TITLE 24, PART 6 | 2025 CODE CYCLE

Opaque Envelope Assemblies

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

Simon Pallin, Avani Goyal, Maureen Guttman
February 14, 2023

CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

Building Type: Single Family

Single Family - Proposed Measures

Mandatory R-Value Requirements for Framed Walls

- Increase mandatory wall cavity insulation for framed walls (U-factor in parenthesis):
  - From R-13 (0.102) to R-15 (0.095) for 2x4, and
  - From R-20 (0.071) to R-21 (0.069) for 2x6
- Existing and proposed requirements apply to new construction, additions, alterations

Building Type: Single Family

Market Overview

- Current Market Conditions
- Market Trends
- Potential Market Barriers

Market Overview and Analysis

Current Market

- Wood framing dominates SF new construction
- 2x4 and 2x6 studs dominate wood framing

Market Trends

- R-15 and R-21 already commonly used
  - 53% and 60%, respectively, of applicable projects

Market Barriers

- No market barriers identified

Will proposed measures affect cost of labor?

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

Building Type: Single Family

Technical Considerations

- Technical Considerations
- Potential Barriers and Solutions

Technical Considerations

Technical Considerations

- Minimal upfront change to standard design practices
- High density batt makes QII easier to meet

Technical Barriers and Potential Solutions

- No technical barriers identified

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

Building Type: 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

Methodology for per-home energy and demand impacts:

- Modeled via CBECC-Res 2025:
  - **Prototypes:** 2100, and 2700 ft^2 homes (Blended prototype used)
  - **Climate zones:** All

- Cost-effectiveness not required; proposed change is to mandatory requirements and is less stringent than the prescriptive requirements in place.
  - No change to the energy budget for the Standard Design.

Assumptions for Standard and Proposed Designs

Standard Design

- R13 in 2x4 wall
- R20 in 2x6 wall

Proposed Design

- **R15** in 2x4 wall
- **R21** in 2x6 wall

Preliminary Energy Impacts Per Home: 2400 ft^2 prototype

R13 → R15

Climate Zone	Electricity Impacts (kWh/yr)	Natural Gas Impacts (therms/yr)	Source Energy Impacts (kBtu/yr)
1	6	13	1,152
2	5	8	672
3	56	0	168
4	82	0	216
5	4	6	564
6	3	2	192
7	4	2	192
8	13	2	216
9	14	3	264
10	19	3	264
11	32	7	636
12	15	7	612
13	88	0	204
14	104	0	276
15	78	1	180
16	8	13	1,116

R20 → R21

Climate Zone	Electricity Impacts (kWh/yr)	Natural Gas Impacts (therms/yr)	Source Energy Impacts (kBtu/yr)
1	2	3	300
2	1	2	180
3	14	0	48
4	20	0	60
5	1	2	120
6	1	1	60
7	1	0	36
8	3	1	60
9	3	1	72
10	5	1	60
11	7	2	144
12	4	2	168
13	22	0	36
14	25	0	60
15	19	0	36
16	1	3	276

Building Type: Single Family

Compliance and Enforcement

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

Compliance and Verification Process

1. **Design Phase:**
   Specify wall cavity insulation meeting new R-factor requirements

2. **Permit Application Phase:** No Change

3. **Construction Phase:** No Change

4. **Inspection Phase:** No Change

Market Actors

Market actors involved in implementing this measure include:

- Building/Envelope Designers & Consultants
- Insulation Manufacturers, Suppliers, Distributors
- Residential framed wall 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?**

Building Type: Single Family

Review of Code Language Markup

- Draft Code Change Language

Draft Code Change Language

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

- **Subchapter 7** Section 150.0(c)
- **ACM** Section 2.5.6.3 Exterior Walls

Building Type: Multifamily

Building Type: Multifamily

Background

- Proposed Code Change
- Context and History

Wall Insulation Proposed Measures

In the mandatory requirements in Section 160.1(b) —

- Change wall insulation mandatory requirements:
  - Metal-framed Walls
  - Wood-framed Walls

Cost-effectiveness not required; proposed change is to mandatory requirements and is less stringent than the prescriptive requirements in place.

Proposed Code Change

- Update mandatory requirements for exterior wall insulation
  - Metal-framed – reduce U-factor from 0.151 to 0.148
  - Wood-framed and Others -
    - Nominal **2x4** inch framing, reduce U-factor from 0.102 to **0.095**
    - Nominal **2x6** inch framing, reduce U-factor from 0.071 to **0.069**

Code language built on wall assembly U-factor, the proposed code change corresponds to increasing wall cavity insulation R-13 to R-15 for 2x4 and R-20 to R-21 for 2x6.

Draft code language for this measure is available in the **resources tab.**

Context and History

Why are we proposing this measure?

- **Maintain alignment with single family residential mandatory minimum requirements.**

  Lower area-weighted average U-factor of the wall assembly to reflect:

  – Change R-13 to R-15 for 2x4 assemblies

  – Change R-20 to R-21 for 2x6 assemblies

- **Capture insulation industry standard practice (ISP) savings for life of the building**

Building Type: Multifamily

Market Overview

Market Overview and Analysis

Current Market

- Wall insulation is available in a variety of performance levels within a range limited by available wall cavity space.

Market Trends

- The current multifamily market commonly installs insulation that exceeds minimum requirements in most buildings.

Market Barriers

- **Cost:** High density cavity insulation is more (~35%) expensive
- **Availability:** High density products are less commonly stocked.

  Manufacturer interviews indicate supply chain shift will have minimal impact.

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

Building Type: Multifamily

Technical Considerations

Technical Considerations

- Builders comply with current requirements by adjusting the framing spacing and using appropriate cavity insulation.
- Some buildings may use exterior insulation to meet the code requirements.

Technical Barriers and Potential Solutions:

- None. Walls of the proposed performance level are standard design practice for many designers and achievable across all construction and insulation approaches.

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

Building Type: Multifamily

Review of Code Language Markup

Draft Code Change Language

Section 160.1 – Mandatory Requirements for Building Envelopes

- **Section 160.1(b) Wall Insulation.**

1. Metal Building- The area-weighted average U-factor of the wall assembly shall not exceed 0.113.
2. Metal Framed- The area-weighted average U-factor of the wall assembly shall not exceed ~~0.151~~ 0.148.
3. Wood Framed and Others-
   A. Nominal 2x4 inch framing shall have an area-weighted average U-factor of the wall assembly not exceeding ~~0.102~~ 0.95.
   B. Nominal 2x6 inch framing shall have an area-weighted average U-factor of the wall assembly not exceeding ~~0.071~~ 0.69.
   C. Other wall assemblies shall have an area-weighted average U-factor of the wall assembly not exceeding 0.102.

Building Type: Nonresidential

Building Type: Nonresidential

Background

- Code Change Proposal
- Context and History

Proposal Summary

This measure would consider **improvements to thermal performance factors** for opaque assemblies in nonresidential buildings.

Description	Construction Type	Type of Change	Section(s) of Code Updated
Decrease U-factor for Roofs and Walls	New Construction	Mandatory	120.7(a), 120.7(b)
Decrease U-factor for Roofs and Walls	New Construction	Prescriptive	TABLE 140.3-B
Decrease U-factor for Roofs and Walls	Alterations	Mandatory	141.0(b)1B
Hotel/Motel Guest Room	New Construction	Prescriptive	TABLE 140.3-C
Consolidate U-factors	New Construction	Prescriptive	TABLE 140.3-B

Context and History – Mandatory U-factor

Opaque Assemblies	New Construction U-Factor		Existing Buildings U-Factor	
	2013	2022	2013	2022
Roof/Ceiling – Metal Building	0.098	0.098	141.0(b)2Bii	141.0(b)2Bii
Roof/Ceiling – Wood Framed and Other	0.075	0.075	141.0(b)2Bii	141.0(b)2Bii
Walls – Metal Building	0.113	0.113	0.113	0.113
Walls – Metal Framed	**0.105**	**0.151**	**0.217**	**0.113**
Walls – Mass Light	0.44	0.44	NR	NR
Walls – Mass Heavy	0.69	0.69	NR	NR
Walls – Wood and Other	0.11	0.11	0.11	0.11
Spandrel panels and Glass curtain walls	0.28	0.28	0.28	0.28

- Mandatory Requirements for insulation were introduced in 2013
- The mandatory requirements remain the same since 2013 except for metal-framed walls. Metal-framed mandatory requirement was changed from 0.105 to 0.151 in 2016.
- There is no mandatory requirement in IECC or ASHRAE

Context and History - Prescriptive U-factor

Envelope Assembly	Climate Zone	2022 Title 24 U-Factor	Proposed U-Factor	2022 Title 24 R-value of Insulation	Proposed R-value of Insulation
Roof/Ceiling – Metal Building	All zones	0.041	0.036	23.61	25.61
Roof/Ceiling – Wood and Other	6,7,8	0.049	0.044	19.63	21.63
Roof/Ceiling – Wood and Other	All other zones	0.034	0.032	28.63	30.63
Walls – Metal Building	1,3 ,6,7	0.113	0.092	8	10
Walls – Metal Building	15	0.057	0.051	16.69	18.69
Walls – Metal Building	All other zones	0.061	0.054	15.54	17.54

Context and History - Prescriptive U-factor, cont'd

Envelope Assembly	Climate Zone	2022 Title 24 U-Factor	Proposed U-Factor	2022 Title 24 R-value	Proposed R-value
Heavy Mass Wall	1,12	0.253	0.168	1.41	3.41
Heavy Mass Wall	11,14,15	0.184	0.135	2.89	4.89
Heavy Mass Wall	13	0.211	0.135	2.19	4.89
Heavy Mass Wall	16	0.161	0.122	3.67	5.67
Heavy Mass Wall	2-5,10	0.649	0.282	0.10	2.10
Heavy Mass Wall	6,7,8,9	0.690	0.290	0.01	2.01

Context and History - Prescriptive U-factor, cont'd

Envelope Assembly	Climate Zone	2022 Title 24 U-Factor	Proposed U-Factor	2022 Title 24 R-value	Proposed R-value
Light Mass Wall	1	0.196	0.141	2.85	4.85
Light Mass Wall	3	0.278	0.179	1.35	3.35
Light Mass Wall	4	0.227	0.156	2.15	4.15
Light Mass Wall	5-9	0.441	0.234	0.02	2.02
Light Mass Wall	All other zones	0.170	0.127	3.63	5.63

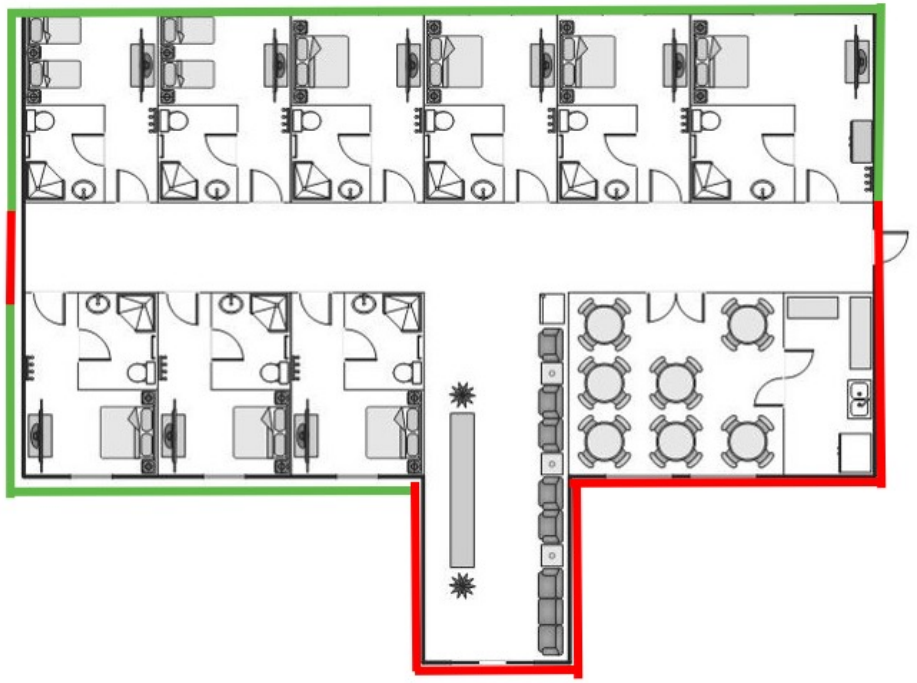
Context and History - Prescriptive U-factor, cont'd

Envelope Assembly	Climate Zone	2022 Title 24 U-Factor	Proposed U-Factor	2022 Title 24 R-value	Proposed R-value
Wood-framed and other	1	0.095	0.080	7.90	9.90
Wood-framed and other	11	0.045	0.041	19.60	21.60
Wood-framed and other	15	0.042	0.039	21.15	23.15
Wood-framed and other	3,6,7	0.110	0.090	6.46	8.46
Wood-framed and other	5,8	0.102	0.085	7.18	9.18
Wood-framed and other	All other zones	0.059	0.053	14.32	16.32

Context and History – Hotel/Motel Guestroom

TABLE 140.3-C

- The prescriptive requirements for guest room walls and windows have remained the same since 2013. Some of the guest room wall types in some climate zones are less stringent than nonresidential wall types. For some, they are more stringent. For the metal roof, both have the same requirements.
- Prior to 2022, this table addressed High-Rise Residential and Hotel/Motel Guest Rooms.



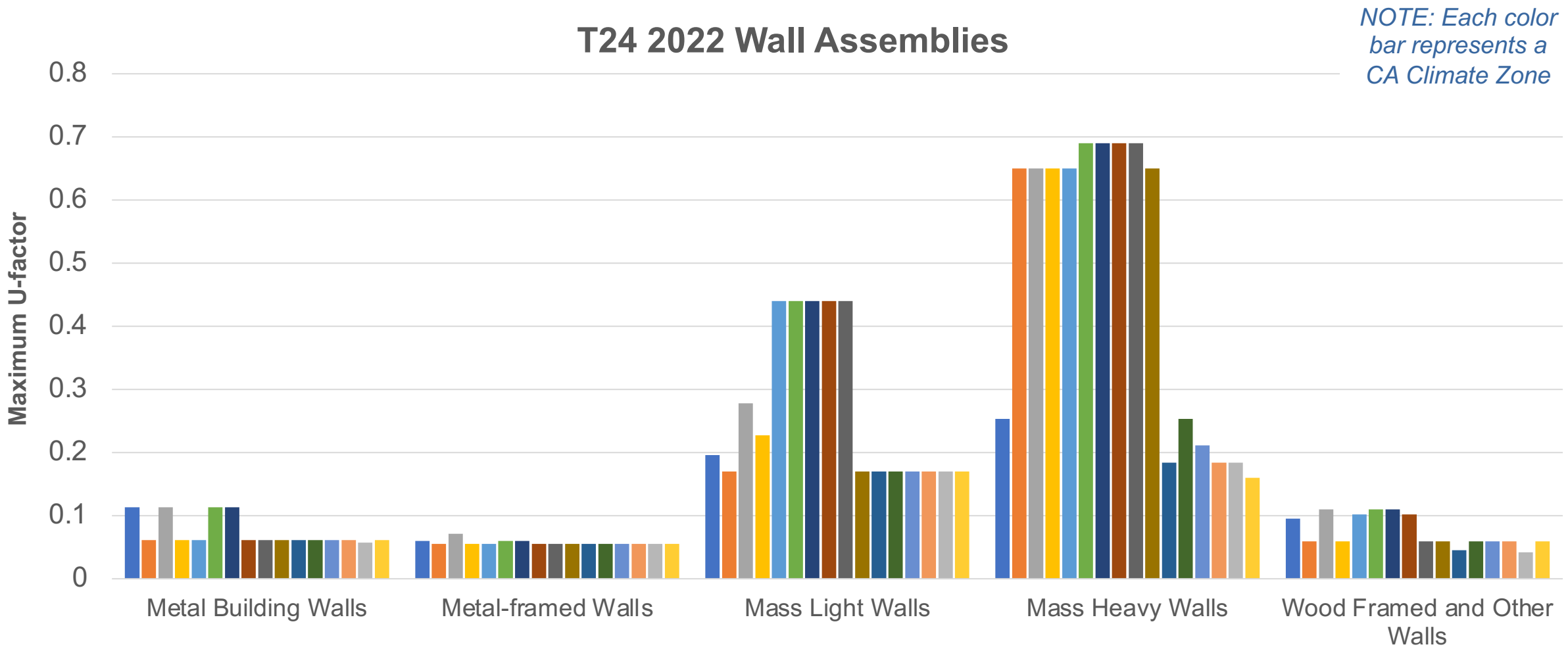
Hotel/Motel Guest Room U-factors

Nonresidential U-factors

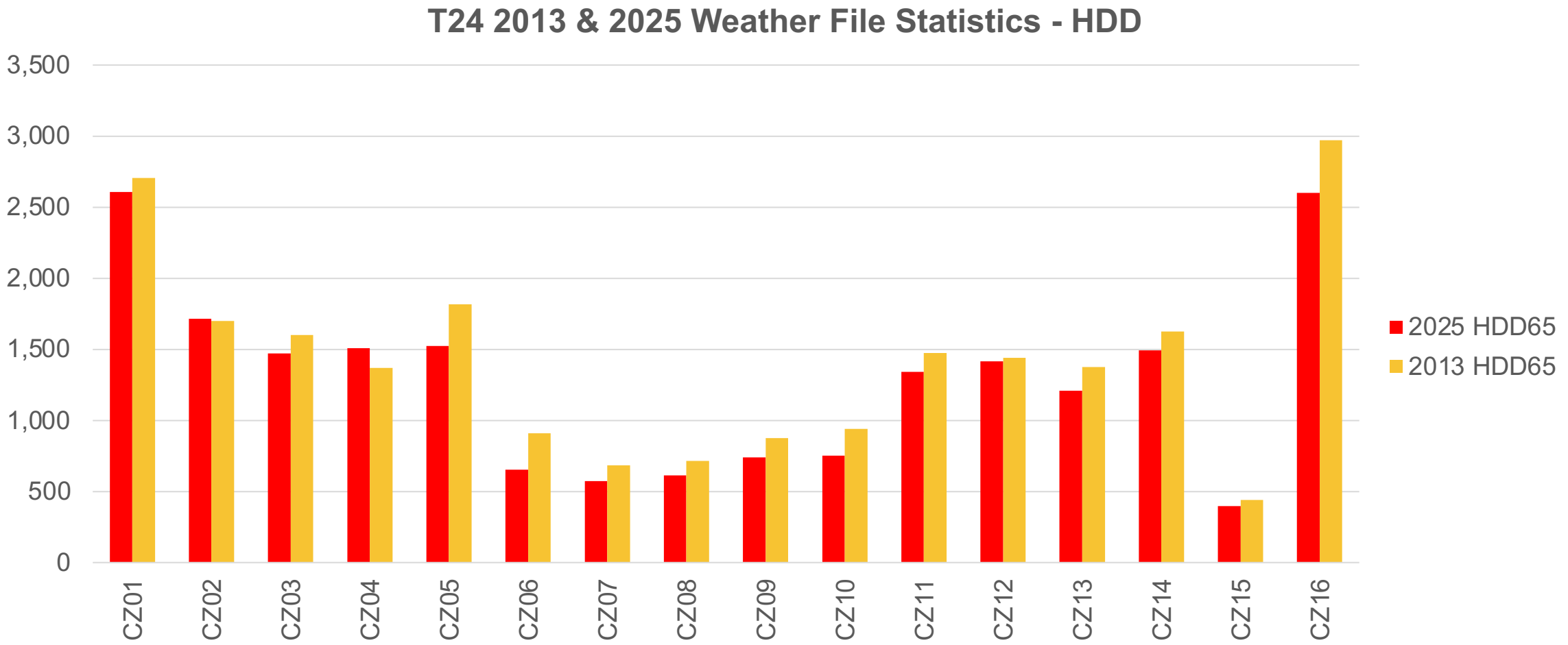
Context and History – Consolidating U-factors

- **Metal building roofs:** 0.041 for all climate zones
- **Wood-framed and other roofs:** Two requirements (0.049 and 0.034)
- **Metal walls:** Three requirements (0.057, 0.061, 0.113)
- **Metal-framed:** Three requirements (0.055, 0.060, 0.071)
- **Light mass walls:** **Five** requirements (0.17, 0.196, 0.227, 0.278, 0.44)
- **Heavy mass walls:** **Six** requirements (0.16, 0.184, 0.211, 0.253, 0.65, 0.69)
- **Wood framed walls:** **Six** requirements (0.042, 0.045, 0.059, 0.095, 0.102, 0.11)

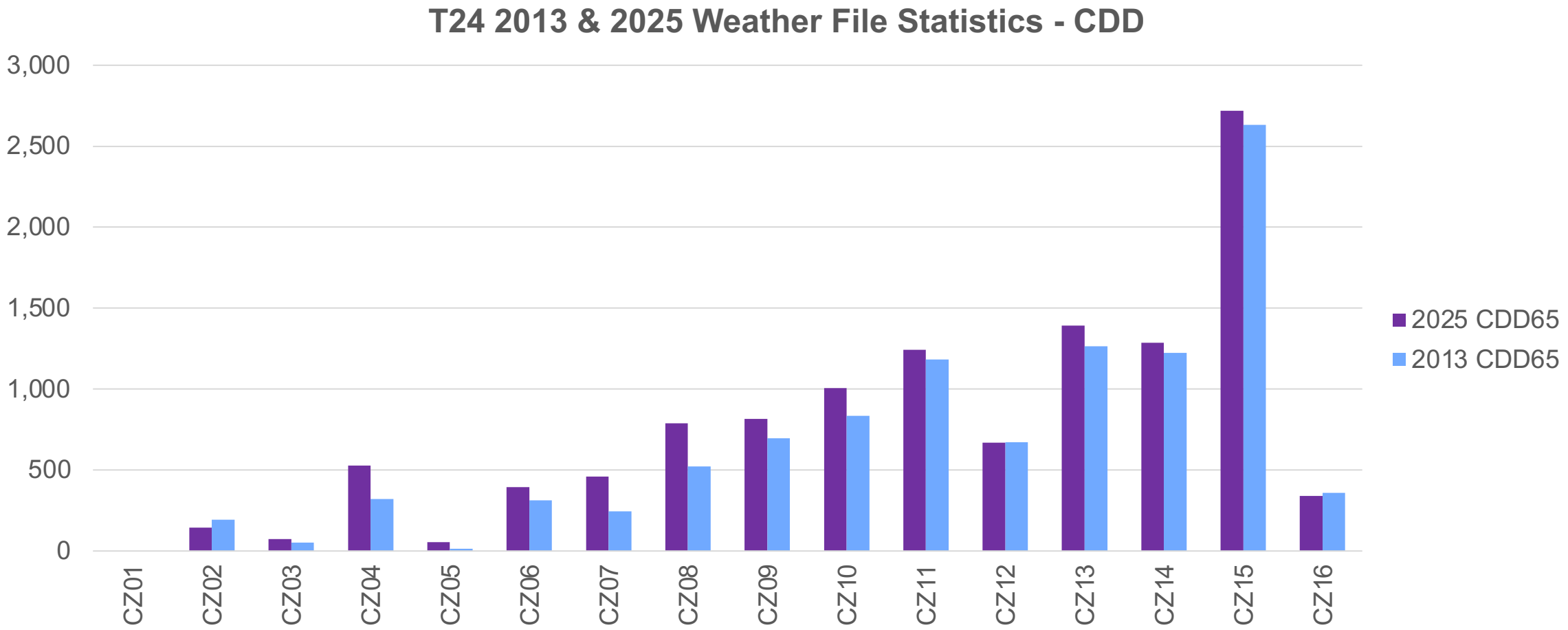
Context and History – Consolidating U-factors



Why Do We Revise and Regroup U-factors?



Why Do We Revise and Regroup U-factors?



Building Type: Nonresidential

Market Overview

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

Market Overview and Analysis

Current Market

- The market for opaque assemblies is **well-established** and the proposed U-factors are far from new to the market.
- High-performance envelope projects include dynamic facades, breathing walls, Phase Change Materials, Integrated Heat & Moisture Exchange Panels, Vacuum Insulated Panels etc. These newer technologies are becoming cheaper and more relevant every day.

Market Trends

- U.S. Green Building Council reports in 2021 California tops the LEED certified total area among the US; roughly 10.6 million SQFT. This has been a trend from 2015. These buildings typically require more stringent U-factors than T24 requires.

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

Market Overview and Analysis

Market Barriers

- **Critical barriers.** There are no critical market barriers in the proposed U-factor improvements as these materials are already available in the market in abundance.
- **Temporary barriers.** A temporary market barrier could be an immediate shortage of materials at the effective date of the code cycle in 2025. To address that issue, mass stakeholder communication will be taking place to prime the market before the launch.
- **Lack of building science knowledge.** Within the industry, there remains a lack of proper knowledge about high-performance envelope and its relationship with heating/cooling load.
- **Workmanship.** Poor workmanship is still the most vital cause of envelope failure.

Do you agree with these known barriers? What else should be known?

Building Type: Nonresidential

Technical Considerations

- Technical Considerations
- Potential Barriers and Solutions

Technical Considerations

- Proposal will not impact the regular design process, but it will emphasize the minimum envelope requirements in the performance path
- There will not be any significant changes to construction, installation, or inspection practices
- 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?

Technical Barriers

Technical Barriers and Potential Solutions

- **Thicker Insulation.** There might be concerns regarding fasteners for thicker continuous insulation. But using spray foams and fasteners like Hurricane Washer, MW Plate, and impelling fasteners are already available in the market for installing thicker insulation.

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

Building Type: Nonresidential

Energy and Cost Impacts Per Unit

Methodology and Assumptions

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

T24 2025 Prototype Buildings – Building Characteristics

Prototype	# of Floors	Conditioned Floor Area (CFA) sq.ft.	Roof Area (sq.ft.)	Wall Area (sq.ft.)	Window Area (sq.ft.)	Wall to Roof Ratio	Window to Wall Ratio
Assembly	1	315,339	315,339	415,620	60,208	1.32	0.14
Hospital	5	241,501	40,254	63,203	9,133	1.57	0.14
HotelSmall	4	42,554	10,802	18,242	1,983	1.69	0.11
OfficeLarge	12	498,589	38,357	131,136	48,134	3.42	0.37
OfficeMedium	3	53,628	17,878	21,290	7,027	1.19	0.33
OfficeMediumLab	3	53,628	17,878	21,290	7,027	1.19	0.33
OfficeSmall	1	5,502	5,502	3,031	642	0.55	0.21
RestaurantFastFood	1	2,501	2,501	2,001	280	0.80	0.14
RetailLarge	1	240,000	240,000	50,005	5,881	0.21	0.12
RetailMedium	1	24,563	24,563	12,671	904	0.52	0.07
RetailStripMall	1	9,375	9,375	6,799	558	0.73	0.08
SchoolLarge	2	210,866	128,124	64,245	22,162	0.50	0.34
SchoolSmall	1	24,413	24,413	13,951	4,964	0.57	0.36
Warehouse	1	52,045	52,045	26,880	190	0.52	0.01

Source Data: CBECC 2025 Research Version Prototypes

Note Preliminary Selection:

- The warehouse will be modeled with metal building roofs.
- All other prototypes will be modeled with wood-framed roofs.
- The non-refrigerated warehouse will be modeled with metal walls.
- Hospitals, Large Office, Retail Large, and Retail Medium will be modeled with mass walls
- Large Office and Medium Office will be modeled with Spandrel Panels

Assumptions for Standard and Proposed Designs

Standard Design

New Construction U-factors:

- Mandatory - meet T24 2022
- Prescriptive - meet T24 2022

Alterations U-factors:

- Mandatory - meet T24 2022

Proposed Design

New Construction U-factors:

- Mandatory - 20% more stringent than T24 2022
- Prescriptive - more stringent by adding R-2 to T24

Alterations U-factors:

- Mandatory - 20% more stringent than T24 2022

Assumptions for Standard and Proposed Designs, cont'd

Standard Design

Hotel/Motel Guest Room U-factors:

- Mandatory - meet T24 2022
- Prescriptive - meet T24 2022

Consolidated U-factors/Assembly:

- Light mass walls: Five requirements
- Heavy mass walls: Six requirements
- Wood framed walls: Six requirements

Proposed Design

Hotel/Motel Guest Room U-factors:

- Mandatory - meet T24 2025 for NR Assemblies
- Prescriptive - meet T24 2025 for NR Assemblies

Consolidated U-factors/Assembly:

- Light mass walls: Three or four requirements
- Heavy mass walls: Three or four requirements
- Wood framed walls: Three or four requirements

Incremental Per Unit Cost

Over 30 Year Period of Analysis

Incremental First Cost	
R-2 insulation increase per sq. ft.	$0.10
Installation	N/A
Commissioning	N/A
Other (extra hardware) per sq. ft.	N/A
Total	**$0.10**

Incremental Maintenance Cost	
Equipment replacement	N/A
Annual maintenance	N/A
Total	**N/A**

Note

Labor costs will be the same for baseline & proposed cases.

Material cost is averaged out through California, including the Inflation index per Bureau of Labor Statistics. The CASE team presumes there will not be any extra hardware cost for additional R2 insulation. If you have any cost information, please let us know.

Total incremental cost over 30 year-period of analysis:
$0.10 per SQFT

Cost Data Sources:

- Interview with general contractor
- Verified cost data from big box improvement stores.

Do you agree with this cost information?

Building Type: Nonresidential

Statewide Energy Impacts

Methodology and Assumptions

- Statewide Energy Impacts

Building Type: Nonresidential

Compliance and Enforcement

- Design
- Permit Application
- Construction
- Inspection

Compliance and Verification Process

1. **Design Phase**
   Building designers must be aware of the code changes to the envelope U-factors. The qualified design reviewer, per commissioning requirements, as well as energy consultants and compliance documentation authors must verify that plans and specifications match, and therefore meet the requirements of Title 24, Part 6.

2. **Permit Application Phase**
   Plans examiners would verify that the project meets new envelope U-factor requirements by ensuring that the NR Compliance Certificate (NRCC) matches the plan and specifications.

3. **Construction Phase**
   Envelopes would be built to new U-factor requirements per energy documentations and/or specifications. Installers need to complete the NR Compliance Installation (NRCI) documents.

4. **Inspection Phase**
   Building inspectors would verify that the U-factor meets what is listed on energy documentation, plans, and/or specifications

Review of Code Language Markup

- Draft Code Change Language:

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

Simon Pallin, PhD, CEM
Frontier Energy
530-316-1503
Spallin@frontierenergy.com

Maureen Guttman, AIA
Energy Solutions
510-482-4420 x390
mguttman@energy-solution.com

Avani Goyal
TRC
510-403-9343
Agoyal@trccompanies.com

CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM