



TITLE 24, PART 6

2025 CODE CYCLE

Window Measures

Codes and Standards Enhancement (CASE) Proposal
Single Family, Multifamily, Nonresidential | Envelope

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**Building Type:
Single Family**

Window Measures – Single Family

Background



Single Family - Proposed Measures

- Lower prescriptive U-factor maximum:

Climate Zones	Existing	Proposed
1, 16	0.3	0.25
All others	0.3	0.28

- Add SHGC requirements in CZs currently unregulated:

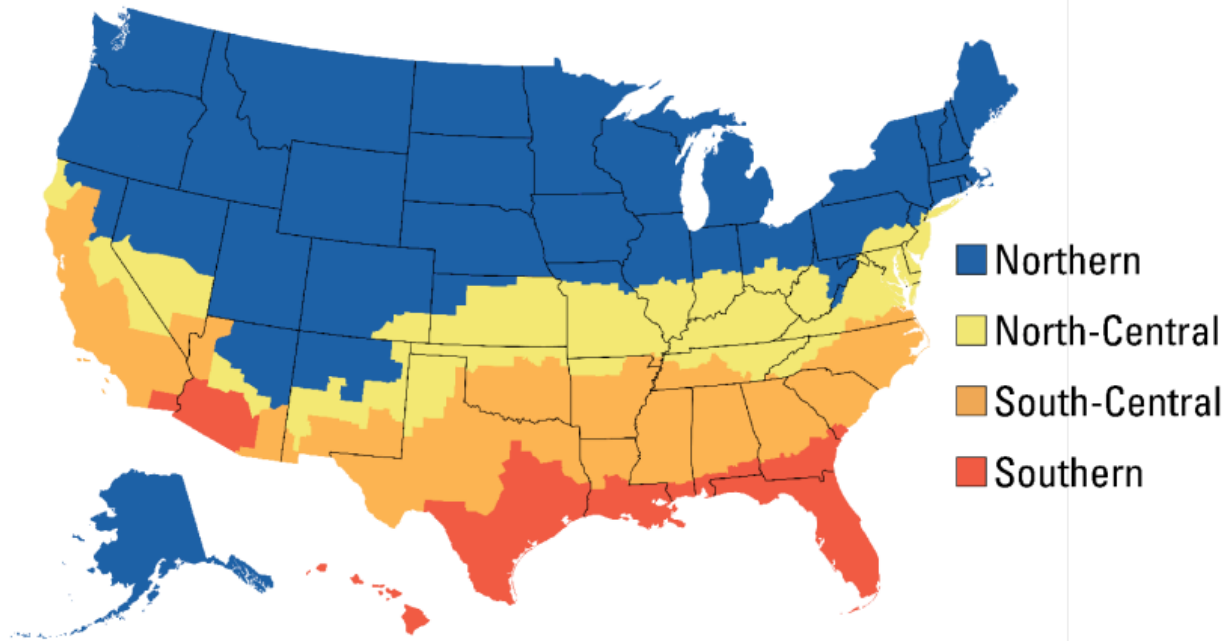
Climate Zones	Existing	Proposed
1, 3, 5, 16	Not Required	Min 0.35
All others	0.23	No change

- Reduce mandatory U-factor maximum: 0.45 → 0.40 in all CZs

Existing and proposed requirements apply to new construction, additions, alterations

Context and History

We are proposing this measure for **better alignment with new ENERGY STAR criteria**



Windows

Climate Zone	U-Factor ¹	SHGC ²	
Northern	≤ 0.22	≥ 0.17	Prescriptive
	$= 0.23$	≥ 0.35	Equivalent Energy Performance
	$= 0.24$		
	$= 0.25$		
	$= 0.26$		
North-Central	≤ 0.25	≤ 0.40	
South-Central	≤ 0.28	≤ 0.23	
Southern	≤ 0.32	≤ 0.23	

Air Leakage for windows ≤ 0.3 cfm/ft²

¹ Btu/h ft²·°F

² Solar Heat Gain Coefficient



Window Measures – Single Family

Market Overview

- Current Market Conditions
- Market Trends
- Potential Market Barriers and Solutions

Market Overview and Analysis

Current Market

- Dominated by dual-paned, vinyl, low-e windows
- Market is well established with products readily available
- Highly variable pricing across similar product types
- Most utility incentive programs retired due to cost effectiveness

Market Trends

- Manufacturers expected to be impacted by new ENERGY STAR window criteria (not just California)

Market Barriers

- Technical conflicts with customer preference (next section)
- Krypton supply chain issues

Do you agree with this description? What else should be known?

Any other marketplace concerns? Consider labor costs, components, etc.



Window Measures – Single Family

Technical Considerations

- Technical Considerations
- Potential Barriers and Solutions

Technical Considerations

Technical Considerations

- U-factor and SHGC describes whole window assembly
 - Listed in NFRC database
- Minimal upfront change to standard design practices, will abate as market adapts

Technical Barriers and Potential Solutions

- U-factor: Slim windows vs. triple paned
 - More product options anticipated due to ENERGY STAR
- SHGC: Visual transmittance vs. heavily coated (dark)
 - No change to regulated CZs—already in “sweet spot”

Do you agree with this description? What else should we know? Do you foresee any other technical barriers?

Window Measures – Single Family

Energy and Cost Impacts Per Home

Methodology and Assumptions

- Energy Savings
- Cost Impacts
 - Incremental costs
 - Energy cost savings



Methodology for Energy Impacts Analysis

Modeled via CBECC-Res 2025:

- **Prototypes:**
 - 500 ft² home
 - 2,400 ft² home (average of 2,100 and 2,700 ft² homes)
- **Climate Zones: All**



Assumptions for Standard and Proposed Designs



Standard Design

Minimally compliant with 2022 Code:

- 0.3 U-factor
- 0.35 SHGC in CZs 1, 3, 5, 16
- 0.23 SHGC in CZs 2, 4, 6-15



Proposed Design

High performance windows:

- 0.25 U-factor in CZs 1, 16
- 0.28 U-factor in CZs 2-15
- 0.35 SHGC in CZs 1, 3, 5, 16
- 0.23 SHGC in CZs 2, 4, 6-15

Preliminary Energy Savings Estimates

Per Home: 2400 ft²

Savings	CZ 1	CZ 16	CZs 2–15
Annual Electricity Savings (kWh/yr)	21	1	-11 to 83
Annual Natural Gas Savings (therms/yr)	33	34	0 to 9
Peak Demand Reduction (W)	2.2	2.4	-0.3 to 29
Annual Life Cycle Energy Cost Savings (\$2026 PV)	4,188	4,296	288 to 1,128
Annual Source Energy Savings (kBtu/yr)	3,060	3,072	120 to 804

Key Assumptions:

- 0.25 U-factor for CZs 1 & 16
- 0.28 U-factor for CZs 2-15
- Savings apply statewide

Incremental Cost Information

Methodology

- ENERGY STAR V7 window criteria research
- Interviews with manufacturers, distributors and contractors

Costs

- Window U-factor:
 - $0.3 \rightarrow 0.28 = \$0.51/\text{ft}^2$
 - $0.3 \rightarrow 0.25 = \$1.65/\text{ft}^2$
- Incremental labor: \$0

- What components of costs did we leave out?
- Do you find these costs to be reasonable?
- Other foreseen costs?



Incremental Per Home Cost

Over 30 Year Period of Analysis

2100 to 2700 ft² prototype

Incremental First Cost 0.3 → 0.28	
Materials	\$214–\$275
Installation	\$0
Total	\$214–\$275

Incremental First Cost 0.3 → 0.25	
Materials	\$693–\$891
Installation	\$0
Total	\$693–\$891

500 ft² prototype

Incremental First Cost 0.3 → 0.28	
Materials	\$51
Installation	\$0
Total	\$51

Incremental First Cost 0.3 → 0.25	
Materials	\$165
Installation	\$0
Total	\$165

Cost data came from:

- ENERGY STAR
- Stakeholders

Do you foresee other costs?

Cost Effectiveness: 2400 ft² prototype, prescriptive U-factor

Climate Zone	Benefits <i>Life Cycle Energy Cost Savings + Other PV Savings (2026 PV\$)</i>	Costs <i>Total Incremental PV Costs (2026 PV\$)</i>	<i>Benefit-to-Cost Ratio</i>
1	\$4,188	\$792	5.3
2	\$1,128	\$245	4.6
3	\$492	\$245	2.0
4	\$588	\$245	2.4
5	\$876	\$245	3.6
6	\$312	\$245	1.3
7	\$288	\$245	1.2
8	\$300	\$245	1.2
9	\$408	\$245	1.7
10	\$444	\$245	1.8
11	\$960	\$245	3.9
12	\$936	\$245	3.8
13	\$372	\$245	1.5
14	\$636	\$245	2.6
15	\$288	\$245	1.2
16	\$4,296	\$792	5.4

Cost Effectiveness: 500 ft² prototype, prescriptive U-factor

Climate Zone	Benefits <i>Life Cycle Energy Cost Savings + Other PV Savings (2026 PV\$)</i>	Costs <i>Total Incremental PV Costs (2026 PV\$)</i>	<i>Benefit-to-Cost Ratio</i>
1	\$580	\$165	3.5
2	\$155	\$51	3.0
3	\$65	\$51	1.3
4	\$85	\$51	1.7
5	\$40	\$51	0.8
6	(\$15)	\$51	0.0
7	(\$40)	\$51	0.0
8	(\$35)	\$51	0.0
9	(\$15)	\$51	0.0
10	(\$15)	\$51	0.0
11	\$140	\$51	2.7
12	\$125	\$51	2.5
13	\$70	\$51	1.4
14	\$100	\$51	2.0
15	\$0	\$51	0.0
16	\$645	\$165	3.9



Window Measures – Single Family

Compliance and Enforcement

- Design
- Permit Application
- Construction
- Inspection
- Revisions to Compliance Software

Compliance and Verification Process



1. Design Phase:

- Specify windows meeting new U-factor and SHGC requirements
- SHGC check is new step for previously unregulated CZs, otherwise no change



2. Permit Application Phase:

Existing part of permitting—no change except to previously unregulated CZs



3. Construction Phase:

No change



4. Inspection Phase:

No change except new step for SHGC check in previously unregulated CZs (data given by window label/sticker already being inspected)

Market Actors

Market actors involved in implementing this measure include:

- Building/Envelope Designers & Consultants
- Window Manufacturers, Suppliers, Distributors
- Residential Builders
- Plans Examiners, Building Inspectors, HERS Raters

We welcome input from these and any other market actors.

- **Did we miss any?**
- **How may market actors be impacted?**

Code Changes

Draft code language available for review in the resources tab and download.

If adopted, the following sections of Title 24, Part 6 will be revised accordingly:

- **Subchapter 7:** Section 150.0(q)1
- **Subchapter 8:** Section 150.1(c)3A, Table 150.1-A
- **ACM:** Section 2.5.6.6 Fenestration

Building Type: Multifamily

Window Measures – Multifamily

Background



Multifamily Windows Proposed Measures

In the *prescriptive* requirements for fenestration in Table 170.2-A:

- Change the RSHGC requirements to establish a “minimum” RSHGC in CZ 1, 3, 5, 16 for all window types.
- Lower the U-factor requirement in (most) CZs for the "all other" window type from 0.3 to 0.28.

Code cleanup: Update U-factor in CZ6 and CZ8 for the "All Other" window to correct a clerical error.

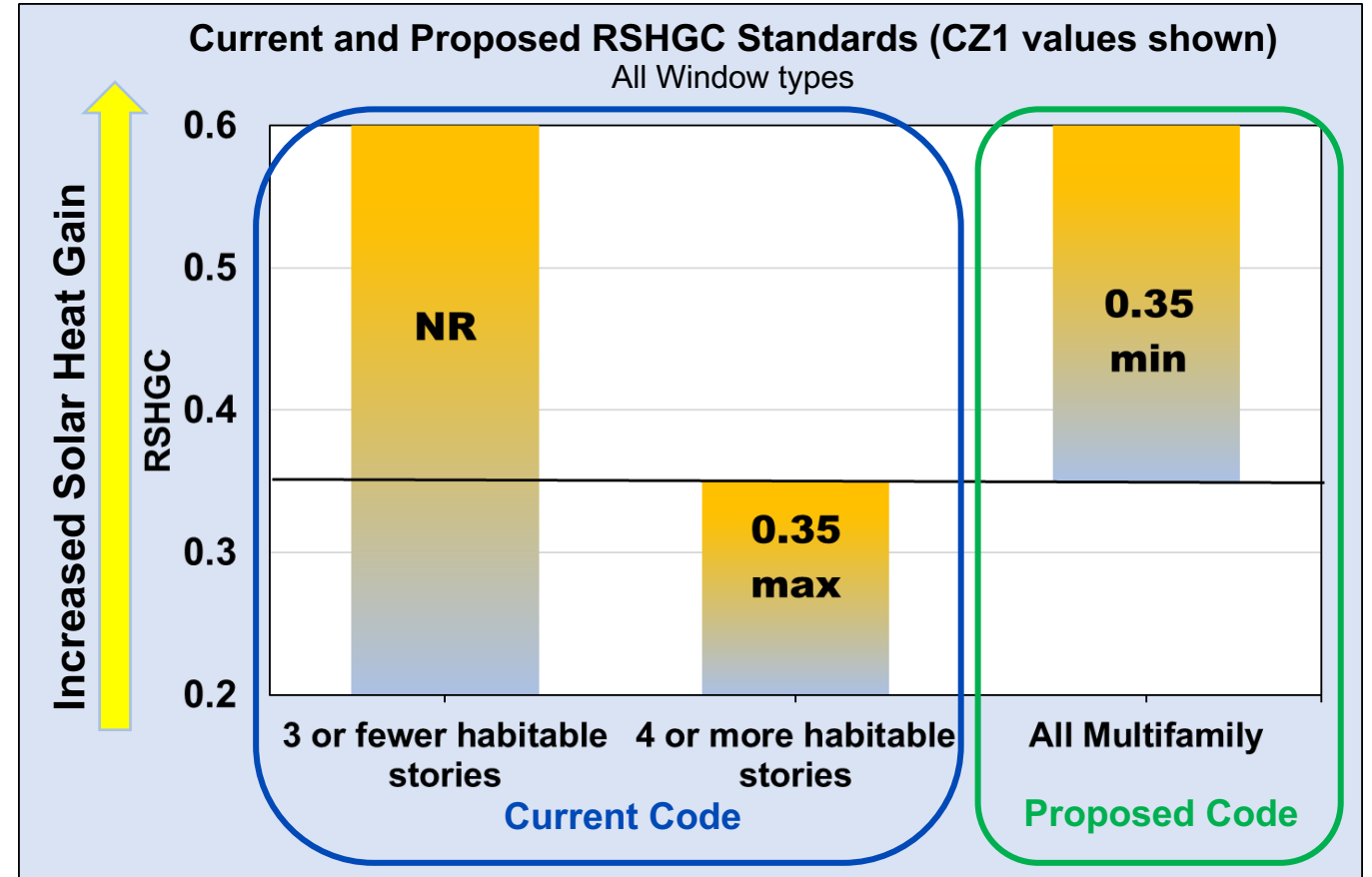
- CZ6: U-factor 0.34 vs. 0.30
- CZ8: U-factor 0.30 vs. 0.34



Proposed Code Change Background - RSHGC

RSHGC Background:

- Warmer CZs:
Decreasing **Relative Solar Heat Gain (RSHGC)** reduces cooling load during warm months leading to lower annual energy consumption.
- Colder CZs:
Increasing RSHGC reduces heating load during cold months, leading to lower annual energy consumption.
- Heating-dominated climate zones (1, 3, 5, and 16) show increased energy savings with increased RSHGC.



Proposed Code Requirement Changes - RSHGC

RSHGC Code Change Proposal:

- Current RSHGC values are either a MAXIMUM, or there is no required value (NR).
- Code change proposal recommends establishing a MINIMUM RSHGC for four CZs (1, 3, 5, 16).
- *The table will be modified to identify minimum and maximum values as below*



TABLE 170.2-A ENVELOPE COMPONENT PACKAGE – Multifamily Standard Building Design

Multifamily		Climate Zone															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
NAFS 2017 Performance Class AW ⁵	Maximum U-factor	0.38	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.38
	RSHGC (Maximum unless otherwise indicated)	0.35 min	0.24	0.35 min	0.24	0.35 min	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.35 min
	Minimum VT, four or more habitable stories	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37

Proposed Code Changes

Existing prescriptive requirements and highlighted fenestration changes in **Section 170.2, Table 170.2-A**

Multifamily		Climate Zone															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Curtain Wall/ Storefront	Maximum U-factor	0.38	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.38
	Maximum RSHGC, three or fewer habitable stories	NR	0.26	NR	0.26	NR	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.25	0.26	NR
	Maximum RSHGC, four or more habitable stories	0.35	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.25	0.26	0.25
NAFS 2017 Performance Class AW ⁵	Maximum U-factor	0.38	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.38
	Maximum RSHGC, three or less habitable stories	NR	0.24	NR	0.24	NR	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	NR
	Maximum RSHGC, four or more habitable stories	0.35	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
All Other Fenestration	Maximum U-factor	0.3	0.3	0.3	0.3	0.3	0.34*	0.34	0.3*	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
	Maximum RSHGC, three or less habitable stories	NR	0.23	NR	0.23	NR	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	NR
	Maximum RSHGC, four or more habitable stories	0.35	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

-  Proposed “Minimum” RSHGC of 0.35
-  Proposed lower U-factor of 0.28

— * = Corrected values

Context and History

Why are we proposing this MF Windows measure?

RSHGC Proposed Changes:

- *Modify code for heating-dominated CZs to encourage higher RSHGC.*
 - *Streamline fenestration requirements in Table 170.2-A, remove bifurcation by number of stories.*
- Improve heat gain through fenestration in heating-dominated CZs to reduce total energy consumption.
- Higher RSHGC will generally result in lower window costs.

U-factor Proposed Changes:

- Reduce fenestration heat gain/loss to reduce total energy consumption.
- Align prescriptive requirements with current fenestration market technologies.



Window Measures – Multifamily

Market Overview

Market Overview and Analysis

Current Market: Products to meet proposed changes are readily available.

Market Trends

- Most multifamily buildings use the Performance compliance approach.
- 90% multifamily buildings do not trade off window performance and still install windows that meet or exceed 2019 prescriptive requirements.

Market Barriers and Potential Solutions

- **Cost Concerns:** Improved U-factor = higher costs
 - *Cost-benefit analysis shows positive impact in all proposed CZs.*
- **Regional product availability:** For all-other windows, slight reduction in product availability for higher RSHGC in windows, but market can adjust to offer more based on demand
 - *Compliant assemblies are commonly stocked in northern climates and the market can shift in California quickly.*

**Do you agree with
this description?
What else should we
know?**



Window Measures – Multifamily

Technical Considerations

Technical Considerations

U-Factor	Most Common Technical Pathways
0.32–0.35	1 Low-e coating, air-filled IGU and basic frames
0.28–0.31	1 Low-e coating with argon-filled IGU
0.27	1 Low-e coating with argon-filled IGU and improved frames and spacers
0.24–0.26	2 Low-e coatings (room-side low-e) with argon-filled IGU
0.22–0.23	Triple-pane with 2 low-e coatings and argon-filled IGU
0.21 and Below	Triple-pane with room-side low-e, argon-filled IGU, non-metal spacers, and improved and/or foamed frames

The double pane windows in market can easily meet proposed U-factor 0.28 with argon fill and a single low-e coating.

The incremental addition is an argon layer to change U-factor from 0.3 to 0.28

EPA. Oct 20,2023. https://www.energystar.gov/sites/default/files/asset/document/ES_Residential_WDS_Draft%201_Criteria%20Analysis%20Report.pdf

Window Measures – Multifamily

Energy and Cost Impacts Per Dwelling Unit

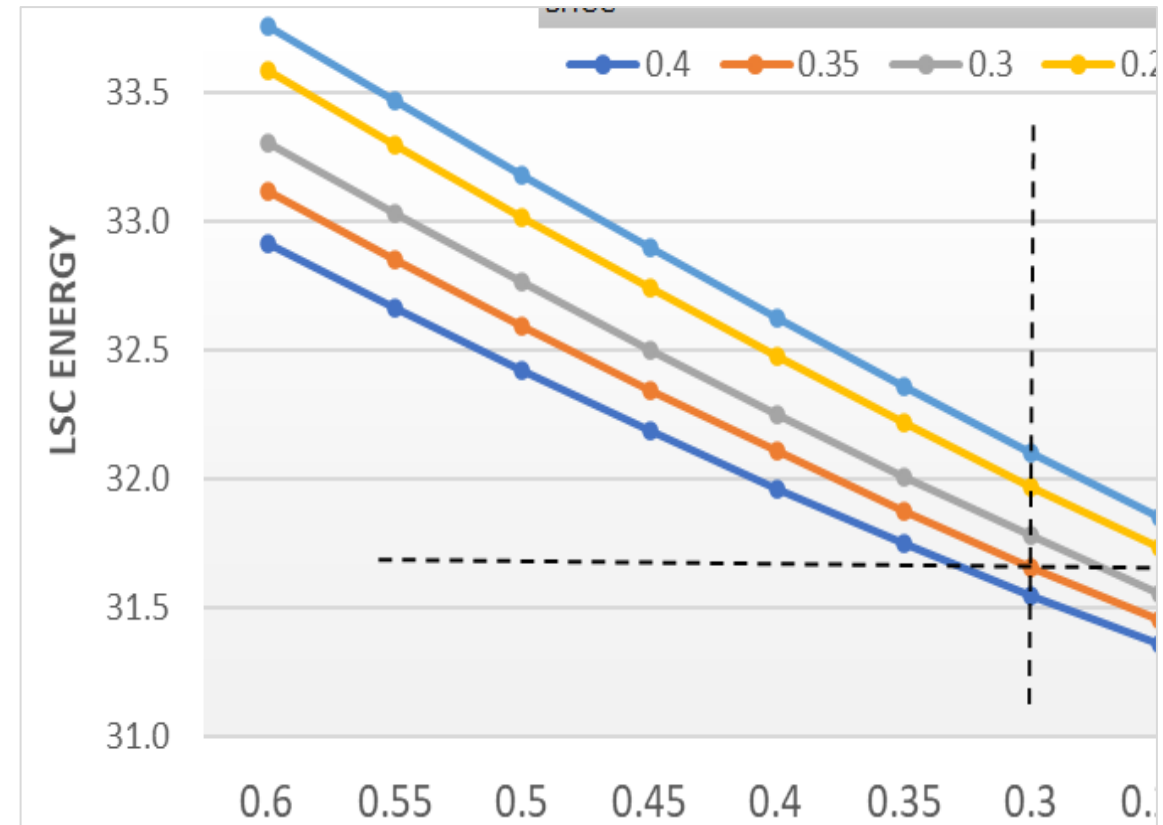
Methodology and Assumptions



Methodology for Energy Impacts Analysis

- 2026 Long-term System Cost (LSC) factors
- Building prototypes built in CBECC software
- 2022 T24 prescriptive requirements assumed as the base case.
- Parametric (U/RSHGC) modeling to evaluate energy impact trends.

CZ 1,3,5,16 (Cold Climates)
LSC Energy decrease with increase in SHGC



Assumptions for Standard and Proposed Designs



Standard Design

- Minimally compliant with 2022 prescriptive Code for all building systems.
- Fenestration U-factor: "All Other" windows, U-factor 0.30 for CZ1-5, CZ8-16, U-factor 0.34 for CZ6-7
- Fenestration RSHGC: Varies, based on Table 170.2-A



Proposed Design

- Minimally compliant with 2022 prescriptive Code for all building systems.
- Fenestration U-factor: 0.28, CZ 1-16, building prototypes Low-rise Garden, Low-rise loaded corridor, & Mid-rise mixed use for the "All Other" window type.
- Fenestration RSHGC: 0.35 min. CZ 1, 3, 5, 16

Preliminary Energy Savings Estimates Per Dwelling Unit

- **CZ 1,3,5,16:**
\$58 – \$265 savings per DU with U-factor decrease and increase in RSHGC.
- **CZ 2,4,11-15:**
\$34 – \$59 savings per DU with U-factor decrease only.

Energy and Energy Cost Impacts - New Construction & Additions					
Climate Zone	First-Year Electricity Savings (kWh)	First-Year Peak Electrical Demand Reduction (W)	First-Year Natural Gas Savings (therms)	First-Year Source Energy Savings (kBtu)	30-Year Present Valued Energy Cost Savings (2026 PV\$)
CZ01	5.63	(0.09)	0.12	26.01	57.95
CZ02	5.08	(0.09)	0.00	16.31	41.58
CZ03	17.49	(0.59)	0.00	78.92	159.38
CZ04	7.73	0.04	0.00	21.54	59.10
CZ05	14.84	(0.47)	0.00	72.49	127.58
CZ11	6.12	0.66	0.00	18.17	49.51
CZ12	5.02	(0.17)	0.00	15.79	40.78
CZ13	5.16	1.04	0.00	13.85	42.13
CZ14	6.95	0.45	0.00	20.66	54.50
CZ15	5.09	2.42	0.00	5.00	33.62
CZ16	(27.75)	(22.93)	3.36	283.42	265.04

Incremental Cost Information

- Collected cost information of base case technology and proposed technology from EPA Product Cost database
 - Cost impacts were reviewed during Manufacturer, Designer, and Builder interviews
 - **Material costs only.** No change in labor/installation; proposed changes do not impact installation methods.

Window type	Building type	Measure Description	2022 T24 Base Case	2025 T24 Proposed	Incremental Cost (\$/dwelling unit)
All-other (Typ., CZ2 Shown)	MixedUseMidRise	U-factor decrease	0.3/0.23	0.28/0.23	~\$57.61
All-other (Typ., CZ3 Shown)	MixedUseMidRise	U-factor decrease & RSHGC increase	0.3/0.23	0.28/0.35	~\$0.43

Cost Effectiveness

Assuming 2022 forecast proportions across the four prototypes until construction forecast is available.

Climate Zone	Benefits <i>Life Cycle Energy Cost Savings + Other PV Savings (2026 PV\$)</i>	Costs <i>Total Incremental PV Costs (2026 PV\$)</i>	<i>Benefit-to-Cost Ratio</i>
1	57.95	26.03	2.23
2	41.58	26.03	1.60
3	159.38	23.17	6.88
4	59.10	26.03	2.27
5	127.58	23.17	5.51
11	49.51	26.03	1.90
12	40.78	26.03	1.57
13	42.13	26.03	1.62
14	54.50	26.03	2.09
15	33.62	26.03	1.29
16	265.04	(30.71)	infinite



Window Measures – Multifamily

Compliance and Enforcement

Compliance and Verification Process



1. Design Phase

- Architect/designer decides window area layout and window products to be installed.
- Fill LMCC/NRCC compliance forms.



2. Permit Application Phase

- Building owner/designer/energy consultant submits documentation to building department.
- Plan examiner/building inspector reviews construction plans and compliance documentation.



3. Construction Phase

- General contractor procures specified window products and performs installation.
- Complete LMCI/NRCI installation certificates.



4. Inspection Phase

- Building owner/designer submits all compliance forms to building department
- Building inspector conducts on-site verification, checks NFRC labels and/or NAFS certificates.

Compliance and Verification

- RSHGC criteria must be checked per climate zones since some have a “minimum” requirement and others a “maximum” requirement.
Building inspectors in climate zones with a minimum RSHGC requirement will need to be aware of the change from maximum to minimum and how to apply an "or better" mindset.
- Note that the minimum 0.35 RSHGC requirement **will not impact** the performance method for most scenarios, since 0.35 is already the standard design basis in CZ 1, 3, 5 and 16.
- No compliance impact for U-factor change, as inspectors are already checking window labels for agreement with compliance forms.



Market Actors

Market actors involved in implementing this measure include:

- Manufacturers/distributors
- Designers/consultants/architects/builders
- Plan examiners
- Building contractors
- Regulatory Agency
- Building Inspector
- Trade/Industry Organization

We anticipate the proposed changes will have a minimal impact on all market actors.



Window Measures – Multifamily

Review of Code Language Markup



Draft Code Change Language

Section 170.2 – Prescriptive Approach. Section 170.2 (a) 1. TABLE 170.2-A

TABLE 170.2-A ENVELOPE COMPONENT PACKAGE – Multifamily Standard Building Design																	
Multifamily		Climate Zone															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Curtain Wall/ Storefront	Maximum U-factor	0.38	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.38
	Maximum RSHGC (Maximum unless otherwise indicated) three or less habitable stories	NR 0.35 min.	0.26	NR 0.35 min.	0.26	NR 0.35 min.	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.25	NR 0.35 min.
	Maximum RSHGC, four or more habitable stories	0.35	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.25	0.26	0.25
	Minimum VT, four or more habitable stories	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
NAFS 2017 Performance Class AW ⁵	Maximum U-factor	0.38	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.38
	Maximum RSHGC (Maximum unless otherwise indicated) three or less habitable stories	NR 0.35 min.	0.24	NR 0.35 min.	0.24	NR 0.35 min.	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	NR 0.35 min.
	Maximum RSHGC, four or more habitable stories	0.35	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
	Minimum VT, four or more habitable stories	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37
All Other Fenestration	Maximum U-factor	0.3 0.28	0.3 0.28	0.3 0.28	0.3 0.28	0.3 0.28	0.34	0.34	0.3	0.3	0.3	0.3 0.28	0.3 0.28	0.3 0.28	0.3 0.28	0.3 0.28	0.3 0.28
	Maximum RSHGC (Maximum unless otherwise indicated) three or less habitable stories	NR 0.35 min.	0.23	NR 0.35 min.	0.23	NR 0.35 min.	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	NR 0.35 min.
	Maximum RSHGC, four or more habitable stories	0.35	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
Maximum Window to Floor Ratio		20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Maximum Window to Wall Ratio		40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%
Maximum Skylight Roof Ratio		5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%

**Building Type:
Nonresidential**



Window Measures – Nonresidential

Background

- Code Change Proposal
- Context and History

Proposal Summary

- This measure would consider improvements to thermal performance factors for windows in nonresidential buildings.

Building Type	Construction Type	Type of Change	Section(s) of Code Updated	Software Updates Required
Nonresidential	New Construction	Mandatory	120.7 new section	Minimum
Nonresidential	Alterations	Mandatory	141.0(b) new section	Minimum

- New Mandatory U-factor** – introduce a mandatory U-factor requirement for vertical fenestration assemblies in new construction and alterations applications.
- Alterations** - We are considering a requirement to replace existing windows to meet the new mandatory requirement. We want your feedback on what conditions should trigger this requirement. (i.e. existing window-to-wall ratio greater than X%; when X% of the opaque envelope is being altered, orientation, etc.)

Draft code language for this measure is available at title24stakeholders.com



Window Measures – Nonresidential

Market Overview

- Current Market Conditions
- Market Trends
- Potential Market Barriers and Solutions

Market Overview and Analysis

Current Market and Trends

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

**Do you agree with
this description?**

Sources:

1. Interview with an employee from View, a Smart Glass Manufacturer .
2. Rethinking Building Skins; Woodhead Publishing; <https://www.sciencedirect.com/science/article/pii/B9780128224779000255#!>
3. MIT Real Estate Innovation Lab Study - https://realestateinnovationlab.mit.edu/research_article/the-value-of-daylight-in-office-spaces/

Market Overview and Analysis

Market Barriers

- Post-pandemic supply chain issues have resulted in inconsistencies in delivery time for fenestration products.
- For smaller, low- and mid-rise commercial projects (or retrofits), property owners, contractors, and builders are still using bare minimum code required fenestration. For that, the HVAC equipment is typically sized incorrectly larger, yielding higher utility bills.

**Do you agree with
this description?
What else should be
known?**



Window Measures – Nonresidential

Technical Considerations

- Technical Considerations
- Potential Barriers and Solutions

Technical Considerations

- New technologies allow for a wide range of U-factors. Introducing a mandatory U-factor will not have any impact on the design and installation process
- Windows meeting the proposed U-factor are readily available in the market
- Windows in alterations may not seem to pose any big change in the structural stability
- In the existing building, reduced load on HVAC system may impact system sizing and controls in a positive way.

**Do you agree with
this description?
What else should we
know?**

Technical Barriers & Potential Solutions

- There are no such technical barriers in the proposed U-value upgrade as these materials are **already available in the market**.
- A temporary barrier could be an immediate **shortage in/low stocking of materials** starting from the effective date of the code cycle in 2025. To address that issue, mass stakeholder communication is and will be taking place to prime the market before the launch.

**Do you agree with
this description?
What else should we
know?**

Window Measures – Nonresidential

Energy and Cost Impacts Per Unit

Methodology and Assumptions

- Energy Savings
- Cost Impacts
 - Incremental costs
 - Energy cost savings



Assumptions for Standard and Proposed Designs

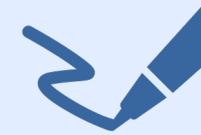


Standard Design

New Construction and Alterations:

- U-factor for windows – 0.58*
- Windows are the only envelope component with no mandatory requirement
- The prescriptive value for windows can be completely traded away in the performance path

*Least stringent window value identified in the code



Proposed Design

New Construction and Alterations:

- U-factor for windows – 0.47
- Achievable with currently available vertical fenestration products in the market, typically with insulated glazing units (IGUs) in lieu of single pane glazing.
- May require thermally broken framing for large scale custom storefront glazing

Incremental Cost per sq.ft. of Fenestration

Over 30 Year Period of Analysis

Incremental First Cost	
Cost Difference* /sq.ft	\$12.31
Installation (same for both cases)	NA
Commissioning	NA
Other	NA
Total	\$12.31

Cost of **single pane metal frame** vs. **standard double pane glazing argon filled w/ metal frame**

Incremental Maintenance Cost	
Replacement	NA
Annual Maintenance	NA
Total	\$0.0

Total incremental cost over 30-year period of analysis: **\$12.31/sq.ft.**

Cost data came from:

- Manufacturers (SAGE, Nippon Sheet Glass)
- Glazing Consultant
- NFRC's CMAST software/database

Overall costs were estimated by climate and economic zones in CA. Material cost remains the same throughout California, but the labor cost changes by the region.

Window Measures – Nonresidential

Statewide Energy Impacts

Methodology and Assumptions





Window Measures – Nonresidential

Compliance and Enforcement

- Design
- Permit Application
- Construction
- Inspection
- Revisions to Compliance Software

Compliance and Verification Process



1. Design Phase

- Designer decides window area and passes on the MEP designer; HVAC equipment size is reduced
- Fill NRCC compliance forms in Energy Code Ace online portal—no change from 2022 process



2. Permit Application Phase

Procedure remains the same as of Code Cycle of 2022



3. Construction Phase

Procedure remains the same; Contractors completes NRCI installation certificates



4. Inspection Phase

Procedure remains the same; Building inspector verifies NFRC labels and/or related certificate

Window Measures – Nonresidential

Review of Code Language Markup

- Draft Code Change Language:
Title24stakeholders.com





Discussion and Next Steps

We want to hear from you!

- Provide **any last comments or feedback** on this presentation now verbally or over the chat
- More information on pre-rulemaking for the 2025 Energy Code at <https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2025-building-energy-efficiency>

Comments on this measure are due by February 28, 2023. Please send comments to info@title24stakeholders.com and copy CASE Authors (see contact info on following slide).

Thank You

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