Welcome to the California Statewide Codes and Standards Enhancement (CASE) Team's Stakeholder Meeting on

Nonresidential Envelope Part 1.

We'll get started shortly.

In the meantime, please fill out the polls below.

CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

Pacific Gas and Electric Company

SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL Company

SoCalGas
A Sempra Energy utility

SDGE
A Sempra Energy utility

LA DWP Los Angeles Department of Water & Power

Welcome: Connect Your Audio

Audio – there are **three** options for connecting to the meeting audio:

To view options, click on the  icon on the top ribbon, then select *Connect My Audio.*

1. **Dial-out:** receive a call from the meeting. *Please note this feature **requires a direct line.***
2. **Dial-in:** dial-in to the conference via phone. Conference phone number and room number code provided. *Please then **identify your line** by entering your unique user ID on your phone.*
3. Use the **microphone** from your computer/device.

Above: audio conference settings pop-up box

2022 TITLE 24 CODE CYCLE, PART 6

First Utility-Sponsored Stakeholder Meeting

Nonresidential Envelope Part 1

Statewide CASE Team

October 24, 2019

CALIFORNIA ENERGY CODES & STANDARDS

A STATEWIDE UTILITY PROGRAM

Meeting Guidelines

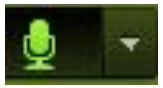
Muting Guidelines

Once you turn on your preferred audio connection, please **MUTE** your microphone.

- Please keep yourself **MUTED.**
- Wait for instructions and/or permission to unmute yourself during designated Q&A periods.

Phone users – please mute your phone line.

Computer/device users – please mute your microphone by clicking on the microphone icon on your top ribbon.



NOT MUTED

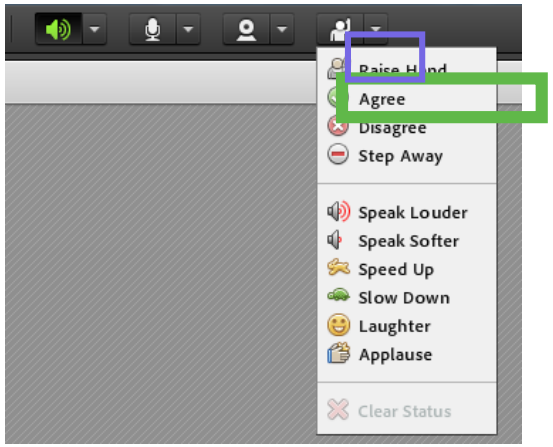
MUTED

Meeting Guidelines

Participation Guidelines

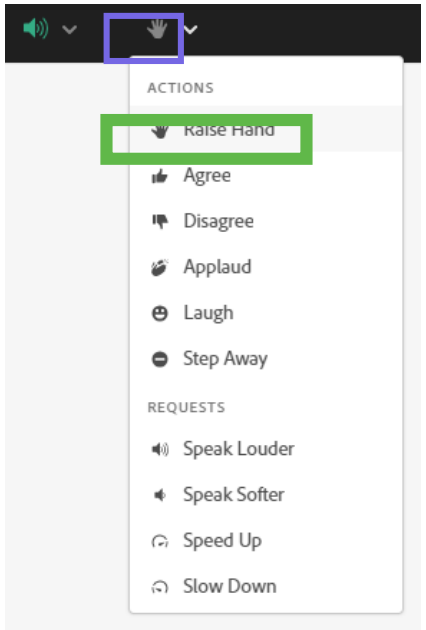
- **Questions & Comments**
  - Click **“*Raise Hand*”** if you would like to speak. Those with a hand raised will be called on by the speaker.
  - All questions and comments are also welcome via the chat window.

- **Other Meeting Feedback**
  - Provide live meeting feedback from the **top toolbar drop-down**.



***Above**: feedback view for Adobe Connect app users.*

***Below**: feedback view for HTML users.*



Meeting Ground Rules

- **We want to hear your thoughts**
  - Supporting and opposing viewpoints are welcome
- **When making comments**
  - Unmute yourself
  - Clearly state your name and affiliation prior to speaking
  - Speak loudly for phone audio
  - Place yourself back on mute
- **Calls are recorded** for note development, recordings will not be publicized
- Notes and presentation material will be posted on Title24Stakeholders.com

Agenda

1	**Meeting Guidelines**	*8:30 am*
2	**Opening Remarks** from the California Energy Commission	*8:35 am*
3	**Overview & Welcome** from the Statewide Utility Team	*8:40 am*
4	**Presentation I:** High Performance Envelope	*8:45 am*
9	**Closing**	*12:00 pm*

Opening Remarks: California Energy Commission

Policy Drivers: Building Standards

The following policy documents establish the goal for new building standards:

- **2008 CPUC/CEC Energy Action Plan** – ZNE for Residential buildings by 2020 and nonresidential buildings by 2030
- **SB 100** – Clean electricity by 2045
- **B-55-18** – Governor Jerry Brown's Executive Order to achieve carbon neutrality
- **AB 3232** – Assess the potential for the state to reduce the emissions of greenhouse gases from the state's residential and commercial building stock by at least 40% below 1990 levels by January 1, 2030

9

2022 Standards Schedule

Estimated Date	Activity or Milestone
November 2018 - April 2019	Updated Weather Data Files
November 2018 - July 2019	Measures Identified and Approved (Internal at the Energy Commission)
November 2018 - July 2019	Compliance Metrics Development
April 24, 2019	Efficiency Measure Proposal Template for public to submit measures
October 17, 2019	Compliance Metrics and Climate Data workshop
November, 2019	Final Metrics Workshop
November, 2019	Research Version of CBECC Available with new weather data files and updated Metrics
July 2019 - March 2020	Utility-Sponsored Stakeholder Workshops
March, 2020	All Initial CASE/PUBLIC Reports Submitted to Commission
March - August 2020	Commission-Sponsored Workshops
July, 2020	All Final CASE/PUBLIC Reports Submitted to the Commission
July - September 2020	Express Terms Developed
January, 2021	45-Day Language posted and set to list serve, Start of 45-Day review/comment period
January, 2021	Lead Commissioner Hearing
April, 2021	Adoption of 2022 Standards at Business Meeting
May - November 2021	Staff work on Software, Compliance Manuals, Electronic Documents
May - November 2021	Final Statement of Reasons Drafted and Approved
October, 2021	Adoption CALGreen (energy provisions) - Business Meeting
December, 2021	CBSC Approval Hearing
January, 2022	Software, Compliance Manuals, Electronic Documents Available to Industry
January - December 2022	Standards Training (provided by 3rd parties)
June 1, 2022	6 Month Statutory Wait Period Deadline
January 1, 2023	Effective Date

2022 Standards Contact Info

Mazi Shirakh, PE
ZNE Technical Lead
Building Standard Staff.
Mazi.Shirakh@energy.ca.gov
916-654-3839

Payam Bozorgchami, PE
Project Manager, 2022 Building Standards
Payam.Bozorgchami@energy.ca.gov
916-654-4618

Larry Froess, PE
CBECC Software Lead
Larry.froess@energy.ca.gov
916-654-4525

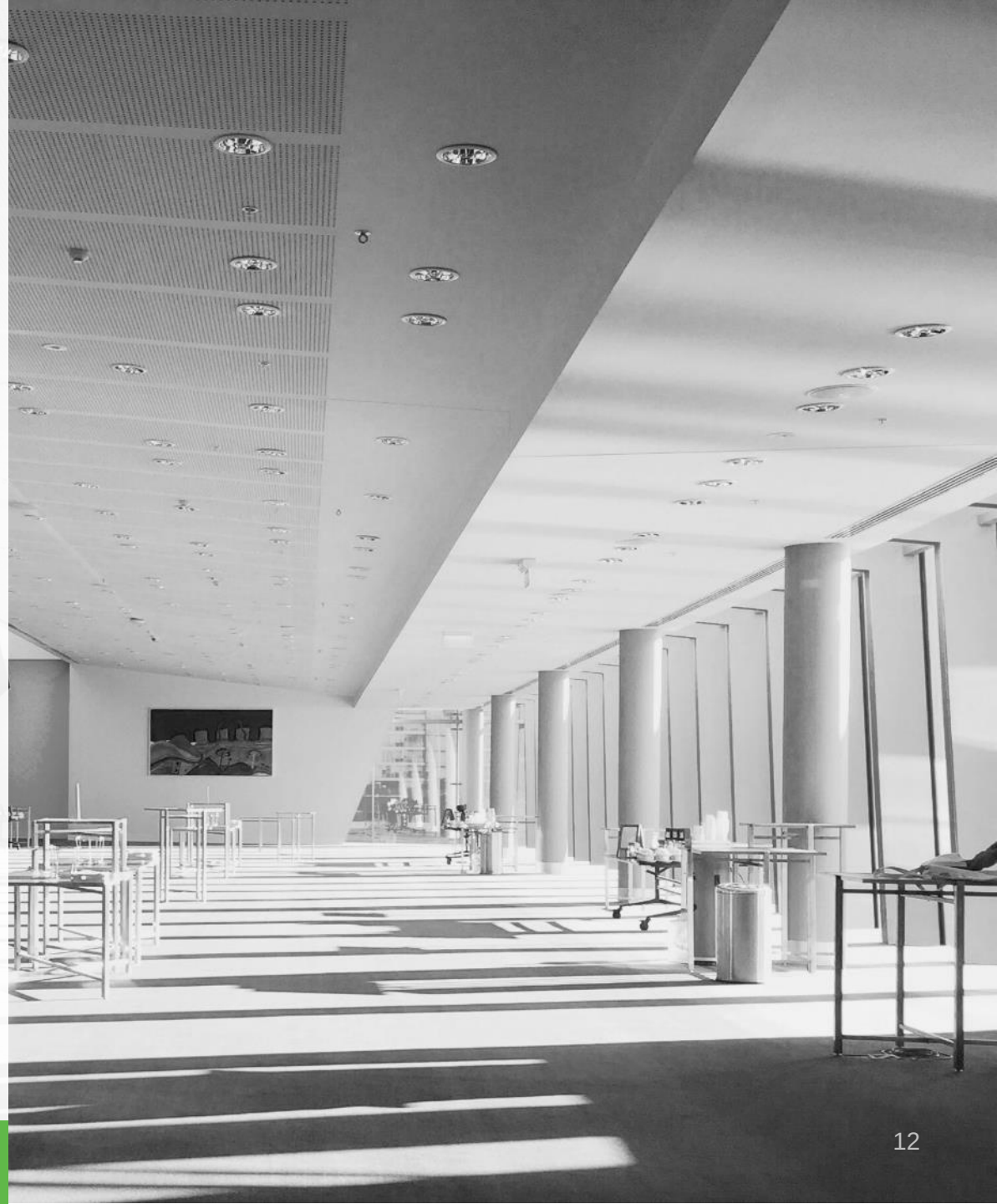
Peter Strait
Supervisor
Building Standards Development
Peter.Strait@energy.ca.gov
916-654-2817

Christopher Meyer
Manager
Building Standards Office
Christopher.Meyer@energy.ca.gov
916-654-4052

More information on pre-rulemaking for the 2022 Energy Code at:
https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2022-building-energy-efficiency

Title 24, Part 6 Overview

Kelly Cunningham
Codes and Standards
Pacific Gas & Electric



Statewide Utility Codes and Standards Team

- **Actively supporting the California Energy Commission** in developing proposed changes to the California Energy Code (Title 24, Part 6)
- Achieve significant energy savings through the development of **feasible**, **enforceable**, **cost-effective, and non-proprietary** code change proposals for the 2022 code update, and beyond

Requirements for a Successful Code Change Proposal

The utilities support the California Energy Commission by proposing changes to the Energy Code that are:

Feasible | Cost effective | Enforceable | Non-proprietary

Utility-Sponsored Stakeholder Meetings

- All meetings can be attended **remotely**
- Check Title24Stakeholders.com/events for information about meetings and topic updates
- Sign up to receive email notifications

First Round Utility-Sponsored Stakeholder Meetings

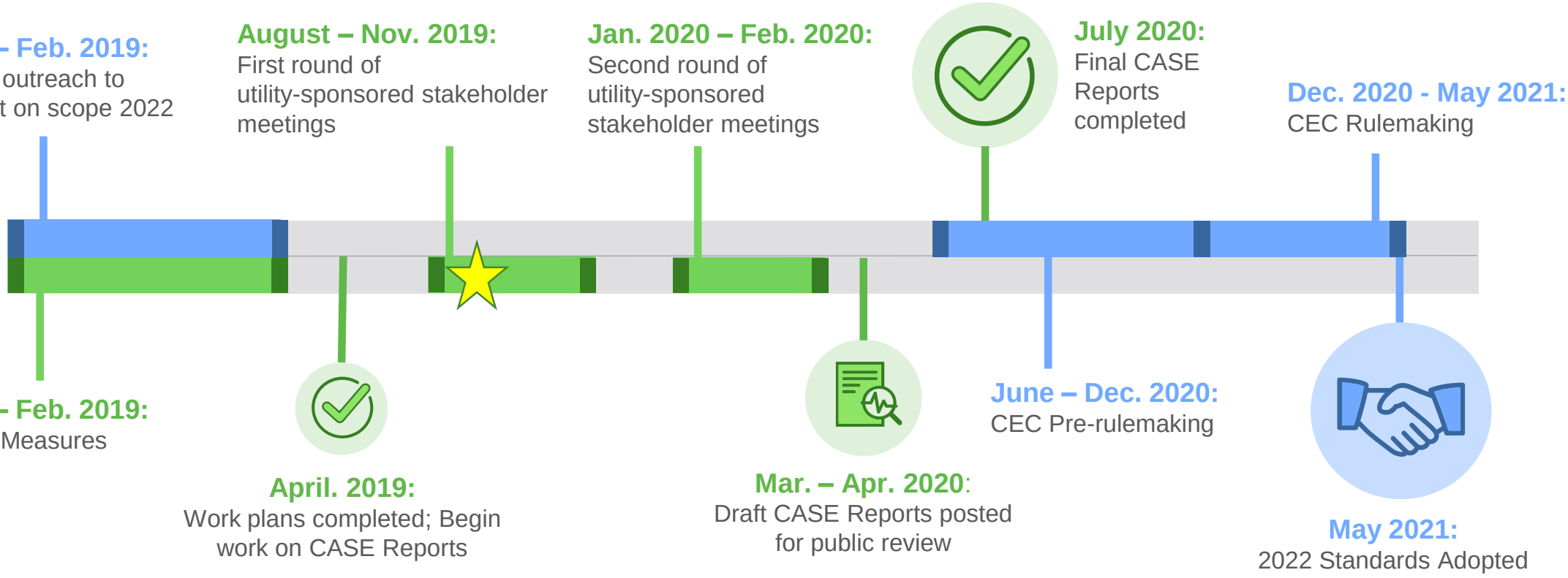
Meeting Topic	Building Type	Date
Multifamily HVAC and Envelope	MF, NR	Thursday August 22, 2019
Outdoor Lighting and Daylighting	MF, NR	Thursday September 5, 2019
Indoor Lighting	NR	Thursday September 12, 2019
Covered Processes Part 1: Controlled Environment Horticulture	NR	Thursday, September 19, 2019
Multifamily & Nonresidential Water Heating	MF/NR	Thursday, October 3, 2019
Single Family HVAC	SF	Thursday, October 10, 2019
Nonresidential HVAC Part 1: Data Centers, Boilers, & Controls	NR	Tuesday, October 15, 2019
Nonresidential Envelope Part 1	NR	Thursday, October 24, 2019
Nonresidential HVAC and Envelope Part 2: Air Distribution, & Controls	NR	Tuesday, November 5, 2019
Covered Processes Part 2: Compressed Air, Steam Traps, & Refrigeration	NR	Thursday, November 7, 2019
Single Family Whole Building	SF	Tuesday, November 12, 2019
Nonresidential Software Improvements	NR	Tuesday, November 12, 2019

Sign up for all meetings at title24stakeholders.com/events/

2022 Code Cycle – Key Milestones

CEC Milestone

Utility Team Milestone



The **Codes and Standards Reach Codes Program** provides technical support to local jurisdictions considering adopting a local energy efficiency ordinance.

www.LocalEnergyCodes.com

This program is funded by California utility customers under the auspices of the California Public Utilities Commission and in support of the California Energy Commission.

Thank You

Kelly Cunningham
Pacific Gas & Electric
Kelly.Cunningham@pge.com

Christopher Kuch
Southern California Edison
Christopher.Kuch@sce.com

James Kemper
Los Angeles Department of Water and Power
James.Kemper@ladwp.com

Jeremy Reefe
San Diego Gas & Electric
jmreefe@sdge.com

CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

2022 CALIFORNIA ENERGY CODE (TITLE 24, PART 6)

Nonresidential High Performance Envelope – Part 1

Codes and Standards Enhancement (CASE) Proposal

Nonresidential | Envelope

Alamelu Brooks, *Energy Solutions*

October 24, 2019

CALIFORNIA ENERGY CODES & STANDARDS

A STATEWIDE UTILITY PROGRAM

Agenda

1	Overview of Envelope Measures	*5 min*
2	Cool Roof	*30 min*
3	Thermal Bridging	*45 min*
4	Roof Alterations	*30 min*
5	High Performance Windows	*40 min*
6	Opaque Envelope	*35 min*
7	Discussion and Next Steps	*10 min*

Methodology and Assumptions that Apply to All Topics Presented Today

Energy Impacts Analysis:

- All submeasures will share the following characteristics:
  - All climate zones will be used for analysis
  - All nonresidential building types will be cost tested with 30-year measure life
  - Healthcare buildings will be included
  - Multifamily high rise buildings are excluded from analysis unless and otherwise stated

Submeasure A: Cool Roof

Submeasure B: Thermal Bridging

Submeasure C: Roof Alterations

Submeasure D: High Performance Windows

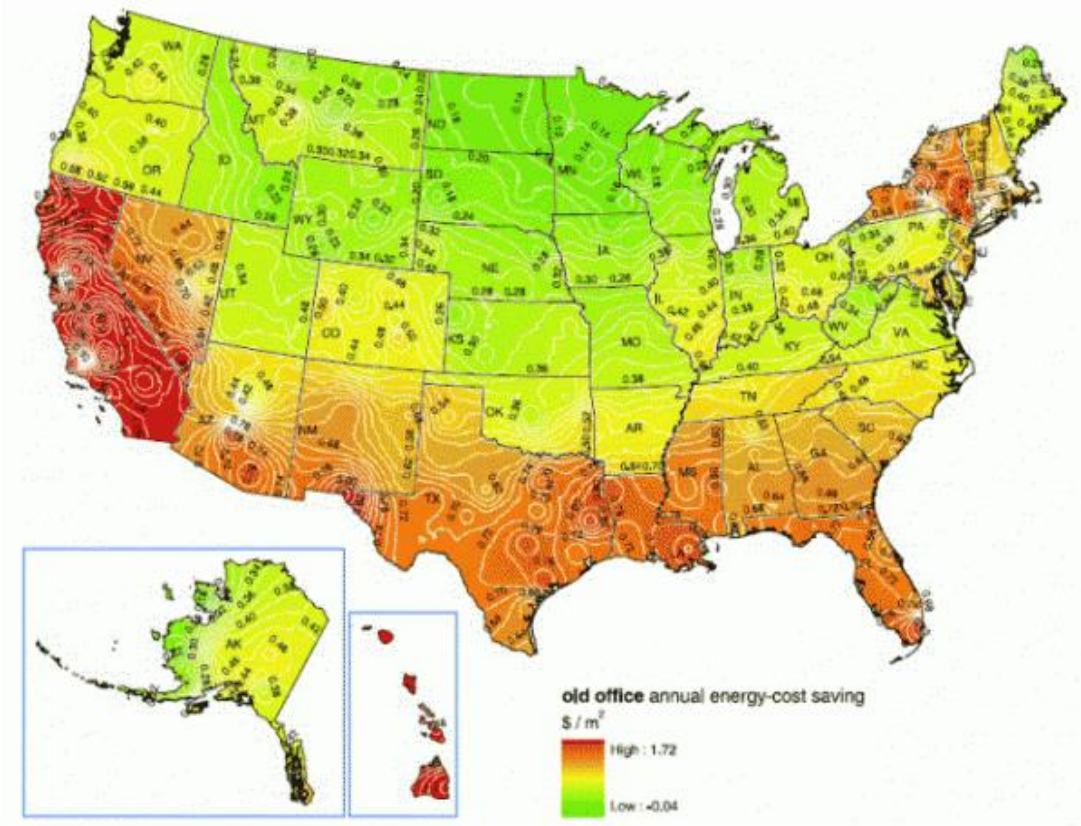
Submeasure E: Opaque Envelope

Background

- Context and History
- 2019 Code Requirements
- Code Change Proposal

Context and History

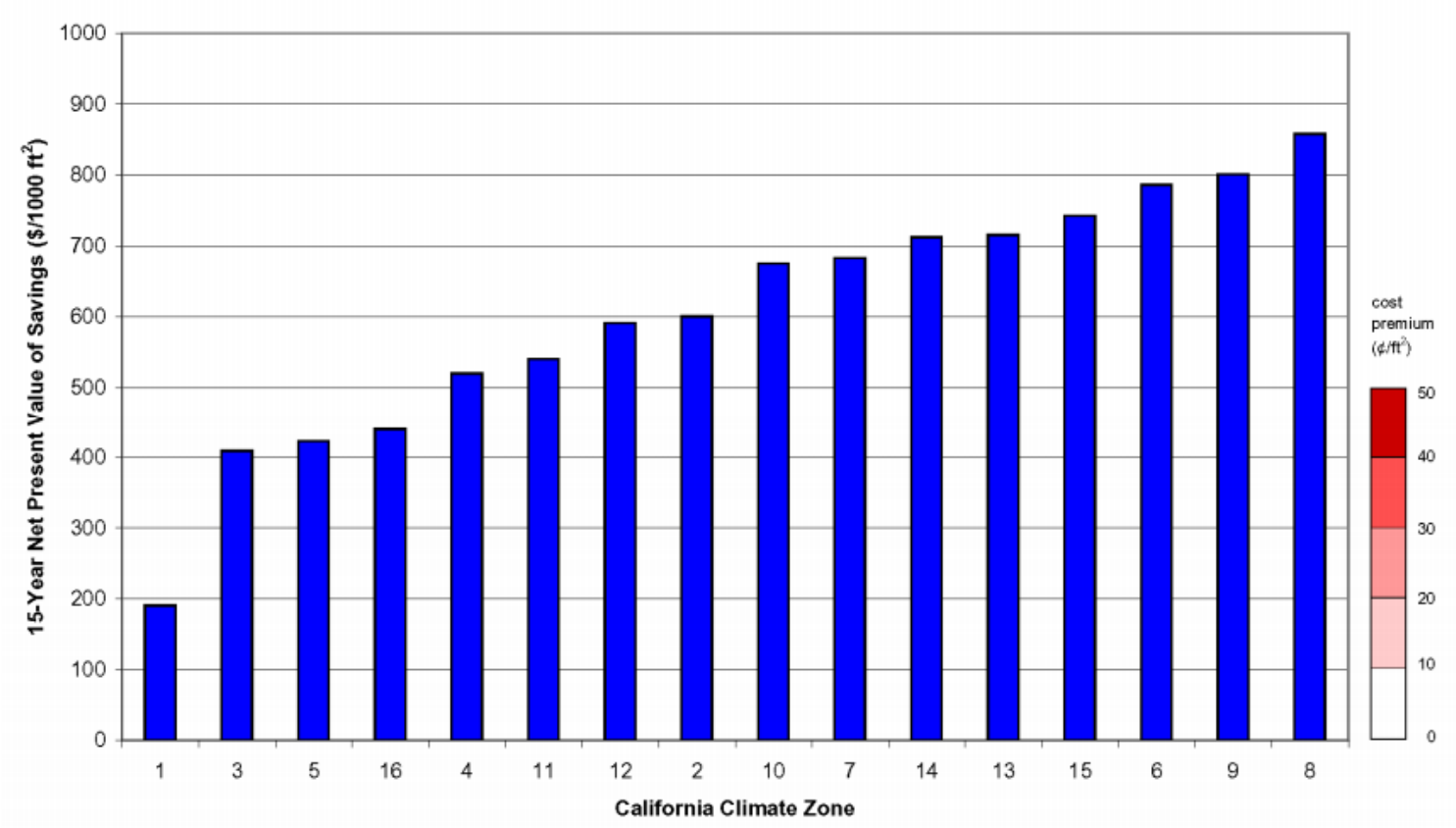
- Title 24, Part 6 Cool Roof requirements have not been updated since 2013
- Voluntary CALGreen requirements are more stringent than Title 24, Part 6
- Potential for significant savings opportunity based on California climate and current roofing products
- Local ordinances in Brisbane, San Matteo, and LA County have found it feasible to adopt more stringent cool roof standards



https://heatisland.lbl.gov/coolscience/cool-roofs

Cool Roof Savings From Heat Island Study Report 2007

Nonresidential building energy and equipment savings:
15-year net present value of savings ($/1000ft^2)



https://www.energy.gov/sites/prod/files/2015/07/f25/Cool_Roofing_Technologies.pdf

2019 Title 24, Part 6 Cool Roof Requirements

Exterior Roof Requirements in Section 140.3 (a)1.A.

Building	Aged Solar Reflectance	Solar Emittance	Solar Reflective Index (SRI)
Low-Sloped Roofs			
Nonresidential	0.63	0.75	75
Hotels and Motels	0.55	0.75	64
High-rise MF	0.55	0.75	64
Steep-Sloped Roofs			
Nonresidential	0.2	0.75	16
Hotels and Motels	0.2	0.75	16
High-rise MF	0.2	0.75	16

- Roofs must meet the aged solar reflectance AND thermal emittance requirements OR the SRI requirement

Cool Roof Proposal – Summary

- Update the aged solar reflectance, thermal emittance, and SRI requirements for low-slope and steep-slope roofs of nonresidential buildings
- Requirements will vary by climate zone
- The proposal will impact the solar radiative requirements for new construction, alterations, and additions
- Separate multifamily requirements from nonresidential

Building Types	Section Number	Type of Change	Software Updates Required
Nonresidential	140.3(a) 141.0(b)2B	Prescriptive	Yes

Proposed Code Change Overview

- Solar reflectance, solar emittance, SRI
  - Propose new and revised requirements for appropriate climate zones and building types
  - Separate multifamily requirements from nonresidential
- The insulation tradeoff for low-slope roofs will be analyzed to ensure the roofing method that leads to the most energy savings is selected. Below is a copy of the current trade-off table. (Table 140.3, Title 24 Part 6, Sec 140.3)

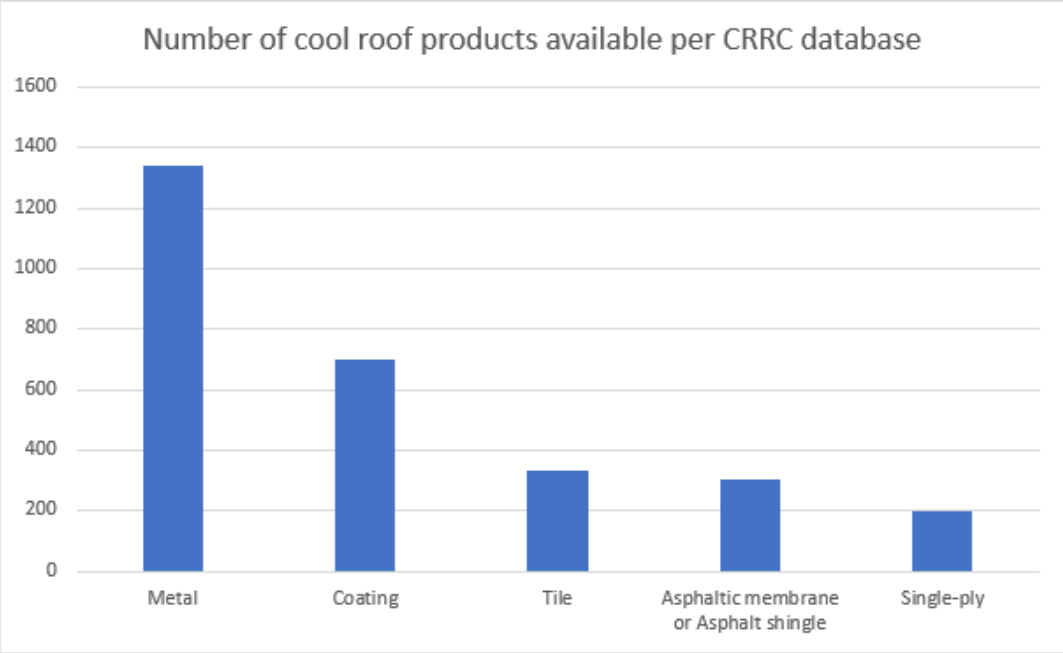
Nonresidential			
Aged Solar Reflectance	Metal Building Climate Zone 1-16 U-factor	Wood framed and other Climate Zone 6 & 7 U-factor	Wood framed and Other All Other Climate Zones U-Factor
0.62-0.56	0.038	0.045	0.032
0.55-0.46	0.035	0.042	0.03
0.45-0.36	0.033	0.039	0.029
0.35-0.25	0.031	0.037	0.028

Market Overview

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

Market Overview and Analysis

- Cool roofing products have been available in the market for multiple decades.
- According to surveys, nearly 9 in 10 commercial roofers are involved with single-ply roofing, with 4 in 5 involved with metal and two-thirds having coating offerings.[1]
- Asphalt modified bitumen products make up an estimated 25% of the low-slope market, single-ply comprises an estimated 41%, Built-up roofing makes up 8%, and liquid applied products (eg coatings) make up about 10%[2]



1 https://www.roofingcontractor.com/articles/93398-roofing-contractors-state-of-the-industry-report-and-survey-2019
2 http://www.westernroofing.net/2018/11/20/market-survey-commercial-roofing-market/

Poll

Over the past 10 years, how has the availability of highly reflective roofing material changed?

A. Increased significantly
B. Increased somewhat
C. No change
D. Decreased somewhat
E. Decreased significantly
F. Not sure

Available Products for Low-Slope

- The Cool Roof Rating Council maintains a database of roofing products. The products fall into three groups: those used for low-slope, those used for steep-slope, and those used for both.

- Of the low-slope products with available data, **69%** have a higher aged solar reflectance than the current standard, **97%** have a thermal emittance higher than 0.75, and **76%** have a higher SRI than 75.

Products for low-slope roofs				
	Exceed requirement	Don't exceed	Don't have data	Total
Aged solar reflectance(0.63)	160	72	58	290
Thermal Emittance (0.75)	282	8	0	290
SRI (75)	219	71	0	290

Source: Cool Roof Rating Council database

Available Products for Steep-Slope

- Of the steep-slope products with reported values, **82%** have a higher aged solar reflectance than 0.2, **98%** have a higher thermal emittance than 0.75, and **86%** of the products have a higher SRI than 16.
- Of the products with reported values, about **69%** have aged solar reflectance levels of 0.25 or higher and about **42%** are 0.3 or higher. All major technology types have options that meet the 0.3 aged solar reflectance level.

Products for steep-slope roofs				
	Exceed requirement	Don't exceed	Don't have data	Total
Aged solar reflectance(0.2)	586	133	134	853
Thermal Emittance (0.75)	835	18	0	853
SRI (16)	737	116	0	853

Source: Cool Roof Rating Council database

Available Products for Both Steep - and Low - Slope

- There are 1808 products in the CRRC database that are used for both steep and low slope roofs

Products rated for both steep and low-slope roofs				
	Exceed requirement	Don't exceed	Don't have data	Total
Aged solar reflectance (0.2)	1753	9	46	1808
Aged solar reflectance (0.63)	572	1190	46	1808
Thermal Emittance (0.75)	1672	136	0	1808
SRI (16)	1797	11	0	1808
SRI (75)	708	1100	0	1808

- Of the products with report values:
  - **99%** had a higher aged solar reflectance than 0.2 and **32%** higher than 0.63.
  - **92%** have a greater thermal emittance than 0.75.
  - **99%** have a higher SRI than 16, and **39%** have a higher SRI than 75

Source: Cool Roof Rating Council database

What low-slope products exceed the current standard?

- Of all the low-slope products that exceed the current standards of 0.63 aged solar reflectance and 0.75 thermal emittance:
  - 22 are asphaltic membrane products
  - 485 are coatings
  - 107 are single ply (including EPDM, PVC, TPO, KEE)

What type of steep-slope products exceed the standard?

Of all the steep-slope products that exceed the current steep-slope standard of 0.2 aged solar reflectance and 0.75 thermal emittance:

- 1188 are metal products
- 199 are tile
- 492 are coatings
- 70 are asphalt shingles

Market Barriers

Market Barrier	Solution
Lack of products that meet new standard.	Statewide CASE Team will collaborate with stakeholders to ensure the standard chosen can be met by many products of different technologies.
Metal roofing products are seeing a price increase due to a change in national trade policy.	While the price of metal may currently be higher than is typical, its use in cool roofs is more essential with this new standard. The average metal roofing product is highly reflective and will thus save money with reduced energy usage.
High first cost of installation.	To combat a high price of installation, the Statewide CASE Team will outline the energy and cost savings associated with cool roofs to demonstrate cost effectiveness.
Increased confusion with roofing requirements differing by climate zone.	Outreach will be conducted through forums and reports to ensure that all appropriate parties are aware of what is required where.

Poll

Which of these are potential barriers? Select one or more

A. Product availability
B. Technical compliance
C. Cost
D. Education to the building community
E. Other (type in comment box)

Technical Considerations

- Technical Considerations
- Potential Barriers and Solutions

Technical Considerations

- Proposal may require change in standard design practices
- Barriers
  - Product selection may be limited
  - Envelope trade-off may lead to more savings over cool roof option
  - Lack of cost information may increase the possibility of being rejected in value engineering

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

Technical Barriers

Technical Barriers	Solution
Insulation tradeoff may produce different savings levels than the roof radiative requirements.	The Statewide CASE Team will conduct model outcomes to ensure the option that saves the most energy is utilized. Additionally, we will engage with stakeholders to learn their experiences with the tradeoff.
Re-roofing projects may have fewer product options that meet reflectance standards.	The Statewide CASE Team will work with trade groups and contractors to learn of the availability of products for re-roofing efforts.
Cool roof products may not perform as tested in the field.	The Statewide CASE Team will consult with building owners that have previously made cool roof improvements.
Higher reflectance standards may not be available for all roofing products.	The proposed change will not block technologies out of the market, as the CASE Team will ensure there are cost effective products available for all technologies.

Energy and Cost Impacts

Methodology and Assumptions

- Energy Impacts Methodology
- Cost Impacts Methodology

Methodology for Energy Impacts Analysis

- Impacts will be characterized as the differences between the Baseline and Proposed conditions
- Energy savings analysis will include calculations for new construction, alterations, and additions
- Prescriptive option 1 will be analyzed for all building types and climate zones
  - Option 1: product meets thermal emittance and solar reflectance
- The 2008 CASE Report for cool roofs gathered survey data and other estimates showing that 20 percent of nonresidential roofs are steep-slope. We will review market survey data to get a more recent estimate.

Definition of Baseline and Proposed Conditions

Baseline Conditions

- Minimally compliant with 2019 Code

Aged Solar Reflectance	Solar Emittance	Solar Reflective Index (SRI)
Low-slope		
0.63	0.75	75
Steep-slope		
0.2	0.75	16

Proposed Conditions

- Solar reflectance
- Thermal emittance

Incremental Cost Information

- How can we collect costs of base case technology and proposed technology?
  - RS Means or other cost-estimating publications
  - Interviews with manufacturers, distributors or contractors
  - Survey to Design-Build firms, American Institute of Architects member, and roofing contractors
  - Blind cost estimates from roofing associations
  - Previous reports written on cost-effectiveness of reach code efforts
- What components of costs do we include?
  - Incremental product cost difference of a cool roof material compared to a standard roofing product

Do you agree with the approach? What is missing?

Market Actors

Market actors involved in implementing this measure will include:

- Building Owners
- Architects
- Cool Roof Rating Council
- Asphalt Roofing Manufacturers Association
- Cool Metal Roofing Coalition
- Roof Coatings Manufacturers Association
- Roofing Association Members
- Building designers and contractors
- Energy consultants

Compliance Verification Process

1. Design Phase

- Changes in the design phase of roofs that requires the updated standards
- For reroofing projects, there will be design changes to consider if an insulation tradeoff is selected

2. Permit Application Phase

- No major changes in the permit application phase

Compliance Verification Process

3. Construction phase

- No significant change in the construction phase – roofing contractors will install materials under the current processes

4. Inspection Phase

- Building inspector verifies the roofing meets the radiative requirements listed on the energy documentation and specifications

Discussion and Next Steps

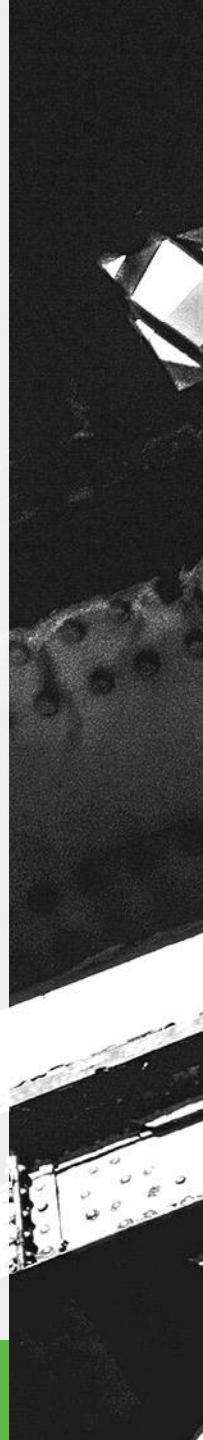
Submeasure A: Cool Roof

Submeasure B: Thermal Bridging

Submeasure C: Roof Alterations

Submeasure D: High Performance Windows

Submeasure E: Opaque Envelope



Background

- Context and History
- 2019 Code Requirements
- Code Change Proposal

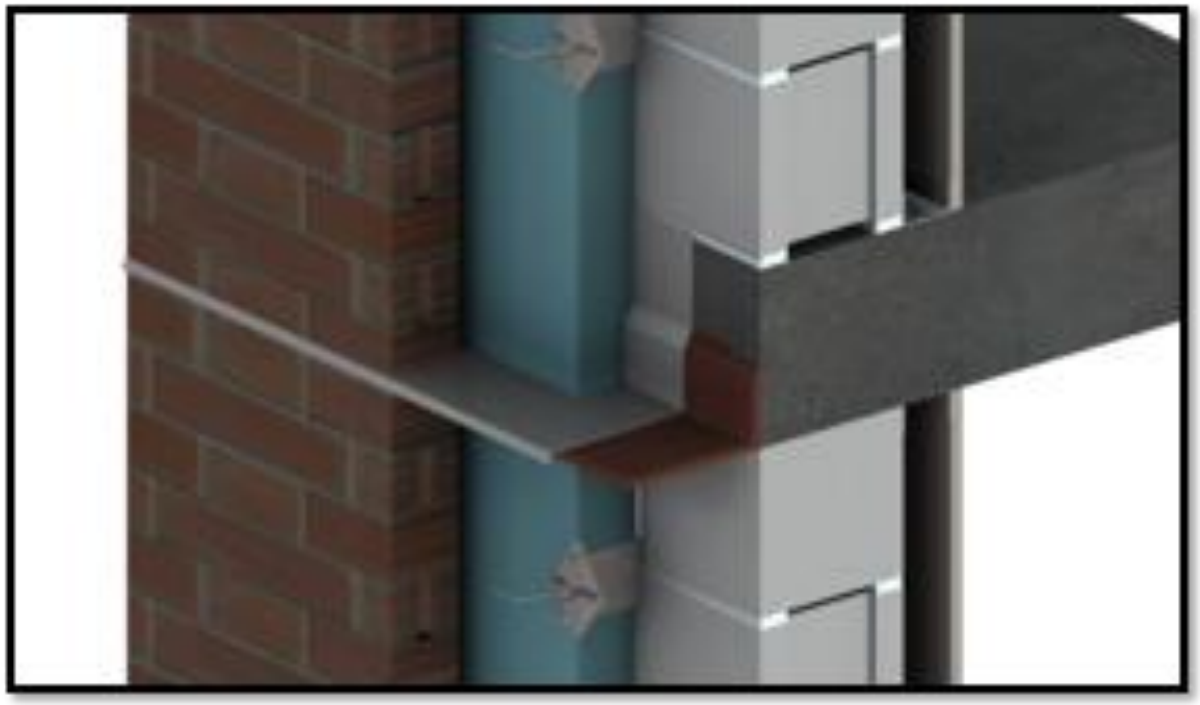
Thermal Bridging Proposal – Summary

Building Types	Construction Type	Section Number	Type of Change	Software Updates Required	Compliance Forms
Nonresidential	New	140.3(a)	Prescriptive/Performance	Yes	Yes

- Account for thermal bridging in assembly U-factors where it is not done already
  - At envelope assembly interfaces
- Improve detailing and performance of the building envelope

What is a thermal bridge?

- A pathway of least resistance that bypasses insulation
- More exterior than interior surface area, which increases heat transfer (e.g., roof-to-wall interface)
- Misaligned or reduced insulation at an interface (e.g. window-to-wall interface)



Thermal Bridging due to a shelf angle that supports brick veneer

Image source: Morrison Hershfield

Implications of unmitigated Thermal Bridges

- Over-estimated building performance
- Increased risk of condensation on cold surfaces
- Reduced occupant comfort
- Reduced durability
- Inefficient HVAC operation
- Higher embodied energy
- This is increasingly important as designs rely on higher “effective” R-values

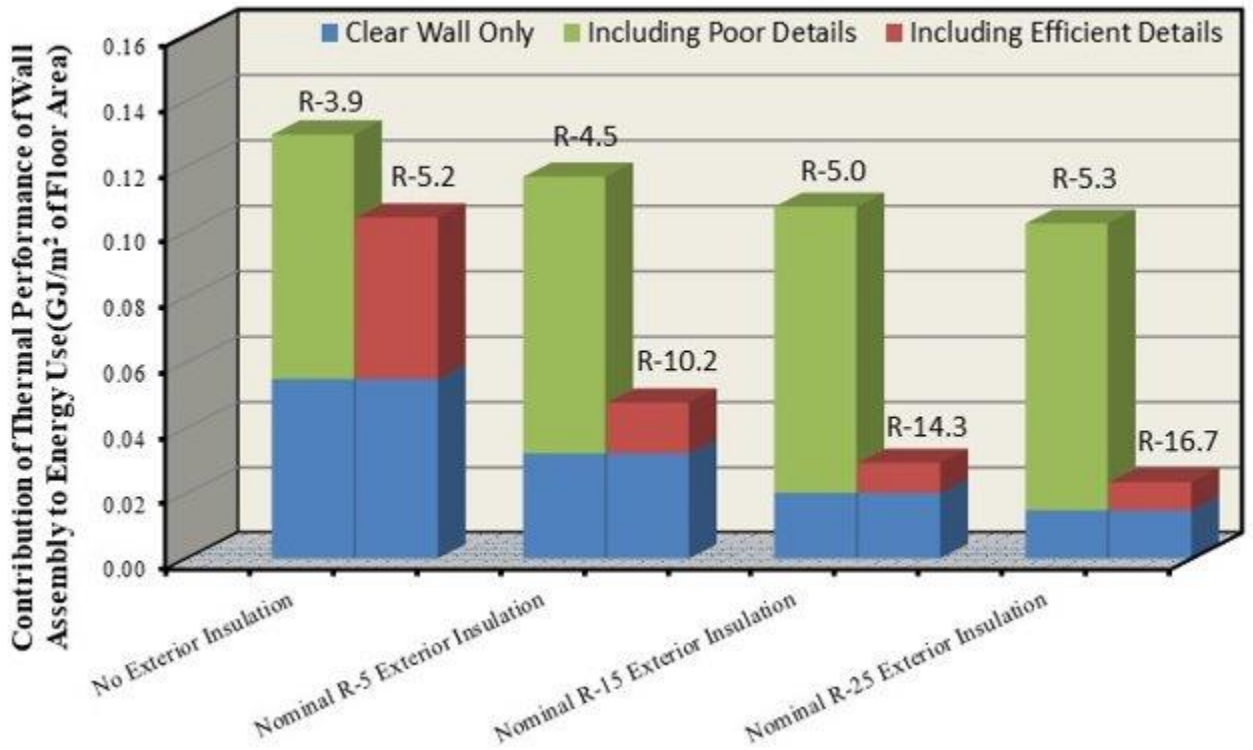


Image source: Morrison Hershfield

Context and History

- Thermal bridging is accounted for in steel and wood framing members U-factors
- Thermal bridging from poor detailing at the interface of assemblies and envelope components is **not** accounted for
- Poorly-designed details can increase overall assembly U-factors by as much as 50%
- Addressing thermal bridging and improving detailing will result in:
  - Reduction of moisture problems
  - Longer building lifetimes
  - Improved comfort
  - More efficient HVAC performance

Types of Transmittance to Account for

- Clear Field – heat loss per area, U-value
- E.g., wall, floor, roof assembly

- Linear – additional heat loss, Psi-value
- E.g., window-to-wall, intermediate floor

- Point – additional heat loss, Chi-value
- E.g. beam penetration

Image source: Morrison Hershfield

Proposed Code Change Overview

- See the proposal summary and mark-up language in **resources tab**
- Explore requirements that will mitigate heat transfer across major thermal bridges:
  - Window-fenestration intersections
  - Wall-roof intersections
  - Wall-intermediate floor intersections
  - Wall-exterior projections (e.g., balconies, overhangs, architectural features)
- Precise format of requirements (mandatory, prescriptive, or performance credit) yet to be determined

Proposed Code Change Overview

- See the proposal summary and mark-up language in **resources tab**
- Potential implementation methods
  - Adjust assembly U-factor calculation methods
  - Prescribe acceptable details and insulation – drawing from the thermal bridging guide and ASHRAE 90.1 addendum AV
  - Identify the most impactful thermal bridges and prescribe thermal breaks
  - Prescribe additional insulation

Thermal Bridging in Other Codes

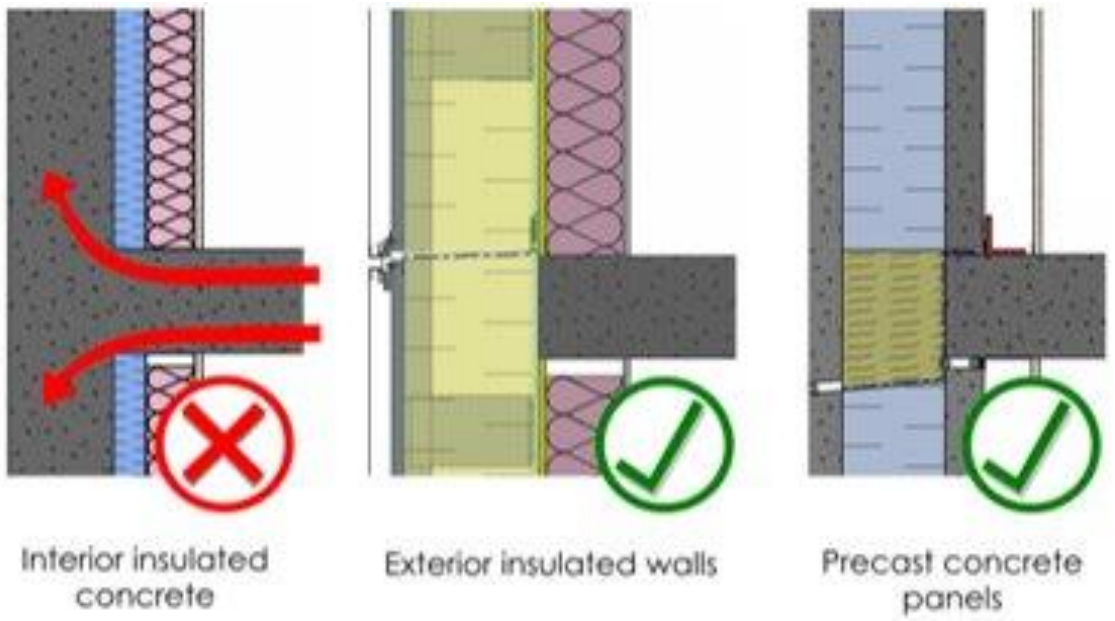
- Addendum AV provides prescriptive and performance path requirements to address thermal bridging in ASHRAE Standard 90.1
- The Canadian National Energy Code for Buildings (NECB) provides a framework for calculating thermal bridging and requires the modeler to carry out comprehensive U-factor calculations
- The Statewide CASE Team is evaluating the best approach for implementing thermal bridging requirements in Title 24

Market Overview

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

Market Overview and Analysis

- Current state of how well assembly details are designed is being investigated
- There is no incentive to mitigate thermal bridging at interfaces
- Enough of a concern nationally that the 90.1 Envelope Subcommittee made it a priority in 2015
- Market Barriers
  - Perception that it is difficult to design, costs a lot, and is difficult to enforce
  - Will require training and education; good details exist but likely that not all designers are aware of problems
  - New to the construction industry



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

Image source: Morrison Hershfield

Poll

Are thermal bridging details at interfaces incorporated in the design and construction documents?

A. Yes, this is standard practice
B. Sometimes, it depends on certain factors (elaborate in the chat)
C. Rarely (elaborate in the chat)
D. No
E. I don’t know

Poll

In your experience, which assembly interfaces are vulnerable to thermal bridging? Select all that apply

A. Wall-to-roof/parapet
B. Wall-to-intermediate floor
C. Wall-to-projections
D. Wall-to-window
E. Other (elaborate in chat)

Technical Considerations

- Technical Considerations
- Potential Barriers and Solutions

Technical Considerations

- Is it worth the effort? Are there savings in California from this measure?
- This would increase complexity of the envelope requirements
  - Prescribing acceptable details could be restrictive
  - But providing design flexibility could increase complexity by asking designers to learn new terms (psi/chi factors... what are they?)
- How much effort is needed on the training, education, and enforcement side?
- Structural and seismic concerns: does this get in the way of structural requirements?

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

Energy and Cost Impacts

Methodology and Assumptions

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

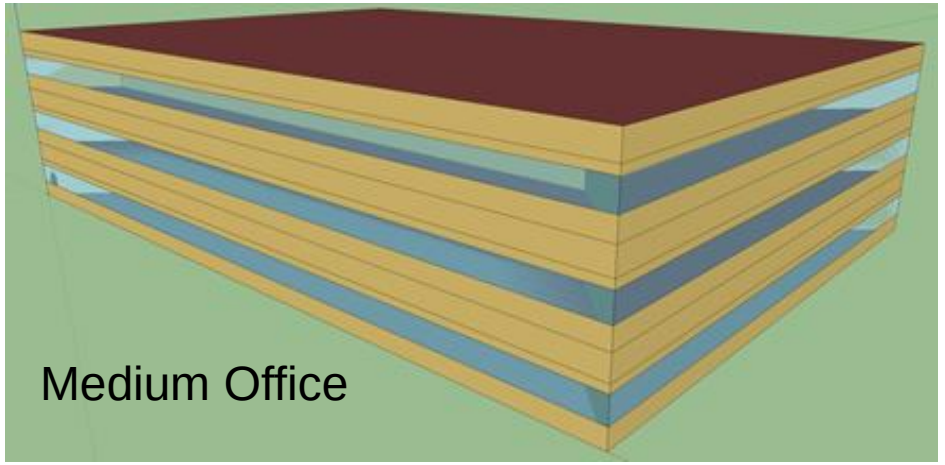
Methodology for Energy Impacts Analysis

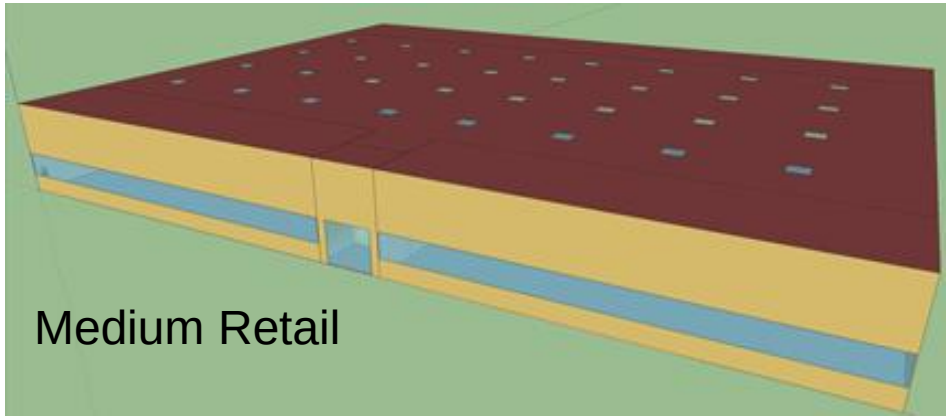
- Simulate a range of U-factors and establish regression equation for U-factor versus energy (or TDV) for each impacted assembly in each climate zone for a prototype
  - Select up to three prototypes to represent all components and assemblies (for example, steel-framed, mass, etc.)
- Select unmitigated and mitigated assembly details and calculate the corresponding assembly U-factors
  - Unmitigated based on standard design details in California (being researched)
  - Mitigated based on "good practice" or "high performance" details in BCHydro guide
- Determine energy, cost, and TDV savings by parsing unmitigated and mitigated U-factors through regression equation

Preliminary Energy Savings Estimates

- **Goal:** Provide range of potential savings from thermal bridging

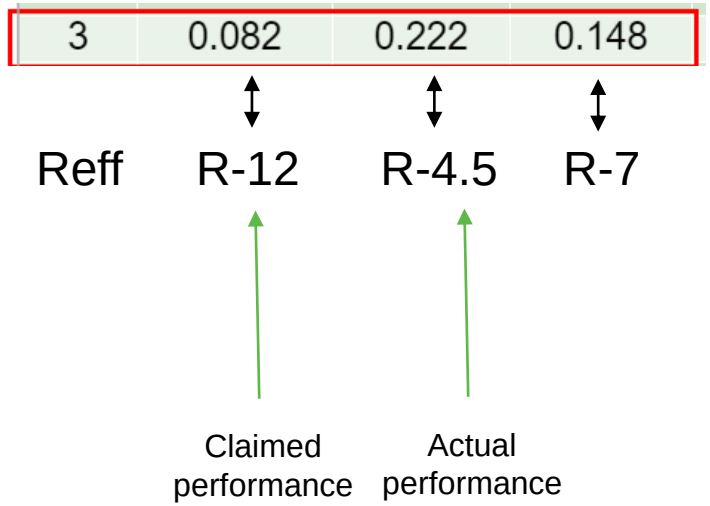
- Prototypes: Medium Office and Medium Retail
- Unmitigated and mitigated psi-factors from ASHRAE Standard 90.1 Addendum AV
- Thermal bridges included in the analysis:
  - Roof edge
  - Intermediate floor-wall intersection (Medium Office only)
  - Wall-fenestration intersection
  - Sun-shade (west-facing façade only for Medium Office)





Unmitigated and Mitigated U-factors

	Medium Office			Medium Retail		
CZ	T24 2019	Unmtgd	Mtgd	T24 2019	Unmtgd	Mtgd
1	0.069	0.209	0.135	0.253	0.294	0.266
2	0.062	0.202	0.128	0.650	0.691	0.663
3	0.082	0.222	0.148	0.650	0.691	0.663
4	0.062	0.202	0.128	0.650	0.691	0.663
5	0.062	0.202	0.128	0.650	0.691	0.663
6	0.069	0.209	0.135	0.690	0.731	0.703
7	0.069	0.209	0.135	0.690	0.731	0.703
8	0.062	0.202	0.128	0.690	0.731	0.703
9	0.062	0.202	0.128	0.690	0.731	0.703
10	0.062	0.202	0.128	0.650	0.691	0.663
11	0.062	0.202	0.128	0.184	0.225	0.197
12	0.062	0.202	0.128	0.253	0.294	0.266
13	0.062	0.202	0.128	0.211	0.252	0.224
14	0.062	0.202	0.128	0.184	0.225	0.197
15	0.062	0.202	0.128	0.184	0.225	0.197
16	0.062	0.202	0.128	0.160	0.201	0.173

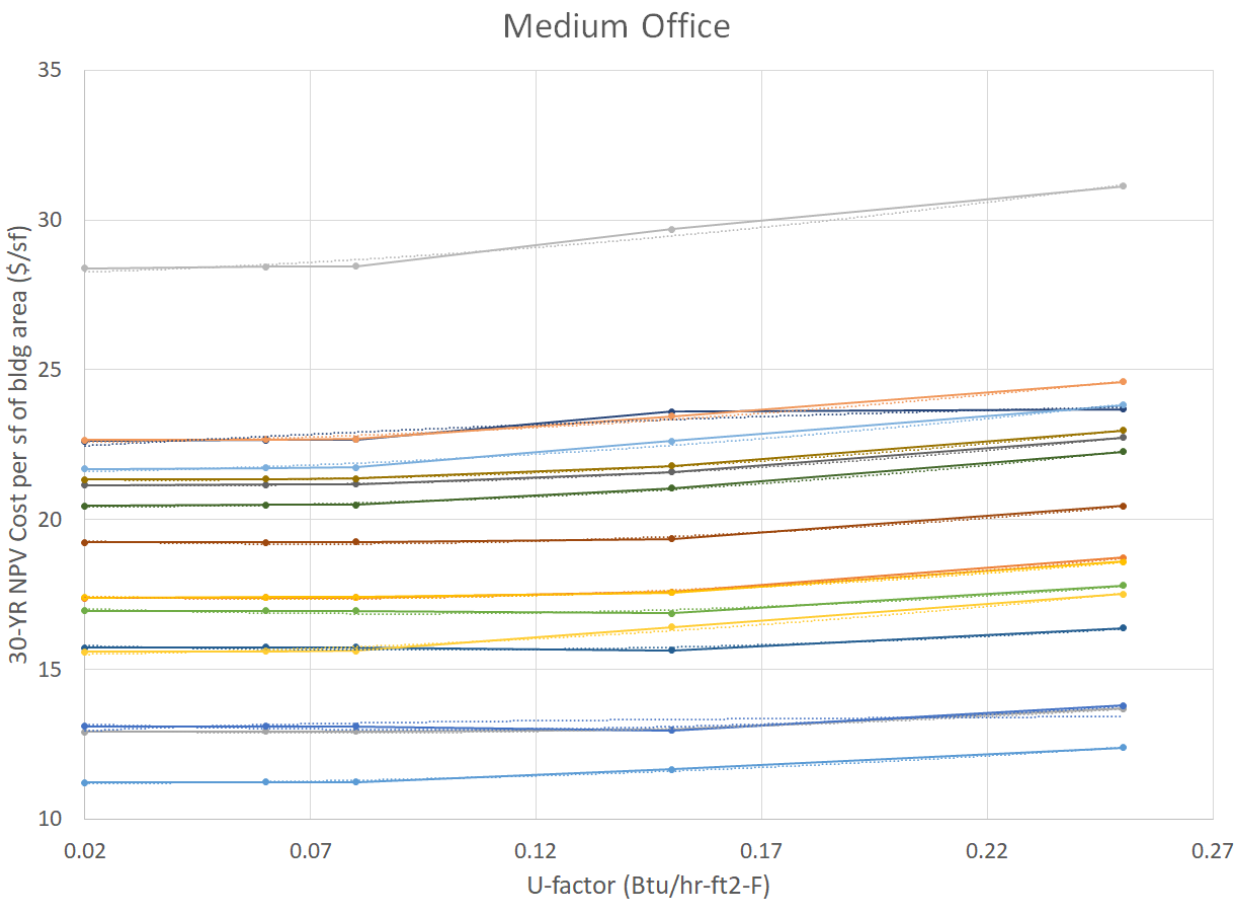


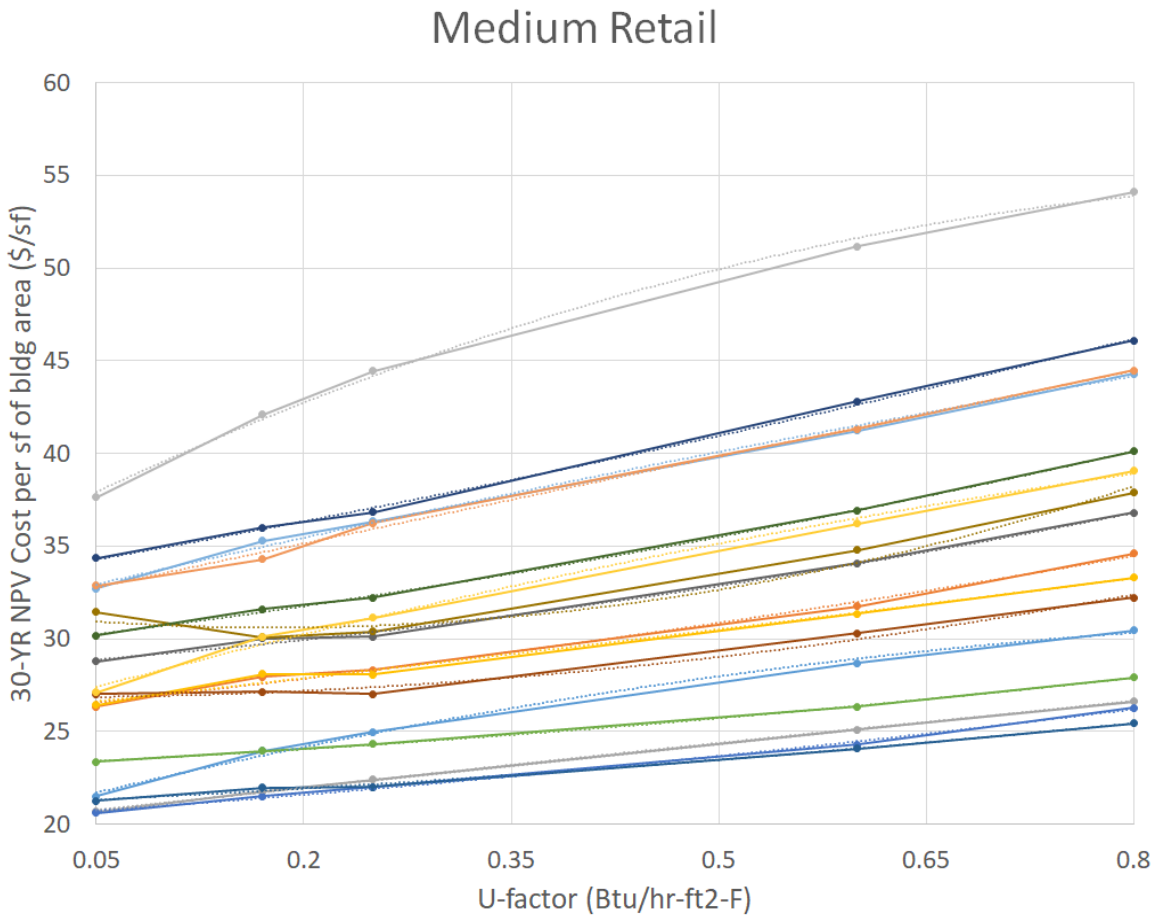
Heat Flow Through Thermal Bridges

		Unmitigated		Mitigated	
Prototype	U-factor Type	U-factor	% of Heat Flow	U-factor	% of Heat Flow
Office	clear field	0.069	33%	0.069	56%
	details	0.140	67%	0.054	44%
Retail	clear field	0.062	60%	0.069	84%
	details	0.041	40%	0.013	16%

Morrison Hershfield's past experience with real designs suggests that 70% of the heat flow is through unmitigated details. With mitigation, this can be brought down to 30%.

U-factor versus 30-YR NPV Whole Building Energy Cost ($/sf of bldg area)





Potential Savings from Thermal Bridging

Units: 30-YR NPV Whole Building Energy Cost

Medium Office

		Wall U-factor			Energy Cost ($/sf of opaque wall area)			Energy Cost Savings ($/sf of opaque wall area)		% Energy Cost Savings	
CZ	Location	T24 2019	Unmtgd	Mtgd	T24 2019	Unmtgd	Mtgd	Unmtgd to Mtgd	Unmtgd to T24 2019	Unmtgd to Mtgd	Unmtgd to T24 2019
3	Oakland	0.082	0.222	0.136	$49	$51	$49	$1.75	$2.12	3%	4%
7	San Diego	0.069	0.209	0.123	$59	$60	$59	$1.37	$1.42	2%	2%
12	Sacramento	0.062	0.202	0.116	$77	$81	$78	$3.16	$4.12	4%	5%
16	Blue Canyon	0.062	0.202	0.116	$59	$64	$60	$3.31	$4.59	5%	8%

Medium Retail

		Wall U-factor			Energy Cost ($/sf of opaque wall area)			Energy Cost Savings ($/sf of opaque wall area)		% Energy Cost Savings	
CZ	Location	T24 2019	Unmtgd	Mtgd	T24 2019	Unmtgd	Mtgd	Unmtgd to Mtgd	Unmtgd to T24 2019	Unmtgd to Mtgd	Unmtgd to T24 2019
3	Oakland	0.650	0.691	0.663	$54	$55	$54	$0.44	$0.64	1%	1%
7	San Diego	0.690	0.731	0.703	$52	$53	$52	$0.41	$0.60	1%	1%
12	Sacramento	0.253	0.294	0.266	$68	$69	$69	$0.70	$1.02	1%	1%
16	Blue Canyon	0.160	0.201	0.173	$62	$64	$63	$1.09	$1.60	2%	3%

Incremental Cost Information

- **We will begin researching costs after the proposed requirements are finalized**
- Methods for gathering cost information:
  - Interview with stakeholders: building designers, energy consultants, SMEs, manufacturers, distributors, and contractors
  - Incremental cost estimates from similar work in other codes
  - Design and other ‘soft’ costs are not part of the measure cost-effectiveness
- **What components of costs should we consider?**

Compliance and Enforcement

- Design
- Permit Application
- Construction
- Inspection

Compliance Verification Process

1. Design Phase

Require integrative design process

- Placeholder on details
- Specifications needed to meet performance energy model needs, value engineering, and tendering
- Placed on plans, communicated to procurement to get competitive pricing and alternative solutions
- Coordination between designers and trades/specialists and earthquake/structural safety

2. Permit Application Phase

- Update compliance software
- New compliance forms
- Examine assembly details to confirm compliance

Compliance Verification Process

3. Construction phase

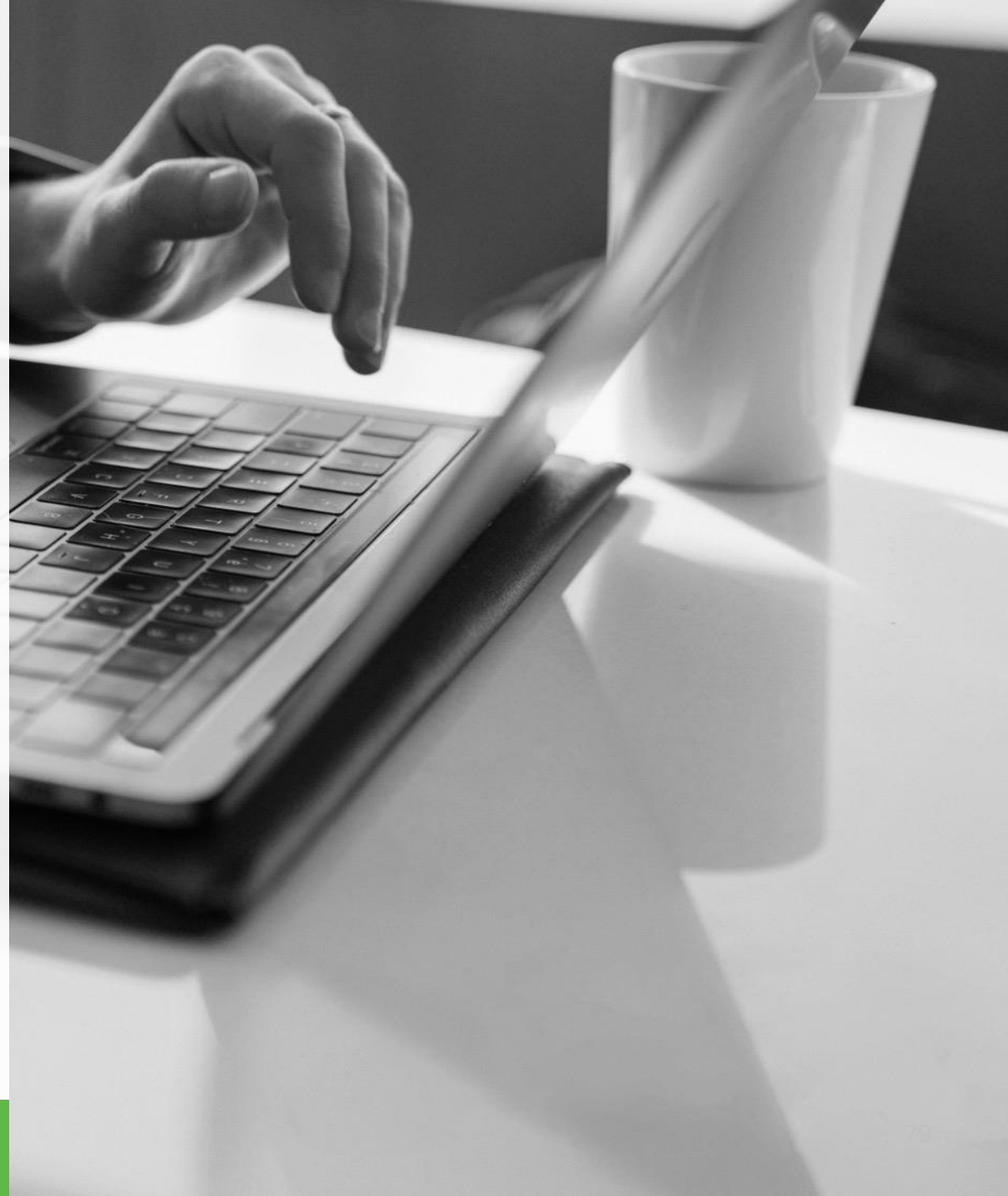
- General contractor provides oversight to confirm assemblies and details are constructed according to plans
- Building inspector visits site when assemblies and details are exposed to confirm installation occurred according to design

4. Inspection Phase

- Building inspector visits site when assemblies and details are exposed to confirm installation occurred according to design
- A commission agent/ATTCP completes a verification of the details with the appropriate acceptance form
  - photo documentation of details (done for passive house)

Proposed Code Changes

- Draft Code Change Language
- Proposed Software Updates



Software Updates

- CBECC-Com can capture impact of thermal bridging by simulating a change in the U-factor of assemblies
- The Statewide CASE Team will recommend updates to CBECC-Com so the 2022 compliance software can calculate energy impacts from thermal bridging
  - There may be screens to input Psi/Chi values and number of occurrences or linear feet based on assembly details
  - This information to will be used to develop adjusted U-factors for the assembly

Discussion and Next Steps

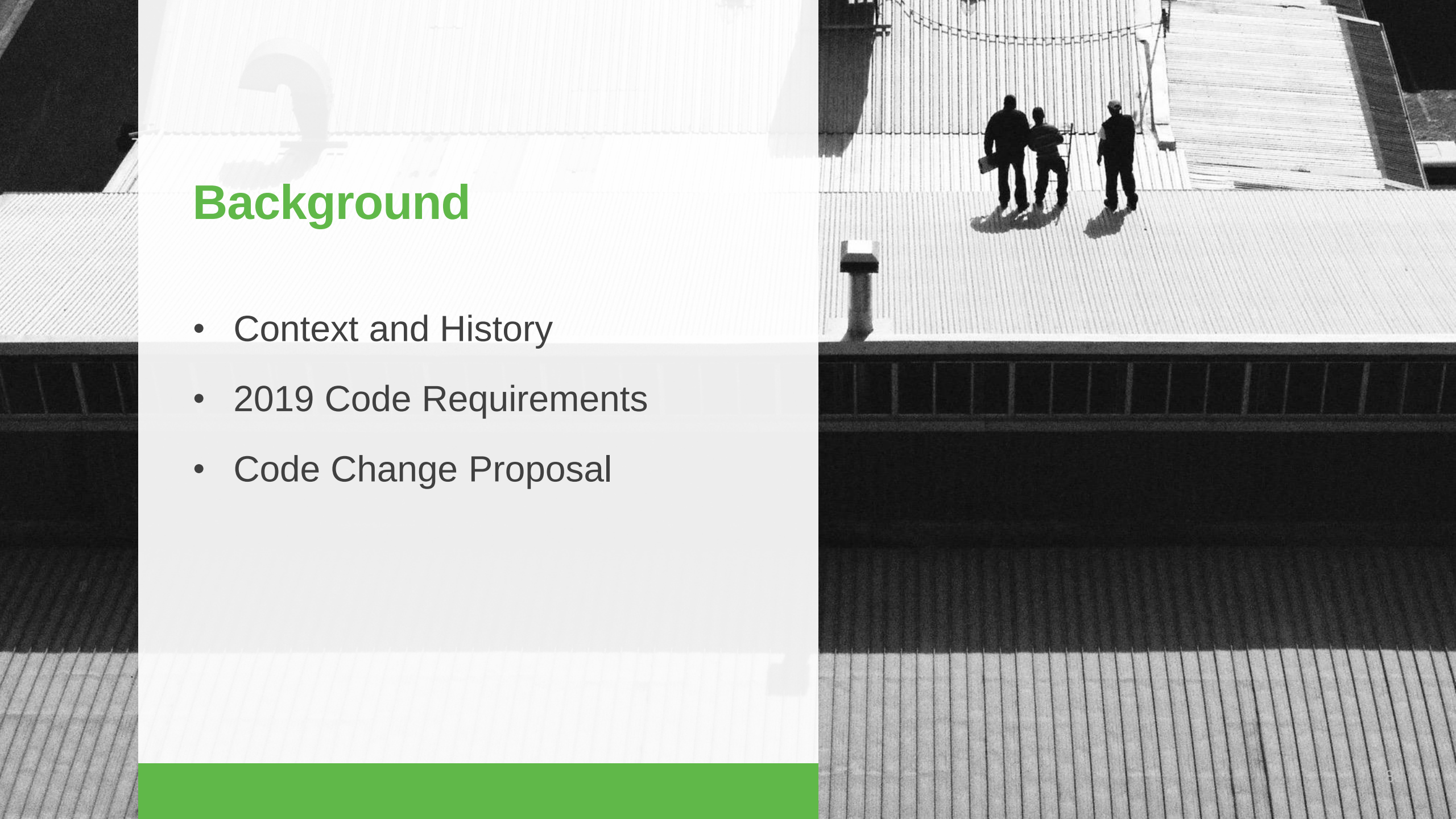
Submeasure A: Cool Roof

Submeasure B: Thermal Bridging

Submeasure C: Roof Alterations

Submeasure D: High Performance Windows

Submeasure E: Opaque Envelope



Background

- Context and History
- 2019 Code Requirements
- Code Change Proposal

What is covered under Roof Alterations?

- **Roof replacement: The process of removing the existing roof covering, repairing any damaged substrate, and installing a new roof covering.**
- Roof recover: The process of installing an additional roof covering over a prepared existing roof covering without removing the existing roof covering.
- Roof recoat: A roof repair where a reflective coating is applied.

Code Change Proposal – Summary

- When low-sloped roofs in existing buildings are exposed to the roof deck or to the roof recover boards, the exposed area above the roof deck shall be insulated to the same degree as new construction
- Applies to roofs with more than 50 percent of the roof area or more than 2,000 square feet of roof, whichever is less, being altered

Building Types	Construction Type	Code Section	Type of Change	Software Updates Required	Compliance Forms
Nonresidential	Alterations	141.0(b)2Biii	Prescriptive	Yes	Yes

Context and History

- **Why are we proposing this measure?**
  - Title 24, Part 6 insulation requirements for roof replacements have not been updated since it was introduced in the 2008 code cycle
  - Title 24, Part 6 roof replacement construction requirements are aligned with new construction for cool roof but not for insulation
  - Significant energy savings opportunity, over 70% the of roofing market is for existing buildings
  - Will offer the opportunity to bring existing building stock up to new construction energy standards over time in a cost effective manner.

2019 Code Requirements

- 2019 Requirements in Title 24, Part 6
  - Section 141(b)2Biii: When low-sloped roofs are exposed to the roof deck or to the roof recover boards, and meets Section 141.0(b)2Bia or iia, the exposed area shall be insulated to the levels specified in TABLE 141.0-C.

Alterations: Table 141.0-C, Insulation R-Values & U-Factors for Roof Replacements

Climate Zones	**1, 3-9**		**2, 10-16**	
Nonresidential	R-8	U-0.082	R-14	U-0.055
High-Rise Residential and Hotels	R-14	U-0.055	R-14	U-0.055

Proposed Code Change Overview

- See the proposal summary and mark-up language in **resources tab**
- Proposed code changes:
  - Simplify Section 141.0(b)2Bi & 141.0(b)2Bii by referencing the new construction requirements instead of rewriting them.
  - Modify parts of Section 141.0(b)2Biii, including:
    - Require insulation to meet the requirements, above deck, in Table 140.3-C (new construction)
    - Removal of Table 141.0-C.
    - Removal of exception a. for roofs with at least R-7 insulations
    - Removal of exception b. for lifting mechanical equipment
    - Removal of exception c. for penthouse or parapet walls

Market Overview

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

Market Overview and Analysis

- Current Market
  - Greater than 70% of the low-slope roofing market is alterations (roof replacement, recovering, recoating) rather than new construction
- Market Trends
  - We expect alterations to be minimally compliant with the code
- Market Barriers
  - It might delay roof upgrades from occurring because of perceived additional cost – cost effectiveness model will show that it is worth the upgrade
- **Do you agree with this description? What else should we know?**

Poll

What percentage of the roof alteration market is replacement of >2000 sq. ft. or >50% of the roof?

A. Less than 10%
B. 10-30%
C. 30-50%
D. 50-70%
E. Greater than 70%

Poll

Is it current practice to add more insulation when the existing insulation is at least R-7?

A. Yes
B. No
C. I don’t know

Technical Considerations

- Technical Considerations
- Potential Barriers and Solutions

Technical Considerations

- The Statewide CASE Team will confirm that the U-factors are achievable in existing assemblies.
- The Statewide CASE Team will confirm that a variety of insulation materials can meet the insulation requirements above the roof deck
  - Creating a continuous insulation layer can be achieved by insulating only above deck
- Barriers and Potential Solutions
  - This may be more difficult for certain buildings and roof types. Above-deck rigid insulation may be a feasible solution
- **Do you agree with this description? What else should we know?**

Energy and Cost Impacts

Methodology and Assumptions

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

Methodology for Energy Impacts Analysis

- Interview roofing contractors and code officials to understand how often the insulation is exposed and permits are pulled
  - This will tell us how much of the building stock undergoes roof replacements each year
- Interview insulation manufacturers and contractors to understand the cost of added insulation
  - This will tell us the incremental cost of additional insulation
- Modeling analysis for all nonresidential buildings and climate zones
- **The baseline prototype building will be at least 10 years old. Do you agree?**

Poll

How often are roofs replaced?

A. More than 30 years
B. 25-30 years
C. 20-25 years

Definition of Baseline and Proposed Conditions

Baseline Conditions

- Minimally compliant with 2008 Code

Proposed Conditions

- Roof replacement complaint with new construction code
- Alterations meeting insulation levels in Table 140.3-C

Incremental Cost Information

- How we will collect costs of base case technology and proposed technology
  - The incremental costs of added insulation will be considered
  - RS Means will be used to estimate incremental insulation costs
  - Interviews with roofing contractors and insulation manufacturers for the itemized incremental costs of labor and materials
- **Do you agree with this description? What components of costs did we leave out?**

Compliance and Enforcement

- Design
- Permit Application
- Construction
- Inspection

Compliance Verification Process

1. Design Phase

- Installers are aware of new insulation requirements
- Installers take responsibility for meeting insulation requirements by signing the compliance documentation

2. Permit Application Phase

- Plan examiners are aware of new insulation requirements
- Plan examiners review compliance documentation to verify the insulation requirements are met

Compliance Verification Process

3. Construction phase

- Required insulation is installed per energy documentation, plans, and/or specifications

4. Inspection Phase

- Building inspector verifies the installed insulation meets what is listed on the energy documentation, plans, and specifications

Market Actors

- Building owners
- Insulation manufacturers
- Insulation suppliers
- Roofing contractors
- Energy compliance documentation authors
- Plans examiners
- Building inspectors

Discussion and Next Steps

Submeasure A: Cool Roof

Submeasure B: Thermal Bridging

Submeasure C: Roof Alterations

Submeasure D: High Performance Windows

Submeasure E: Opaque Envelope

Background – High Performance Windows

- Context and History
- 2019 Code Requirements
- Code Change Proposal

Code Change Proposal – Summary

- This measure proposal will consider improvements to thermal performance factors for windows in nonresidential buildings
- Window performance improvement will have direct effect on daylighting, occupancy comfort and overall envelope efficiency
- **Improved Fenestration U-factor –** reduce prescriptive U-factor requirements for vertical fenestration and skylights with available market technologies
- **Improved Fenestration SHGC –** consider impact of introducing climate specific SHGC requirements

Building Types	Code Section	Type of Change	Software Updates Required	Compliance Forms
Nonresidential	10-111, 140.3 B-D	Prescriptive	Yes	

Context and History

- **Why are we proposing this measure?**
  - Title 24, Part 6 requirements exist but have not been updated since 2013
  - There is a significant savings opportunity since windows influence total building energy performance
  - Fenestration technologies have improved and are available in the market
  - California's Energy Efficiency Strategic Plan calls for all new commercial construction to be net zero energy by 2030
  - California is a leader in zero energy commercial buildings

NBI Getting to Zero Buildings Database

NBI. https://newbuildings.org/resource/getting-to-zero-database/

2019 Title 24, Part 6 Code Requirements

		All Climate Zones				
			Fixed Window	Operable Window	Curtainwall or Storefront	Glazed Doors[2]
Vertical	Area-Weighted Performance Rating	Max U-factor	0.36	0.46	0.41	0.45
		Max RSHGC	0.25	0.22	0.26	0.23
	Area-Weighted Performance Rating	Min VT	0.42	0.32	0.46	0.17
	Maximum WWR%	**40%**				
Skylights			Glass, Curb Mounted	Glass, Deck Mounted	Plastic, Curb Mounted	Tubular Daylighting Devices (TDDs)
	Area-Weighted Performance Rating	Max U-factor	0.58	0.46	0.88	0.88
		Max SHGC	0.25	0.25	NR	NR
	Area-Weighted Performance Rating	Min VT ($Min\ VT_{annual}$ for TDDs)	0.49	0.49	0.64	0.38
	Maximum SRR%	**5%**				

Title 24, Part 6. Table 140.3-B B – PRESCRIPTIVE ENVELOPE CRITERIA FOR NONRESIDENTIAL BUILDINGS.

Alternative Code Requirements

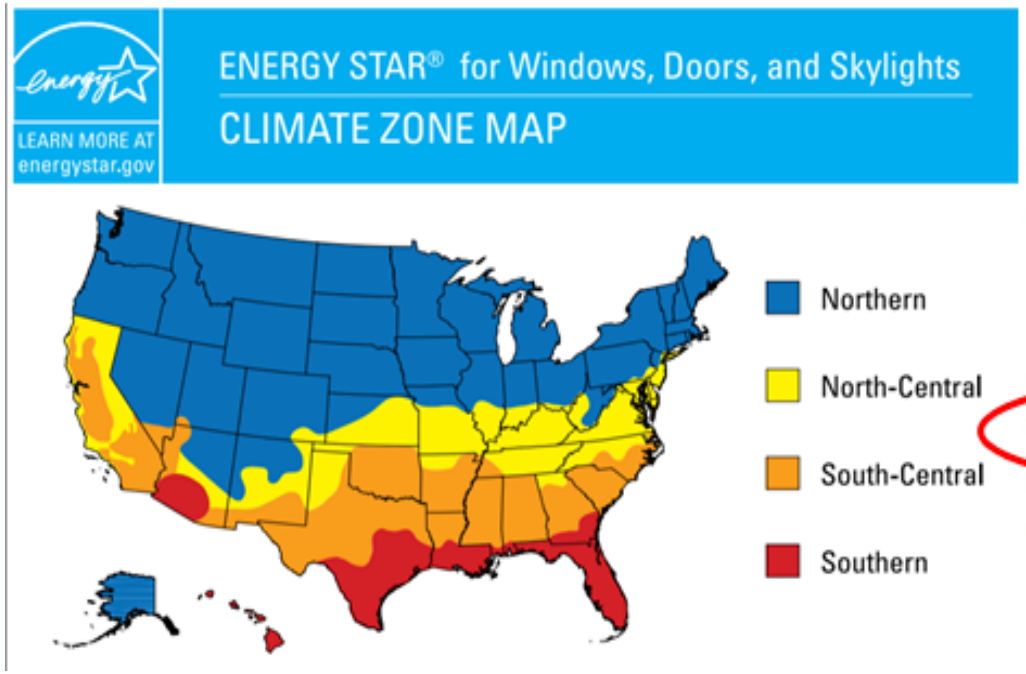
		U-Factor		
		Title 24	IECC / ASHRAE Proposal	
		Effective July 2014	Published 2020 (state adoptions ~2023)	
	Climate Zone:	All	CZ 3	CZ 6
Vertical Fenestration	Fixed Window	0.36	0.42	0.34
	Operable Window	0.46	0.54	0.43
	Curtainwall/Storefront	0.41	n/a	
	Glazed Door*	0.45	0.68	0.63

*Title 24 defines Glazed Door as > 25% glazing. IECC/ASHRAE define Entrance Door as >50% glazing

- IECC 2021 and ASHRAE 90.1 Proposal - 2019 will adopt fenestration standards that are a modest gain in efficiency over the California standard that has been in place since 2014

Alternative Code Requirements

- ENERGY STAR already aligns with Title 24 requirement for low-rise residential buildings
- There is opportunity to drive towards these standards for “punched opening” windows in the commercial sector



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	

Source: ENERGY STAR.

Proposed Code Change Overview

- See the proposal summary and mark-up language in **resources tab**
- Description of changes:
  - Expand window efficiency requirements to apply to all nonresidential buildings
  - Build upon existing codes such as ASHRAE 90.1, NFRC, and rating systems such as LEED
  - Improve requirements for window thermal performance factors to maximize energy savings
    - U-Factor
    - Relative Solar Heat Gain Coefficient
    - Visible Transmittance

Poll

Should the "Curtainwall/Storefront" category be addressed in the 2022 code change proposal? Select all that apply.

A. Yes, it should be broadened to include all site-built windows.
B. Yes, and it should add a breakout within the category for operable units.
C. No, the category should remain as is.
D. Unsure.

Poll

Should Title 24 prescriptive fenestration requirements vary by climate zone?

A. Yes, for Solar Heat Gain Coefficient (SHGC) only.
B. Yes, for U-factor only.
C. Yes, for SHGC and U-factor.
D. No.

Market Overview

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

Current Market

- 163,570,000 square feet per year of unit energy savings (UES) installations potential in California
- High performance windows market is well established
  - Considered best practice, becoming standard practice
- Incentive Programs
  - Multiple incentive programs for high performance windows, including rebates and interest loans
  - Incentives are offered for windows that increase overall building energy savings, e.g. ENERGY STAR-rated windows
  - Utilities that offer these incentives include but are not limited to: Alameda Municipal Power, LADWP, PG&E and SoCal Gas

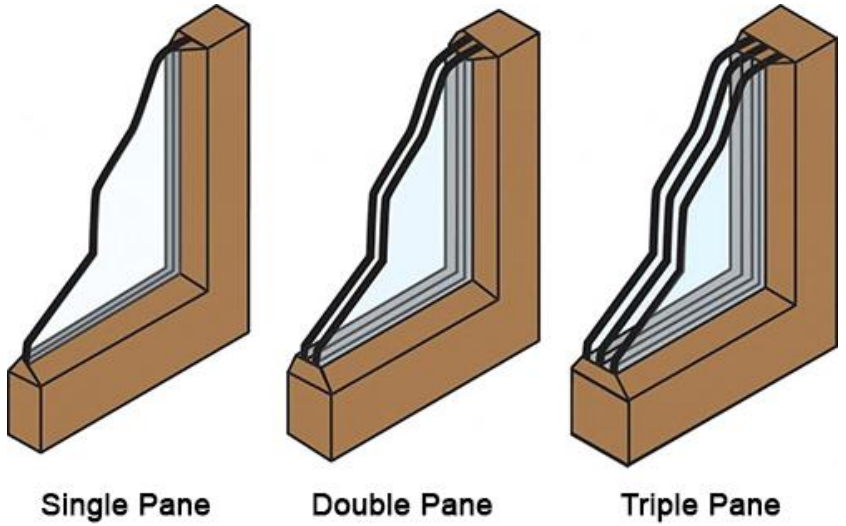


Image Source: The Window Dog. https://thewindowdog.com/triple-pane-vs-double-pane-windows/

Market Trends

- High performance windows are already a common industry practice due to energy savings, such as lower U-factor from double-paned windows
  - Cost-effective payback and energy efficient
    - Payback varies with climate
- Market for energy efficient windows expected to progress quickly
  - Demand for efficient space heating and lighting
  - Influences occupancy comfort

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

https://www.marketwatch.com/press-release/energy-efficient-windows-market-size-share-industry-growth-future-demand-and-trends-and-forecast-2017-2022-2019-01-16

Market Barriers and Solutions

- Custom-built or site-built windows
  - Relatively easy to rate off-the-shelf (manufactured) windows
  - More difficult to bring every custom (field-fabricated, site-built) product through the rating process
  - Further research and stakeholder input to determine next steps
- Cost of high performance windows
  - Higher initial cost of installation, payback in energy savings
  - Triple-glazed and double-glazed windows can be higher cost
  - Technologies such as double-pane windows are not just emerging but they currently exist and are widespread
  - Incentive programs provide additional financial relief

Technical Feasibility

- Technical Considerations
- Potential Barriers and Solutions

Technical Considerations

- Proposal would not require drastic change in standard design process
  - Triple pane windows add increased weight
  - Materials and designs for high performance windows are readily available
  - Additional design updates could include triple glazing
- Compliance will emphasize high performance vs traditional windows
- The Statewide CASE Team will review industry literature to determine further technical considerations
  - No new materials or processes would need to be developed for measure success

PGE Net Zero Case Studies: https://www.pge.com/pge_global/common/pdfs/save-energy-money/savings-programs/zero-net-energy-program/ZNE-Case-Study-Buildings-Vol1.pdf

Technical Considerations

- New technologies allow for a wide range of U-factors
  - U <0.30 require gas-fill, advanced low-e coatings, frame thermal breaks, advanced spacers, triple-pane glazing or equivalent
  - Significant research is being conducted in the field of Thin-glass Triple-pane Glazing and Vacuum glazing
- Solar Heat Gain Coefficient (SHGC) is highly tunable
  - Changes to SHGC affect Visible Transmittance (VT)
  - SHGC impacts vary widely between climates and building types
- Visible Transmittance (VT) affects lighting and health
  - Reducing VT may have a negative effect on daylighting and human health

https://windows.lbl.gov/triple-glazing-thin-non-structural-center-glass

https://cdn.ymaws.com/www.aec.org/resource/resmgr/library/whitepapers/aecdaylighting-whitepaper-ju.pdf

Technical Feasibility

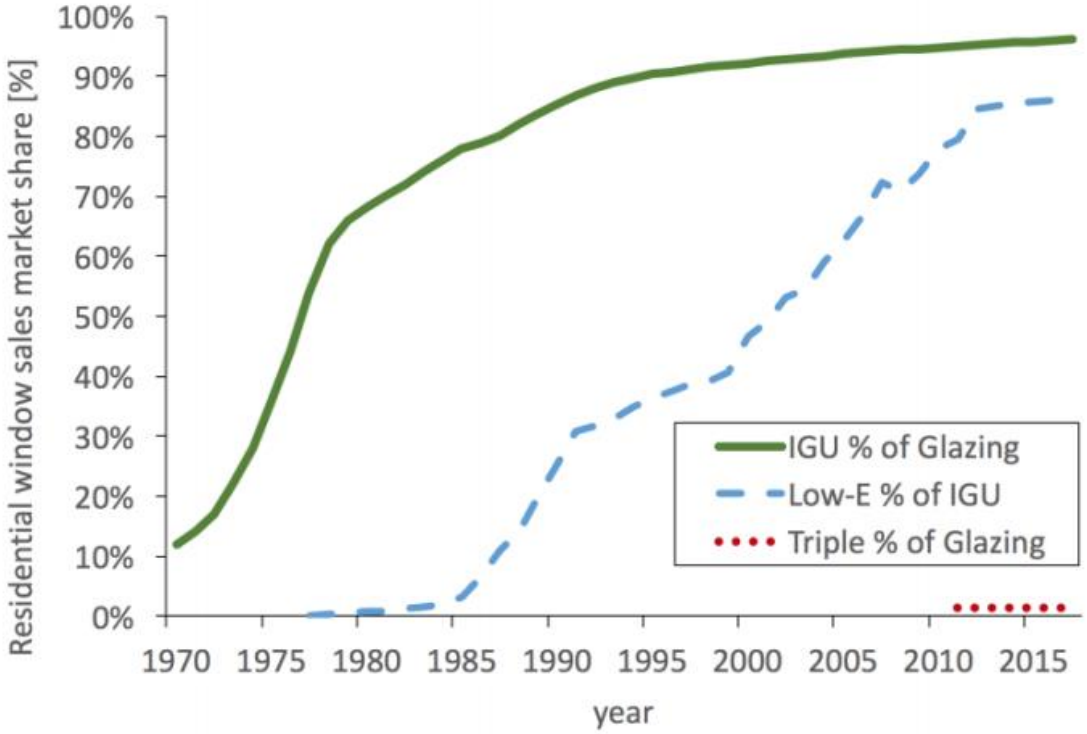
- U-factors across existing window technologies

#	Window description	Glass package description*	COG U-factor	Whole window U-factor	CR
1	Non-thermally broken window wall	Dual-pane with low-e and air	0.30 Btu/F•hr•sf	0.45 Btu/F•hr•sf	38
2		Dual-pane with low-e and argon/air	0.24 Btu/F•hr•sf	0.40 Btu/F•hr•sf	39
3		Triple-pane with low-e surface (2, 5) and krypton	0.14 Btu/F•hr•sf	0.32 Btu/F•hr•sf	40
4	Thermally broken window wall	Dual-pane with low-e and air	0.30 Btu/F•hr•sf	0.38 Btu/F•hr•sf	50
5		Dual-pane with low-e and argon/air	0.24 Btu/F•hr•sf	0.33 Btu/F•hr•sf	53
6		Triple-pane with low-e surface (2, 5) and krypton	0.14 Btu/F•hr•sf	0.24 Btu/F•hr•sf	60

https://www.constructionspecifier.com/effectively-specifying-fenestration-managing-thermal-structural-durability-performance/

Technical Feasibility

- Market trend/rise of Low-e coatings and lack of rise of triple pane demand
  - There has not been a strong market driver, including codes, to drive demand despite the existing technology
- Typical triple-pane construction has been viable since the early 1980's, but there has been no market driver for its refinement and adoption



Source: ACEEE 2018, Breaking the 20 Year Logjam to Better Insulating Windows, Stephen Selkowitz, Robert Hart, Charlie Curcija, Lawrence Berkeley National Laboratory

Technical Barriers

- Addition of gas (krypton, argon) to insulated glass unit to decrease U-factor:
  - Availability of krypton has increased and cost has decreased due to recent transition of the lighting market to LEDs
- Framing of curtainwall/ storefront fenestration allows for thermal bridging; can be offset by center of glass performance.
  - Most manufactures have thermally broken frame options available

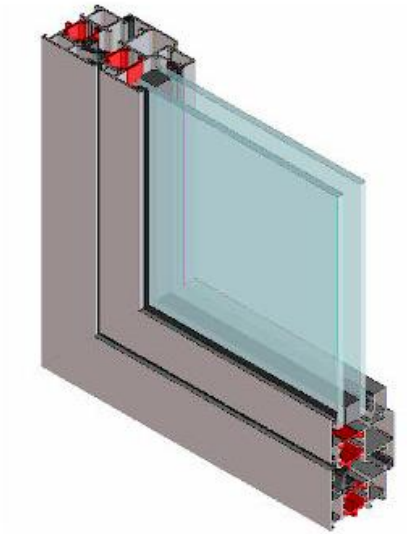


Image Source: https://www.archiexpo.com/prod/european-facade-products/product-149694-1711086.html

Technical Barriers and Solutions

- Double vs. Triple Pane Glass: current frame technology more easily accepts double pane glazing
  - Thin-glass Triple-pane glazing is an emerging technology which will work with current frame technology without adding significant weight to the window
  - Potential Solutions to discuss LBNL "Super Window"
- Coatings: Low-E coatings have been used to maximize current performance of double-pane glazing
  - Triple-pane glazing will allow performance beyond double-pane glazing with coatings

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

Reference and Image Source: https://newscenter.lbl.gov/2018/06/06/super-window-could-save-billions-in-energy-costs/

Energy and Cost Impacts

Methodology and Assumptions

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

Methodology for Energy Impacts Analysis

- Software modeling
  - CBECC-Com will be used to model energy impacts of this measure
  - Building model that is minimally compliant to 2019 code will be used to evaluate energy performance of proposed requirements
  - Calculation methodologies will adhere to established practices, industry standards for thermal factor calculations and reference previous CASE efforts
- Considerations
  - Impacts will vary by climate zone, and therefore all nonresidential prototype buildings in all climate zones will be modeled.
  - All building prototypes impacted by proposed code change will be modeled
- Energy and cost-effectiveness analysis will be presented at a later date

Definition of Baseline and Proposed Conditions

Baseline Conditions

- Minimally compliant with 2019 Code

Proposed Conditions

- High Performance Windows that exceeds 2019 requirements

Incremental Cost Information

- Statewide CASE Team to collect costs of base case and proposed technology
  - RS Means or other cost-estimating publications or software
  - Interviews with manufacturers, distributors, stakeholders or subject matter experts
  - Design and other ‘soft’ costs are not part of the measure cost-effectiveness
- Incremental cost to include:
  - Cost of proposed window and all materials as part of assembly up to, but not including rough opening
    - Glass panes, coatings, spacers, gas, frame components, etc.
  - Cost of installation of proposed window above base case installation

Compliance and Enforcement

- Design
- Permit Application
- Construction
- Inspection

Compliance Verification Process

1. Design Phase

- Building designers and installers are aware of prescriptive code changes for windows
- Installers take responsibility for meeting fenestration requirements by completing compliance documentation

2. Permit Application Phase

- Plan examiners are aware of new prescriptive window code
- Plan examiners review compliance documentation to verify that fenestration requirements are met

Compliance Verification Process

3. Construction phase

- Windows installed per energy documentation, plans and/or specifications

4. Inspection Phase

- Building inspector verifies the installed fenestration thermal factors meet what is listed on energy documentation, plans and/or specifications

Submeasure A: Cool Roof

Submeasure B: Thermal Bridging

Submeasure C: Roof Alterations

Submeasure D: High Performance Windows

Submeasure E: Opaque Envelope

Background

- Context and History
- 2019 Code Requirements
- Code Change Proposal

Code Change Proposal – Summary

- Consider improvements to assembly U-Value
- The opaque envelope performance measure requires that existing assembly U-factor requirements be re-evaluated for the 2022 cycle using the latest cost parameters.

Building Types	Code Section	Type of Change	Software Updates Required	Compliance Forms
Nonresidential	Section 140	Prescriptive	Yes	

Poll

Which Compliant method is widely used in California?

A. Prescriptive
B. Performance Method
C. Both are equally used
D. I do not know

Context and History

- Opaque building envelope standards have been periodically updated to remain consistent with current construction practice and costs
  - U-factor updates considered most recently in 2016 code cycle due to increasing efficiency of new technologies
  - Cost parameters should be updated for the 2022 cycle
  - Products are currently available to increase building envelope efficiency
- Re-evaluation of envelope components to determine if cost-effective reductions in U-factor are justified
  - U-factor is a measure of thermal transmittance that describes insulation performance
  - Lower U-factors indicate greater resistance to heat flow and better insulation
- The impact of U-factors can be modeled in CBECC
- Reduce cooling and heating load which would impact HVAC size
- Increase the load reduction and hence optimizing the solar energy production

2019 Code Requirements

- 2019 Requirements in Title 24, Part 6, Section 140. B,C or D

Construction	140.3-B	140.3-C	140.3-D
Roof - Metal Building	0.041	0.041	0.041
Roof - Other	0.034-0.049 (0.034)	0.028-0.039 (0.028)	0.034
Wall - Metal Building	0.057-0.113 (0.061)	0.057-0.061 (0.061)	0.057
Wall - Metal-Framed	0.062-0.082 (0.062)	0.048-0.105 (0.069)	0.057
Wall- Mass Light	0.17-0.44 (0.17)	0.17-0.227 (0.17)	0.17
Wall - Mass Heavy	0.184-0.69	0.16-0.69	-
Wall - Other	0.039-0.071 (0.071)	0.042-0.059 (0.059)	0.042
Wall - Raised mass	0.058-0.269	0.037-0.092	0.048
Wall - Other	0.039-0.071 (0.071)	0.034-0.071 (0.039)	0.048
Door - Non- Swinging	0.5-1.45 (1.45)	0.5-1.45 (1.45)	0.5
Door - Swinging	0.7	0.7	0.7

Proposed Code Change Overview

- See the proposal summary and mark-up language in **resources tab**
- Description of changes:
  - Cover all nonresidential buildings
  - Increase stringency of requirements for opaque envelope performance including U-factors
  - Simplify the prescriptive tables to base requirements on Climate Zone

Poll

Should Title 24 have Total UA (Component Performance Alternative) like Washington State Code or IECC?

A. Yes
B. No
C. Do not know

Market Overview

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

Market Conditions

- Market availability
  - 2023 new construction forecast includes 172.78 million square feet of nonresidential buildings
  - Building envelope market is well established
  - Different construction such as wood-framed, metal-framed and mass walls have separate requirements and different best practices of installation and maintenance
- Utility Programs
  - There are utility incentive programs for energy efficient building envelopes
  - Programs already promote greater envelope efficiency
- **Do you agree with this description? What else should we know?**

Market Trends

- Wall-framed construction
  - When continuous insulation is specified, one to three inches of rigid insulation is applied
- Wood-framed walls
  - Continuous insulation can be applied to the exterior
  - Trend towards moving to thicker studs (2x6) and not using continuous insulation
  - For mass walls, common practice is to partially grout concrete masonry unit (CMU) walls
- Additional materials
  - Polyisocyanurate and expanded polystyrene foam (EPS) are commonly used to meet current Title 24 requirements

Potential Market Barriers

- Barrier - Initial cost and value engineering strategy
  - Review of design strategies
  - Review of product availability
- This proposal will impact a variety of stakeholders
  - Builders, manufacturers, retailers and other stakeholders will be contacted in order to determine actual impact of measure adoption

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

Technical Feasibility

- Technical Considerations

Technical Considerations

- Proposal would not require change in regular design process, but will emphasize high performance
- Construction techniques for this proposal involve no significant change from standard practice
- Existing design approaches and equipment can be used with higher performing building envelopes
- The Statewide CASE Team will review industry literature to determine further technical considerations
- No new materials or processes would need to be developed for measure success

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

Energy and Cost Impacts

Methodology and Assumptions

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

Methodology for Energy Impacts Analysis

- Software modeling
  - Research version of CBECC-Com will be used to model energy impacts
  - Impacts will potentially be modeled using model vintage (20 years old) buildings to model 2019 baseline then 2022 proposed
  - Calculation methodologies will adhere to established practices and reference previous CASE efforts
- Considerations
  - Impacts will vary by climate zone
  - All building prototypes impacted by proposed code change will be modeled
- Savings and cost data will be gathered from the current market
- Energy and cost-effectiveness analysis will be presented at a later date

Definition of Baseline and Proposed Conditions

Baseline Conditions

- Minimally compliant with 2019 code
- Vintage (20 year old) building brought up to 2019 code

Proposed Conditions

- Compliant with proposed 2022 code
- Adjusted U-factors for each climate zone

Incremental Cost Information

- How we collected costs of base case technology and proposed technology
  - RS Means or other cost-estimating publications or software
  - Interviews with manufacturers, distributors or contractors
- Additional components of cost?
  - Cost to manufacture (materials, labor)
  - Cost to purchase units
  - Installation cost
- Do you find these costs to be reasonable?

Compliance and Enforcement

- Design
- Permit Application
- Construction
- Inspection

Compliance Verification Process

1. Design Phase

- Building designers are aware of code changes for envelope U-factor
- Energy consultant or compliance documentation author verifies that plans and specifications match

2. Permit Application Phase

- Examiners are aware of new envelope U-factor requirements

Compliance Verification Process

3. Construction phase

- Envelope U-factor built to the new requirements per energy documentation and specifications

4. Inspection Phase

- The U-factor is verified by building inspector to meet what is listed on the energy documentation, plans, and specifications

Poll

Should Title 24 continue tradeoffs between envelope and non-envelope systems in performance compliance method?

A. Yes
B. No
C. Do not know

Discussion and Next Steps

Stakeholder Survey

The envelope measure stakeholder survey will be sent out soon, and we appreciate your participation!

- Cool Roof
- Thermal Bridging

Thank You

Questions?

Alamelu Brooks

Energy Solutions

510 482 4420 x267

abrooks@energy-solution.com

CALIFORNIA ENERGY CODES & STANDARDS

A STATEWIDE UTILITY PROGRAM

Thank you for your participation today

Alamelu Brooks, Energy Solutions
abrooks@energy-solution.com

Please complete the closing polls below

Upcoming Meetings

Meeting Topic	Building Type	Date
Nonresidential HVAC and Envelope Part 2: Air Distribution, & Controls	NR	Tuesday, November 5, 2019
Covered Processes Part 2: Compressed Air, Steam Traps, & Refrigeration	NR	Thursday, November 7, 2019
Single Family Whole Building	SF	Tuesday, November 12, 2019
Nonresidential Software Improvements	NR	Tuesday, November 12, 2019