. While visibility and aesthetics are top considerations for fenestration choices, there is increased recognition that window performance is also a selling point.

3.2 Technical Feasibility and Market Availability

No new materials or processes would need to be developed for any of the nonresidential envelope measures to be successful.

Opaque Assemblies

There are different requirements for different construction materials and methods, such as wood-framed, metal-framed, and mass walls, and many products are available to enable designers to meet or exceed the proposed standards. Best practices of installation and maintenance are already well understood. Common types of wall insulation for commercial buildings include fiberglass, cellulose, extruded polystyrene (XPS), expanded polystyrene (EPS), polyisocyanurate, and spray-applied polyurethane (SPF). Wider dimensional lumber (2x6, 2x8, etc.) is commonly used to create room for

additional cavity insulation. When continuous exterior insulation is utilized, rigid or semi-rigid insulation such as EPS, XPS, or mineral wool is installed outboard of exterior sheathing to increase thermal efficiency. For mass walls, common practice is to fill hollow concrete masonry units (CMU) with insulation, while reduced webbed CMUs are sometimes employed. Wood-framed, metal-framed, and mass walls constitute most wall assemblies used in nonresidential construction.

Vestibules

While the inclusion of a vestibule into a building would have design impacts such as on usable floor area and HVAC systems design, no new materials or assemblies would need to be developed for measure success. The walls of a vestibule function as an air barrier similar to the exterior enclosure of a building but do not have the same water and thermal control functions. Therefore, the materials and design complexity of a vestibule are less than that of the adjacent exterior envelope.

Opaque vestibules would be comprised of typical interior partition elements such as gasketed doors, wood/steel framing, drywall, batt insulation, and interior finishes. Glazed vestibules would be comprised of typical storefront glazing systems and glazed doors. Similar to vestibule materials and assemblies, alternative compliance approaches such as revolving doors and air curtains exist in the market and are commonly deployed in existing high-traffic buildings.

All the materials and equipment noted in this section are readily available products and are commonly seen within the industry. The Statewide CASE Team therefore does not see any technical or market barriers to carrying out this measure.

Windows

The proposed U-factor requirement of 0.47 for vertical fenestration is based on products widely available in the market. The only exception is for large scale storefront glazing assemblies incorporating single pane structural glazing. In these cases, thermally broken frames would be needed to meet the requirement. Since it is common practice for retailers to procure fenestration products designed specifically for these conditions, the Statewide CASE Team does not anticipate technical or market challenges to meeting this requirement within the time frame when this code change would take effect (January 1, 2026).

The baseline U-factor requirement of 0.58 matches current existing building alterations requirement for vertical fenestration in California Climate Zone 3. This is typically met with insulated double-pane units rather than un-coated single-pane glazing.

3.3 Market Impacts and Economic Assessments

3.3.1 Impact on Builders

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

California's commercial construction industry comprised over 17,000 businesses and 368,000 employees in 2022, with a total estimated payroll of about $35 billion (see Table 12).

Table 12: California Commercial Construction Industry, Establishments, Employment, and Payroll in 2022 (Estimated)

Construction Sectors	Businesses	Employment	Annual Payroll (Billions $)
All	**17,621**	**368,810**	**35.0**
Building Construction Contractors	4,919	83,028	9.0
Foundation, Structure, & Building Exterior	2,194	59,110	5.0
Building Equipment Contractors	6,039	139,442	13.5
Building Finishing Contractors	4,469	87,230	7.4

Source: (State of California n.d.)

The effects on the commercial building industry would not be felt by all firms and workers, but rather would be concentrated in specific industry subsectors. The proposed changes to the nonresidential envelope requirements would likely affect commercial builders but would not impact firms that focus on construction and retrofit of industrial buildings, utility systems, public infrastructure, or other heavy construction.

The Statewide CASE Team's estimates of the magnitude of these impacts are shown in Section 3.4: Economic Impacts.

Opaque Assemblies

Builders would need to factor in higher up-front costs of envelope assembly pricing. They may have to consider longer lead times when ordering if products have lower market availability. Installation processes and costs would be the same as current requirements. Table 13 shows the commercial building subsectors the Statewide CASE Team expects to be impacted by the changes proposed in this report for opaque assemblies.

Table 13: Specific Subsectors of the California Commercial Building Industry Impacted by Proposed Change to OPAQUE ASSEMBLIES by Subsector in 2022 (Estimated)

Construction Subsector	Establishments	Employment	Annual Payroll (Billions $)
Commercial Building Construction	4,919	83,028	9.0
Nonresidential structural steel contractors	363	13,110	1.1
Nonresidential Framing Contractors	133	3,406	0.3
Nonresidential Masonry Contractors	229	4,246	0.3
Nonresidential Roofing Contractors	354	10,382	0.9
Nonresidential Siding Contractors	26	668	0.0
Other Nonresidential Exterior contractors	277	3,006	0.2
Nonresidential Drywall Contractors	585	22,824	2.1

Source: (State of California n.d.)

Vestibules

Builders would need to factor in higher up-front costs of vestibule assembly pricing. They may have to consider long lead times when ordering if products have lower market availability. Table 14 shows the commercial building subsectors the Statewide CASE Team expects to be impacted by the proposed requirement for vestibules in nonresidential buildings.

Table 14: Specific Subsectors of the California Commercial Building Industry Impacted by Proposed Change to VESTIBULE by Subsector in 2022 (Estimated)

Construction Subsector	Establishments	Employment	Annual Payroll (Billions $)
Commercial building construction	4,919	83,028	9.0
Nonresidential poured foundation contractors	529	18,159	1.6
Nonresidential structural steel contractors	363	13,110	1.1
Nonresidential framing contractors	133	3,406	0.3
Nonresidential masonry contractors	229	4,246	0.3
Nonresidential glass and glazing contractors	283	6,133	0.6
Nonresidential roofing contractors	354	10,382	0.9
Nonresidential siding contractors	26	668	0.0
Other nonresidential exterior contractors	277	3,006	0.2
Nonresidential electrical Contractors	3,137	74,277	7.0
Nonresidential plumbing & HVAC contractors	2,346	55,572	5.5
Other nonresidential equipment contractors	556	9,594	1.0
Nonresidential drywall contractors	585	22,824	2.1

Construction Subsector	Establishments	Employment	Annual Payroll (Billions $)
Nonresidential painting contractors	500	10,263	0.7
Nonresidential flooring contractors	278	3,756	0.3
Nonresidential tile and terrazzo contractors	153	2,822	0.2
Nonresidential finish carpentry contractors	363	4,667	0.4
Other nonresidential finishing contractors	491	6,549	0.4
Nonresidential site preparation contractors	1,159	18,322	1.6
All other nonresidential trade contractors	940	18,027	1.6

Source: (State of California n.d.)

Windows

Builders may need to factor in higher up-front costs of vertical fenestration if the design is using the performance path for code compliance. They may have to consider long lead times when ordering if products have lower market availability. Table 15 shows the commercial building subsectors the Statewide CASE Team expects to be impacted by the proposed requirement for windows in nonresidential buildings.

Table 15: Specific Subsectors of the California Commercial Building Industry Impacted by Proposed Change to WINDOWS by Subsector in 2022 (Estimated)

Construction Subsector	Establishments	Employment	Annual Payroll (Billions $)
Commercial Building Construction	4,919	83,028	9.0
Nonresidential Framing Contractors	133	3,406	0.3
Nonresidential Masonry Contractors	229	4,246	0.3
Nonresidential glass and glazing contractors	283	6,133	0.6

Source: (State of California, n.d.)

3.3.2 Impact on Building Design Professionals 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 current 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 16 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 from the proposed nonresidential envelope changes to affect firms that focus on 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 establishments within the Building Inspection Services sector are focused on energy efficiency consulting. The information shown in Table 16 provides an upper bound indication of the size of this sector in California.

Table 16: 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.

Opaque Assemblies

Increasing mandatory stringency affects the choice of envelope assemblies within the context of the performance compliance pathway. The range of code compliant envelope

[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.

assemblies would be decreased by the number of assemblies no longer meeting the mandatory minimum requirements.

While building designers and energy consultants may need to adjust what envelope assemblies are chosen for a project, building designers and energy consultants would not have to develop new envelope assemblies or incorporate new materials to meet this requirement. Therefore, this measure would have minimal effect on building designers and energy consultants.

Vestibules

Vestibules are not currently required in Title 24, Part 6, so this would have a notable impact on the work of building designers and energy consultants. Designers would need to coordinate the vestibule requirement with other provisions including, but not limited to, means of egress, accessibility, fire safety, HVAC design and lighting.

Windows

Proposed changes in the code would impact approximately 4000 new projects in Large Office, Medium Office, Small Office, Restaurant, Strip Mall, Large Retail, Medium Retail, & Small School projects. The tables in Section 3.3 show the total estimation of job created due to this change and the economic impact on the California economy. Retrofitting older windows from the existing building stocks would generate the most jobs and economic upturn.

The economic analysis is based on an additional 20 hours combined for building designers and/or energy consultants per project. An average estimated annual cost per building designers & energy consultant is $167,101 per sector payroll reported by the State of California is considered here to calculate the economic impact of proposed changes in the windows section.

3.3.3 Impact on Occupational Safety and Health

The proposed code changes do 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 (Cal/OSHA). All existing health and safety rules would remain in place. Complying with the proposed code changes 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.

3.3.4 Impact on Building Owners and Occupants

3.3.4.1 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.

3.3.4.2 Estimating Impacts

Building owners and occupants would benefit from improved indoor comfort and air quality, and lower energy bills. The Statewide CASE Team does not expect the proposed nonresidential envelope code changes for the 2025 code cycle to impact building owners or occupants adversely.

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

Opaque Assemblies

Retailers, manufacturers, and distributors who offer higher performing wall and roof materials and assemblies could have increased business from proposed code modifications. Some retailers and manufacturers may need to increase production or availability of these lower U-factor materials.

Vestibules

This measure would generally expand the market for building component retailers selling components that would be incorporated into vestibules. The degree of the impact would depend on whether building owners opt for building a vestibule or whether they opt for using accepted alternatives to vestibules such as revolving doors and air curtains.

For building types with greater flexibility in floor space, the Statewide CASE Team anticipates that building owners would opt for incorporating vestibules due to the relatively straightforward nature of constructing an inward extension of the building enclosure. In this case, there would be an expanded market for building component retailers of products such as storefront glazing, steel/wood framing, drywall, sealant, and fasteners.

For buildings with less flexibility in floor area, the Statewide CASE Team anticipates that building owners will opt for incorporating revolving doors or air curtains due to those products having a smaller footprint than typical vestibules. In this case, the Statewide

CASE Team anticipates an expanded market for building component retailers of vestibules, revolving doors, and air curtains.

Windows

The Statewide CASE Team anticipates the proposed change would have no material impact on California component retailers.

3.3.6 Impact on Building Inspectors

Table 17 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 17: 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.)

a. Administration of Housing Programs (NAICS 925110) comprises government establishments primarily engaged in the administration and planning of housing programs, including building codes and standards, housing authorities, and housing programs, planning, and development.
b. Urban and Rural Development Administration (NAICS 925120) comprises government establishments primarily engaged in the administration and planning of the development of urban and rural areas. Included in this industry are government zoning boards and commissions.

3.3.7 Impact on Statewide Employment

As described in Sections 3.3.2 through 3.3.6, 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 the above sections the Statewide CASE Team estimated the proposed changes to nonresidential envelope requirements would affect statewide employment and economic output directly and indirectly through its impact on builders, designers, energy consultants, and building inspectors. In addition, the

Statewide CASE Team estimated how energy savings associated with these changes would lead to modest ongoing financial savings for California residents, which would then be available for other economic activities.

3.4 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 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 changes. By following this approach, the economic impacts presented below represent lower bound estimates of the actual benefits associated with the proposed code changes.

Adoption of these code change proposals 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.

[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.

Opaque Envelope

Table 18: Estimated Impact that Adoption of the Opaque Envelope Measure would have on the California Commercial Construction Sector

Type of Economic Impact	Employment (Jobs)	Labor Income (Million)	Total Value Added (Million)	Output (Million)
Direct Effects (Additional spending by Commercial Builders)	197.8	$15.36	$17.75	$30.24
Indirect Effect (Additional spending by firms supporting Commercial Builders)	48.4	$4.18	$6.57	$12.09
Induced Effect (Spending by employees of firms experiencing "direct" or "indirect" effects)	82.2	$5.61	$10.05	$15.99
Total Economic Impacts	**328.4**	**$25.16**	**$34.37**	**$58.33**

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

Table 19: Estimated Impact that Adoption of the Opaque Envelope Measure would have on the California Building Designers and Energy Consultants

Type of Economic Impact	Employment (Jobs)	Labor Income (Million)	Total Value Added (Million)	Output (Million)
Direct Effects (Additional spending by Building Designers & Energy Consultants)	88.6	$9.71	$9.61	$15.20
Indirect Effect (Additional spending by firms supporting Bldg. Designers & Energy Consultants)	35.6	$2.89	$4.02	$6.47
Induced Effect (Spending by employees of firms experiencing "direct" or "indirect" effects)	53.2	$3.62	$6.49	$10.33
Total Economic Impacts	**177.4**	**$16.23**	**$20.12**	**$32.00**

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

Table 20: Estimated Impact that Adoption of the Opaque Envelope 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)	0.5	$0.06	$0.07	$0.09
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)	0.3	$0.02	$0.03	$0.05
Total Economic Impacts	**0.9**	**$0.09**	**$0.12**	**$0.16**

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

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

Vestibules

Table 21: Estimated Impact that Adoption of the Vestibules Measure would have on the California Commercial Construction Sector

Type of Economic Impact	Employment (Jobs)	Labor Income (Million)	Total Value Added (Million)	Output (Million)
Direct Effects (Additional spending by Commercial Builders)	102.7	$7.976	$9.217	$15.699
Indirect Effect (Additional spending by firms supporting /Commercial Builders)	25.1	$2.173	$3.409	$6.278
Induced Effect (Spending by employees of firms experiencing "direct" or "indirect" effects)	42.7	$2.914	$5.217	$8.304
Total Economic Impacts	**170.5**	**$13.62**	**$17.844**	**$30.281**

Source: Statewide CASE Team analysis of data from the IMPLAN modeling software.[32]

Table 22: Estimated Impact that Adoption of the Vestibules 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)	12.2	$1.336	$1.322	$2.090
Indirect Effect (Additional spending by firms supporting Bldg. Designers & Energy Consultants)	4.9	$0.398	$0.553	$0.890
Induced Effect (Spending by employees of firms experiencing "direct" or "indirect" effects)	7.3	$0.498	$0.893	$1.421
Total Economic Impacts	**24.4**	**$2.232**	**$2.768**	**$4.401**

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

Table 23: Estimated Impact that Adoption of the Vestibules 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)	0.1	$0.011	$0.013	$0.016
Indirect Effect (Additional spending by firms supporting Building Inspectors)	0.0	$0.001	$0.002	$0.003
Induced Effect (Spending by employees of Building Inspection Bureaus and Departments)	0.1	$0.004	$0.006	$0.010
Total Economic Impacts	**0.2**	**$0.016**	**$0.021**	**$0.029**

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

Windows

Table 24: Estimated Impact that Adoption of the Windows Measure would have on the California Commercial Construction Sector – New Construction

Type of Economic Impact	Employment (Jobs)	Labor Income (Million)	Total Value Added (Million)	Output (Million)
Direct Effects (Additional spending by Commercial Builders)	216.1	$16.78	$19.39	$33.03
Indirect Effect (Additional spending by firms supporting Commercial Builders)	52.9	$4.57	$7.17	$13.21
Induced Effect (Spending by employees of firms experiencing "direct" or "indirect" effects)	89.9	$6.13	$10.97	$17.47
Total Economic Impacts	**358.8**	**$27.48**	**$37.55**	**$63.72**

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

Table 25: Estimated Impact that Adoption of the Windows Measure would have on the California Commercial Construction Sector – Alterations

Type of Economic Impact	Employment (Jobs)	Labor Income (Million)	Total Value Added (Million)	Output (Million)
Direct Effects (Additional spending by Commercial Builders)	1,335.3	$106.19	$159.88	$345.93
Indirect Effect (Additional spending by firms supporting Commercial Builders)	778.4	$61.38	$105.38	$184.49
Induced Effect (Spending by employees of firms experiencing "direct" or "indirect" effects)	705.7	$48.15	$86.21	$137.22
Total Economic Impacts	**2,819.4**	**$215.72**	**$351.48**	**$667.65**

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

Table 26: Estimated Impact that Adoption of the Windows 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)	37.7	$4.14	$4.09	$6.47
Indirect Effect (Additional spending by firms supporting Bldg. Designers & Energy Consultants)	15.1	$1.23	$1.71	$2.75
Induced Effect (Spending by employees of firms experiencing "direct" or "indirect" effects)	22.6	$1.54	$2.76	$4.40
Total Economic Impacts	**75.5**	**$6.91**	**$8.57**	**$13.62**

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

Table 27: Estimated Impact that Adoption of the Windows 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)	0.5	$0.05	$0.06	$0.08
Indirect Effect (Additional spending by firms supporting Building Inspectors)	0.1	$0.00	$0.01	$0.01
Induced Effect (Spending by employees of Building Inspection Bureaus and Departments)	0.2	$0.02	$0.03	$0.05
Total Economic Impacts	**0.8**	**$0.07**	**$0.10**	**$0.14**

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

3.4.1 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 changes would not result in economic disruption to any sector of the California economy. Rather, the estimates of economic impacts discussed in Section 3.3 would lead to modest changes in employment of existing jobs.

3.4.2 Creation or Elimination of Businesses in California

As stated in Section 3.3, the Statewide CASE Team's proposed changes would not result in economic disruption to any sector of the California economy. The proposed changes represent a modest change to nonresidential building practices, which would not excessively burden or competitively disadvantage California businesses – nor would they 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.

3.4.3 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

[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.

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.

3.4.4 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 28 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 28: 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.)

[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:

Opaque Assemblies:

*Change in Proprietor Income ($7,865,088) * 0.26 = $2,083,670*

Vestibules:

*Change in Proprietor Income ($3,125,341) * 0.26 = $827,986*

Windows:

*Change in Proprietor Income ($50,409,597) * 0.26 = $13,354,839*

3.4.5 Incentives for Innovation in Products, Materials, or Processes

There is a consistent trend within the building design and construction industry of increasing focus on thermal performance of the exterior envelope. This trend is reflected by the development, success, and adoption of building performance standards that incentivize increasing usage of insulation, thermal breaks, and U-value optimization. Examples of such standards include LEED, Passive House, Net Zero, Living Building Challenge, Green Globe, etc.

The industry shift toward higher thermal performance envelopes has resulted in building component manufacturers developing products to meet this demand. Such products include new insulation types (i.e., MAI/polyiso panel,[10] Phase Change materials, etc.), higher R-value insulation, and structural thermal breaks. The proposed measure would leverage the ready availability of products and design solutions that exist due to broader industry trends. It would further incentivize the development of low-cost options for meeting higher thermal performance envelope requirements.

CEC offers[11] incentives for creativity and innovations in the building industry which includes improvements in envelopes; like Bright Schools program, Building Energy Benchmarking Program, and Energy Efficiency in Existing Buildings programs. There are incentives based on a project's anticipated modeled energy usage reduction, peak load reduction and greenhouse gas (GHG) emission reduction as compared to the mixed-fuel 2019 Energy Code prescriptive standards.

[10] MAI = modified atmosphere insulation; https://www.ornl.gov/news/buildings-inside-out

[11] https://www.energy.ca.gov/programs-and-topics/programs

With our existing code change proposal, the bar for participating in these programs would increase slightly, hence more opportunities and avenues for innovations in the building sector.

There are no known existing incentive programs or utility programs that directly offer encouragement for the addition of vestibules in the buildings.

3.4.6 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.

3.4.7 Cost of Enforcement

Cost to the State: State government has budget for code development, education, and compliance enforcement. While state government would 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 covered by existing state budgets. The costs to the state government are small when compared to the overall cost savings and policy benefits associated with the code change proposals.

Cost to Local Governments: All proposed code changes to Title 24, Part 6 would result in changes to compliance determinations. Local governments would need to train building department staff on the revised Title 24, Part 6 Standards. While this re-training is an expense to local governments, it is not a new cost associated with the 2025 code change cycle. The building code is updated on a triennial basis, and local governments plan and budget for retraining every time the code is updated. There are numerous resources available to local governments to support compliance training that can help mitigate the cost of retraining, including tools, training and resources provided by the IOU Codes and Standards program (such as Energy Code Ace). As noted in Section 3.3 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.

3.4.8 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. There are no foreseen impacts on specific persons or groups. The materials and technologies to meet the proposed code changes are neither proprietary nor sole-sourced. Refer to Sections 4.5, 5.5, and 6.5 for more details addressing energy equity and environmental justice.

3.5 Fiscal Impacts

3.5.1 Mandates on Local Agencies or School Districts

Local agencies or school districts undertaking new construction or building envelope renovation projects would be impacted by the opaque assemblies proposal and may be impacted by the vestibule (depending on the size and type of facility) or windows (depending on the code compliance path chosen) proposals.

3.5.2 Costs to Local Agencies or School Districts

These measures would impose minor additional costs for increased insulation to local agencies and school districts undertaking new construction or building envelope renovation projects, and may impose additional costs for the vestibule (depending on the size and type of facility) or windows (depending on the code compliance path chosen) proposals.

3.5.3 Costs or Savings to Any State Agency

These measures would impose minor additional costs for increased insulation to state agencies undertaking new construction or building envelope renovation projects and may impose additional costs for the vestibule (depending on the size and type of facility) or windows (depending on the code compliance path chosen) proposals. The proposed measures are expected to provide commensurate savings in energy costs.

3.5.4 Other Nondiscretionary Cost or Savings Imposed on Local Agencies

There are no added non-discretionary costs or savings to local agencies.

3.5.5 Costs or Savings in Federal Funding to the State

There are no costs or savings to federal funding to the state.

4. Opaque Assemblies

4.1 Measure Description

4.1.1 Proposed Code Changes

The opaque assemblies of the building envelope are all those that are not transparent. This proposal would make the prescriptive U-factors more stringent for all new wall and roof/ceiling assemblies, except for metal-framed walls for which the U-factors were revised during the 2022 Title 24, Part 6 code cycle. This proposal does not apply to alterations. Also, it would not add or modify field verification or acceptance tests or require any technology not previously regulated.

For the last two code cycles, the Statewide CASE Team has been aware that the opaque envelope requirements for Hotel/Motel guest room should be simplified. However, this work has been deferred in favor of higher priorities. For details on the decision process in 2022, please see 2022 Results Report, NR High Performance Envelope.

4.1.2 Justification and Background

In this CASE Report, opaque assemblies refers to those that separate conditioned spaces from unconditioned spaces. The U-factor defines heat loss or heat gain through a standard building component, also known as the rate of heat transfer through the envelope. The higher the insulation of the element, the lower the U-factor and the lower the rate of heat transfer.

Reducing the U-factor values for opaque envelope assemblies can significantly reduce operating costs throughout a building's lifecycle by improving energy performance and helping downsize HVAC equipment.

In the 2016 cycle, the prescriptive U-factor requirements were made more stringent for metal-framed walls, wood-framed walls (Climate Zone 1 only), metal building roofs, and wood-framed roof assemblies. In the 2022 cycle, they were updated again for new construction metal-framed walls. Besides the abovementioned change, the prescriptive U-factor requirements for metal building walls, mass walls, and wood-framed walls have not changed since 2008.

The current prescriptive U-factors for opaque assemblies are described below.

Table 29: Current Prescriptive U-Factors Values for Opaque Assemblies New Construction and Additions

Envelope Assembly	New Construction (area weighted average)	Climate Zones
Roofs/Ceilings – Metal building	0.041	All Climate Zones
Roofs/Ceilings – Wood Framed and other	0.034	1-5, 9-16
	0.049	6-8
Walls – Metal building	0.057	15
	0.061	2 ,4 ,5, 8-14
	0.113	1, 3, 6, 7
Walls – Mass Light	0.17	2, 10-16
	0.196	1
	0.227	4
	0.278	3
	0.44	5-9
Walls – Mass Heavy	0.16	16
	0.184	11, 14, 15
	0.211	13
	0.253	1, 12
	0.65	2-5, 10
	0.69	6-9
Walls – Wood-framed and others	0.042	15
	0.059	2, 10, 12-14, 16
	0.095	1
	0.102	5
	0.110	3, 6, 7

This proposal would increase the stringency of the opaque assemblies for new construction and additions. The U-factors and compliance insulation values vary based on climate zones.

4.1.3 Summary of Proposed Changes to Code Documents

The sections below summarize how the Energy Code, Reference Appendices, Alternative Calculation Method (ACM) Reference Manuals, and compliance documents would be modified by the proposed change.[12] See Section 7 for the proposed language.

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

4.1.3.1 Specific Purpose and Necessity of Proposed Code Changes

Each proposed change to the language in Title 24, Part 6 and to the reference appendices to Part 6 are described below.

Section: Table 140.3-B Prescriptive Envelope Criteria for Nonresidential Buildings – Modify U-factors

Specific Purpose: The specific purpose of this change is to increase stringency of prescriptive envelope U-factor criteria for walls and roof of nonresidential buildings.

Necessity: This change is necessary to reduce energy consumption from building cooling and heating loads. The prescriptive compliance approach remains unchanged.

4.1.3.2 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 for the proposed revisions to ACM Reference Manual text.

Section: **5.5**

Specific Purpose: The specific purpose of this change is to update the standard design construction assemblies prescriptive requirements outlined in Title 24, Part 6 Table 140.3-B and Section 141(b)1A.

Necessity: These changes are necessary to ensure the ACM Reference Manual reflects the proposed code changes and that compliance with the performance pathway can be achieved.

4.1.3.3 Summary of Changes to the Nonresidential Compliance Manual

Sections of Chapter 3 pertaining to prescriptive U-factor values for roof/wall and ceiling assemblies in new construction and additions would need to be revised.

4.1.3.4 Summary of Changes to Compliance Documents

The proposed code change would modify the compliance documents listed below.

- NRCC-ENV-E Certificate of Compliance - No changes would be required for this document.
- 2022-NRCI-ENV-E Certificate of Installation – No changes would be required for this document.

4.1.4 Regulatory Context

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

This proposed measure's intent is to update existing requirements in Title 24, Part 6. Therefore, there are no expected issues with inconsistencies or incompatibility.

4.1.4.2 Duplication or Conflicts with Federal Laws and Regulations

There are no relevant federal laws or regulations.

4.1.4.3 Difference From Existing Model Codes and Industry Standards

The model energy codes used elsewhere in the country, ASHRAE 90.1 and the International Energy Conservation Code (IECC), currently have more stringent envelope provisions for many assembly types in similar climate zones. ASHRAE and IECC have eight climate zones, compared to the sixteen in California. Most of the California climate zones fall within ASHRAE/IECC Climate Zones 3, 4, and 5, as shown in Table 30.

Table 30: Comparison of California and ASHRAE/IECC Climate Zones (CZs)

California CZs	National Model Codes CZs	Notes
1	4c	4c is Mixed Marine, covered by CZ 4 in 90.1, and CZ 5 in IECC
2-6	3c	3c is Warm Marine, covered by CZ 3 in 90.1 and IECC
7-13	3b	3b is Warm Dry, covered by CZ 3 in 90.1 and IECC
14	4b	4b is Mixed Dry, covered by CZ 4 in 90.1 and IECC
15	2b	2b is Hot Dry, covered by CZ 2 in 90.1 and IECC
16	4b, 5b, 6b	4b is Mixed Dry, covered by CZ 4 in 90.1 and IECC 5b is Cool Dry, covered by CZ 5 in 90.1 and IECC 6b is Cold Dry, covered by CZ 6 in 90.1 and IECC

Source: silo.tips_energy-efficiency-comparison.pdf

Table 31 compares U-factor values between Title 24, Part 6, ASHRAE 90.1 and IECC.

The differences in U-factors among these codes are partially due to differences in calculation methods. However, the Statewide CASE Team finds it instructive to evaluate the differences in required U-factors to understand the California requirements compared to the rest of the U.S.

Table 31: Comparison of New Construction U-factor Requirements

Envelope Assembly	California Climate Zone	Title 24 – 2022 Prescriptive	ASHRAE 90.1 2022	IECC 2021
Roof/Ceiling – Metal Building	1, 14, 16	0.041	0.037	0.035
	2-13, 15	0.041	0.041	0.035
Roof/Ceiling – Wood Frame and Others	1, 14, 16	0.034	0.021	0.021
	2-5	0.034	0.027	0.027
	6-8	0.049	0.027	0.027
	9-13	0.034	0.027	0.027
	15	0.034	0.027	0.027
Walls – Metal Building	1	0.113	0.060	0.050
	2, 4, 5, 8-13	0.061	0.094	0.079
	3,6,7	0.113	0.094	0.079
	14, 16	0.061	0.050	0.050
	15	0.057	0.094	0.079
Walls – Metal Framed [a]	1	0.060	0.064	0.055
	2, 4, 5, 8-13	0.055	0.077	0.064
	3	0.071	0.077	0.064
	6, 7	0.060	0.077	0.064
	14	0.055	0.064	0.064
	15	0.055	0.084	0.077
	16	0.055	0.055	0.055
Walls – Mass Light	1	0.196	0.104	0.090
	2, 10-13	0.170	0.123	0.123
	3	0.278	0.123	0.123
	4	0.227	0.123	0.123
	5-9	0.440	0.123	0.123
	14	0.170	0.104	0.104
	15	0.170	0.151	0.151
	16	0.170	0.090	0.090
Walls – Mass Heavy	1	0.253	0.104	0.090
	2-5, 10	0.650	0.123	0.123
	6-9	0.690	0.123	0.123
	11	0.184	0.123	0.123
	12	0.253	0.123	0.123
	13	0.211	0.123	0.123
	14	0.184	0.104	0.104
	15	0.184	0.151	0.151
	16	0.160	0.090	0.090
Walls – Wood Framed and Other	1	0.095	0.064	0.051
	2, 4, 9, 10,12-13	0.059	0.089	0.064
	3, 6, 7	0.110	0.089	0.064
	5, 8	0.102	0.089	0.064
	11	0.045	0.089	0.064
	14	0.059	0.064	0.064
	15	0.042	0.089	0.064
	16	0.059	0.051	0.051

a. These values were updated in the 2022 code cycle and would not be updated in this proposal.

4.1.5 Compliance and Enforcement

When developing this proposal, the Statewide CASE Team considered how to streamline the compliance and enforcement process and how to reduce or mitigate any negative impacts on market actors This section describes how to comply with the proposed code change and the compliance verification process.

This proposal would not change the compliance process. Designers, builders, and compliance officials would reference the same tables with updated values. The compliance verification activities related to this measure are described below:

- **Design Phase:** Building designers must be aware of envelope U-factor requirements. The qualified design reviewer must verify that plans and specifications meet the requirements of Title 24, Part 6, as must any energy consultants and compliance documentation authors. This proposal would not change the process for completing NRCC (Nonresidential Certificates of Compliance) documents.
- **Permit Application Phase:** Plans examiners would verify the project meets new envelope U-factor requirements by ensuring the NRCC documentation matches the plans and specifications.
- **Construction Phase:** Envelopes would be built to the required U-factor requirements per energy documentations and/or specifications. This proposal would not change the process for how installers complete the required NRCI (Nonresidential Certificates of Installation) forms.
- **Inspection Phase:** Building inspectors would verify that the U-factor meets what is listed on energy documentation, plans, and/or specifications.

Appendix E presents how the proposed changes could impact various market actors in more detail.

4.2 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 4.5 for more details addressing energy equity and environmental justice.

4.2.1 Energy Savings Methodology

4.2.1.1 Energy Savings Analysis Assumptions

For savings calculations, the Statewide CASE Team used EnergyPlus v9.4.0 with CBECC-com rulesets. It modified the CBECC energy models to reflect the proposed

changes to the energy standards, and used the 2022 Standard Design as the baseline for the prescriptive proposals.

Two roof assembly types and four wall assembly types were modeled on 11 prototype buildings in all climate zones. Table 32 shows which prototypes were used to model each assembly. For each assembly, the Statewide CASE Team chose the most appropriate building types based on experience and stakeholder feedback. For example, for the Metal Building Roof assembly only the Non-refrigerated Warehouse and the Retail Medium prototypes were used, since other building types are likely to have different assemblies (wood rafter construction, wood attic construction, low slope roofs over metal deck, low slope roofs over concrete deck, etc.).

Table 32: Summary of Building and Opaque Assembly Types Analyzed per Prototype Building

Building Type	Roof and Ceilings: Wood-framed and Other	Roof and Ceilings: Metal Building	Walls: Mass, Heavy	Walls: Mass, Light	Walls: Metal Building	Walls: Wood-framed and Other
Hospital	✓	-	✓	-	-	-
Non-Refrigerated Warehouse	✓	✓	-	✓	✓	-
Office Large	-	-	✓	✓	-	-
Office Medium	✓	-	-	✓	-	✓
Office Small	-	-	-	-	-	✓
Restaurant Fast-food	-	-	-	-	-	✓
Retail Large	✓	-	✓	-	-	-
Retail Medium	✓	✓	✓	-	-	-
Retail Strip Mall	✓	-	-	-	-	✓
School Large	-	-	-	-	-	-
School Small	✓	-	-	-	-	✓

Detailed input assumptions for the models are included in Appendix C.

4.2.1.2 Energy Savings Methodology per Prototypical Building

To quantify impacts, the Statewide CASE Team developed several scenarios by calculating per-unit energy savings expected from the proposed code changes. First, savings are calculated by fuel type. Electricity savings are measured in terms of energy usage and peak demand reduction. Natural gas savings are quantified in energy usage. Second, the Statewide CASE Team calculated source energy savings. Source energy represents the total amount of raw fuel required to operate a building. In addition to all energy used from on-site production, source energy incorporates all transmission, delivery, and production losses. The hourly source energy values provided by CEC are strongly correlated with GHG emissions.[13] Finally, the Statewide CASE Team calculated LSC (LSC) savings, formerly known as Time Dependent Valuation (TDV) Energy Cost Savings. LSC savings are calculated using LSC hourly factors for both electricity and natural gas provided by the CEC. These factors are projected over the 30-year life of the building and incorporate the hourly cost of marginal generation, transmission and distribution, fuel, capacity, losses, and cap-and-trade-based CO_2 emissions.[14]

The CEC directed the Statewide CASE Team to model the energy impacts using prototypical building models that represent typical building geometries for different types of buildings.[15] The prototype buildings that the Statewide CASE Team used for this proposal are presented in Table 33.

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

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

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

Table 33: Prototype Buildings Used for Energy, Demand, Cost, and Environmental Impacts Analysis

Prototype Name	Number of Stories	Floor Area (Square Feet)	Description
Warehouse	1	42,554	Single story high ceiling warehouse. Includes one office space. WWR–0.7%, SRR–5%
Hospital	5	241,501	5-Story Hospital plus basement. Source: U.S. DOE Standard 90.1 Hospital prototype and scorecard. Contains Title 24, Part 6, minimally compliant envelope features and lighting. For HVAC systems, AIA guidelines recommend using VAV systems where possible.
OfficeLarge[a]	**12**	**498,589**	**12-story + 1 basement office building with 5 zones and a ceiling plenum on each floor. WWR–0.40.***
OfficeMedium[a]	**3**	**53,628**	**3-story office building with 5 zones and a ceiling plenum on each floor. WWR–0.33**
OfficeSmall	1	5,502	1-story, 5-zone office building with pitched roof and unconditioned attic. WWR–0.24
Restaurant FastFood	1	2,501	Fast food restaurant with a small kitchen and dining areas. 14% WWR. Pitched roof with an unconditioned attic.
RetailLarge[a]	**1**	**240,000**	**Big-box retail building with WWR–12% and SRR–0.82%**
RetailMedium[a]	**1**	**24,563**	**Similar to a Target or Walgreens. 7% WWR on the front façade, none on other sides. SRR–2.1%.**
RetailStripMall	1	9,375	Strip mall building with WWR–10%
SchoolSmall[a]	**1**	**24,413**	**Elementary school with WWR–0.36**

a. This prototype has been modeled for this CASE Report.

The Statewide CASE Team estimated LSC, source energy, electricity, natural gas, peak demand, and GHG impacts by simulating the proposed code change in EnergyPlus using prototypical buildings and rulesets from the 2025 Research Version of the California Building Energy Code Compliance (CBECC) software (California Energy Commission n.d.).

CBECC generates two models based on user inputs: the Standard Design and the Proposed Design. The Standard Design represents the geometry of the prototypical building and a set of features that result in LSC and Source Energy budgets that are minimally compliant with 2022 Title 24, Part 6. Features used in the Standard Design are described in the 2022 Nonresidential ACM Reference Manual. Savings are calculated as the difference between the energy usage of the Proposed Design and that of the Standard Design. Table 34 presents the parameters that were modified, and which values were used in the Standard Design and Proposed Design.

Table 34: Modifications to Standard Design to Simulate Proposed Code Change

Construction Assembly	Climate Zone	Compliance Insulation R-Value, Standard Design	Compliance Insulation R-Value, Proposed Design
Metal Building Roof	All	23.61	25.56
Wood Framed and Others Roof	6-8	19.63	20.49
Wood Framed and Others Roof	All Others	28.63	34.93
Metal Building Wall	15	16.69	18.69
Metal Building Wall	2,4,5,8-14,16	15.54	17.54
Metal Building Wall	1,3,6,7	8.00	10.00
Light Mass Walls	1	2.85	3.63
Light Mass Walls	2,10-16	3.63	5.00
Light Mass Walls	3	1.35	2.15
Light Mass Walls	4	2.15	2.85
Light Mass Wall	5-9	0.02	0.50
Heavy Mass Wall	16	3.7	4.00
Heavy Mass Wall	11,14,15	2.89	3.70
Heavy Mass Wall	13	2.19	2.89
Heavy Mass Wall	1,12	1.41	2.19
Heavy Mass Wall	2-5,10	0.10	0.30
Heavy Mass Wall	6-9	0.01	0.10
Wood-framed Wall	15	21.18	23.70
Wood-framed Wall	11	19.6	21.18
Wood-framed Wall	2,4,9,10,12,13,14,16	14.32	16.00
Wood-framed Wall	1	8.00	9.94
Wood-framed Wall	5,8	7.18	8.00
Wood-framed Wall	3,6,7	6.46	7.18

CBECC calculates whole-building energy consumption for every hour of the year measured in kilowatt-hours per year (kWh/y) and therms per year (therms/y). It then applies the 2025 LSC hourly factors to calculate LSC in 2026 present value dollars (2026 PV$), source energy hourly factors to calculate source energy use in kilo British thermal units per year (kBtu/y), and hourly GHG emissions factors to calculate annual GHG emissions in metric tons of carbon dioxide emissions equivalent per year (MT or “tonnes” CO2e/y). CBECC also calculates annual peak electricity demand in kilowatts (kW).

The energy impacts of the proposed code change vary by climate zone. The Statewide CASE Team simulated the energy impacts in every climate zone and applied the climate-zone specific LSC hourly factors when calculating energy and energy cost impacts.

Per-unit energy impacts for nonresidential buildings are presented in savings per square foot. Annual energy, GHG, and peak demand impacts for each prototype building were translated into impacts per square foot by dividing by the floor area of the prototype building. This step allows for an easier comparison of savings across different building types and enables a calculation of statewide savings using the construction forecast that is published for floor area by building type.

4.2.1.3 Statewide Energy Savings Methodology

The per-unit energy impacts were extrapolated to statewide impacts using the Statewide Construction Forecasts that the CEC provided. The Statewide Construction Forecasts (California Energy Commission 2022) estimate new construction or additions that would occur in 2026, the first year that the 2025 Title 24, Part 6 requirements are in effect (California Energy Commission 2022). The construction forecast provides construction (new construction or additions and existing building stock) by building type and climate zone, as shown in Appendix A.

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

4.2.2 Per-Unit Energy Impacts Results

Impacts per square foot are presented in two formats. The first format shows results for each savings category by climate zone for a given assembly and prototype. The second format shows results of each building type by climate zone for a given assembly and savings category. Both tables are useful to help check modeling results, but there are too many to present all of them. This section includes selected tables in the first format, and Appendix H contains all tables in the second format.

Table 35 through Table 40, which use the first format, provide samples of results from the six assemblies in either Office Medium, Non-Refrigerated Warehouse, Retail Medium, or Restaurant Fast Food. In most of these examples, first-year kWh savings and LSC savings are correlated and tend to be higher in cooling-dominated climate zones. Also, source energy savings are correlated with natural gas savings and tend to be higher in heating-dominated climate zones. The highest LSC savings among the tables presented are for RetailMedium with Mass Heavy Walls in Climate Zone 4, driven by electricity savings, and for Non-Refrigerated Warehouse in Climate Zone 16, driven by heating savings.

Table 35: Wood-Framed and Other Roof - OfficeMedium – Savings Summary (Per Square Foot)

OfficeMedium Climate Zones	First-Year Electricity Savings (kWh)	Peak Demand Savings (W)	Natural Gas Savings (kBtu)	Source Energy Savings (kBtu)	30-year LSC Savings ($2026)
1	0.002	0.001	0.166	0.150	0.107
2	0.002	0.000	0.128	0.116	0.080
3	0.001	0.001	0.112	0.101	0.073
4	0.004	0.001	0.103	0.093	0.078
5	-0.004	0.000	-0.070	-0.063	-0.056
6	-0.000	-	-0.017	-0.015	-0.013
7	-0.004	-0.001	-0.151	-0.135	-0.109
8	0.004	0.001	0.111	0.100	0.092
9	0.003	0.000	0.061	0.055	0.048
10	0.004	0.000	0.068	0.061	0.058
11	0.006	-	0.084	0.076	0.074
12	0.005	0.001	0.117	0.106	0.091
13	0.008	0.001	0.064	0.058	0.074
14	0.008	0.001	0.105	0.094	0.101
15	0.013	0.001	0.060	0.054	0.099
16	0.003	0.001	0.169	0.152	0.115

Table 36: Metal Building Roof – Non-Refrigerated Warehouse – Savings Summary (Per Square Foot)

Non-Refrigerated Warehouse Climate Zones	First-Year Electricity Savings (kWh)	Peak Demand Savings (W)	Natural Gas Savings (kBtu)	Source Energy Savings (kBtu)	30-year LSC Savings ($2026)
1	0.01	0.00	0.25	0.23	0.19
2	0.01	0.00	0.19	0.17	0.16
3	0.00	0.00	0.13	0.12	0.12
4	0.01	0.00	0.15	0.14	0.13
5	0.00	0.00	0.16	0.14	0.11
6	0.00	0.00	0.08	0.07	0.07
7	0.00	-	0.07	0.06	0.06
8	-0.00	0.00	0.09	0.08	0.05
9	0.00	0.00	0.09	0.08	0.07
10	-0.00	0.00	0.10	0.09	0.07
11	0.01	0.00	0.18	0.16	0.16
12	0.01	0.00	0.19	0.17	0.16
13	0.01	0.00	0.15	0.13	0.13
14	0.01	0.01	0.16	0.14	0.16
15	-0.00	0.00	0.06	0.05	0.03
16	0.02	0.00	0.29	0.26	0.29

Table 37: Metal Building Walls – Warehouse (Non-Refrigerated) – Savings Summary (Per Square Foot)

Non-Refrigerated Warehouse Climate Zones	First-Year Electricity Savings (kWh)	Peak Demand Savings (W)	Natural Gas Savings (kBtu)	Source Energy Savings (kBtu)	30-year LSC Savings ($2026)
1	0.02	0.00	0.51	0.46	0.40
2	0.01	0.00	0.21	0.19	0.16
3	0.01	0.01	0.33	0.30	0.27
4	0.01	0.00	0.18	0.17	0.17
5	0.00	0.00	0.16	0.14	0.11
6	0.00	0.00	0.13	0.11	0.10
7	-0.00	-0.00	0.12	0.11	0.07
8	0.00	0.00	0.07	0.06	0.05
9	0.00	0.00	0.08	0.07	0.07
10	-0.00	0.00	0.10	0.09	0.06
11	0.01	0.00	0.19	0.17	0.16
12	0.00	0.00	0.19	0.17	0.15
13	0.01	0.00	0.15	0.14	0.15
14	0.01	0.01	0.16	0.15	0.19
15	-0.00	0.00	0.04	0.04	0.04
16	0.01	0.00	0.36	0.32	0.30

Table 38: Mass Light Walls – Warehouse (Non-refrigerated) – Savings Summary (Per Square Foot)

RetailMedium Warehouse Climate Zones	First-Year Electricity Savings (kWh)	Peak Demand Savings (W)	Natural Gas Savings (kBtu)	Source Energy Savings (kBtu)	30-year LSC Savings ($2026)
1	0.02	0.01	0.52	0.47	0.41
2	0.01	0.01	0.48	0.43	0.39
3	0.02	0.01	0.54	0.49	0.45
4	0.02	0	0.4	0.36	0.33
5	0.02	0.01	0.6	0.54	0.46
6	0.01	0	0.23	0.2	0.2
7	0.01	0	0.18	0.16	0.18
8	0.02	0	0.25	0.22	0.27
9	0.02	0	0.33	0.3	0.34
10	0.01	0	0.18	0.16	0.18
11	0.03	0.01	0.51	0.46	0.52
12	0.02	0.01	0.45	0.41	0.39
13	0.03	0.01	0.38	0.35	0.43
14	0.03	0.01	0.45	0.41	0.47
15	0.04	0	0.1	0.09	0.25
16	0.03	0.01	0.96	0.86	0.77

Table 39: Mass Heavy Walls – RetailMedium – Savings Summary (Per Square Foot)

Non-Refrigerated Warehouse Climate Zones	First-Year Electricity Savings (kWh)	Peak Demand Savings (W)	Natural Gas Savings (kBtu)	Source Energy Savings (kBtu)	30-year LSC Savings ($2026)
1	0.04	0.00	0.40	0.36	0.49
2	0.08	0.01	-	-	0.50
3	0.07	0.01	-	-	0.51
4	0.12	0.01	-	-	0.75
5	0.08	0.01	-	-	0.41
6	0.02	0.00	-	-	0.11
7	0.02	0.00	-	-	0.15
8	0.02	0.00	-	-	0.14
9	0.04	0.00	-	-	0.24
10	0.08	0.01	-	-	0.51
11	0.08	0.01	-	-	0.46
12	0.06	0.01	-	-	0.42
13	0.07	0.00	-	-	0.45
14	0.06	0.01	-	-	0.33
15	0.07	0.00	-	-	0.33
16	0.00	0.00	0.18	0.17	0.13

Note about blanks: some of prototypes do not have gas heating.

Table 40: Wood-Framed and Other Walls - RestaurantFastFood – Savings Summary (Per Square Foot)

Restaurant FastFood Climate Zones	First-Year Electricity Savings (kWh)	Peak Demand Savings (W)	Natural Gas Savings (kBtu)	Source Energy Savings (kBtu)	30-year LSC Savings ($2026)
1	0.00	-	1.11	1.00	0.62
2	0.00	-	0.34	0.31	0.21
3	0.00	-	0.39	0.35	0.23
4	0.01	-	0.29	0.26	0.20
5	0.00	-	0.38	0.35	0.23
6	0.01	-	0.19	0.17	0.14
7	0.01	-	0.17	0.15	0.13
8	0.01	-	0.19	0.17	0.17
9	0.01	-	0.17	0.15	0.14
10	0.01	-	0.17	0.15	0.14
11	0.01	-	0.15	0.14	0.12
12	0.01	-	0.29	0.26	0.21
13	0.01	-	0.23	0.21	0.21
14	0.01	-	0.26	0.23	0.20
15	0.02	-	0.07	0.07	0.13
16	0.00	-	0.43	0.38	0.27

The tables in Appendix H, which use the second format, show how different prototypes have different savings within the same climate zone. Figure 1 provides an example of this second format and shows how the savings from adding insulation to heavy-mass walls for RetailLarge are much less than they are for RetailMedium. This is most likely because the walls comprise a smaller portion of the envelope for RetailLarge than they do for RetailMedium.

H.1.5 Prescriptive Heavy Mass Walls

Table 195: First-Year Electricity Savings (kWh) Per Sq. Ft. - Opaque Assemblies Prescriptive Heavy Mass Walls

	CZ01	CZ02	CZ03	CZ04	CZ05	CZ06	CZ07	CZ08	CZ09	CZ10	CZ11	CZ12	CZ13	CZ14	CZ15	CZ16
Hospital	-0.00	0.01	-0.00	0.01	-0.00	0.00	0.01	0.01	0.01	0.03	0.01	0.00	0.01	0.00	0.02	-0.00
OfficeLarge	-0.00	-0.00	-0.01	0.00	-0.01	-0.00	-0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.00	0.01	-0.00
RetailLarge	0.02	0.05	0.03	0.05	0.03	0.01	0.00	0.02	0.02	0.02	0.02	0.03	0.03	0.01	0.08	0.00
RetailMedium	0.04	0.08	0.07	0.12	0.08	0.02	0.02	0.02	0.04	0.08	0.08	0.06	0.07	0.06	0.07	0.00

Figure 1: Image of Appendix Table

4.3 Cost and Cost-Effectiveness

4.3.1 Energy Cost Savings Methodology

Energy cost savings were calculated by applying the LSC hourly factors to the energy savings estimates derived using the methodology described in Section 4.2.1. 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 30-year period of analysis.

The CEC requested LSC savings in 2026 present value dollars (2026 PV$) and nominal dollars. The cost-effectiveness analysis presented in this section uses 2026 PV$. Appendix G presents LSC savings results in nominal dollars, which are used to complete the Economic and Fiscal Impacts Statement (Form 399) for the entire package of proposed changes to Title 24, Part 6.

The Statewide CASE Team analyzed six opaque assembly types for different prototype buildings across 16 climate zones.

4.3.2 Energy Cost Savings Results

This section presents results for each of the six assembly types averaged across all modeled prototypes. Results are the 2026 PV$ LSC savings per square foot over 30 years for newly constructed buildings and additions. The data for the remaining assembly and building types are presented in Appendix I.

As seen in Table 41 through Table 46, the highest savings from adding insulation are often in Climate Zone 16, which has the highest energy consumption in the state[16]. However, the ranking of climate zones differs by building type since the maximum U-factors are different for each.

[16] Pacific Energy Center's Guide to: California Climate Zones and Bioclimatic Design

Table 41: Average 2026 PV LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction and Additions – All Modeled Prototypes – Wood-framed and Other Roof

Climate Zone	30-Year LSC Electricity Savings (2026 PV $)	30-Year LSC Natural Gas Savings (2026 PV $)	Total 30-Year LSC Savings (2026 PV $)
1	0.08	0.13	0.22
2	0.14	0.04	0.18
3	0.12	0.04	0.15
4	0.16	0.04	0.21
5	0.08	0.00	0.08
6	0.00	0.00	0.00
7	0.01	-0.02	-0.01
8	0.08	0.02	0.11
9	0.05	0.03	0.08
10	0.12	0.02	0.15
11	0.15	0.04	0.19
12	0.13	0.05	0.18
13	0.18	0.03	0.21
14	0.24	0.04	0.28
15	0.13	0.02	0.16
16	0.08	0.28	0.35

Table 42: Average 2026 PV LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction and Additions – All Modeled Prototypes – Metal Building Roof

Climate Zone	30-Year LSC Electricity Savings (2026 PV $)	30-Year LSC Natural Gas Savings (2026 PV $)	Total 30-Year LSC Savings (2026 PV $)
1	0.05	0.13	0.18
2	0.07	0.09	0.16
3	0.04	0.07	0.11
4	0.05	0.08	0.13
5	0.03	0.08	0.11
6	0.02	0.04	0.06
7	0.02	0.04	0.06
8	0.03	0.05	0.09
9	0.02	0.05	0.07
10	-0.01	0.05	0.05
11	0.06	0.10	0.16
12	0.05	0.11	0.15
13	0.04	0.08	0.12
14	0.07	0.09	0.16
15	0.00	0.03	0.03
16	0.12	0.17	0.29

Table 43: Average 2026 PV LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction and Additions – All Modeled Prototypes – Metal Building Walls

Climate Zone	30-Year LSC Electricity Savings (2026 PV $)	30-Year LSC Natural Gas Savings (2026 PV $)	Total 30-Year LSC Savings (2026 PV $)
1	0.12	0.28	0.40
2	0.04	0.12	0.16
3	0.08	0.19	0.27
4	0.06	0.11	0.17
5	0.02	0.09	0.11
6	0.02	0.08	0.10
7	-0.01	0.07	0.07
8	0.01	0.04	0.05
9	0.02	0.05	0.07
10	0.00	0.06	0.06
11	0.04	0.12	0.16
12	0.04	0.11	0.15
13	0.06	0.09	0.15
14	0.09	0.10	0.19
15	0.01	0.03	0.04
16	0.10	0.21	0.30

Table 44: Average 2026 PV LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction and Additions – All Modeled Prototypes – Light Mass Walls

Climate Zone	30-Year LSC Electricity Savings (2026 PV $)	30-Year LSC Natural Gas Savings (2026 PV $)	Total 30-Year LSC Savings (2026 PV $)
1	0.06	0.23	0.29
2	0.19	0.65	0.84
3	0.07	0.23	0.31
4	0.08	0.18	0.25
5	0.08	0.27	0.35
6	0.06	0.11	0.18
7	0.09	0.09	0.18
8	0.13	0.13	0.25
9	0.14	0.16	0.30
10	0.09	0.13	0.21
11	0.20	0.27	0.47
12	0.11	0.22	0.33
13	0.20	0.20	0.40
14	0.15	0.19	0.34
15	0.22	0.05	0.28
16	0.16	0.47	0.63

Table 45: Average 2026 PV LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction and Additions – All Modeled Prototypes – Heavy Mass Walls

Climate Zone	30-Year LSC Electricity Savings (2026 PV $)	30-Year LSC Natural Gas Savings (2026 PV $)	Total 30-Year LSC Savings (2026 PV $)
1	0.16	0.27	0.43
2	0.31	0.13	0.44
3	0.15	0.05	0.20
4	0.31	0.06	0.37
5	0.15	0.03	0.18
6	0.06	0.01	0.07
7	0.06	0.01	0.08
8	0.10	0.01	0.11
9	0.13	0.01	0.14
10	0.22	0.04	0.26
11	0.14	0.01	0.15
12	0.16	0.02	0.18
13	0.22	0.01	0.23
14	0.11	0.02	0.13
15	0.37	0.00	0.37
16	0.01	0.06	0.07

Table 46: Average 2026 PV LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction and Additions – All Modeled Prototypes – Wood-Framed and Other Walls

Climate Zone	30-Year LSC Electricity Savings (2026 PV $)	30-Year LSC Natural Gas Savings (2026 PV $)	Total 30-Year LSC Savings (2026 PV $)
1	0.09	0.17	0.26
2	0.05	0.03	0.08
3	0.05	0.07	0.12
4	0.06	0.06	0.12
5	0.04	0.05	0.08
6	0.02	0.04	0.06
7	0.03	0.03	0.05
8	0.06	0.04	0.10
9	0.04	0.04	0.08
10	0.06	0.03	0.09
11	0.04	0.03	0.07
12	0.08	0.04	0.12
13	0.09	0.03	0.11
14	0.06	0.04	0.10
15	0.09	0.01	0.10
16	0.06	0.14	0.20

4.3.3 Incremental First Cost

The incremental costs include the incremental material cost of additional insulation. This cost information was gathered through calls to general contractors, subcontractors, survey data, previous 2022 CASE Report cost research, RS Means, and internet sales information from manufacturers' websites. The cost associated with each R-value represents the incremental cost for an approximate range that includes additional R-2. The final model reflects the cost of adding an additional R-2 insulative value to the roof or wall ($0.12/square foot averaged across both). Installation costs were assumed to remain the same, with a corresponding incremental first cost of $0 for labor. The cost for R-2 for new construction roof continuous insulation is averaged out through California, including the inflation index per Bureau of Labor Statistics. The Statewide CASE Team assumed higher incremental costs associated with increasing the density and thickness of interior cavity insulation in both wall and roof assemblies. If designers opt for continuous exterior insulation to meet the proposed requirements, incremental costs may include both labor and materials for structures such as steel girts, furring, screws, and clips used to support the exterior insulation and cladding. The degree of incremental cost will vary depending on the type of exterior insulation and cladding chosen and is project specific.

4.3.4 Incremental Maintenance and Replacement Costs

In general, opaque envelope assemblies do not require complete replacement within the typical lifetime (39 years of life per IRS, Publication 946) of a typical building. There are, however, some specific items and elements that require inspection to ensure that materials and assemblies perform as expected for this period. Maintenance and replacement are typically associated with moisture-related damage, often due to precipitation but in other cases due to accumulation of interior condensation without proper drainage and ventilation.

Items requiring maintenance include elements for water drainage such as roof drains, scuppers, transition flashing, and gutters. Sealant joints, typically employed to transition between different cladding and fenestration types should be inspected annually. While regular inspections are best practice for the opaque envelope, most building owners do not inspect their property to ensure drainage. In such cases, wholesale replacement of sections of the building envelope or structure is often required. The timing, frequency, and magnitude of these costs are not quantified for this Final CASE Report.

If building envelopes are inspected as noted above, the only common replacement cost for building envelopes is for exterior sealant joints exposed to the weather and solar UV radiation. The frequency of replacement will depend on the type of sealants used as some are more resistant to the elements than others, but for the purposes of the Final

CASE Report the Statewide CASE Team assumes a period of 10 years between sealant joint replacement.

For roofing, the industry standard for roofing warranty periods is 20 years. While roofing replacements may sometimes be only for the roofing membrane, it is increasingly common (due to updated codes elsewhere in the country) for a building owner to completely replace the roofing insulation also. For the purposes of this Final CASE Report, the Statewide CASE Team assumes a 30-year replacement period for both the roofing and insulation.

Incremental maintenance cost is the incremental cost of periodic maintenance required to maintain and repair the envelope components over the 30-year period of analysis. The present value of maintenance costs (or savings) was calculated using a three percent discount rate (d), which is consistent with the discount rate used when developing the 2025 LSC Hourly Factors. The present value of maintenance costs that occurs in the n^{th} year is calculated as follows:

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

4.3.5 Cost Effectiveness

A cost analysis is required to demonstrate that the measure is cost effective over the 30-year period of analysis. For the opaque assembly measures, the Statewide CASE Team has conducted cost-effectiveness analyses for the revised prescriptive measures.

The CEC establishes the procedures for calculating cost effectiveness. The Statewide CASE Team collaborated with CEC staff to confirm that the methodology in this report is consistent with their guidelines, including which costs were included in the analysis. The incremental first cost and incremental maintenance costs over the 30-year period of analysis were included. The LSC savings from electricity and natural gas were also included in the evaluation. Design costs and the incremental costs of code compliance verification were not included.

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. The discount rate for calculating present value is three percent per CEC guidance.

Results of the per-unit cost-effectiveness analyses are presented in Table 47 through Table 52. Benefits include LSC savings and incremental first-cost savings if applicable, as well as the present value of any maintenance cost savings or increased residual value over 30 years. Costs include any increase in first costs and the present value of

any increases in maintenance or replacement costs. There are no negative incremental maintenance costs included with the measure.

All of the assemblies have B/C ratios greater than one, except for Metal Building Roof assembly with B/C = 0.85 (Table 48). The highest aggregated B/C ratio is 6.76 for Mass Walls Heavy (Table 49). As would be expected, the highest benefits tend to be in climate zones with more extreme temperatures.

Table 47: 30-Year Cost-Effectiveness Summary Per Square Foot – New Construction/Additions – Wood-framed and Other Roof – All Prototypes Modeled

Climate Zone	Benefits: 30-year LSC Savings + Other PV Savings (2026 PV$)	Costs: Total Incremental PV Costs (2026 PV$)	Benefit-to-Cost Ratio
1	0.22	0.08	2.73
2	0.18	0.08	2.16
3	0.15	0.09	1.80
4	0.21	0.08	2.44
5	0.08	0.08	1.00
6	0.00	0.09	0.02
7	-0.01	0.08	-0.17
8	0.11	0.09	1.23
9	0.08	0.08	0.90
10	0.15	0.09	1.68
11	0.19	0.09	2.12
12	0.18	0.08	2.29
13	0.21	0.09	2.38
14	0.28	0.09	3.17
15	0.16	0.08	1.86
16	0.35	0.09	3.97
Weighted Average	**0.13**	**0.08**	**1.51**

Table 48: 30-Year Cost-Effectiveness Summary Per Square Foot – New Construction/Additions – Metal Building Roof – All Prototypes Modeled

Climate Zone	Benefits: 30-year LSC Savings + Other PV Cost Savings (2026 PV$/square foot)	Costs: Total Incremental PV Costs (2026 PV$/square foot)	Benefit-to-Cost Ratio
1	0.18	0.12	1.53
2	0.16	0.12	1.35
3	0.11	0.12	0.95
4	0.13	0.12	1.07
5	0.11	0.12	0.90
6	0.06	0.12	0.48
7	0.06	0.12	0.50
8	0.09	0.12	0.71
9	0.07	0.12	0.57
10	0.05	0.12	0.40
11	0.16	0.12	1.34
12	0.15	0.12	1.28
13	0.12	0.12	1.04
14	0.16	0.12	1.30
15	0.03	0.12	0.28
16	0.29	0.12	2.42
Weighted Average	**0.10**	**0.12**	**0.85**

Table 49: 30-Year Cost-Effectiveness Summary Per Square Foot – New Construction/Additions – Mass Walls Heavy – All Prototypes Modeled

Climate Zone	Benefits: 30-year LSC Savings + Other PV Cost Savings (2026 PV$/square foot)	Costs: Total Incremental PV Costs (2026 PV$/square foot)	Benefit-to-Cost Ratio
1	0.43	0.05	9.06
2	0.44	0.04	9.82
3	0.20	0.03	7.98
4	0.37	0.03	14.29
5	0.18	0.03	6.99
6	0.07	0.03	2.56
7	0.08	0.03	2.95
8	0.11	0.03	4.27
9	0.14	0.03	5.32
10	0.26	0.03	9.17
11	0.15	0.03	5.80
12	0.18	0.03	7.04
13	0.23	0.03	8.14
14	0.13	0.03	4.54
15	0.37	0.03	13.88
16	0.07	0.03	2.48
Weighted Average	**0.18**	**0.03**	**6.76**

Table 50: 30-Year Cost-Effectiveness Summary Per Square Foot – New Construction/Additions – Mass Walls Light – All Prototypes Modeled

Climate Zone	Benefits: 30-year LSC Savings + Other PV Cost Savings (2026 PV$/square foot)	Costs: Total Incremental PV Costs (2026 PV$/square foot)	Benefit-to-Cost Ratio
1	0.29	0.05	6.39
2	0.80	0.05	16.52
3	0.31	0.04	7.35
4	0.25	0.04	5.91
5	0.35	0.05	7.81
6	0.18	0.04	4.20
7	0.20	0.04	4.70
8	0.26	0.04	6.02
9	0.31	0.04	7.34
10	0.21	0.05	4.39
11	0.46	0.05	8.76
12	0.33	0.05	6.73
13	0.39	0.05	7.54
14	0.34	0.05	7.33
15	0.27	0.05	5.28
16	0.61	0.05	12.54
Weighted Average	**0.30**	**0.04**	**6.66**

Table 51: 30-Year Cost-Effectiveness Summary Per Square Foot – New Construction/Additions – Metal Building Walls – All Prototypes Modeled

Climate Zone	Benefits: 30-year LSC Savings + Other PV Cost Savings (2026 PV$/square foot)	Costs: Total Incremental PV Costs (2026 PV$/square foot)	Benefit-to-Cost Ratio
1	0.40	0.06	6.55
2	0.16	0.06	2.66
3	0.27	0.06	4.33
4	0.17	0.06	2.68
5	0.11	0.06	1.82
6	0.10	0.06	1.61
7	0.07	0.06	1.10
8	0.05	0.06	0.76
9	0.07	0.06	1.07
10	0.06	0.06	0.91
11	0.16	0.06	2.61
12	0.15	0.06	2.47
13	0.15	0.06	2.41
14	0.19	0.06	3.15
15	0.04	0.06	0.61
16	0.30	0.06	4.94
Weighted Average	**0.13**	**0.06**	**2.05**

Table 52: 30-Year Cost-Effectiveness Summary Per Square Foot – New Construction/Additions – Wood-Framed and Other Walls – All Prototypes Modeled

Climate Zone	Benefits: 30-year LSC Savings + Other PV Cost Savings (2026 PV$/square foot)	Costs: Total Incremental PV Costs (2026 PV$/square foot)	Benefit-to-Cost Ratio
1	0.26	0.05	5.44
2	0.08	0.05	1.47
3	0.12	0.06	1.93
4	0.12	0.06	2.01
5	0.08	0.05	1.69
6	0.06	0.06	0.92
7	0.05	0.06	0.87
8	0.10	0.06	1.51
9	0.08	0.06	1.26
10	0.09	0.07	1.36
11	0.07	0.06	1.21
12	0.12	0.05	2.24
13	0.11	0.06	1.94
14	0.10	0.07	1.55
15	0.10	0.06	1.71
16	0.20	0.06	3.23
Weighted Average	**0.09**	**0.06**	**1.55**

4.4 First-Year Statewide Impacts

4.4.1 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 4.2.2, 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).

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. Because this measure applies to an element already regulated by Title 24, Part 6, statewide savings are not discounted for current compliance.

Table 53 presents the first-year statewide energy and energy cost savings from newly constructed buildings and additions by climate zone. This section of the Final CASE Report includes the analysis results for the prescriptive requirements for one assembly type, wood-framed and other roof, modeled in seven building prototypes: Office Medium, Retail Medium, Retail Large, Hospital, Warehouse, Strip Mall and School Small. The tables containing data for the other assembly types and building types, as well as for the mandatory requirements for each combination, are in Appendix J.

While a statewide analysis is crucial to understanding broader effects of code change proposals, there is potential for unintended consequences impacting DIPs that needs to be considered. Refer to Section 4.5 for more details addressing energy equity and environmental justice.

The CEC construction forecast is zero in Climate Zones 1, 2, 5 and 13 for Large Offices. For the Large Retail prototype, there is no construction expected in Climate Zones 1 or 2, therefore these zones would not have any statewide savings.

Table 53: Statewide Energy and Energy Cost Impacts Per Square Foot: New Construction and Additions – Wood-Framed and Other Roof – All Modeled Prototypes

Climate Zone	Statewide New Construction & Additions Impacted by Proposed Change in 2026 (square feet)	First-Year[a] Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (million therms)	First-Year Source Energy Savings (million kBtu)	30-Year LSC Savings (million 2026 PV$)
1	322,824	0.00	0.00	0.00	0.07	$0.07
2	1,490,444	0.03	0.01	0.00	0.10	$0.27
3	5,469,961	0.09	0.02	0.00	0.32	$0.84
4	2,839,733	0.07	0.01	0.00	0.19	$0.58
5	864,872	0.01	0.00	-0.00	-0.01	$0.07
6	3,970,095	-0.00	0.00	-0.00	-0.00	$0.01
7	2,919,935	-0.00	0.00	-0.00	-0.09	-$0.04
8	5,494,953	0.08	0.00	0.00	0.20	$0.59
9	9,360,294	0.12	0.01	0.00	0.36	$0.71
10	5,380,017	0.11	0.01	0.00	0.19	$0.79
11	1,148,006	0.03	0.00	0.00	0.07	$0.22
12	7,465,202	0.16	0.03	0.01	0.57	$1.36
13	2,377,000	0.07	0.01	0.00	0.10	$0.50
14	1,309,356	0.05	0.01	0.00	0.07	$0.37
15	889,422	0.02	0.00	0.00	0.03	$0.14
16	417,932	0.00	0.00	0.00	0.17	$0.15
Total	**51,720,047**	**0.86**	**0.12**	**0.03**	**2.36**	**$6.63**

a. First-year savings from all new construction and additions completed statewide in 2026.

4.4.2 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 $123.15 per metric ton 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 is based on a proxy for permit costs (not social costs).[17] The cost-effectiveness analysis presented in Section 4.3 of this report does not include the cost savings from avoided GHG emissions. To demonstrate the cost savings of avoided GHG emissions, the Statewide CASE Team disaggregated the value of avoided GHG emissions from the other economic impacts.

Table 54 presents the estimated first-year avoided GHG emissions of the proposed code change. During the first year, GHG emissions of 10,820 metric tons CO2e would be avoided.

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

Table 54: First-Year Statewide GHG Emissions Impacts – Opaque Assembles, New Construction & Additions

Envelope Assembly	Electricity Savings[a] (GWh/y)	Reduced GHG Emissions from Electricity Savings[a] (Metric Tons CO2e)	Natural Gas Savings[a] (Million Therms/y)	Reduced GHG Emissions from Natural Gas Savings[a] (Metric Tons CO2e)	Total Reduced GHG Emissions[b] (Metric Ton CO2e)	Total Monetary Value of Reduced GHG Emissions[c] ($)
Metal Building Wall	4	911	1.69	9,217	10,128	1,247,203
Wood Framed and Other Wall	0	13	0.01	58	70	8,682
Light Mass Wall	0	25	0.04	222	247	30,417
Heavy Mass Wall	0	16	0.00	15	31	3,798
Metal Building Roof Prescriptive	0	12	0.02	97	109	13,399
Wood Framed and Other Roof Prescriptive	1	93	0.03	142	235	28,957
All	**5**	**1,070**	**2**	**9,751**	**10,820**	**1,332,456**

a. First-year savings from all applicable newly constructed buildings, additions, and alterations completed statewide in 2026.

b. GHG emissions savings were calculated using hourly GHG emission factors published alongside the LSC hourly factors and source energy hourly factors by CEC.

c. The monetary value of avoided GHG emissions is based on a proxy for permit costs (not social costs) derived from the 2022 TDV Update Model published by CEC here.

4.4.3 Statewide Water Use Impacts

The proposed code change would not result in water savings.

4.4.4 Statewide Material Impacts

The material impacts of this measure would include an increase in the use of continuous insulation products, such as rigid polyisocyanurate, but likely at a minimal quantity. There are no other significant anticipated statewide impacts on material use. See more in Appendix D.

4.4.5 Other Non-Energy Impacts

Increased insulation would provide tighter building envelopes, thus improving occupant comfort by regulating indoor temperature.

4.5 Addressing Energy Equity and Environmental Justice

The Statewide CASE Team assessed the potential impacts of the proposed measure, and based on a preliminary review, the measure is unlikely to have significant impacts on energy equity or environmental justice, therefore reducing the impacts of disparities in DIPs.

4.5.1 Research Methods and Engagement

The Statewide CASE Team evaluated the measure for its potential impacts to health, cost, resiliency, and comfort. Tighter building envelopes can reduce health impacts from intrusion of dampness and contaminants and can provide a measure of resilience during extreme conditions. In this way, the proposed measure has the potential to positively impact the resiliency and health of DIPs. The proposed measure also has the potential to positively impact the comfort of building occupants as thermal comfort may be improved. There are no expected impacts to DIPs related to cost.

5. Vestibules

5.1 Measure Description

5.1.1 Proposed Code Change

The proposed code change would establish a new mandatory requirement for vestibules in nonresidential buildings with high-traffic main entrances. The affected building types would be Assembly, Business, Education, Institutions, and Mercantile.

The vestibule requirement would be applicable to main entrances in new construction and additions. This measure would not apply to alterations. Exceptions to the requirement would parallel those identified in ASHRAE 90.1 and in IECC, including the option of using a revolving door[18] or air curtain in some applications. See Section 5.1.4.3 for more details.

The proposed code change would require small changes to the compliance software.

5.1.2 Justification and Background Information

5.1.2.1 Justification

Air infiltration through door openings can be an important factor to the building envelope when doors are used frequently. Many commercial buildings such as restaurants, strip-mall stores, retail stores, supermarkets, offices and hospitals are likely to have high door-opening frequency, either at specific periods of the day or in some cases throughout the occupied hours. 2011 NIST analysis found that the 79 buildings with air barriers have an average air leakage almost 70 percent less than the average for the 290 buildings not specified as having an air barrier.[19]

This measure was proposed for the 2022 Title 24, Part 6 code cycle, but was not adopted due to a lack of data supporting cost effectiveness. The Statewide CASE Team also found low estimated energy savings when analysis was conducted only for heating-dominated climate zones. For this proposal, the Statewide CASE Team conducted savings analysis for all climate zones in California.

"If global greenhouse gas emissions continue at current rates, the state of California is likely to experience further warming by more than 2 °F by 2040."[20] In fact, the Statewide CASE Team analyzed the number of heating degree days (HDD) and cooling degree

[18] California Title 24, Part 2 provides restrictions on when a revolving door can be used a part of a means of egress.

[19] Analysis of U.S. Commercial Building Envelope Air Leakage Database to Support Sustainable Building Design (https://tsapps.nist.gov/publication/get_pdf.cfm?pub_id=914293)

[20] https://scripps.ucsd.edu/research/climate-change-resources/faq-climate-change-california

days (CDD) in 2013 and predicted for 2025. The data represented in Table 55 indicate the warming occurring over this ten-year period in nearly every California climate zone.

Additionally, researchers have found that the number of wildfires could grow significantly over the next 40 years, impacting outdoor and indoor air quality.[21] These predicted trends[22] are likely to lead to an increase in air conditioning in all building types, and a need to ensure tighter building envelopes that keep bad air out of the building (e.g., smoky air from wildfires) and high-quality conditioned air in the building.

Vestibules reduce air infiltration under negative pressurization conditions and exfiltration under positive pressurization conditions through doors and create a tighter seal for the building envelope, leading to energy savings and improved indoor air quality in many climates.

This proposal would not only save energy by controlling heating and cooling losses, but it would also lead to improved indoor air quality by reducing the infiltration of unfiltered outdoor air.

Table 55: Comparison of CA Heating Degree Days and Cooling Degree Days between 2013 and 2025

Station Name	CZ	2025 CDD65	2025 HDD65	2013 CDD65	2013 HDD65
ARCATA-AP	1	0	2606	0	2705
SONOMA-COUNTY-AP	2	144	1715	194	1699
METRO-OAKLAND-INTL	3	73	1471	52	1602
PASO-ROBLES-MUNICIPAL	4	529	1507	322	1370
SANTA-MARIA-AP	5	55	1524	15	1817
LOS-ANGELES-INTL	6	395	653	313	908
SAN-DIEGO-INTL	7	460	572	244	685
FULLERTON-MUNICIPAL	8	788	612	521	715
HOLLYWOOD-BURBANK-AP	9	817	740	697	874
RIVERSIDE-MUNICIPAL	10	1005	753	834	941
RED-BLUFF-AP	11	1243	1341	1183	1474
SACRAMENTO-EXECUTIVE	12	668	1415	671	1439
FRESNO-YOSEMITE-INTL	13	1392	1208	1265	1376
PALMDALE-REGIONAL	14	1286	1493	1225	1624
PALM-SPRINGS-INTL	15	2720	397	2633	441
BLUE-CANYON-NYACK-AP	16	340	2601	360	2970

Source: EnergyPlus Weather Files

[21] https://cal-adapt.org/tools/wildfire/

[22] https://www.ipcc.ch/report/ar6/wg2/chapter/chapter-14/

5.1.2.2 Background Information

As described in Section 5.1.4.3, both ASHRAE 90.1 and IECC have requirements for vestibules.

5.1.3 Summary of Proposed Changes to Code Documents

The sections below summarize how the Energy Code, Reference Appendices, Alternative Calculation Method (ACM) Reference Manuals, and compliance documents would be modified by the proposed change.[23]

5.1.3.1 Specific Purpose and Necessity of Proposed Code Changes

Each proposed change to language in Title 24, Part 6 as well as the reference appendices to Part 6 are described below. See Section 7.2 of this report for marked-up code language.

Section: Section 120.7I New mandatory provisions for vestibules

Specific Purpose: The specific purpose of the change is to add a mandatory requirement for incorporating an enclosed vestibule at building entrances, and to clarify scoping with a list of exceptions.

Necessity: This addition is necessary to increase energy efficiency and improve building air barrier performance via cost-effective building design standards, as directed by California Public Resources Code Sections 25213

5.1.3.2 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: **5.5 Building Envelope Data**

Specific Purpose: The specific purpose of the proposed change would be to add the requirement for mandatory vestibules in new construction and certain additions.

Necessity: This change is necessary to compare the performance of the proposed design with the performance of the standard design.

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

5.1.3.3 Summary of Changes to the Nonresidential Compliance Manual

Chapter 3 of the Nonresidential Compliance Manual would need to be revised to incorporate information regarding code compliant vestibule design and construction.

5.1.3.4 Summary of Changes to Compliance Documents

The proposed code change would modify the compliance documents listed below. Details of the required revisions to the compliance documents are presented in Section 7.5.

- 2022-NRCC-ENV-E Certificate of Compliance would require several changes to add a reference to mandatory vestibules.
- 2022-NRCI-ENV-E Certificate of Installation would require a new section indicating installation of vestibule where required.

5.1.4 Regulatory Context

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

Currently, Title 24, Part 6 includes prescriptive requirements for air barriers and there are egress considerations in Title 24, Part 2 – the California Building Code. While the proposed measure has some overlap, there are no expected conflicts or incompatibilities.

5.1.4.2 Duplication or Conflicts with Federal Laws and Regulations

There are no relevant federal laws or regulations.

5.1.4.3 Difference From Existing Model Codes and Industry Standards

For over two decades, ASHRAE has required vestibules as part of building entrances, with some exceptions. Vestibules have also been required by the IECC since at least 2006. Table 56 compares the requirements between 90.1 and IECC. In both model codes, the vestibule requirement is a component of the section addressing building envelope air barrier performance.

Table 56: Comparison of Vestibule Requirements in National Model Codes with Title 24, Part 6 Proposal

Requirement	Title 24, Part 6 Proposed	ASHRAE 90.1-2022	IECC 2021
Location	Building entrances separating conditioned space from the exterior	Building entrances separating conditioned space from the exterior	Building entrances
Doors	Revolving doors shall not eliminate vestibule requirement for any doors adjacent to the revolving doors	Revolving doors can be used as an option	Revolving doors shall not eliminate vestibule requirement for any doors adjacent to the revolving doors
	Revolving doors cannot be used for more than 50 percent of required egress capacity (IBC and Title 24, Part 2 – Section 1010.3.1.1)	N/A	Revolving doors cannot be used for more than 50 percent of required egress capacity (IBC and Title 24, Part 2 – Section 1010.3.1.1)
	Must have self-closing devices	Must have self-closing devices	Must have self-closing devices
Spacing of Doors	Designed so that it is not necessary for the interior and exterior doors to be open at the same time. Minimum distance between them of 7 feet when in the closed position.	Designed so that it is not necessary for the interior and exterior doors to be open at the same time. Minimum distance between them of 7 feet when in the closed position.	Designed so that it is not necessary for the interior and exterior doors to be open at the same time.
Size	No greater than 160 square feet or 2 percent of gross conditioned floor area for that level of the building	No greater than 50 square feet or 2 percent of gross conditioned floor area for that level of the building	N/A
Envelope	Exterior surfaces shall comply with the continuous air barrier requirements	Exterior surfaces shall comply with the continuous air barrier requirements	Air barrier requirements apply per Section C402.5
Exceptions	1. Doors not intended to be used by the public, such as doors to mechanical or electrical equipment rooms, or intended solely for employee use. 2. Doors opening directly from a sleeping or dwelling unit. 3. Doors that open directly from a space less than 3,000 square feet in area. 4. Revolving doors. 5. Doors used primarily to facilitate vehicular movement or material handling and adjacent personnel doors. 6. Doors that have an air curtain.	1. Doors not intended to be used as a building entrance. 2. Doors opening directly from a dwelling unit. 3. Building entrances in buildings in Climate Zone 1 or 2. 4. Doors opening into semi-heated spaces. 5. Enclosed elevator lobbies for building entrances directly from parking garages. 6. Building entrances in buildings in Climate Zone 3, where the building is less than 4 stories above grade and less than 10,000 square feet in gross conditioned floor area. 7. Building entrances in buildings in Climate Zones 0, 4-8 where the building is less than 1000 square feet in gross conditioned floor area.	1. Doors not intended to be used by the public, such as doors to mechanical or electrical equipment rooms, or intended solely for employee use. 2. Doors opening directly from a sleeping or dwelling unit. 3. Buildings in Climate Zones 0-2. 4. Doors that open directly from a space less than 3,000 square feet in area. 5. Revolving doors. 6. Doors used primarily to facilitate vehicular movement or material handling and adjacent personnel doors. 7. Doors that have an air curtain (remainder of language specifies performance of air curtain).

5.1.5 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:** Building designers must be aware of the code change requiring vestibules in certain building types and climate zones, and how vestibule design must consider factors such as security, lighting, HVAC and accessibility. The qualified design reviewer, per commissioning requirements, as well as energy consultants and compliance documentation authors must verify that plans and specifications match and therefore meet the requirements of Title 24, Part 6.
- **Permit Application Phase:** Plans examiners would verify that the project meets the new mandatory vestibule requirement by ensuring that the compliance documentation (NRCC) matches the plan and specifications.
- **Construction Phase:** Building plans and specifications must be followed regarding incorporation of an enclosed vestibule. Installers need to complete the required installation certificates (NRCI). Where required by Title 24, Part 6 Section 120.8, the vestibule should be tested for air leakage as part of the commissioning process.
- **Inspection Phase:** Building inspectors would verify that the vestibule meets the criteria listed on the approved documentation and specifications, and that testing requirements have been met.

5.2 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 5.5 for more details addressing energy equity and environmental justice.

5.2.1 Energy Savings Methodology

The Statewide CASE Team used EnergyPlus v9.4.0 to conduct the energy savings calculations for all code change proposals since CBECC is not adequately flexible to handle the input assumptions for some of the envelope measures. Rulesets were

sourced from the CBECC prototypical building models (California Energy Commission n.d.). The Statewide CASE Team simulated the energy impacts in every climate zone and applied the climate-zone LSC (LSC) hourly factors when calculating energy cost impacts. The Statewide CASE Team evaluated various scenarios comparing energy impacts and cost effectiveness across prototypes and climate zones. For modeling energy impacts, the Statewide CASE Team chose prototypes that typically would have high rates of traffic through entranceways but where vestibules are not yet common practice to use: OfficeLarge, OfficeMedium, RetaiLarge, RetailMedium, and SchoolSmall.

The CBECC energy models were modified to include the proposed changes to the energy standards. The 2022 Standard Design also serves as the baseline with modification.

5.2.1.1 Key Assumptions for Energy Savings Analysis

The Statewide CASE Team used a methodology for the energy savings analysis similar to that used by the Pacific Northwest National Laboratory (PNNL) for their study of ASHRAE 90.1 vestibule requirements (Cho, Gowri Liu 2010). The PNNL report presented a method to estimate air infiltration rate through the door openings with and without vestibules. Estimated peak infiltration rates through door openings for each building type, with and without vestibules, were used in EnergyPlus building energy simulations to estimate the impact of specific vestibule requirements on buildings' air leakage and energy use.

The PNNL methodology for determining air infiltration rates requires analysis of building type, usage, outdoor wind speed and building pressure differentials. PNNL found outdoor temperature has little impact on the air infiltration rate, but that door opening frequency is critical (see Figure 2).

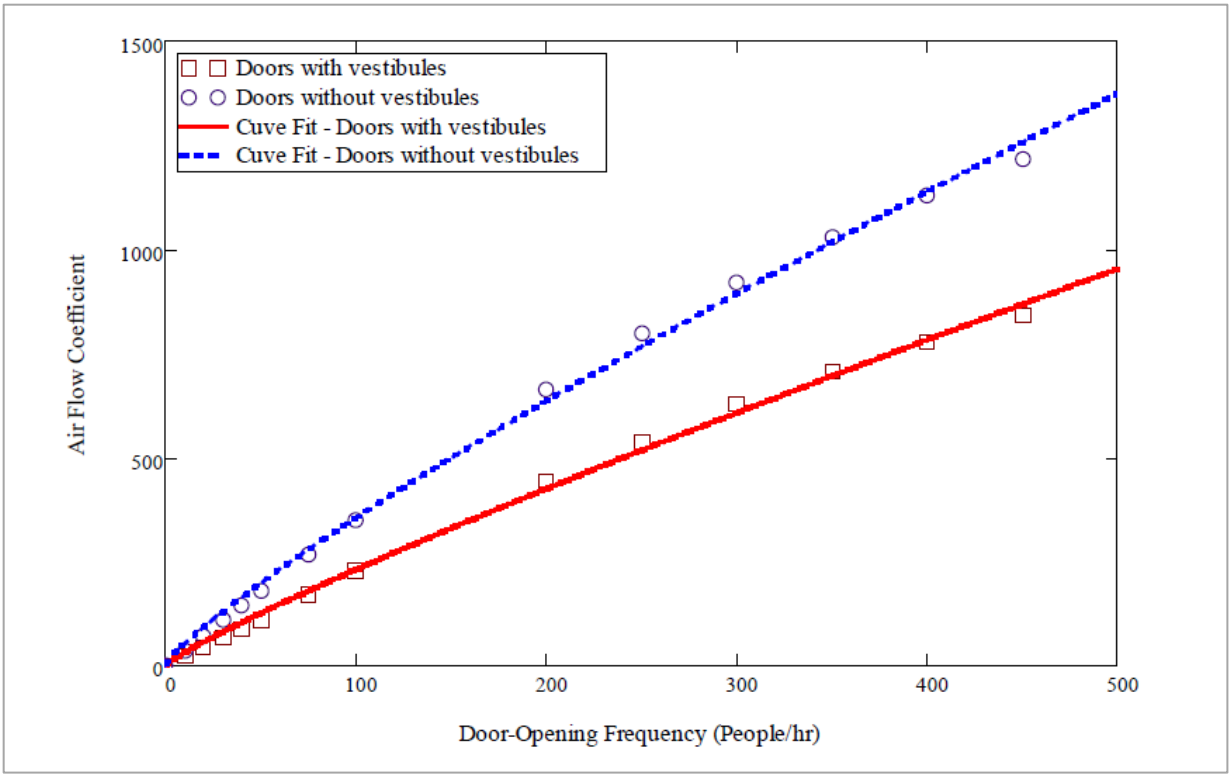

Figure 2: Air flow coefficient vs door opening frequency

Source: (Cho, Gowri Liu 2010); See footnote 25.

Using the PNNL methodology for calculating air infiltration as a means to understand energy loss and the prototype assumptions in Table 57, the Statewide CASE Team determined the peak and off-peak rates of infiltration for five building prototypes. See the results in Table 58.

Table 57: Title 24 2022 Prototype Building Characteristics and Assumptions

Prototype	Number of Floors	Conditioned Floor Area (ft^2)	Floor Area (ft^2)	Entrance Space	Entrance Space (ft^2)	Ceiling Height (ft)	Building Height (ft)	Peak Occupancy	Peak Door-Open Frequency	Off-peak Door-Open Frequency	Vestibule floor area (ft^2)
OfficeLarge	12	498,589	38,357	Ground Floor Core	3,374	9	108	959	959	96	80
OfficeMedium	3	53,628	17,878	Bottom Floor	2,232	9	27	269	269	27	80
RetailLarge	1	240,000	240,000	Main Entry	6,750	25	25	2,137	3,206	321	160
RetailMedium	1	24,563	24,563	Core Retail	17,227	20	20	179	358	36	80
SchoolSmall	1	24,413	24,413	Lobby	2,201	14.8	15	442	442	44	80

Table 58: Air Infiltration Rates Through Door Openings With and Without Vestibule – All Climate Zones

Building Type	Objects Modified	Proposed Design–Peak Rate with Vestibule (cfm)	Standard Design–Peak Rate without Vestibule (cfm)	Proposed Design–Off-Peak Rate with Vestibule (cfm)	Standard Design–Off-Peak Rate without Vestibule (cfm)
OfficeLarge	Infiltration Rate	11,862	16,856	1,465	1,953
OfficeMedium	Infiltration Rate	3,350	5,481	457	548
RetailLarge	Infiltration Rate	37,091	52,708	3,654	5,481
RetailMedium	Infiltration Rate	3,959	6,090	609	914
SchoolSmall	Infiltration Rate	4,568	7,613	761	1218

5.2.1.2 Energy Savings Methodology per Prototypical Building

To quantify impacts, the Statewide CASE Team measured per-unit energy savings expected from the proposed code changes in various scenarios. First, savings are calculated by fuel type. Electricity savings are measured in terms of both energy usage and peak demand reduction. Natural gas savings are quantified in terms of energy usage. Second, the Statewide CASE Team calculated source energy savings, representing the total amount of raw fuel required to operate a building. In addition to all energy used from on-site production, source energy incorporates transmission, delivery, and production losses. The hourly source energy values provided by CEC are strongly correlated with GHG emissions.[24] Finally, the Statewide CASE Team calculated LSC (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 CO2 emissions (California Energy Commission 2022a).[25]

The CEC directed the Statewide CASE Team to model the energy impacts using specific prototypical building models that represent typical building geometries for different types of buildings.[26] The prototype buildings that the Statewide CASE Team used in the analysis are presented in Table 59 (California Energy Commission 2022).

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

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

[26] See Appendix A of CEC New Measure Proposal Template https://www.energy.ca.gov/media/3538.

Table 59: Prototype Buildings Used for Energy, Demand, Cost, and Environmental Impacts Analysis

Prototype Name	Number of Stories	Floor Area (Square Feet)	Description
OfficeLarge	12	498,589	12-story + 1 basement office building with 5 zones and a ceiling plenum on each floor. WWR–0.40.
OfficeMedium	3	53,628	3-story office building with 5 zones and a ceiling plenum on each floor. WWR–0.33
RetailLarge	1	240,000	Big-box type retail building with WWR–12% and SRR–0.82%
RetailMedium	1	24,563	Similar to a Target or Walgreens. 7% WWR on the front façade, none on other sides. SRR–2.1%.
RetailStripMall	1	9,375	Strip Mall building with WWR–10%
SchoolSmall	1	24,413	Elementary school with WWR–0.36

The Statewide CASE Team estimated LSC, source energy, electricity, natural gas, peak demand, and GHG impacts by simulating the proposed code change in EnergyPlus using prototypical buildings and rulesets from the 2025 Research Version of the California Building Energy Code Compliance (CBECC) software (California Energy Commission n.d.).

CBECC generates two models based on user inputs: the Standard Design and the Proposed Design.[27] The Standard Design represents the geometry of the prototypical building and a design that uses a set of features that result in a LSC budget and source 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 entered by the software user.

To develop savings estimates for the proposed code changes, the Statewide CASE Team created a Standard Design and Proposed Design for each prototypical building with the Standard Design representing compliance with 2022 code and the Proposed Design representing compliance with the proposed requirements. Comparing the energy impacts of the Standard Design to the Proposed Design reveals the impacts of the proposed code change relative to a building that is minimally compliant with the 2022 Title 24, Part 6 requirements, following typical industry practices.

[27] CBECC-Res creates a third model, the Reference Design, which represents a building similar to the Proposed Design, but with construction and equipment parameters that are minimally compliant with the 2006 International Energy Conservation Code (IECC). The Statewide CASE Team did not use the Reference Design for energy impacts evaluations.

The Proposed Design was identical to the Standard Design in all ways except for the revisions that represent the proposed changes to the code. Table 58 presents which parameters were modified and the values used in the Standard Design and Proposed Design.

CBECC calculates whole-building energy consumption for every hour of the year measured in kilowatt-hours per year (kWh/y) and therms per year (therms/y). It then applies the 2025 LSC hourly factors to calculate LSC in 2026 present value dollars (2026PV$), source energy hourly factors to calculate source energy use in thousand British thermal units per year (KBtu/y), and hourly GHG emissions factors to calculate annual GHG emissions in metric tons of carbon dioxide emissions equivalent per year (MT or “tonnes” CO2e/yr). CBECC also calculates annual peak electricity demand measured in kilowatts (kW).

The energy impacts of the proposed code change do vary by climate zone. The Statewide CASE Team simulated the energy impacts in every climate zone and applied the climate-zone specific LSC hourly factors when calculating energy and energy cost impacts.

Per-unit energy impacts for nonresidential buildings are presented in savings per square foot. Annual energy, GHG, and peak demand impacts for each prototype building were translated into impacts per square foot by dividing by the floor area of the prototype building. This step allows for an easier comparison of savings across different building types and enables a calculation of statewide savings using the construction forecast that is published in terms of floor area by building type.

5.2.1.3 Statewide Energy Savings Methodology

The per-unit energy impacts were extrapolated to statewide impacts using the Statewide Construction Forecasts that the CEC provided. The Statewide Construction Forecasts (California Energy Commission 2022) estimate new construction or additions that would occur in 2026, the first year that the 2025 Title 24, Part 6 requirements are in effect (California Energy Commission 2022). The construction forecast provides construction (new construction or additions and existing building stock) by building type and climate zone, as shown in Appendix A.

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

5.2.2 Per-Unit Energy Impacts Results

This measure to add mandatory vestibules in certain buildings was analyzed for Office Large, Office Medium, Retail Large, Retail Medium, and School Small across 16 climate zones. Energy savings and peak demand reductions are presented in Table 60 through

Table 64. For four of the five prototypes modeled, the highest LSC savings were in Climate Zone 15, which has high cooling loads.

Table 60: OfficeLarge – Vestibule – Savings Summary (Per Square Foot)

OfficeLarge Climate Zones	First-Year Electricity Savings (kWh)	Peak Demand Savings (kW)	Natural Gas Savings (kBtu)	Source Energy Savings (kBtu)	30-year LSC Savings ($2026)
1	0.19	0.00	0.51	0.47	1.21
2	0.21	0.00	0.44	0.40	1.24
3	0.20	0.00	0.37	0.34	1.16
4	0.22	0.00	0.43	0.39	1.28
5	0.20	0.00	0.40	0.36	1.19
6	0.21	0.00	0.14	0.13	1.10
7	0.21	0.00	0.11	0.10	1.11
8	0.22	0.00	0.16	0.15	1.17
9	0.22	0.00	0.18	0.16	1.17
10	0.23	0.00	0.20	0.18	1.21
11	0.22	0.00	0.39	0.36	1.30
12	0.21	0.00	0.37	0.33	1.24
13	0.22	0.00	0.30	0.27	1.25
14	0.22	0.00	0.39	0.35	1.31
15	0.25	0.00	0.10	0.09	1.26
16	0.21	0.00	0.58	0.52	1.34

Table 61: OfficeMedium – Vestibule – Savings Summary (Per Square Foot)

OfficeMedium Climate Zones	First-Year Electricity Savings (kWh)	Peak Demand Savings (kW)	Natural Gas Savings (kBtu)	Source Energy Savings (kBtu)	30-year LSC Savings ($2026)
1	0.21	0.00	0.60	0.54	1.34
2	0.23	0.00	0.44	0.40	1.36
3	0.22	0.00	0.32	0.29	1.25
4	0.25	0.00	0.40	0.37	1.44
5	0.23	0.00	0.35	0.31	1.28
6	0.24	0.00	0.12	0.11	1.24
7	0.25	0.00	0.10	0.09	1.27
8	0.26	0.00	0.14	0.13	1.35
9	0.26	0.00	0.16	0.15	1.35
10	0.27	0.00	0.17	0.15	1.40
11	0.26	0.00	0.40	0.36	1.52
12	0.25	0.00	0.38	0.34	1.42
13	0.27	0.00	0.31	0.28	1.49
14	0.26	0.00	0.40	0.36	1.52
15	0.32	0.00	0.09	0.08	1.60
16	0.23	0.00	0.63	0.56	1.48

Table 62: RetailLarge – Vestibule – Savings Summary (Per Square Foot)

RetailLarge Climate Zones	First-Year Electricity Savings (kWh)	Peak Demand Savings (kW)	Natural Gas Savings (kBtu)	Source Energy Savings (kBtu)	30-year LSC Savings ($2026)
1	0.33	0.00	0.29	0.26	1.89
2	0.61	0.01	0.00	0.00	3.99
3	0.55	0.01	0.00	0.00	3.60
4	0.65	0.01	0.00	0.00	4.24
5	0.56	0.01	0.00	0.00	3.58
6	0.57	0.01	0.00	0.00	3.62
7	0.59	0.01	0.00	0.00	4.00
8	0.64	0.01	0.00	0.00	4.05
9	0.64	0.01	0.00	0.00	4.05
10	0.66	0.01	0.00	0.00	4.21
11	0.70	0.01	0.00	0.00	4.55
12	0.65	0.01	0.00	0.00	4.22
13	0.70	0.01	0.00	0.00	4.52
14	0.71	0.02	0.00	0.00	4.50
15	0.80	0.01	0.00	0.00	5.01
16	0.57	0.01	0.00	0.06	3.68

Table 63: RetailMedium – Vestibule – Savings Summary (Per Square Foot)

RetailMedium Climate Zones	First-Year Electricity Savings (kWh)	Peak Demand Savings (kW)	Natural Gas Savings (kBtu)	Source Energy Savings (kBtu)	30-year LSC Savings ($2026)
1	0.58	0.01	0.00	0.02	3.83
2	0.69	0.02	0.00	0.00	4.55
3	0.62	0.01	0.00	0.00	4.11
4	0.73	0.02	0.00	0.00	4.80
5	0.62	0.01	0.00	0.00	4.06
6	0.63	0.01	0.00	0.00	4.03
7	0.65	0.01	0.00	0.00	4.54
8	0.66	0.01	0.00	0.00	4.25
9	0.70	0.01	0.00	0.00	4.52
10	0.69	0.01	0.00	0.00	4.42
11	0.75	0.02	0.00	0.00	4.94
12	0.73	0.02	0.00	0.00	4.80
13	0.78	0.02	0.00	0.00	5.10
14	0.81	0.02	0.00	0.00	5.19
15	0.83	0.01	0.00	0.00	5.22
16	0.00	0.00	0.00	0.08	0.49

Table 64: SchoolSmall – Vestibule – Savings Summary (Per Square Foot)

SchoolSmall Climate Zones	First-Year Electricity Savings (kWh)	Peak Demand Savings (kW)	Natural Gas Savings (kBtu)	Source Energy Savings (kBtu)	30-year LSC Savings ($2026)
1	0.03	0.00	-0.07	-0.07	0.99
2	0.29	0.01	0.00	0.00	2.56
3	0.26	0.00	0.00	0.00	2.35
4	0.31	0.01	0.00	0.00	2.70
5	0.27	0.00	0.00	0.00	2.32
6	0.27	0.00	0.00	0.00	2.29
7	0.27	0.00	0.00	0.00	2.34
8	0.29	0.00	0.00	0.00	2.51
9	0.29	0.00	0.00	0.00	2.51
10	0.31	0.00	0.00	0.00	2.62
11	0.32	0.01	0.00	0.00	2.88
12	0.30	0.01	0.00	0.00	2.67
13	0.33	0.01	0.00	0.00	2.89
14	0.33	0.01	0.00	0.00	2.89
15	0.36	0.00	0.00	0.00	3.11
16	0.25	0.00	1.29	1.16	3.01

5.3 Cost and Cost Effectiveness

5.3.1 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 5.2.1. LSC hourly factors are a normalized metric to calculate energy cost savings that accounts for the variable cost of electricity and natural gas for each hour of the year, along with how costs are expected to change over the 30-year period of analysis.

The CEC requested LSC savings over the 30-year period of analysis in both 2026 present value dollars (2026 PV$) and nominal dollars. The cost-effectiveness analysis uses LSC values in 2026 PV$. Costs and cost effectiveness using 2026 PV$ are presented in Section 5.2.1 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 LSC savings results in nominal dollars.

5.3.2 Energy Cost Savings Results

Per-unit energy cost savings for newly constructed buildings and additions in terms of LSC savings realized over the 30-year period of analysis are presented 2026 present value dollars (2026 PV$) in Table 65 through Table 70.

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

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

Table 65: 2026 PV LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction and Additions– OfficeLarge

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Savings (2026 PV$)
1	0.00*	0.00*	0.00*
2	0.00*	0.00*	0.00*
3	0.95	0.21	1.16
4	1.03	0.25	1.28
5	0.00*	0.00*	0.00*
6	1.02	0.08	1.10
7	1.04	0.07	1.11
8	1.07	0.10	1.17
9	1.06	0.11	1.17
10	1.09	0.12	1.21
11	1.07	0.23	1.30
12	1.02	0.21	1.24
13	0.00*	0.00*	0.00*
14	1.07	0.24	1.31
15	1.19	0.06	1.26
16	1.00	0.34	1.34

*Construction forecast for this prototype near zero in this climate zone

Table 66: 2026 PV LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction and Additions– OfficeMedium

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Energy Cost Savings (2026 PV$)
1	1.00	0.34	1.34
2	1.11	0.25	1.36
3	1.05	0.19	1.25
4	1.20	0.24	1.44
5	1.08	0.20	1.28
6	1.17	0.07	1.24
7	1.21	0.06	1.27
8	1.27	0.09	1.35
9	1.25	0.10	1.35
10	1.29	0.10	1.40
11	1.28	0.24	1.52
12	1.19	0.23	1.42
13	1.30	0.19	1.49
14	1.28	0.24	1.52
15	1.54	0.06	1.60
16	1.11	0.37	1.48

Table 67: 2026 PV LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction and Additions– RetailLarge

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Energy Cost Savings (2026 PV$)
1	0.00*	0.00*	0.00*
2	0.00*	0.00*	0.00*
3	3.60	0.00	3.60
4	4.24	0.00	4.24
5	3.58	0.00	3.58
6	3.62	0.00	3.62
7	4.00	0.00	4.00
8	4.05	0.00	4.05
9	4.05	0.00	4.05
10	4.21	0.00	4.21
11	4.55	0.00	4.55
12	4.22	0.00	4.22
13	4.52	0.00	4.52
14	4.50	0.00	4.50
15	5.01	0.00	5.01
16	3.61	0.08	3.68

*Construction forecast for this prototype near zero in this climate zone

Table 68: 2026 PV LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction and Additions– RetailMedium

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Energy Cost Savings (2026 PV$)
1	3.80	0.03	3.83
2	4.55	0.00	4.55
3	4.11	0.00	4.11
4	4.80	0.00	4.80
5	4.06	0.00	4.06
6	4.03	0.00	4.03
7	4.54	0.00	4.54
8	4.25	0.00	4.25
9	4.52	0.00	4.52
10	4.42	0.00	4.42
11	4.94	0.00	4.94
12	4.80	0.00	4.80
13	5.10	0.00	5.10
14	5.19	0.00	5.19
15	5.22	0.00	5.22
16	0.39	0.10	0.49

Table 69: 2026 PV LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction and Additions– SchoolSmall

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Energy Cost Savings (2026 PV$)
1	0.98	0.02	0.99
2	2.56	0.00	2.56
3	2.35	0.00	2.35
4	2.70	0.00	2.70
5	2.32	0.00	2.32
6	2.29	0.00	2.29
7	2.34	0.00	2.34
8	2.51	0.00	2.51
9	2.51	0.00	2.51
10	2.62	0.00	2.62
11	2.88	0.00	2.88
12	2.67	0.00	2.67
13	2.89	0.00	2.89
14	2.89	0.00	2.89
15	3.11	0.00	3.11
16	2.17	0.84	3.01

Table 70: Average 2026 PV LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction and Additions– All Modeled Prototypes

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Savings (2026 PV$)
1	2.84	0.11	2.95
2	3.58	0.06	3.63
3	1.88	0.14	2.02
4	2.20	0.16	2.36
5	3.08	0.04	3.12
6	2.16	0.05	2.21
7	2.25	0.04	2.29
8	2.20	0.06	2.26
9	2.23	0.07	2.30
10	3.26	0.04	3.30
11	3.67	0.06	3.73
12	3.14	0.08	3.22
13	4.23	0.02	4.25
14	3.01	0.11	3.12
15	4.43	0.01	4.44
16	1.69	0.20	1.89

5.3.3 Incremental First Cost

The incremental first costs include the material and labor involved with constructing a vestibule. The walls of a vestibule function as an air barrier similar to the exterior enclosure of a building but do not have the same water and thermal control functions. Therefore, the area-normalized cost of vestibules can be conservatively assumed to cost the same as that of the adjacent exterior envelope, and most likely costs less. For opaque vestibules, the cost would include typical interior partition elements such as wood/steel framing, drywall, batt insulation, and interior finishes. For glazed vestibules, the cost would be similar to that of a typical storefront glazing system.

The incremental cost of the vestibule is also a function of the floor area dedicated to the vestibule space, which in turn depends on the number/size of entrances the building owner and designer choose to incorporate. For the purposes of this analysis, the Statewide CASE Team assumed one public entrance and therefore one vestibule per building.

The vestibule size used for this analysis was based on a minimum 80 square feet for most occupancy types, and a minimum 160 square feet for Retail Large prototypes. The Statewide CASE Team used an estimated average cost of $250 per square foot for cost-analysis, based on an average cost of new construction for commercial buildings.

5.3.4 Incremental Maintenance and Replacement Costs

Incremental maintenance cost is the incremental cost of replacing the equipment or parts of the equipment, as well as periodic maintenance required to keep the equipment operating relative to current practices over the 30-year period of analysis. The present value of equipment maintenance costs (or savings) was calculated using a three percent discount rate (d), which is consistent with the discount rate used when developing the 2025 LSC hourly factors. The present value of maintenance costs that occurs in the n^{th} year is calculated as follows:

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

For this proposal, the Statewide CASE Team assumes the interior construction of a vestibule would be the same as the exterior envelope system. In general, envelope assemblies do not require complete replacement within the typical lifetime (39 years of life per IRS, Publication 946) of a typical building. Unless the purpose of the building changes, exterior envelope systems are rarely replaced. However, there would be some incidental replacements during the lifetime of a building which would be the same in

both proposed and in the baseline cases meaning there are no anticipated incremental maintenance or replacement costs.

5.3.5 Cost-Effectiveness

This measure proposes a mandatory requirement. But as there is not a corresponding prescriptive requirement already proven to be cost effective, 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 (California Energy Commission 2022b). The Statewide CASE Team collaborated with CEC staff to confirm that the methodology in this report is consistent with their guidelines, including which costs were included in the analysis. The incremental first cost and incremental maintenance costs over the 30-year period of analysis were included. The LSC savings from electricity and natural gas were also included in the evaluation. Design costs were not included nor were the incremental costs of code compliance verification.

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

Results of the per-unit cost-effectiveness analyses are presented in Table 71.

Table 71: 30-Year Cost-Effectiveness Summary Per Square Foot – New Construction/Additions – All Modeled Prototypes

Climate Zone	Benefits Lifecycle Energy Cost Savings + Other PV Savings [a] (2026 PV$)	Costs Total Incremental PV Costs [b] (2026 PV$)	Benefit-to-Cost Ratio
1	2.95	0.70	4.20
2	3.63	0.71	5.10
3	2.02	0.17	11.93
4	2.36	0.18	13.13
5	3.12	0.37	8.39
6	2.21	0.22	10.12
7	2.29	0.21	10.90
8	2.26	0.21	10.88
9	2.30	0.20	11.51
10	3.30	0.37	8.97
11	3.73	0.28	13.43
12	3.22	0.29	11.23
13	4.25	0.44	9.73
14	3.12	0.30	10.42
15	4.44	0.36	12.43
16	1.89	0.36	5.27
Weighted Average	2.52	0.23	10.77

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

b. **Costs: Total Incremental Present Valued Costs:** Costs include incremental equipment, replacement, and maintenance costs over the period of analysis. Costs are discounted at a real (inflation-adjusted) three percent rate and if PV of proposed maintenance costs is greater than PV of current maintenance costs. If incremental maintenance cost is negative, it is treated as a positive benefit. If there are no total incremental PV costs, the B/C ratio is infinite. Total Incremental Cost = (Measure Case First Cost + PV of Measure Case Maintenance and Replacement Costs over 30 years) – (Base Case First Cost + PV of Base Case Maintenance and Replacement Costs over 30 years).

5.4 First-Year Statewide Impacts

5.4.1 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 5.2.1 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). Because this measure does not apply to an element already regulated by Title 24, Part 6, statewide savings are discounted for the estimated portion of the market already in compliance.

Table 72 below presents the first-year statewide energy and energy cost savings from newly constructed buildings and additions by climate zone.

While a statewide analysis is crucial to understanding broader effects of code change proposals, there is potential for unintended consequences impacting DIPs that needs to be considered. Refer to Section 5.5 for more details addressing energy equity and environmental justice.

Table 72: Statewide Energy and Energy Cost Impacts | Vestibules | New Construction and Additions

Climate Zone	Statewide New Construction Impacted by Proposed Change in 2026 (Million Square Feet)	First-Year[a] Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year LSC Savings (Million 2026 PV$)
1	76,706	0.03	0.00	0.00	0.01	$0.20
2	307,195	0.15	0.00	0.00	0.03	$1.00
3	4,681,030	1.35	0.03	0.01	0.94	$8.51
4	2,344,525	0.79	0.02	0.01	0.54	$4.99
5	262,614	0.11	0.00	0.00	0.02	$0.74
6	2,516,030	0.84	0.01	0.00	0.16	$5.00
7	1,419,860	0.46	0.01	0.00	0.08	$2.92
8	3,649,740	1.25	0.02	0.00	0.30	$7.41
9	6,715,410	2.32	0.04	0.01	0.62	$13.89
10	1,657,855	0.79	0.01	0.00	0.08	$4.93
11	517,991	0.27	0.01	0.00	0.04	$1.74
12	2,629,000	1.19	0.03	0.00	0.28	$7.62
13	684,115	0.40	0.01	0.00	0.02	$2.62
14	488,100	0.22	0.00	0.00	0.07	$1.37
15	300,695	0.19	0.00	0.00	0.00	$1.20
16	166,173	0.04	0.00	0.00	0.04	$0.28
Total	**28,417,039**	**10.41**	**0.19**	**0.04**	**3.24**	**$64.44**

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

5.4.2 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 $123.15 per metric tons of carbon dioxide equivalent emissions (metric tons CO2e).

The monetary value of avoided GHG emissions is based on a proxy for permit costs (not social costs).[28] The cost-effectiveness analyses presented in Section 0 of this report do 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.

Vestibule material impacts were calculated for the five modeled building types. The statewide construction forecast for each building type was divided by the prototype floor area to estimate the number of impacted buildings. For most buildings vestibule size was assumed to be 10 feet deep, 8 feet wide, and 7 feet high. For the Large Retail building type the vestibule was assumed to be 16 feet wide. Using these dimensions and the estimated number of buildings and vestibules, the Statewide CASE Team calculated the total square footage of material used to build the vestibules. The exterior wall was assumed to always be included for a building entrance, so adding the vestibule only added three walls.

Calculations accounted for different prototype ceiling heights. The Office Large and Office Medium prototypes have 9 foot high ceilings, and it was assumed their vestibules would be 9 feet high. The School Small prototype has a 14 foot high ceiling, so it was assumed that 50 percent of these buildings would have a separate ceiling for the vestibule. The Retail Large and Retail Medium prototypes have 25 and 20 foot high ceilings, respectively, and it was assumed that 80 percent of these buildings would have a separate ceiling for the vestibule.

Vestibule materials were taken to be 15 percent aluminum and 85 percent glass, which is similar to using typical storefront glazing as the vestibule walls. The Statewide CASE Team did not have readily available data on the industry average carbon intensity of typical dropped ceilings or interior drywall. Therefore, it applied the wall assumptions for aluminum and glass material fractions and carbon intensity to the calculated ceiling area. The estimated carbon impact for vestibule ceilings alone is conservative since

[28] 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.

aluminum and glass are generally understood to be more carbon intensive than materials for dropped ceilings and drywall.

Table 73 presents the estimated first-year avoided GHG emissions of the proposed code change. During the first year, GHG emissions of 887 metric tons CO2e would be avoided.

Table 73: First-Year Statewide GHG Emissions Impacts | Vestibules

Measure	Electricity Savings (GWh/y)	Reduced GHG Emissions from Electricity Savings[a] (Metric Tons CO2e)	Natural Gas Savings (Million Therms/y)	Reduced GHG Emissions from Natural Gas Savings[a] (Metric Tons CO2e)	Total Reduced GHG Emission[a] (Metric Ton CO2e)	Total Monetary Value of Reduced GHG Emissions[b] ($)
Vestibules	10	594	0.04	293	887	109,225
TOTAL	**10**	**594**	**0.04**	**293**	**887**	**109,225**

a. GHG emissions savings were calculated using hourly GHG emission factors published alongside the LSC hourly factors and source energy hourly factors by CEC.

b. The monetary value of avoided GHG emissions is based on a proxy for permit costs (not social costs) derived from the 2022 TDV Update Model published by CEC here.

5.4.3 Statewide Water Use Impacts

The proposed code change would not result in water savings.

5.4.4 Statewide Material Impacts

The proposal would increase the usage of glass and aluminum used for the construction of vestibules. The Statewide CASE Team assumed vestibules of various sizes for different building types, including that most of the materials used for vestibules would be glass with aluminum framing. After translating the size (and amount) of vestibules for each building type to construction estimate material impacts, which are presented in Table 74. See more information in Appendix D.

Table 74: First-Year Statewide Impacts on Material Use | Vestibules

Material	Impact	Per-Unit Impacts (Pounds per Square Foot)	First-Year[a] Statewide Impacts (Pounds)
Glass	Increase	13	727,883
Aluminum Frame	Increase	2.1	21,162

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

5.5 Addressing Energy Equity and Environmental Justice

The Statewide CASE Team assessed the potential impacts of the proposed measure, and based on a preliminary review, the measure is unlikely to have significant impacts on energy equity or environmental justice, therefore reducing the impacts of disparities in DIPs. The Statewide CASE Team evaluated the measure for its potential impacts to health, cost, resiliency, and comfort. The proposed measure would reduce air infiltration leading to improved indoor air quality. The specific health benefits of improved indoor air quality to DIPs are outlined in Section 2.1.2. It is not likely that the proposed measure would impact DIPs in relation to cost, resiliency, or comfort.

6. Windows

6.1 Measure Description

6.1.1 Proposed Code Change

This proposal would set a new mandatory requirement establishing a U-factor for window assemblies for nonresidential buildings. It would affect new construction, additions, and alterations. It would apply to all vertical fenestration including fixed windows, curtainwall, storefront, and operable windows.

This proposal would not add or modify acceptance tests or require any technology not previously regulated. Compliance would be verified through the existing verification process and the current CEC-NRCC-ENV-E form.

6.1.2 Justification and Background Information

6.1.2.1 Justification

Heat transfer through the building envelope and associated air leakage comprise the largest HVAC loads in most climates. Windows, the weakest link in the thermal envelope, make up approximately eight percent of a typical building envelope but are responsible for 45 percent of the energy transfer through the envelope.[29]

Currently, Title 24, Part 6 includes prescriptive U-factor and RSHGC requirements for exterior vertical fenestration, but these values can be traded away for higher efficiency HVAC equipment or other building systems when a designer uses the performance path to achieve code compliance. However, this can be a counterproductive trade because non-envelope systems typically have much shorter lifespans. This measure, by establishing a maximum mandatory U-factor value for vertical fenestration, would create a backstop limiting how much window efficiency can be replaced by a non-envelope system.

Creating this mandatory requirement could produce significant and persistent savings throughout the entire life of the building by improving compliance, since windows are generally a permanent feature of building's envelope. A U.S. DOE and PNNL report from 2020 on non-compliance showed windows, wall, and roof insulation measures were in the top 10 non-compliant measures even in cold and hot climate zones.[30] The same report found the present value of lost energy cost savings from not meeting fenestration requirements can be up to $1,162 per thousand square feet. As seen in

[29] Pathway to Zero Energy Windows: Advancing Technologies and Market Adoption - https://www.nrel.gov/docs/fy22osti/80171.pdf

[30] Hart, Rosenberg, Zhang, & Chen, 2020

Table 96 and Table 97, the first-year savings for new construction and additions for this measure are forecast to be 0.61 GWh and 11.68 GWh, respectively.

6.1.2.2 Background Information

Vertical fenestration refers to all types of windows except doors and skylights. They can be operable or fixed. The resistance to heat loss or gain is determined by the U-factor, also known as the rate of heat transfer through the component. The lower the U-factor, the lower the rate of heat transfer, and the better the insulation value of the component. The proposed measure would introduce a maximum mandatory U-factor value for nonresidential vertical fenestration, providing energy savings to all climate zones.

6.1.3 Summary of Proposed Changes to Code Documents

The sections below summarize how the Energy Code, Reference Appendices, ACM Reference Manuals, and compliance documents would be modified by the proposed change.[31]

6.1.3.1 Specific Purpose and Necessity of Proposed Code Changes

Each proposed change to language in Title 24, Part 6 as well as the reference appendices to Part 6 are described below. See Section 7.2 of this report for marked-up code language.

Section: Section 120.7(d) New mandatory requirement for exterior windows

Specific Purpose: The specific purpose is to add a mandatory provision for windows.

Necessity: These changes are necessary to ensure a minimum level of performance for the entire building envelope when the performance compliance path is used.

Section: Section 141.0(b)1E New mandatory requirement for exterior windows in alterations

Specific Purpose: The specific purpose is to add a mandatory provision for window alterations.

Necessity: These changes are necessary to ensure a minimum level of performance for the building envelope when window alterations are undertaken.

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

6.1.3.2 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: 5.5 Building Envelope Data

Specific Purpose: The specific purpose of the proposed change would be to add the mandatory maximum U-factor requirement for windows in new construction and alterations.

Necessity: These changes are necessary to create a non-tradeable minimum level of performance for windows when the performance compliance path is used.

6.1.3.3 Summary of Changes to the Nonresidential Compliance Manual

Chapter 3 of the Nonresidential Compliance Manual would need to be revised to incorporate mandatory U-factor requirements for windows.

6.1.3.4 Summary of Changes to Compliance Documents

The proposed code change would modify the compliance documents listed below. Details of the required revisions to the compliance documents are presented in Section 7.5.

- NRCC-ENV-E Certificate of Compliance would require deletion of Footnote 1 in Section K.
- 2022-NRCI-ENV-E Certificate of Installation – No changes would be required for this document.
- NRCA-ENV-02-F Certificate of Acceptance – No changes would be required for this document.

6.1.4 Regulatory Context

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

California has already set prescriptive requirements for window U-factor, SHGC, and VT. The tables in the code specify U-factor limits based on frame, product, and glazing type. This set of requirements was created to simplify the code. A single SHGC and VT is listed for all fenestration ratios up to the maximum fenestration ratio; a single U-factor, SHGC, and VT for all climate zones; and a single SHGC and VT for all orientations. The

existing language also specifies a calculated RSHGC to account for contributions from overhangs or exterior horizontal fins.

6.1.4.2 Duplication or Conflicts with Federal Laws and Regulations

There are no relevant federal laws or regulations.

6.1.4.3 Difference From Existing Model Codes and Industry Standards

The following model codes are relevant to this measure:

- ASHRAE 90.1 2022
- IECC 2021

ASHRAE 90.1 allows unlimited envelope trade-off in the Prescriptive Building Envelope Compliance path (Section 5.6) using the simulation-based envelope performance factor per the Normative Appendix C and performance path (Normative Appendix G).

The most current edition of IECC allows unlimited trade-offs between building envelope components and other building systems.

6.1.5 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:** Building designers must be aware of the code changes to the window U-factors. The qualified design reviewer, per commissioning requirements, as well as energy consultants and compliance documentation authors must verify that plans and specifications match, and therefore meet the requirements of Title 24, Part 6. No change in the process to complete NRCC compliance documents.
- **Permit Application Phase:** Plans examiners would verify that the project meets new mandatory window U-factor requirements by ensuring that the compliance documentation (NRCC) matches the plan and specifications.
- **Construction Phase:** Windows must be provided to meet new U-factor requirements per energy documentations and/or specifications. Installers need to complete the required installation certificates (NRCI).

- **Inspection Phase:** Procedure remains the same; Building inspector verifies NFRC labels and/or related certificate.

6.2 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 for unintended consequences impacting DIPs. Refer to Section 6.5 for more details addressing energy equity and environmental justice.

6.2.1 Energy Savings Methodology

6.2.1.1 Key Assumptions for Energy Savings Analysis

This proposal evaluates changes to new construction, additions, and alterations. The Statewide CASE Team used EnergyPlus v9.4.0 to conduct the energy savings calculations for all code change proposals since CBECC is not adequately flexible to handle the input assumptions for some of the envelope measures. Energy models are sourced from the CBECC prototypical building models. The Statewide CASE Team simulated the energy impacts in every climate zone and applied the climate-zone LSC (LSC) hourly factors when calculating energy cost impacts.

This measure to add mandatory U-factors for vertical fenestration in new construction and additions was analyzed for 8 prototype buildings (OfficeLarge, OfficeMedium, OfficeSmall, RestaurantFastFood, RetailLarge, RetailMedium, RetailStripMall, and SchoolSmall) across 16 climate zones. One of the key considerations for selection of these prototypes was the high window-to-wall ratio (WWR) expected in each building type.

Savings for mandatory measures are generally calculated by taking the difference between the energy consumption of a Standard Design and the Proposed Design for each prototype building. In most cases, the Standard Design, or baseline, is the existing mandatory or prescriptive code requirement, as applicable. However, for fenestration there is no existing mandatory maximum U-factor, so the Statewide CASE Team did a literature review to determine what U-factors would be appropriate for the new construction and alterations baselines. For new construction the Statewide CASE Team selected a U-factor of 0.58, which was the maximum value found in Table 141.0-A in the code for alterations. This value is also comparable to the new construction prescriptive requirement in 2008, showing this approach is quite conservative. For alterations, the Statewide CASE Team selected a baseline U-factor of 0.86 (see Table 75).

Table 75: Modifications Made to Standard Design to Simulate Proposed Code Change

Prototype ID	Climate Zone	Objects Modified	Parameter Name	Standard Design Parameter Value	Proposed Design Parameter Value
All Prototypes – New Construction and Additions	All	Base_AllCZ_FixedWindowU34	U-factor	0.58	0.47
All Prototypes - Alterations	All	Base_AllCZ_FixedWindowU34	U-factor	0.86	0.58

6.2.1.2 Energy Savings Methodology per Prototypical Building

To quantify impacts, the Statewide CASE Team calculated per-unit energy savings expected from the proposed code changes in several ways. First, savings are calculated by fuel type. Electricity savings are measured in both energy usage and peak demand reduction; natural gas savings are quantified in terms of energy usage. Second, the Statewide CASE Team calculated source energy Savings. Source energy represents the total amount of raw fuel required to operate a building. In addition to all energy used from on-site production, source energy incorporates all transmission, delivery, and production losses. The hourly source energy values provided by CEC are strongly correlated with GHG emissions (California Energy Commission 2022a).[32] Finally, the Statewide CASE Team calculated LSC (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 CO_2 emissions.[33]

The CEC directed the Statewide CASE Team to model the energy impacts using prototypical building models that represent typical building geometries.[34] The prototype buildings that the Statewide CASE Team used for this proposal are presented in Table 76.

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

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

[34] See Appendix A of CEC New Measure Proposal Template https://www.energy.ca.gov/media/3538.

Table 76: Prototype Buildings Used for Energy, Demand, Cost, and Environmental Impacts Analysis

Prototype ID	Number of Stories	Floor Area (square feet)	Description
OfficeLarge	12	498,589	12-story + 1 basement office building with 5 zones and a ceiling plenum on each floor. WWR–40%.
OfficeMedium	3	53,628	3-story office building with 5 zones and a ceiling plenum on each floor. WWR–33%
OfficeSmall	1	5,502	1-story, 5-zone office building with pitched roof and unconditioned attic. WWR–24%
RestaurantFastFood	1	2,501	Fast food restaurant with a small kitchen and dining areas. WWR–14%. Pitched roof with an unconditioned attic.
RetailLarge	1	240,000	Big-box type retail building with WWR–12% and SRR–0.82%
RetailMedium	1	24,563	Similar to a Target or Walgreens.7% WWR on the front façade, none on other sides. SRR–2.1%.
RetailStripMall	1	9,375	Strip mall building with WWR–10%
SchoolSmall	1	24,413	Elementary school with WWR–36%

The Statewide CASE Team estimated LSC, source energy, electricity, natural gas, peak demand, and GHG impacts by simulating the proposed code change in EnergyPlus using prototypical buildings and rulesets from the 2025 Research Version of the California Building Energy Code Compliance (CBECC) software (California Energy Commission n.d.).

CBECC calculates whole-building energy consumption for every hour of the year measured in kilowatt-hours per year (kWh/y) and therms per year (therms/y). It then applies the 2025 LSC hourly factors to calculate LSC in 2026 present value dollars (2026 PV$), source energy hourly factors to calculate source energy use in thousand British thermal units per year (kBtu/y), and hourly GHG emissions factors to calculate annual GHG emissions in metric tons of carbon dioxide emissions equivalent per year (MT or “tonnes” CO2e/yr).

The energy impacts of the proposed code change vary by climate zone. The Statewide CASE Team simulated the energy impacts in every climate zone and applied the climate-zone specific LSC hourly factors when calculating energy and energy cost impacts.

6.2.1.3 Statewide Energy Savings Methodology

The per-unit energy impacts were extrapolated to statewide impacts using the Statewide Construction Forecasts that the CEC provided. The Statewide Construction Forecasts (California Energy Commission 2022) estimate new construction or additions that would occur in 2026, the first year that the 2025 Title 24, Part 6 requirements are in effect (California Energy Commission 2022). The construction forecast provides construction (new construction or additions and existing building stock) by building type and climate zone, as shown in Appendix A.

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

6.2.2 Per-Unit Energy Impacts Results: New Construction and Additions

Impacts per square foot are presented in two formats. The first format shows results for each savings category by climate zone for a given assembly and prototype. The second format shows results of each building type by climate zone for a given assembly and savings category. Both formats are useful to help check modeling results, but there are too many to present all of them in the body of this report. This section includes selected tables in the first format, and Appendix H contains all tables in the second format.

Table 77 through Table 81 present savings per square foot in the first format for new construction and additions. These tables cover the following prototypes: Office Medium, Office Large, Retail Medium, Retail Large, and School Small. Data for the remaining three prototypes, Restaurant, Small Office, and Strip Mall, are found in Appendix H.

LSC savings are highly correlated with kWh savings, which come from cooling load reductions. The highest electricity savings among the tables below, for both new construction and alterations, are in Climate Zone 15 for School Small (see Table 81). This is reasonable because Climate Zone 15 is hot and dry in summer, and this building type has a relatively high WWR of 36 percent.

Table 77: Office Medium – Windows New Construction & Additions– Savings Summary (Per Square Foot)

OfficeMedium Climate Zones	First-Year Electricity Savings (kWh)	First-Year Peak Demand Savings (kW)	First-Year Natural Gas Savings (kBtu)	First-Year Source Energy Savings (kBtu)	30-year LSC Savings ($2026)
1	0.05	0.00	0.38	0.35	0.42
2	0.10	0.00	0.23	0.21	0.57
3	0.09	0.00	0.16	0.14	0.48
4	0.11	0.00	0.17	0.15	0.67
5	0.10	0.00	0.18	0.16	0.54
6	0.12	0.00	0.07	0.07	0.59
7	0.11	0.00	0.06	0.05	0.60
8	0.13	0.00	0.08	0.07	0.68
9	0.13	0.00	0.10	0.09	0.68
10	0.14	0.00	0.09	0.08	0.72
11	0.13	0.01	0.27	0.24	0.87
12	0.11	0.00	0.13	0.12	0.65
13	0.14	0.00	0.20	0.18	0.85
14	0.14	0.00	0.19	0.17	0.81
15	0.21	0.00	0.05	0.05	1.06
16	0.09	0.00	0.38	0.34	0.64

Table 78: OfficeLarge – Windows New Construction & Additions – Savings Summary (Per Square Foot)

OfficeLarge Climate Zones	First-Year Electricity Savings (kWh)	First-Year Peak Demand Savings (kW)	First-Year Natural Gas Savings (kBtu)	First-Year Source Energy Savings (kBtu)	30-year LSC Savings ($2026)
1	0.05	0.00	0.40	0.37	0.38
2	0.10	0.00	0.39	0.35	0.51
3	0.09	0.00	0.31	0.28	0.44
4	0.11	0.00	0.33	0.30	0.54
5	0.10	0.00	0.35	0.32	0.50
6	0.12	0.00	0.21	0.19	0.47
7	0.11	0.00	0.17	0.15	0.49
8	0.13	0.00	0.03	0.03	0.38
9	0.13	0.00	0.18	0.16	0.51
10	0.14	0.00	0.19	0.17	0.54
11	0.13	0.00	0.40	0.36	0.62
12	0.11	0.00	0.32	0.29	0.55
13	0.14	0.00	0.24	0.22	0.53
14	0.14	0.00	0.32	0.29	0.58
15	0.21	0.00	0.14	0.13	0.58
16	0.09	0.00	0.49	0.44	0.53

Table 79: RetailMedium – Windows New Construction & Additions – Savings Summary (Per Square Foot)

RetailMedium Climate Zones	First-Year Electricity Savings (kWh)	First-Year Peak Demand Savings (kW)	First-Year Natural Gas Savings (kBtu)	First-Year Source Energy Savings (kBtu)	30-year LSC Savings ($2026)
1	0.00	-	-0.01	-0.01	-0.01
2	0.11	0.00	-	-	0.47
3	0.06	0.00	-	-	0.28
4	0.08	0.00	-	-	0.41
5	0.09	0.00	-	-	0.36
6	0.16	-0.00	-	-	0.68
7	-0.01	-0.00	-	-	-0.21
8	0.10	-0.00	-	-	0.45
9	0.14	0.00	-	-	0.69
10	0.16	-0.00	-	-	0.74
11	0.17	0.01	-	-	0.83
12	0.07	0.00	-	-	0.24
13	0.18	0.00	-	-	0.91
14	-0.03	-0.01	-	-	-0.18
15	0.45	0.00	-	-	2.24
16	0.07	0.00	-0.02	-0.02	0.32

Table 80: RetailLarge – Windows New Construction & Additions – Savings Summary (Per Square Foot)

RetailLarge Climate Zones	First-Year Electricity Savings (kWh)	First-Year Peak Demand Savings (kW)	First-Year Natural Gas Savings (kBtu)	First-Year Source Energy Savings (kBtu)	30-year LSC Savings ($2026)
1	0.00	0.00	0.02	0.02	0.02
2	0.08	0.00	-	-	0.36
3	0.05	0.00	-	-	0.18
4	0.10	0.00	-	-	0.56
5	0.06	0.00	-	-	0.24
6	0.09	0.00	-	-	0.46
7	0.08	0.00	-	-	0.46
8	0.15	0.00	-	-	0.78
9	0.11	0.00	-	-	0.55
10	0.11	-	-	-	0.51
11	0.09	0.00	-	-	0.52
12	0.07	0.00	-	-	0.33
13	0.11	0.00	-	-	0.59
14	0.11	0.00	-	-	0.53
15	0.26	0.00	-	-	1.32
16	0.04	0.00	0.03	0.03	0.21

Table 81: SchoolSmall – Windows New Construction & Additions – Savings Summary (Per Square Foot)

SchoolSmall Climate Zones	First-Year Electricity Savings (kWh)	First-Year Peak Demand Savings (kW)	First-Year Natural Gas Savings (kBtu)	First-Year Source Energy Savings (kBtu)	30-year LSC Savings ($2026)
1	0.08	0.01	0.13	0.12	0.48
2	0.24	0.02	-	-	1.13
3	0.17	0.01	-	-	0.79
4	0.30	0.01	-	-	1.63
5	0.18	0.00	-	-	0.84
6	0.27	0.01	-	-	1.35
7	0.23	0.00	-	-	1.31
8	0.35	0.01	-	-	1.76
9	0.36	0.01	-	-	1.86
10	0.39	0.01	-	-	1.99
11	0.39	0.03	-	-	2.19
12	0.31	0.03	-	-	1.78
13	0.42	0.03	-	-	2.28
14	0.43	0.02	-	-	2.20
15	0.59	0.01	-	-	2.92
16	0.27	0.02	0.67	0.61	1.75

6.2.3 Per-Unit Energy Impacts Results: Alterations

Table 82 through Table 86 present results in the first format for alterations for the same five building types as presented for new construction in the previous section. As for new construction, the highest electricity savings and LSC savings are for School Small in Climate Zone 15. The savings values are higher, since the baseline for alterations is lower. Data for the remaining three prototypes, Restaurant, Small Office, and Strip Mall, are found in Appendix H.

Table 82: OfficeMedium – Windows Alterations – Savings Summary (Per Square Foot)

OfficeMedium Climate Zones	First-Year Electricity Savings (kWh)	First-Year Peak Demand Savings (kW)	First-Year Natural Gas Savings (kBtu)	First-Year Source Energy Savings (kBtu)	30-year LSC Savings ($2026)
1	0.11	0.00	0.44	0.40	0.77
2	0.24	0.00	0.45	0.40	1.32
3	0.22	0.00	0.49	0.44	1.25
4	0.30	0.01	0.36	0.32	1.68
5	0.24	0.00	0.31	0.28	1.23
6	0.30	0.00	0.14	0.12	1.47
7	0.28	0.00	0.11	0.10	1.49
8	0.35	0.01	0.27	0.24	1.86
9	0.34	0.01	0.31	0.28	1.84
10	0.36	0.01	0.17	0.15	1.84
11	0.35	0.01	0.57	0.52	2.12
12	0.29	0.01	0.39	0.36	1.69
13	0.37	0.01	0.29	0.26	2.02
14	0.37	0.01	0.38	0.34	2.01
15	0.55	0.01	0.15	0.13	2.76
16	0.22	0.01	0.81	0.73	1.51

Table 83: OfficeLarge – Windows Alterations – Savings Summary (Per Square Foot)

OfficeLarge Climate Zones	First-Year Electricity Savings (kWh)	First-Year Peak Demand Savings (kW)	First-Year Natural Gas Savings (kBtu)	First-Year Source Energy Savings (kBtu)	30-year LSC Savings ($2026)
1	0.07	0.01	0.99	0.89	0.91
2	0.15	0.00	0.69	0.63	1.07
3	0.12	0.00	0.64	0.58	0.87
4	0.18	0.01	0.67	0.61	1.29
5	0.15	0.01	0.60	0.54	1.04
6	0.19	0.00	0.38	0.34	1.09
7	0.19	0.00	0.34	0.31	1.15
8	0.21	0.00	0.37	0.33	1.20
9	0.19	0.00	0.45	0.40	1.19
10	0.23	0.00	0.43	0.39	1.33
11	0.19	0.01	0.75	0.68	1.39
12	0.18	0.01	0.66	0.60	1.25
13	0.19	0.01	0.46	0.42	1.26
14	0.20	0.01	0.72	0.64	1.41
15	0.29	0.01	0.31	0.28	1.59
16	0.12	0.01	1.07	0.96	1.22

Table 84: RetailMedium – Windows Alterations – Savings Summary (Per Square Foot)

RetailMedium Climate Zones	First-Year Electricity Savings (kWh)	First-Year Peak Demand Savings (kW)	First-Year Natural Gas Savings (kBtu)	First-Year Source Energy Savings (kBtu)	30-year LSC Savings ($2026)
1	-0.05	0.00	0.01	0.01	-0.20
2	0.01	0.00	0.00	0.00	0.05
3	0.00	0.00	0.00	0.00	-0.01
4	0.04	0.00	0.00	0.00	0.19
5	0.01	0.00	0.00	0.00	0.04
6	0.04	0.00	0.00	0.00	0.19
7	0.09	0.00	0.00	0.00	0.42
8	0.17	0.00	0.00	0.00	0.78
9	0.11	0.00	0.00	0.00	0.57
10	0.16	0.00	0.00	0.00	0.72
11	0.18	0.00	0.00	0.00	0.94
12	0.06	0.00	0.00	0.00	0.34
13	0.08	0.00	0.00	0.00	0.44
14	0.10	0.00	0.00	0.00	0.49
15	0.41	0.00	0.00	0.00	2.12
16	0.04	0.00	0.01	0.01	0.16

Table 85: RetailLarge – Windows Alterations – Savings Summary (Per Square Foot)

RetailLarge Climate Zones	First-Year Electricity Savings (kWh)	First-Year Peak Demand Savings (kW)	First-Year Natural Gas Savings (kBtu)	First-Year Source Energy Savings (kBtu)	30-year LSC Savings ($2026)
1	-0.03	0.00	0.06	0.05	-0.07
2	0.06	0.00	0.00	0.00	0.29
3	0.03	0.00	0.00	0.00	0.16
4	0.08	0.00	0.00	0.00	0.45
5	0.04	0.00	0.00	0.00	0.17
6	0.09	0.00	0.00	0.00	0.41
7	0.06	0.00	0.00	0.00	0.28
8	0.11	0.00	0.00	0.00	0.53
9	0.14	0.00	0.00	0.00	0.71
10	0.13	0.00	0.00	0.00	0.69
11	0.14	0.00	0.00	0.00	0.71
12	0.11	0.00	0.00	0.00	0.61
13	0.13	0.00	0.00	0.00	0.71
14	0.12	0.00	0.00	0.00	0.58
15	0.29	0.00	0.00	0.00	1.46
16	0.06	0.00	0.04	0.04	0.30

Table 86: SchoolSmall – Windows Alterations – Savings Summary (Per Square Foot)

SchoolSmall Climate Zones	First-Year Electricity Savings (kWh)	First-Year Peak Demand Savings (kW)	First-Year Natural Gas Savings (kBtu)	First-Year Source Energy Savings (kBtu)	30-year LSC Savings ($2026)
1	0.12	0.01	0.11	0.10	0.65
2	0.33	0.02	0.00	0.00	1.56
3	0.25	0.01	0.00	0.00	1.20
4	0.42	0.01	0.00	0.00	2.24
5	0.27	0.00	0.00	0.00	1.28
6	0.38	0.00	0.00	0.00	1.91
7	0.35	0.01	0.00	0.00	1.91
8	0.47	0.01	0.00	0.00	2.33
9	0.50	0.01	0.00	0.00	2.50
10	0.52	0.01	0.00	0.00	2.61
11	0.51	0.04	0.00	0.00	2.86
12	0.44	0.03	0.00	0.00	2.41
13	0.53	0.03	0.00	0.00	2.81
14	0.56	0.02	0.00	0.00	2.83
15	0.80	0.02	0.00	0.00	3.99
16	0.39	0.00	0.00	0.00	2.31

6.3 Cost and Cost Effectiveness

6.3.1 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 6.2.1. LSC hourly factors are a normalized metric to calculate energy cost savings that accounts for the variable cost of electricity and natural gas for each hour of the year, along with how costs are expected to change over the 30-year period of analysis.

The CEC requested LSC savings over the 30-year period of analysis in both 2026 present value dollars (2026 PV$) and nominal dollars. The cost-effectiveness analysis uses LSC in 2026 PV$, which allows peak electricity savings to be valued more than electricity savings during non-peak periods. Costs and cost effectiveness using 2026 PV$ are presented in Section 1.1.1 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 LSC savings results in nominal dollars.

6.3.2 Energy Cost Savings Results

LSC cost savings per square foot over the 30-year period of analysis by prototype are presented in 2026 present value dollars (2026 PV$) in Table 87 through

Table 95.

Table 87: 2026 PV LSC Savings Per Square Foot Over 30-Year Period of Analysis – New Construction, Additions and Alterations – Windows/Fenestration – OfficeSmall Prototype

Climate Zone	New Construction & Additions 30-Year LSC Electricity Savings (2026 PV $)	New Construction & Additions 30-Year LSC Gas Savings (2026 PV $)	New Construction & Additions Total 30-Year LSC Savings (2026 PV $)	Alterations 30-Year LSC Electricity Savings (2026 PV $)	Alterations 30-Year LSC Gas Savings (2026 PV $)	Alterations Total 30-Year LSC Savings (2026 PV $)
1	0.18	0.00	0.18	0.43	0.00	0.43
2	0.31	0.00	0.31	0.79	0.00	0.79
3	0.23	0.00	0.23	0.61	0.00	0.61
4	0.41	0.00	0.41	1.04	0.00	1.04
5	0.25	0.00	0.25	0.66	0.00	0.66
6	0.34	0.00	0.34	0.93	0.00	0.93
7	0.37	0.00	0.37	0.96	0.00	0.96
8	0.41	0.00	0.41	1.04	0.00	1.04
9	0.46	0.00	0.46	1.21	0.00	1.21
10	0.45	0.00	0.45	1.14	0.00	1.14
11	0.59	0.00	0.59	1.37	0.00	1.37
12	0.42	0.00	0.42	1.03	0.00	1.03
13	0.56	0.00	0.56	1.37	0.00	1.37
14	0.49	0.00	0.49	1.21	0.00	1.21
15	0.77	0.00	0.77	1.89	0.00	1.89
16	0.26	0.14	0.40	0.68	0.27	0.95

Table 88: 2026 Present Value LSC Savings Per Square Foot Over 30-Year Period of Analysis – New Construction, Additions and Alterations – Windows/Fenestration – RetailStripMall Prototype

Climate Zone	New Construction & Additions 30-Year LSC Electricity Savings (2026 PV $)	New Construction & Additions 30-Year LSC Gas Savings (2026 PV $)	New Construction & Additions Total 30-Year LSC Savings (2026 PV $)	Alterations 30-Year LSC Electricity Savings (2026 PV $)	Alterations 30-Year LSC Gas Savings (2026 PV $)	Alterations Total 30-Year LSC Savings (2026 PV $)
1	-0.04	-0.12	-0.15	-0.09	-0.30	-0.39
2	0.00	0.00	0.00	0.13	0.00	0.13
3	-0.02	0.00	-0.02	0.00	0.00	0.00
4	0.07	0.00	0.07	0.27	0.00	0.27
5	0.01	0.00	0.01	0.10	0.00	0.10
6	0.15	0.00	0.15	0.65	0.00	0.65
7	0.24	0.00	0.24	0.52	0.00	0.52
8	0.16	0.00	0.16	0.72	0.00	0.72
9	0.11	0.00	0.11	0.78	0.00	0.78
10	0.28	0.00	0.28	0.78	0.00	0.78
11	0.22	0.00	0.22	0.72	0.00	0.72
12	0.10	0.00	0.10	0.44	0.00	0.44
13	0.23	0.00	0.23	0.79	0.00	0.79
14	0.16	0.00	0.16	0.27	0.00	0.27
15	0.49	0.00	0.49	1.36	0.00	1.36
16	0.14	-0.14	0.00	0.14	-0.38	-0.24

Table 89: 2026 Present Value LSC Savings Per Square Foot Over 30-Year Period of Analysis – New Construction, Additions and Alterations – Windows/Fenestration – RestaurantFastFood Prototype

Climate Zone	New Construction & Additions 30-Year LSC Electricity Savings (2026 PV $)	New Construction & Additions 30-Year LSC Gas Savings (2026 PV $)	New Construction & Additions Total 30-Year LSC Savings (2026 PV $)	Alterations 30-Year LSC Electricity Savings (2026 PV $)	Alterations 30-Year LSC Gas Savings (2026 PV $)	Alterations Total 30-Year LSC Savings (2026 PV $)
1	0.02	-0.09	-0.07	0.06	-0.26	-0.19
2	0.25	-0.08	0.17	0.74	-0.21	0.53
3	0.17	-0.13	0.04	0.52	-0.30	0.23
4	0.41	-0.10	0.31	1.15	-0.25	0.90
5	0.20	-0.14	0.06	0.63	-0.35	0.28
6	0.38	-0.10	0.28	1.09	-0.24	0.86
7	0.38	-0.09	0.29	1.09	-0.22	0.87
8	0.50	-0.08	0.43	1.43	-0.19	1.24
9	0.51	-0.08	0.43	1.44	-0.19	1.26
10	0.54	-0.08	0.47	1.51	-0.18	1.32
11	0.57	0.02	0.58	1.53	0.04	1.57
12	0.45	-0.04	0.40	1.23	-0.12	1.12
13	0.60	-0.03	0.57	1.61	-0.09	1.52
14	0.52	-0.11	0.41	1.41	-0.26	1.15
15	0.89	-0.05	0.84	2.33	-0.13	2.21
16	0.24	0.01	0.26	0.72	0.00	0.73

In some cases, the new construction forecast is zero in some climate zones, which causes the 30-year LSC forecast to also be zero.

Table 90 presents the total LSC savings over 30 years per square foot of all projects combined. Results for alterations follow the same pattern as those for new construction. The highest savings per square foot are in Climate Zone 15, which has high cooling loads, and the lowest are in Climate Zone 1 which has low cooling loads.

Table 90: 2026 PV LSC Cost Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction, Additions and Alterations– OfficeLarge Prototype

Climate Zone	New Construction and Additions 30-Year LSC Electricity Savings (2026 PV$)	New Construction and Additions 30-Year LSC Natural Gas Savings (2026 PV$)	New Construction and Additions Total 30-Year LSC Savings (2026 PV$)	Alterations 30-Year LSC Electricity Savings (2026 PV$)	Alterations 30-Year LSC Natural Gas Savings (2026 PV$)	Alterations Total 30-Year LSC Savings (2026 PV$)
1	-	-	-	0.35	0.56	0.91
2	-	-	-	0.67	0.40	1.07
3	0.27	0.17	0.44	0.51	0.36	0.87
4	0.35	0.19	0.54	0.90	0.39	1.29
5	-	-	-	0.70	0.34	1.04
6	0.36	0.12	0.47	0.88	0.22	1.09
7	0.39	0.10	0.49	0.96	0.20	1.15
8	0.35	0.02	0.38	0.98	0.22	1.20
9	0.40	0.11	0.51	0.93	0.26	1.19
10	0.43	0.11	0.54	1.08	0.25	1.33
11	0.38	0.23	0.62	0.94	0.45	1.39
12	0.37	0.18	0.55	0.87	0.38	1.25
13	-	-	-	0.98	0.28	1.26
14	0.39	0.19	0.58	0.99	0.42	1.41
15	0.50	0.09	0.58	1.40	0.19	1.59
16	0.24	0.29	0.53	0.60	0.62	1.22

Table 91: 2026 PV LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction, Additions and Alterations– OfficeMedium Prototype

Climate Zone	New Construction and Additions 30-Year LSC Electricity Savings (2026 PV$)	New Construction and Additions 30-Year LSC Natural Gas Savings (2026 PV$)	New Construction and Additions Total 30-Year LSC Savings (2026 PV$)	Alterations 30-Year LSC Electricity Savings (2026 PV$)	Alterations 30-Year LSC Natural Gas Savings (2026 PV$)	Alterations Total 30-Year LSC Savings (2026 PV$)
1	0.22	0.20	0.42	0.49	0.28	0.77
2	0.44	0.14	0.57	1.05	0.26	1.32
3	0.39	0.09	0.48	0.96	0.29	1.25
4	0.57	0.10	0.67	1.48	0.21	1.68
5	0.44	0.10	0.54	1.05	0.18	1.23
6	0.55	0.04	0.59	1.39	0.08	1.47
7	0.56	0.04	0.60	1.42	0.07	1.49
8	0.63	0.05	0.68	1.69	0.17	1.86
9	0.63	0.06	0.68	1.65	0.19	1.84
10	0.67	0.05	0.72	1.74	0.10	1.84
11	0.70	0.16	0.87	1.77	0.35	2.12
12	0.57	0.08	0.65	1.46	0.24	1.69
13	0.72	0.12	0.85	1.84	0.17	2.02
14	0.69	0.12	0.81	1.78	0.23	2.01
15	1.02	0.03	1.06	2.67	0.09	2.76
16	0.42	0.22	0.64	1.03	0.48	1.51

Table 92: 2026 PV LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction, Additions and Alterations– RetailLarge Prototype

Climate Zone	New Construction and Additions 30-Year LSC Electricity Savings (2026 PV$)	New Construction and Additions 30-Year LSC Natural Gas Savings (2026 PV$)	New Construction and Additions Total 30-Year LSC Savings (2026 PV$)	Alterations 30-Year LSC Electricity Savings (2026 PV$)	Alterations 30-Year LSC Natural Gas Savings (2026 PV$)	Alterations Total 30-Year LSC Savings (2026 PV$)
1	-	-	-	-0.10	0.04	-0.07
2	-	-	-	0.29	0.00	0.29
3	0.09	0.00	0.09	0.16	0.00	0.16
4	0.28	0.00	0.28	0.45	0.00	0.45
5	0.12	0.00	0.12	0.17	0.00	0.17
6	0.23	0.00	0.23	0.41	0.00	0.41
7	0.23	0.00	0.23	0.28	0.00	0.28
8	0.39	0.00	0.39	0.53	0.00	0.53
9	0.27	0.00	0.27	0.71	0.00	0.71
10	0.25	0.00	0.25	0.69	0.00	0.69
11	0.26	0.00	0.26	0.71	0.00	0.71
12	0.17	0.00	0.17	0.61	0.00	0.61
13	0.29	0.00	0.29	0.71	0.00	0.71
14	0.27	0.00	0.27	0.58	0.00	0.58
15	0.66	0.00	0.66	1.46	0.00	1.46
16	0.09	0.01	0.10	0.27	0.03	0.30

Table 93: 2026 PV LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction, Additions and Alterations– RetailMedium Prototype

Climate Zone	New Construction and Additions 30-Year LSC Electricity Savings (2026 PV$)	New Construction and Additions 30-Year LSC Natural Gas Savings (2026 PV$)	New Construction and Additions Total 30-Year LSC Savings (2026 PV$)	Alterations 30-Year LSC Electricity Savings (2026 PV$)	Alterations 30-Year LSC Natural Gas Savings (2026 PV$)	Alterations Total 30-Year LSC Savings (2026 PV$)
1	0.00	0.00	0.00	-0.21	0.01	-0.20
2	0.24	0.00	0.24	0.05	0.00	0.05
3	0.14	0.00	0.14	-0.01	0.00	-0.01
4	0.20	0.00	0.20	0.19	0.00	0.19
5	0.18	0.00	0.18	0.04	0.00	0.04
6	0.34	0.00	0.34	0.19	0.00	0.19
7	-0.11	0.00	-0.11	0.42	0.00	0.42
8	0.23	0.00	0.23	0.78	0.00	0.78
9	0.34	0.00	0.34	0.57	0.00	0.57
10	0.37	0.00	0.37	0.72	0.00	0.72
11	0.41	0.00	0.41	0.94	0.00	0.94
12	0.12	0.00	0.12	0.34	0.00	0.34
13	0.45	0.00	0.45	0.44	0.00	0.44
14	-0.09	0.00	-0.09	0.49	0.00	0.49
15	1.12	0.00	1.12	2.12	0.00	2.12
16	0.16	0.00	0.16	0.15	0.01	0.16

Table 94: 2026 PV LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction, Additions and Alterations– SchoolSmall Prototype

Climate Zone	New Construction and Additions 30-Year LSC Electricity Savings (2026 PV$)	New Construction and Additions 30-Year LSC Natural Gas Savings (2026 PV$)	New Construction and Additions Total 30-Year LSC Savings (2026 PV$)	Alterations 30-Year LSC Electricity Savings (2026 PV$)	Alterations 30-Year LSC Natural Gas Savings (2026 PV$)	Alterations Total 30-Year LSC Savings (2026 PV$)
1	0.20	0.04	0.24	0.58	0.07	0.65
2	0.56	0.00	0.56	1.56	0.00	1.56
3	0.40	0.00	0.40	1.20	0.00	1.20
4	0.81	0.00	0.81	2.24	0.00	2.68
5	0.42	0.00	0.42	1.28	0.00	1.28
6	0.68	0.00	0.68	1.91	0.00	1.91
7	0.66	0.00	0.66	1.91	0.00	1.91
8	0.88	0.00	0.88	2.33	0.00	2.33
9	0.93	0.00	0.93	2.50	0.00	2.50
10	1.00	0.00	1.00	2.61	0.00	2.61
11	1.10	0.00	1.10	2.86	0.00	2.86
12	0.89	0.00	0.89	2.41	0.00	2.41
13	1.14	0.00	1.14	2.81	0.00	2.81
14	1.10	0.00	1.10	2.83	0.00	2.83
15	1.46	0.00	1.46	3.99	0.00	3.99
16	0.67	0.20	0.87	1.90	0.41	2.13

Table 95: Average 2026 PV LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction, Additions and Alterations– All Prototypes

Climate Zone	New Construction and Additions 30-Year LSC Electricity Savings (2026 PV $)	New Construction and Additions 30-Year LSC Gas Savings (2026 PV $)	New Construction and Additions Total 30-Year LSC Savings (2026 PV $)	Alterations 30-Year LSC Electricity Savings (2026 PV $)	Alterations 30-Year LSC Gas Savings (2026 PV $)	Alterations Total 30-Year LSC Savings (2026 PV $)
1	0.13	0.07	0.19	0.26	0.00	0.26
2	0.33	0.02	0.35	0.74	0.09	0.84
3	0.21	0.06	0.26	0.49	0.16	0.65
4	0.36	0.06	0.42	0.90	0.16	1.06
5	0.30	0.03	0.33	0.67	0.05	0.73
6	0.36	0.02	0.38	0.88	0.07	0.95
7	0.34	0.02	0.35	0.91	0.06	0.97
8	0.39	0.01	0.40	1.09	0.09	1.18
9	0.42	0.03	0.45	1.07	0.11	1.19
10	0.43	0.01	0.44	1.19	0.04	1.23
11	0.48	0.04	0.52	1.45	0.09	1.54
12	0.39	0.03	0.42	1.02	0.12	1.14
13	0.55	0.02	0.57	1.32	0.04	1.36
14	0.35	0.03	0.38	1.07	0.10	1.17
15	0.86	0.01	0.86	2.06	0.02	2.09
16	0.26	0.06	0.32	0.65	0.18	0.83

6.3.3 Incremental First Cost

The Statewide CASE Team anticipates negligible incremental first costs associated with instituting a mandatory U-factor requirements for vertical fenestration. This is because the proposed requirements are easily met by insulated glazing unit products already existing in the market and in common use. As noted in the Technical Feasibility and Market Availability section, any incremental first cost would be limited to the small subset of projects that utilized custom-made large-scale fenestration such as that commonly used in ground floors. The incremental first cost for these types of fenestrations may increase in order to provide the mandatory U-factor needed to meet the proposed requirements. We have omitted these scenarios from the cost analysis because we assume that custom-made large-scale fenestration installations are not prevalent enough to be included at the statewide scale.

6.3.4 Incremental Maintenance and Replacement Costs

In general, vertical fenestration is only replaced on an as-needed basis like in the case of accidental damage. Maintenance and replacement are typically associated with moisture-related damage and for condensation issues in the frame assembly.

Items requiring maintenance include inspections for adjacent building elements providing water drainage at the building such as window head flashing, roof drains, scuppers, transition flashing, and gutters. Sealant joints are typically employed to transition between different cladding and fenestration types within the building envelope. These sealant joints are often a critical component in the durability of a building envelope and also merit annual inspection. While regular inspections are best practice for the opaque envelope, it is also true that the vast majority of building owners do not inspect their property to ensure drainage. In cases such as these, wholesale replacement of sections of the vertical fenestration is often required. The timing, frequency, and magnitude of these costs are not quantified for this Final CASE Report.

If building drainage elements are inspected as noted above, the only common replacement cost for vertical fenestration is exterior sealant joints exposed to the weather and solar UV radiation. The frequency of replacement would depend on the type of sealants used as some are more resistant to the elements than others, but for the purposes of this report the Statewide CASE Team assumes a period of 10 years between sealant joint replacement.

Incremental maintenance cost is the incremental cost of replacing windows, as well as periodic maintenance and repair required to keep windows operating relative to current practices over the 30-year period of analysis. The present value of window maintenance costs (or savings) was calculated using a three percent discount rate (d), which is consistent with the discount rate used when developing the 2025 LSC hourly factors.

The present value of maintenance costs that occurs in the n^{th} year is calculated as follows:

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

6.3.5 Cost Effectiveness

This measure proposes a mandatory requirement that is less stringent than the existing prescriptive requirements, which have already proven to be cost effective. As such, a cost analysis is not required to demonstrate that the measure is cost effective over the 30-year period of analysis.

6.4 First-Year Statewide Impacts

6.4.1 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 per square foot for each building prototype from Section 6.2 by the number of square feet of each type 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).

The 30-year energy cost savings represent the energy cost savings over the entire 30-year analysis period. Because this measure does not apply to an element already regulated by Title 24, Part 6, statewide savings are discounted for the estimated portion of the market already in compliance.

Table 96: Statewide Energy and Energy Cost Impacts – New Construction and Additions

Climate Zone	Statewide New Construction & Additions Impacted by Proposed Change in 2026	First-Year[a] Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (million therms)	First-Year Source Energy Savings (million kBtu)	30-Year LSC Savings (million 2026 PV$)
1	57,594	0.00	0.00	0.00	0.00	$0.01
2	316,978	0.02	0.00	0.00	0.01	$0.08
3	1,311,202	0.04	0.00	0.00	0.08	$0.24
4	655,947	0.03	0.00	0.00	0.05	$0.19
5	153,967	0.01	0.00	0.00	0.00	$0.04
6	914,700	0.05	0.00	0.00	0.02	$0.24
7	608,102	0.03	0.00	0.00	0.01	$0.15
8	1,301,900	0.07	0.00	0.00	0.01	$0.36
9	2,213,276	0.13	0.00	0.00	0.07	$0.69
10	1,080,939	0.07	0.00	0.00	0.01	$0.33
11	219,230	0.01	0.00	0.00	0.01	$0.08
12	1,345,801	0.07	0.00	0.00	0.04	$0.40
13	479,429	0.04	0.00	0.00	0.01	$0.19
14	272,065	0.01	0.00	0.00	0.01	$0.07
15	163,737	0.02	0.00	0.00	0.00	$0.10
16	86,600	0.00	0.00	0.00	0.01	$0.02
Total	**11,181,469**	**0.61**	**0.01**	**0.00**	**0.34**	**$3.20**

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

Table 97: Statewide Energy and Energy Cost Impacts – Alterations

Climate Zone	Statewide Alterations Impacted by Proposed Change in 2026	First-Year[a] Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (million therms)	First-Year Source Energy Savings (million kBtu)	30-Year LSC Savings (million 2026 PV$)
1	240,558	0.01	0.00	-0.00	-0.00	$0.06
2	1,398,075	0.24	0.01	0.00	0.20	$1.17
3	6,325,350	0.71	0.02	0.02	1.62	$4.14
4	3,217,545	0.57	0.01	0.01	0.82	$3.41
5	674,850	0.10	0.00	0.00	0.06	$0.49
6	4,787,700	0.88	0.01	0.01	0.50	$4.53
7	3,586,140	0.65	0.01	0.00	0.34	$3.47
8	6,887,250	1.58	0.02	0.01	0.92	$8.15
9	11,445,900	2.48	0.05	0.02	2.03	$13.59
10	6,032,400	1.47	0.02	0.00	0.36	$7.42
11	1,217,745	0.33	0.02	0.00	0.16	$1.87
12	6,754,650	1.32	0.06	0.01	1.19	$7.70
13	2,369,040	0.60	0.02	0.00	0.14	$3.23
14	1,438,140	0.32	0.01	0.00	0.22	$1.68
15	831,540	0.34	0.01	0.00	0.03	$1.74
16	448,680	0.06	0.00	0.00	0.12	$0.37
Total	**57,655,563**	**11.68**	**0.26**	**0.10**	**8.72**	**$63.04**

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

Table 98: Statewide Energy and Energy Cost Impacts – New Construction, Additions, and Alterations

Measure	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (million therms)	First-Year Source Energy Savings (million therms)	30-Year LSC Savings (PV$ million)
New Construction & Additions	0.6	0.0	0.0	0.3	3
Alterations	11.7	0.3	0.1	8.7	63
Total	12.3	0.3	0.1	9.0	66

6.4.2 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 $123.15 per metric tons of carbon dioxide equivalent emissions (metric tons CO2e).

The monetary value of avoided GHG emissions is based on a proxy for permit costs (not social costs).[35] The cost-effectiveness analysis presented in Section 6.3 of this report does not include the cost savings from avoided GHG emissions. To demonstrate the cost savings of avoided GHG emissions, the Statewide CASE Team disaggregated the value of avoided GHG emissions from the other economic impacts.

Table 99 presents the estimated first-year avoided GHG emissions of the proposed code change. During the first year, GHG emissions of over 1,000 metric tons CO2e would be avoided.

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

Table 99: First-Year Statewide GHG Emissions Impacts

Measure	Electricity Savings[a] (GWh/y)	Reduced GHG Emissions from Electricity Savings[a] (Metric Tons CO2e)	Natural Gas Savings[a] (Million Therms/yr)	Reduced GHG Emissions from Natural Gas Savings[a] (Metric Tons CO2e)	Total Reduced GHG Emissions[b] (Metric Ton CO2e)	Total Monetary Value of Reduced GHG Emissions[c] ($)
Windows (New Construction and Additions)	1	26	0.0	20	46	5,723
Windows (Alterations)	12	510	0.1	526	1,036	127,582
TOTAL	**13**	**536**	**0.1**	**546**	**1,082**	**133,305**

a. First-year savings from all applicable newly constructed buildings, additions, and alterations completed statewide in 2026.

b. GHG emissions savings were calculated using hourly GHG emission factors published alongside the LSC hourly factors and source energy hourly factors by CEC.

c. The monetary value of avoided GHG emissions is based on a proxy for permit costs (not social costs) derived from the 2022 TDV Update Model published by CEC here.

6.4.3 Statewide Water Use Impacts

The proposed code change would not result in water savings.

6.4.4 Statewide Material Impacts

The Statewide CASE Team expects little to no changes to materials impacts because the proposed code change is only changing existing U-factors which doesn't necessarily translate to more or different materials being used.

6.5 Addressing Energy Equity and Environmental Justice

The Statewide CASE Team assessed the potential impacts of the proposed measure, and based on a preliminary review, the measure is unlikely to have significant impacts on energy equity or environmental justice, therefore reducing the impacts of disparities in DIPs.

6.5.1 Research Methods and Engagement

The Statewide CASE Team evaluated the measure for its potential impacts to health, cost, resiliency, and comfort. The proposed measure would reduce heat transfer and air leakage, as well as strengthen the building thermal envelope. The specific health, comfort, and resiliency benefits of a tighter building envelope to DIPs are outlined in Section 2.1.2. There are no expected impacts to DIPs related to cost.

7. Proposed Revisions to Code Language

7.1 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).

7.2 Standards

SECTION 120.7 – MANDATORY ~~INSULATION~~ THERMAL ENVELOPE REQUIREMENTS

Nonresidential and hotel/motel buildings shall comply with the applicable requirements in Sections 120.7(a) through 120.7~~(c)~~(e).

(a) Roof/Ceiling Insulation. (No change)

(b) Wall Insulation. (No change)

(c) Floor and Soffit Insulation. (No change)

(d) **Exterior Windows.** Vertical fenestration assemblies shall:

1. Have an area-weighted average U-factor no greater than 0.47.

(e) **Vestibules.** *Public entrances* in buildings of occupancy types A, B, E, I, and M shall be protected with an enclosed vestibule meeting the applicable requirements of Items 1 and 2 below:

1. All doors opening into and out of the vestibule shall be equipped with self-closing devices. Vestibules shall be designed so that in passing through the vestibule it is not necessary for the interior and exterior doors to open at the same time. The installation of one or more revolving doors in the building entrance shall not eliminate the requirement that a vestibule be provided on any *public entrance* doors adjacent to revolving doors.
2. Where provided, the heating system for heated vestibules and air curtains with integral heating shall be provided with controls configured to shut off the source of heating when the outdoor air temperature is greater than 45°F. Vestibule heating and cooling systems shall be controlled by a thermostat located in the vestibule configured to limit heating to a temperature not greater than 60°F and cooling to a temperature not less than 85°F.

EXCEPTIONS to Section 120.7(e): Vestibules are not required for the following:

1. Doors not intended to be used by the public, such as doors to mechanical or electrical equipment rooms, or intended solely for employee use.
2. Doors opening directly from a sleeping unit or dwelling unit.
3. Doors that open directly from a space less than 3,000 square feet in area.
4. Revolving doors.

5. Doors used primarily to facilitate vehicular movement or material handling and adjacent personnel doors.
6. Doors that have an air curtain with a velocity of not less than 6.56 feet per second at the floor that have been tested in accordance with ANSI/AMCA 220 and installed in accordance with the manufacturer's instructions. Manual or automatic controls shall be provided that operate the air curtain with the opening and closing of the door.

SECTION 140.3 – PRESCRIPTIVE REQUIREMENTS FOR BUILDING ENVELOPES

A building complies with this section by being designed with and constructed to meet all prescriptive requirements in Subsection (a) and the requirements of Subsection (c) and (d) where they apply.

TABLE 140.3-B – PRESCRIPTIVE ENVELOPE CRITERIA FOR NONRESIDENTIAL BUILDINGS (INCLUDING RELOCATABLE PUBLIC SCHOOL BUILDINGS WHERE MANUFACTURER CERTIFIES USE ONLY IN SPECIFIC CLIMATE ZONE; NOT INCLUDING HIGH-RISE RESIDENTIAL BUILDINGS AND GUEST ROOMS OF HOTEL/MOTEL BUILDINGS)

				Climate Zone															
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Envelope	**Maximum U-factor**	**Roofs/ Ceilings**	Metal Building	~~0.041~~ 0.038	~~0.041~~ 0.038	~~0.041~~ 0.038	~~0.041~~ 0.038	~~0.041~~ 0.038	~~0.041~~ 0.038	~~0.041~~ 0.038	~~0.041~~ 0.038	~~0.041~~ 0.038	~~0.041~~ 0.038	~~0.041~~ 0.038	~~0.041~~ 0.038	~~0.041~~ 0.038	~~0.041~~ 0.038	~~0.041~~ 0.038	~~0.041~~ 0.038
			Wood Framed and Other	~~0.034~~ 0.028	~~0.034~~ 0.028	~~0.034~~ 0.028	~~0.034~~ 0.028	~~0.034~~ 0.028	~~0.049~~ 0.047	~~0.049~~ 0.047	~~0.049~~ 0.047	~~0.034~~ 0.028	~~0.034~~ 0.028	~~0.034~~ 0.028	~~0.034~~ 0.028	~~0.034~~ 0.028	~~0.034~~ 0.028	~~0.034~~ 0.028	~~0.034~~ 0.028
		Walls	Metal Building	~~0.113~~ 0.098	~~0.061~~ 0.053	~~0.113~~ 0.098	~~0.061~~ 0.053	~~0.061~~ 0.053	~~0.113~~ 0.098	~~0.113~~ 0.098	~~0.061~~ 0.034	~~0.061~~ 0.053	~~0.061~~ 0.053	~~0.061~~ 0.053	~~0.061~~ 0.053	~~0.061~~ 0.053	~~0.061~~ 0.053	~~0.057~~ 0.050	~~0.061~~ 0.053
			Metal-framed	0.060	0.055	0.071	0.055	0.055	0.060	0.060	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055
			Mass Light[1]	~~0.196~~ 0.170	~~0.170~~ 0.138	~~0.278~~ 0.227	~~0.227~~ 0.196	~~0.440~~ 0.364	~~0.440~~ 0.364	~~0.440~~ 0.364	~~0.440~~ 0.364	~~0.440~~ 0.364	~~0.170~~ 0.138	~~0.170~~ 0.138	~~0.170~~ 0.138	~~0.170~~ 0.138	~~0.170~~ 0.138	~~0.170~~ 0.138	~~0.170~~ 0.138
			Mass Heavy[1]	~~0.253~~ 0.211	~~0.650~~ 0.575	~~0.650~~ 0.575	~~0.650~~ 0.575	~~0.650~~ 0.575	~~0.690~~ 0.650	~~0.690~~ 0.650	~~0.690~~ 0.650	~~0.690~~ 0.650	~~0.650~~ 0.575	~~0.184~~ 0.160	~~0.253~~ 0.211	~~0.211~~ 0.184	~~0.184~~ 0.160	~~0.184~~ 0.160	~~0.160~~ 0.153
			Wood-framed and Other	~~0.095~~ 0.078	~~0.059~~ 0.053	~~0.110~~ 0.102	~~0.059~~ 0.053	~~0.102~~ 0.095	~~0.110~~ 0.102	~~0.110~~ 0.102	~~0.102~~ 0.095	~~0.059~~ 0.053	~~0.059~~ 0.053	~~0.045~~ 0.042	~~0.059~~ 0.053	~~0.059~~ 0.053	~~0.059~~ 0.053	~~0.042~~ 0.038	~~0.059~~ 0.053
		Floors/ Soffits	Raised Mass	0.092	0.092	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.092	0.092	0.092	0.092	0.092	0.058
			Other	0.048	0.039	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.039	0.071	0.071	0.039	0.039	0.039
	Roofing Products	**Low-sloped**	Aged Solar Reflectance	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
			Thermal Emittance	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
		Steep Sloped	Aged Solar Reflectance	0.20	0.25	0.20	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
			Thermal Emittance	0.75	0.80	0.75	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
	Air Barrier			REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ
	Exterior Doors, Maximum U-factor		Non-Swinging	0.50	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	0.50
			Swinging	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70

SECTION 141.0 – ADDITIONS, ALTERATIONS, AND REPAIRS TO EXISTING NONRESIDENTIAL, AND HOTEL/MOTEL BUILDINGS, TO EXISTING OUTDOOR LIGHTING, AND TO INTERNALLY AND EXTERNALLY ILLUMINATED SIGNS

(b) Alterations.

Alterations to components of existing nonresidential, hotel/motel, or relocatable public school buildings, including alterations made in conjunction with a change in building occupancy to a nonresidential, high-rise residential, or hotel/motel occupancy shall meet item 1, and either Item 2 or 3 below:

1. Mandatory Requirements.

Altered components in a nonresidential, or hotel/motel building shall meet the minimum requirements in this Section.

A. **Roof/Ceiling Insulation.** (No change)

B. **Wall Insulation.** (No change)

C. **Floor Insulation.** (No change)

D**. Fan Energy Index:** (No change)

E. **Exterior Windows.** Fenestration alterations other than repair shall meet the requirements below:

1. **Vertical fenestration alterations.** Where over 150 square feet of the entire building's vertical fenestration is replaced, the maximum U-factor of the replaced units shall not exceed U-0.58.

   NOTE: Glass replaced in an existing sash and frame, or sashes replaced in an existing frame, are considered repairs. In these cases, Section 141.0(c) requires that the replacement be at least equivalent to the original in performance.

2. **Added vertical fenestration.** Where over 50 square feet of vertical fenestration is added, it shall meet the requirements of Section 120.7(d). Where 50 square feet or less of vertical fenestration is added, this requirement shall not apply.

7.3 Appendices

Joint Appendix C – Definitions

ANSI/AMCA 220 is the Air Movement and Control Association document titled "Laboratory Methods of Testing Air Curtain Units for Aerodynamic Performance Rating," 2021(ANSI/AMCA Standard 220-21).

7.4 Nonresidential ACM Reference Manual

The purpose of this section is to present marked-up language for all relevant sections of the ACM Reference Manual, including describing how the software should treat the Proposed Design and the Standard Design. There are several changes needed to the Nonresidential and Multifamily ACM to account for the Envelope Measures.

This section describes needed changes.

- Section 5.5.3 Roofs
- Section 5.5.7 Fenestration

Section 5.5.3 Roofs

ROOF CONSTRUCTION

Standard Design: Roofs in the standard design are of the type “insulation entirely above deck.” The insulation requirement is determined by climate zone. The standard design building roof construction shall be modeled as layers as defined. See Appendix 5.5 for details.

For newly constructed buildings, the standard design roof type is wood framed and other, and the roof is a standing seam metal roof, with the R-value of continuous insulation adjusted to match the prescriptive standards for wood-framed and other roofs. The U-factor required for roof construction is defined in Table 140.3-B, 140.3-C, 140.3-D, or Table 170.2-A of the Energy Code. Programs that model a U-factor shall include an exterior and interior air film resistance. The standard design construction is based on JA4 Table 4.2.7 and assumes an exterior air film of R-0.17 and an interior air film of R-0.61.

The standard design construction shall include the following layers:

Layer 1Metal Standing Seam 1/16 in.

R - 0.00

Layer 2

Continuous Insulation

R - Based on Climate Zone

Layer 3

Open Framing + No Insulation

R - 0.00

The value of the continuous insulation layer entirely above framing shall be set to achieve the following R-values:

Nonresidential Buildings: Continuous Insulation

- ~~Climate Zones 2, 3, 4, 9-16~~
  - ~~R - 28.63 (U-0.034)~~
- ~~Climate Zones 1, 5~~
  - ~~R - 28.63 (U-0.034)~~
- ~~Climate Zones 7, 8~~

- ~~R - 19.62 (U-0.049)~~

- ~~Climate Zones 6~~
- ~~R - 19.62 (U-0.049)~~
- Climate Zones 6, 7, 8
  - R-21.34 (U-0.0470)
- All other zones
- R 35.78 (0.028)

Section 5.5.7 Fenestration

Input Restrictions: The area weighted-average U-factors, must be equal to or more efficient than the mandatory U-factor requirements of §120.7 of the Energy Code for newly constructed buildings. The area weighted-average of the construction assembly U-factors, must be equal to or more efficient than the mandatory U-factor requirements of §141.0(b)E. of the Energy Code for altered buildings.

New Construction

U – 0.47

Additions and Alterations

U- 0.58

7.5 Compliance Documents

Compliance document NRCI-ENV-01-E (based on the 2019 code) has been retired. Effective from this year January 1st, 2023, there will be no Dynamic PDF but only Energy Code Ace Virtual Compliance Assistant (VCA) and compliance documents reports from the simulation tool EnergyPro will be accepted – necessary changes need to happen on these platforms.

The proposed code changes would modify the compliance documents listed below.

NRCC-ENV-E Certificate of Compliance:

- Add references to mandatory vestibules.
- Delete Footnote 1 in Section K.

2022-NRCI-ENV-E Certificate of Installation:

- Add a new section indicating installation of vestibule where required.

8. Bibliography

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

Abualsaud, R., Ostrovskiy, G., & Mahfoud, Z. (2019). Ethnicity-Based Inequality in Heat-Related Illness Is on the Rise in California. *Wilderness & Environmental Medicine*, 100-103.

ACEEE. (n.d.). *Energy Equity.* Retrieved 2023, from ACEEE.org: https://www.aceee.org/topic/energy-equity

Association, National Energy Assistance Directors. (2011). *2011 National Energy Assistance Survey Final Report.*

Blankenship, B. J. (2020). *Hand-in-Hand: Environmental and Social Justice Communities and California Energy Code.* ACEEE Summer Study on Energy Efficiency in Buildings.

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. Retrieved from https://www.arb.ca.gov/cc/inventory/background/gwp.htm#transition

California Department of Water Resources. (2016). *California Counties by Hydrologic Regions.* Retrieved April 3, 2016, from http://www.water.ca.gov/landwateruse/images/maps/California-County.pdf

California Energy Commission . (2022). *2025 Building Energy Efficiency Standards.* Retrieved March 21, 2023, from 2025 Energy Code Hourly Factors: https://efiling.energy.ca.gov/getdocument.aspx?tn=239439

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

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

California Energy Commission. (2022). *2025 California Energy Code Measure Proposal to the California Energy Commission.* Retrieved from https://www.energy.ca.gov/media/3538

California Energy Commission. (2022). Housing and Commercial Construction Data-Excel.

California Energy Commission. (2022a, November 10). *Energy Accounting Workshop Presentations Combined.* (D. N. 22-BSTD-01, Ed.) Retrieved from https://efiling.energy.ca.gov/GetDocument.aspx?tn=247362

California Energy Commission. (2022b). *Energy Code Data for Measure Proposals.* Retrieved from energy.ca.gov: https://www.energy.ca.gov/title24/documents/2022_Energy_Code_Data_for_Measure_Proposals.xlsx

California Energy Commission. (2022c). Housing and Commercial Construction Data - Excel. Retrieved from https://ww2.energy.ca.gov/title24/documents/2022_Energy_Code_Data_for_Measure_Proposals.xlsx

California Energy Commission. (n.d.). *2025 Energy Code Compliance Software, Research Version*. Retrieved 2022, from https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2025-building-energy-efficiency-1

California Governer's Office of Emergency Services. (2021, August 3). *Cal OES News*. Retrieved 2023, from 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.* Retrieved from 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.* Retrieved from http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=5350

CEC. (2018, June 25). *Energy Equity Indicators Tracking Progress.* Retrieved 2023, from Energy.ca.gov: https://www.energy.ca.gov/sites/default/files/2019-12/energy_equity_indicators_ada.pdf

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

Cho, H., Gowri, K., & Liu, B. (2010, November). Energy Saving Impact of ASHRAE 90.1 Vestibule Requirements: Modeling of Air Infiltration through Door Openings. (PNNL-20026). Pacific Northwest National Laboratory (PNNL). Retrieved from

https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-20026.pdf

Cluett, R. J. (2015). Multiple Benefits of Multifamily Energy Efficiency for Cost-Effectiveness Screening. *American Council for an Energy-Efficiency Economy*.

CPUC. (n.d.). *Disadvantaged Communities.* Retrieved 2023, from 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.

CTCAC. (2014). *Affordable Housing Cost Study: Analysis of the Factors that Influence the Cost of Building Multifamily Affordable Housing in California.* California Department of Housing and Community Development, California Housing Finance Agency, California Debt Limit Allocation Committee.

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

Deng, H., Aldrich, D. P., Danziger, M. M., Gao, J., Phillips, N. E., Cornelius, S. P., & Wang, Q. R. (2021). High-resolution human mobility data reveal race and wealth disparities in disaster evacuation patterns. *Humanities & Social Sciences Communications*.

Drehobl, A. L. (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.

Energy + Environmental Economics. (2016, July). *Time Dependent Valuation of Energy for Developing Building Efficiency Standards: 2019 Time Dependent Valuation (TDV) Data Sources and Inputs.* Retrieved from http://docketpublic.energy.ca.gov/PublicDocuments/16-BSTD-06/TN212524_20160801T120224_2019_TDV_Methodology_Report_7222016.pdf

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

Ettenson, L., & Heavey, C. (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.). Retrieved Sepember 14, 2022, from https://fred.stlouisfed.org/release/tables?eid=258470&rid=144

Federal Reserve Economic Data (FRED). (n.d.). *Data series relied on: Net Domestic Private Investment, Corporate Profits After Taxes*. Retrieved September 18, 2022, from https://fred.stlouisfed.org

Goldman, C., Fuller, M. C., Stuart, E., Peters, J. S., McRay, M., Albers, N., . . . Spahic, M. (2010). *Energy Efficiency Services Sector: Workforce Size and Expectations for Growth.* Lawrence Berkeley National Laboratory.

Goldsmith, L., & Bell, M. L. (2021). Queering Environmental Justice: Unequal Environmental Health Burden on the LGBTQ+ Community. *American Journal of Public Health*. Retrieved from https://ajph.aphapublications.org/doi/10.2105/AJPH.2021.306406

Hart, R., Rosenberg, M., Zhang, J., & Chen, Y. (2020, December). *Development of Lost Energy Cost Savings for Energy Code Compliance in Commercial Buildings.* Pacific Northwest National Laboratory (PNNL). Retrieved from https://www.energycodes.gov/sites/default/files/2021-02/Com_Code_Compliance_Lost_Sav_121720.pdf

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

Internal Revenue Service, Treasury. (2011). *CFR-2011-title26-vol1-sec1-42-10.pdf.* Retrieved 2023, from Govinfo.gov: https://www.govinfo.gov/content/pkg/CFR-2011-title26-vol1/pdf/CFR-2011-title26-vol1-sec1-42-10.pdf

Kenney, M. H. (2019). *2019 California Energy Efficiency Action Plan.* California Energy Commission. Retrieved from 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, K. A. (2012). The Impact of Heat Islands on Mortality in Paris during the August 2003 Heat Wave. *Environmental Health Perspectives*.

Lewis, L. B., Sloane, D. C., Nascimento, L. M., Diamant, A. L., Guinyard, J. J., Yancey, A. K., & Flynn, G. (2005). African Americans' Access to Healthy Food Options in South Los Angeles Restaurants. *American Journal of Public Health*.

Ming, Z., Clark, V., Price, S., Conlon, B., Staver, H., Horii, B., . . . Contoyannis, D. (2016, July). *California Energy Commission.* Retrieved March 21, 2023, from Time Dependent Valuation of Energy for Developing Building Efficiency Standards: http://docketpublic.energy.ca.gov/PublicDocuments/16-BSTD-06/TN212524_20160801T120224_2019_TDV_Methodology_Report_7222016.pdf

Morelix, A. R. (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*. Retrieved from http://www.appriseinc.org/reports/Final%20NEADA%202011%20Report.pdf

NMHC. (2022). *2022 Renter Preferences Survey Report.* Grace Hill, Kingsley Surveys. Retrieved from https://www.nmhc.org/research-insight/research-report/nmhc-grace-hill-renter-preferences-survey-report/

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

Notes - May 22 - Nonresidential Envelope, Existing Buildings, and Multifamily Restructuring Utility-Sponsored Stakeholder Meeting Notes. (2023d). Retrieved from title24stakeholders.com: https://title24stakeholders.com/wp-content/uploads/2023/06/May-22_R2-Mtg-Notes_NR-ENV_ExistBldgs_MFrestructuring-1.pdf

Oh, H.-J. (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*. Retrieved 2023, from https://www.pewresearch.org/religion/religious-landscape-study/compare/attendance-at-religious-services/by/racial-and-ethnic-composition/

PG&E. (n.d.). *The Pacific Energy Center's Guide to: California Climate Zones and Bioclimatic Design.* Retrieved from https://www.pge.com/includes/docs/pdfs/about/edusafety/training/pec/toolbox/arch/climate/california_climate_zones_01-16.pdf

Power, M. (2007). Technical Report of Accomplishments of the Weatherization Leveraging Partnership Project. *Economic Opportunity Studies*.

Ramanathan, L. (2017, January 16). Mall outside DC has found a niche: immigrants. *AP News*. Retrieved from https://apnews.com/article/--9557e5da878b4328af8aab985167039d

Rose, E. H. (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.* San Francisco: California Public Utility Commission.

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

State of California. (n.d.). *Government Code Title 7 Division 1 Chapter 1.5 Article 4.* Retrieved 2023, from California Legislative Information: 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)*. Retrieved September 1, 2022, from https://www.labormarketinfo.edd.ca.gov/cgi/dataanalysis/areaselection.asp?tablename=industry

Statewide CASE Team. (2023a). *Meeting Resources - Feb 14 - Nonresidential, Multifamily, Single Family Envelope Utility-Sponsored Stakeholder Meeting.* Retrieved from title24stakeholders.com: https://title24stakeholders.com/event/nonresidential-multifamily-and-single-family-envelope-utility-sponsored-stakeholder-meeting/

Statewide CASE Team. (2023b). *Meeting Resources - May 22 - Nonresidential Envelope, Existing Buildings, and Multifamily Restructuring Utility-Sponsored Stakeholder Meeting.* Retrieved from https://title24stakeholders.com/event/nonresidential-multifamily-and-single-family-envelope-utility-sponsored-stakeholder-meeting/: https://title24stakeholders.com/event/nonresidential-envelope-existing-buildings-and-multifamily-restructuring-utility-sponsored-stakeholder-meeting/

Statewide CASE Team. (2023c). *Notes - Feb 14 - Nonresidential, Multifamily, Single Family Envelope Utility-Sponsored Stakeholder Meeting.* Retrieved from https://title24stakeholders.com/event/nonresidential-multifamily-and-single-family-envelope-utility-sponsored-stakeholder-meeting/: https://title24stakeholders.com/wp-content/uploads/2023/04/Updated_Meeting-Notes-Group-F-2.14.2023_ENVELOPE_T24_Utility-Sponsored-StakeholderMeeting.pdf

Statewide CASE Team. (2023d). *Notes - May 22 - Nonresidential Envelope, Existing Buildings, and Multifamily Restructuring Utility-Sponsored Stakeholder Meeting.* Retrieved from title24stakeholders.com: https://title24stakeholders.com/wp-

content/uploads/2023/06/May-22_R2-Mtg-Notes_NR-ENV_ExistBldgs_MFrestructuring-1.pdf

Stone, N., Nickelsburg, J., & Yu, W. (2015). *Codes and Standards White Paper: Report - New Home Cost v. Price Study.* Pacific Gas and Electric Company. Retrieved February 2, 2017, from 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

Stone, N., Nickelsburg, J., & Yu, W. (2018, March). *New Home Cost v. Price Study.* Retrieved from https://acrobat.adobe.com/id/urn:aaid:sc:US:3f17d871-94bb-4226-be4e-ea215ebadb70

Tessum, C. W., Apte, J. S., Goodkind, A. L., Muller, N. Z., Mullins, K. A., Paolella, D. A., . . . HIll, J. D. (2019, March 11). Inequity in consumption of goods and services adds to racial–ethnic disparities in air pollution exposure. *PNSA, 113*(13). Retrieved from 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, C., Chong, H., & Fowler, A. (2016). *California Green Innovation Index - 8th Edition.* Next 10.

U.S. BUREAU OF LABOR STATISTICS. (2023, January 25). *U.S. Bureau of Labor Statistics*. Retrieved 2023, from 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.* Retrieved from http://factfinder2.census.gov/bkmk/table/1.0/en/PEP/2014/PEPANNRES/0400000US06.05000

U.S. Department of Energy. (n.d.). *Better Buildings*. Retrieved August 24, 2023, from Building Envelope: https://betterbuildingssolutioncenter.energy.gov/alliance/technology-solution/building-envelope

U.S. EPA (United States Environmental Protection Agency). (2011). *Emission Factors for Greenhouse Gas Inventories.* Retrieved December 2, 2013, from 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*. Retrieved September 12, 2022, from 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.* Retrieved from 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.* Retrieved from 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, C., & Chapple, K. (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. Retrieved February 3, 2017, from 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. The CEC provided the construction estimates on March 27, 2023, at the Staff Workshop on Triennial California Energy Code Measure Proposal Template (California Energy Commission, n.d.).

The CEC Building Standards Branch provided the nonresidential construction forecast, which is available for public review on the CEC's website.

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 and included in the analysis for this report are summarized in Table 100 (nonresidential new construction forecast) and Table 101 (nonresidential existing statewide building stock). The proposed changes would impact all building types.

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 projected nonresidential new construction that would be impacted by the proposed code changes in 2026, as well as the existing statewide building stock that would be impacted by the proposed code change as a result of alterations, are presented in Table 103 through Table 127. This section describes how the Statewide CASE Team developed these estimates.

The Statewide CASE Team made assumptions about the percentage of newly constructed floorspace that would be impacted by the proposed code change. The assumed percentage of floorspace that would be impacted by the proposed code change by building type is presented Table 105 through Table 127. 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.

A.1 CEC Construction Forecast and Statewide Nonresidential New Construction Building Types

Table 100: 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	0.6	3.6	20.8	11.5	1.7	16.2	9.1	19.7	27.4	12.1	3.0	16.2	5.3	3.0	1.9	1.0	152.9

Source: CEC Measure Proposal Template https://www.energy.ca.gov/media/3538

Table 101: Estimated Existing 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	0.13	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	1033.49
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	644.04
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	228.13
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	435.64
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	535.21
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	462.38
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	0.76	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	396.23
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	313.04
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	1167.60
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	375.50
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	718.16
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	400.51
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	165.74
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	191.78
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	261.32
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	473.23
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	40.15
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	11.15
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	40.21
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	392.01
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	742.28
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	62.89
TOTAL	34.7	205.1	999.3	583.9	95.5	757.8	547.1	1140.0	1761.4	974.3	191.2	990.7	370.2	230.6	130.7	78.5	9090.7

Table 102: Statewide Nonresidential New Construction Building Types

Forecast Building Types	Uses	Number of Stories	Floor Area (ft2)
Assembly	Gatherings including, but not limited to: Arenas, Coliseums, Auditoriums, Transportation Terminals, Clubs and Lodges, Exhibition Halls, Funeral or Internment Facilities, Religious Buildings, Libraries, Museums, Theaters, Recreational and Exercise Facilities.	Any	Any
Controlled-environment Horticulture	Buildings with indoor conditioned spaces used for agriculture.	Any	Any
Hospital	Hospitals, Clinics, and Nursing Convalescent Facilities	Any	Any
Hotel	Hotels and Motels	Any	Any
Laboratory	Laboratories	Any	Any
Large Office	Offices, Banks and Financial Institutions, Government Services Buildings, Post Offices	≥ 5	Any
Medium Office	Offices, Banks and Financial Institutions, Government Services Buildings, Post Offices	4-Feb	Any
Small Office	Offices, Banks and Financial Institutions, Government Services Buildings, Post Offices	1	Any
Restaurant	Food and/or Beverage Service	Any	Any
Large Retail	Stores and Other Mercantile Buildings	Any	≥ 50k
Medium Retail	Stores and Other Mercantile Buildings	Any	< 50k
Grocery	Stores and Other Mercantile Buildings used for the sale of food items	Any	Any
Strip Mall Retail	Shopping Centers	Any	Any
Large School	Schools and Educational Facilities	Any	≥ 50k
Small School	Schools and Educational Facilities	Any	< 50k
Warehouse	Warehouses and Freight Terminals	Any	Any
Refrigerated Warehouse	Refrigerated Warehouses	Any	Any
Vehicle Service	Auto, Aircraft, Bus, Truck, Railroad, Boat, or any other Vehicle Servicing Facility	Any	Any
Manufacturing	Manufacturing Facilities	Any	Any
Enclosed Parking Garage	Parking Garages enclosed by walls and a roof with rooftop parking.	Any	Any
Open Parking Garage	Parking Garages that are open to the ambient environment. Parking lots with canopies are not considered Parking Garages.	Any	Any
Miscellaneous	Miscellaneous Non-Residential Buildings.	Any	Any

A.2 Opaque Assemblies

A.2.1 Prescriptive Wood Framed Roof and Other Roof

Table 103: Estimated New Nonresidential Construction Impacted by Proposed Code Change in 2026 Measured by Floorspace (million square feet), by Climate Zone (CZ)and Building Type

Building Prototype	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	0.01	0.07	0.43	0.22	0.04	0.27	0.14	0.39	0.60	0.27	0.13	0.57	0.16	0.07	0.07	0.03	3.49
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
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	0.5	3.1	14.8	7.6	1.5	8.9	6.6	12.7	21.3	10.3	2.5	13.3	4.6	2.5	1.5	0.8	112.6

Table 104 : Percent of New Construction and/or Additions Impacted by Proposed Measure, by Climate Zone (Nonresidential)

Climate Zone	New Construction & Additions
1	68%
2	62%
3	48%
4	43%
5	63%
6	39%
7	50%
8	46%
9	56%
10	59%
11	52%
12	60%
13	60%
14	60%
15	63%
16	53%

Table 105: Percentage of Nonresidential Floorspace Impacted by Proposed Wood Roof Assemblies Code Change in 2026, by Building Type – New Construction

Building Type	New Construction Impacted (Percent Square Footage)
Large Office	100%
Medium Office	100%
Small Office	100%
Large Retail	100%
Medium Retail	100%
Strip Mall	100%
Mixed-use Retail	100%
Large School	100%
Small School	100%
Non-refrigerated Warehouse	20%
Hotel	100%
Assembly	100%
Hospital	100%
Laboratory	100%
Restaurant	100%
Grocery	100%
Refrigerated Warehouse	100%
Controlled-environment Horticulture	100%
Vehicle Service	100%
Manufacturing	100%
Unassigned	100%

A.2.2 Prescriptive Metal Building Roof

Table 106: Estimated New Nonresidential Construction Impacted by Proposed Code Change in 2026 Measured by Floorspace (million square feet), by Climate Zone (CZ) and Building Type

Building Prototype	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
Medium Retail	0.02	0.07	0.16	0.09	0.02	0.12	0.06	0.17	0.28	0.16	0.03	0.13	0.08	0.04	0.02	0.02	1.46
Non-refrigerated Warehouse	0.05	0.29	1.73	0.89	0.14	1.09	0.57	1.56	2.41	1.09	0.51	2.28	0.66	0.29	0.29	0.11	13.95
TOTAL	0.1	0.4	1.9	1.0	0.2	1.2	0.6	1.7	2.7	1.3	0.5	2.4	0.7	0.3	0.3	0.1	15.4

Table 107: Percent of New Construction and/or Additions Impacted by Proposed Measure, by Climate Zone (Nonresidential)

Climate Zone	New Construction & Additions
1	12%
2	10%
3	9%
4	9%
5	9%
6	7%
7	7%
8	9%
9	10%
10	10%
11	18%
12	15%
13	14%
14	11%
15	17%
16	12%

Table 108: Percentage of Nonresidential Floorspace Impacted by Proposed Metal Building Roof Assemblies Code Change in 2026, by Building Type – New Construction

Building Type	New Construction Impacted (percent square footage)
Non-refrigerated Warehouse	80%
Medium Retail	20%

A.2.3 Prescriptive Metal Building Walls

Table 109: Estimated New Nonresidential Construction Impacted by Proposed Code Change in 2026 Measured in Floorspace (million square feet), by Climate Zone and Building Type

Building Prototype	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
Non-refrigerated Warehouse	0.04	0.26	1.51	0.78	0.12	0.95	0.50	1.36	2.11	0.95	0.44	1.99	0.57	0.25	0.26	0.10	12.21
TOTAL	0.0	0.3	1.5	0.8	0.1	1.0	0.5	1.4	2.1	1.0	0.4	2.0	0.6	0.3	0.3	0.1	12.2

Table 110: Percent of New Construction and/or Additions Impacted by Proposed Measure, by Climate Zone (Nonresidential)

Climate Zone	Percent of Square Footage Impacted
1	8%
2	7%
3	7%
4	7%
5	7%
6	6%
7	5%
8	7%
9	8%
10	8%
11	15%
12	12%
13	11%
14	9%
15	14%
16	9%

Table 111: Percentage of Nonresidential Floorspace Impacted by Proposed Metal Building Walls Assemblies Code Change in 2026, by Building Type – New Construction

Building Type	New Construction Impacted (percent square footage)
Non-refrigerated Warehouse	70%

A.2.4 Prescriptive Light Mass Walls

Table 112: Estimated New Nonresidential Construction Impacted by Proposed Code Change in 2026 Measured in Floorspace (million square feet), by Climate Zone and Building Type

Building Prototype	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	0.58	0.28	0.00	0.26	0.15	0.41	0.74	0.07	0.02	0.10	0.00	0.04	0.00	0.01	2.66
Medium Office	0.03	0.10	0.27	0.15	0.07	0.24	0.16	0.33	0.64	0.23	0.05	0.56	0.12	0.07	0.05	0.02	3.09
Small Office	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 Retail	0.00	0.00	0.22	0.11	0.03	0.14	0.07	0.17	0.33	0.13	0.06	0.26	0.07	0.03	0.04	0.01	1.67
Medium Retail	0.02	0.07	0.16	0.09	0.02	0.12	0.06	0.17	0.28	0.16	0.03	0.13	0.08	0.04	0.02	0.02	1.46
Non-refrigerated Warehouse	0.02	0.15	0.86	0.45	0.07	0.55	0.28	0.78	1.20	0.54	0.25	1.14	0.33	0.14	0.15	0.06	6.98
Hospital	0.00	0.02	0.08	0.04	0.01	0.03	0.05	0.04	0.08	0.08	0.01	0.08	0.03	0.01	0.01	0.00	0.58
TOTAL	0.1	0.3	2.2	1.1	0.2	1.3	0.8	1.9	3.3	1.2	0.4	2.3	0.6	0.3	0.3	0.1	16.4

Table 113: Percent of New Construction and/or Additions Impacted by Proposed Measure, by Climate Zone (Nonresidential)

Climate Zone	Percent of Square Footage Impacted
1	10%
2	7%
3	9%
4	8%
5	9%
6	7%
7	7%
8	8%
9	10%
10	8%
11	11%
12	12%
13	9%
14	9%
15	11%
16	9%

Table 114: Percentage of Nonresidential Floorspace Impacted by Proposed Light Mass Walls Assemblies Code Change in 2026, by Building Type – New Construction

Building Type	New Construction Impacted (percent square footage)
Large Office	20%
Medium Office	20%
Large Retail	20%
Medium Retail	20%
Non-Refrigerated Warehouse	40%
Hospital	10%

A.2.5 Prescriptive Heavy Mass Walls

Table 115: Estimated New Nonresidential Construction Impacted by Proposed Code Change in 2026 Measured by Floorspace (million square feet), by Climate Zone and Building Type

Building Prototype	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	0.15	0.07	0.00	0.06	0.04	0.10	0.19	0.02	0.00	0.03	0.00	0.01	0.00	0.00	0.67
Large Retail	0.00	0.00	0.55	0.27	0.07	0.35	0.19	0.42	0.83	0.32	0.15	0.65	0.18	0.07	0.09	0.03	4.17
Medium Retail	0.01	0.03	0.08	0.04	0.01	0.06	0.03	0.09	0.14	0.08	0.01	0.06	0.04	0.02	0.01	0.01	0.73
Hospital	0.00	0.03	0.12	0.06	0.01	0.05	0.08	0.06	0.11	0.12	0.02	0.12	0.04	0.02	0.02	0.01	0.87
TOTAL	0.0	0.1	0.9	0.5	0.1	0.5	0.3	0.7	1.3	0.5	0.2	0.9	0.3	0.1	0.1	0.0	6.4

Table 116: Percent of New Construction and/or Additions Impacted by Proposed Measure, by Climate Zone (Nonresidential)

Climate Zone	Percent of Square Footage Impacted
1	2%
2	2%
3	4%
4	4%
5	6%
6	3%
7	4%
8	3%
9	5%
10	4%
11	6%
12	5%
13	5%
14	4%
15	6%
16	4%

Table 117: Percentage of Nonresidential Floorspace Impacted by Proposed Heavy Mass Walls Assemblies Code Change in 2026, by Building Type – New Construction

Building Type	New Construction Impacted (percent square footage)
Large Office	5%
Large Retail	50%
Medium Retail	10%
Hospital	15%

A.2.6 Prescriptive Wood-Framed and Other Walls

Table 118: Estimated New Nonresidential Construction Impacted by Proposed Code Change in 2026 Measured by Floorspace (million square feet), by Climate Zone and Building Type

Building Prototype	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
Medium Office	0.03	0.10	0.27	0.15	0.07	0.24	0.16	0.33	0.64	0.23	0.05	0.56	0.12	0.07	0.05	0.02	3.09
Small Office	0.01	0.35	0.15	0.02	0.05	0.12	0.19	0.13	0.29	0.33	0.07	0.43	0.31	0.03	0.08	0.03	2.57
Strip Mall	0.00	0.08	0.25	0.11	0.00	0.28	0.24	0.49	0.53	0.67	0.04	0.30	0.16	0.16	0.05	0.03	3.40
Small School	0.03	0.13	0.23	0.11	0.07	0.16	0.15	0.18	0.33	0.17	0.05	0.39	0.15	0.05	0.02	0.02	2.25
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
TOTAL	0.1	0.7	1.2	0.6	0.2	1.1	0.9	1.6	2.6	1.8	0.3	2.0	0.9	0.4	0.3	0.1	14.9

Table 119: Percent of New Construction and/or Additions Impacted by Proposed Measure, by Climate Zone (Nonresidential)

Climate Zone	Percent of Square Footage Impacted
1	15%
2	21%
3	6%
4	5%
5	14%
6	7%
7	10%
8	8%
9	10%
10	15%
11	9%
12	12%
13	17%
14	14%
15	13%
16	13%

Table 120: Percentage of Nonresidential Floorspace Impacted by Proposed Wood-framed and Other Walls Assemblies Code Change in 2026, by Building Type – New Construction

Building Type	New Construction Impacted (percent square footage)
Medium Office	20%
Small Office	80%
Strip Mall	50%
Small School	50%
Restaurant	100%

A.3 Vestibules

Table 121: Estimated New Nonresidential Construction Impacted by Proposed Code Change in 2026 Measured by Floorspace (million square feet), by Climate Zone and Building Type

Building Prototype	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	2.91	1.42	0.00	1.28	0.74	2.06	3.74	0.35	0.10	0.52	0.00	0.18	0.01	0.04	13.35
Medium Office	0.02	0.07	0.21	0.11	0.06	0.18	0.12	0.25	0.48	0.18	0.04	0.42	0.09	0.05	0.04	0.02	2.32
Large Retail	0.00	0.00	1.04	0.52	0.14	0.66	0.36	0.79	1.58	0.60	0.28	1.24	0.34	0.14	0.17	0.05	7.92
Medium Retail	0.05	0.21	0.48	0.27	0.05	0.36	0.17	0.52	0.85	0.49	0.09	0.38	0.23	0.11	0.07	0.05	4.37
Small School	0.01	0.03	0.05	0.02	0.01	0.03	0.03	0.04	0.07	0.03	0.01	0.08	0.03	0.01	0.00	0.00	0.45
TOTAL	0.1	0.3	4.7	2.3	0.3	2.5	1.4	3.6	6.7	1.7	0.5	2.6	0.7	0.5	0.3	0.2	28.4

Table 122: Percent of New Construction and/or Additions Impacted by Proposed Measure, by Climate Zone (Nonresidential)

Climate Zone	Percent of Square Footage Impacted
1	14%
2	9%
3	22%
4	20%
5	15%
6	16%
7	16%
8	19%
9	25%
10	14%
11	17%
12	16%
13	13%
14	16%
15	16%
16	16%

Table 123: Percentage of Nonresidential Floorspace Impacted by Proposed Vestibules Code Change in 2026, by Building Type – New Construction

Building Type	New Construction Impacted (percent square footage)
Large Office	90%
Medium Office	15%
Large Retail	95%
Medium Retail	60%
Small School	10%

A.4 Windows

Table 124: Estimated New Nonresidential Construction Impacted by Proposed Code Change in 2026 Measured in Floorspace (million square feet), by Climate Zone and Building Type

Building Prototype	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	0.36	0.18	0.00	0.16	0.09	0.26	0.47	0.04	0.01	0.06	0.00	0.02	0.00	0.01	1.66
Medium Office	0.02	0.06	0.17	0.09	0.05	0.15	0.10	0.21	0.40	0.15	0.03	0.35	0.07	0.04	0.03	0.01	1.93
Small Office	0.00	0.05	0.02	0.00	0.01	0.02	0.03	0.02	0.04	0.05	0.01	0.07	0.05	0.01	0.01	0.00	0.40
Large Retail	0.00	0.00	0.14	0.07	0.02	0.09	0.05	0.10	0.21	0.08	0.04	0.16	0.04	0.02	0.02	0.01	1.04
Medium Retail	0.01	0.04	0.10	0.06	0.01	0.08	0.04	0.11	0.18	0.10	0.02	0.08	0.05	0.02	0.02	0.01	0.91
Strip Mall	0.00	0.02	0.06	0.03	0.00	0.07	0.06	0.12	0.13	0.17	0.01	0.07	0.04	0.04	0.01	0.01	0.85
Small School	0.01	0.03	0.06	0.03	0.02	0.04	0.04	0.04	0.08	0.04	0.01	0.10	0.04	0.01	0.00	0.01	0.56
Laboratory	0.00	0.02	0.16	0.09	0.01	0.05	0.03	0.06	0.11	0.04	0.02	0.05	0.01	0.01	0.00	0.00	0.68
Restaurant	0.00	0.01	0.04	0.02	0.00	0.04	0.03	0.06	0.10	0.05	0.01	0.04	0.02	0.01	0.01	0.00	0.45
TOTAL	0.0	0.2	1.1	0.6	0.1	0.7	0.5	1.0	1.7	0.7	0.2	1.0	0.3	0.2	0.1	0.1	8.5

Table 125: Estimated Nonresidential Alterations Impacted by Proposed Code Change in 2026 Measured in Floorspace (million square feet), by Climate Zone and Building Type

Building Prototype	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	0.05	2.10	1.09	0.03	1.49	1.09	2.44	4.55	0.88	0.04	1.18	0.14	0.30	0.07	0.07	15.50
Medium Office	0.05	0.46	1.18	0.63	0.20	0.72	0.66	0.89	1.30	1.00	0.25	1.53	0.38	0.20	0.15	0.06	9.66
Small Office	0.06	0.19	0.33	0.17	0.11	0.20	0.13	0.20	0.31	0.37	0.16	0.66	0.32	0.07	0.09	0.04	3.42
Large Retail	0.02	0.13	0.88	0.40	0.06	0.48	0.38	0.65	1.00	0.80	0.17	0.87	0.34	0.16	0.14	0.05	6.53
Medium Retail	0.02	0.20	0.67	0.39	0.08	0.66	0.52	1.00	1.62	1.00	0.16	0.91	0.36	0.23	0.13	0.08	8.03
Strip Mall	0.05	0.15	0.56	0.28	0.08	0.60	0.42	0.84	1.26	1.00	0.18	0.73	0.36	0.23	0.13	0.07	6.94
Small School	0.03	0.17	0.38	0.15	0.09	0.39	0.22	0.52	0.81	0.50	0.20	0.63	0.35	0.13	0.06	0.05	4.70
Laboratory	0.00	0.06	0.55	0.42	0.02	0.18	0.26	0.23	0.29	0.16	0.01	0.18	0.07	0.03	0.01	0.01	2.49
Restaurant	0.01	0.05	0.22	0.11	0.02	0.25	0.16	0.36	0.60	0.49	0.05	0.25	0.12	0.10	0.05	0.03	2.88
TOTAL	0.2	1.5	6.9	3.6	0.7	5.0	3.8	7.1	11.7	6.2	1.2	6.9	2.4	1.5	0.8	0.5	60.1

Table 126: Percent Square Footage of Nonresidential New Construction and/or Additions Impacted by Proposed Measure, by Climate Zone

Climate Zone	New Construction & Additions	Existing Building Stock (Alterations)
1	7%	1%
2	7%	1%
3	5%	1%
4	5%	1%
5	7%	1%
6	4%	1%
7	5%	1%
8	5%	1%
9	6%	1%
10	6%	1%
11	5%	1%
12	6%	1%
13	6%	1%
14	6%	1%
15	6%	1%
16	6%	1%

Table 127: Percent Square Footage of Nonresidential New Construction and Additions/Alterations Impacted by Proposed Windows Code Change in 2026, by Building Type

Building Type	New Construction Impacted (percent square footage)	Alterations Impacted (percent square footage)
Large Office	12.5%	1.5%
Medium Office	12.5%	1.5%
Small Office	12.5%	1.5%
Large Retail	12.5%	1.5%
Medium Retail	12.5%	1.5%
Strip Mall	12.5%	1.5%
Mixed-use Retail	12.5%	1.5%
Small School	12.5%	1.5%
Laboratory	12.5%	1.5%
Restaurant	12.5%	1.5%

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

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. The Statewide CASE Team will include software specifications in the Final CASE Report.

Technical Basis for Software Change

As described in Section 4.1.1, the proposed code change would increase the prescriptive efficiency required for envelope assembly's dependent on climate zones except for metal-framed wall. This is an envelope thermal performance improvement from the current requirement.

Description of Software Change

Background Information for Software Change

The Statewide CASE Team recommends that the prescriptive baseline value in the ACM Reference Manual Standard Design be updated from the current value to the proposed values for each assembly dependent on climate zone. This change would reflect the update recommended to the prescriptive standards in Section 5.5.

Existing CBECC Building Energy Modeling Capabilities

The 2022 Nonresidential ACM Reference Manual Section 5.5.3 currently specifies that the Standard Design roof (wood-framed roof assembly).

Nonresidential Buildings: Continuous Insulation

- Climate Zones 2, 3, 4, 9-16
  - R - 28.63 (U-0.034)
- Climate Zones 1, 5
  - R - 28.63 (U-0.034)
- Climate Zones 7, 8
  - R - 19.62 (U-0.049)
- Climate Zones 6
  - R - 19.62 (U-0.049)

Summary of Proposed Revisions to CBECC

Section 5.5.3 of the Nonresidential ACM Reference Manual should be updated as specified below

- Climate Zones 1-5, 9-16
    - R – 35.78 (U-0.028)
- Climate Zones 6,7, 8
    - R – 21.34 (U-0.047)

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

Opaque Assemblies

There are significant energy savings and GHG emission reductions from this proposal due to tighter envelope requirements so less air leakage and thermal exchange occurs. There are no water savings associated with this proposal. For more information on the energy savings, see Section 4.4.1. For more information on the GHG emission reductions, see Section 4.4.2. There are no identified direct adverse environmental impacts from this code change proposal.

Vestibules

There are significant energy savings and GHG emission reductions from this proposal due to less air leakage and thermal exchange occurs as a result of the required vestibules. There are no water savings associated with this proposal. For more information on the energy savings, see Section 5.4.1. For more information on the GHG emission reductions, see Section 5.4.2. There are no identified direct adverse environmental impacts from this code change proposal.

Windows/ Fenestration

There are significant energy savings and GHG emission reductions from this proposal as a result of mandatory U-factor for vertical fenestration. These requirements ensure less thermal energy is exchanged through windows which increases the heating and cooling efficiency within spaces. There are no water savings associated with this proposal. For more information on the energy savings, see Section 6.4.1. For more

information on the GHG emission reductions, see Section 6.4.2. There are no identified direct adverse environmental impacts from this code change proposal.

Indirect Environmental Impacts

Opaque Assemblies

The proposed code change is likely to lead to increased embodied carbon emissions from the likely increase in the usage of insulation to meet updated R-values and U-factors. For more information on the material impacts see Section 4.4.4.

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

Vestibules

The proposed code change is likely to lead to increased embodied carbon emissions from the increase in the usage of construction materials to build vestibules. These materials typically include aluminum and glass. For more information on the material impacts see Section 5.4.4.

The Statewide CASE Team has determined that the operational emissions reductions from this proposal would outweigh the increase in embodied carbon emissions. The Statewide CASE Team plans to revisit this calculation for the Final CASE Report. There are no identified indirect environmental benefits from this code change proposal.

Windows/ Fenestration

There are no identified indirect adverse environmental impacts nor indirect environmental benefits from this code change proposal.

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 whether 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 Environmental Impact Report (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 early stages of materials production and manufacturing instead of emissions reductions from energy efficiency alone.

The Statewide CASE Team calculated emissions impacts associated with embodied carbon from the change in materials as a result of the proposed measures. The calculation builds off the materials impacts outlined in 4.4.4, and 6.4.4. See these sections for more details on the materials 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).[36, 37] These industry-

[36] 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.

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

wide EPDs provide global warming potential (GWP) values per weight of specific materials.[38] The Statewide CASE Team chose the industry-wide average for GWP values in the EPDs because the materials accounted for in the statewide calculation will 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 will not specify low embodied carbon products. Therefore, an average is appropriate for a statewide estimate.

First-year statewide impacts per material (in pounds) were multiplied by the GWP impacts for each material. This provides the total statewide embodied carbon impact for each material. If a material's use is increased, then there is an increase in embodied carbon impacts (additional emissions). Table 128 presents estimated first-year GHG emissions impacts associated with 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 carbon but enable the building as a whole to have lower total emissions (operational plus building-wide embodied carbon).

The results show an increase in emissions as a result of embodied carbon. Within nine years, the emissions reductions from increased efficiency surpass the emissions related to embodied carbon.

Table 128: Statewide Embodied Carbon Impacts from First-year Construction

Proposal	Material	Impact	First-Year Statewide Impacts (Pounds)	Statewide Embodied GHG Emissions Reductions (Metric Tons CO2e)
Opaque Assemblies	Not calculated	Not calculated	Not calculated	Not calculated
Vestibules	Glass	Increase	727,883	-472
	Aluminum Frame	Increase	21,162	-92
Windows	Not calculated	Not calculated	Not calculated	Not calculated
All	**TOTAL**	**-**	**-**	**-564**

[38] 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.

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

This appendix discusses how the recommended compliance process, which is described in Sections 4.1.5, 4.1.5, and 5.1.5, could impact various market actors. Table 129 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. 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 129: 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
Owners / Tenants	Understand options and negotiate design, materials and orientation.	Provide direction to Architects & design team	Owners would have to account for cost differences of the new material based on changed code for time and materials.	Include in-depth cost effectiveness of each measure in CASE Report.
Architects/ Architectural Designers	• Select the design of the building envelope including opaque and transparent assemblies • Coordinate with design engineers and select the envelope materials based on the required thermal values per codes • Discuss with the market actors (i.e., suppliers, contractors, manufacturers and specifiers) and the owners from the cost/budget perspective and establish the final selection of materials and design. • Complete compliance documentation or use energy consultant to complete the compliance report • Review submittals during construction • Coordinate with Building Inspectors, Commissioning agent, ATT or authorities for necessary steps in completion of the project	• There would be a change of the selection of the materials process based on the cost of the products • With the current supply chain issues, narrowing the available selection of materials might encourage the alternative compliance pathways (such as tailored or performance) bypassing using the required materials. • Provide plans to building owners. • Show compliance on the building plans.	• Building Energy Modeling software would need to be updated to include proposed U-factors • NRCC- ENV-E form would need to be updated with new vestibule requirement and updated U-factors.	• Information about the updated values would create enough awareness; not much extra training is required. • Software update notice with the newer required values would be enough for the designers' awareness. • Proposed documentation methodology uses materials already produced as part of the design/construction process. No additional documentation necessary just updates to existing.
HVAC Designer & Energy Consultants	• Following Architectural designers' recommendations on the product/material selection, find the most optimum system design based on the energy & cost performance • Possibly find the alternate routes for compliance based on the feedback from the previous step. • Coordinate with Building Inspectors, Commissioning agent, ATT or authorities for necessary steps in completion of the project	N/A	Same as above like Architectural Designers	N/A

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
Plans Examiner	Read drawings and confirm compliance with forms and standards.	Review compliance documents and be able to quickly verify that the plans meet requirements.	Verify in plans and NRCC that the new requirements were properly designed.	Clear code language and compliance documents
CEC	N/A	N/A	N/A	N/A
Plumbing Designer	N/A	N/A	N/A	N/A
Electrical Designer	N/A	N/A	N/A	N/A
Commissioning Agent	N/A	N/A	N/A	N/A
Building Inspector	Conduct site visits to verify code compliance and proper installation of approved plans.	• Coordinate with general contractor to conduct visits. • For Opaque and fenestration U-factors: Confirm the u values meet the proposed Title 24, Part 6 Standards.	No changes to workflow.	Clear and easy to understand code language and compliance documents.
ATT	N/A	N/A	N/A	N/A
Manufacturers	Design and build envelope materials and components	Manufacture envelope components that are up to code.	Provide cut sheets of products that meet the new code requirements.	Easy to understand code language and compliance documents.
General Contractors	• Adhere to current Title 24, Part 6 requirements. • • Constructing building in accordance with building plans. • High Performance Windows: Coordinate installation of windows that meet requirements, which in some cases includes heavier windows. • Verify NFRC certification and window performance factor adherence to code	• Follow requirements in Title 24, Part 6 to meet compliance. • Ensure the quick and efficient completion of compliance documents. • Coordinate a quick and efficient building	Coordinate with the architect and subcontractors to ensure the new requirements are being built to code.	Make simple and easy to understand code language and compliance documents.

Appendix F: Summary of Stakeholder Engagement

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

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

Utility-Sponsored Stakeholder Meetings

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

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

The Statewide CASE Team hosted two stakeholder meetings for Nonresidential Envelope measures via webinar described in Table 130. 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.[39] [40]

[39] (Statewide CASE Team 2023a)

[40] (Statewide CASE Team 2023b)

Table 130: Utility-Sponsored Stakeholder Meetings

Meeting Name	Meeting Date	Event Page from Title24stakeholders.com
First Round of Nonresidential Envelope Utility-Sponsored Stakeholder Meeting	Tuesday, February 14, 2023	https://title24stakeholders.com/event/nonresidential-multifamily-and-single-family-envelope-utility-sponsored-stakeholder-meeting/
Second Round of Nonresidential Envelope Utility-Sponsored Stakeholder Meeting	Monday, May 22, 2023	https://title24stakeholders.com/event/nonresidential-envelope-existing-buildings-and-multifamily-restructuring-utility-sponsored-stakeholder-meeting/

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

The second round of utility-sponsored stakeholder meetings occurred in May 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 131.

Table 131: Engaged Stakeholders

Organization/Individual Name	Market Role
Birch Point Consulting/Tom Culp	Manufacturer's representative
AIA California/Mike Malinowski	Architects
Jeff Mang	Manufacturer's representative
Gabel Energy	Consultant
NRDC	Consultant
Responsible Energy Code Alliance	Advocate
WDMA	Manufacturer's representative
McHugh Energy	Consultant
Owens Corning	Manufacturer
American Chemistry Council	Manufacturer's representative
Covestro	Manufacturer
NAIMA	Manufacturer's representative
Oldcastle Building Envelope/ Ben West	Manufacturer
Bear Insulation/Seth Duty	Manufacturer/Contractor
Starline/Amber Mengede	Manufacturer
Gensler/Kirsten Ritchie, Robert Garlipp	Architects, Engineers
Sika/Steve Dubin	Manufacturer
Alcal Specialty Contracting/George Thym	Manufacturer's representative/Wholesaler
Alpen/Brad Begin	Manufacturer

Appendix G: Energy Cost Savings in Nominal Dollars

G.1 Opaque Assemblies

G.1.1 Prescriptive Wood Framed and Other Roof

Table 132: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – Hospital Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	-0.05	0.21	0.16
2	0.00	0.20	0.20
3	-0.01	0.15	0.13
4	0.02	0.20	0.22
5	0.00	0.17	0.16
6	0.00	0.03	0.03
7	0.00	0.03	0.03
8	0.02	0.04	0.06
9	0.02	0.14	0.16
10	0.03	0.14	0.17
11	0.03	0.17	0.20
12	0.03	0.18	0.21
13	0.04	0.16	0.20
14	0.03	0.18	0.21
15	0.08	0.12	0.19
16	-0.04	0.23	0.19

Table 133: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – RetailLarge Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	N/A*	N/A*	N/A*
2	N/A*	N/A*	N/A*
3	0.55	0.00	0.55
4	0.55	0.00	0.55
5	0.40	0.00	0.40
6	0.03	0.00	0.03
7	-0.01	0.00	-0.01
8	0.33	0.00	0.33
9	0.48	0.00	0.48
10	0.57	0.00	0.57
11	0.40	0.00	0.40
12	0.66	0.00	0.66
13	0.75	0.00	0.75
14	0.70	0.00	0.70
15	0.63	0.00	0.63
16	0.28	1.02	1.30

*The CEC forecasts no impact for this climate zone and prototype. For further details on the CEC's construction forecast, refer to Appendix A.1.

Table 134: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – OfficeMedium Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	0.03	0.23	0.27
2	0.02	0.18	0.20
3	0.02	0.16	0.18
4	0.04	0.15	0.19
5	-0.05	-0.08	-0.13
6	0.00	-0.03	-0.03
7	-0.05	-0.22	-0.27
8	0.06	0.17	0.23
9	0.03	0.09	0.12
10	0.04	0.10	0.14
11	0.05	0.13	0.18
12	0.05	0.17	0.22
13	0.08	0.10	0.18
14	0.09	0.16	0.24
15	0.14	0.09	0.23
16	0.04	0.25	0.28

Table 135: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – Non-refrigerated Warehouse Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	0.24	0.76	1.00
2	0.19	0.59	0.78
3	0.14	0.41	0.54
4	0.21	0.50	0.70
5	0.08	0.44	0.53
6	0.02	0.07	0.09
7	-0.03	0.07	0.04
8	0.01	0.09	0.10
9	0.01	0.34	0.35
10	0.04	0.30	0.34
11	0.19	0.51	0.71
12	0.17	0.54	0.71
13	0.17	0.43	0.60
14	0.26	0.49	0.76
15	0.06	0.19	0.24
16	0.30	0.94	1.23

Table 136: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – SchoolSmall Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	0.50	0.34	0.84
2	0.63	0.00	0.63
3	0.44	0.00	0.44
4	0.56	0.00	0.56
5	0.38	0.00	0.38
6	0.04	0.00	0.04
7	0.04	0.00	0.04
8	0.03	0.00	0.03
9	0.22	0.00	0.22
10	0.21	0.00	0.21
11	0.76	0.00	0.76
12	0.58	0.00	0.58
13	0.64	0.00	0.64
14	0.80	0.00	0.80
15	0.31	0.00	0.31
16	0.40	0.77	1.17

Table 137: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – StripMall Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	0.19	0.74	0.93
2	0.66	0.00	0.66
3	0.33	0.00	0.33
4	0.52	0.00	0.52
5	0.43	0.00	0.43
6	0.03	0.00	0.03
7	0.01	0.00	0.01
8	0.09	0.00	0.09
9	0.46	0.00	0.46
10	0.30	0.00	0.30
11	0.75	0.00	0.75
12	0.48	0.00	0.48
13	0.61	0.00	0.61
14	0.84	0.00	0.84
15	0.27	0.00	0.27
16	0.19	1.04	1.24

G.1.2 Prescriptive Metal Building Roof

Table 138: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – RetailMedium Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	0.14	0.23	0.37
2	0.39	0.00	0.39
3	0.22	0.00	0.22
4	0.30	0.00	0.30
5	0.13	0.00	0.13
6	-0.07	0.00	-0.07
7	0.14	0.00	0.14
8	0.82	0.00	0.82
9	0.02	0.00	0.02
10	-0.19	0.00	-0.19
11	0.26	0.00	0.26
12	0.18	0.00	0.18
13	0.17	0.00	0.17
14	0.29	0.00	0.29
15	0.23	0.00	0.23
16	0.29	0.48	0.76

Table 139: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – Non-refrigerated Warehouse Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	0.12	0.36	0.47
2	0.11	0.28	0.39
3	0.09	0.20	0.28
4	0.08	0.23	0.31
5	0.05	0.23	0.28
6	0.05	0.12	0.17
7	0.03	0.11	0.15
8	-0.01	0.15	0.14
9	0.04	0.14	0.18
10	0.01	0.16	0.17
11	0.13	0.26	0.40
12	0.10	0.28	0.39
13	0.09	0.22	0.32
14	0.14	0.25	0.39
15	-0.02	0.09	0.07
16	0.26	0.43	0.69

G.1.3 Prescriptive Metal Building Walls

Table 140: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – Warehouse Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	0.27	0.71	0.98
2	0.10	0.31	0.40
3	0.17	0.48	0.65
4	0.13	0.27	0.40
5	0.05	0.22	0.28
6	0.05	0.19	0.24
7	-0.01	0.19	0.17
8	0.01	0.10	0.12
9	0.03	0.13	0.16
10	-0.01	0.15	0.14
11	0.10	0.29	0.39
12	0.09	0.28	0.37
13	0.12	0.24	0.36
14	0.21	0.25	0.46
15	0.02	0.07	0.09
16	0.22	0.52	0.74

G.1.4 Prescriptive Light Mass Walls

Table 141: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – OfficeLarge Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	N/A*	N/A*	N/A*
2	N/A*	N/A*	N/A*
3	0.02	0.36	0.39
4	0.08	0.27	0.35
5	N/A*	N/A*	N/A*
6	0.13	0.21	0.34
7	0.16	0.16	0.33
8	0.18	0.20	0.38
9	0.19	0.30	0.48
10	0.06	0.04	0.10
11	0.17	0.26	0.43
12	0.13	0.23	0.36
13	N/A*	N/A*	N/A*
14	0.12	0.25	0.37
15	0.27	0.07	0.35
16	0.09	0.43	0.53

*The CEC forecasts no impact for this climate zone and prototype. For further details on the CEC's construction forecast, refer to Appendix A.1.

Table 142: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – OfficeMedium Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	0.02	0.43	0.46
2	0.75	3.03	3.78
3	0.04	0.42	0.47
4	0.19	0.29	0.48
5	0.08	0.51	0.58
6	0.19	0.24	0.43
7	0.30	0.19	0.48
8	0.47	0.30	0.78
9	0.51	0.27	0.77
10	0.34	0.50	0.84
11	0.42	0.37	0.78
12	0.24	0.35	0.59
13	0.44	0.29	0.73
14	0.29	0.14	0.43
15	0.71	0.08	0.79
16	0.21	0.81	1.02

Table 143: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – Non-refrigerated Warehouse Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	0.26	0.74	1.00
2	0.24	0.72	0.95
3	0.30	0.80	1.10
4	0.22	0.60	0.82
5	0.27	0.87	1.14
6	0.14	0.34	0.48
7	0.16	0.28	0.43
8	0.26	0.39	0.65
9	0.31	0.52	0.82
10	0.15	0.28	0.43
11	0.48	0.78	1.26
12	0.27	0.68	0.96
13	0.45	0.59	1.04
14	0.42	0.70	1.13
15	0.43	0.15	0.59
16	0.46	1.43	1.89

G.1.5 Prescriptive Heavy Mass Walls

Table 144: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – Hospital Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	-0.04	0.81	0.77
2	0.12	0.76	0.88
3	0.04	0.66	0.70
4	0.35	0.75	1.10
5	0.01	0.58	0.59
6	0.11	0.17	0.28
7	0.18	0.14	0.32
8	0.26	0.23	0.49
9	0.26	0.29	0.55
10	0.53	0.46	0.98
11	0.09	0.21	0.30
12	0.10	0.34	0.44
13	0.16	0.14	0.30
14	0.07	0.18	0.25
15	0.23	-0.06	0.17
16	0.01	0.15	0.16

Table 145: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – OfficeLarge Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	N/A*	N/A*	N/A*
2	N/A*	N/A*	N/A*
3	-0.05	0.24	0.20
4	0.11	0.28	0.40
5	N/A*	N/A*	N/A*
6	0.02	0.05	0.07
7	0.04	0.04	0.08
8	0.04	0.04	0.08
9	0.05	0.03	0.09
10	0.15	0.11	0.26
11	0.10	0.16	0.25
12	0.07	0.23	0.30
13	N/A*	N/A*	N/A*
14	0.07	0.16	0.23
15	0.17	0.03	0.20
16	0.00	0.09	0.09

*The CEC forecasts no impact for this climate zone and prototype. For further details on the CEC's construction forecast, refer to Appendix A.1.

Table 146: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – RetailLarge Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	N/A*	N/A*	N/A*
2	N/A*	N/A*	N/A*
3	0.40	0.00	0.40
4	0.77	0.00	0.77
5	0.33	0.00	0.33
6	0.14	0.00	0.14
7	0.11	0.00	0.11
8	0.26	0.00	0.26
9	0.30	0.00	0.30
10	0.34	0.00	0.34
11	0.27	0.00	0.27
12	0.35	0.00	0.35
13	0.46	0.00	0.46
14	0.20	0.00	0.20
15	0.96	0.00	0.96
16	0.02	0.13	0.15

*The CEC forecasts no impact for this climate zone and prototype. For further details on the CEC's construction forecast, refer to Appendix A.1.

Table 147: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – RetailMedium Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	0.57	0.60	1.17
2	1.13	0.00	1.13
3	1.16	0.00	1.16
4	1.69	0.00	1.69
5	0.93	0.00	0.93
6	0.25	0.00	0.25
7	0.34	0.00	0.34
8	0.32	0.00	0.32
9	0.55	0.00	0.55
10	1.14	0.00	1.14
11	1.03	0.00	1.03
12	0.94	0.00	0.94
13	1.02	0.00	1.02
14	0.74	0.00	0.74
15	0.75	0.00	0.75
16	0.05	0.28	0.33

G.1.6 Prescriptive Wood-Framed and Other Walls

Table 148: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – OfficeMedium Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	0.02	0.33	0.35
2	0.02	0.08	0.09
3	0.02	0.11	0.13
4	0.04	0.08	0.13
5	0.02	0.11	0.12
6	0.02	0.05	0.07
7	0.04	0.05	0.08
8	0.06	0.06	0.12
9	0.05	0.05	0.09
10	0.05	0.05	0.10
11	0.05	0.05	0.09
12	0.11	0.15	0.26
13	0.07	0.06	0.14
14	0.07	0.08	0.15
15	0.11	0.03	0.13
16	0.04	0.14	0.18

Table 149: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – RestaurantFastFood Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	0.00	1.57	1.57
2	0.04	0.48	0.52
3	0.02	0.56	0.58
4	0.08	0.42	0.50
5	0.03	0.55	0.58
6	0.06	0.28	0.34
7	0.07	0.26	0.33
8	0.12	0.29	0.41
9	0.08	0.25	0.34
10	0.09	0.25	0.35
11	0.07	0.23	0.30
12	0.09	0.42	0.51
13	0.15	0.35	0.50
14	0.11	0.39	0.50
15	0.19	0.12	0.30
16	0.05	0.63	0.68

Table 150: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – OfficeSmall Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	0.51	0.00	0.51
2	0.13	0.00	0.13
3	0.12	0.00	0.12
4	0.14	0.00	0.14
5	0.11	0.00	0.11
6	0.06	0.00	0.06
7	0.03	0.00	0.03
8	0.10	0.00	0.10
9	0.07	0.00	0.07
10	0.10	0.00	0.10
11	0.12	0.00	0.12
12	0.16	0.00	0.16
13	0.19	0.00	0.19
14	0.23	0.00	0.23
15	0.14	0.00	0.14
16	0.10	0.24	0.34

Table 151: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – SchoolSmall Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	0.32	0.18	0.50
2	0.17	0.00	0.17
3	0.16	0.00	0.16
4	0.17	0.00	0.17
5	0.14	0.00	0.14
6	0.06	0.00	0.06
7	0.05	0.00	0.05
8	0.09	0.00	0.09
9	0.11	0.00	0.11
10	0.07	0.00	0.07
11	0.14	0.00	0.14
12	0.15	0.00	0.15
13	0.23	0.00	0.23
14	0.18	0.00	0.18
15	0.21	0.00	0.21
16	0.17	0.18	0.35

Table 152: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – RetailStripMall Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	0.23	0.72	0.95
2	0.24	0.00	0.24
3	0.25	0.00	0.25
4	0.32	0.00	0.32
5	0.25	0.00	0.25
6	0.04	0.00	0.04
7	0.11	0.00	0.11
8	0.21	0.00	0.21
9	0.17	0.00	0.17
10	0.26	0.00	0.26
11	0.14	0.00	0.14
12	0.45	0.00	0.45
13	0.29	0.00	0.29
14	0.14	0.00	0.14
15	0.41	0.00	0.41
16	0.28	0.43	0.70

G.2 Vestibules

Table 153: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – OfficeLarge Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	N/A*	N/A*	N/A*
2	N/A*	N/A*	N/A*
3	2.14	0.54	2.68
4	2.33	0.63	2.97
5	N/A*	N/A*	N/A*
6	2.30	0.21	2.51
7	2.34	0.17	2.51
8	2.42	0.25	2.67
9	2.39	0.28	2.67
10	2.45	0.31	2.76
11	2.41	0.59	3.00
12	2.31	0.54	2.85
13	N/A*	N/A*	N/A*
14	2.42	0.60	3.02
15	2.69	0.16	2.86
16	2.25	0.85	3.10

*The CEC forecasts no impact for this climate zone and prototype. For further details on the CEC's construction forecast, refer to Appendix A.1.

Table 154: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – RetailLarge Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	N/A*	N/A*	N/A*
2	N/A*	N/A*	N/A*
3	8.12	0.00	8.12
4	9.57	0.00	9.57
5	8.09	0.00	8.09
6	8.16	0.00	8.16
7	9.03	0.00	9.03
8	9.14	0.00	9.14
9	9.14	0.00	9.14
10	9.50	0.00	9.50
11	10.26	0.00	10.26
12	9.52	0.00	9.52
13	10.22	0.00	10.22
14	10.16	0.00	10.16
15	11.30	0.00	11.30
16	8.14	0.19	8.33

*The CEC forecasts no impact for this climate zone and prototype. For further details on the CEC's construction forecast, refer to Appendix A.1.

Table 155: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – OfficeMedium Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	2.26	0.86	3.12
2	2.50	0.64	3.14
3	2.38	0.48	2.86
4	2.70	0.60	3.30
5	2.43	0.50	2.94
6	2.64	0.18	2.82
7	2.73	0.15	2.88
8	2.86	0.22	3.08
9	2.82	0.25	3.07
10	2.92	0.26	3.18
11	2.88	0.61	3.50
12	2.68	0.57	3.26
13	2.93	0.48	3.41
14	2.88	0.62	3.50
15	3.48	0.15	3.62
16	2.50	0.93	3.44

Table 156: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – RetailMedium Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	8.58	0.07	8.65
2	10.27	0.00	10.27
3	9.28	0.00	9.28
4	10.83	0.00	10.83
5	9.16	0.00	9.16
6	9.09	0.00	9.09
7	10.25	0.00	10.25
8	9.59	0.00	9.59
9	10.19	0.00	10.19
10	9.97	0.00	9.97
11	11.15	0.00	11.15
12	10.84	0.00	10.84
13	11.52	0.00	11.52
14	11.72	0.00	11.72
15	11.78	0.00	11.78
16	0.87	0.26	1.13

Table 157: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – SchoolSmall Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	2.20	0.04	2.25
2	5.77	0.00	5.77
3	5.30	0.00	5.30
4	6.10	0.00	6.10
5	5.24	0.00	5.24
6	5.17	0.00	5.17
7	5.27	0.00	5.27
8	5.67	0.00	5.67
9	5.66	0.00	5.66
10	5.92	0.00	5.92
11	6.51	0.00	6.51
12	6.02	0.00	6.02
13	6.52	0.00	6.52
14	6.52	0.00	6.52
15	7.01	0.00	7.01
16	4.89	2.12	7.02

G.3 Windows

G.3.1 Windows: New Construction and Additions

Table 158: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – OfficeLarge Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	N/A*	N/A*	N/A*
2	N/A*	N/A*	N/A*
3	0.60	0.44	1.04
4	0.79	0.48	1.27
5	N/A*	N/A*	N/A*
6	0.80	0.30	1.10
7	0.88	0.25	1.13
8	0.80	0.06	0.85
9	0.91	0.26	1.17
10	0.97	0.27	1.24
11	0.87	0.58	1.45
12	0.83	0.46	1.30
13	N/A*	N/A*	N/A*
14	0.88	0.48	1.36
15	1.13	0.22	1.34
16	0.54	0.73	1.26

*The CEC forecasts no impact for this climate zone and prototype. For further details on the CEC's construction forecast, refer to Appendix A.1.

Table 159: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – RetailLarge Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	N/A*	N/A*	N/A*
2	N/A*	N/A*	N/A*
3	0.20	0.00	0.20
4	0.63	0.00	0.63
5	0.27	0.00	0.27
6	0.52	0.00	0.52
7	0.52	0.00	0.52
8	0.88	0.00	0.88
9	0.62	0.00	0.62
10	0.57	0.00	0.57
11	0.59	0.00	0.59
12	0.38	0.00	0.38
13	0.66	0.00	0.66
14	0.60	0.00	0.60
15	1.49	0.00	1.49
16	0.21	0.03	0.24

*The CEC forecasts no impact for this climate zone and prototype. For further details on the CEC's construction forecast, refer to Appendix A.1.

Table 160: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – OfficeMedium Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	0.50	0.51	1.01
2	0.99	0.34	1.33
3	0.88	0.23	1.11
4	1.29	0.26	1.55
5	0.99	0.26	1.24
6	1.23	0.11	1.34
7	1.27	0.09	1.36
8	1.43	0.12	1.54
9	1.41	0.15	1.56
10	1.50	0.14	1.64
11	1.59	0.41	2.00
12	1.28	0.20	1.48
13	1.64	0.31	1.94
14	1.56	0.29	1.85
15	2.31	0.08	2.39
16	0.94	0.56	1.51

Table 161: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – RetailMedium Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	0.01	0.00	0.01
2	0.53	0.00	0.53
3	0.32	0.00	0.32
4	0.46	0.00	0.46
5	0.40	0.00	0.40
6	0.77	0.00	0.77
7	-0.24	0.00	-0.24
8	0.51	0.00	0.51
9	0.78	0.00	0.78
10	0.84	0.00	0.84
11	0.93	0.00	0.93
12	0.27	0.00	0.27
13	1.03	0.00	1.03
14	-0.21	0.00	-0.21
15	2.53	0.00	2.53
16	0.36	0.00	0.36

Table 162: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – RestaurantFastFood Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	0.04	-0.23	-0.19
2	0.56	-0.19	0.37
3	0.38	-0.32	0.06
4	0.93	-0.25	0.67
5	0.45	-0.36	0.09
6	0.85	-0.26	0.60
7	0.86	-0.23	0.63
8	1.13	-0.19	0.94
9	1.16	-0.20	0.96
10	1.23	-0.19	1.04
11	1.28	0.04	1.32
12	1.01	-0.11	0.90
13	1.35	-0.06	1.28
14	1.17	-0.27	0.89
15	2.01	-0.13	1.87
16	0.55	0.03	0.58

Table 163: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – OfficeSmall Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	0.41	0.00	0.41
2	0.70	0.00	0.70
3	0.53	0.00	0.53
4	0.92	0.00	0.92
5	0.56	0.00	0.56
6	0.77	0.00	0.77
7	0.84	0.00	0.84
8	0.91	0.00	0.91
9	1.03	0.00	1.03
10	1.01	0.00	1.01
11	1.33	0.00	1.33
12	0.96	0.00	0.96
13	1.26	0.00	1.26
14	1.10	0.00	1.10
15	1.74	0.00	1.74
16	0.59	0.34	0.93

Table 164: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – SchoolSmall Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	0.45	0.10	0.55
2	1.27	0.00	1.27
3	0.90	0.00	0.90
4	1.84	0.00	1.84
5	0.95	0.00	0.95
6	1.53	0.00	1.53
7	1.48	0.00	1.48
8	1.98	0.00	1.98
9	2.10	0.00	2.10
10	2.25	0.00	2.25
11	2.47	0.00	2.47
12	2.01	0.00	2.01
13	2.57	0.00	2.57
14	2.49	0.00	2.49
15	3.29	0.00	3.29
16	1.52	0.51	2.03

Table 165: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction & Additions – RetailStripMall Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	-0.08	-0.29	-0.38
2	-0.01	0.00	-0.01
3	-0.04	0.00	-0.04
4	0.17	0.00	0.17
5	0.01	0.00	0.01
6	0.33	0.00	0.33
7	0.54	0.00	0.54
8	0.36	0.00	0.36
9	0.25	0.00	0.25
10	0.63	0.00	0.63
11	0.49	0.00	0.49
12	0.22	0.00	0.22
13	0.52	0.00	0.52
14	0.37	0.00	0.37
15	1.11	0.00	1.11
16	0.32	-0.36	-0.04

G.3.2 Windows: Alterations

Table 166: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – Alterations – OfficeLarge Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	0.78	1.42	2.20
2	1.52	1.00	2.52
3	1.16	0.91	2.07
4	2.03	0.97	3.00
5	1.58	0.85	2.43
6	1.98	0.54	2.52
7	2.16	0.50	2.65
8	2.22	0.54	2.76
9	2.10	0.65	2.76
10	2.44	0.63	3.07
11	2.13	1.12	3.26
12	1.97	0.95	2.92
13	2.22	0.69	2.91
14	2.23	1.07	3.30
15	3.17	0.48	3.65
16	1.36	1.56	2.92

Table 167: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – Alterations – RetailLarge Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	-0.23	0.09	-0.14
2	0.65	0.00	0.65
3	0.35	0.00	0.35
4	1.02	0.00	1.02
5	0.38	0.00	0.38
6	0.92	0.00	0.92
7	0.63	0.00	0.63
8	1.19	0.00	1.19
9	1.61	0.00	1.61
10	1.56	0.00	1.56
11	1.60	0.00	1.60
12	1.37	0.00	1.37
13	1.59	0.00	1.59
14	1.31	0.00	1.31
15	3.30	0.00	3.30
16	0.61	0.08	0.69

Table 168: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – Alterations – OfficeMedium Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	1.11	0.70	1.82
2	2.38	0.66	3.05
3	2.17	0.72	2.89
4	3.34	0.52	3.86
5	2.37	0.45	2.82
6	3.13	0.20	3.34
7	3.21	0.17	3.37
8	3.82	0.42	4.24
9	3.73	0.47	4.20
10	3.92	0.26	4.18
11	4.00	0.87	4.88
12	3.29	0.60	3.89
13	4.16	0.44	4.60
14	4.01	0.58	4.59
15	6.03	0.23	6.26
16	2.34	1.20	3.54

Table 169: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – Alterations – RetailMedium Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	-0.48	0.03	-0.45
2	0.12	0.00	0.12
3	-0.03	0.00	-0.03
4	0.42	0.00	0.42
5	0.08	0.00	0.08
6	0.43	0.00	0.43
7	0.94	0.00	0.94
8	1.76	0.00	1.76
9	1.28	0.00	1.28
10	1.62	0.00	1.62
11	2.13	0.00	2.13
12	0.77	0.00	0.77
13	0.98	0.00	0.98
14	1.11	0.00	1.11
15	4.77	0.00	4.77
16	0.35	0.03	0.37

Table 170: Nominal LSC Savings Over 30-Year Period of Analysis — per Square Foot — Alterations — RestaurantFastFood Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	0.14	-0.64	-0.51
2	1.66	-0.52	1.14
3	1.18	-0.74	0.43
4	2.59	-0.63	1.96
5	1.42	-0.87	0.55
6	2.47	-0.59	1.87
7	2.46	-0.56	1.90
8	3.23	-0.48	2.75
9	3.26	-0.47	2.79
10	3.40	-0.46	2.93
11	3.46	0.10	3.56
12	2.79	-0.29	2.49
13	3.64	-0.22	3.42
14	3.19	-0.66	2.53
15	5.26	-0.32	4.95
16	1.63	0.01	1.64

Table 171: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – Alterations – OfficeSmall Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	0.96	0.00	0.96
2	1.79	0.00	1.79
3	1.38	0.00	1.38
4	2.35	0.00	2.35
5	1.48	0.00	1.48
6	2.09	0.00	2.09
7	2.18	0.00	2.18
8	2.35	0.00	2.35
9	2.74	0.00	2.74
10	2.56	0.00	2.56
11	3.10	0.00	3.10
12	2.33	0.00	2.33
13	3.10	0.00	3.10
14	2.73	0.00	2.73
15	4.26	0.00	4.26
16	1.54	0.67	2.21

Table 172: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – Alterations – SchoolSmall Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	1.31	0.18	1.49
2	3.51	0.00	3.51
3	2.70	0.00	2.70
4	5.07	0.00	5.07
5	2.90	0.00	2.90
6	4.32	0.00	4.32
7	4.32	0.00	4.32
8	5.25	0.00	5.25
9	5.65	0.00	5.65
10	5.90	0.00	5.90
11	6.45	0.00	6.45
12	5.43	0.00	5.43
13	6.35	0.00	6.35
14	6.39	0.00	6.39
15	9.00	0.00	9.00
16	4.29	1.04	5.33

Table 173: Nominal LSC Savings Over 30-Year Period of Analysis – Per Square Foot – Alterations – RetailStripMall Prototype

Climate Zone	30-Year LSC Electricity Savings (Nominal $)	30-Year LSC Natural Gas Savings (Nominal $)	Total 30-Year LSC Savings (Nominal $)
1	-0.20	-0.76	-0.96
2	0.29	0.00	0.29
3	-0.01	0.00	-0.01
4	0.61	0.00	0.61
5	0.22	0.00	0.22
6	1.47	0.00	1.47
7	1.18	0.00	1.18
8	1.62	0.00	1.62
9	1.77	0.00	1.77
10	1.77	0.00	1.77
11	1.63	0.00	1.63
12	1.00	0.00	1.00
13	1.77	0.00	1.77
14	0.61	0.00	0.61
15	3.06	0.00	3.06
16	0.32	-0.96	-0.64

Appendix H: Per-Unit Energy Impact Results

H.1 Opaque Assemblies

H.1.1 Prescriptive Wood Framed and Other Roof

Table 174: First-Year Electricity Savings - kWh Per Square Foot - Opaque Assemblies Prescriptive Wood Framed and Other Roof

Prototype	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
Warehouse	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.02
Hospital	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	0.01	0.00
OfficeMedium	0.00	0.00	0.00	0.00	-0.00	-0.00	-0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.00
RetailLarge	0.03	0.05	0.03	0.04	0.03	0.00	0.00	0.03	0.04	0.04	0.03	0.05	0.05	0.05	0.06	0.02
RetailMedium	0.02	0.03	0.03	0.07	0.05	0.00	0.00	0.04	-0.01	0.06	0.04	0.04	0.05	0.09	0.05	0.02
RetailStripMall	0.02	0.05	0.02	0.04	0.03	0.00	0.00	0.01	0.04	0.02	0.05	0.04	0.04	0.07	0.03	0.01
SchoolSmall	0.03	0.04	0.03	0.04	0.03	0.00	0.00	0.00	0.02	0.02	0.06	0.04	0.04	0.06	0.03	0.02

Table 175: First-Year Peak Demand Reduction - kW Per Square Foot - Opaque Assemblies Prescriptive Wood Framed and Other Roof

Prototype	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
Warehouse	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.01
Hospital	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
OfficeMedium	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
RetailLarge	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.00	0.00
RetailMedium	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.00	0.00
RetailStripMall	0.00	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00
SchoolSmall	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.01

Table 176: First-Year Natural Gas Savings - kBtu Per Square Foot - Opaque Assemblies Prescriptive Wood Framed and Other Roof

Prototype	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
Warehouse	0.54	0.40	0.28	0.33	0.31	0.05	0.05	0.06	0.22	0.19	0.34	0.35	0.28	0.32	0.12	0.63
Hospital	0.15	0.15	0.10	0.14	0.12	0.02	0.02	0.03	0.10	0.10	0.12	0.13	0.11	0.13	0.08	0.16
OfficeMedium	0.17	0.13	0.11	0.10	-0.07	-0.02	-0.15	0.11	0.06	0.07	0.08	0.12	0.06	0.10	0.06	0.17
RetailLarge	0.24	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	0.68
RetailMedium	0.31	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	0.61
RetailStripMall	0.50	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	0.70
SchoolSmall	0.22	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	0.51

Table 177: First-Year Source Energy Savings – kBtu Per Square Foot - Opaque Assemblies Prescriptive Wood Framed and Other Roof

Prototype	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
Warehouse	0.49	0.36	0.25	0.30	0.28	0.04	0.04	0.05	0.20	0.17	0.31	0.32	0.25	0.29	0.11	0.57
Hospital	0.14	0.13	0.09	0.13	0.11	0.02	0.02	0.03	0.09	0.09	0.11	0.12	0.10	0.11	0.08	0.14
OfficeMedium	0.15	0.12	0.10	0.09	-0.06	-0.02	-0.14	0.10	0.06	0.06	0.08	0.11	0.06	0.09	0.05	0.15
RetailLarge	0.22	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	0.61
RetailMedium	0.28	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	0.55
RetailStripMall	0.46	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	0.63
SchoolSmall	0.20	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	0.46

Table 178: 30-year LSC Savings – 2026PV$ Per Square Foot - Opaque Assemblies Prescriptive Wood Framed and Other Roof

Prototype	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
Warehouse	0.41	0.32	0.22	0.29	0.21	0.04	0.01	0.04	0.14	0.14	0.29	0.29	0.24	0.31	0.10	0.50
Hospital	0.06	0.08	0.05	0.09	0.07	0.01	0.01	0.02	0.07	0.07	0.08	0.08	0.08	0.09	0.08	0.07
OfficeMedium	0.11	0.08	0.07	0.08	-0.06	-0.01	-0.11	0.09	0.05	0.06	0.07	0.09	0.07	0.10	0.10	0.11
RetailLarge	0.29	0.30	0.24	0.24	0.18	0.01	0.00	0.15	0.21	0.25	0.18	0.29	0.33	0.31	0.28	0.53
RetailMedium	0.29	0.21	0.21	0.41	0.27	-0.02	0.12	0.29	-0.15	0.32	0.28	0.26	0.28	0.53	0.23	0.47
RetailStripMall	0.38	0.29	0.15	0.23	0.19	0.01	0.00	0.04	0.20	0.13	0.33	0.21	0.27	0.37	0.12	0.50
SchoolSmall	0.36	0.28	0.20	0.25	0.17	0.02	0.02	0.01	0.10	0.09	0.34	0.26	0.28	0.35	0.14	0.48

H.1.2 Prescriptive Metal Building Roof

Table 179: First-Year Electricity Savings - (kWh) Per Square Foot - Opaque Assemblies Prescriptive Metal Building Roof

Prototype	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
RetailMedium	0.01	0.02	0.02	0.02	0.00	-0.00	-0.01	0.06	0.00	-0.02	0.02	0.01	0.01	0.02	0.02	0.03
Warehouse	0.01	0.01	0.00	0.01	0.00	0.00	0.00	-0.00	0.00	-0.00	0.01	0.01	0.01	0.01	-0.00	0.02

Table 180: First-Year Peak Demand Reduction– (kW) Per Square Foot - Opaque Assemblies Prescriptive Metal Building Roof

Prototype	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
RetailMedium	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
Warehouse	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	0.01	0.00	0.00

Table 181: First-Year Natural Gas Savings - (Btu) Per Square Foot - Opaque Assemblies Prescriptive Metal Building Roof

Prototype	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
RetailMedium	0.15	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	0.32
Warehouse	0.25	0.19	0.13	0.15	0.16	0.08	0.07	0.09	0.09	0.10	0.18	0.19	0.15	0.16	0.06	0.29

Table 182: First-Year Source Energy Savings - (Btu) Per Square Foot - Opaque Assemblies Prescriptive Metal Building Roof

Prototype	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
RetailMedium	0.14	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	0.28
Warehouse	0.23	0.17	0.12	0.14	0.14	0.07	0.06	0.08	0.08	0.09	0.16	0.17	0.13	0.14	0.05	0.26

Table 183: 30-year LSC Savings (2026–PV$) Per Square Foot - Opaque Assemblies Prescriptive Metal Building Roof

Prototype	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
RetailMedium	0.16	0.17	0.10	0.13	0.06	-0.03	0.06	0.37	0.01	-0.08	0.11	0.08	0.08	0.13	0.10	0.32
Warehouse	0.19	0.16	0.12	0.13	0.11	0.07	0.06	0.05	0.07	0.07	0.16	0.16	0.01	0.16	0.03	0.29

H.1.3 Prescriptive Metal Building Walls

Table 184: First Year Electricity Savings (kWh) Per Square Foot - Opaque Assemblies Prescriptive Metal Building Walls

Prototype	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
Warehouse	0.02	0.01	0.01	0.01	0.00	0.00	-0.00	0.00	0.00	-0.00	0.01	0.00	0.01	0.01	-0.00	0.01

Table 185: First-Year Peak Demand Reduction (Watts) Per Square Foot - Opaque Assemblies Prescriptive Metal Building Walls

Prototype	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
Warehouse	0.00	0.00	0.01	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00

Table 186: First-Year Natural Gas Savings (kBtu) Per Square Foot - Opaque Assemblies Prescriptive Metal Building Walls

Prototype	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
Warehouse	0.51	0.21	0.33	0.18	0.16	0.13	0.12	0.07	0.08	0.10	0.19	0.19	0.15	0.16	0.04	0.36

Table 187: First-Year Source Energy Savings (kBtu) Per Square Foot - Opaque Assemblies Prescriptive Metal Building Walls

Prototype	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
Warehouse	0.46	0.19	0.30	0.17	0.14	0.11	0.11	0.06	0.07	0.09	0.17	0.17	0.14	0.15	0.04	0.32

Table 188: 30-year LSC Savings (2026 PV$) Per Square Foot - Opaque Assemblies Prescriptive Metal Building Walls

Prototype	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
Warehouse	0.40	0.16	0.27	0.17	0.11	0.10	0.07	0.05	0.07	0.06	0.16	0.15	0.15	0.19	0.04	0.30

H.1.4 Prescriptive Light Mass Walls

Table 189: Opaque Assemblies Prescriptive Walls Mass Light – First-Year Electricity Savings (kWh) Per Square Foot

Prototype	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
Hospital	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.04	0.04	0.01	0.01	0.01	0.02	0.01	0.03	0.00
OfficeLarge	-0.00	-0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.02	0.01
OfficeMedium	0.00	0.05	0.00	0.01	0.00	0.01	0.01	0.03	0.03	0.02	0.03	0.01	0.03	0.02	0.06	0.01
Warehouse	0.02	0.01	0.02	0.02	0.02	0.01	0.01	0.02	0.02	0.01	0.03	0.02	0.03	0.03	0.04	0.03

Table 190: Opaque Assemblies Prescriptive Walls Mass Light – First-Year Peak Demand Reduction (kW) Per Square Foot

Prototype	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
Hospital	-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
OfficeLarge	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
OfficeMedium	0.00	0.01	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
Warehouse	0.01	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.01

Table 191: Opaque Assemblies Prescriptive Walls Mass Light – First-Year Natural Gas Savings (kBtu) Per Square Foot

Prototype	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
Hospital	0.42	0.35	0.51	0.33	0.78	0.44	0.38	0.52	0.63	0.15	0.32	0.31	0.23	0.32	0.10	0.57
OfficeLarge	0.20	0.08	0.25	0.19	0.29	0.15	0.11	0.13	0.20	0.02	0.17	0.15	0.05	0.16	0.05	0.29
OfficeMedium	0.30	2.03	0.29	0.19	0.35	0.16	0.12	0.20	0.17	0.32	0.24	0.23	0.19	0.09	0.05	0.54
Warehouse	0.52	0.48	0.54	0.40	0.60	0.23	0.18	0.25	0.33	0.18	0.51	0.45	0.38	0.45	0.10	0.96

Table 192: Opaque Assemblies Prescriptive Walls Mass Light – First-Year Source Energy Savings (kBtu) Per Square Foot

Prototype	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
Hospital	0.38	0.32	0.46	0.30	0.71	0.40	0.34	0.47	0.56	0.13	0.29	0.28	0.21	0.29	0.09	0.51
OfficeLarge	0.18	0.07	0.23	0.17	0.26	0.13	0.10	0.12	0.18	0.02	0.15	0.14	0.05	0.14	0.04	0.26
OfficeMedium	0.27	1.84	0.26	0.17	0.32	0.14	0.11	0.18	0.16	0.29	0.22	0.21	0.17	0.08	0.04	0.48
Warehouse	0.47	0.43	0.49	0.36	0.54	0.20	0.16	0.22	0.30	0.16	0.46	0.41	0.35	0.41	0.09	0.86

Table 193: Opaque Assemblies Prescriptive Walls Mass Light – 30-year LSC Savings (2026 PV$) Per Square Foot

Prototype	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
Hospital	0.23	0.23	0.31	0.26	0.49	0.38	0.43	0.56	0.61	0.17	0.30	0.27	0.27	0.27	0.25	0.35
OfficeLarge	0.12	0.05	0.15	0.14	0.19	0.14	0.14	0.16	0.20	0.04	0.18	0.15	0.09	0.15	0.15	0.21
OfficeMedium	0.18	1.53	0.19	0.20	0.24	0.18	0.20	0.33	0.33	0.35	0.33	0.24	0.31	0.18	0.35	0.41
Warehouse	0.41	0.39	0.45	0.33	0.46	0.20	0.18	0.27	0.34	0.18	0.52	0.39	0.43	0.47	0.25	0.77

H.1.5 Prescriptive Heavy Mass Walls

Table 194: First-Year Electricity Savings (kWh) Per Square Foot - Opaque Assemblies Prescriptive Heavy Mass Walls

Prototype	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
Hospital	-0.00	0.01	-0.00	0.01	-0.00	0.00	0.01	0.01	0.01	0.03	0.01	0.00	0.01	0.00	0.02	-0.00
OfficeLarge	-0.00	-0.00	-0.01	0.00	-0.01	-0.00	-0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.00	0.01	-0.00
RetailLarge	0.02	0.05	0.03	0.05	0.03	0.01	0.00	0.02	0.02	0.02	0.02	0.03	0.03	0.01	0.08	0.00
RetailMedium	0.04	0.08	0.07	0.12	0.08	0.02	0.02	0.02	0.04	0.08	0.08	0.06	0.07	0.06	0.07	0.00

Table 195: First-Year Peak Demand Reduction (kW) Per Square Foot - Opaque Assemblies Prescriptive Heavy Mass Walls

Prototype	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
Hospital	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
OfficeLarge	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
RetailLarge	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
RetailMedium	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.01	0.00	0.00

Table 196: First-Year Natural Gas Savings (kBtu) Per Square Foot - Opaque Assemblies Prescriptive Heavy Mass Walls

Prototype	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
Hospital	0.57	0.51	0.45	0.51	0.40	0.11	0.09	0.15	0.20	0.31	0.12	0.20	0.07	0.10	-0.06	0.10
OfficeLarge	0.28	0.20	0.16	0.19	0.13	0.03	0.03	0.03	0.02	0.07	0.10	0.15	0.08	0.10	0.02	0.06
RetailLarge	0.11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.09
RetailMedium	0.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.18

Table 197: First-Year Source Energy Savings (kBtu) Per Square Foot - Opaque Assemblies Prescriptive Heavy Mass Walls

Prototype	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
Hospital	0.51	0.46	0.41	0.46	0.36	0.10	0.08	0.14	0.18	0.28	0.11	0.18	0.06	0.09	-0.06	0.09
OfficeLarge	0.25	0.18	0.15	0.17	0.11	0.03	0.02	0.02	0.02	0.06	0.09	0.13	0.07	0.09	0.01	0.05
RetailLarge	0.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.08
RetailMedium	0.36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.17

Table 198: 30-year LSC Savings (2026 PV$) Per Square Foot - Opaque Assemblies Prescriptive Heavy Mass Walls

Prototype	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
Hospital	0.30	0.35	0.28	0.45	0.24	0.12	0.14	0.21	0.23	0.41	0.12	0.18	0.13	0.10	0.08	0.06
OfficeLarge	0.15	0.12	0.08	0.16	0.06	0.03	0.03	0.04	0.04	0.11	0.10	0.12	0.11	0.09	0.09	0.03
RetailLarge	0.20	0.29	0.18	0.34	0.15	0.06	0.05	0.11	0.13	0.15	0.12	0.16	0.20	0.09	0.43	0.06
RetailMedium	0.49	0.50	0.51	0.75	0.41	0.11	0.15	0.14	0.24	0.51	0.46	0.42	0.45	0.33	0.33	0.13

H.1.6 Prescriptive Wood-Framed and Other Walls

Table 199: Opaque Assemblies Prescriptive Wood-Framed and Other Walls – First-Year Electricity Savings (kWh) Per Square Foot

Prototype	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
OfficeMedium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00
OfficeSmall	0.03	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01
RestaurantFastFood	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.00
RetailStripMall	0.02	0.02	0.02	0.03	0.02	0.00	0.01	0.02	0.01	0.02	0.01	0.03	0.02	0.01	0.04	0.03
SchoolSmall	0.02	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.02	0.01

Table 200: Opaque Assemblies Prescriptive Wood-Framed and Other Walls – First-Year Peak Demand Reduction (kW) Per Square Foot

Prototype	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
OfficeMedium	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
OfficeSmall	0.01	0.00	0.00	0.00	0.00	-	-	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00
RestaurantFastFood	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RetailStripMall	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
SchoolSmall	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

Table 201: Opaque Assemblies Prescriptive Wood-Framed and Other Walls – First-Year Natural Gas Savings (kBtu) Per Square Foot

Prototype	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
OfficeMedium	0.23	0.05	0.08	0.06	0.08	0.03	0.03	0.04	0.03	0.03	0.03	0.11	0.04	0.05	0.02	0.09
OfficeSmall	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.16
RestaurantFastFood	1.11	0.34	0.39	0.29	0.38	0.19	0.17	0.19	0.17	0.17	0.15	0.29	0.23	0.26	0.07	0.43
RetailStripMall	0.49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.28
SchoolSmall	0.12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.12

Table 202: Opaque Assemblies Prescriptive Wood-Framed and Other Walls – First-Year Source Energy Savings (kBtu) Per Square Foot

Prototype	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
OfficeMedium	0.21	0.05	0.07	0.05	0.07	0.03	0.03	0.04	0.03	0.03	0.03	0.10	0.04	0.05	0.01	0.08
OfficeSmall	0.11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.11
RestaurantFastFood	1.00	0.31	0.35	0.26	0.35	0.17	0.15	0.17	0.15	0.15	0.14	0.26	0.21	0.23	0.07	0.38
Small Office	0.45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.26
Small School	0.11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.11

Table 203: Opaque Assemblies Prescriptive Wood-Framed and Other Walls – 30-year LSC Savings (2026 PV$) Per Square Foot

Prototype	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
OfficeMedium	0.14	0.04	0.05	0.05	0.05	0.03	0.03	0.05	0.04	0.04	0.04	0.11	0.06	0.06	0.06	0.07
OfficeSmall	0.23	0.06	0.05	0.06	0.05	0.02	0.01	0.05	0.03	0.04	0.05	0.07	0.09	0.10	0.06	0.14
RestaurantFastFood	0.62	0.21	0.23	0.20	0.23	0.14	0.13	0.17	0.14	0.14	0.12	0.21	0.21	0.20	0.13	0.27
Small Office	0.39	0.11	0.11	0.14	0.11	0.02	0.05	0.09	0.07	0.11	0.06	0.20	0.13	0.06	0.18	0.29
Small School	0.21	0.07	0.07	0.07	0.06	0.03	0.02	0.04	0.05	0.03	0.06	0.07	0.10	0.08	0.09	0.15

H.2 Windows

H.2.1 Windows: New Construction and Additions

Table 204: First-Year Electricity Savings (kWh) Per Square Foot – Windows New Construction and Additions

Prototype	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
OfficeLarge	0.03	0.07	0.06	0.07	0.07	0.08	0.08	0.08	0.08	0.09	0.07	0.07	0.08	0.08	0.10	0.05
OfficeMedium	0.05	0.10	0.09	0.11	0.10	0.12	0.11	0.13	0.13	0.14	0.13	0.11	0.14	0.14	0.21	0.09
OfficeSmall	0.03	0.06	0.05	0.08	0.05	0.07	0.07	0.08	0.09	0.09	0.10	0.08	0.10	0.10	0.15	0.05
RestaurantFastFood	0.00	0.06	0.04	0.08	0.05	0.07	0.07	0.10	0.10	0.11	0.11	0.08	0.11	0.10	0.18	0.05
RetailLarge	0.00	0.08	0.05	0.10	0.06	0.09	0.08	0.15	0.11	0.11	0.09	0.07	0.11	0.11	0.26	0.04
RetailMedium	0.00	0.11	0.06	0.08	0.09	0.16	-0.01	0.10	0.14	0.16	0.17	0.07	0.18	-0.03	0.45	0.07
RetailStripMall	-0.01	0.02	0.01	0.04	0.02	0.07	0.08	0.06	0.06	0.12	0.09	0.05	0.09	0.08	0.20	0.07
SchoolSmall	0.08	0.24	0.17	0.30	0.18	0.27	0.23	0.35	0.36	0.39	0.39	0.31	0.42	0.43	0.59	0.27

Table 205: First-Year Peak Demand Reduction (kW) Per Square Foot – Windows New Construction and Additions

Prototype	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
OfficeLarge	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
OfficeMedium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
OfficeSmall	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.01	0.00
RestaurantFastFood	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
RetailLarge	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
RetailMedium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	-0.01	0.00	0.00
RetailStripMall	0.00	-0.01	0.00	-0.01	-0.01	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	-0.01	0.00	0.00
SchoolSmall	0.01	0.02	0.01	0.01	0.00	0.01	0.00	0.01	0.01	0.01	0.03	0.03	0.03	0.02	0.01	0.02

Table 206: First-Year Natural Gas Savings (kBtu) Per Square Foot – Windows New Construction and Additions

Prototype	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
OfficeLarge	0.40	0.39	0.31	0.33	0.35	0.21	0.17	0.03	0.18	0.19	0.40	0.32	0.24	0.32	0.14	0.49
OfficeMedium	0.38	0.23	0.16	0.17	0.18	0.07	0.06	0.08	0.10	0.09	0.27	0.13	0.20	0.19	0.05	0.38
OfficeSmall	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	0.23
RestaurantFastFood	-0.20	-0.15	-0.24	-0.18	-0.26	-0.18	-0.15	-0.13	-0.14	-0.13	0.02	-0.09	-0.05	-0.18	-0.08	0.01
RetailLarge	0.02	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	0.03
RetailMedium	-0.01	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	-0.02
RetailStripMall	-0.39	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	-0.47
SchoolSmall	0.13	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	0.67

Table 207: First-Year Source Energy Savings (kBtu) Per Square Foot – Windows New Construction and Additions

Prototype	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
OfficeLarge	0.37	0.35	0.28	0.30	0.32	0.19	0.15	0.03	0.16	0.17	0.36	0.29	0.22	0.29	0.13	0.44
OfficeMedium	0.35	0.21	0.14	0.15	0.16	0.07	0.05	0.07	0.09	0.08	0.24	0.12	0.18	0.17	0.05	0.34
OfficeSmall	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	0.21
RestaurantFastFood	-0.18	-0.14	-0.22	-0.16	-0.24	-0.16	-0.14	-0.12	-0.12	-0.12	0.02	-0.08	-0.04	-0.16	-0.08	0.01
RetailLarge	0.02	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	0.03
RetailMedium	-0.01	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	-0.02
RetailStripMall	-0.36	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	-0.42
SchoolSmall	0.12	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	0.61

Table 208: 30-year LSC Savings (2026 PV$) Per Square Foot – Windows New Construction and Additions

Prototype	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
OfficeLarge	0.38	0.51	0.44	0.54	0.50	0.47	0.49	0.38	0.51	0.54	0.62	0.55	0.53	0.58	0.58	0.53
OfficeMedium	0.42	0.57	0.48	0.67	0.54	0.59	0.60	0.68	0.68	0.72	0.87	0.65	0.85	0.81	1.06	0.64
OfficeSmall	0.18	0.31	0.23	0.41	0.25	0.34	0.37	0.41	0.46	0.45	0.59	0.42	0.56	0.49	0.77	0.40
RestaurantFastFood	-0.07	0.17	0.04	0.31	0.06	0.28	0.29	0.43	0.43	0.47	0.58	0.40	0.57	0.41	0.84	0.26
RetailLarge	0.02	0.36	0.18	0.56	0.24	0.46	0.46	0.78	0.55	0.51	0.52	0.33	0.59	0.53	1.32	0.21
RetailMedium	0.01	0.47	0.28	0.41	0.36	0.68	-0.21	0.45	0.69	0.74	0.83	0.24	0.91	-0.18	2.24	0.32
RetailStripMall	-0.31	-0.01	-0.03	0.15	0.01	0.29	0.48	0.32	0.22	0.56	0.43	0.19	0.46	0.33	0.99	0.00
SchoolSmall	0.48	1.13	0.79	1.63	0.84	1.35	1.31	1.76	1.86	1.99	2.19	1.78	2.28	2.20	2.92	1.75

H.2.2 Windows: Alterations

Table 209: First-Year Electricity Savings (kWh) Per Square Foot – Windows Alterations

Prototype	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
OfficeLarge	0.07	0.15	0.12	0.18	0.15	0.19	0.19	0.21	0.19	0.23	0.19	0.18	0.19	0.20	0.29	0.12
OfficeMedium	0.11	0.24	0.22	0.30	0.24	0.30	0.28	0.35	0.34	0.36	0.35	0.29	0.37	0.37	0.55	0.22
OfficeSmall	0.09	0.17	0.13	0.20	0.14	0.19	0.18	0.21	0.24	0.23	0.25	0.19	0.25	0.24	0.37	0.14
RestaurantFastFood	0.02	0.17	0.11	0.23	0.14	0.22	0.20	0.29	0.29	0.30	0.29	0.24	0.31	0.29	0.47	0.15
RetailLarge	-0.03	0.06	0.03	0.08	0.04	0.09	0.06	0.11	0.14	0.13	0.14	0.11	0.13	0.12	0.29	0.06
RetailMedium	-0.05	0.01	0.00	0.04	0.01	0.04	0.09	0.17	0.11	0.16	0.18	0.06	0.08	0.10	0.41	0.04
RetailStripMall	-0.01	0.05	0.02	0.06	0.04	0.14	0.10	0.16	0.16	0.16	0.15	0.09	0.15	0.08	0.28	0.04
SchoolSmall	0.12	0.33	0.25	0.42	0.27	0.38	0.35	0.47	0.50	0.52	0.51	0.44	0.53	0.56	0.80	0.39

Table 210: First-Year Peak Demand Reduction (kW) Per Square Foot – Windows Alterations

Prototype	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
OfficeLarge	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
OfficeMedium	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
OfficeSmall	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.01	0.01	0.01	0.01	0.01
RestaurantFastFood	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
RetailLarge	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
RetailMedium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
RetailStripMall	0.00	0.00	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00
SchoolSmall	0.01	0.02	0.01	0.02	0.00	0.01	0.01	0.01	0.01	0.01	0.04	0.03	0.03	0.02	0.02	0.02

Table 211: First-Year Natural Gas Savings (kBtu) Per Square Foot – Windows Alterations

Prototype	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
OfficeLarge	0.99	0.69	0.64	0.67	0.60	0.38	0.34	0.37	0.45	0.43	0.75	0.66	0.46	0.72	0.31	1.07
OfficeMedium	0.44	0.45	0.49	0.36	0.31	0.14	0.11	0.27	0.31	0.17	0.57	0.39	0.29	0.38	0.15	0.81
OfficeSmall	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	0.44
RestaurantFastFood	-0.53	-0.41	-0.56	-0.45	-0.65	-0.41	-0.37	-0.32	-0.33	-0.32	0.04	-0.23	-0.16	-0.45	-0.20	-0.03
RetailLarge	0.06	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	0.04
RetailMedium	0.01	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	0.01
RetailStripMall	-0.52	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	-0.63
SchoolSmall	0.11	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	0.68

Table 212: First-Year Source Energy Savings (kBtu) Per Square Foot – Windows Alterations

Prototype	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
OfficeLarge	0.89	0.63	0.58	0.61	0.54	0.34	0.31	0.33	0.40	0.39	0.68	0.60	0.42	0.64	0.28	0.96
OfficeMedium	0.40	0.40	0.44	0.32	0.28	0.12	0.10	0.24	0.28	0.15	0.52	0.36	0.26	0.34	0.13	0.73
OfficeSmall	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	0.40
RestaurantFastFood	-0.48	-0.37	-0.50	-0.41	-0.59	-0.37	-0.34	-0.29	-0.29	-0.29	0.04	-0.21	-0.15	-0.40	-0.18	-0.03
RetailLarge	0.05	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	0.04
RetailMedium	0.01	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	0.01
RetailStripMall	-0.47	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	-0.57
SchoolSmall	0.10	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	0.61

Table 213: 30-year LSC Savings (2026 PV$) Per Square Foot – Windows Alterations

Prototype	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
OfficeLarge	0.91	1.07	0.87	1.29	1.04	1.09	1.15	1.20	1.19	1.33	1.39	1.25	1.26	1.41	1.59	1.22
OfficeMedium	0.77	1.32	1.25	1.68	1.23	1.47	1.49	1.86	1.84	1.84	2.12	1.69	2.02	2.01	2.76	1.51
OfficeSmall	0.43	0.79	0.61	1.04	0.66	0.93	0.96	1.04	1.21	1.14	1.37	1.03	1.37	1.21	1.89	0.95
RestaurantFastFood	-0.19	0.53	0.23	0.90	0.28	0.86	0.87	1.24	1.26	1.32	1.57	1.12	1.52	1.15	2.21	0.73
RetailLarge	-0.07	0.29	0.16	0.45	0.17	0.41	0.28	0.53	0.71	0.69	0.71	0.61	0.71	0.58	1.46	0.30
RetailMedium	-0.20	0.05	-0.01	0.19	0.04	0.19	0.42	0.78	0.57	0.72	0.94	0.34	0.44	0.49	2.12	0.16
RetailStripMall	-0.39	0.13	0.00	0.27	0.10	0.65	0.52	0.72	0.78	0.78	0.72	0.44	0.79	0.27	1.36	-0.24
SchoolSmall	0.65	1.56	1.20	2.24	1.28	1.91	1.91	2.33	2.50	2.61	2.86	2.41	2.81	2.83	3.99	2.31

Appendix I: Energy Cost Savings Results

I.1 Opaque Assemblies

I.1.1 Prescriptive Wood Framed and Other Roof

Table 214: 2026 PV 30-year LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction and Additions– Hospital -Wood-Framed and Other Roof

Climate Zone	30-Year LSC Electricity Savings (2026 PV $)	30-Year LSC Natural Gas Savings (2026 PV $)	Total 30-Year LSC Savings (2026 PV $)
1	-0.02	0.08	0.06
2	0.00	0.08	0.08
3	-0.01	0.06	0.05
4	0.01	0.08	0.09
5	0.00	0.07	0.07
6	0.00	0.01	0.01
7	0.00	0.01	0.01
8	0.01	0.02	0.02
9	0.01	0.06	0.07
10	0.01	0.06	0.07
11	0.01	0.07	0.08
12	0.01	0.07	0.08
13	0.02	0.06	0.08
14	0.01	0.07	0.09
15	0.03	0.05	0.08
16	-0.02	0.09	0.07

Table 215: 2026 PV 30-year LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction and Additions– RetailLarge – Wood Framed and Other Roof

Climate Zone	30-Year LSC Electricity Savings (2026 PV $)	30-Year LSC Natural Gas Savings (2026 PV $)	Total 30-Year LSC Savings (2026 PV $)
1	N/A*	N/A*	N/A*
2	N/A*	N/A*	N/A*
3	0.24	0.00	0.24
4	0.24	0.00	0.24
5	0.18	0.00	0.18
6	0.01	0.00	0.01
7	0.00	0.00	0.00
8	0.15	0.00	0.15
9	0.21	0.00	0.21
10	0.25	0.00	0.25
11	0.18	0.00	0.18
12	0.29	0.00	0.29
13	0.33	0.00	0.33
14	0.31	0.00	0.31
15	0.28	0.00	0.28
16	0.12	0.41	0.53

*The CEC forecasts no impact for this climate zone and prototype. For further details on the CEC's construction forecast, refer to Appendix A.1.

Table 216: 2026 PV 30-year LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction and Additions– OfficeMedium – Wood Framed and Other Roof

Climate Zone	30-Year LSC Electricity Savings (2026 PV $)	30-Year LSC Natural Gas Savings (2026 PV $)	Total 30-Year LSC Savings (2026 PV $)
1	0.01	0.09	0.11
2	0.01	0.07	0.08
3	0.01	0.06	0.07
4	0.02	0.06	0.08
5	-0.02	-0.03	-0.06
6	0.00	-0.01	-0.01
7	-0.02	-0.09	-0.11
8	0.03	0.07	0.09
9	0.01	0.04	0.05
10	0.02	0.04	0.06
11	0.02	0.05	0.07
12	0.02	0.07	0.09
13	0.04	0.04	0.07
14	0.04	0.06	0.10
15	0.06	0.04	0.10
16	0.02	0.10	0.11

Table 217: 2026 PV 30-year LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction and Additions– RetailMedium – Wood Framed and Other Roof

Climate Zone	30-Year LSC Electricity Savings (2026 PV $)	30-Year LSC Natural Gas Savings (2026 PV $)	Total 30-Year LSC Savings (2026 PV $)
1	0.10	0.19	0.29
2	0.21	0.00	0.21
3	0.21	0.00	0.21
4	0.41	0.00	0.41
5	0.27	0.00	0.27
6	-0.02	0.00	-0.02
7	0.12	0.00	0.12
8	0.29	0.00	0.29
9	-0.15	0.00	-0.15
10	0.32	0.00	0.32
11	0.28	0.00	0.28
12	0.26	0.00	0.26
13	0.28	0.00	0.28
14	0.53	0.00	0.53
15	0.23	0.00	0.23
16	0.10	0.37	0.47

Table 218: 2026 PV 30-year LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction and Additions– Warehouse – Wood Framed and Other Roof

Climate Zone	30-Year LSC Electricity Savings (2026 PV $)	30-Year LSC Natural Gas Savings (2026 PV $)	Total 30-Year LSC Savings (2026 PV $)
1	0.11	0.30	0.41
2	0.08	0.23	0.32
3	0.06	0.16	0.22
4	0.09	0.20	0.29
5	0.04	0.18	0.21
6	0.01	0.03	0.04
7	-0.01	0.03	0.01
8	0.01	0.04	0.04
9	0.00	0.14	0.14
10	0.02	0.12	0.14
11	0.08	0.20	0.29
12	0.08	0.21	0.29
13	0.07	0.17	0.24
14	0.12	0.20	0.31
15	0.02	0.07	0.10
16	0.13	0.37	0.50

Table 219: 2026 PV 30-year LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction and Additions– SchoolSmall – Wood Framed and Other Roof

Climate Zone	30-Year LSC Electricity Savings (2026 PV $)	30-Year LSC Natural Gas Savings (2026 PV $)	Total 30-Year LSC Savings (2026 PV $)
1	0.22	0.14	0.36
2	0.28	0.00	0.28
3	0.20	0.00	0.20
4	0.25	0.00	0.25
5	0.17	0.00	0.17
6	0.02	0.00	0.02
7	0.02	0.00	0.02
8	0.01	0.00	0.01
9	0.10	0.00	0.10
10	0.09	0.00	0.09
11	0.34	0.00	0.34
12	0.26	0.00	0.26
13	0.28	0.00	0.28
14	0.35	0.00	0.35
15	0.14	0.00	0.14
16	0.18	0.31	0.48

Table 220: 2026 PV LSC Savings Over 30-Year Period of Analysis – Per Square Foot – New Construction and Additions– RetailStripMall – Wood Framed and Other Roof

Climate Zone	30-Year LSC Electricity Savings (2026 PV $)	30-Year LSC Natural Gas Savings (2026 PV $)	Total 30-Year LSC Savings (2026 PV $)
1	0.09	0.29	0.38
2	0.29	0.00	0.29
3	0.15	0.00	0.15
4	0.23	0.00	0.23
5	0.19	0.00	0.19
6	0.01	0.00	0.01
7	0.00	0.00	0.00
8	0.04	0.00	0.04
9	0.20	0.00	0.20
10	0.13	0.00	0.13
11	0.33	0.00	0.33
12	0.21	0.00	0.21
13	0.27	0.00	0.27
14	0.37	0.00	0.37
15	0.12	0.00	0.12
16	0.09	0.41	0.50

I.1.2 Prescriptive Metal Building Roof

This section of the Final CASE Report contains analysis results for the prescriptive requirements for metal building roof. Refer to Section 5.3.1 for the Energy Cost Savings Methodology.

Table 221: 30-year LSC per Square Foot – New Construction & Additions – Prescriptive Metal Building Roof U-value – Warehouse Prototype

Climate Zone	30-Year LSC Electricity Savings (2026 PV $)	30-Year LSC Natural Gas Savings (2026 PV $)	Total 30-Year LSC Savings (2026 PV $)
1	0.05	0.14	0.19
2	0.05	0.11	0.16
3	0.04	0.08	0.12
4	0.04	0.09	0.13
5	0.02	0.09	0.11
6	0.02	0.05	0.07
7	0.02	0.04	0.06
8	0.00	0.06	0.05
9	0.02	0.05	0.07
10	0.00	0.06	0.07
11	0.06	0.11	0.16
12	0.05	0.11	0.16
13	0.04	0.09	0.13
14	0.06	0.10	0.16
15	-0.01	0.04	0.03
16	0.11	0.17	0.29

Table 222: 30-year LSC per Square Foot – New Construction & Additions – Prescriptive Metal Building Roof U-value – RetailMedium Prototype

Climate Zone	30-Year LSC Electricity Savings (2026 PV $)	30-Year LSC Natural Gas Savings (2026 PV $)	Total 30-Year LSC Savings (2026 PV $)
1	0.06	0.09	0.16
2	0.17	0.00	0.17
3	0.10	0.00	0.10
4	0.13	0.00	0.13
5	0.06	0.00	0.06
6	-0.03	0.00	-0.03
7	0.06	0.00	0.06
8	0.37	0.00	0.37
9	0.01	0.00	0.01
10	-0.08	0.00	-0.08
11	0.11	0.00	0.11
12	0.08	0.00	0.08
13	0.08	0.00	0.08
14	0.13	0.00	0.13
15	0.10	0.00	0.10
16	0.13	0.19	0.32

I.1.3 Prescriptive Metal Building Walls

This section of the Final CASE Report contains analysis results for the prescriptive requirements for metal building walls. Refer to Section 5.3.1 for the Energy Cost Savings Methodology. The only prototype modeled for this assembly type was Warehouse.

Table 223: 30-year LSC per Square Foot – New Construction & Additions – Prescriptive Metal Building Walls U-value – Warehouse Prototype

Climate Zone	30-Year LSC Electricity Savings (2026 PV $)	30-Year LSC Natural Gas Savings (2026 PV $)	Total 30-Year LSC Savings (2026 PV $)
1	0.12	0.28	0.40
2	0.04	0.12	0.16
3	0.08	0.19	0.27
4	0.06	0.11	0.17
5	0.02	0.09	0.11
6	0.02	0.08	0.10
7	-0.01	0.07	0.07
8	0.01	0.04	0.05
9	0.02	0.05	0.07
10	0.00	0.06	0.06
11	0.04	0.12	0.16
12	0.04	0.11	0.15
13	0.06	0.09	0.15
14	0.09	0.10	0.19
15	0.01	0.03	0.04
16	0.10	0.21	0.30

I.1.4 Prescriptive Light Mass Walls

Table 224: Present Value LSC Savings Per Square Foot Over 30-Year Period of Analysis – New Construction & Additions – Prescriptive Light Mass Walls U-value – Hospital Prototype

Climate Zone	30-Year LSC Electricity Savings (2026 PV $)	30-Year LSC Natural Gas Savings (2026 PV $)	Total 30-Year LSC Savings (2026 PV $)
1	-0.01	0.24	0.23
2	0.02	0.21	0.23
3	0.01	0.29	0.31
4	0.07	0.19	0.26
5	0.05	0.44	0.49
6	0.12	0.26	0.38
7	0.20	0.23	0.43
8	0.26	0.30	0.56
9	0.25	0.36	0.61
10	0.08	0.09	0.17
11	0.11	0.19	0.30
12	0.08	0.19	0.27
13	0.13	0.14	0.27
14	0.07	0.20	0.27
15	0.18	0.06	0.25
16	0.02	0.33	0.35

Table 225: Present Value LSC Savings Per Square Foot Over 30-Year Period of Analysis – New Construction & Additions – Prescriptive Light Mass Walls U-value – OfficeLarge Prototype

Climate Zone	30-Year LSC Electricity Savings (2026 PV $)	30-Year LSC Natural Gas Savings (2026 PV $)	Total 30-Year LSC Savings (2026 PV $)
1	N/A*	N/A*	N/A*
2	N/A*	N/A*	N/A*
3	0.01	0.14	0.15
4	0.03	0.11	0.14
5	N/A*	N/A*	N/A*
6	0.06	0.09	0.14
7	0.07	0.07	0.14
8	0.08	0.08	0.16
9	0.08	0.12	0.20
10	0.03	0.02	0.04
11	0.08	0.10	0.18
12	0.06	0.09	0.15
13	N/A*	N/A*	N/A*
14	0.06	0.10	0.15
15	0.12	0.03	0.15
16	0.04	0.17	0.21

*The CEC forecasts no impact for this climate zone and prototype. For further details on the CEC's construction forecast, refer to Appendix A.1.

Table 226: Present Value LSC Savings Per Square Foot Over 30-Year Period of Analysis – New Construction & Additions – Prescriptive Light Mass Walls U-value – OfficeMedium Prototype

Climate Zone	30-Year LSC Electricity Savings (2026 PV $)	30-Year LSC Natural Gas Savings (2026 PV $)	Total 30-Year LSC Savings (2026 PV $)
1	0.01	0.17	0.18
2	0.33	1.20	1.53
3	0.02	0.17	0.19
4	0.09	0.11	0.20
5	0.03	0.20	0.24
6	0.08	0.09	0.18
7	0.13	0.07	0.20
8	0.21	0.12	0.33
9	0.22	0.11	0.33
10	0.15	0.20	0.35
11	0.19	0.15	0.33
12	0.11	0.14	0.24
13	0.19	0.11	0.31
14	0.13	0.06	0.18
15	0.32	0.03	0.35
16	0.09	0.32	0.41

Table 227: Present Value LSC Savings Per Square Foot Over 30-Year Period of Analysis – New Construction & Additions – Prescriptive Light Mass Walls U-value – Non-refrigerated Warehouse Prototype

Climate Zone	30-Year LSC Electricity Savings (2026 PV $)	30-Year LSC Natural Gas Savings (2026 PV $)	Total 30-Year LSC Savings (2026 PV $)
1	0.11	0.30	0.41
2	0.10	0.28	0.39
3	0.13	0.32	0.45
4	0.10	0.24	0.33
5	0.12	0.35	0.46
6	0.06	0.14	0.20
7	0.07	0.11	0.18
8	0.12	0.15	0.27
9	0.14	0.21	0.34
10	0.07	0.11	0.18
11	0.21	0.31	0.52
12	0.12	0.27	0.39
13	0.20	0.23	0.43
14	0.19	0.28	0.47
15	0.19	0.06	0.25
16	0.20	0.57	0.77

I.1.5 Prescriptive Heavy Mass Walls

Table 228: 30-year LSC per Square Foot – New Construction & Additions – Prescriptive Heavy Mass Walls U-value – Hospital Prototype

Climate Zone	30-Year LSC Electricity Savings (2026 PV $)	30-Year LSC Natural Gas Savings (2026 PV $)	Total 30-Year LSC Savings (2026 PV $)
1	-0.02	0.32	0.30
2	0.05	0.30	0.35
3	0.02	0.26	0.28
4	0.16	0.30	0.45
5	0.00	0.23	0.24
6	0.05	0.07	0.12
7	0.08	0.06	0.14
8	0.12	0.09	0.21
9	0.11	0.11	0.23
10	0.23	0.18	0.41
11	0.04	0.08	0.12
12	0.04	0.14	0.18
13	0.07	0.06	0.13
14	0.03	0.07	0.10
15	0.10	-0.03	0.08
16	0.00	0.06	0.06

Table 229: 30-year LSC per Square Foot – New Construction & Additions – Prescriptive Heavy Mass Walls U-value – OfficeLarge Prototype

Climate Zone	30-Year LSC Electricity Savings (2026 PV $)	30-Year LSC Natural Gas Savings (2026 PV $)	Total 30-Year LSC Savings (2026 PV $)
1	N/A*	N/A*	N/A*
2	N/A*	N/A*	N/A*
3	-0.02	0.10	0.08
4	0.05	0.11	0.16
5	N/A*	N/A*	N/A*
6	0.01	0.02	0.03
7	0.02	0.02	0.03
8	0.02	0.02	0.04
9	0.02	0.01	0.04
10	0.07	0.04	0.11
11	0.04	0.06	0.10
12	0.03	0.09	0.12
13	N/A*	N/A*	N/A*
14	0.03	0.06	0.09
15	0.08	0.01	0.09
16	0.00	0.04	0.03

*The CEC forecasts no impact for this climate zone and prototype. For further details on the CEC's construction forecast, refer to Appendix A.1.

Table 230: 30-year LSC per Square Foot – New Construction & Additions – Prescriptive Heavy Mass Walls U-value – RetailLarge Prototype

Climate Zone	30-Year LSC Electricity Savings (2026 PV $)	30-Year LSC Natural Gas Savings (2026 PV $)	Total 30-Year LSC Savings (2026 PV $)
1	N/A*	N/A*	N/A*
2	N/A*	N/A*	N/A*
3	0.18	0.00	0.18
4	0.34	0.00	0.34
5	0.15	0.00	0.15
6	0.06	0.00	0.06
7	0.05	0.00	0.05
8	0.11	0.00	0.11
9	0.13	0.00	0.13
10	0.15	0.00	0.15
11	0.12	0.00	0.12
12	0.16	0.00	0.16
13	0.20	0.00	0.20
14	0.09	0.00	0.09
15	0.43	0.00	0.43
16	0.01	0.05	0.06

*The CEC forecasts no impact for this climate zone and prototype. For further details on the CEC's construction forecast, refer to Appendix A.1.

Table 231: 30-year LSC per Square Foot – New Construction & Additions – Prescriptive Heavy Mass Walls U-value – RetailMedium Prototype

Climate Zone	30-Year LSC Electricity Savings (2026 PV $)	30-Year LSC Natural Gas Savings (2026 PV $)	Total 30-Year LSC Savings (2026 PV $)
1	0.25	0.24	0.49
2	0.50	0.00	0.50
3	0.51	0.00	0.51
4	0.75	0.00	0.75
5	0.41	0.00	0.41
6	0.11	0.00	0.11
7	0.15	0.00	0.15
8	0.14	0.00	0.14
9	0.24	0.00	0.24
10	0.51	0.00	0.51
11	0.46	0.00	0.46
12	0.42	0.00	0.42
13	0.45	0.00	0.45
14	0.33	0.00	0.33
15	0.33	0.00	0.33
16	0.02	0.11	0.13

I.1.6 Prescriptive Wood-Framed and Other Walls

Table 232: Present Value LSC Savings Per Square Foot Over 30-Year Period of Analysis – New Construction & Additions – Prescriptive Wood-Framed and Other Walls U-value – OfficeMedium Prototype

Climate Zone	30-Year LSC Electricity Savings (2026 PV $)	30-Year LSC Natural Gas Savings (2026 PV $)	Total 30-Year LSC Savings (2026 PV $)
1	0.01	0.13	0.14
2	0.01	0.03	0.04
3	0.01	0.04	0.05
4	0.02	0.03	0.05
5	0.01	0.04	0.05
6	0.01	0.02	0.03
7	0.02	0.02	0.03
8	0.03	0.02	0.05
9	0.02	0.02	0.04
10	0.02	0.02	0.04
11	0.02	0.02	0.04
12	0.05	0.06	0.11
13	0.03	0.03	0.06
14	0.03	0.03	0.06
15	0.05	0.01	0.06
16	0.02	0.05	0.07

Table 233: Present Value LSC Savings Per Square Foot Over 30-Year Period of Analysis – New Construction & Additions – Prescriptive Wood-Framed and Other Walls U-value – OfficeSmall Prototype

Climate Zone	30-Year LSC Electricity Savings (2026 PV $)	30-Year LSC Natural Gas Savings (2026 PV $)	Total 30-Year LSC Savings (2026 PV $)
1	0.23	0.00	0.23
2	0.06	0.00	0.06
3	0.05	0.00	0.05
4	0.06	0.00	0.06
5	0.05	0.00	0.05
6	0.02	0.00	0.02
7	0.01	0.00	0.01
8	0.05	0.00	0.05
9	0.03	0.00	0.03
10	0.04	0.00	0.04
11	0.05	0.00	0.05
12	0.07	0.00	0.07
13	0.09	0.00	0.09
14	0.10	0.00	0.10
15	0.06	0.00	0.06
16	0.05	0.10	0.14

Table 234: Present Value LSC Savings Per Square Foot Over 30-Year Period of Analysis – New Construction & Additions – Prescriptive Wood-Framed and Other Walls U-value – RestaurantFastFood Prototype

Climate Zone	30-Year LSC Electricity Savings (2026 PV $)	30-Year LSC Natural Gas Savings (2026 PV $)	Total 30-Year LSC Savings (2026 PV $)
1	0.00	0.62	0.62
2	0.02	0.19	0.21
3	0.01	0.22	0.23
4	0.04	0.17	0.20
5	0.01	0.22	0.23
6	0.02	0.11	0.14
7	0.03	0.10	0.13
8	0.05	0.11	0.17
9	0.04	0.10	0.14
10	0.04	0.10	0.14
11	0.03	0.09	0.12
12	0.04	0.17	0.21
13	0.07	0.14	0.21
14	0.05	0.15	0.20
15	0.08	0.05	0.13
16	0.02	0.25	0.27

Table 235: Present Value LSC Savings Per Square Foot Over 30-Year Period of Analysis – New Construction & Additions – Prescriptive Wood-Framed and Other Walls U-value – RetailStripMall Prototype

Climate Zone	30-Year LSC Electricity Savings (2026 PV $)	30-Year LSC Natural Gas Savings (2026 PV $)	Total 30-Year LSC Savings (2026 PV $)
1	0.10	0.29	0.39
2	0.11	0.00	0.11
3	0.11	0.00	0.11
4	0.14	0.00	0.14
5	0.11	0.00	0.11
6	0.02	0.00	0.02
7	0.05	0.00	0.05
8	0.09	0.00	0.09
9	0.07	0.00	0.07
10	0.11	0.00	0.11
11	0.06	0.00	0.06
12	0.20	0.00	0.20
13	0.13	0.00	0.13
14	0.06	0.00	0.06
15	0.18	0.00	0.18
16	0.12	0.17	0.29

Table 236: Present Value LSC Savings Per Square Foot Over 30-Year Period of Analysis – New Construction & Additions – Prescriptive Wood-Framed and Other Walls U-value – SchoolSmall Prototype

Climate Zone	30-Year LSC Electricity Savings (2026 PV $)	30-Year LSC Natural Gas Savings (2026 PV $)	Total 30-Year LSC Savings (2026 PV $)
1	0.14	0.07	0.21
2	0.07	0.00	0.07
3	0.07	0.00	0.07
4	0.07	0.00	0.07
5	0.06	0.00	0.06
6	0.03	0.00	0.03
7	0.02	0.00	0.02
8	0.04	0.00	0.04
9	0.05	0.00	0.05
10	0.03	0.00	0.03
11	0.06	0.00	0.06
12	0.07	0.00	0.07
13	0.10	0.00	0.10
14	0.08	0.00	0.08
15	0.09	0.00	0.09
16	0.08	0.07	0.15

Appendix J: Statewide Energy and Energy Cost Savings

J.1 Opaque Assemblies

J.1.1 Prescriptive Metal Building Roof

Table 237: Statewide Energy and Energy Cost Impacts – New Construction & Additions, Prescriptive Metal Building Roof, All Modeled Prototypes

Climate Zone	Statewide New Construction & Additions Impacted by Proposed Change in 2026 (square feet)	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (million therms)	First-Year Source Energy Savings (million kBtu)	30-Year LSC Savings (million 2026 PV$)
1	66,258	0.00	0.00	0.00	0.01	$0.01
2	363,360	0.00	0.00	0.00	0.05	$0.06
3	1,886,940	0.01	0.01	0.00	0.21	$0.22
4	983,580	0.01	0.00	0.00	0.12	$0.13
5	159,228	0.00	0.00	0.00	0.02	$0.02
6	1,210,940	0.00	0.00	0.00	0.08	$0.07
7	625,760	0.00	0.00	0.00	0.04	$0.04
8	1,731,220	0.01	0.00	0.00	0.13	$0.15
9	2,692,800	0.00	0.00	0.00	0.19	$0.18
10	1,252,480	-0.00	0.00	0.00	0.10	$0.06
11	533,600	0.00	0.00	0.00	0.08	$0.09
12	2,400,680	0.02	0.01	0.00	0.39	$0.37
13	732,040	0.01	0.00	0.00	0.09	$0.09
14	325,440	0.00	0.00	0.00	0.04	$0.05
15	318,680	-0.00	0.00	0.00	0.02	$0.01
16	126,724	0.00	0.00	0.00	0.03	$0.04
Total	15,409,730	0.07	0.03	0.02	1.60	$1.57

J.1.2 Prescriptive Metal Building Walls

Table 238: Statewide Energy and Energy Cost Impacts – New Construction & Additions, Prescriptive Metal Building Walls, All Modeled Prototypes

Climate Zone	Statewide New Construction & Additions Impacted by Proposed Change in 2026 (square feet)	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (million therms)	First-Year Source Energy Savings (million kBtu)	30-Year LSC Savings (million 2026 PV$)
1	43,239	0.00	0.00	0.00	0.02	$0.02
2	257,040	0.00	0.00	0.00	0.05	$0.04
3	1,512,000	0.01	0.01	0.00	0.45	$0.40
4	782,600	0.01	0.00	0.00	0.13	$0.13
5	124,320	0.00	0.00	0.00	0.02	$0.01
6	954,100	0.00	0.00	0.00	0.11	$0.09
7	497,560	-0.00	-0.00	0.00	0.05	$0.03
8	1,363,600	0.00	0.00	0.00	0.08	$0.06
9	2,107,000	0.00	0.00	0.00	0.15	$0.14
10	952,000	-0.00	0.00	0.00	0.08	$0.05
11	442,050	0.00	0.00	0.00	0.08	$0.07
12	1,990,800	0.01	0.01	0.00	0.34	$0.30
13	574,210	0.00	0.00	0.00	0.08	$0.09
14	253,260	0.00	0.00	0.00	0.04	$0.05
15	257,110	-0.00	0.00	0.00	0.01	$0.01
16	96,670	0.00	0.00	0.00	0.03	$0.03
Total	12,207,559	0.05	0.03	0.02	1.72	$1.54

J.1.3 Prescriptive Light Mass Walls

Table 239: Statewide Energy and Energy Cost Impacts – New Construction & Additions – Prescriptive Light Mass Walls – All Modeled Prototypes

Climate Zone	Statewide New Construction & Additions Impacted by Proposed Change in 2026 (square feet)	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (million therms)	First-Year Source Energy Savings (million kBtu)	30-Year LSC Savings (million 2026 PV$)
1	53,589	0.00	0.00	0.00	0.02	$0.02
2	258,980	0.01	0.00	0.00	0.24	$0.21
3	1,799,946	0.02	0.01	0.01	0.66	$0.56
4	921,266	0.01	0.00	0.00	0.25	$0.23
5	152,847	0.00	0.00	0.00	0.07	$0.05
6	1,072,266	0.01	0.00	0.00	0.19	$0.20
7	646,322	0.01	0.00	0.00	0.10	$0.13
8	1,561,523	0.03	0.00	0.00	0.30	$0.41
9	2,661,988	0.06	0.01	0.01	0.64	$0.82
10	927,635	0.01	0.00	0.00	0.17	$0.20
11	339,924	0.01	0.00	0.00	0.14	$0.16
12	1,880,291	0.03	0.01	0.01	0.61	$0.62
13	471,684	0.01	0.00	0.00	0.14	$0.19
14	263,975	0.01	0.00	0.00	0.07	$0.09
15	212,956	0.01	0.00	0.00	0.02	$0.06
16	89,254	0.00	0.00	0.00	0.06	$0.05
Total	13,314,449	0.22	0.05	0.04	3.67	$3.98

J.1.4 Prescriptive Heavy Mass Walls

Table 240: Statewide Energy and Energy Cost Impacts – New Construction & Additions, Prescriptive Heavy Mass Walls, All Modeled Prototypes

Climate Zone	Statewide New Construction & Additions Impacted by Proposed Change in 2026 (square feet)	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (million therms)	First-Year Source Energy Savings (million kBtu)	30-Year LSC Savings (million 2026 PV$)
1	12,683	0.00	0.00	0.00	0.01	$0.01
2	60,121	0.00	0.00	0.00	0.01	$0.03
3	895,064	0.02	0.00	0.00	0.07	$0.18
4	453,413	0.02	0.00	0.00	0.04	$0.17
5	94,685	0.00	0.00	0.00	0.00	$0.02
6	520,586	0.00	0.00	0.00	0.01	$0.04
7	332,477	0.00	0.00	0.00	0.01	$0.03
8	668,810	0.01	0.00	0.00	0.01	$0.08
9	1,275,096	0.02	0.00	0.00	0.02	$0.18
10	534,026	0.02	0.00	0.00	0.03	$0.14
11	190,088	0.00	0.00	0.00	0.00	$0.03
12	859,701	0.02	0.00	0.00	0.02	$0.15
13	255,676	0.01	0.00	0.00	0.00	$0.06
14	119,628	0.00	0.00	0.00	0.00	$0.02
15	119,832	0.01	0.00	-0.00	-0.00	$0.04
16	45,077	0.00	0.00	0.00	0.00	$0.00
Total	6,436,963	0.15	0.01	0.00	0.25	$1.15

J.1.5 Prescriptive Wood-Framed and Other Walls

Table 241: Statewide Energy and Energy Cost Impacts – New Construction & Additions – Prescriptive Wood-Framed and Other Walls – All Modeled Prototypes

Climate Zone	Statewide New Construction & Additions Impacted by Proposed Change in 2026 (square feet)	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (million therms)	First-Year Source Energy Savings (million kBtu)	30-Year LSC Savings (million 2026 PV$)
1	84,117	0.00	0.00	0.00	0.02	$0.02
2	736,204	0.01	0.00	0.00	0.03	$0.06
3	1,229,774	0.01	0.00	0.00	0.13	$0.14
4	559,047	0.01	0.00	0.00	0.05	$0.07
5	232,521	0.00	0.00	0.00	0.02	$0.02
6	1,133,314	0.00	0.00	0.00	0.06	$0.07
7	941,056	0.01	0.00	0.00	0.04	$0.05
8	1,617,422	0.02	0.00	0.00	0.10	$0.16
9	2,602,658	0.02	0.00	0.00	0.14	$0.20
10	1,824,610	0.02	0.00	0.00	0.07	$0.16
11	283,883	0.00	0.00	0.00	0.01	$0.02
12	1,989,371	0.02	0.00	0.00	0.13	$0.24
13	877,867	0.01	0.00	0.00	0.03	$0.10
14	419,855	0.00	0.00	0.00	0.03	$0.04
15	251,983	0.00	0.00	0.00	0.00	$0.03
16	128,810	0.00	0.00	0.00	0.03	$0.03
Total	14,912,492	0.14	0.02	0.01	0.90	$1.40