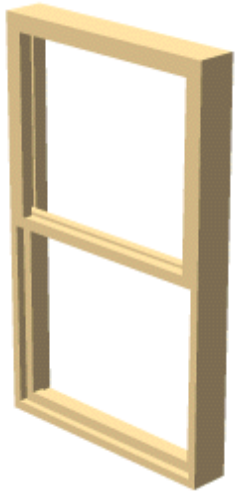
CALIFORNIA ENERGY CODES & STANDARDS

A STATEWIDE UTILITY PROGRAM

2019 Title 24 Codes & Standards Enhancement (CASE) Proposal

Residential Improved Windows and Doors

September 14, 2016



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Los Angeles Department of Water & Power | SMUD | SDGE A Sempra Energy utility | SoCalGas A Sempra Energy utility | Southern California Edison An EDISON INTERNATIONAL Company | Pacific Gas and Electric Company

Proposed Code Change Overview

- Types of building impacted
  - Single family and low-rise multifamily residential
- Building system impacted
  - Windows and Doors
- Anticipated type of change
  - Prescriptive Requirement
- Description of change
  - Tighten window prescriptive requirements to align with widely available higher performance window and door products

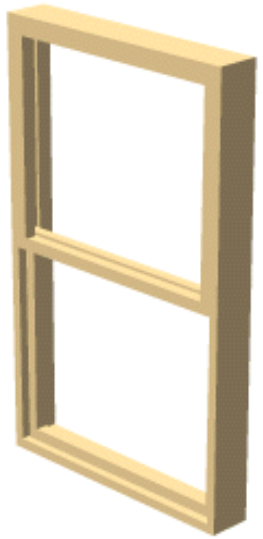
Some things to keep in mind about why fenestration is a unique energy feature

- They provide daylight, ventilation and egress
- Homes typically have 15 – 25 windows
- Each window type can have different ratings due to differences in frame to glass ratio
- Orientation very significant
- It's tricky to balance both lower U-factor and the appropriate SHGC with a single product
- Lower SHGC helps with high TDV cooling, but can increase heating

Proposed Code Change History

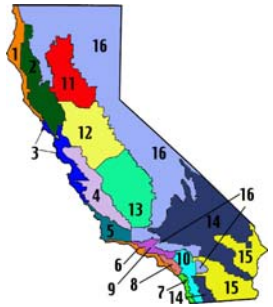
- Why are we proposing this measure?
  - To move the standard to the most common products available and capture extra energy efficiency
  - Door improvements have not been considered in recent updates that there are many insulated doors
  - Window and door performance has a significant impact on building energy efficiency
  - Not proposing change to skylights that are handled with a prescriptive exception for 16ft^2

Windows

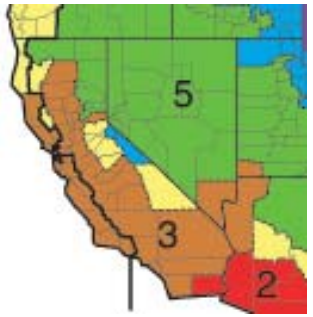


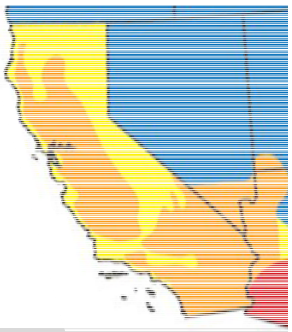
Window Animation from
www.efficientwindows.org

Current Code Requirements - Windows



- Existing Title 24 Requirements
  - U-factor ≤ 0.32
  - SHGC ≤ 0.25
  - No SHGC requirement zones 1, 3 and 5
- Existing Model Code Requirements
  - 2015 IECC U-factor between 0.40 to 0.32
  - 2019 IECC U-factor proposal 0.30
  - SHGC 0.25 in cooling climates
- Other regulatory considerations
  - ENERGY STAR has big market penetration
  - Federal Tax credits during the downturn required 0.30 U-factor and 0.30 SHGC





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2016 Energy Star Criteria

Windows

Climate Zone	U-Factor[1]	SHGC[2]	
Northern*	≤ 0.27	Any	Prescriptive
	= 0.28	≥ 0.32	Equivalent Energy Performance
	= 0.29	≥ 0.37	
	= 0.30	≥ 0.42	
North-Central	≤ 0.30	≤ 0.40	
South-Central	≤ 0.30	≤ 0.25	
Southern	≤ 0.40	≤ 0.25	

Air Leakage ≤ 0.3 cfm/ft^2

[1] Btu/h ft^2·°F
[2] Solar Heat Gain Coefficient

* The effective date for the Northern Zone prescriptive and equivalent energy performance criteria for windows is January 1, 2016.

Doors

Glazing Level	U-Factor[1]	SHGC[2]	
Opaque	≤ 0.17	No Rating	
≤ ½-Lite	≤ 0.25	≤ 0.25	
> ½-Lite	≤ 0.30	Northern North-Central	≤ 0.40
		Southern South-Central	≤ 0.25

Air Leakage for Sliding Doors ≤ 0.3 cfm/ft^2
Air Leakage for Swinging Doors ≤ 0.5 cfm/ft^2

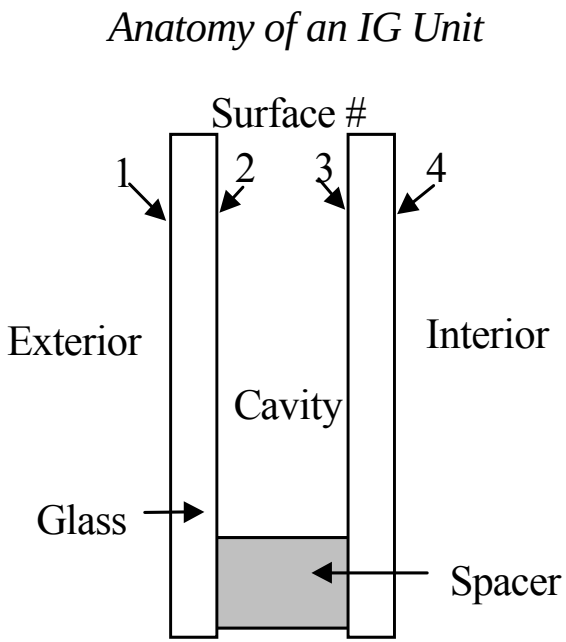
Skylights

Climate Zone	U-Factor[1]	SHGC[2]
Northern	≤ 0.50	Any
North-Central	≤ 0.53	≤ 0.35
South-Central	≤ 0.53	≤ 0.28
Southern	≤ 0.60	≤ 0.28

Air Leakage ≤ 0.3 cfm/ft^2

Typical Practice Technology - Windows

- **Recipe for current code window**
  - Low conductance frame
  - Extra low solar gain low emissivity coating
  - Argon gas cavity fill in many cases
  - Improved spacer system
- **For this product**
  - U-factor ≤ 0.30
  - SHGC ≤ 0.25



Next Technology Steps - Windows

- No lower SHGC coatings available unless tinted
- Chromogenics that have variable SHGC are expensive and rarely used
- Triple glazing not widely available and requires redesign of many frames
- Inside surface low emissivity coatings have not caught on

Market Overview and Analysis - Windows

- Current Market
  - CalCERTS registry data (Jan 2015- April 2016)
    - ~2/3 of windows SF <= SHGC 0.24
    - ~1/2 of windows MF <= SHGC 0.24
  - Product availability in Big Box stores suggests Argon fill is a standard feature
  - Custom building more varied
  - For new construction, ENERGY STAR residential window market penetration ranges from 70% to 88% (PNNL)
  - Some utility incentive programs mostly for alterations
    - Varied, but based on Energy Star and a dollar/ft^2 level
    - Sometimes part of whole house improvements and loan programs

- ***Other market information sources we should know about?***

Proposal - Windows

- U-factor ≤ 0.30
- SHGC ≤ 0.23
- Except zones 1, 3 and 5 that have no SHGC requirement (modeled at 0.50 in software)

Incremental Cost Estimation – Windows (preliminary)

- **How we collected costs of base case technology and proposed technology**
  - Big Box store product survey
  - Discussions with manufacturers, distributors, and contractors (in process)
  - Material costs only
- **Incremental costs**
  - In many cases, builders are already using the proposed window so cost is arguably $0
  - Estimated cost is $0.15/ft^2
  - Data collected by DOE indicates a cost of $0.18/ft^2 for upgrading U-factor from 0.35 to 0.30 (PNNL)

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

Doors

Door Animation from
www.animatedimages.org

Current Code Requirements - Doors

- U-factor 0.50 usually used in software
- Doors with < 50% glass treated as opaque
- Doors ≥ 50% glass modeled as window

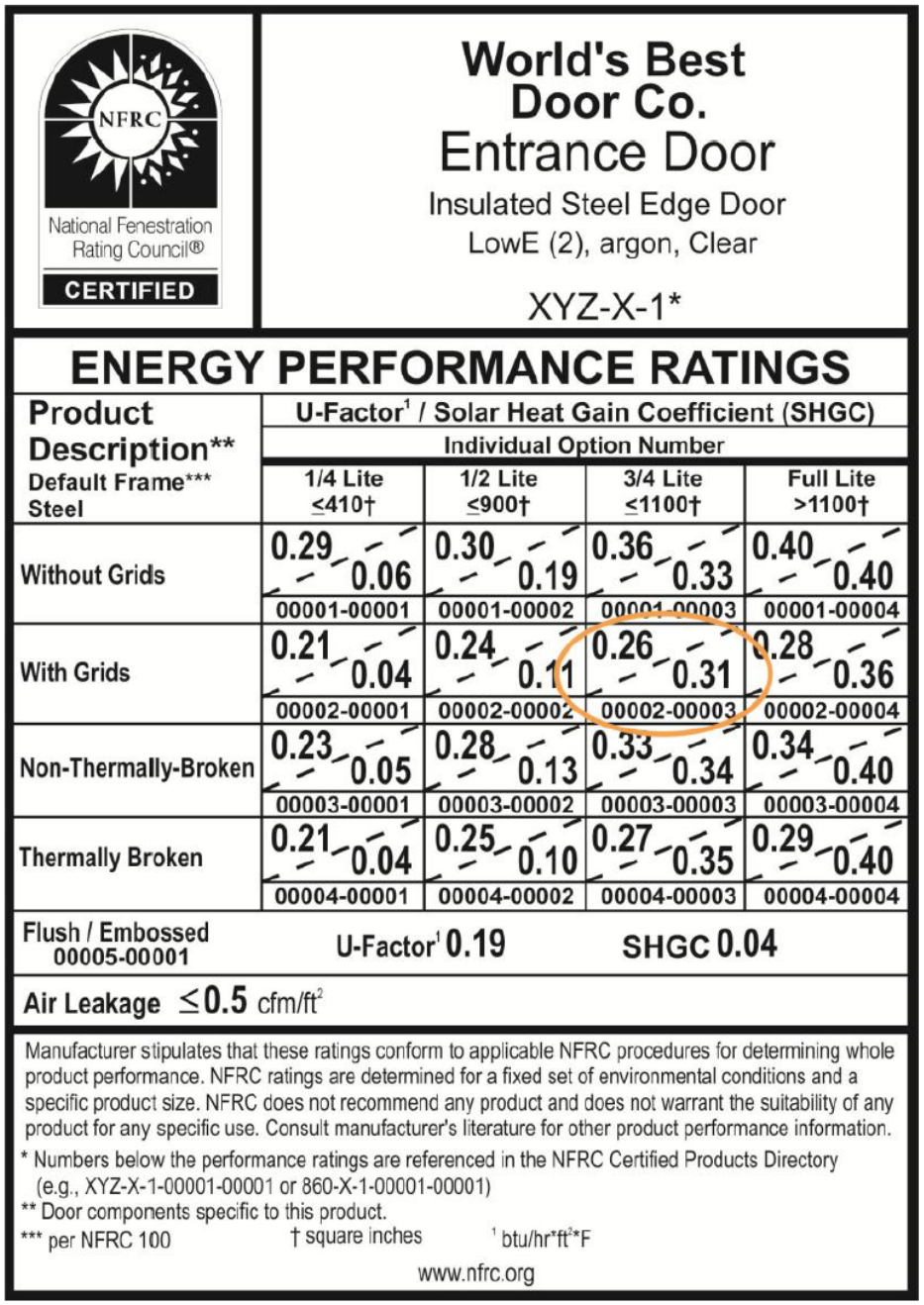
Table 4.5.1 – Doors

Description		U-factor (Btu/°F-ft²)
		A
Uninsulated single-layer metal *swinging doors* or *non-swinging doors*, including single-layer uninsulated access hatches and uninsulated smoke vents:	1	1.45
Uninsulated double-layer metal *swinging doors* or *non-swinging doors*, including double-layer uninsulated access hatches and uninsulated smoke vents:	2	0.70
Insulated metal *swinging doors*, including fire-rated *doors*, insulated access hatches, and insulated smoke vents:	3	0.50
Wood *doors*, minimum nominal thickness of 1-3/4 in. (44 mm), including panel *doors* with minimum panel thickness of 1-1/8 in. (28 mm), and solid core flush *doors*, and hollow core flush *doors*:	4	0.50
Any other wood *door*:	5	0.60
Uninsulated single layer metal *roll up doors* including fire rated *door*	6	1.45
Insulated single layer metal *sectional doors*, minimum insulation nominal thickness of 1-3/8 inch; expanded polystyrene (R-4 per inch).	7	0.179
Source: ASHRAE 90.1-2007, Section A7.		

Current Code Requirements - Doors

- **Existing Title 24 Requirements**
  - U-factor defaults to 0.50, representative of a solid wood core door
- **Existing Model Code Requirements**
  - 2015 IECC Opaque Doors are treated as windows
  - Exception for one door (24ft^2)
- **Other regulatory considerations**
  - Doors complicated by how much glass
  - Energy Star has big market penetration in retail

NFRC Label - Doors



National Fenestration Rating Council®
CERTIFIED

World's Best Door Co.
Entrance Door
Insulated Steel Edge Door
LowE (2), argon, Clear
XYZ-X-1*

ENERGY PERFORMANCE RATINGS

Product Description** Default Frame*** Steel	U-Factor[1] / Solar Heat Gain Coefficient (SHGC) Individual Option Number			
	1/4 Lite ≤410†	1/2 Lite ≤900†	3/4 Lite ≤1100†	Full Lite >1100†
Without Grids	0.29 / 0.06	0.30 / 0.19	0.36 / 0.33	0.40 / 0.40
	00001-00001	00001-00002	00001-00003	00001-00004
With Grids	0.21 / 0.04	0.24 / 0.11	0.26 / 0.31	0.28 / 0.36
	00002-00001	00002-00002	00002-00003	00002-00004
Non-Thermally-Broken	0.23 / 0.05	0.28 / 0.13	0.33 / 0.34	0.34 / 0.40
	00003-00001	00003-00002	00003-00003	00003-00004
Thermally Broken	0.21 / 0.04	0.25 / 0.10	0.27 / 0.35	0.29 / 0.40
	00004-00001	00004-00002	00004-00003	00004-00004

Flush / Embossed 00005-00001 — U-Factor[1] 0.19 — SHGC 0.04

Air Leakage ≤0.5 cfm/ft²

Manufacturer stipulates that these ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size. NFRC does not recommend any product and does not warrant the suitability of any product for any specific use. Consult manufacturer's literature for other product performance information.

* Numbers below the performance ratings are referenced in the NFRC Certified Products Directory (e.g., XYZ-X-1-00001-00001 or 860-X-1-00001-00001)
** Door components specific to this product.
*** per NFRC 100 † square inches [1] btu/hr*ft²*F

www.nfrc.org

Market Overview and Analysis - Doors

- **Current Market**
  - Many entry doors are already insulated
  - Insulated doors outperform the default tables
  - NFRC labels do not appear common for new construction
  - Credit for lowering the U-factor for doors will require NFRC labels
  - NFRC ratings for less than ¼, ½, ¾ or full lite
  - Recommend considering changing definition of glazed door to a lower percentage
  - Need to review need for thermally broken sills and fire doors to the garage

- ***Other market information sources we should know about?***

Proposal - Doors

- U-factor ≤ 0.20 for opaque doors
- Add opaque doors to Default U-factor and SHGC tables
- Consider exemption for doors between house and garage
- NFRC labels on doors will be necessary to document this level of performance
- Lower definition of glazed doors to ¼ glass to match NFRC definition
  - Doors with more than ¼ area modeled as fenestration
  - Might affect nonresidential since same definition is used

Doors between House and Garage – 2016 California Building Standard Code

R302.5.1 "…Other openings between the garage and residence shall be equipped with solid wood doors not less than 1 3/8 inches (35mm) in thickness, solid or honeycomb-core steel doors not less than 1 3/8 inches (35mm) thick, or 20-minute fire-rated doors, equipped with a self-closing and self-latching device.

> Exception: Where the residence and the private garage are protected by an automatic residential fire sprinkler in accordance with Sections R309.6 and R313…"

R309.6 "...Attached garages and carports with habitable space above shall be protected by fire sprinkler…"

R313 is the full section on Automatic Fire Sprinkler Systems

Incremental Cost Estimation – Doors (preliminary)

- **How we collected costs of base case technology and proposed technology**
  - Big Box store product survey
  - Discussions with manufacturers, distributors, and contractors (in process)
  - Material costs only
- **Incremental costs**
  - In many cases, builders are already using the proposed window so cost is arguably $0
  - Estimated cost is $1.00/ft^2

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

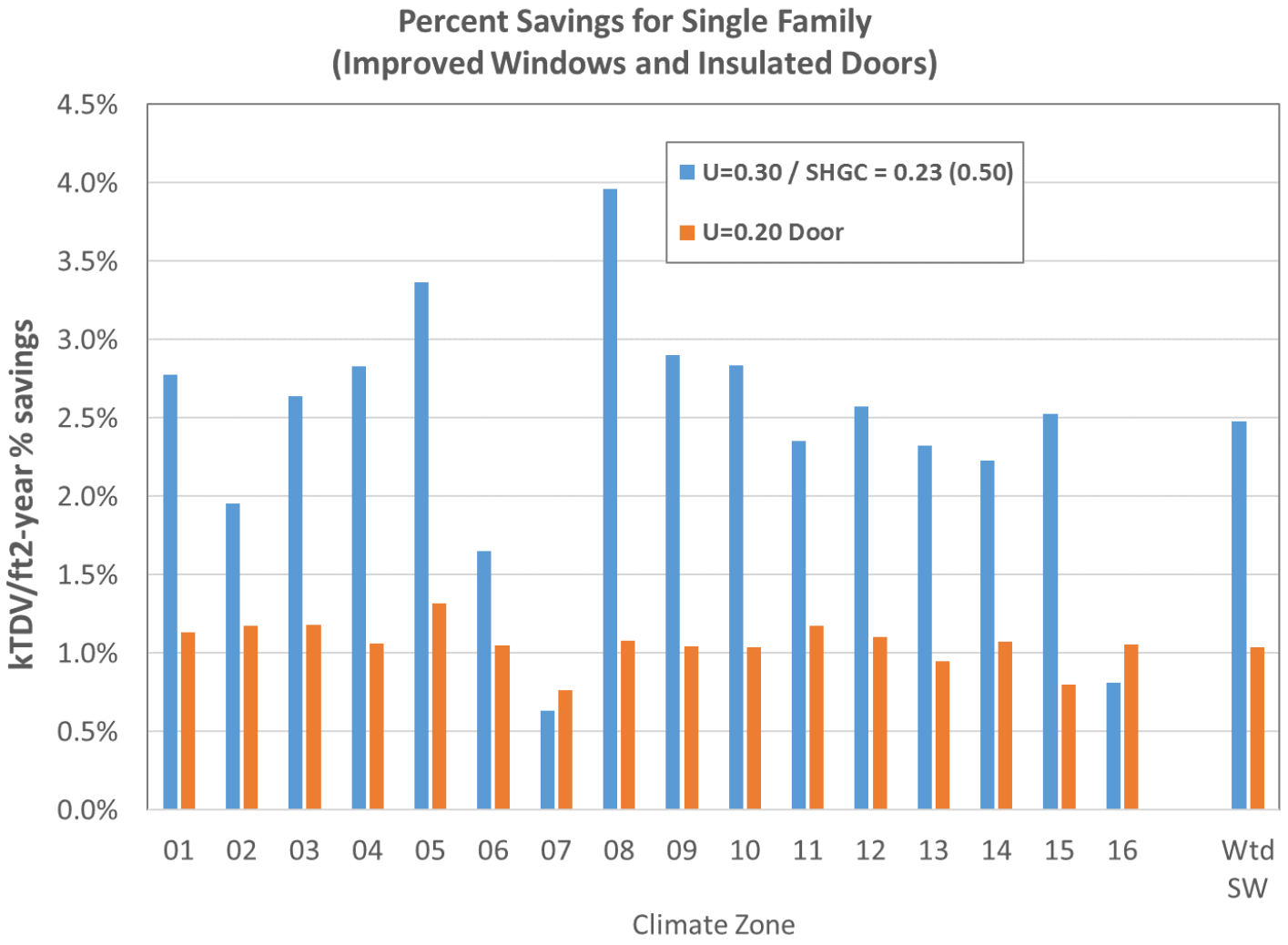
Methodology for Savings Analysis (preliminary)

- **Methodology for energy and demand Impacts**
  - Recent CBECC-Res software
  - 2019 TDV
  - 2016 housing start data to weight by climate zone
  - Other features modeled with 2016 prescriptive requirements
- **Incremental Cost Savings**
  - Calculated based on TDV energy savings for the 30 year assumed period of analysis
  - Net Present Value of savings based on 2019 TDV cost multiplier of $0.1732/TDV kBTU saved

Prototypes and First Costs (preliminary)

- **Single family prototype**
  - Weighted 45% 2100ft^2 one story and 55% 2700ft^2 two story averaging 2430ft^2
  - 20% window area
  - Windows with 30% builder markup $95/home
  - Two Doors with 30% builder markup $52/home
- **Multifamily prototype**
  - 6960ft^2 8 unit apartment
  - 15% window area
  - Windows with 30% builder markup $204/building
  - Eight Doors with 30% builder markup $208/building

Preliminary Energy Impacts – Single Family Percent Savings



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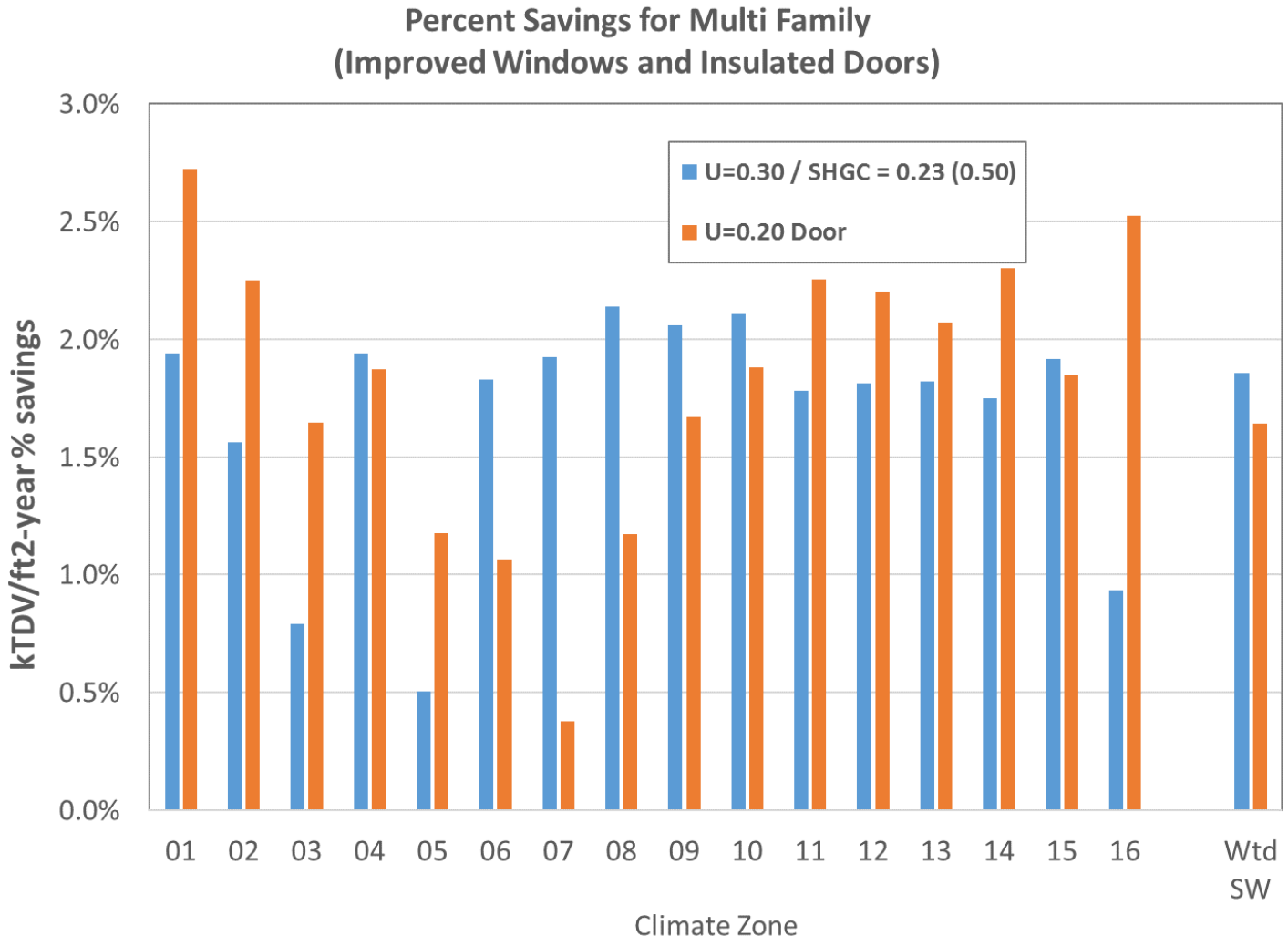
Preliminary Energy Impacts – Multifamily Percent Savings



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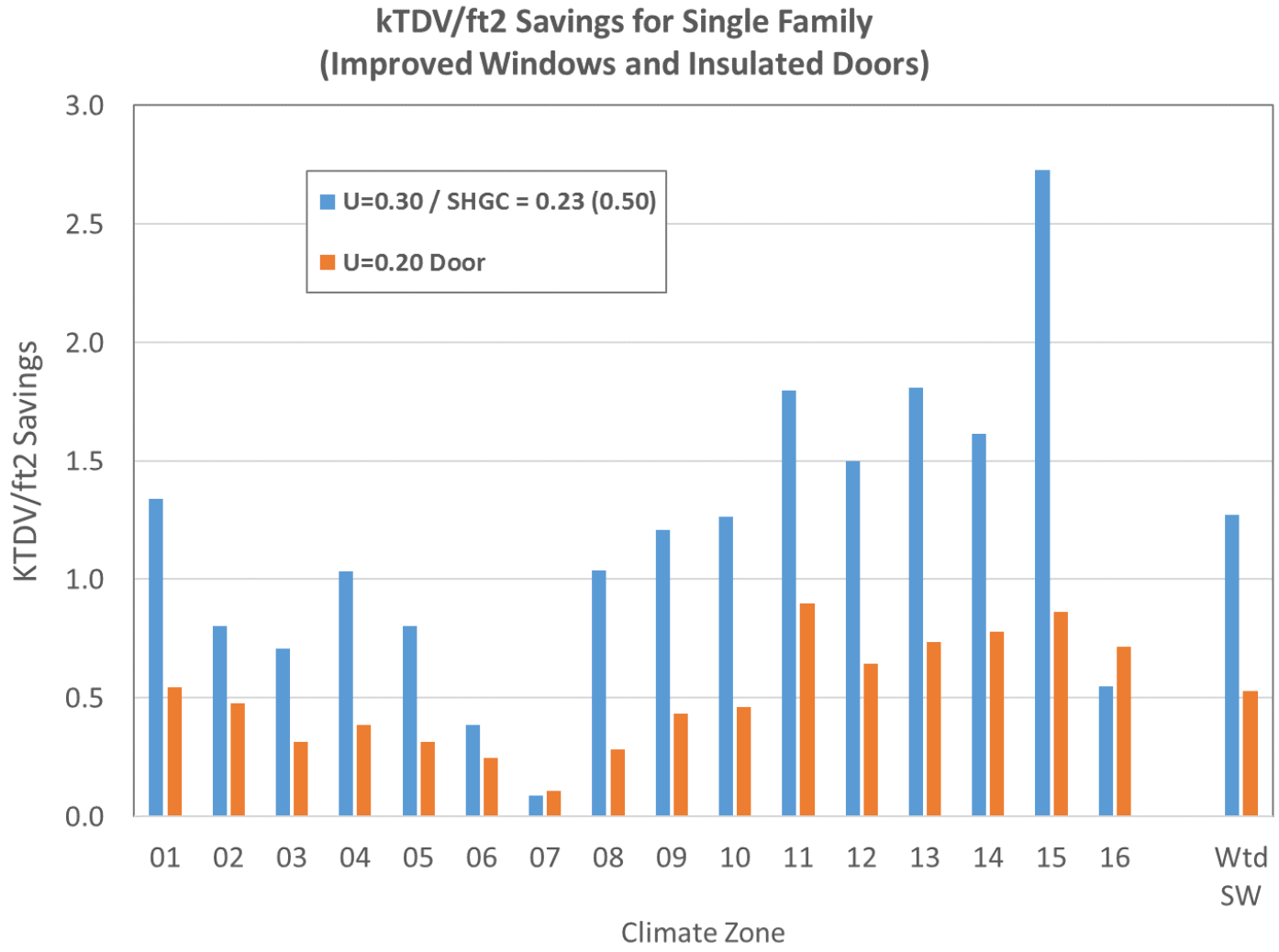
Preliminary Energy Impacts – Single Family kTDV/ft2 Savings



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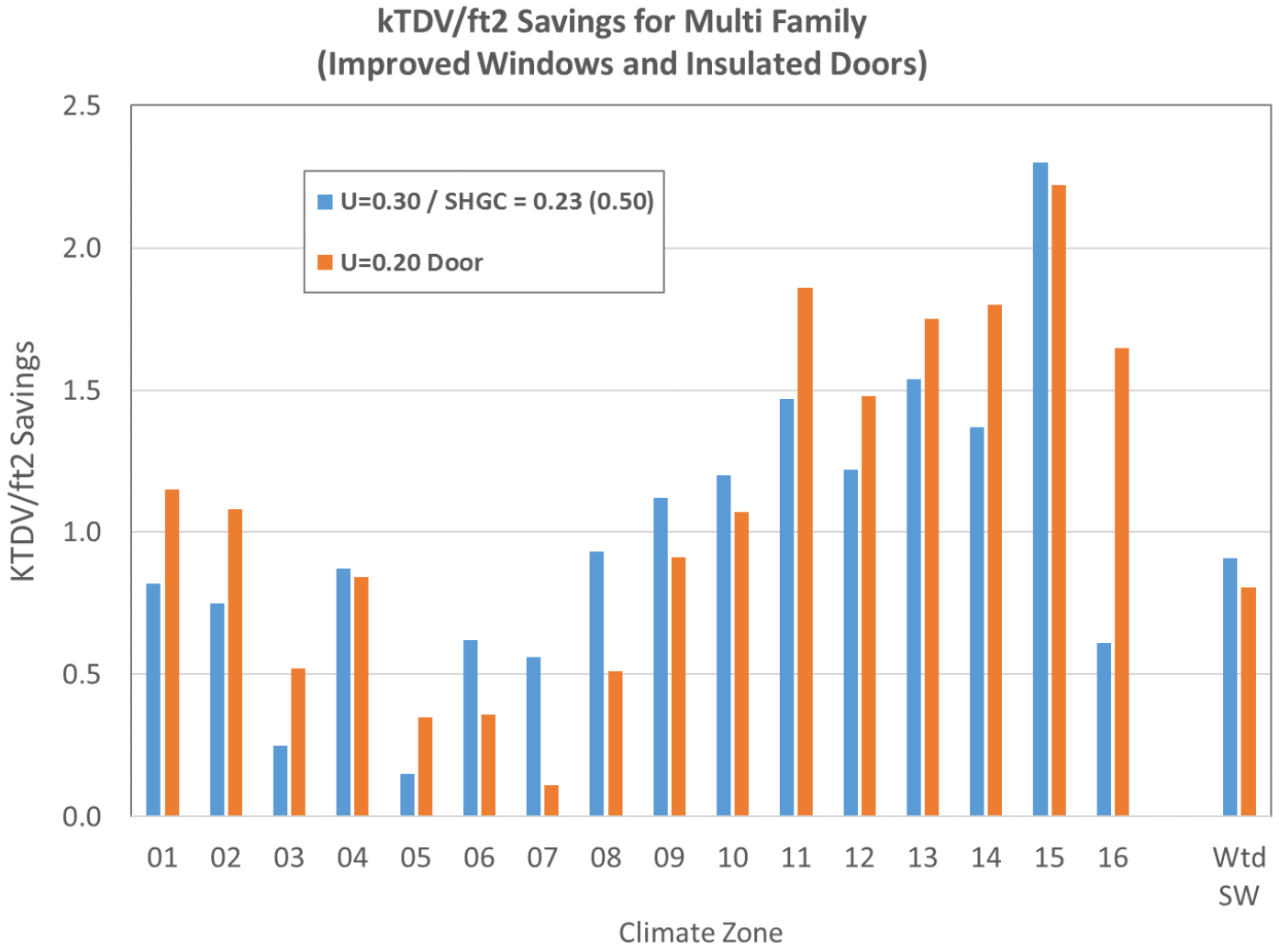
Preliminary Energy Impacts – Multifamily kTDV/ft2 Savings



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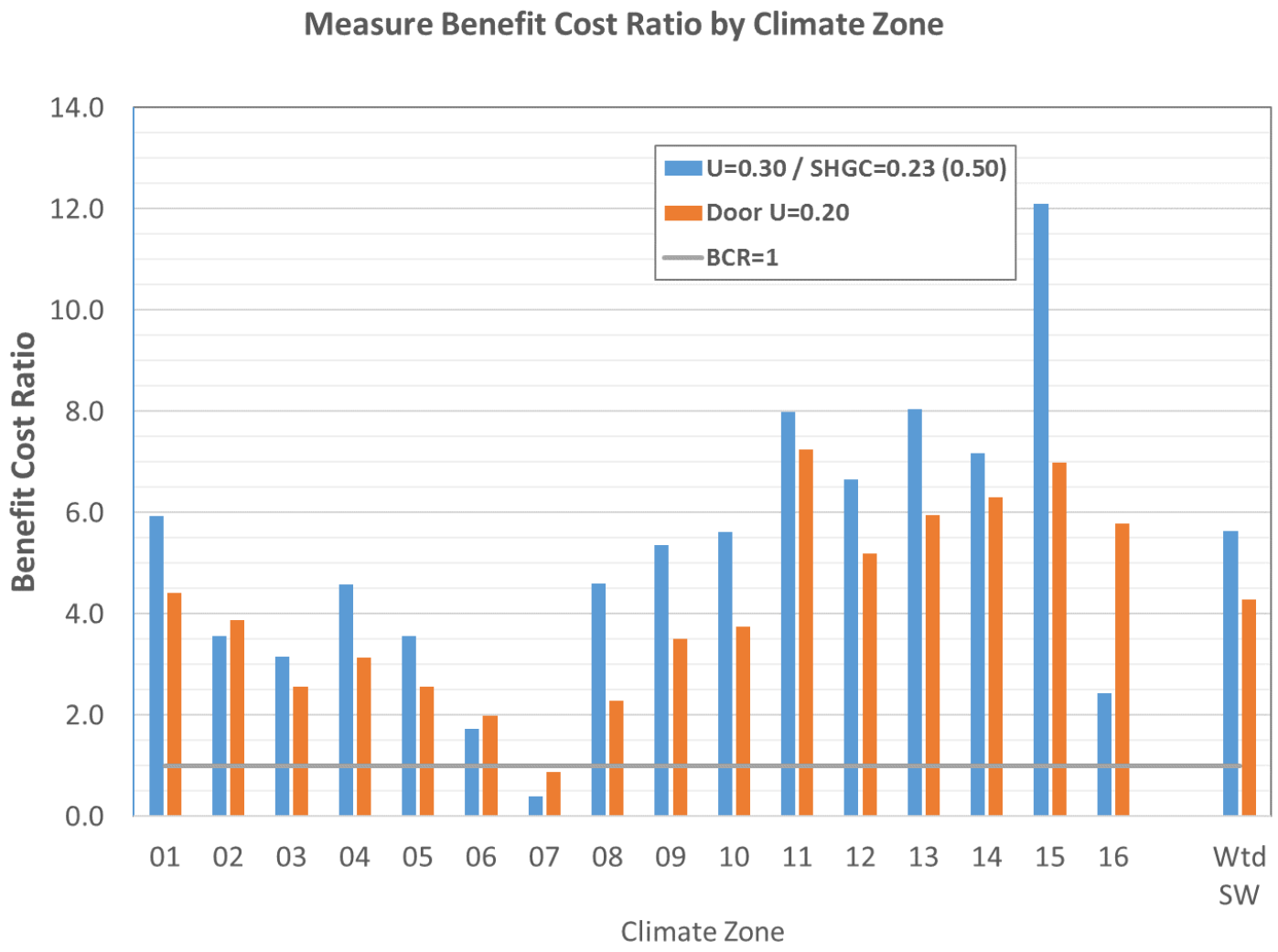
Preliminary Benefit Cost Ratios – Single Family



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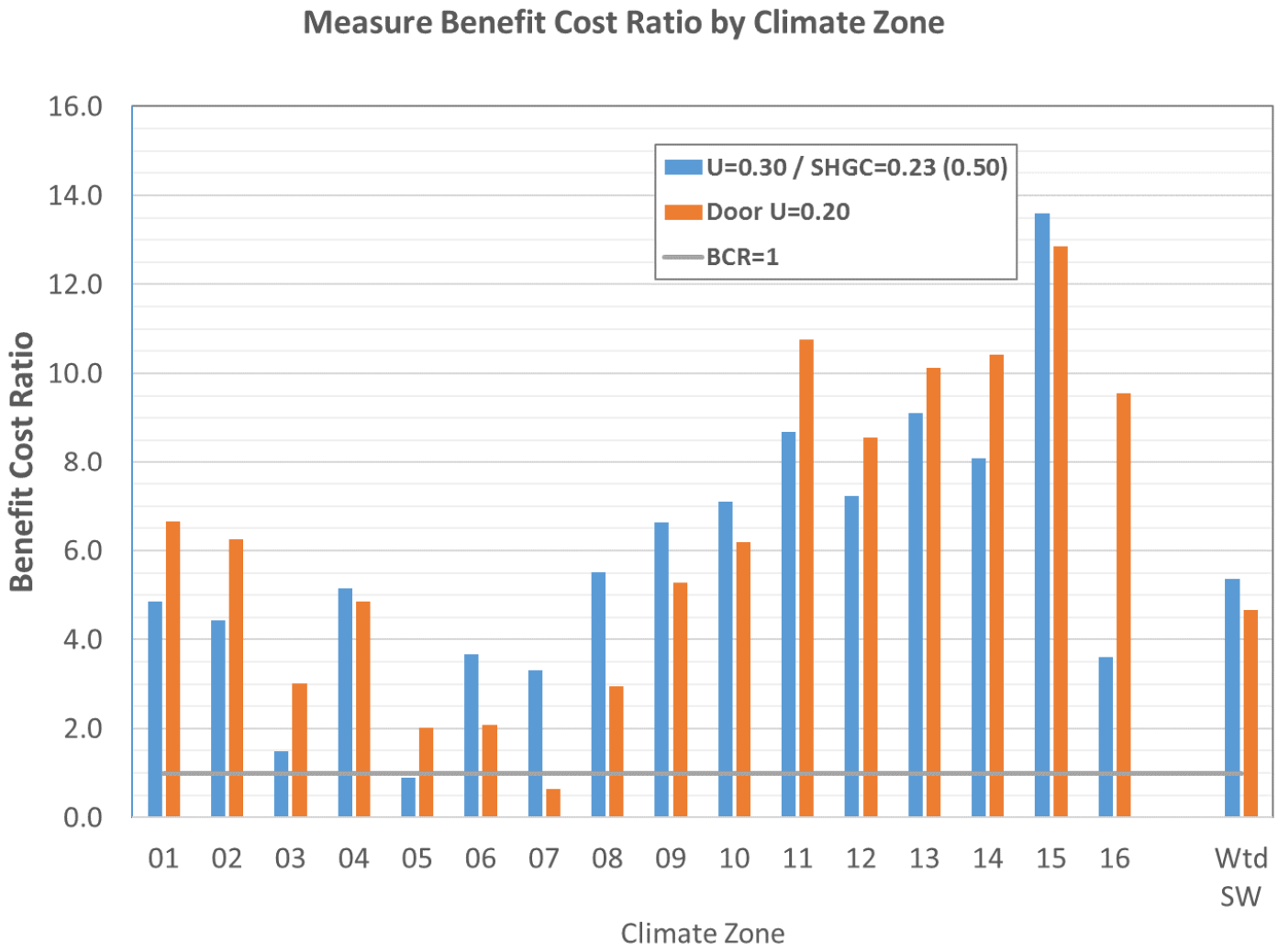
Preliminary Benefit Cost Ratios – Multifamily



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Preliminary Energy Impacts – Statewide Weighted

	Preliminary Energy Savings Estimate				
Description	Annual per Unit Electricity Savings* (kWh/unit-yr)	Annual per Unit Natural Gas Savings* (Therms/unit-yr)	First Year Statewide Electricity Savings** (GWh/yr)	First Year Statewide Natural Gas Savings** (Million Therms/yr)	Confidence Level (high, medium, low)
SF Window	43	-0.2	4.7	-0.0	High
MF Window	12	0.3	0.3	0.0	High
SF Door	10	3	1.1	0.3	High
MF Door	4	1.3	0.1	0.0	High
Statewide Total			**6.2**	**0.3**	

* Per unit kWh & Therm savings based on weighted statewide values

** Statewide values based on 2016 assumptions for housing starts

Preliminary Cost Effectiveness – Statewide Weighted

	Preliminary Cost Effectiveness			
Description	Total per Unit Incremental Cost Over Period of Analysis	Per Unit TDV NPV Energy Savings over Period of Analysis	Benefit/Cost Ratio	Climate Zones not Cost Effective
SF Window	$95	$534	5.6	7
MF Window	$204	$1093	5.4	5
SF Door	$52	$223	4.3	7
MF Door	$208	$969	4.7	7

Summary

- **Window and door proposals are cost effective on a statewide basis except for:**
  - Single family windows in climate zone 7
  - Multifamily windows in climate zone 5
  - Single and Multifamily Doors in climate zone 7

- Consider using the proposed windows and doors in all climate zones so the same product specifications are in place statewide for U-factor and keep things simpler

Strawman Code Change Language - Windows

- **Title 24 Standards**
  - Update Table 150.1-A
    - U-factor of 0.30 maximum in all zones
    - SHGC of 0.23 maximum in CZs except 1, 3, 5 (no requirement in those zones)
- **Reference Manual**
  - Update 3.5.4, 3.5.7, 3.5.8.3
- **ACM Reference Manual**
  - Update section 2.10.3.3 Fenestration to reflect new values

Strawman Code Change Language - Doors

- **Title 24 Standards**
  - Update 100.1 definition Glazed Door
  - Add opaque doors to 110.6 Tables 110.6-A and 110.6-B default tables using data from JA4
  - Add section on doors to 150.1(c)3 including possible exemption for door between house and garage
  - Add row with opaque door U-factors to Table 150.1-A
- **Reference Manual**
  - Update 3.5, 3.5.4, 3.5.7, 3.5.8.3
- **ACM Reference Manual**
  - Update section 2.5.6.5 Doors

Compliance and Enforcement- Market Actors

- **Who would be involved in implementing this measure?**
  - Title 24 Consultant / CEA
  - Builder
  - Window and Door Manufacturers
  - Window and Door Contractors
  - Building Inspector

- ***Others?***

Compliance and Enforcement—Tasks

Market Actor	Task(s)	Success Criteria
T-24 Consultant	- Ensure builder is aware of the requirements - Windows – similar to current practice - Doors – need to use either NFRC ratings or defaults for U-factor and SHGC	- Builder and construction team are aware of requirements and there are no surprises.
Builder / General Contractor	- Coordinate with window and door contractor to ensure everyone understands requirements specified on the CF1R - Require window and door contractor to provide NFRC labeled product when specified	- Work is completed within budget and on schedule - Ensure inspections due not cause schedule delays - Minimize / eliminate inspection failures / callbacks - Minimize paperwork required
Window and Door Manufacturers	- Windows – similar to current practice - Doors – need to provide NFRC labels for insulated products	- NFRC labeled door products widely available for new construction

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What are we not capturing?

Compliance and Enforcement—Tasks

Market Actor	Task(s)	Success Criteria
Windows and Door Contractor	- Install product on compliance documentation with labels	- Meet builder's schedules - Minimize paperwork needed to complete
Building Inspector	- Check for proper window and door labeling - Verify that all paperwork is in order and CF-2R and CF-3Rs are signed off and certified - Sign off permit	- Minimize amount of paperwork needed to complete process

What are we not capturing?

Compliance and Enforcement—Resources

Market Actor	Resource(s)
T-24 Consultant	- Compliance software - EnergyCodeAce tools - T-24 Compliance manuals
Builder / General Contractor	- Building officials at jurisdiction - T-24 Consultant - Window and Door Manufacturers - Window and Door Contractors
Window and Door Manufacturers	- EnergyCodeAce tools - T-24 Compliance manuals
Windows and Door Contractors	- EnergyCodeAce tools - Utility-sponsored training classes?
Building Inspector	- EnergyCodeAce tool - Utility-sponsored training classes?

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What resources or tools are typically used for compliance?

Feedback Request from Stakeholders

We would like stakeholder Input on proposals included in presentation:

- Proposed window criteria
- Proposed door criteria
- Treatment of doors between house and garage

Please provide input at Title24Stakeholders.com

Thank you.

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