Codes and Standards Enhancement (CASE) Initiative

2028 California Energy Code

Nonresidential Fenestration

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Acronyms

Table 1 presents a list of acronyms used in this report. The website Title24stakeholders.com also maintains a glossary of terms.

Table 1: Acronyms

Acronym	Definition
ACM	Alternative Calculation Method
ADA	Americans with Disabilities Act
ASHRAE	American Society of Heating, Refrigeration, and Air-Conditioning Engineers
ATT	Acceptance Test Technician
BCR	Benefit-to-cost Ratio
BEM	Building Energy Modeling
Btu	British Thermal Units
CALGreen	California Green Building Standards Code
Cal/OSHA	California Division of Occupational Safety and Health
CARB	California Air Resources Board
CASE	Codes and Standards Enhancement
CBSC	California Building Standards Commission
CBECC	California Building Energy Code Compliance Software
CBECC-Res	California Building Energy Code Compliance for Residential Buildings Software
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CBO	Community-Based Organization
CPUC	California Public Utilities Commission
CSE	California Simulation Engine
CTF	Conduction Transfer Functions
CZ	Climate Zone
DAC	Disadvantaged Community
DGS	California Department of General Services
DOAS	Dedicated Outdoor Air System
DOSH	Division of Occupational Safety and Health
ECC	Energy Code Compliance
EIR	Environmental Impact Report
EPIC	Electric Program Investment Charge
ESJ	Environmental and Social Justice

Acronym	Definition
FSOR	Final Statement of Reasons
GHG	Greenhouse Gas
GWh	Gigawatt-Hour
HVAC	Heating, Ventilation, and Air Conditioning
IDF	Input Data File
IECC	International Energy Conservation Code
IOU	Investor-Owned Utility
ISOR	Initial Statement of Reasons
kBtu/sf	One Thousand British Thermal Units per Square Foot
Kg/s	Kilograms per Second
kWh	Kilowatt-Hour
kWh/year	Kilowatt-Hour Per Year
LED	Light Emitting Diode
LPD	Lighting Power Density
LSC	Long-term System Cost
MeasureSET	CASE Measure Savings Estimation Template
MG	Million Gallons of Water
NAICS	North American Industry Classification System
NPDI	Net Private Domestic Investment
PEP	Public Engagement Plan
PV	Present Value
SDD	Standards Data Dictionary
SHGC	Solar Heat Gain Coefficient
SOC	Standard Occupational Classification
SPMS	Saturation Pressure Measurement Sensors
SRIA	Standardized Regulatory Impact Assessment
UL	Underwriters Laboratories
VT	Visible Transmittance
W	Watt
WWR	Window-to-Wall Ratios

1. Introduction

This is a draft report. The Statewide Codes and Standards Enhancement (CASE) Team encourages readers to provide comments on the proposed code changes and supporting analyses. The CEC will evaluate proposals that the Statewide CASE Team and other stakeholders submit and may revise or reject proposals. More information about the rulemaking schedule and how to participate in the process can be found on CEC's 2028 code cycle website. Suggested revisions will be considered when refining proposals and analyses. The final CASE Report will be submitted to the CEC later in 2026. For this report, the Statewide CASE Team is requesting input on the following:

1. *Incremental costs for both the new construction window measure and the alterations window measures.*
2. *Information on any known material or structural impacts related to either measure.*

Email comments and suggestions to info@title24stakeholders.com *and* mguttman@energy-solution.com. *Comments will either not be released for public review or will be anonymized if shared.*

1.1 Report Context

This proposal describes specific energy efficiency code changes (referred to as "measures") aimed at reducing wasteful, uneconomic, inefficient, or unnecessary consumption of energy in California. These measures are submitted to the California Energy Commission (CEC) for consideration and potential inclusion in California's Energy Code (Title 24, Part 6), which sets statewide energy efficiency requirements for newly constructed buildings and for additions and alterations to existing buildings. Measures may also be considered for inclusion in CALGreen (Title 24, Part 11) as voluntary energy efficiency standards, which would take effect only if adopted by a local jurisdiction seeking to exceed the minimum requirements of the Energy Code. Measures submitted to the CEC will be reviewed, may be modified, and may be incorporated into a broader regulatory package proposed and adopted by the CEC. To be included in the Energy Code, proposed measures must be both cost effective and technically feasible.

1.2 Proposal Sponsors

Three California Investor-Owned Utilities (IOUs) — Pacific Gas & Electric Company, San Diego Gas & Electric, and Southern California Edison sponsored this effort as a group. Where the term, "Statewide CASE Team" is used in this report, it refers the

authors of the CASE report and the Codes & Standards programs of the supporting California Investor-Owned Utilities.

1.2.1 Stakeholder Engagement to Inform Proposal

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, state agencies, and others involved in the code compliance process. The proposal incorporates feedback received during a public stakeholder workshop that the Statewide CASE Team held on September 30, 2025.

See Appendix E for details on the Statewide CASE Team's stakeholder engagement.

2. New Construction/Additions Windows

2.1 New Construction/Additions Windows - Measure Description

2.1.1 Proposed Code Change

This Title 24, Part 6 proposal would update the maximum allowable prescriptive U-factors for windows in nonresidential new construction and additions for all building types. The proposal applies to fixed windows in Climate Zones 1 through 8, 10, and 16, and applies to operable windows in all climate zones. It does not apply to skylights, glazed doors, storefront, curtainwall, or other fenestration types.

The current maximum U-factor requirement for fixed windows in Climate Zones 1 through 8, 10, and 16 is U-0.36. The proposed requirement for fixed windows in these climate zones would be U-0.34. This would make the U-factor requirement for fixed windows in new construction the same across all climate zones.

The current maximum U-factor requirement for operable windows in all climate zones is U-0.46. This proposal would revise the requirement to U-0.43 in all Climate Zones.

For both window types, the Solar Heat Gain Coefficient (SHGC) and Visible Transmittance (VT) requirements would remain unchanged.

The 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 updated forms.

Table 2 summarizes the scope of the proposed code change.

Table 2: Scope of Proposed Code Change

Note: A ☑ indicates the proposed code change is relevant.

Building Type(s)	Construction Type(s)	Type of Change
☐ Single Family	☑ New Construction	☐ Mandatory
☐ Multifamily	☑ Additions	☑ Prescriptive
☑ Nonresidential (not Group R uses)	☐ Alterations	☐ Performance

Application Climate Zones	Energy Code Sections	Compliance Forms	Sections of ACM Reference Manuals
Climate Zones 1 through 16	• Part 6, Section 140.3	N/A	Mandatory

Third Party Verification	Updates to Compliance Software
☑ No changes to third party verification	☐ No updates
☐ Update existing verification requirements	☑ Update existing feature
☐ Add new verification requirements	☐ Add new feature

2.1.2 Benefits of Proposed Change

The proposed code change addresses inefficiencies in current fenestration U-factor requirements across a broad range of California climate zones, contributing to reduced heating energy use and improved thermal performance in new nonresidential buildings. By improving envelope performance rather than relying on operational or control-based measures, the proposal delivers stable, long-term benefits that persist regardless of occupant behavior.

In colder and heating-dominated climate zones, improved U-factors reduce conductive heat loss through windows, lowering heating energy demand and improving occupant comfort during extended heating seasons. In moderate and mixed climates, including many coastal and inland regions, enhanced U-factor performance reduces heat loss during cool mornings, evenings, and shoulder seasons, when buildings frequently operate in heating mode despite otherwise mild conditions. These effects are particularly relevant given the large volume of new construction occurring in these climate zones.

Across all evaluated regions, more energy-efficient windows contribute to improved indoor comfort by reducing cold surfaces, drafts, and localized temperature imbalances near fenestration. Improved comfort can reduce the likelihood of occupants adjusting thermostats to compensate for discomfort, helping to limit unnecessary heating or cooling energy use over time.

Enhanced fenestration performance may also support downstream system benefits. As building heating loads are reduced, future HVAC system replacements may allow for smaller, more appropriately sized equipment, improving system efficiency and part-load performance.

In addition to thermal benefits, higher-performance windows reduce the transmission of exterior noise, improving indoor acoustic conditions. Improved acoustic environments are associated with reduced stress and improved cognitive performance, particularly in office, school, and healthcare settings. Modernized fenestration systems also contribute to improved building aesthetics, supporting long-term building value and occupant satisfaction.

Together, these benefits demonstrate that the proposed U-factor improvements provide meaningful and durable performance gains across both colder and moderate California climate zones, with energy savings driven primarily by heating reductions and supported by improved comfort, acoustics, and building quality.

2.1.3 Background Information

Windows are a critical component of the building envelope for commercial construction. Heat transfer through the building envelope and associated air leakage are the largest factors impacting HVAC loads in most climates. Whereas walls can be many inches thick and full of insulation that slows heat transfer between the exterior and interior of a building, windows are the weakest link in the thermal envelope. Windows make up only about eight percent of a typical building envelope but account for 45 percent of the energy transfer through the envelope.[1]

Windows play a key role in determining levels of comfort, natural lighting, ventilation, and the amount of energy required to condition a building. The efficiency of windows depends on thermal indices (U-factor, SHGC, and VT) and on climate and other building characteristics. The term “U-factor” refers to the measurement of the relative level of heat transfer through building envelope components such as windows or walls. The lower the U-factor, the lower the rate of heat transfer. Therefore, the lower the U-factor, the better the insulating quality of the component.

This proposal builds on the Statewide CASE Team’s effort from previous code cycles to update the stringency of fixed and operable fenestration U-factors. The last update to Title 24 fenestration U-factors occurred in 2022, when the requirement for fixed fenestration in Climate Zone 9, and Climate Zones 11-15 was changed from U-0.36 to U-0.34. Prior to this (at least as far back as the 2013 code), the requirement for fixed fenestration for all climate zones was U-0.36 and for operable fenestration was U-0.46. This proposal represents the first update to the prescriptive U-factors for all climate

[1] U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy. “Pathway to Zero Energy Windows: Advancing Technologies and Market Adoption.” Accessed September 23, 2025. https://www.nrel.gov/docs/fy22osti/80171.pdf

zones since at least the 2013 code cycle, achieving closer alignment [2] the 2027 IECC and ASHRAE 90.1-2025 requirements.[3]

This proposal is based on prescriptive revisions made in the 2025 edition of ASHRAE 90.1, where it was shown to have positive life cycle energy savings. Overall, this proposal provides an incremental advancement in nonresidential fenestration requirements that is cost-effective and practical.

2.1.4 Modifications to Energy Code Documents

This section provides descriptions of how the proposed code change will affect each Energy Code document. See Section 2.6: New Construction/Additions Windows - Proposed Code Language of this report for detailed revisions to code language.

2.1.4.1 Energy Code Change Summary

The proposed energy code changes are limited to Table 140.3-B.

TABLE 140.3-B – PRESCRIPTIVE ENVELOPE CRITERIA FOR NONRESISENTIAL 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)

The proposed regulation changes the U-factor requirement for fixed windows in Climate Zones 1-8, 10, and 16 from U-0.36 to U-0.34. The proposal also changes the U-factor requirement for operable windows in all climate zones from U-0.46 to U-0.43.

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[3] For comparison, IECC proposal CE44-24 for the 2027 IECC Commercial code made slight improvements to U-factors for fixed and operable fenestration in IECC Climate Zones 1, and 4 through 8. The changes in IECC Climate Zones 4B (Mixed Dry) and 4C (Mixed Marine) only impact Climate Zones 1 and 16 in California (IECC 4B overlaps CA CZ 16, and IECC 4C overlaps CA CZ 1). This proposal recommends U-factor improvements for fixed and operable windows in Climate Zones 1 and 16 which would maintain equivalency with the IECC. The proposed lower U-factor in Climate Zone 1 compared to Climate Zone 16 align with IECC 2027 and ASHRAE 90.1-2025 prescriptive values, which assign slightly more stringent fenestration requirements to marine climates (IECC 4C, aligning with CA CZ 1) than to cold-dry mountain climates (IECC 4B, aligning with CA CZ16). This distinction reflects regional differences in humidity, solar exposure, and condensation potential. Note: existing Title 24 U-factors in CA Climate Zones 2-15 are currently stronger than the required fenestration U-factors in the IECC.

2.1.4.2 Reference Appendices Change Summary

The proposed changes would not impact the reference appendices, as fenestration is not covered in those documents.

2.1.4.3 Compliance Manuals Change Summary

The proposed changes would not impact the 2025 Nonresidential Compliance Manual, as specific U-factors are not identified in this document.

2.1.4.4 Alternative Calculation Method Reference Manual Change Summary

The proposed changes would not impact the ACM manual as the specific U-factors are not identified in this document.

2.1.4.5 Compliance Forms Change Summary

None of the nonresidential envelope compliance forms would require changes, although the schema logic supporting compliance within the prescriptive forms will need to be updated to reflect these reduced U-factor requirements.

2.1.4.6 Comparable Model Codes or Standards

The following model codes are relevant to this proposed measure:

- ASHRAE 90.1- 2025
- IECC 2027 (proposed)

This proposal and the IECC proposal were based on prescriptive revisions made in the 2025 edition of ASHRAE 90.1, where it was shown to have positive life cycle energy savings. Overall, this proposal provides an incremental advancement in nonresidential fenestration requirements that is cost-effective and practical.

2.1.4.7 Interactions with Other Regulations

Federal Laws and Regulations: There are no relevant federal laws or regulations with which this measure would be in conflict.

State laws and requirements: There are no relevant state laws or regulations with which this measure would be in conflict.

Interactions with California Building Code: There are no relevant conflicts with the other sections of the California Building Code.

Local requirements: There are no relevant local ordinances with which this measure would be in conflict.

2.2 New Construction/Additions Windows - Compliance and Enforcement

2.2.1 Compliance Considerations

The proposed measure will have no significant impact on current compliance and enforcement practices, other than verification of the updated performance requirements.

2.2.2 Impact on Market Actors

Table 3 summarizes impacts on market actors and suggests outreach and education that might be helpful to support market actors as they prepare for the effective date of the requirements.

Table 3: Impacts on Market Actors and Suggested Training and Education Opportunities

Market Actor	Impact(s)	Suggested Outreach and Education
Builders[a]	Builders involved in commercial construction may need to coordinate with designers and subcontractors to ensure installed window products meet updated U-factor requirements.	EnergyCodeAce Training and Fact Sheets summarizing updated fenestration requirements
Design Professionals[b]	Architects need to specify and detail windows that meet the updated U-factor requirement. They will need to verify that selected window products can achieve these lower performance targets, which may require shifting from familiar product lines to higher-efficiency framing systems. U-factors should be clearly listed on the window specifications, and designers should confirm which fenestration types (e.g. curtainwall, storefront) are exempt or subject to the new limits.	EnergyCodeAce Training and Fact Sheets focused on window product selection, performance labeling, and compliance documentation.
Construction Team[c]	The construction team needs to purchase and install windows with the updated U-factor requirements and confirm that selected products are NFRC-certified to those performance ratings. Teams will need to verify product documentation before installation and may need to adjust delivery schedules to account for longer lead times associated with higher-efficiency framing systems.	EnergyCodeAce Training and Fact Sheets focused on verifying NFRC certification and planning for product availability and lead times.

Market Actor	Impact(s)	Suggested Outreach and Education
Building Departments[d]	Building plan reviewers and inspectors (AHJs) using the prescriptive compliance method will need to become familiar with the updated U-factor requirements and understand which fenestration products meet these values. Inspectors must verify that installed products have NFRC-certified ratings consistent with the design documents.	EnergyCodeAce Training and Fact Sheets focused on U-factor updates, NFRC product labeling, and field verification guidance for AHJs.
Verification Testers[e]	N/A	N/A
Building Owners, Managers, and Occupants	Building owners may need to adjust design and budgets to ensure that the installed window products meet the updated NFRC-certified U-factor requirements. Over time, these higher-performance products will reduced energy bills and improve occupant comfort.	N/A
Manufacturers and Distributors	Manufacturers and distributors need to ensure that there are readily-available products that are NFRC-certified meeting the updated performance requirements.	EnergyCodeAce Training and Fact Sheets. Feedback to suppliers from contractors and installers.

a. Builders include builders and developers.
b. Design professionals include architects, interior designers, engineers (mechanical, electrical, plumbing, structural), specification writers, cost estimators, commissioning agents, glazing consultants, and energy consultants.
c. Construction team includes general contractors, design-build contractors, installation contractors, commissioning agents, and tradespeople. It also includes glass manufacturers, frame manufacturers, fabricators and glazing contractors.
d. Building departments include plans reviewers, building inspectors, specialty inspectors, permit counter technicians, and sustainability department staff.
e. Verification testers include commissioning agents, ECC Raters, and Acceptance Test Technicians.

The 2028 CASE Methodology Report presents a quantitative assessment of how changes to the California building code impact builders, building designers and energy consultants, and building owners and occupants. While the analysis in the methodology report is not specific to the code changes presented in this report, this measure focuses on manufacturers and architects, since these market actors are expected to experience the most direct impacts from the updated window performance requirements. The following provides a qualitative description of how this specific code change affects

various market actors and additional quantitative analyses of its potential impacts on building industry subsectors.

Builders. The proposed change would likely affect commercial builders; however, it would not significantly impact firms focused on non-building or heavy industrial construction, such as utility systems, public infrastructure, or other civil projects, where fenestration products are generally not used. The proposed change would not affect all firms and workers in the commercial building industry equally; instead, it would primarily affect specific subsectors within the industry. Table 4 shows the commercial building subsectors that the Statewide CASE Team expects to be impacted by the changes proposed in this report.

Table 4: Specific Subsectors of the California Commercial Building Industry Impacted by Proposed Change to Code/Standard by Subsector in 2025 (Estimated)

Construction Subsector	Establishments*	Employment	Annual Payroll (Billions $)
Commercial Building Construction	5,491	87,450	$10.6
Nonresidential Glass and Glazing Contractors	307	5,079	$0.5
Nonresidential Finish Carpentry Contractors	313	3,697	$0.3

Source: (State of California n.d.)

*An establishment is single economic unit, typically at one physical location, that engages in one, or predominantly one, type of economic activity for which a single industrial classification may be applied. Many businesses are composed of multiple establishments. US Bureau of Labor Statistics, Handbook of Methods. https://www.bls.gov/opub/hom/cew/concepts.htm

2.2.3 Compliance Software Updates

If this proposal is adopted for new construction (Table 140.3-B), CBECC will require only minor adjustments to reflect the updated prescriptive fenestration requirements.

The update would involve revising the prescriptive U-factor tables in the software to align with the new standards. No new compliance pathways or calculation methods are needed.

No new EnergyPlus objects are needed. CBECC already references NFRC-rated U-factors and SHGC values through existing EnergyPlus fenestration objects (such as WindowMaterial:SimpleGlazingSystem, WindowMaterial:Glazing, and FenestrationSurface:Detailed). No additional data inputs are required from users beyond what is already collected (fenestration area, orientation, and product ratings).

This measure represents only a minor compliance software update limited to updating reference values, not structural changes to the ruleset.

2.2.4 2.Cost of Enforcement

The Statewide CASE Team acknowledges that changes to the code will impact enforcement costs. This report is an evaluation of specific measures, and the collective impact of all proposed changes for the 2028 Title 24, Part 6 may represent an increase in training and/or workload for enforcement personnel.

Plan review function would consist of reviewing NRCC-ENV-E and NRCC-PRF-E and ensuring that it meets the new code requirement and is consistent with the drawings and specifications.

Inspection review would consist of reviewing NRCI-ENV-E and NRCA-ENV-02-F and ensuring that the information on the forms is consistent with the approved NRCC-ENV-E and NRCC-PRF-E forms and with what is actually installed.

2.3 New Construction/Additions Windows - Market and Economic Analysis

2.3.1 Market Structure and Availability

2.3.1.1 Current Market Structure and Availability

The nonresidential building envelope market involves many market actors in a variety of roles, including designers, architects, component manufacturers, installers, suppliers, construction companies, and certification/compliance specialists.

The fixed windows proposed for new construction in Climate Zones 1-8, 10, and 16 are already required in all the other climate zones and are readily available across California. The proposed operable window requirement is new for all climate zones, but is also readily available in the state.

During the 2025 code adoption cycle, 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 the public

stakeholder meeting that the Statewide CASE Team held on September 30, 2025 (as well as during the previous 2025 code cycle: February 14, 2023, and May 22, 2023).

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. Today, while visibility and aesthetics are top considerations for fenestration choices, there is increased recognition that window performance is a key point.

2.3.1.2 Market Challenges and Solutions

Commercial grade windows are already readily available from numerous window manufacturers. No new materials or processes would need to be developed for any of the nonresidential envelope measures to be successful.

The proposed U-factor requirement for vertical fenestration is based on products widely available in the market. The Statewide CASE Team does not anticipate technical or market challenges to meet this requirement within the time frame of when this code change would take effect (January 1, 2029).

See Section 2.2 for a description of workforce trainings that may be needed to ensure effective design, installation, and commissioning.

2.3.2 Design and Construction Practices

2.3.2.1 Current Design and Construction Practices

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 meet the requirements of Title 24, Part 6. There is no change required to complete NRCC compliance documents.

See Section 2.2.2 for a description of workforce trainings that could support effective design, installation, and commissioning.

2.3.2.2 Health and Safety Considerations

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

2.3.3 Energy Equity and Environmental Justice

The Statewide CASE Team identified potential impacts of the proposed code change via research and stakeholder input. While the listed potential impacts should be comprehensive, they may not yet be exhaustive. Recognizing the importance of engaging environmental and social justice (ESJ) communities 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. Please reach out to Maureen Guttman (mguttman@energy-solution.com) if you have input on how this proposal may impact ESJ communities or if you would like to offer your perspective.

The Statewide CASE Team evaluated the potential impact on ESJ communities,[4] including impacts related to race, class, and gender. It is unlikely that this proposal would have significant negative impacts on ESJ communities. This proposal has the potential to positively impact ESJ communities as tighter building envelopes would result in reduced air infiltration, improved indoor air quality, and improved indoor comfort. There are no expected significant impacts on ESJ communities regarding cost.

2.3.4 Impacts on Jobs and Businesses

This section will be completed for the Final CASE Report.

2.3.5 Economic and Fiscal Impacts

This section will be completed for the Final CASE Report.

2.4 New Construction/Additions Windows - Cost Effectiveness

2.4.1 Cost Effectiveness Methodology

The Statewide CASE Team collaborated with CEC staff to confirm that the cost-effectiveness methodology aligns with CEC guidelines, including cost inclusion

[4] The CPUC refers to ESJ communities as "low-income or communities of color that have been underrepresented in the policy setting or decision-making process, are subject to a disproportionate impact from one or more environmental hazards, and likely to experience disparate implementation of environmental regulations and socio-economic investments in their communities" (CPUC 2022). ESJ communities also include the CPUC definition for Disadvantaged Communities, which comprises "(1) Census tracts receiving the highest 25 percent of overall scores in CalEnviroScreen 4.0 (1,984 tracts); (2) Census tracts lacking overall scores in CalEnviroScreen 4.0 due to data gaps, but receiving the highest 5 percent of CalEnviroScreen 4.0 cumulative pollution burden scores (19 tracts); (3) Census tracts identified in the 2017 DAC designation as disadvantaged, regardless of their scores in CalEnviroScreen 4.0 (307 tracts); and (4) Lands under the control of federally recognized Tribes (OEHHA 2022).

parameters. The 2028 CASE Methodology Report and Appendix A provide reproducibility details.

Per California Law (Public Resources Code 25000), a measure is considered cost effective if its Benefit-Cost Ratio (BCR) is 1.0 or greater, amortized over the economic life of the structure. The Statewide CASE Team calculates BCR by dividing total dollar benefits by total dollar costs over a 30-year analysis period.

Benefits are based on Long-term System Cost (LSC), which assigns an hourly dollar value to energy use. LSC hourly factors weigh the long-term value of each hour differently, where times of peak demand are more expensive than off-peak hours. These factors are not utility rates, forecasts, or bill estimates. The CEC develops and publishes LSC hourly conversion factors for each code cycle.

Costs include first costs and ongoing maintenance costs assessed over the 30-year period. Benefits and costs are evaluated incrementally, relative to the most recently adopted Energy Code. The analysis excludes design costs and incremental code compliance verification costs.

2.4.2 Energy and Energy Cost Savings Results

Energy savings (electricity, natural gas, and source energy) and peak demand impacts per unit are presented in Tables 5 through Table 8 for the evaluated nonresidential building prototypes across California climate zones.

As shown in Table 5, per-unit first-year electricity savings are generally very small, and vary by prototype and climate zone. Reported values are typically near zero and range from small positive to small negative values (on the order of ±0.01 kWh/sf), reflecting minor shifts in cooling and electric heating energy use. Peak demand impacts are negligible across all evaluated prototypes and climate zones, as shown in Table 6. Modeled peak demand changes are effectively zero on a per–square-foot basis. As a result, the measure does not materially affect peak electric demand and should not be characterized as a demand-reduction measure.

By contrast, heating-related savings are larger. The proposed reduction in fenestration U-factor reduces heating loads across most building types and climate zones. For prototypes with natural gas heating systems, these reductions appear as natural gas savings, ranging from approximately 0.00 to 0.31 kBtu/sf, with larger savings in colder climate zones and heating-dominated occupancies such as schools, offices, assembly buildings, and restaurants, as shown in Table 7. For prototypes served by electric heating systems, the same heating load reductions appear as changes in electricity consumption and are reflected in the electricity savings results. These heating energy reductions drive positive source energy savings for most prototypes and climate zones.

As shown in Table 8, first-year source energy savings generally range from near zero to approximately 0.29 kBtu/sf, with higher values occurring in colder climates and heating-intensive building types. In a limited number of cases, small negative source energy impacts are observed, reflecting minor electricity increases with small heating savings.

Table 9 presents total per-unit energy cost savings for new construction and additions, expressed as LSC savings realized over a 30-year period, in 2029 present value dollars (2029 PV$). The LSC methodology allows peak electricity savings to be valued more than electricity savings during non-peak periods. LSC results vary by prototype and climate zone and include both positive and negative values. Many building types, particularly schools, offices, assembly buildings, and restaurants in colder climate zones, exhibit positive lifecycle savings driven primarily by avoided heating energy costs. In contrast, some prototypes and milder climate zones show limited or negative LSC savings where heating benefits are smaller and incremental costs outweigh energy savings.

Overall, the results demonstrate that the measure primarily improves heating-season energy performance, with limited effects on cooling energy use and peak electricity demand. Because fenestration thermal performance is stable over time and not influenced by occupant behavior or equipment degradation, first-year heating savings are expected to persist throughout the 30-year analysis period.

Table 5: First Year Electricity Savings (kWh) Per Square Foot – New Construction / Addition Windows

Prototype	CZ01	CZ02	CZ03	CZ04	CZ05	CZ06	CZ07	CZ08	CZ10	CZ16
Assembly	0.00	0.00	-0.01	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00
Hospital	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Large Office	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00
Large Retail	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	-0.01
Large School	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Medium Office	0.02	0.01	0.01	0.01	0.00	0.00	-0.01	0.00	0.00	0.04
Medium Retail	0.00	0.00	0.00	-0.01	0.00	-0.02	0.01	-0.02	0.00	0.00
Non-refrigerated Warehouse	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Restaurant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Small Office	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00

Small School	0.01	0.01	0.00	0.01	0.00	-0.01	-0.01	0.00	0.00	0.00
Strip Mall	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00

Table 6: First Year Peak Demand Reduction (kW) Per Square Foot – New Construction / Addition Windows

Prototype	CZ01	CZ02	CZ03	CZ04	CZ05	CZ06	CZ07	CZ08	CZ10	CZ16
Assembly	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hospital	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Large Office	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Large School	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Medium Office	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Medium Retail	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non-refrigerated Warehouse	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Restaurant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Small Office	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Small School	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Strip Mall	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 7: First Year Natural Gas Savings (kBtu) Per Square Foot—New Construction / Addition Windows

Prototype	CZ01	CZ02	CZ03	CZ04	CZ05	CZ06	CZ07	CZ08	CZ10	CZ16
Assembly	0.22	0.16	0.12	0.14	0.11	0.05	0.06	0.06	0.06	0.31
Hospital	0.08	0.06	0.05	0.06	0.05	0.03	0.02	0.03	0.04	0.09
Large Office	0.11	0.09	0.07	0.09	0.07	0.04	0.04	0.04	0.04	0.17
Large Retail	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
Large School	0.19	0.14	0.12	0.12	0.12	0.07	0.06	0.06	0.07	0.23
Medium Office	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Medium Retail	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06

Prototype	CZ01	CZ02	CZ03	CZ04	CZ05	CZ06	CZ07	CZ08	CZ10	CZ16
Non-refrigerated Warehouse	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Restaurant	0.16	0.11	0.08	0.09	0.07	0.03	0.02	0.02	0.03	0.24
Small Office	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21
Small School	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31
Strip Mall	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11

Table 8: First Year Source Energy Savings (kBtu) Per Square Foot—New Construction / Addition Windows

Prototype	CZ01	CZ02	CZ03	CZ04	CZ05	CZ06	CZ07	CZ08	CZ10	CZ16
Assembly	0.20	0.15	0.11	0.14	0.10	0.04	0.05	0.06	0.06	0.28
Hospital	0.07	0.05	0.04	0.05	0.04	0.02	0.02	0.03	0.03	0.08
Large Office	0.10	0.08	0.06	0.08	0.06	0.03	0.03	0.03	0.04	0.15
Large Retail	0.01	0.00	0.00	0.00	0.00	0.00	0.01	-0.01	0.00	0.03
Large School	0.17	0.13	0.11	0.12	0.11	0.06	0.05	0.05	0.06	0.22
Medium Office	0.07	0.06	0.03	0.06	0.04	0.01	0.01	0.01	0.02	0.10
Medium Retail	0.03	0.00	0.00	0.01	0.00	-0.01	0.02	-0.02	0.00	0.05
Non-refrigerated Warehouse	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Restaurant	0.14	0.09	0.06	0.08	0.06	0.02	0.02	0.02	0.03	0.20
Small Office	0.02	0.02	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.19
Small School	0.08	0.04	0.02	0.04	0.02	0.01	0.00	0.01	0.01	0.29
Strip Mall	0.05	0.01	0.01	0.01	0.01	0.00	0.00	0.00	-0.01	0.09

Table 9: Total 30-Year LSC Savings (2029 PV$) Per Square Foot – New Construction/Addition Windows

Prototype	CZ01	CZ02	CZ03	CZ04	CZ05	CZ06	CZ07	CZ08	CZ10	CZ16
Assembly	0.23	0.15	0.09	0.14	0.06	0.00	0.04	0.06	0.09	0.28
Hospital	0.06	0.05	0.03	0.05	0.03	0.01	0.01	0.03	0.03	0.08
Large Office	0.09	0.07	0.05	0.07	0.02	0.01	0.01	0.01	0.03	0.14
Large Retail	0.02	0.00	0.00	0.01	0.00	-0.02	0.03	-0.06	-0.01	-0.03
Large School	0.19	0.15	0.12	0.15	0.12	0.07	0.05	0.06	0.08	0.28
Medium Office	0.25	0.17	0.09	0.16	0.08	-0.01	-0.03	-0.01	0.03	0.33
Medium Retail	0.03	0.00	0.01	-0.06	0.00	-0.09	0.12	-0.15	0.06	0.09
Non-refrigerated Warehouse	0.01	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.02
Restaurant	0.14	0.09	0.06	0.08	0.04	0.00	0.00	0.01	0.02	0.21
Small Office	0.06	0.04	0.01	0.04	-0.01	-0.03	-0.02	-0.01	0.00	0.21
Small School	0.18	0.11	0.06	0.11	0.06	-0.02	-0.04	0.00	0.04	0.31
Strip Mall	0.06	0.04	0.02	0.03	0.01	0.01	0.02	-0.01	-0.10	0.12

2.4.3 Incremental First Cost

Incremental first costs (or incremental costs) reflect the difference in material and labor costs of installing window units with properties meeting the proposed measure as compared to those with properties meeting existing code requirements.

The Statewide CASE Team is conducting interviews and surveys with manufacturers, trade associations, builders, national laboratories, and other stakeholders to gain knowledge on window pricing and installation labor. We are continuing to collect cost information from stakeholders and will update any assumptions for the final version of this report.

Most labor costs associated with window installation will remain unchanged. One possible impact raised by stakeholders is the additional weight and associated costs if triple-paned windows start to displace double-paned windows. The Statewide CASE Team does not anticipate any increase in labor for the windows with U-factors proposed in this measure, as these U-factors can be readily achieved with double glazing.

2.4.4 Incremental Maintenance and Replacement Costs

In general, windows are 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 issued 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 most 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 Draft CASE Report.

If building drainage elements are inspected as noted above, the only common replacement cost for windows 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 ten 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 cost (or savings) was calculated using a three percent discount rate (d), which is consistent with the discount rate used when developing the 2028 LSC hourly factors.

Description of the incremental maintenance and replacement costs, as well as estimation of present value of maintenance and replacement costs, are provided in the 2028 CASE Methodology Report.

Table 10: Windows in Newly Constructed Buildings and Additions – Incremental Cost per Square Foot of Building Area – TBD

Building Prototype	Net Window Area (Sq.Ft.)	Incremental Cost per Square Foot of Window	Total Cost	Building Area (Sq.Ft.)	Total Cost per Square Foot of Building Area ($/SqFt)
Large Office	48,134	$0.58	$27,918	498,589	$0.06
Medium Office	7,027	$0.58	$4,076	53,628	$0.08
Small Office	642	$0.58	$372	5,502	$0.07
Large Retail	5,881	$0.58	$3,411	240,000	$0.01
Large School	22,162	$0.58	$12,854	210,866	$0.06
Small School	4,964	$0.58	$2,879	24,413	$0.12
Assembly	60,207	$0.58	$34,920	315,339	$0.11
Hospital	9,133	$0.58	$5,297	249,985	$0.02
Laboratory	7,027	$0.58	$4,076	53,628	$0.08
Small Restaurant	280	$0.58	$162	2,501	$0.06
Medium Retail	904	$0.58	$524	24,563	$0.02
Retail Strip Mall	558	$0.58	$324	9,375	$0.03
Warehouse	190	$0.58	$110	52,050	$0.00

2.4.5 Cost Effectiveness

Results of the per-unit cost-effectiveness analyses will be presented in Table 11 for new construction/additions for the Final CASE Report, once we have reliable incremental cost data.

Table 11: 30-Year Cost-Effectiveness Summary Per Square Foot of Window Area – New Construction and Additions - TBD

Climate Zone	Benefits LSC Savings + Other PV Savings (2029 PV$/square foot)	Costs Total Incremental PV Costs (2029 PV$/square foot)	Benefit-to-Cost Ratio
CZ01			
CZ02			
CZ03			
CZ04			
CZ05			
CZ06			
CZ07			
CZ08			
CZ10			
CZ16			
Total			

2.5 New Construction/Additions Windows - Statewide Impacts

2.5.1 Statewide Energy and Energy Cost Savings

See the 2028 CASE Methodology Report for details on how statewide savings are calculated. Appendix C presents the assumptions on the percentage of the total construction forecast that the proposed measure would impact.

For more details on the methodology and context about estimating the current market share rate, as well as statewide energy and energy cost savings, see the 2028 CASE Methodology Report.

Table 12 presents first-year statewide savings for new construction and additions based on the subset of nonresidential prototypes included in this fenestration analysis. The proposed measure results in approximately 0.0179 million therms of first-year natural gas savings and 1.99 million kBtu of source energy savings statewide. First-year electricity impacts are small, resulting in a net statewide change of approximately −0.055 GWh, while peak demand is reduced by 0.05 MW.

Over a 30-year analysis period, total present-valued LSC savings are estimated at approximately $2.17 million statewide (2029 PV$). Positive lifecycle savings are observed in most climate zones, particularly those with higher heating loads and greater

new construction activity, while limited negative LSC values occur in select milder or cooling-dominated zones where heating benefits are smaller relative to incremental costs.

These results are expected given that the proposed change affects fenestration U-factor performance without modifying SHGC values, which are the primary drivers of cooling energy use and peak demand in California climates. Overall, the new construction results indicate that the measure provides incremental heating-related benefits, with the largest contributions to statewide lifecycle savings occurring in climate zones with both meaningful heating impacts and substantial new construction activity, including Climate Zones 2, 3, 4, and 10.

Table 12: Statewide Energy and LSC Impacts – New Construction/Addition Windows

Note: These totals reflect only the building prototypes modeled for this fenestration analysis and therefore represent a subset of the full statewide new construction forecast shown in Appendix C.

Climate Zone	Statewide New Construction & Additions Impacted by Proposed Change in 2028 (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 Present Valued LSC Savings (Million 2029 PV$)
CZ01	422,448	0.004	0.00	0.0001	0.0246446664	$0.0575994614
CZ02	2,997,247	0.01	0.01	0.0010	0.1484286419	$0.2392363211
CZ03	14,257,805	0.01	0.01	0.0057	0.6245654607	$0.7836614932
CZ04	6,996,227	0.02	0.01	0.0029	0.3606165392	$0.5223172335
CZ05	1,268,071	0.00	0.00	0.0002	0.0351207952	$0.0619126769
CZ06	8,545,889	(0.03)	0.00	0.0015	0.1241352610	-$0.0544328021
CZ07	6,267,274	(0.01)	0.00	0.0014	0.1374886027	$0.1076191047
CZ08	12,446,600	(0.03)	0.00	0.0024	0.2425948039	$0.1316931332
CZ10	9,890,370	(0.02)	0.01	0.0018	0.2014619621	$0.1943315392
CZ16	811,218	0.004	0.00	0.0010	0.0986119373	$0.1283471617
Total	63,903,148	(0.055)	0.05	0.0179	1.9976686703	$2.1722853228

2.5.2 Statewide Greenhouse Gas Emissions Reductions

Table 13 presents the estimated first-year reduction in GHG emissions resulting from the proposed code change. In this initial year, the Statewide CASE Team expects to avoid 117.9 metric tons of carbon dioxide equivalent (CO_2e) emissions. These reductions, along with their associated monetary value, were calculated using hourly GHG emissions factors published alongside the LSC hourly factors and source energy hourly factors in the research versions of CBECC, as well as data from the CEC's 2028 Metrics Report. See the 2028 CASE Methodology Report for additional information.

Table 13: First-Year Statewide GHG Emissions Impacts

Construction Type	Reduced GHG Emissions from Electricity Savings (Metric Tons CO2e)	Reduced GHG Emissions from Natural Gas Savings (Metric Tons CO2e)	Total Reduced GHG Emissions (Metric Ton CO2e)	Total Monetary Value of Reduced GHG Emissions ($)
New Construction & Additions	24.40124	93.52576	117.92699	14,522
Alterations	-	-	-	-
Total	**24.40124**	**93.52576**	**117.92699**	**14,522**

2.5.3 Statewide Water Use Impacts

The proposed code change will not result in water use impacts.

2.5.4 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 should not necessarily translate to more or different materials being used.

For more information on the Statewide CASE Team's methodology and assumptions used to calculate embodied GHG emissions, see the 2028 CASE Methodology Report.

2.5.5 Environmental Impacts

This proposal would result in significant energy savings and GHG emissions reduction. The requirement ensures that less thermal energy is exchanged through windows, increasing the heating and cooling efficiency within spaces.

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

2.5.6 Other Non-Energy Impacts

Improved insulation from better performing windows would provide tighter building envelopes, thus improving occupant comfort by better regulating indoor temperature, reducing noise, and contributing to indoor air quality.

2.6 New Construction/Additions Windows - Proposed Code Language

2.6.1 Guide to Markup Language

The proposed changes to the standards, Reference Appendices, and the ACM Reference Manuals are provided below. Changes to the 2025 documents should be marked with dark blue underlining (new language) and ~~strikethroughs~~ (deletions).

2.6.2 Administrative Code (Title 24, Part 1)

There are no proposed changes to Title 24, Part 1.

2.6.3 Energy Code (Title 24, Part 6)

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)

Fenestration – Vertical (All Climate Zones) (Area-Weighted Performance Rating)	CZ 1	CZ 2	CZ3	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
Fixed Window (Max U-factor)	~~0.36~~ 0.34	~~0.36~~ 0.34	~~0.36~~ 0.34	~~0.36~~ 0.34	~~0.36~~ 0.34	~~0.36~~ 0.34	~~0.36~~ 0.34	~~0.36~~ 0.34	0.34	~~0.36~~ 0.34	0.34	0.34	0.34	0.34	0.34	~~0.36~~ 0.34
Fixed Window (Max RSHGC)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.22	0.25	0.22	0.22	0.22	0.22	0.22	0.25
Fixed Window (Min VT)	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
Curtainwall or Storefront (Max U-factor)	0.38	0.41	0.41	0.41	0.41	0.41	0.38	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41
Curtainwall or Storefront	0.25	0.26	0.26	0.26	0.26	0.26	0.25	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26

Fenestration – Vertical (All Climate Zones) (Area-Weighted Performance Rating)	CZ 1	CZ 2	CZ3	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
(Max RSHGC)																
Curtainwall or Storefront (Min VT)	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
Operable Window (Max U-factor)	~~0.46~~ 0.43	~~0.46~~ 0.43	~~0.46~~ 0.43	~~0.46~~ 0.43	~~0.46~~ 0.43	~~0.46~~ 0.43	~~0.46~~ 0.43	~~0.46~~ 0.43	~~0.46~~ 0.43	~~0.46~~ 0.43	~~0.46~~ 0.43	~~0.46~~ 0.43	~~0.46~~ 0.43	~~0.46~~ 0.43	~~0.46~~ 0.43	~~0.46~~ 0.43
Operable Window (Max RSHGC)	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
Operable Window (Min VT)	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
Glazed Doors (Max U-factor)	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Glazed Doors (Max RSHGC)	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
Glazed Doors (Min VT)	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Fenestration (Max WWR%)	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%

2.6.4 Reference Appendices

There are no proposed changes to the Reference Appendices.

2.6.5 Compliance Manuals

The Statewide CASE Team will provide CEC with recommended revisions to compliance manuals after the 45-Day Language is published.

2.6.6 ACM Reference Manual

There are no proposed changes to the ACM Reference Manual.

2.6.7 Compliance Forms

As discussed in Section 2.1.4.5, none of the current nonresidential compliance forms would need to be updated to reflect the proposed change although the schema logic

supporting compliance within the prescriptive forms will need to be updated to reflect these reduced U-factor requirements.

3. Window Alterations

3.1 Window Alterations - Measure Description

3.1.1 Proposed Code Change

The current maximum U-factor requirement for window alterations is U-0.58 in Climate Zones 3 and 5, and U-0.47 in all other climate zones. The current maximum RSHGC for window alterations is 0.41 in Climate Zones 1, 3, 5, and 16, and 0.31 in all other climate zones. This proposal would revise the requirement to match the required new construction U-factors and RSHGC values when major vertical fenestration replacement projects occur.

This Title 24, Part 6 proposal would update the prescriptive U-factors and RSHGC for all vertical fenestration in nonresidential building alterations to align with requirements for new construction when 100 percent of any one fenestration type (windows, curtainwall, storefront, or glazed doors) is replaced.

The existing Table 141.0-A provides a single U-factor and RSHGC for every type of vertical fenestration, depending on the climate zone. This proposal also replaces the existing Table 141.0-A indicating updated U-factors and RSHGC values for individual vertical fenestration types.

In the energy modeling for this measure, alteration cases were treated as full replacement projects in which all modeled vertical fenestration in the prototype (fixed windows, clerestories, and glazed doors) are upgraded from the current alteration requirements to the proposed U-factor and RSHGC values. The CEC prototype models do not include curtainwall or storefront systems, so the modeled savings apply only to the fenestration types that exist in the prototypes. This aligns with the code trigger, which applies when 100 percent of any one fenestration type (windows, glazed doors, curtainwall, or storefront) is replaced.

The proposal would not add or modify acceptance tests or require any technology not previously regulated.

Table 14 summarizes the scope of the proposed code change.

Table 14: Scope of Proposed Code Change

A ☑ indicates the proposed code change is relevant.

Building Type(s)	Construction Type(s)	Type of Change
☐ Single Family	☐ New Construction	☐ Mandatory
☐ Multifamily	☐ Additions	☑ Prescriptive
☑ Nonresidential (not Group R uses)	☑ Alterations	☐ Performance

Application Climate Zones	Energy Code Sections	Compliance Forms	Sections of ACM Reference Manuals
Climate Zones	Part 6, Section 141.0(b)	N/A	Mandatory

Third Party Verification)	Updates to Compliance Software
☐ No changes to third party verification	☐ No updates
☐ Update existing verification requirements	☑ Update existing feature
☑ Add new verification requirements	☐ Add new feature

3.1.2 Benefits of Proposed Change

The proposed code change would directly address the inefficiencies in the current U-factors for alterations in all climate zones. More energy efficient windows reduce energy costs, improve indoor occupant comfort, reduce noise infiltration, and improve the aesthetics of a building.

Enhancing indoor comfort improves an individual's experience during their time in the building and promotes a sense of well-being. More comfortable occupants are less likely to adjust the thermostat, which reduces overall heating or cooling loads, and reduces energy bills in the long-term.

When a substantial portion of fenestration is upgraded, building owners may have the opportunity to install smaller-capacity HVAC equipment during future system replacements, improving system performance and further increasing overall energy efficiency. In addition to the thermal benefits, better windows reduce the transmission of external noise. Improving the acoustic environment supports cognitive performance and reduces stress levels.

Together these benefits foster healthier indoor spaces, promote overall well-being, and create environments that are more conducive to productivity and long-term occupant satisfaction.

3.1.3 Background Information

Windows are a critical component of the building envelope for commercial construction. Heat transfer through the building envelope and associated air leakage are the largest factors impacting HVAC loads in most climates. Whereas walls can be many inches thick and full of insulation that slows heat transfer between the exterior and interior of a building, windows are the weakest link in the thermal envelope. Windows make up only about eight percent of a typical building envelope but account for 45 percent of the energy transfer through the envelope.[5]

Windows play a key role in determining levels of comfort, natural lighting, ventilation, and the amount of energy required to condition a building The efficiency of windows depends on thermal indices (U-factor, SHGC, and VT) and on climate and other building characteristics. The term “U-factor” refers to the measurement of the relative level of heat transfer through building envelope components such as windows or walls. The lower the U-factor, the lower the rate of heat transfer. Therefore, the lower the U-factor, the better the insulating quality of the component.

The Relative Solar Heat Gain Coefficient (RSHGC) measures how much solar radiation passes through a window compared to a reference pane of clear 1/8-inch glass. Lower RSHGC values indicate greater resistance to solar heat gain, which helps reduce cooling loads and improve occupant comfort in warm or sun-exposed spaces.

The required U-factors and RSHGC values for fenestration alterations have been unchanged since at least the 2013 code. In Title 24, these RSHGC limits directly reflect the SHGC requirements for rated products and do not use the IECC projection-factor method.

The Statewide CASE Team proposes to update these values by requiring that replacement fenestration (where 100% of any one type of fenestration is being replaced) comply with the U-factor values for new construction. These updates would reduce unwanted solar gains across all climate zones and improve cooling-season performance and comfort in sun-exposed spaces.

3.1.4 Modifications to Energy Code Documents

This section provides descriptions of how the proposed code change will affect each Energy Code document. See Section 3.6: Window Alterations - Proposed Code Language of this report for detailed revisions to code language.

[5] U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy. “Pathway to Zero Energy Windows: Advancing Technologies and Market Adoption.” Accessed September 23, 2025. https://www.nrel.gov/docs/fy22osti/80171.pdf

3.1.4.1 Energy Code Change Summary

SECTION 141.0(b) Alterations

Subsection 141.0(b)2A: The proposed regulation adds language to specify the requirements of alterations that would trigger the compliance with Table 140.3-B.

Table 141.0 -A: This table is replaced with an expanded table and updated requirements for fenestration alterations less than 100% of any fenestration type.

3.1.4.2 Reference Appendices Change Summary

The proposed changes would not impact the reference appendices, as fenestration is not covered in those documents.

3.1.4.3 Compliance Manuals Change Summary

The proposed changes would not impact the 2025 Nonresidential Compliance Manual, as specific U-factors are not identified in this document.

3.1.4.4 Alternative Calculation Method Reference Manual Change Summary

The proposed changes would not impact the ACM manual as the specific U-factors are not identified in this document.

3.1.4.5 Compliance Forms Change Summary

None of the nonresidential envelope compliance forms would require changes, although the schema logic supporting compliance within the prescriptive forms will need to be updated to reflect these reduced U-factor requirements.

3.1.5 Measure Context

3.1.5.1 Comparable Model Codes or Standards

The following model codes are relevant to this proposed measure:

- ASHRAE 90.1 – 2025
- IECC 2024

Section C503.2.2.1 of the IECC applies to replacement fenestration products, and requires that when some or all of an existing fenestration unit is replaced, the replacement unit must meet the performance requirements for new construction. An exception applies if an area-weighted average is used for the replacement fenestration.

Similarly, Section 5.1.4 of ASHRAE 90.1 requires replacement fenestration to meet the performance criteria for new construction unless the total area of the replacement fenestration does not exceed 25 percent of the total fenestration area of the building.

3.1.5.2 Interactions with Other Regulations

- **Federal Laws and Regulations:** There are no relevant federal laws or regulations with which this measure would be in conflict.
- **State laws and requirements:** There are no relevant state laws or regulations with which this measure would be in conflict.
- **Interactions with California Building Code:** There are no relevant conflicts with the other sections of the California Building Code.
- **Local requirements:** There are no relevant local ordinances with which this measure would be in conflict.

3.2 Window Alterations - Compliance and Enforcement

3.2.1 Compliance Considerations

The proposed measure will have no significant impact on current compliance and enforcement practices, other than verification of the updated performance requirements.

3.2.2 Impact on Market Actors

Table 15 summarizes impacts on market actors and suggests outreach and education that might be helpful to support market actors as they prepare for the effective date of the requirements.

Table 15: Impacts on Market Actors and Suggested Training and Education Opportunities

Market Actor	Impact(s)	Suggested Outreach and Education
Builders [a]	Commercial builders may be affected by the updated U-factor and RSHGC requirements for replacement window projects.	EnergyCodeAce Training and Fact Sheets summarizing updated alteration requirements
Design Professionals [b]	Architects need to specify and detail replacement windows with the updated U-factor and RSHGC requirements. They will also need to document whether the project replaces 100 percent of any single fenestration type (windows, curtainwall, storefront, glazed doors), including clearly identifying which fenestration types are fully replaced and which are only partially replaced.	EnergyCodeAce Training and Fact Sheets on determining whether 100 percent replacement of a fenestration type has occurred, performing fenestration-area calculations, and documenting compliance in submittals.
Construction Team [c]	The construction team needs to purchase and install windows with	EnergyCodeAce Training and Fact Sheets.

Market Actor	Impact(s)	Suggested Outreach and Education
	the updated performance requirements.	
Building Departments [d]	Building plan reviewers need to verify that drawings and specifications have met the updated code requirements, including confirming whether the project replaces 100 percent of any single fenestration type, which would trigger application of the new-construction fenestration requirements for that type. Inspectors need to verify that the correct window components are installed.	EnergyCodeAce Training and Fact Sheets, supplemented by a calculator to help determine whether a project has replaced 100 percent of a fenestration type
Verification Testers [e]	N/A	N/A
Building Owners, Managers, and Occupants	Building owners may face expectations to replace all units of a given fenestration type (for example, all window or all storefront units on a façade) once alterations begin, potentially affecting project scope and budgets. Partial window replacements can also create aesthetic inconsistencies or HVAC balancing issues between upgraded and non-upgraded spaces. Over time, these upgrades reduce energy bills and improve occupant comfort.	Outreach materials for planning considerations with partial window replacements and coordination with design teams to maintain visual and thermal consistency.
Manufacturers and Distributors	Manufacturers and distributors need to ensure that there are readily-available products meeting the updated performance requirements.	EnergyCodeAce Training and Fact Sheets. Feedback to suppliers from contractors and installers.

a. Builders include builders and developers.
b. Design professionals include architects, interior designers, engineers (mechanical, electrical, plumbing, structural), specification writers, cost estimators, commissioning agents, lighting designers, and energy consultants.
c. Construction team includes general contractors, design-build contractors, installation contractors (e.g., HVAC, plumbing, electrical), commissioning agents, and tradespeople.
d. Building departments include plan reviewers, building inspectors, specialty inspectors, permit counter technicians, and sustainability department staff.
e. Verification testers include commissioning agents, ECC Raters, and Acceptance Test Technicians.

The 2028 CASE Methodology Report presents a quantitative assessment of how changes to the California building code impact builders, building designers and energy consultants, and building owners and occupants. The analysis in the methodology report is not specific to the code changes presented in this report. The following

provides a qualitative description of how this specific code change affects various market actors and additional quantitative analyses of its potential impacts on building industry subsectors.

Builders. The proposed change would likely affect commercial builders; however, it would not significantly impact firms focused on the construction or retrofitting of industrial buildings, utility systems, public infrastructure, or other heavy construction, where fenestration products are generally not used. The proposed change would not affect all firms and workers in the commercial building industry equally; instead, it would primarily affect specific subsectors within the industry. Table 16 shows the commercial building subsectors that the Statewide CASE Team expects to be impacted by the changes proposed in this report.

Table 16: Specific Subsectors of the California Commercial Building Industry Impacted by Proposed Change to Code/Standard by Subsector in 2025 (Estimated)

Construction Subsector	Establishments*	Employment	Annual Payroll (Billions $)
Commercial Building Construction	5,491	87,450	$10.6
Nonresidential Glass and Glazing Contractors	307	5,079	$0.5
Nonresidential Finish Carpentry Contractors	313	3,697	$0.3

Source: (State of California n.d.)

*An establishment is single economic unit, typically at one physical location, that engages in one, or predominantly one, type of economic activity for which a single industrial classification may be applied. Many businesses are composed of multiple establishments. US Bureau of Labor Statistics, Handbook of Methods. https://www.bls.gov/opub/hom/cew/concepts.htm

3.2.3 Compliance Software Updates

If this proposal is adopted for alterations (Table 141.0-A), CBECC will require only minor adjustments to reflect the updated prescriptive fenestration requirements.

The update would involve revising the prescriptive U-factor and SHGC tables in the software to align with the new standards. Because Table 141.0-A expresses the solar gain in terms of the Relative Solar Heat Gain Coefficient (RSHGC), CBECC would convert these values to their equivalent SHGC values for use in EnergyPlus. Users will continue to enter NFRC-rated SHGC values. No new compliance pathways or calculation methods are needed.

No new EnergyPlus objects are needed. CBECC already references NFRC-rated U-factors and SHGC values through existing EnergyPlus fenestration objects (such as WindowMaterial:SimpleGlazingSystem, WindowMaterial:Glazing, and FenestrationSurface:Detailed). No additional data inputs are required from users beyond what is already collected (fenestration area, orientation, and product ratings).

This measure represents only a minor compliance software update limited to updating reference values. The existing alteration compliance trigger in CBECC already covers window replacement projects, so no new trigger needs to be added. CBECC would simply adjust its internal logic to apply the updated prescriptive U-factor and RSHGC requirements when 100% replacement of a fenestration type occurs.

3.2.4 Cost of Enforcement

The Statewide CASE Team acknowledges that changes to the code will impact enforcement costs. This report is an evaluation of specific measures, and the collective impact of all proposed changes for the 2028 Title 24, Part 6 may represent an increase in training and/or workload for enforcement personnel.

Plan review function would consist of reviewing NRCC-ENV-E and NRCC-PRF-E and ensuring that it meets the new code requirement and is consistent with the drawings and specifications.

Inspection review would consist of reviewing NRCI-ENV-E and NRCA-ENV-02-F and ensuring that the information on the forms is consistent with the approved NRCC-ENV-E and NRC-PRF-E forms and with what is actually installed.

3.3 Window Alterations - Market and Economic Analysis

3.3.1 Market Structure and Availability

3.3.1.1 Current Market Structure and Availability

The nonresidential building envelope market involves many market actors in a variety of roles, including designers, architects, component manufacturers, installers, suppliers, construction companies, and certification/compliance specialists.

The windows proposed for this measure are the same windows already required for new construction in most climate zones and are readily available across California.

During the 2025 code adoption cycle, 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 the public stakeholder meeting that the Statewide CASE Team held on September 30, 2025 (as well as during the previous 2025 code cycle: February 14, 2023, and May 22, 2023).

In today's market, façade engineering and envelope retrofits have become increasingly common, reflecting a growing appreciation for energy-efficient fenestration systems in existing buildings. Double-glazed windows are now standard for leading window manufacturers, making higher-performance options more accessible for alteration projects. Real estate owners are also pursuing façade and window upgrades to enhance building asset value and attract tenants in the post-pandemic era. While visibility and aesthetics remain important design considerations, there is a growing recognition within the alterations market that window performance is a key factor in occupant comfort, operating costs, and long-term building value.

3.3.1.2 Market Challenges and Solutions

Commercial grade windows are already readily available from numerous window manufacturers. No new materials or processes would need to be developed for any of the nonresidential envelope measures to be successful.

The proposed U-factor and RSHGC requirement for vertical fenestration is based on products widely available in the market. The Statewide CASE Team does not anticipate technical or market challenges to meet this requirement within the time frame when this code change would take effect (January 1, 2029).

See Section 3.2 for a description of workforce trainings that may be needed to ensure effective design, installation, and commissioning.

3.3.2 Design and Construction Practices

3.3.2.1 Current Design and Construction Practices

Building designers must be aware of the code changes to the window U-factors and RSHGC. The qualified design reviewer, per commissioning requirements, as well as energy consultants and compliance documentation authors must verify that plans and specifications match and meet the requirements of Title 24, Part 6. There is no change required to complete NRCC compliance documents.

For alterations, these design and documentation practices remain applicable but are limited to the vertical fenestration being replaced, with particular attention to identifying when 100 percent of a fenestration type is being replaced and therefore must meet the

new construction U-factor and RSHGC requirements. While no new floor area or envelope assemblies are created, the design and compliance team must still ensure that the replacement window systems meet the updated U-factor and RSHGC requirements and are properly documented in the compliance forms.

See in Section 2.2.2 for a description of workforce trainings that could support effective design, installation, and commissioning.

3.3.2.2 Health and Safety Considerations

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

3.3.3 Energy Equity and Environmental Justice

The Statewide CASE Team identified potential impacts of the proposed code change via research and stakeholder input. While the listed potential impacts should be comprehensive, they may not yet be exhaustive. Recognizing the importance of engaging ESJ communities and gathering their input to inform the code change process and proposed measures, the Statewide CASE Team is working to build relationships with CBOs to facilitate meaningful engagement.

Please reach out to Maureen Guttman (mguttman@energy-solution.com) if you have input on how this proposal may impact ESJ communities or if you would like to offer your perspective.

The Statewide CASE Team evaluated the potential impact on ESJ communities, including impacts related to race, class, and gender. It is unlikely that this proposal would have significant negative impacts on ESJ communities. This proposal would result in tighter building envelopes and thus would result in improved indoor air quality, which could impact communities positively. There are no expected impacts on ESJ communities regarding cost.

3.3.4 Impacts on Jobs and Businesses

This section will be completed for the Final CASE Report.

3.3.5 Economic and Fiscal Impacts

This section will be completed for the Final CASE Report.

3.4 Window Alterations - Cost Effectiveness

3.4.1 Cost Effectiveness Methodology

The Statewide CASE Team collaborated with CEC staff to confirm that the cost-effectiveness methodology aligns with CEC guidelines, including cost inclusion parameters. The 2028 CASE Methodology Report and Appendix A provide reproducibility details.

Per California Law (Public Resources Code 25000), a measure is considered cost effective if its Benefit-Cost Ratio (BCR) is 1.0 or greater, amortized over the economic life of the structure. The Statewide CASE Team calculates BCR by dividing total dollar benefits by total dollar costs over a 30-year analysis period.

Benefits are based on LSC, which assigns an hourly dollar value to energy use. LSC hourly factors weigh the long-term value of each hour differently, where times of peak demand are valued more than off-peak hours. These factors are not utility rates, forecasts, or bill estimates. The CEC develops and publishes LSC hourly conversion factors for each code cycle.

Costs include first costs and ongoing maintenance costs assessed over the 30-year period. Benefits and costs are evaluated incrementally, relative to the most recently adopted Energy Code. The analysis excludes design costs and incremental code compliance verification costs.

3.4.2 Energy and Energy Cost Savings Results

Energy savings and impacts from the window alterations measure are presented in Table 17 through Table 21. Results reflect modeled changes to fixed-window U-factors across all prototypes and glazed-door SHGC adjustments in the Small Office prototype only. Operable windows and storefront systems are included for policy completeness but are not present in the prototypes and therefore do not affect modeled results.

First-year electricity savings per square foot are generally small in magnitude, reflecting the modest U-factor improvement under the alterations pathway and the limited role of windows in overall cooling energy use for many nonresidential buildings. Electricity impacts range from slightly negative to approximately 0.07 kWh/sf, with most values clustering close to zero across climate zones and prototypes, as shown in Table 17. Some prototypes exhibit small negative electricity savings in select climate zones, driven by reduced solar gains or minor shifts in heating and cooling balance. Peak demand impacts are negligible across all prototypes and climate zones, with modeled values effectively zero, as shown in Table 18.

Natural gas savings are consistently positive across most prototypes and climate zones, driven by reduced heating loads from improved window U-factors, as shown in Table 19. Heating-dominated building types, such as Schools, Offices, Hospitals, and Assembly, show the largest gas savings, particularly in colder climate zones. Natural gas savings typically range from near zero up to approximately 0.7 kBtu/sf, depending on prototype and climate zone. Prototypes without significant space heating loads (or without gas heating systems in the prototypes) show limited or no gas savings, as expected.

Source energy results mirror the natural gas trends and are positive in most cases, as shown in Table 20. Heating-dominated prototypes achieve the largest source energy reductions, particularly in cooler climate zones. Small negative source energy values appear in a limited number of cases and are associated with minor electricity increases that outweigh modest heating savings. Overall, source energy impacts remain small but favorable across the majority of modeled scenarios.

Table 21 presents total long-term systemwide cost (LSC) savings over a 30-year period, expressed in 2029 present value dollars per square foot. LSC results are predominantly positive, with savings commonly ranging from near zero to $0.67/sf, depending on prototype and climate zone.

Heating-intensive building types, such as Schools, Offices, Hospitals, and Assembly, show the most consistent LSC benefits. Some prototypes and climate zones exhibit small negative LSC values, typically in mild climates where reduced heating savings and negligible electricity benefits offset the incremental cost of improved fenestration. These cases are limited in scope and magnitude.

Overall, the results are consistent with expectations for an alterations measure focused on incremental U-factor improvements. Electricity and peak demand impacts are minimal, while natural gas, source energy, and long-term cost savings are driven primarily by reduced heating energy use. Although a small number of prototype and climate zone combinations show neutral or slightly negative results, the measure delivers net energy and cost savings in most cases, with strong persistence over the 30-year analysis period due to the durable nature of fenestration performance.

Table 17: First Year Electricity Savings (kWh) Per Square Foot – Window 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
Assembly	0.00	0.00	-0.05	0.00	-0.06	-0.01	-0.01	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.01	-0.01
Hospital	0.00	0.00	-0.01	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
Large Office	0.00	-0.01	-0.02	0.00	-0.03	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Large Retail	0.00	0.00	0.00	0.00	-0.01	0.00	-0.01	0.00	0.00	0.00	-0.01	0.00	-0.01	0.00	0.00	0.00
Large School	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.01
Medium Office	0.03	0.02	0.02	0.02	0.01	-0.01	-0.01	-0.01	0.00	0.00	0.02	0.02	0.01	0.02	0.01	0.07
Medium Retail	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.03	-0.01	-0.01	0.00	0.03	0.01	0.00
Non-refrigerated 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	0.00	0.00	0.00
Restaurant	0.00	0.00	-0.02	0.00	-0.02	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Small Office	0.01	0.00	-0.02	0.00	-0.02	-0.01	-0.01	-0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.00
Small School	0.02	0.02	0.00	0.01	-0.01	0.00	-0.01	-0.01	-0.01	0.00	0.03	0.02	0.01	0.02	0.02	0.01
Strip Mall	0.00	0.01	0.00	0.01	0.01	-0.01	0.00	0.01	-0.01	0.00	0.01	0.01	0.01	0.01	0.00	-0.01

Table 18: First Year Peak Demand Reduction (kW) Per Square Foot – Window 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
Assembly	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
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
Large 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
Large 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
Large School	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
Medium 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
Medium 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
Non-refrigerated 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	0.00	0.00	0.00
Restaurant	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
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
Small School	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
Strip Mall	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 19: First Year Natural Gas Savings (kBtu) Per Square Foot – Window 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
Assembly	0.34	0.27	0.63	0.24	0.52	0.08	0.08	0.09	0.10	0.09	0.27	0.22	0.16	0.26	0.07	0.51
Hospital	0.12	0.11	0.25	0.10	0.25	0.04	0.03	0.05	0.06	0.06	0.11	0.10	0.08	0.09	0.06	0.15
Large Office	0.22	0.17	0.49	0.16	0.49	0.07	0.07	0.07	0.08	0.08	0.16	0.14	0.10	0.17	0.06	0.31
Large Retail	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.08
Large School	0.31	0.24	0.72	0.21	0.67	0.12	0.09	0.10	0.11	0.11	0.22	0.20	0.15	0.21	0.07	0.40
Medium Office	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Medium Retail	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.11

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
Non-refrigerated Warehouse	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(0.00)	0.00	(0.00)
Restaurant	0.28	0.20	0.48	0.17	0.41	0.05	0.04	0.04	0.06	0.06	0.19	0.16	0.10	0.17	0.03	0.42
Small Office	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.27
Small School	0.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.56
Strip Mall	0.09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.20

Table 20: First Year Source Energy Savings (kBtu) Per Square Foot – Window 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
Assembly	0.31	0.25	0.56	0.23	0.45	0.07	0.06	0.08	0.09	0.09	0.26	0.21	0.15	0.25	0.07	0.47
Hospital	0.10	0.10	0.20	0.09	0.20	0.03	0.03	0.04	0.05	0.05	0.09	0.08	0.07	0.08	0.06	0.13
Large Office	0.19	0.15	0.42	0.14	0.42	0.06	0.05	0.06	0.07	0.07	0.15	0.13	0.09	0.15	0.06	0.27
Large Retail	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.02	0.07
Large School	0.29	0.23	0.65	0.21	0.62	0.10	0.08	0.09	0.11	0.10	0.21	0.19	0.15	0.21	0.07	0.38
Medium Office	0.13	0.11	0.23	0.11	0.22	0.02	0.01	0.02	0.04	0.03	0.10	0.09	0.07	0.11	0.04	0.19
Medium Retail	0.04	0.01	0.01	0.01	0.01	0.02	-0.01	0.04	0.02	0.04	-0.01	-0.01	0.01	0.02	0.00	0.09
Non-refrigerated Warehouse	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Restaurant	0.24	0.17	0.40	0.14	0.34	0.04	0.03	0.03	0.05	0.05	0.16	0.14	0.09	0.15	0.03	0.36

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
Small Office	0.03	0.04	0.05	0.03	0.04	0.00	-0.01	0.01	0.01	0.01	0.04	0.03	0.03	0.05	0.02	0.25
Small School	0.14	0.07	0.13	0.07	0.12	0.01	0.01	0.02	0.02	0.03	0.08	0.07	0.06	0.11	0.05	0.53
Strip Mall	0.08	0.02	0.03	0.02	0.03	-0.01	0.00	0.01	-0.01	0.00	0.02	0.02	0.01	0.02	-0.02	0.18

Table 21: Total 30-Year LSC Savings (2029 PV$) Per Square Foot – Window 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
Assembly	0.32	0.25	0.36	0.25	0.10	0.01	(0.02)	0.07	0.08	0.10	0.33	0.27	0.21	0.29	0.21	0.47
Hospital	0.08	0.09	0.13	0.09	0.13	0.02	0.02	0.04	0.06	0.06	0.11	0.09	0.09	0.09	0.09	0.13
Large Office	0.17	0.13	0.30	0.13	0.26	0.02	0.01	0.04	0.05	0.06	0.15	0.12	0.11	0.16	0.13	0.27
Large Retail	0.02	0.03	0.03	0.03	(0.01)	0.01	(0.03)	(0.02)	0.05	0.04	(0.03)	0.00	(0.04)	0.01	0.11	0.04
Large School	0.33	0.26	0.68	0.26	0.62	0.09	0.07	0.10	0.13	0.13	0.29	0.23	0.21	0.28	0.16	0.47
Medium Office	0.43	0.30	0.57	0.29	0.43	0.00	(0.04)	(0.01)	0.04	0.04	0.28	0.23	0.18	0.26	0.16	0.61
Medium Retail	0.05	0.03	0.03	0.00	0.02	0.07	(0.02)	0.12	0.10	0.32	(0.09)	(0.06)	(0.01)	0.23	0.08	0.08
Non-refrigerated Warehouse	0.01	0.01	0.02	0.00	0.00	0.01	0.01	(0.00)	0.00	0.01	0.01	(0.00)	0.01	0.00	0.01	0.01
Restaurant	0.25	0.16	0.31	0.15	0.24	0.00	(0.01)	0.01	0.04	0.04	0.18	0.14	0.13	0.16	0.11	0.36
Small Office	0.09	0.08	0.01	0.07	(0.05)	(0.06)	(0.07)	(0.02)	(0.00)	0.01	0.10	0.05	0.08	0.12	0.11	0.30

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
Small School	0.28	0.24	0.26	0.19	0.13	0.01	(0.05)	0.00	(0.00)	0.03	0.28	0.20	0.17	0.28	0.27	0.67
Strip Mall	0.10	0.07	0.07	0.10	0.11	(0.07)	0.02	0.07	(0.07)	0.02	0.14	0.08	0.09	0.07	(0.06)	0.13

3.4.3 Incremental First Cost

Incremental first costs (or incremental costs) reflect the difference in material and labor costs of installing window units with properties meeting the proposed measure as compared to those with properties meeting existing code requirements.

The Statewide CASE Team is conducting interviews and surveys with manufacturers, trade associations, builders, national laboratories, and other stakeholders to gain knowledge on window pricing and installation labor. We are continuing to collect cost information from stakeholders and will update incremental first cost assumptions for the final version of this report.

3.4.4 Incremental Maintenance and Replacement Costs

In general, windows are 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 issued 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 Draft CASE Report.

If building drainage elements are inspected as noted above, the only common replacement cost for windows 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 ten 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 cost (or savings) was calculated using a three percent discount rate (d), which is consistent with the discount rate used when developing the 2028 LSC hourly factors.

Description of the incremental maintenance and replacement costs, as well as estimation of present value of maintenance and replacement costs, are provided in the 2028 CASE Methodology Report.

Table 22 Window Alterations – Cost per Square Foot of Building Area - TBD

Building Prototype	Net Window Area (Sq.Ft.)	Incremental Cost per Square Foot of Window	Total Cost	Building Area (Sq.Ft.)	Total Cost per Square Foot of Building Area ($/SqFt)
Large Office	48,134			498,589	
Medium Office	7,027			53,628	
Small Office	642			5,502	
Large Retail	5,881			240,000	
Large School	22,162			210,866	
Small School	4,964			24,413	
Assembly	60,207			315,339	
Hospital	9,133			249,985	
Laboratory	7,027			53,628	
Small Restaurant	280			2,501	
Medium Retail	904			24,563	
Retail Strip Mall	558			9,375	
Warehouse	190			52,050	

3.4.5 Cost Effectiveness

Results of the per-unit cost-effectiveness analyses will be presented in Table 23 for alterations for the Final CASE Report, once we have reliable incremental cost data.

Table 23: 30-Year Cost-Effectiveness Summary Per Square Foot – Alterations - TBD

Climate Zone	Benefits LSC Savings + Other PV Savings (2029 PV$/square foot)	Costs Total Incremental PV Costs (2029 PV$/square foot)	Benefit-to-Cost Ratio
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
Total			

3.5 Window Alterations - Statewide Impacts

3.5.1 Statewide Energy and Energy Cost Savings

See the 2028 CASE Methodology Report for details on how statewide savings are calculated. Appendix C presents the assumptions on the percentage of the total construction forecast that the proposed measure would impact.

For more details on the methodology and context about estimating the current market share rate, as well as statewide energy and energy cost savings, see the 2028 CASE Methodology Report.

The alteration savings presented here are based on per-unit results that represent major fenestration replacement events (full replacement of the modeled vertical fenestration area) and a 3 percent annual replacement rate, consistent with an assumed 30-year fenestration life. The code trigger of 100 percent of a fenestration type (windows, curtainwall, storefront, or glazed doors) does not change this underlying representation of major replacement projects,

but more clearly aligns the code trigger with the modeled case in which an entire fenestration system is upgraded during an alteration project.

Table 24 presents first-year statewide savings and LSC savings for alterations by climate zone. Statewide results indicate minimal net electricity impacts, with first-year electricity savings totaling approximately –0.03 GWh, reflecting small increases in some climate zones offset by modest savings in others. This outcome is consistent with the measure's focus on incremental U-factor improvements, which primarily affect heating energy rather than cooling electricity use.

Despite limited electricity savings, the measure delivers a meaningful first-year peak demand reduction of approximately 1.27 MW statewide, driven by reduced heat transfer during peak conditions in warmer climate zones. First-year statewide natural gas savings total approximately 0.13 million therms, resulting in 15.13 million kBtu of source energy savings.

Over the 30-year analysis period, the alterations measure yields approximately $19.1 million in present-valued LSC savings (2029 PV$) statewide. Most climate zones show positive LSC savings, with the largest contributions coming from high-activity zones such as CZ 3, CZ 9, and CZ 12, which combine large altered floor area with favorable heating and peak demand impacts. One climate zone (CZ7) exhibits marginally negative LSC values due to minimal heating savings and limited peak benefits; however, these impacts are small and do not affect statewide results.

Table 25 presents combined statewide results for new construction, additions, and alterations. New construction and additions contribute relatively small impacts, with modest first-year source energy savings and approximately $2.2 million in LSC savings over 30 years. In contrast, alterations account for the majority of statewide benefits, delivering nearly all of the peak demand reduction, natural gas savings, and long-term cost savings.

In total, the combined measure yields approximately 17.1 million kBtu of first-year source energy savings, a 1.32 MW peak demand reduction, and $21.2 million in present-valued LSC savings statewide. These results show that the proposed fenestration updates provide limited benefits for new construction, where baseline performance is already relatively strong, but offer meaningful and cost-effective statewide benefits when applied to alterations, where the majority of retrofit activity occurs.

Table 24: Statewide Energy and LSC Impacts – Alterations

Climate Zone	Statewide Alterations Impacted by Proposed Change in 2028(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 Present Valued LSC Savings (Million 2029 PV$)
1	794,949	0.01	0.00	0.00	0.09	$0.15
2	4,641,750	0.03	0.04	0.00	0.42	$0.74
3	22,242,600	-0.17	0.29	0.05	5.51	$5.71
4	11,390,190	0.05	0.06	0.01	1.10	$1.68
5	2,101,290	-0.01	0.05	0.00	0.34	$0.33
6	16,057,200	-0.06	0.11	0.01	0.50	$0.29
7	11,950,080	-0.07	0.02	0.00	0.35	-$0.02
8	23,279,400	-0.02	0.12	0.01	0.88	$1.08
9	37,599,900	-0.05	0.27	0.02	1.58	$1.80
10	23,490,900	0.07	0.00	0.01	0.87	$1.68
11	4,595,460	0.03	0.05	0.00	0.36	$0.64
12	23,610,900	0.07	0.15	0.01	1.73	$2.55
13	8,773,260	0.04	0.08	0.00	0.50	$0.92
14	5,288,430	0.04	0.03	0.00	0.46	$0.76
15	3,280,740	0.02	0.00	0.00	0.08	$0.30
16	1,661,268	0.01	0.01	0.00	0.35	$0.42
Total	200,758,317	-0.03	1.27	0.13	15.13	$19.06

Table 25: Statewide Energy and LSC Impacts – New Construction, Additions, and Alterations

Construction Type	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First -Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year Present Valued LSC Savings (Million 2029 PV$)
New Construction & Additions	-0.05	0.05	0.017	1.997	$2.17
Alterations	-0.03	1.27	0.130	15.130	$19.06
Total	**-0.08**	**1.32**	**0.147**	**17.127**	**$21.23**

3.5.2 Statewide Greenhouse Gas Emissions Reductions

Table 26 presents the estimated first-year statewide reduction in GHG emissions resulting from the proposed fenestration alterations measure. In the first year of compliance, the measure is estimated to reduce statewide GHG emissions by approximately 892 metric tons of carbon dioxide equivalent (CO_2e). The estimated first-year GHG reductions correspond to a monetary value of approximately $110,000, reflecting avoided emissions costs in the first year of compliance.

The majority of these reductions are attributable to natural gas savings from reduced heating loads, which account for approximately 703 metric tons CO_2e, while changes in electricity consumption contribute an additional 189 metric tons CO_2e. Although the aggregated statewide results show a small net increase in annual electricity consumption, the measure still achieves a net reduction in electricity-related GHG emissions. This outcome reflects the use of hourly long-run marginal emissions factors published by the CEC. Because emissions intensity varies significantly by hour, a measure can increase total annual electricity use while simultaneously shifting electricity consumption away from high-emissions hours toward lower-emissions hours. As a result, the net effect is a reduction in annual electricity-related CO_2e emissions despite slightly negative annual electricity savings.

GHG emissions reductions and their associated monetary value were calculated using hourly GHG emissions factors published alongside the LSC and source energy hourly factors in the research versions of CBECC, in combination with data from the CEC's 2028 Metrics Report. Additional methodological details are provided in the 2028 CASE Methodology Report.

Overall, these results indicate that while the proposed measure delivers modest statewide energy impacts, it provides meaningful GHG emissions reductions, driven primarily by reductions in natural gas use in altered nonresidential buildings.

Table 26: First-Year Statewide GHG Emissions Impacts

Construction Type	Reduced GHG Emissions from Electricity Savings (Metric Tons CO2e)	Reduced GHG Emissions from Natural Gas Savings (Metric Tons CO2e)	Total Reduced GHG Emissions (Metric Ton CO2e)	Total Monetary Value of Reduced GHG Emissions ($)
New Construction & Additions	-	-	-	-
Alterations	188.91210	702.88802	891.80013	$109,823
Total	**188.91210**	**702.88802**	**891.80013**	**$109,823**

3.5.3 Statewide Water Use Impacts

The proposed code change will not result in water use impacts.

3.5.4 Statewide Material Impacts

The Statewide CASE Team expects little to no changes to material impacts because the proposed code change is only changing existing U-factors and SHGC values which should not necessarily translate to more or different materials being used.

For more information on the Statewide CASE Team's methodology and assumptions used to calculate embodied GHG emissions, see the 2028 CASE Methodology Report.

3.5.5 Environmental Impacts

This proposal would result in significant energy savings and GHG emissions reduction. The requirement ensures less thermal energy is exchanged through windows, increasing the heating and cooling efficiency within spaces.

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

3.5.6 Other Non-Energy Impacts

Improved insulation from better performing windows would provide tighter building envelopes, thus improving occupant comfort by better regulating indoor temperature, reducing noise, and contributing to indoor air quality.

3.6 Window Alterations - Proposed Code Language

3.6.1 Guide to Markup Language

The proposed changes to the standards, Reference Appendices, and the ACM Reference Manuals are provided below. Changes to the 2025 documents should be marked with dark blue underlining (new language) and ~~strikethroughs~~ (deletions).

3.6.2 Administrative Code (Title 24, Part 1)

There are no proposed changes to Title 24, Part 1.

3.6.3 Energy Code (Title 24, Part 6)

SECTION 141.0(b) Alterations.

2. Prescriptive approach. The altered components of the envelope, or space conditioning, lighting, electrical power distribution and water heating systems, and any newly installed equipment serving the alteration, shall meet the applicable requirements of Sections 110.0 through 110.9, Sections 120.0 through 120.6, and Sections 120.9 through 130.5.

Exception to Section 141.0(b)2: The requirements of Section 120.2(i) shall not apply to alterations of space-conditioning systems or components.

A. Fenestration alterations other than repair and those subject to Section 141.0(b)2 shall meet the requirements below:

i. Vertical fenestration alterations replacing one hundred percent of any single fenestration type (windows, storefront, curtainwall, spandrel, glazed doors) shall meet the requirements of Section 140.3(a)5.

ii. All other vertical ~~Vertical~~ fenestration alterations shall meet the requirements in Table 141.0-A.

iii. Added vertical fenestration shall meet the requirements of TABLE 140.3-B, C, or D.

iv. All altered or newly installed skylights shall meet the requirements of TABLE 140.3-B, C or D.

(Exceptions remain unchanged)

Table 141.0-A Altered Vertical Fenestration Maximum U-Factor and Maximum RSHGC

Requirement	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
~~**U-factor**~~	~~0.47~~	~~0.47~~	~~0.58~~	~~0.47~~	~~0.58~~	~~0.47~~	~~0.47~~	~~0.47~~	~~0.47~~	~~0.47~~	~~0.47~~	~~0.47~~	~~0.47~~	~~0.47~~	~~0.47~~	~~0.47~~
~~**RSHGC**~~	~~0.41~~	~~0.31~~	~~0.41~~	~~0.31~~	~~0.41~~	~~0.31~~	~~0.31~~	~~0.31~~	~~0.31~~	~~0.31~~	~~0.31~~	~~0.31~~	~~0.31~~	~~0.31~~	~~0.31~~	~~0.41~~
Requirement	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

Requirement	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
Fixed Window (Max U-factor)	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
Fixed Window (Max RSHGC)	0.41	0.31	0.41	0.31	0.41	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.41
Fixed Window (Min VT)	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
Curtain Wall or Storefront (Max U-factor)	0.41	0.43	0.43	0.43	0.43	0.43	0.41	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
Curtain Wall or Storefront (Max RSHGC)	0.25	0.26	0.26	0.26	0.26	0.26	0.25	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
Curtain Wall or Storefront (Min VT)	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
Operable Window (Max U-factor)	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
Operable Window (Max RSHGC)	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31
Operable Window (Min VT)	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
Glazed Doors (Max U-factor)	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
Glazed Doors (Max RSHGC)	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31
Glazed Doors (Min VT)	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17

~~Note: The required values for VT are located in Tables 140.3-B, C or D for all Climate Zones.~~

3.6.4 Reference Appendices

There are no proposed changes to the Reference Appendices.

3.6.5 Compliance Manuals

The Statewide CASE Team will provide CEC with recommended revisions to compliance manuals after the 45-Day Language is published.

3.6.6 ACM Reference Manual

There are no proposed changes to the ACM Reference Manual.

3.6.7 Compliance Forms

As discussed in Section 3.1.4.5, none of the current nonresidential compliance forms would need to be updated to reflect the proposed change.

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Appendix A: Assumptions for Cost-effectiveness Analysis

Nonresidential Fenestration – New Construction

Key Assumptions for Energy Savings Analysis

- The Statewide CASE Team simulated the energy impacts in climate zone 1 and 16 and applied the climate-zone-specific LSC hourly factors when calculating energy and energy cost impacts.
- The base case (standard design) used 2025 Title 24, Part 6 prescriptive fenestration U-factor and SHGC requirements (Table 140.3-B).
- The proposed case applied more stringent U-factor values (0.36 for fixed windows in CZ 1 and CZ 16; 0.43 for operable windows in CZ 1). SHGC values were unchanged between base and proposed cases.
- Prototypes modeled were limited to high WWR building types, chosen to maximize sensitivity to fenestration performance changes. This assumption makes results conservative for low-WWR buildings.
- Fenestration assemblies were modeled as NFRC-rated, double-pane units consistent with typical market-available products. No specific technology or manufacturer was assumed.
- Stakeholder engagement confirmed that the scope of the new construction measure is limited to U-factor tightening only, with SHGC values unchanged. Stakeholders reviewed and did not request revisions to these assumptions.

Energy Savings Methodology per Prototypical Building

The 2028 CASE Methodology Report provides details on estimating energy savings per prototypical building and unit. The CEC directed the Statewide CASE Team to model energy impacts using specific prototypical building models that represent typical building geometries for different building types. Table 27 lists the eight prototype buildings used in this analysis. These prototypes are drawn from existing CBECC prototype sets and reflect building characteristics typical of California's commercial building stock.

Energy savings were calculated by simulating each prototype under baseline (2025 Title 24, Part 6) prescriptive fenestration requirements and comparing results to the proposed fenestration requirements for the 2028 code cycle. For new construction, this meant reducing U-factor values in CZ 1 and CZ 16 while holding SHGC constant. Simulations were run in CBECC 2025, with outputs converted to EnergyPlus and post-processed in MeasureSET to

calculate electricity, natural gas, source energy, peak demand, and long-term system costs impacts. High WWR prototypes such as large office, hospital, and school buildings were included to ensure results captured the greatest sensitivity to fenestration performance.

Table 27: Prototype Buildings Used for Energy, Demand, Cost, and Environmental Impacts Analysis

Prototype Name	Number of Stories	Floor Area (Square Feet)	Description
Assembly	1	315,339	The main assembly prototype comprises five different assembly buildings i.e. Dodge building types: Religious Worship, Sports & Recreation, Library, Exhibits & Events, and Transportation Terminals. The CBECC model is separated into individual building files before using the Standard Design. The CBECC Standard Design is modeled with SZVAVHP for Library and all other assembly building types are modeled with SZVAVAC systems. Gas hot water system is used as the Standard Design SWH.
Hospital	5	241,501	5-story hospital plus basement. Source: DOE Standard 90.1 Hospital prototype and scorecard. The prototype contains Title 24, Part 6, minimally compliant envelope features and lighting. For HVAC systems, the AIA guidelines recommended using VAV systems wherever possible.
OfficeLarge	12	498,589	12-story + 1 basement office building with 5 zones and a ceiling plenum on each floor. WWR–40%. Because CBECC will model single-zone heat pumps in the Large School prototype's Standard Design, results from measures applied to the prototype should be compared to the Proposed Design prototype model, not the Standard Design. For example, as with the Assembly prototype, if a U-factor measure is applied to the Large School windows, that measure should be applied to a copy of the original Proposed Design. The results from that analysis should then be compared to the results of the original prototype's Proposed Design.
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%

Prototype Name	Number of Stories	Floor Area (Square Feet)	Description
RetailLarge	1	240,000	Big-box type retail building with WWR–12% and SRR–0.82%
SchoolSmall	1	24,413	Elementary school with WWR–36%
SchoolLarge	2	210,866	High school with WWR–35% and SRR–1.4%
Warehouse	1	52,045	Single story high ceiling warehouse. Includes one office space. WWR–0.7% ,SRR–5%
RetailStripMall	1	9,375	Strip mall building with WWR–10%
RetailMedium	1	24,563	Similar to a Target or Walgreens.7% WWR on the front façade, none on other sides. SRR–2.1%.
RestaurantFastFood	1	2,501	Fast food restaurant with a small kitchen and dining areas. WWR–14%. Pitched roof with an unconditioned attic.
OfficeMediumLab	3	53,628	3-story office building with 5 zones and a ceiling plenum on each floor. WWR–33%

There is an existing Title 24, Part 6 requirement that covers the building system in question and applies to both new construction and alterations, so the Standard Design is minimally compliant with the 2025 Title 24 requirements. For fenestration, this means meeting the prescriptive U-factor and SHGC values specified in Table 140.3-B of the standard. For this analysis, the Standard Design assumed a U-factor of 0.36 Btu/(hr·ft²·°F) for fixed windows and 0.39 Btu/(hr·ft²·°F) for operable windows in CZ 1, and 0.34 and 0.43, respectively, in CZ 16. SHGC values were unchanged between Standard and Proposed Designs.

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 28 presents the parameters modified and the values used in the Standard Design and Proposed Design. In both climate zones, the Proposed Design applied a U-factor of 0.34 for fixed windows, and 0.43 for operable windows in CZ 1, consistent across all prototypes.

Because SHGC requirements remain unchanged in the proposal, the measure is climate-dependent primarily in heating-dominated locations, where reductions in U-factor yield measurable savings. For this reason, simulations were run only in CZ 1 (mild coastal) and CZ 16 (cold mountain), representing the edge cases of the potential statewide impact.

Table 28: Modifications Made to Standard Design in Each Prototype to Simulate Proposed Code Change

Prototype ID	Climate Zone	Objects Modified	Parameter Name	Standard Design Parameter Value	Proposed Design Parameter Value
Hospital	CZ01 - CZ08, CZ10, CZ16	WindowMaterial:SimpleGlazingSystem	U-Factor	0.36 Btu/(hr-ft²-°F)	0.34 Btu/(hr-ft²-°F)
OfficeMediumLab	CZ01 - CZ08, CZ10, CZ16	WindowMaterial:SimpleGlazingSystem	U-Factor	0.36 Btu/(hr-ft²-°F)	0.34 Btu/(hr-ft²-°F)
OfficeLarge	CZ01 - CZ08, CZ10, CZ16	WindowMaterial:SimpleGlazingSystem	U-Factor	0.36 Btu/(hr-ft²-°F)	0.34 Btu/(hr-ft²-°F)
OfficeMedium	CZ01 - CZ08, CZ10, CZ16	WindowMaterial:SimpleGlazingSystem	U-Factor	0.36 Btu/(hr-ft²-°F)	0.34 Btu/(hr-ft²-°F)
OfficeSmall	CZ01 - CZ08, CZ10, CZ16	WindowMaterial:SimpleGlazingSystem	U-Factor	0.36 Btu/(hr-ft²-°F)	0.34 Btu/(hr-ft²-°F)
RestaurantFastFood	CZ01 - CZ08, CZ10, CZ16	WindowMaterial:SimpleGlazingSystem	U-Factor	0.36 Btu/(hr-ft²-°F)	0.34 Btu/(hr-ft²-°F)
RetailLarge	CZ01 - CZ08, CZ10, CZ16	WindowMaterial:SimpleGlazingSystem	U-Factor	0.36 Btu/(hr-ft²-°F)	0.34 Btu/(hr-ft²-°F)
RetailMedium	CZ01 - CZ08, CZ10, CZ16	WindowMaterial:SimpleGlazingSystem	U-Factor	0.36 Btu/(hr-ft²-°F)	0.34 Btu/(hr-ft²-°F)
RetailStripMall	CZ01 - CZ08, CZ10, CZ16	WindowMaterial:SimpleGlazingSystem	U-Factor	0.36 Btu/(hr-ft²-°F)	0.34 Btu/(hr-ft²-°F)
SchoolLarge	CZ01 - CZ08,	WindowMaterial:SimpleGlazingSystem	U-Factor	0.36 Btu/(hr-ft²-°F)	0.34 Btu/(hr-ft²-°F)

Prototype ID	Climate Zone	Objects Modified	Parameter Name	Standard Design Parameter Value	Proposed Design Parameter Value
	CZ10, CZ16				
SchoolSmall	CZ01 - CZ08, CZ10, CZ16	WindowMaterial:SimpleGlazingSystem	U-Factor	0.36 Btu/(hr-ft²-°F)	0.34 Btu/(hr-ft²-°F)
Warehouse	CZ01 - CZ08, CZ10, CZ16	WindowMaterial:SimpleGlazingSystem	U-Factor	0.36 Btu/(hr-ft²-°F)	0.34 Btu/(hr-ft²-°F)
Assembly	CZ01 - CZ08, CZ10, CZ16	WindowMaterial:SimpleGlazingSystem	U-Factor	0.36 Btu/(hr-ft²-°F)	0.34 Btu/(hr-ft²-°F)

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 LSC impacts.

Nonresidential Fenestration – Alterations

Key Assumptions for Energy Savings Analysis

- 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.
- The base case (Standard Design) was defined as minimally compliant with the 2025 Title 24, Part 6 prescriptive fenestration requirements (Table 141.0-A).
- The Proposed Design applied more stringent requirements for both U-factor and SHGC across all climate zones.
- Prototypes modeled were limited to eight high WWR building types to capture the largest sensitivity to fenestration changes
- Fenestration assemblies were modeled as NFRC-rated, double-pane systems representative of common market practice. No specific manufacturer or product technology was assumed.
- Stakeholder engagement confirmed that both U-factor and SHGC should be reduced in the alterations measure and that savings should be evaluated across all 16 climate

zones. Stakeholders reviewed these assumptions and agreed no additional revisions were necessary.

Energy Savings Methodology per Prototypical Building

The 2028 CASE Methodology Report provides details on estimating energy savings per prototypical building and unit. The CEC directed the Statewide CASE Team to model energy impacts using specific prototypical building models that represent typical building geometries for different building types. Table 29 resents the prototype buildings used in the analysis. These prototypes are consistent with those used for new construction but were simulated separately under alteration assumptions.

Energy savings were calculated by comparing results for the Standard Design (minimally compliant with 2025 Title 24, Part 6 fenestration U-factor and SHGC requirements) against the Proposed Design (more stringent U-factor and SHGC values across all climate zones). Prototypes were modeled in CBECC 2025 and EnergyPlus, with outputs processed in MeasureSET to calculate electricity, natural gas, source energy, peak demand, and long-term system cost impacts. Unlike the new construction analysis, which was limited to CZ 1 and 16, the alterations analysis evaluated all 16 climate zones to capture the full statewide impact of the proposed measure. High WWR prototypes such as large office, hospital, and school buildings were included to ensure results captured the greatest sensitivity to fenestration performance.

Table 29: Prototype Buildings Used for Energy, Demand, Cost, and Environmental Impacts Analysis

Prototype Name	Number of Stories	Floor Area (Square Feet)	Description
Assembly	1	315,339	The main assembly prototype comprises five different assembly buildings i.e. Dodge building types: Religious Worship, Sports & Recreation, Library, Exhibits & Events, and Transportation Terminals. The CBECC model is separated into individual building files before using the Standard Design. The CBECC Standard Design is modeled with SZVAVHP for Library and all other assembly building types are modeled with SZVAVAC systems. Gas hot water system is used as the Standard Design SWH.
Hospital	5	241,501	5-story hospital plus basement. Source: DOE Standard 90.1 Hospital prototype and scorecard. The prototype contains Title 24, Part 6, minimally compliant envelope features and lighting. For HVAC systems, the AIA guidelines

Prototype Name	Number of Stories	Floor Area (Square Feet)	Description
			recommended using VAV systems wherever possible.
OfficeLarge	12	498,589	12-story + 1 basement office building with 5 zones and a ceiling plenum on each floor. WWR–40%. Because CBECC will model single-zone heat pumps in the Large School prototype's Standard Design, results from measures applied to the prototype should be compared to the Proposed Design prototype model, not the Standard Design. For example, as with the Assembly prototype, if a U-factor measure is applied to the Large School windows, that measure should be applied to a copy of the original Proposed Design. The results from that analysis should then be compared to the results of the original prototype's Proposed Design.
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%
RetailLarge	1	240,000	Big-box type retail building with WWR–12% and SRR–0.82%
SchoolSmall	1	24,413	Elementary school with WWR–36%
SchoolLarge	2	210,866	High school with WWR–35% and SRR–1.4%
Warehouse	1	52,045	Single story high ceiling warehouse. Includes one office space. WWR–0.7% ,SRR–5%
RetailStripMall	1	9,375	Strip mall building with WWR–10%
RetailMedium	1	24,563	Similar to a Target or Walgreens.7% WWR on the front façade, none on other sides. SRR–2.1%.
RestaurantFastFood	1	2,501	Fast food restaurant with a small kitchen and dining areas. WWR–14%. Pitched roof with an unconditioned attic.
OfficeMediumLab	3	53,628	3-story office building with 5 zones and a ceiling plenum on each floor. WWR–33%

There is an existing Title 24, Part 6 requirement that covers the building system in question and applies to both new construction/additions and alterations, so the Standard Design is minimally compliant with the 2025 Title 24 requirements. Under the Standard Design, fenestration U-factors are 0.58 Btu/(hr·ft²·°F) in CZ 3 and 5 and 0.47 Btu/(hr·ft²·°F) in all other climate zones. SHGC values are 0.41 in CZs 1, 3, 5, and 16, and 0.31 in all other zones.

These values are consistent with the prescriptive fenestration requirements in Table 141.0-A of the 2025 Standards.

The Proposed Design was identical to the Standard Design except for the revisions that represent the proposed changes to the code.

Table 30 presents the parameters modified and the values used in the Standard Design and Proposed Design. Specifically, the proposed conditions assume a reduced U-factor requirements to 0.32 in CZ 1, 0.34 in CZ 16, and 0.36 in all other climate zones. SHGC requirements were also reduced, to 0.25 in CZs 1–8, 10, and 16, and 0.22 in CZs 9 and 11–15. These changes were applied consistently across all prototypes and climate zones.

Table 30 summarizes the modifications made to each prototype to represent the Proposed Design. Because both U-factor and SHGC requirements are climate-dependent, simulations were performed in all 16 climate zones. This ensured that results captured both the cooling-load benefits of lower SHGC in hot climates and the potential heating penalties in colder climates. 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 LSC impacts.

Table 30: Modifications Made to Standard Design in Each Prototype to Simulate Proposed Code Change

Prototype ID	Climate Zone	Objects Modified	Parameter Name	Standard Design Parameter Value	Proposed Design Parameter Value
Hospital	CZ01-CZ16	WindowMaterial:SimpleGlazingSystem	U-factor	U = 0.58 (CZs 3,5); U = 0.47 (all other CZs)	U = 0.43 (all CZs)
OfficeMediumLab	CZ01-CZ16	WindowMaterial:SimpleGlazingSystem	U-factor	U = 0.58 (CZs 3,5); U = 0.47 (all other CZs)	U = 0.43 (all CZs)
OfficeLarge	CZ01-CZ16	WindowMaterial:SimpleGlazingSystem	U-factor	U = 0.58 (CZs 3,5); U = 0.47 (all other CZs)	U = 0.43 (all CZs)
OfficeMedium	CZ01-CZ16	WindowMaterial:SimpleGlazingSystem	U-factor	U = 0.58 (CZs 3,5); U = 0.47	U = 0.43 (all CZs)

Prototype ID	Climate Zone	Objects Modified	Parameter Name	Standard Design Parameter Value	Proposed Design Parameter Value
				(all other CZs)	
OfficeSmall	CZ01-CZ16	WindowMaterial:SimpleGlazingSystem	U-factor, SHGC	Fixed Windows: U = 0.58 (CZs 3,5); U = 0.47 (all other CZs) | Glazed Doors: U = 0.58 (CZs 3,5); U = 0.47 (all other CZs); SHGC = 0.41 (CZs 1,3,5,16), 0.31 (others)	Fixed Windows: U = 0.43 (all CZs) | Glazed Doors: U = 0.47 (all CZs); SHGC = 0.31 (all CZs)
RestaurantFastFood	CZ01-CZ16	WindowMaterial:SimpleGlazingSystem	U-factor	U = 0.58 (CZs 3,5); U = 0.47 (all other CZs)	U = 0.43 (all CZs)
RetailLarge	CZ01-CZ16	WindowMaterial:SimpleGlazingSystem	U-factor	U = 0.58 (CZs 3,5); U = 0.47 (all other CZs)	U = 0.43 (all CZs)
RetailMedium	CZ01-CZ16	WindowMaterial:SimpleGlazingSystem	U-factor	U = 0.58 (CZs 3,5); U = 0.47 (all other CZs)	U = 0.43 (all CZs)
RetailStripMall	CZ01-CZ16	WindowMaterial:SimpleGlazingSystem	U-factor	U = 0.58 (CZs 3,5); U = 0.47 (all other CZs)	U = 0.43 (all CZs)
SchoolLarge	CZ01-CZ16	WindowMaterial:SimpleGlazingSystem	U-factor	U = 0.58 (CZs 3,5); U = 0.47	U = 0.43 (all CZs)

Prototype ID	Climate Zone	Objects Modified	Parameter Name	Standard Design Parameter Value	Proposed Design Parameter Value
				(all other CZs)	
SchoolSmall	CZ01-CZ16	WindowMaterial:SimpleGlazingSystem	U-factor	U = 0.58 (CZs 3,5); U = 0.47 (all other CZs)	U = 0.43 (all CZs)
Warehouse	CZ01-CZ16	WindowMaterial:SimpleGlazingSystem	U-factor	U = 0.58 (CZs 3,5); U = 0.47 (all other CZs)	U = 0.43 (all CZs)
Assembly	CZ01-CZ16	WindowMaterial:SimpleGlazingSystem	U-factor	U = 0.58 (CZs 3,5); U = 0.47 (all other CZs)	U = 0.43 (all CZs)

Appendix B: Purpose and Necessity of Proposed Code Changes

Introduction

The sections below provide the purpose and necessity of proposed changes to Title 24, Part 1; Title 24, Part 6; and the reference appendices. This section intends to provide the CEC with the information needed for the Initial Statement of Reasons.

See Sections 2.6 and 3.6 of this report for marked-up code language.

Nonresidential Fenestration – New Construction

Purpose and Necessity of Changes to Title 24, Part 1

There are no proposed changes to Title 24, Part 1.

Purpose and Necessity of Changes to Title 24, Part 6

Section: CHAPTER 4, TABLE 140.3-B PRESCRIPTIVE ENVELOPE CRITERIA FOR NONRESIDENTIAL BUILDINGS

Purpose: The purpose of this change is to update the current U-factor requirement for fixed windows in climate zones 1 through 8, 10, and 16 from U- 0.36 to U- 0.34. The proposal would also change the U-factor requirement for operable windows in all climate zones from U-0.46 to U-0.43.

Necessity: This change is necessary to maintain modern industry fenestration standards for fixed and operable windows in all climate zones. The proposal also contributes to alignment between Title 24. Part 6 and the 2027 IECC and ASHRAE 90.1-2025 requirements, since this would be the first update to the prescriptive U-factors for all climate zones since the 2013 code cycle.

Purpose and Necessity of Changes to the Reference Appendices

There are no proposed changes to reference appendices.

Nonresidential Fenestration - Alterations

Purpose and Necessity of Changes to Title 24, Part 1

There are no proposed changes to Title 24, Part 1.

Purpose and Necessity of Changes to Title 24, Part 6

Section: SECTION 141.0(b) Alterations

Purpose: The purpose of this change is to update U-Factor values for vertical fenestration replacement for consistency with the U-factor values for new construction; where more than one hundred percent of any type of fenestration (storefront, windows, spandrel, curtainwall, glazed doors) are being replaced.

This update also applies the new construction RSHGC values in Table 140.3-B to major fenestration replacement projects.

Necessity: The required U-factors for fenestration alterations have been unchanged since at least the 2013 code, so this change represents a substantial improvement in building envelope performance to maintain modern industry standards where window replacement occurs. This change aligns with fenestration requirements for new construction.

Purpose and Necessity of Changes to the Reference Appendices

There are no proposed changes to reference appendices.

Appendix C: Assumptions for Statewide Savings Estimates

The Statewide CASE Team is anticipating updated construction forecasts to be released by the California Energy Commission in February 2026. This will impact statewide energy savings but not the cost effectiveness of the proposal. The final CASE Report will present the updated savings based on the new forecasts.

New Construction/Additions - Windows

The Statewide CASE Team estimated statewide impacts for the first year by multiplying per-unit savings estimates by statewide construction forecasts provided by the CEC. The 2028 CASE Methodology Report includes additional information about the methodology and assumptions used to calculate statewide energy impacts.

The statewide savings and cost estimates consider the current market share rate. The Statewide CASE Team estimated that the current market share rate for the proposed code change is 0 percent for the new construction market. The current market share rate is estimated based on the Statewide CASE Team's professional judgment and data from the evaluation of past Title 24 code cycles.

Table 31 presents the projected nonresidential new construction that the proposed code change would impact in 2028 Table 32 shows the projected nonresidential existing statewide building stock that the proposed code change would affect alterations in 2028. The Statewide CASE Team developed these estimates using the methods described in this section.

The Statewide CASE Team estimated the percentage of newly constructed floorspace that the proposed code change would impact. Table 33 shows the assumed percentage of affected floorspace by building type. If a proposed code change does not apply to a specific building type, the Statewide CASE Team assumes that zero percent of the floorspace would be impacted. If the assumed percentage is non-zero, but less than 100 percent, the proposal is expected to affect some (but not all) buildings. Table 34.represents the assumed percentage of affected floorspace by climate zone. No other climate zones were modeled for new construction because the measure is not proposed there.

The Statewide CASE Team applied prototype-specific per-unit savings to the statewide construction forecasts (Table 31 and Table 32). For new construction, per-unit savings from Climate Zones 1 and 16 were applied to the corresponding forecasted square footage in those zones. This yields the statewide first-year energy, demand, and cost savings reported in the main body of this report.

Table 31: Estimated New Nonresidential Construction Impacted by Proposed Code Change in 2028, by Climate Zone and Building Type (Million Square Feet)

Building Type	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16	All
Large Office	0.00	0.00	2.03	0.99	0.00	0.89	0.52	1.44	2.61	0.25	0.07	0.36	0.00	0.13	0.01	0.03	9.32
Medium Office	0.09	0.33	0.96	0.52	0.26	0.84	0.56	1.15	2.23	0.82	0.19	1.96	0.41	0.24	0.18	0.07	10.83
Small Office	0.01	0.30	0.13	0.01	0.04	0.10	0.16	0.11	0.25	0.29	0.06	0.38	0.27	0.03	0.07	0.02	2.25
Large Retail	0.00	0.00	0.77	0.38	0.10	0.49	0.26	0.58	1.16	0.44	0.21	0.91	0.25	0.10	0.13	0.04	5.83
Medium Retail	0.06	0.24	0.56	0.31	0.06	0.42	0.20	0.60	1.00	0.58	0.10	0.44	0.27	0.13	0.09	0.06	5.10
Strip Mall	0.00	0.11	0.35	0.16	0.01	0.39	0.34	0.69	0.75	0.94	0.05	0.41	0.23	0.22	0.07	0.04	4.77
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	0.00	0.08	0.54	0.27	0.02	0.37	0.38	0.56	0.88	0.53	0.22	0.71	0.38	0.10	0.05	0.04	5.13
Small School	0.05	0.19	0.32	0.16	0.10	0.22	0.21	0.25	0.46	0.24	0.07	0.54	0.21	0.07	0.03	0.03	3.15
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
Hotel	0.03	0.15	0.72	0.37	0.08	0.39	0.34	0.55	0.83	0.40	0.11	0.56	0.18	0.10	0.09	0.03	4.91
Assembly	0.01	0.28	1.11	0.39	0.04	0.55	0.56	1.00	1.28	0.80	0.12	0.99	0.21	0.17	0.08	0.06	7.64
Hospital	0.02	0.12	0.57	0.29	0.05	0.22	0.37	0.30	0.53	0.55	0.10	0.56	0.18	0.10	0.08	0.03	4.08
Laboratory	0.01	0.13	0.90	0.50	0.05	0.29	0.19	0.32	0.59	0.24	0.09	0.30	0.08	0.06	0.03	0.02	3.81
Restaurant	0.01	0.06	0.23	0.12	0.02	0.24	0.14	0.35	0.57	0.29	0.05	0.22	0.10	0.07	0.03	0.02	2.52
Enclosed Parking Garage	0.00	0.01	1.28	0.87	0.00	1.81	0.49	1.59	1.07	0.04	0.00	0.03	0.00	0.01	0.00	0.01	7.21
Open Parking Garage	0.00	0.08	1.73	1.18	0.04	2.55	0.84	2.24	1.51	0.46	0.01	0.37	0.03	0.14	0.03	0.07	11.28
Grocery	0.00	0.03	0.07	0.04	0.01	0.03	0.01	0.04	0.06	0.03	0.01	0.03	0.02	0.01	0.01	0.00	0.41
Refrigerated Warehouse	0.00	0.00	0.04	0.04	0.01	0.02	0.00	0.00	0.01	0.03	0.00	0.05	0.08	0.01	0.01	0.00	0.29

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
Controlled-Environment Horticulture	0.06	0.05	0.22	0.03	0.14	0.18	0.00	0.02	0.02	0.19	0.21	0.21	0.06	0.01	0.03	0.00	1.46
Vehicle Service	0.00	0.05	0.38	0.25	0.02	0.39	0.24	0.56	1.27	0.40	0.02	0.27	0.17	0.14	0.04	0.03	4.23
Manufacturing	0.00	0.01	0.15	0.05	0.01	0.01	0.04	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34
Unassigned	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30
TOTAL	**0.4**	**2.5**	**14.6**	**8.0**	**1.2**	**11.4**	**6.3**	**13.8**	**19.2**	**8.5**	**2.1**	**11.3**	**3.7**	**2.1**	**1.3**	**0.7**	**107.1**

Table 32: Estimated Existing Nonresidential Floorspace Impacted by Proposed Code Change in 2028 (Alterations), by Climate Zone and Building Type (Million Square Feet)

Building Type	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16	All
Large Office	0.10	2.48	111.84	57.88	1.47	79.63	58.17	130.08	242.48	46.78	2.09	62.89	7.41	16.22	3.55	3.73	826.79
Medium Office	2.70	24.79	63.03	33.82	10.66	38.25	35.10	47.29	69.07	53.35	13.55	81.36	20.14	10.66	8.20	3.25	515.23
Small Office	3.34	10.20	17.75	9.06	6.00	10.58	6.81	10.62	16.70	19.54	8.48	35.15	17.18	3.99	4.94	2.14	182.51
Large Retail	0.80	6.93	46.94	21.52	3.36	25.57	20.27	34.77	53.22	42.65	9.12	46.53	18.01	8.73	7.52	2.57	348.51
Medium Retail	0.94	10.49	35.62	20.59	4.35	35.42	27.73	53.38	86.56	53.51	8.30	48.40	19.32	12.42	7.02	4.14	428.17
Strip Mall	2.67	7.87	29.94	14.74	4.08	32.18	22.63	44.61	66.96	53.54	9.80	38.70	19.34	12.22	6.96	3.67	369.90
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	0.61	6.42	27.86	11.16	1.66	22.70	18.03	34.33	58.86	44.81	8.10	42.70	21.13	9.65	6.10	2.87	316.98
Small School	1.78	8.90	20.46	7.98	4.85	20.55	11.97	27.55	43.45	26.42	10.80	33.66	18.75	6.98	3.40	2.92	250.43
Non-refrigerated Warehouse	2.66	16.18	86.64	42.74	7.84	71.98	41.18	102.72	165.84	146.16	26.98	118.64	40.86	31.10	23.24	9.30	934.08
Hotel	1.42	8.42	38.48	19.78	4.01	24.39	26.13	33.58	52.81	29.67	5.77	32.42	10.46	6.40	4.70	1.95	300.40

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
Assembly	3.46	14.54	73.07	36.05	5.28	45.80	32.72	71.31	96.16	73.40	13.08	55.78	24.10	15.16	9.46	5.15	574.53
Hospital	1.49	8.87	38.66	19.74	4.04	22.60	21.72	32.62	55.90	31.68	8.89	42.54	17.99	7.04	4.03	2.59	320.41
Laboratory	0.14	3.21	29.54	22.45	1.22	9.77	13.75	12.49	15.45	8.65	0.54	9.71	3.52	1.38	0.31	0.46	132.59
Restaurant	0.49	2.89	11.78	6.00	1.24	13.17	8.58	19.02	32.00	25.93	2.81	13.56	6.19	5.49	2.76	1.52	153.42
Enclosed Parking Garage	0.01	0.43	32.57	24.75	0.24	23.32	16.54	46.73	58.02	2.14	0.28	2.47	0.39	0.68	0.13	0.35	209.06
Open Parking Garage	0.18	5.62	44.02	33.46	3.09	32.91	28.14	65.95	81.92	27.66	3.57	31.97	5.05	8.84	1.72	4.49	378.59
Grocery	0.08	1.36	4.70	2.85	0.60	2.73	1.67	3.21	5.56	3.21	0.52	2.99	1.16	0.75	0.43	0.31	32.12
Refrigerated Warehouse	0.00	0.36	0.73	0.17	0.31	0.37	0.02	0.34	0.63	0.52	0.21	1.72	3.13	0.15	0.16	0.12	8.92
Controlled-Environment Horticulture	0.56	0.37	2.10	0.86	5.06	6.61	0.86	0.59	1.28	2.89	2.01	3.63	4.29	0.37	0.52	0.19	32.17
Vehicle Service	0.73	4.95	26.92	12.78	2.38	26.98	18.46	39.62	65.42	45.23	5.04	30.66	14.59	12.07	4.94	2.83	313.61
Manufacturing	3.28	13.51	49.54	63.64	4.47	58.66	26.62	98.16	134.48	39.66	10.29	45.61	20.78	13.58	4.12	7.42	593.83
Unassigned	0.29	5.26	7.22	5.05	0.18	2.06	0.62	3.02	6.29	2.04	2.69	11.48	2.35	0.62	0.32	0.82	50.31
TOTAL	**27.7**	**164.1**	**799.4**	**467.1**	**76.4**	**606.2**	**437.7**	**912.0**	**1409.1**	**779.5**	**152.9**	**792.6**	**296.1**	**184.5**	**104.5**	**62.8**	**7,272.55**

Table 33: Percentage of Nonresidential Floorspace Impacted by Proposed Code Change in 2028, by Building Type

Building Type	New Construction Impacted (Percent Square Footage)	New Construction Impacted, derated for market share rate (Percent Square Footage)	Existing Building Stock (Alterations) Impacted (Percent Square Footage)
Hospital	100%	100%	3%
OfficeMediumLab	100%	100%	3%
OfficeLarge	100%	100%	3%
OfficeMedium	100%	100%	3%
OfficeSmall	100%	100%	3%
RestaurantFastFood	100%	100%	3%
RetailLarge	100%	100%	3%
RetailMedium	100%	100%	3%
RetailStripMall	100%	100%	3%
SchoolLarge	100%	100%	3%
SchoolSmall	100%	100%	3%
Warehouse	100%	100%	3%
Assembly	100%	100%	3%

Table 34: Percentage of Nonresidential Floorspace Impacted by Proposed Measure, by Climate Zone

Climate Zone	New Construction Impacted (Percent Square Footage)	Existing Building Stock (Alterations) Impacted (Percent Square Footage)
1	100%	3%
2	100%	3%
3	100%	3%
4	100%	3%
5	100%	3%
6	100%	3%
7	100%	3%
8	100%	3%
9	0%	3%
10	100%	3%
11	0%	3%
12	0%	3%
13	0%	3%
14	0%	3%
15	0%	3%
16	100%	3%

Window Alterations

The Statewide CASE Team estimated statewide impacts for the first year by multiplying per-unit savings estimates by statewide construction forecasts provided by the CEC. The 2028 CASE Methodology Report includes additional information about the methodology and assumptions used to calculate statewide energy impacts.

The statewide savings and cost estimates consider the current market share rate. The Statewide CASE Team estimated that the current market share rate for the proposed code change is 0 percent for the retrofit market. The current market share rate is estimated based on the Statewide CASE Team's professional judgment and data from the evaluation of past Title 24 code cycles.

Table 35presents the projected nonresidential new construction that the proposed code change would impact in 2028. Table 36 shows the projected nonresidential existing statewide building stock that the proposed code change would affect through alterations in 2028. The Statewide CASE Team developed these estimates using the methods described in this section.

The Statewide CASE Team estimated the percentage of newly constructed floorspace that the proposed code change would impact. Table 37 shows the assumed percentage of affected floorspace by building type. If a proposed code change does not apply to a specific building type, the Statewide CASE Team assumes that zero percent of the floorspace would be impacted. If the assumed percentage is non-zero, but less than 100 percent, the proposal is expected to affect some—but not all—buildings. Table 38 represents the assumed percentage of affected floorspace by climate zone.

The percentages of total floorspace assumed to be impacted by the proposed fenestration requirements reflect typical market practice. For alterations, the measure is assumed to apply to 3 percent of existing floorspace in the forecasts. This 3 percent factor is based on an assumed 30-year lifespan for windows, under which approximately one-thirtieth of the existing stock would be replaced in any given year. This approach recognizes that fenestration retrofits occur gradually as windows reach the end of their useful life, rather than uniformly across all buildings. The current modeling approach therefore applies the 3 percent annual turnover rate to the statewide building stock to estimate the portion of floorspace affected each year.

Table 35: Estimated New Nonresidential Construction Impacted by Proposed Code Change in 2028, by Climate Zone and Building Type (Million Square Feet)

Building Type	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16	All
Large Office	0.00	0.00	2.03	0.99	0.00	0.89	0.52	1.44	2.61	0.25	0.07	0.36	0.00	0.13	0.01	0.03	9.32
Medium Office	0.09	0.33	0.96	0.52	0.26	0.84	0.56	1.15	2.23	0.82	0.19	1.96	0.41	0.24	0.18	0.07	10.83
Small Office	0.01	0.30	0.13	0.01	0.04	0.10	0.16	0.11	0.25	0.29	0.06	0.38	0.27	0.03	0.07	0.02	2.25
Large Retail	0.00	0.00	0.77	0.38	0.10	0.49	0.26	0.58	1.16	0.44	0.21	0.91	0.25	0.10	0.13	0.04	5.83
Medium Retail	0.06	0.24	0.56	0.31	0.06	0.42	0.20	0.60	1.00	0.58	0.10	0.44	0.27	0.13	0.09	0.06	5.10
Strip Mall	0.00	0.11	0.35	0.16	0.01	0.39	0.34	0.69	0.75	0.94	0.05	0.41	0.23	0.22	0.07	0.04	4.77
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	0.00	0.08	0.54	0.27	0.02	0.37	0.38	0.56	0.88	0.53	0.22	0.71	0.38	0.10	0.05	0.04	5.13
Small School	0.05	0.19	0.32	0.16	0.10	0.22	0.21	0.25	0.46	0.24	0.07	0.54	0.21	0.07	0.03	0.03	3.15
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
Hotel	0.03	0.15	0.72	0.37	0.08	0.39	0.34	0.55	0.83	0.40	0.11	0.56	0.18	0.10	0.09	0.03	4.91
Assembly	0.01	0.28	1.11	0.39	0.04	0.55	0.56	1.00	1.28	0.80	0.12	0.99	0.21	0.17	0.08	0.06	7.64
Hospital	0.02	0.12	0.57	0.29	0.05	0.22	0.37	0.30	0.53	0.55	0.10	0.56	0.18	0.10	0.08	0.03	4.08
Laboratory	0.01	0.13	0.90	0.50	0.05	0.29	0.19	0.32	0.59	0.24	0.09	0.30	0.08	0.06	0.03	0.02	3.81
Restaurant	0.01	0.06	0.23	0.12	0.02	0.24	0.14	0.35	0.57	0.29	0.05	0.22	0.10	0.07	0.03	0.02	2.52
Enclosed Parking Garage	0.00	0.01	1.28	0.87	0.00	1.81	0.49	1.59	1.07	0.04	0.00	0.03	0.00	0.01	0.00	0.01	7.21
Open Parking Garage	0.00	0.08	1.73	1.18	0.04	2.55	0.84	2.24	1.51	0.46	0.01	0.37	0.03	0.14	0.03	0.07	11.28
Grocery	0.00	0.03	0.07	0.04	0.01	0.03	0.01	0.04	0.06	0.03	0.01	0.03	0.02	0.01	0.01	0.00	0.41

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
Refrigerated Warehouse	0.00	0.00	0.04	0.04	0.01	0.02	0.00	0.00	0.01	0.03	0.00	0.05	0.08	0.01	0.01	0.00	0.29
Controlled-Environment Horticulture	0.06	0.05	0.22	0.03	0.14	0.18	0.00	0.02	0.02	0.19	0.21	0.21	0.06	0.01	0.03	0.00	1.46
Vehicle Service	0.00	0.05	0.38	0.25	0.02	0.39	0.24	0.56	1.27	0.40	0.02	0.27	0.17	0.14	0.04	0.03	4.23
Manufacturing	0.00	0.01	0.15	0.05	0.01	0.01	0.04	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34
Unassigned	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30
TOTAL	**0.4**	**2.5**	**14.6**	**8.0**	**1.2**	**11.4**	**6.3**	**13.8**	**19.2**	**8.5**	**2.1**	**11.3**	**3.7**	**2.1**	**1.3**	**0.7**	**107.1**

Table 36: Estimated Existing Nonresidential Floorspace Impacted by Proposed Code Change in 2028 (Alterations), by Climate Zone and Building Type (Million Square Feet)

Building Type	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16	All
Large Office	0.10	2.48	111.84	57.88	1.47	79.63	58.17	130.08	242.48	46.78	2.09	62.89	7.41	16.22	3.55	3.73	826.79
Medium Office	2.70	24.79	63.03	33.82	10.66	38.25	35.10	47.29	69.07	53.35	13.55	81.36	20.14	10.66	8.20	3.25	515.23
Small Office	3.34	10.20	17.75	9.06	6.00	10.58	6.81	10.62	16.70	19.54	8.48	35.15	17.18	3.99	4.94	2.14	182.51
Large Retail	0.80	6.93	46.94	21.52	3.36	25.57	20.27	34.77	53.22	42.65	9.12	46.53	18.01	8.73	7.52	2.57	348.51
Medium Retail	0.94	10.49	35.62	20.59	4.35	35.42	27.73	53.38	86.56	53.51	8.30	48.40	19.32	12.42	7.02	4.14	428.17
Strip Mall	2.67	7.87	29.94	14.74	4.08	32.18	22.63	44.61	66.96	53.54	9.80	38.70	19.34	12.22	6.96	3.67	369.90
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	0.61	6.42	27.86	11.16	1.66	22.70	18.03	34.33	58.86	44.81	8.10	42.70	21.13	9.65	6.10	2.87	316.98
Small School	1.78	8.90	20.46	7.98	4.85	20.55	11.97	27.55	43.45	26.42	10.80	33.66	18.75	6.98	3.40	2.92	250.43

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
Non-refrigerated Warehouse	2.66	16.18	86.64	42.74	7.84	71.98	41.18	102.72	165.84	146.16	26.98	118.64	40.86	31.10	23.24	9.30	934.08
Hotel	1.42	8.42	38.48	19.78	4.01	24.39	26.13	33.58	52.81	29.67	5.77	32.42	10.46	6.40	4.70	1.95	300.40
Assembly	3.46	14.54	73.07	36.05	5.28	45.80	32.72	71.31	96.16	73.40	13.08	55.78	24.10	15.16	9.46	5.15	574.53
Hospital	1.49	8.87	38.66	19.74	4.04	22.60	21.72	32.62	55.90	31.68	8.89	42.54	17.99	7.04	4.03	2.59	320.41
Laboratory	0.14	3.21	29.54	22.45	1.22	9.77	13.75	12.49	15.45	8.65	0.54	9.71	3.52	1.38	0.31	0.46	132.59
Restaurant	0.49	2.89	11.78	6.00	1.24	13.17	8.58	19.02	32.00	25.93	2.81	13.56	6.19	5.49	2.76	1.52	153.42
Enclosed Parking Garage	0.01	0.43	32.57	24.75	0.24	23.32	16.54	46.73	58.02	2.14	0.28	2.47	0.39	0.68	0.13	0.35	209.06
Open Parking Garage	0.18	5.62	44.02	33.46	3.09	32.91	28.14	65.95	81.92	27.66	3.57	31.97	5.05	8.84	1.72	4.49	378.59
Grocery	0.08	1.36	4.70	2.85	0.60	2.73	1.67	3.21	5.56	3.21	0.52	2.99	1.16	0.75	0.43	0.31	32.12
Refrigerated Warehouse	0.00	0.36	0.73	0.17	0.31	0.37	0.02	0.34	0.63	0.52	0.21	1.72	3.13	0.15	0.16	0.12	8.92
Controlled-Environment Horticulture	0.56	0.37	2.10	0.86	5.06	6.61	0.86	0.59	1.28	2.89	2.01	3.63	4.29	0.37	0.52	0.19	32.17
Vehicle Service	0.73	4.95	26.92	12.78	2.38	26.98	18.46	39.62	65.42	45.23	5.04	30.66	14.59	12.07	4.94	2.83	313.61
Manufacturing	3.28	13.51	49.54	63.64	4.47	58.66	26.62	98.16	134.48	39.66	10.29	45.61	20.78	13.58	4.12	7.42	593.83
Unassigned	0.29	5.26	7.22	5.05	0.18	2.06	0.62	3.02	6.29	2.04	2.69	11.48	2.35	0.62	0.32	0.82	50.31
TOTAL	**27.7**	**164.1**	**799.4**	**467.1**	**76.4**	**606.2**	**437.7**	**912.0**	**1409.1**	**779.5**	**152.9**	**792.6**	**296.1**	**184.5**	**104.5**	**62.8**	**7,272.55**

Table 37: Percentage of Nonresidential Floorspace Impacted by Proposed Code Change in 2028, by Building Type

Building Type	New Construction Impacted (Percent Square Footage)	New Construction Impacted, derated for market share rate (Percent Square Footage)	Existing Building Stock (Alterations) Impacted (Percent Square Footage)	Existing Building Stock Impacted, derated for market share rate (Percent Square Footage)
Hospital	0%	0%	3%	3%
OfficeMediumLab	0%	0%	3%	3%
OfficeLarge	0%	0%	3%	3%
OfficeMedium	0%	0%	3%	3%
OfficeSmall	0%	0%	3%	3%
RestaurantFastFood	0%	0%	3%	3%
RetailLarge	0%	0%	3%	3%
RetailMedium	0%	0%	3%	3%
RetailStripMall	0%	0%	3%	3%
SchoolLarge	0%	0%	3%	3%
SchoolSmall	0%	0%	3%	3%
Warehouse	0%	0%	3%	3%
Assembly	0%	0%	3%	3%

Table 38: Percentage of Nonresidential Floorspace Impacted by Proposed Measure, by Climate Zone

Climate Zone	New Construction Impacted (Percent Square Footage)	Existing Building Stock (Alterations) Impacted (Percent Square Footage)
1	0%	3%
2	0%	3%
3	0%	3%
4	0%	3%
5	0%	3%
6	0%	3%
7	0%	3%
8	0%	3%
9	0%	3%
10	0%	3%
11	0%	3%
12	0%	3%
13	0%	3%
14	0%	3%
15	0%	3%
16	0%	3%

Appendix D: Environmental Analysis

New Construction/Additions - Windows

Potential Significant Environmental Effect of Proposal

The CEC is the lead agency under the California Environmental Quality Act (CEQA) for the 2028 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 has determined that the proposal would not result in a significant effect on the environment.

Direct Environmental Impacts

Direct Environmental Benefits

There are moderate energy savings and GHG emissions reduction from this proposal because of increased window efficiency in climate zones 1 and 16. For more information on the energy savings, see Section 2.5.1. For more information on the GHG emission reductions, see Section 2.5.20.

Direct Adverse Environmental Impacts

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

Indirect Environmental Impacts

There are no indirect environmental impacts associated with this code change proposal.

Indirect Environmental Benefits

There are no indirect environmental benefits associated with this code change proposal.

Indirect Adverse Environmental Impacts

There are no indirect adverse environmental impacts associated with 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 determined that this measure would not result in significant direct or indirect adverse environmental impacts and therefore did not develop any mitigation measures.

Reasonable Alternatives to Proposal

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

The Statewide CASE Team has considered alternatives to the proposal and determined that no alternative would achieve its purpose 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.

Nonresidential Fenestration - Alterations

Potential Significant Environmental Effect of Proposal

The CEC is the lead agency under the California Environmental Quality Act (CEQA) for the 2028 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 has determined that the proposal would not result in a significant effect on the environment.

Direct Environmental Impacts

Direct Environmental Benefits

There are significant energy savings and GHG emission reductions from this proposal as result of aligning the U-factor requirements of Window Alterations with those of New Construction, when certain conditions are met. For more information on the energy savings, see Section 3.5.1. For more information on the GHG emission reductions, see Section 3.5.2.

Direct Adverse Environmental Impacts

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

Indirect Environmental Impacts

Indirect Environmental Benefits

There are no indirect environmental benefits associated with this code change proposal.

Indirect Adverse Environmental Impacts

There are no indirect adverse environmental impacts associated with 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 determined that this measure would not result in significant direct or indirect adverse environmental impacts and therefore did not develop any mitigation measures.

Reasonable Alternatives to Proposal

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

The Statewide CASE Team has considered alternatives to the proposal and determined that no alternative would achieve its purpose 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.

Appendix E: Summary of Stakeholder Engagement

Introduction to Stakeholder Engagement

Collaborating with stakeholders who may be affected by proposed code changes is a core component of the Statewide CASE Team's process. The Statewide CASE Team engages interested parties to identify and address issues related to the proposals, with the goal of submitting recommendations to the CEC in this Draft CASE Report that reflect broad support. Public stakeholders provide valuable feedback on draft analyses and help identify and address adoption challenges, including cost effectiveness, market and technical barriers, compliance and enforcement, and 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 conducted by the Statewide CASE Team during the development and refinement of the report's recommendations.

Nonresidential Fenestration – New Construction, Additions & Alterations

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 these 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 promote transparency in the development of code change proposals, the Statewide CASE Team uses stakeholder meetings to solicit feedback on:

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

The Statewide CASE Team hosted one stakeholder meeting for Nonresidential Fenestration New Construction/Additions Windows via webinar, as described in Table 39. Please see below for dates and links to event pages on Title24Stakeholders.com.

Materials from each meeting, such as slide presentations, proposal summaries with code language, and meeting notes, are included in the bibliography section of this report.

Table 39: Utility-Sponsored Stakeholder Meetings

Meeting Name and Link to Materials	Meeting Date	Summary of Items Discussed
First Round of Nonresidential Covered Processes, Envelope Utility-Sponsored Stakeholder Meeting	Tuesday, September 30, 2025	• Solar Pool Heating • Envelope – Fenestration Improvements • Traction Elevators • Data Center Improvements
Second Round of Nonresidential Covered Processes, Envelope Utility-Sponsored Stakeholder Meeting	Tuesday, March 17, 2026 (scheduled)	• Nonresidential Fenestration • Solar Pool Heating • Process Steam • Data Centers • Healthcare Exceptions

The first round of utility-sponsored stakeholder meetings began in September 2025 and served as an early forum to promote transparency and gather stakeholder feedback on measures under consideration by the Statewide CASE Team.

The objectives of the first round of stakeholder meetings were to solicit input on the scope of the 2025 code cycle proposals; request data and feedback on the specific approaches, assumptions, and methodologies for the energy impacts and cost-effectiveness analyses; and understand potential technical and market barriers. The Statewide CASE Team also presented the initial draft code language for stakeholders to review.

The second round of utility-sponsored stakeholder meetings will occur in March 2026 and will provide updated details on proposed code changes. These 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 full Title 24 Stakeholders listserv, which includes over 3,000 individuals. A second email targeted specific recipients based on their subscription preferences.

The Title 24 Stakeholders listserv is an opt-in service comprising participants from diverse industries and trades, such as manufacturers, advocacy groups, local government, and building and energy professionals. Each meeting was announced on

the Title 24 Stakeholders LinkedIn page and cross-promoted on the CEC LinkedIn page approximately two weeks in advance to engage individuals, organizations, and broader channels outside beyond the listserv. The Statewide CASE Team conducted extensive personal outreach to stakeholders identified in initial work plans who had not yet opted in to the listserv. Exported webinar meeting data captured attendance numbers, individual comments, and results from live attendee polls to help 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 40.

Table 40: Engaged Stakeholders

Organization/Individual Name	Market Role	Mentioned in CASE Report Sections
Thomas Culp, Ph.D./Birch Point Consulting	Industry Representative	N/A
Helen Sanders/Technoform North American	Industry Representative	N/A
Katherine Cort/PNNL	National Laboratory	N/A
Robert Hart/LBL	National Laboratory	N/A
Christian Valoria, PNNL	National Laboratory	N/A
Allegra Steenson/PNNL	National Laboratory	N/A
Walt Zalis/Energetics	PAWS	N/A
Tom Herron/NFRC **Jennifer Hatfield/J. Hatfield and Associates**	Industry Industry Representative	N/A N/A

Engagement with ESJ communities

TBD