DOCKETED	
Docket Number:	22-BSTD-01
Project Title:	2025 Energy Code Pre-Rulemaking
TN #:	251720
Document Title:	Presentation - August 17, 2023 - 2025 Pre-Rulemaking Staff Workshop
Description:	Slides from August 17, 2023, staff pre-rulemaking workshop on single-family buried ducts and envelope requirements, as well as multifamily envelope, indoor air quality, and restructuring requirements.
Filer:	Javier Perez
Organization:	California Energy Commission
Submitter Role:	Commission Staff
Submission Date:	8/22/2023 7:40:23 AM
Docketed Date:	8/22/2023

Good morning and thank you for joining us.

The workshop will begin shortly.

Housekeeping Rules

Public Comment Period

Zoom App/Online

- Click “raise hand”

Telephone

- Press *9 to raise hand
- Press *6 to Mute/Unmute

When called upon

- CEC will open your line
- Unmute on your end
- Spell name and state affiliation, if any
- 2 minutes or less per speaker, 1 speaker per entity

Today's Agenda

	Topics	Presenter
1	Introduction	Javier Perez
2	Single-Family Buried Ducts	Bach Tsan
3	Single-Family Cathedral Ceilings	Bach Tsan
4	Single-Family Envelopes	Michael Shewmaker
5	Multifamily Indoor Air Quality	Anushka Raut
6	Multifamily Envelope	Michael Shewmaker
7	Multifamily Restructuring	Javier Perez
8	Adjourn	

2025 Energy Code – Pre-Rulemaking

Energy Code Authority, Drivers and Themes, Metrics, and Timeline

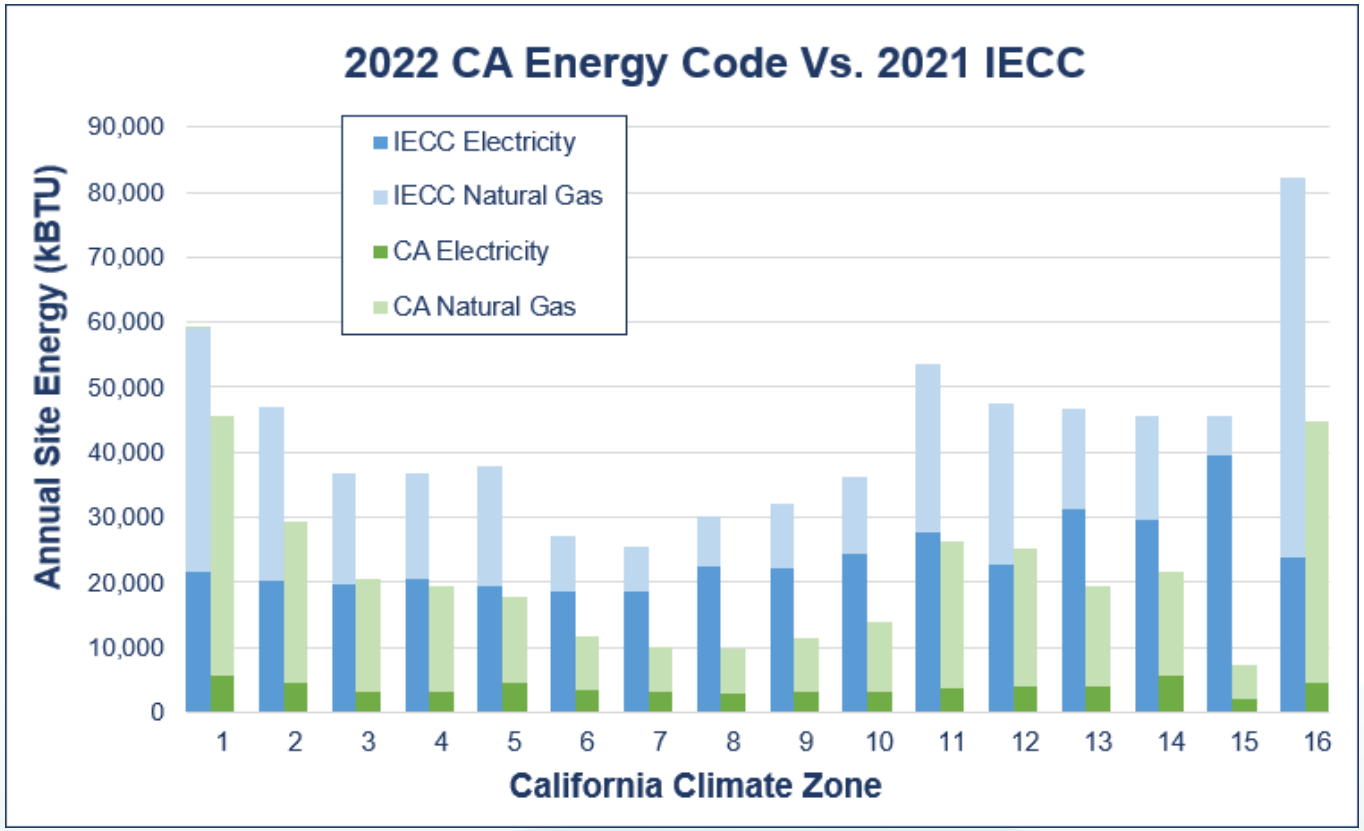
Javier Perez, Project Manager – 2025 Energy Code

August 17, 2023

California Energy Commission's Authority and Process

California's Warren Alquist Act Signed into law in 1974

- Reduction of wasteful, uneconomic, inefficient, or unnecessary consumption of energy as it relates to buildings
- Residential Chart Details:
  - Blue bars: Site energy of a single-family building built to 2021 International Energy Conservation Code (IECC)
  - Green bars: Site energy of a single-family building built to 2022 California Energy Code
- For more on how the 2022 Energy Code compares to federal standards, see our 2022 Impact Analysis at: https://www.energy.ca.gov/publications/2023/impact-analysis-2022-update-california-energy-code



2025 Energy Code Drivers and Themes

State Goals

- Increase building energy efficiency cost-effectively
- Contribute to the state's GHG reduction goals

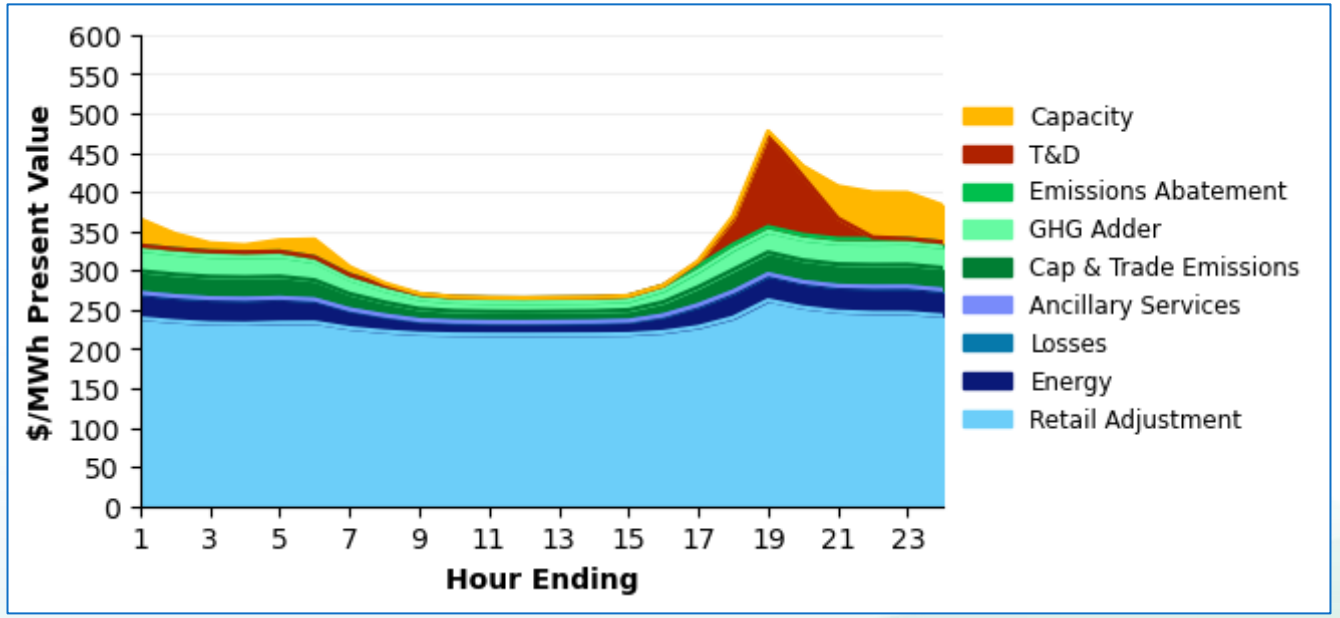
2025 Energy Code Strategies

- Heat pump baselines
- Promote demand flexibility, Solar PV generation and energy storage
- Covered process loads
- Equity & affordable new housing program integration
- Additions, alterations, and smaller homes (e.g., ADUs)
- Electric vehicle readiness support
- Interagency coordination

Long-Term System Cost

Long-term System Cost (LSC) Hourly factors are used to convert predicted site energy use to long-term dollar costs to CA's energy system.

Since the *time* that energy is used is as important as the *amount* of energy used, these factors are generated on an hourly basis for a representative year and created for each of CA's diverse climate zones.



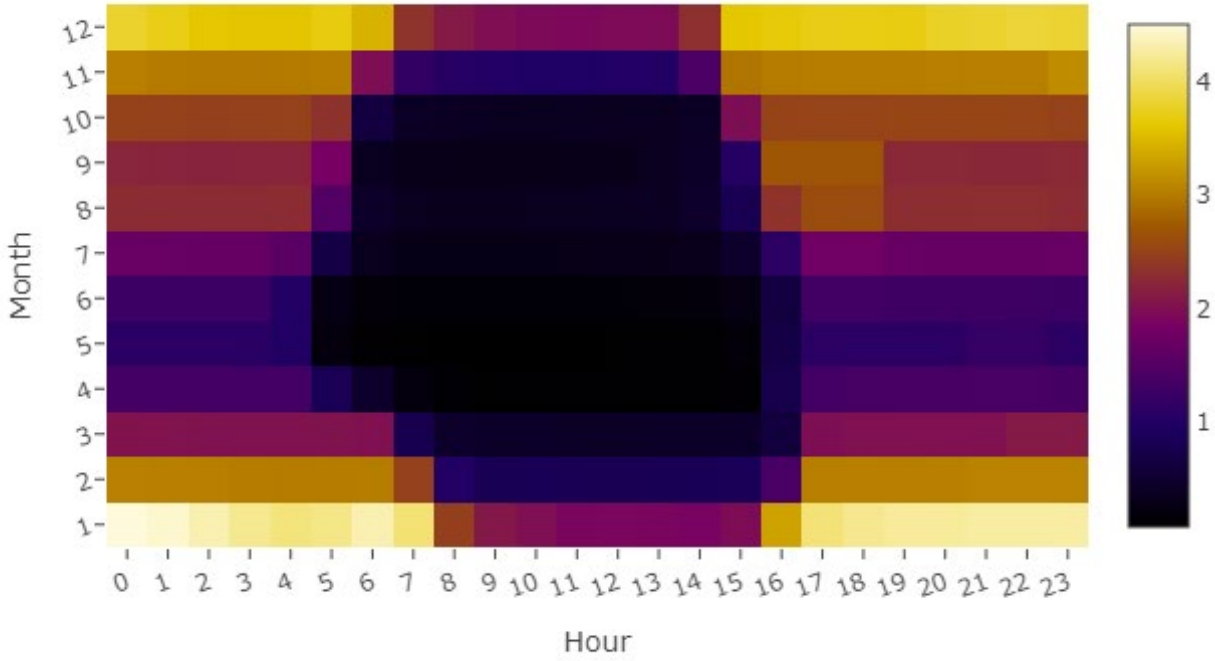
Sample LSC shape by component, average day, levelized 30-year residential, climate zone 12

Source Energy Metric

Long run marginal source energy is defined as the source energy of fossil fuels following the long-term effects of any associated changes in resource procurement.

Source Energy focuses specifically on the amount of fossil fuels that are combusted in association with demand-side energy consumption and assists in aligning our standards with the CA's environmental goals.

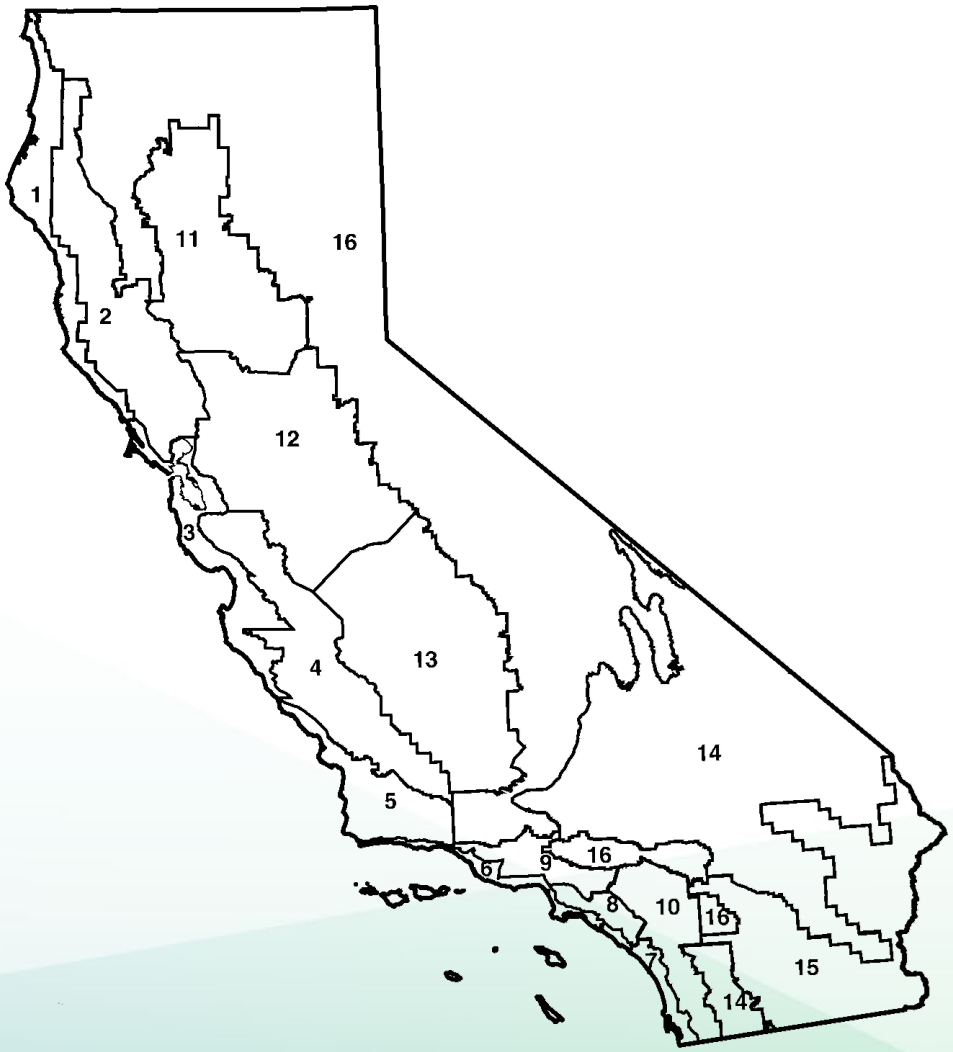
5-Month Average of electricity long run marginal source energy for 2025 Energy Code



California Climate Zones

California has 16 climate zones

- Climate Zones allow software to more accurately simulate variances weather, and as a result, energy consumption of buildings
- A measure's cost effectiveness can vary as a result of weather differences
- Energy Code requirements vary by climate zone as a result



More on 2025 Energy Accounting Metrics

For more on the 2025 Energy Code metrics:

- July 18th, 2022, workshop page, including slides and recording
  - https://www.energy.ca.gov/event/workshop/2022-07/staff-workshop-energy-accounting-2025-building-energy-efficiency-standards
- November 10th, 2022, workshop page, including slides and recording
  - https://www.energy.ca.gov/event/workshop/2022-11/final-staff-workshop-energy-accounting-2025-building-energy-efficiency

2025 Energy Code Work To Date

Milestones	Timelines
Codes & Standards Enhancement (CASE) Team Requested & Received 2025 Measure Proposal Ideas	June 2021 – May 2022
CEC Updated Weather Data, LSC, and Source Energy Metrics	March - November 2022
CASE Team Held Welcome Webinars on 2025 Measures & Work To Come	October 2022
CASE Team Held Stakeholder Workshops on 2025 Proposals	January – May 2023
Energy Commission Worked Feverishly on 2025 Heat Pump and PV System Measures	November 2022 - Now
CASE Team Published Draft Measure Proposal Reports* + Comment Period	May – July 2023

*To view CASE team draft measure proposal reports, and upcoming final reports, visit https://title24stakeholders.com/2025-cycle-case-reports/

2025 Energy Code Work To Come

Milestones	Timelines
CASE Team Publishes Final Measure Proposal Reports	July – August 2023
CEC 2025 Prerulemaking Workshops*	July – August 2023
CEC Publishes 2025 Energy Code Draft Updates (Draft Express Terms)	October 2023
CEC Rulemaking for 2025 Energy Code	January 2023 – June 2024
2025 Energy Code Business Meeting Adoption	June 2024
Building Standards Commission Approval of 2025 Energy Code	December 2024
2025 Energy Code Effective Date	January 2026

2025 Energy Code Senior Staff Contacts

- **Javier Perez** – Project Manager
- **Payam Bozorgchami** – Technical Lead, Envelope, Additions and Alterations, ADUs
- **Haile Bucaneg** – Covered Process, Demand Response, Nonresidential and Residential ACM
- **Muhammad Saeed** – Solar Photovoltaic and Energy Storage Systems
- **Bach Tsan** – HVAC Systems, Refrigeration
- **Email Convention at the Energy Commission:** firstname.lastname@energy.ca.gov

2025 Pre-rulemaking Workshop

Single Family Buried Ducts Update and Cathedral Ceilings

Bach Tsan, P.E., Senior Mechanical Engineer

August 17, 2023

Agenda

- Measure Overview
- Existing code requirements
- What's being proposed

Cathedral Ceilings

- Energy savings methodology
- Energy impact and Savings
- Incremental costs
- Conclusion

Measure Overview – Buried Ducts

Buried Ducts introduced in the 2016 Energy Code (California Energy Commission 2015) as compliance option

- Ducts and attics are exposed to extreme temperatures
- Limited use of buried duct compliance option in place of high- performance attics (HPA)
- Low utilization of the existing buried duct path
  - Software compliance requires entry of detailed duct design information and system drawings,
  - Savings may be undervalued because of underestimated thermal benefits from burying ducts in attic insulation, and verification processes may be seen as onerous.
- 2025 proposal is designed to lessen barriers and improve performance path

2025 Proposed Measure – Buried Ducts – Not Moving Forward Prescriptively

- Propose change in mandatory requirements in Climate Zones 4 and 8-16, revised and new prescriptive requirement in Zones 1-3, 5-7, and 16.

Table 1: Proposed Changes to Table 150.1-A Option B and Related Code Sections by Climate Zone (CZ)

Code	Parameter	CZ 1	CZ 2	CZ 3	CZ 5	CZ 6	CZ 7	CZ 16
Current	Roof Deck Insulation [a]	NR	NR	NR	NR	NR	NR	R-19
	Ceiling Insulation [a]	R-38	R-38	R-30	R-30	R-30	R-30	R-38
	Radiant Barrier [a]	NR	REQ	REQ	REQ	REQ	REQ	NR
	Ducts	R-8	R-8	R-6	R-6	R-6	R-6	R-8
Proposed	Roof Deck Insulation [a]	NR	NR	NR	NR	NR	NR	NR
	Ceiling Insulation [a]	R-49	R-49	R-49	R-49	R-49	R-49	R-60
	Radiant Barrier [a]	REQ	REQ	REQ	REQ	REQ	REQ	REQ
	Ducts [b]	R-6	R-6	R-6	R-6	R-6	R-6	R-6

a. Applies to Option B only.

b. Ducts must be fully buried in ceiling insulation in accordance with the exceptions added to Section 150.1(c)1A and Section 150.1(c)9C on buried duct requirements. See the proposed language in Section 5.2.

Courtesy : California CASE Team https://title24stakeholders.com/wp-content/uploads/2023/08/2025_T24_Final-CASE-Report-Buried-Ducts.pdf

2025 Proposed Measure – Buried Ducts – Updates to Performance Path

- Energy Commission will not pursue prescriptive changes to the 2025 Energy Code related to Buried Ducts
- Improve performance path for buried ducts
  - Update to tables in the ACM of the R-values listed in Tables 15-20
  - Compliance Software Modification with a method to estimate duct surface areas and effective R-values in lieu of requiring each duct segment will be added to software.

Measure Overview – Roofs with Cathedral Ceilings

- Regularly designed in single family homes
- Becoming more increasingly common in small homes and Additional Dwelling Units (ADUs), but are penalized under Performance approach and have no Prescriptive alternative
- Poorly designed cathedral ceilings can result in:
  - Net energy losses
  - Decreased occupant comfort by lack of adequate insulation levels
- This proposal would provide
  - A clearer compliance path for homes with cathedral ceilings by allowing projects more compliance flexibility,
  - Precise minimum requirements to meet code

Existing 2022 Code Requirements – Cathedral Ceilings

- Existing Option C of Table 150.1-A, Title 24, Part 6 for constructing cathedral ceilings in single-family new construction and additions
- No specific code requirements for insulation levels in cathedral ceilings

TABLE 150.1-A COMPONENT PACKAGE – Single-Family Standard Building Design

Single-Family				Climate Zone													
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Envelope	Rc	Option C (meets § 150.1(c)9B)	Ceiling Insulation	R 38	R 30	R 30	R 30	R 30	R 30	R 30	R 30	R 30	R 30	R 38	R 38	R 38	R 38	R 38	R 38
			Radiant Barrier	NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	NR

2025 Proposed Requirements – Cathedral Ceilings (continued)

- Proposal includes cathedral ceilings under existing Option C for roof and ceiling insulation, and radiant barrier requirements.
  - Applies to both vented and unvented assemblies
- Revised prescriptive Option C: minimum-R ceiling/roof deck insulation:
  - R-38 for all roofs constructed as cathedral ceilings in all CZs
  - R-38 (Existing R-30) ceiling insulation for roofs with a vented attic in CZs 8 through 10.
- Ducts and air handler must be in conditioned space (Section 150.1(c)9B)
- Standard Design currently has no cathedral ceiling option
  - Proposed insulation requirements to be added
- Update to reflect ACM section changes:
  - 2.5.6.2 Non-Attic (Cathedral) Ceiling and Roof
  - 2.6.1. Attic Components (Solar Reflectance and Thermal Emittance sections)

Climate Zone	Base Case(Existing Prescriptive Option B)	Proposed
1	R-38 cavity insulation	R-38
2	R-38 cavity insulation + radiant barrier	R-38
3, 5-7	R-30 cavity insulation + radiant barrier	R-38
4, 8-16	R-38 cavity insulation + R-19 roof deck insulation	R-38

Energy Impact Summary

- Energy impact uses 2022 prototypical buildings
  - 2100/2700/500 square foot single family buildings
- Code change does not modify existing energy budget:
  - Savings would be equivalent to base case
    - Reasonably equivalent energy savings in cathedral ceiling construction is achieved through R-38 cavity insulation for all climate zones
  - Requirements developed so that savings are equivalent to the current standard design i.e., Option B of Table 150.1-A.

30-Year Cost Effectiveness Summary Per Home – New Construction/Additions – 2100/2700

Cathedral Ceilings - Alternative

Climate Zone	Base Case LSC (2026 PV$)	Proposed LSC (2026 PV$)	Total LSC Difference (2026 PV$)
1	$59,062	$55,175	$3,887
2	$42,075	$39,877	$2,198
3	$28,499	$27,368	$1,131
4	$34,640	$34,281	$358
5	$25,196	$24,114	$1,082
6	$14,831	$14,326	$506
7	$14,556	$13,952	$603
8	$17,446	$17,525	($78)
9	$20,014	$19,980	$34
10	$21,758	$21,652	$107
11	$44,883	$43,863	$1,021
12	$39,489	$38,932	$557
13	$40,185	$40,001	$184
14	$41,326	$40,563	$763
15	$36,490	$36,437	$52
16	$54,879	$52,763	$2,116

30-Year Cost Effectiveness Summary Per Home – Small Home

Cathedral Ceilings - Alternative

Climate Zone	Base Case LSC (2026 PV$)	Proposed LSC (2026 PV$)	Total LSC Difference (2026 PV$)
1	$13,270	$13,025	$245
2	$10,480	$10,380	$100
3	$12,720	$12,630	$90
4	$14,575	$14,655	($80)
5	$7,300	$7,300	$0
6	$6,275	$6,075	$200
7	$7,055	$6,625	$430
8	$7,990	$7,890	$100
9	$7,965	$7,915	$50
10	$8,550	$8,445	$105
11	$12,480	$12,505	($25)
12	$10,955	$11,090	($135)
13	$16,480	$16,440	$40
14	$16,090	$16,045	$45
15	$14,015	$13,750	$265
16	$12,745	$12,840	($95)

Cost Effectiveness – Cathedral Ceilings

- Alternative to existing prescriptive requirements
  - Cost are not provided since this is an alternative
  - Costs associated with this proposal are not expected to increase that of the standard design

Comments

Comments on today's workshop due

August 30, 2023, by 5:00 PM

Submit comments to CEC Docket 22-BSTD-01
https://efiling.energy.ca.gov/Ecomment/Ecomment.aspx?docketnumber=22-BSTD-01

Contact: Bach.Tsan@energy.ca.gov

Questions

Thank You!

2025 Pre-Rulemaking Workshop

Single Family Envelope

Michael Shewmaker, Supervisor, Building Standards Development Unit

August 17, 2023

Acknowledgement & Thanks

A big thanks to the Single Family Envelope CASE Team:
Simon Palin, Claudia Pingatore,
and Alea German of Frontier Energy

Items Covered In This Presentation

- **Window U-factors:** Mandatory & Prescriptive
  - Key Assumptions, Software & Prototypes Used
  - Firs-Year Energy Savings & Peak Demand Reduction
  - 30-Year Energy Cost Savings
  - Incremental Cost
  - Cost Effectiveness

- **Mandatory Wall U-factor:** 2x4 & 2x6 or greater
  - Key Assumptions
  - Incremental Cost

Window U-factors – Mandatory & Prescriptive

Existing 2022 Code Requirements

Window U-factor

- Mandatory: maximum U-factor = 0.45 in all CZs
  - Exception 1: up to 10ft^2, or 0.5% of CFA, is exempt
  - Exception 2: 30 ft^2 of dual glazed greenhouse or garden windows is exempt
- Prescriptive: maximum U-factor = 0.30 in all CZs

2025 Proposed Requirements

Window U-factor

- Mandatory: maximum U-factor = **0.40 in all CZs**
  - Exceptions 1 & 2 to remain
- Prescriptive: maximum U-factor
  - New Construction = **0.27 in CZs 1-5, 11-14 & 16**; else U=0.30
    - **Exception for small homes in CZs 5; U=0.30**
  - Alterations = **0.27 in all CZs**

Key Assumptions

- CASE Report analysis based on the 2022 prescriptive baseline

- **MAJOR CHANGE FROM THE FINAL CASE REPORT:** Analysis based on a heat pump space conditioning for new construction (2025 baseline); and a gas furnace for alterations.
  - All other building characteristics meet 2022 prescriptive requirements.

Software Used & Prototypes

- **Software used:** CBECC-Res 2025 RV

- **Prototypes used:**

  New construction

  1. Single-story, 2,100 ft^2 home — Weighting: 42%
  2. Two-story, 2,700 ft^2 home — Weighting: 56%
  3. Single-story, 500 ft^2, small home — Weighting: 2%

  Alterations

  1. Single-story, 1,665 ft^2 existing home

First-Year Electricity Savings – kWh Per Home

Climate Zone	2,100/2,700 ft² Weighted New Construction	500 ft² Small Home New Construction	1,665 ft² Alteration + Addition
1	188	30	11
2	131	15	5
3	88	10	(6)
4	120	14	(6)
5	101	4	(8)
6	25	(8)	(5)
7	20	(11)	(9)
8	18	(9)	(28)
9	29	(8)	(23)
10	34	(7)	(18)
11	103	13	2
12	98	10	(8)
13	78	11	9
14	120	19	4
15	45	0	32
16	198	28	(27)

First-Year Peak Electricity Demand Reductions – kW Per Home

Climate Zone	2,100/2,700 ft² Weighted New Construction	500 ft² Small Home New Construction	1,665 ft² Alteration + Addition
1	0.031	0.009	0.001
2	0.026	0.005	0.001
3	0.029	0.005	0.001
4	0.032	0.007	0.002
5	0.033	0.002	0.002
6	0.008	0.000	0.001
7	0.007	0.000	0.000
8	0.015	(0.001)	0.000
9	0.016	(0.001)	0.001
10	0.023	0.000	0.000
11	0.027	0.006	0.000
12	0.026	0.006	0.001
13	0.022	0.005	0.000
14	0.041	0.009	0.002
15	0.012	(0.002)	0.000
16	0.039	0.008	0.002

First-Year Natural Gas Savings – Therms Per Home

Climate Zone	2,100/2,700 ft² Weighted New Construction	500 ft² Small Home New Construction	1,665 ft² Alteration + Addition
1	0	0	15.3
2	0	0	12.5
3	0	0	6.9
4	0	0	12.5
5	0	0	6.4
6	0	0	3.6
7	0	0	2.2
8	0	0	4.5
9	0	0	5.2
10	0	0	5.2
11	0	0	10.9
12	0	0	11.2
13	0	0	8.5
14	0	0	12.4
15	0	0	2.4
16	0	0	18.1

First-Year Source Energy Savings – kBtu Per Home

Climate Zone	2,100/2,700 ft² Weighted New Construction	500 ft² Small Home New Construction	1,665 ft² Alteration + Addition
1	464	85	1,399
2	356	55	1,166
3	279	45	649
4	366	60	1,149
5	290	20	566
6	98	0	333
7	87	(10)	216
8	119	(5)	383
9	122	(5)	466
10	171	(5)	483
11	321	60	999
12	293	50	1,032
13	244	45	783
14	401	70	1,149
15	112	(10)	233
16	524	95	1,632

30-Year Energy Cost Savings – 2100/2700 Weighted NCB

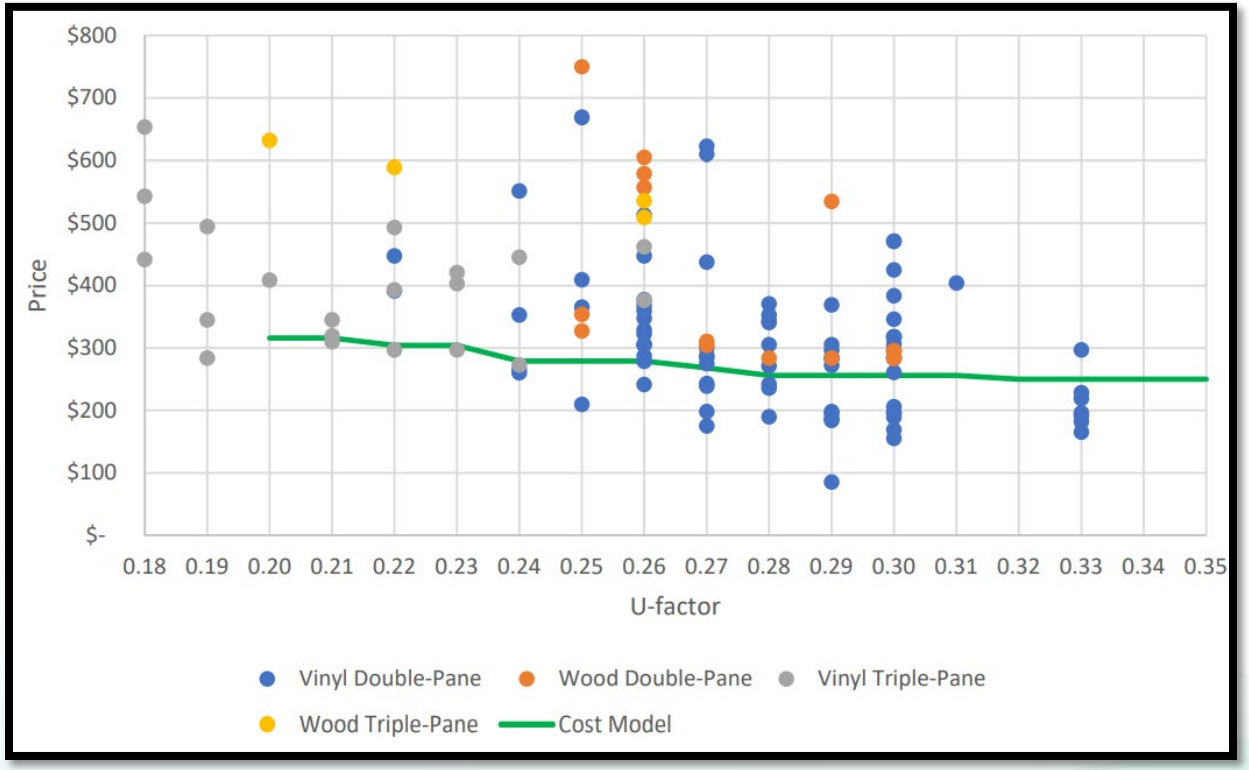
Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Savings (2026 PV$)
1	$1,434	$0	$1,434
2	$1,023	$0	$1,023
3	$754	$0	$754
4	$918	$0	$918
5	$803	$0	$803
11	$817	$0	$817
12	$768	$0	$768
13	$639	$0	$639
14	$974	$0	$974
16	$1,557	$0	$1,557

30-Year Energy Cost Savings – Small Home New Construction

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Savings (2026 PV$)
1	$245	$0	$245
2	$145	$0	$145
3	$100	$0	$100
4	$125	$0	$125
11	$120	$0	$120
12	$105	$0	$105
13	$110	$0	$110
14	$160	$0	$160
16	$250	$0	$250

Incremental Cost

Figure 4 from the Single-Family High-Performance Windows and Walls Final CASE Report



Total Incremental Cost

- Incremental cost for materials only
  - None for labor/maintenance/replacement
- Same costs for new construction, additions, and alterations

Window U-Factor Reduction	Incremental Material Cost, with Multiplier	Incremental Labor Cost	Total Incremental Cost
0.30 → 0.27 (CZs 1-5, 11-14, and 16)	$0.84/ft^2	N/A	$0.84/ft^2

Cost Effectiveness

Climate Zone	2100/2700 Weighted New Construction	500 Small Home New Construction	1665 Existing Building Alteration
1	3.50	2.92	10.82
2	2.49	1.73	8.82
3	1.84	1.19	4.73
4	2.24	1.49	8.46
5	1.96	N/A	4.36
6	N/A	N/A	2.45
7	N/A	N/A	1.95
8	N/A	N/A	2.18
9	N/A	N/A	2.91
10	N/A	N/A	3.27
11	1.99	1.43	7.64
12	1.87	1.25	7.36
13	1.56	1.31	6.46
14	2.37	1.90	8.82
15	N/A	N/A	2.91
16	3.79	2.98	11.73

Mandatory U-factor Requirements for Framed Walls

Existing 2022 Code Requirements

Mandatory Wall U-factor

- Wood framed
  - 2x4: maximum U-factor = 0.102
  - 2x6 or greater: maximum U-factor = 0.071

2025 Proposed Requirements

Mandatory Wall U-factor

- Wood framed
  - 2x4: maximum U-factor = **0.095**
  - 2x6 or greater: maximum U-factor = **0.069**

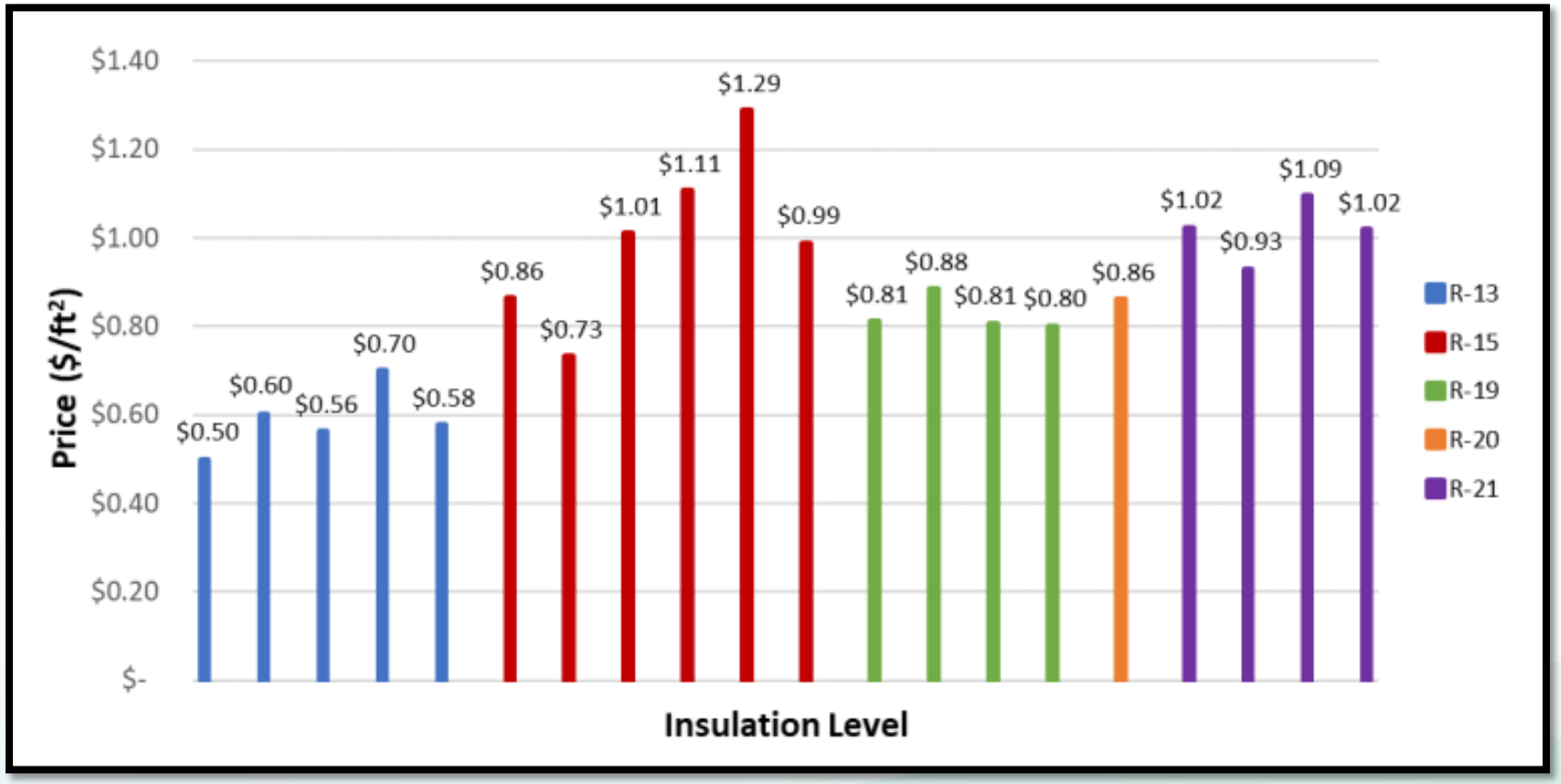
Key Assumptions

- The code change proposal introduces mandatory requirements that are less stringent than the existing prescriptive requirements. And since the proposal will not change the overall energy budget, nor standard design, **no energy savings can be claimed**.

- Though no energy savings can be claimed, this proposed change in mandatory wall insulation requirements will raise the bar for overall building envelope performance by creating a backstop to ensure a minimum level of envelope efficiency.

Incremental Costs

Table 5 from the Single Family High-Performance Windows and Walls Final CASE Report



Total Incremental Cost

Table 36 from the Single-Family High-Performance Windows and Walls Final CASE Report

Proposed Increase	One-Story Single Family New Construction Prototype (2,100 ft^2)	Two-Story Single Family New Construction Prototype (2,700 ft^2)
R-13 → R-15	$366	$767
R-20 → R-21	$163	$341

Questions

Comments can be submitted to the Pre-Rulemaking docket: https://efiling.energy.ca.gov/Ecomment/Ecomment.aspx?docketnumber=22-BSTD-01

Comments on today's workshop are **due August 30, by 5:00pm**

Contact information: Michael.Shewmaker@energy.ca.gov

Thank you for participating!

Thank You!

15-minute Break

We will resume at 10:45

2025 Pre-Rulemaking Workshop

Multifamily Indoor Air Quality

Anushka Raut, Air Pollution Specialist, Standards Development Unit

August 17th, 2023

2022 Title 24, Part 6 Requirements

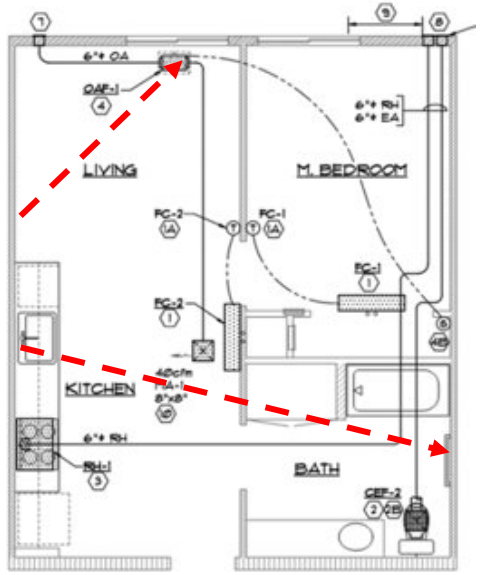
2022 Energy Code Requirements

2022 Title 24, Part 6 requirements for ventilation strategy and compartmentalization

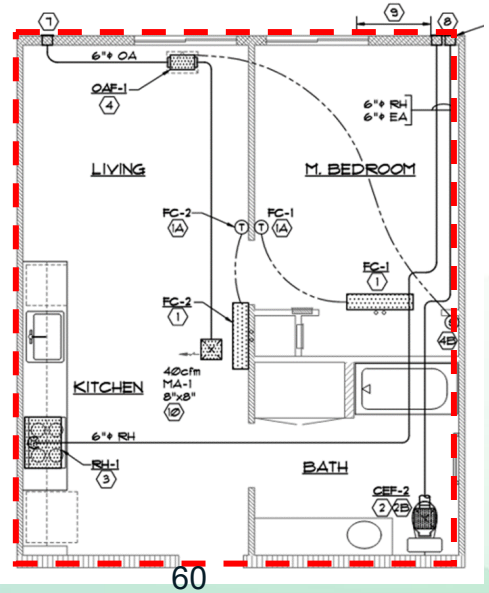
- **Mandatory (since 2019)**: New construction multifamily units must have either:
  - Balanced ventilation, **OR**
  - Meet a compartmentalization requirement of **0.3 cfm at 50 pascals per square foot (cfm50/ft^2).**

- **Prescriptive (since 2022)**: If choosing balanced, new construction multifamily units must use heat or energy recovery ventilator (H/ERV) in Climate Zones **1, 2, 11-16.**

Balanced ventilation example:
- Continuous supply air, and
- Continuous exhaust



Compartmentalization example:
Air sealing around dwelling unit enclosure



2022 Code Requirements (Cont.)

2022 Title 24, Part 6 requirements for Indoor Air Quality (IAQ) System Accessibility and Fault Indicator Displays (FIDs)

- There are no mandatory or prescriptive requirements for IAQ system accessibility or FIDs
- Alternative Compliance Manual (ACM) requires both, in multifamily units.
- Fault Indicator Display (FID): Indicates filter issues or low airflow and informs the end-users through its display or alarm.

2025 Title 24, Part 6 Proposed Changes

2025 Proposed Requirements

2025 Title 24, Part 6, proposed requirements for ventilation strategy and compartmentalization

- **Mandatory requirement**: New constructed multifamily units must have balanced **or** supply-only ventilation, **and** meet a compartmentalization requirement of ≤ 0.3 cfm at 50 pascals per square foot (cfm50/ft^2) of dwelling enclosure area**.**

- **Prescriptive Requirement**: New constructed multifamily units in Climate Zones 1, 2, 4, 11-14, **and** 16 must use balanced ventilation with heat or energy recovery ventilator (H/ERV).

2025 Proposed Requirements (Cont.)

IAQ System Accessibility and FID requirements for multifamily units

- **Mandatory Requirement:** IAQ filter panel and HRV/ERV access panel must be accessible for regular service. Filters and recovery cores must be located ≤ 10 ft above a walking surface.

  Exception: Ventilation systems with an FID located in an attic.

- Prescriptive: FID required for IAQ system.

IAQ systems without an FID may use the performance path and incur the current (T24-2022 ACM) fan energy and HRV SRE de-rating penalty.

IAQ System Accessibility & FID

Requirement	Penalty if requirements not met	Penalty if balanced ventilation with no HRV	Penalty with balanced ventilation with HRV/ERV
IAQ System Accessibility	CBECC "neutralizes“ compliance credit for ventilation system.	CBECC assumes standard efficacy for ventilation fan. No energy savings for higher efficacy fan.	CBECC assumes standard HRV Sensible Recovery Efficiency (SRE). No energy savings for higher SRE.
FID	Ventilation fan penalty and HRV Sensible Recovery Efficiency (SRE) de-rating.	CBECC assumes 10% higher ventilation fan energy than standard design.	CBECC assumes 10% lower HRV/ERV SRE than standard design.

Rationale and Sections Affected

Rationale: Adequate IAQ

The proposed are to protect IAQ, cost effectiveness is not required.

- Promoting adequate indoor air quality by ensuring:
  - Each dwelling unit receives sufficient outdoor air through a balanced or supply-only ventilation strategy approach.
  - Reducing the transfer of pollutants from neighboring dwelling units through compartmentalization.
  - IAQ system accessibility and FID requirements would help accessibility and alert building owners when maintenance is required.

Source: (Archie et al. 2022; Singer et al. 2016)

Rationale: Prescriptive HRV/ERV

The proposed prescriptive HRV/ERV requirement is to promote energy savings when using balanced ventilation

- HRV/ERV transfer heat between incoming fresh air and exhaust air to pre-heat/pre-cool incoming air reducing the heating/cooling demand of the building

- The rationale is energy savings, it **must be cost-effective**

- HRV/ERV is only **proposed** in Climate Zones **1, 2, 4, 11-14, and 16**

Source: (https://vancouver.ca/files/cov/heat-recovery-ventilation-guide-for-houses.pdf)

2025 Code Sections Affected

Standards

- 100.1 (b)
- 150.0(o)1C
- 150.1(c)
- 160.2(b)2Aivb
- 160.2(b)2Axi
- 170.2(c)3B
- 180.1(a)2
- 180.2(b)5

Residential Appendix

- RA3.8.3(c)
- RA3.8.4(a)

Non-Residential Appendix

- NA1.9.1
- NA2.3.3
- NA2.3.4

Joint Appendix

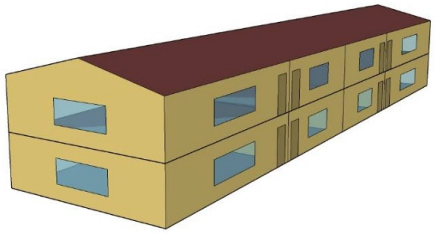
- JA15 Addition

Energy Savings Methodology

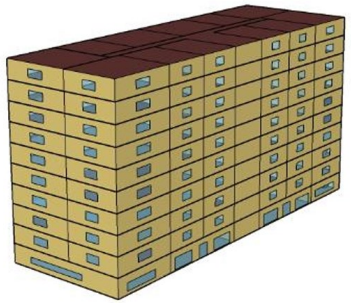
Modelling and Analysis

Conducted energy simulations using CBECC - 2025 software to estimate energy use under different possible scenarios for current and proposed code.

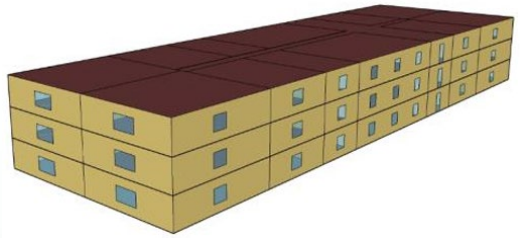
Modeled four building prototypes:



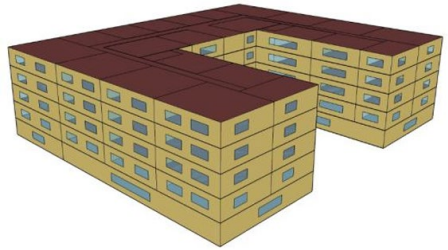
Garden Style Protype



High-rise Prototype



Low-rise Loaded Corridor Prototype



Mid-rise Prototype

Modelling and Analysis (Cont.)

Estimated impact of compartmentalization on exterior air leakage.

- **Base case:** Balanced ventilation without compartmentalization, has a 7 air changes per hour (ACH) at 50 pascals default leakage value assumption as per CBECC software from the exterior.

- **Proposed case**: Based on a field study that measured the fraction of dwelling unit leakage from the exterior, it is assumed compartmentalization reduces exterior leakage to 2.3 - 3.2 ACH 50 pascals depending on the prototype.

Key Assumptions

Based on market research, developed a weighted average of savings from the different scenarios.

Base Case:

- 54% Low-rise MF buildings employed compartmentalization and exhaust-only ventilation strategies and 46% employed balanced ventilation strategy.
- 75% High-rise MF buildings employed balanced ventilation without compartmentalization and 25% employed compartmentalization and exhaust-only ventilation.

Key Assumptions (Cont.)

Proposed Case:

- All MF will comply with compartmentalization, of which 85% would use balanced ventilation and 15% would use supply-only ventilation strategy.
- HRV/ERV where 2022 Title 24, Part 6 requires it.

Air-source heat pump for space heating.

Exception: Climate zone 16 where gas furnace is prominent.

First-Year Energy Impacts

First-Year Savings Summary

Energy and LSC savings from First Year constructions: Entire Measure

Metrics	Values
Electricity Savings (Gwh)	1.7
Peak Electricity Demand Reduction (MW)	0.3
Natural Gas Savings (Million Therms)	0.001
Source Energy Savings (Million kBtu)	3.4
30-Year Total LSC Savings from First Year Constructions (Million 2026 PV$)	12.1
Avoided GHG Emissions (Metric Ton CO_2e)	184.8
Monetary Value of Avoided GHG Emissions ($)	22,755

First-Year Savings: Prescriptive

Climate Zone (CZ)	New constructions impacted by proposed change in 2026	First-year Electricity Savings (GWh)	First Year Peak Electrical Demand Reduction (MW)	First-year Natural Gas Savings (Million therms)	First-year Source Energy Savings (Million kBtu)	30-year Present Value LSC Savings (Million 2026 PV$)
1	144	0.02	0.01	0.00	0.12	0.26
2	1,391	0.15	0.08	0.00	0.75	1.52
4	3,417	0.29	0.18	0.00	1.56	2.80
11	1,173	0.19	0.08	-	0.72	1.68
12	5,537	0.59	0.35	-	2.94	5.54
13	1,009	0.13	0.05	-	0.46	1.17
14	1,446	0.27	0.11	0.00	0.96	2.25
16	187	0.00	0.00	0.00	0.46	0.65
Total	14,304	1.64	0.87	0.00	7.97	15.87

30-Year Energy Savings Results

30-Year Savings for Proposed Mandatory Requirements

New Construction: Ventilation + Compartmentalization (All Prototypes)

Climate Zone (CZ)	30-year LSC Electricity Savings (2026 PV$)	30-year LSC Gas Savings (2026 PV$)	30-year LSC Savings (2026 PV$)
1	445	49	494
2	416	0	416
3	75	0	75
4	187	0	187
5	124	0	124
6	80	0	80
7	111	0	111
8	232	0	232

30-Year Savings for Proposed Mandatory Requirements (Cont.)

New Construction: Ventilation + Compartmentalization (All Prototypes)

Climate Zone (CZ)	30-year LSC Electricity Savings (2026 PV$)	30-year LSC Gas Savings (2026 PV$)	30-year LSC Savings (2026 PV$)
9	159	0	159
10	207	0	207
11	603	0	603
12	452	0	452
13	490	0	490
14	622	0	622
15	470	0	470
16	244	672	916

30-Year Savings for Proposed Prescriptive Requirements

New Construction: Prescriptive HRV (All Prototypes)

Climate Zone (CZ)	30-year LSC Electricity Savings (2026 PV $)	30-year LSC Gas Savings (2026 PV $)	30-year LSC Savings (2026 PV $)
01	1336	482	1818
02	1093	0	1093
04	819	0	819
11	1431	0	1431
12	1000	0	1000
13	1160	0	1160
14	1558	0	1558
16	214	3244	3458

Incremental Cost Analysis

Incremental Cost: Ventilation Types

Reviewed mechanical plans to identify a basis of design (BOD) for each ventilation strategy and requested a cost estimate for each BOD from two mechanical contractors.

Ventilation Strategy Cost Estimates

Ventilation Strategy	Studio	One-bedroom	Two-bedroom	Three-bedroom
Exhaust-only	$0	$0	$0	$0
Supply-only	$1,427	$1,518	$1,427	$1,516
Balanced	$1,427	$1,518	$1,427	$1,518
Balanced, with HRV	$1,879	$1,970	$1,784	$1,876

Incremental Cost: Compartmentalization

- Based on interviews with contractors and HERS Rater to estimate costs per dwelling unit.
- **Assumption:** Air sealing materials have a lifetime ≥ 15 years.
- **<u>Compartmentalization Cost Estimates</u>**
- First cost to air seal to 0.3 cfm at 50 pascals per square foot ($cfm50/ft^2$) of dwelling enclosure area and verification:
- Air sealing: Based on interviews, $450 (wood-framed) or $475 (metal-framed).
- HERS rater testing after sampling: $13 to $107 per unit. Higher cost for prototypes with fewer units (less sampling).
- Total first cost: $465 to $557 per dwelling unit.

Incremental Cost: Assumptions

- **Key Assumptions**:
  - Exhaust fans are required for local exhaust, exhaust-only ventilation = $0
  - Balanced systems are individually ducted, in-line fan for each dwelling unit, with MERV13 filter.
  - Same assumptions for supply-only ventilation. No additional costs assumed for exhaust controls.
  - Replacement of supply fan or HRV at year 15.
  - FID in all cases that include balanced or supply-only ventilation in base and proposed cases.

Incremental Cost: Prescriptive HRV

Based on mechanical contractors' estimates, comparing the base case (**balanced without heat recovery ventilator or supply-only ventilation**), the **first incremental** cost for the HRV would be **$400.**

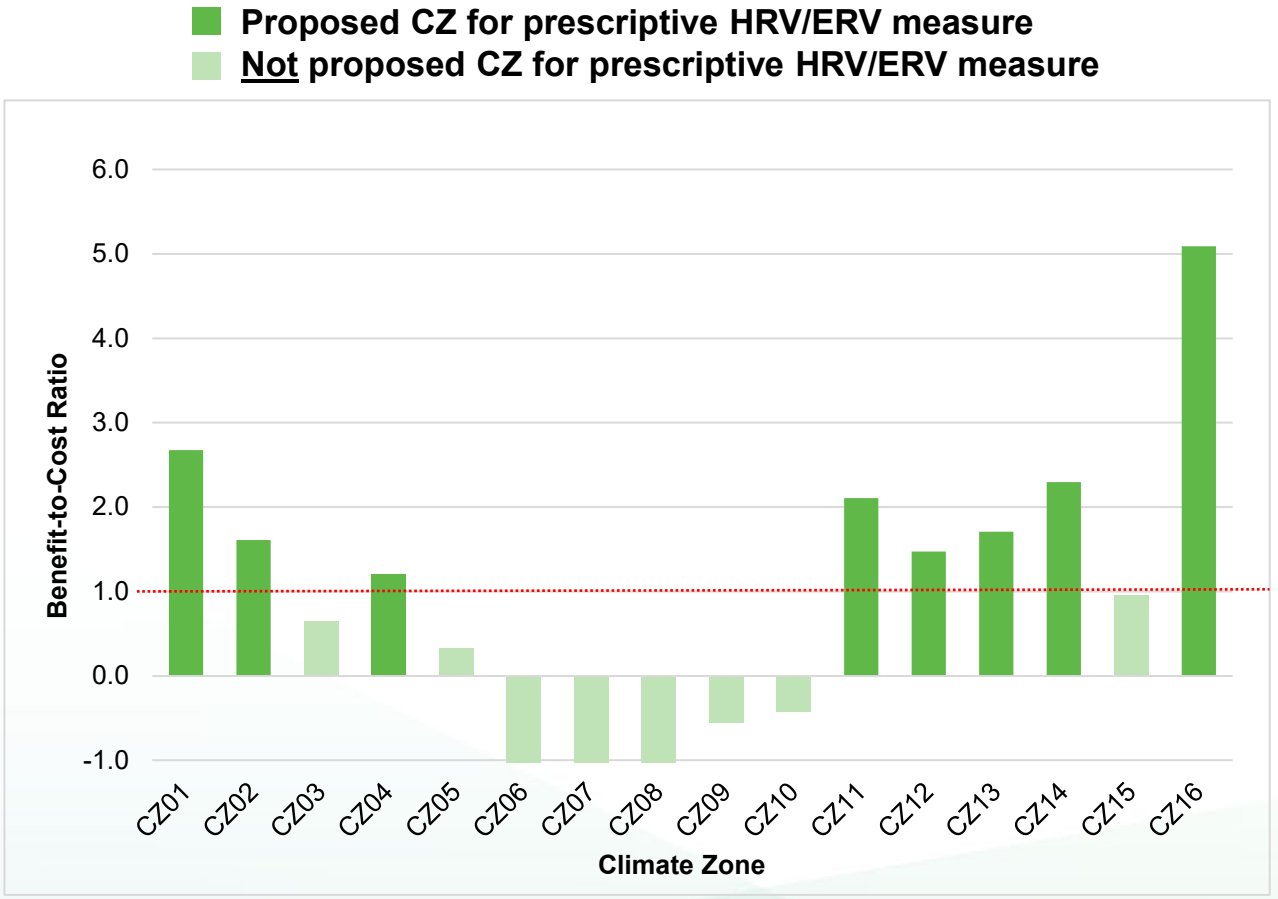
Assumptions:

- No difference in duct work between the base case and the proposed case
- $400 replacement cost at year 15
- Total incremental cost (in 2026 PV$): $679

Cost-Effectiveness Analysis

Cost Effectiveness: Prescriptive

- Energy savings and cost estimates for prescriptive measure of Heat or Energy Recovery Ventilation (HRV/ERV) in Climate Zones 1, 2, 4,11-14,16.
- Proposal is cost effective in all proposed climate zones.
- Cost effectiveness is <u>not required</u> for the mandatory measure package since the focus is on IAQ.



Benefit-to-Cost Ratio of Prescriptive Measure by Climate Zone, Weighted Across all Multifamily Prototypes, over 30 Years.

Questions

- Comments can be submitted to the Pre-rulemaking docket: https://efiling.energy.ca.gov/Ecomment/Ecomment.aspx?docketnumber=22-BSTD-01
- Comments on today's workshop are **due August 30th, by 5:00pm**
- Contact information: Anushka.Raut@energy.ca.gov

Thank You!

2025 Pre-Rulemaking Workshop

Multifamily Envelope

Michael Shewmaker, Supervisor, Building Standards Development Unit

August 17, 2023

Acknowledgement & Thanks

A big thanks to the Multifamily Envelope CASE Team:
Avani Goyal, Daniel Simpson,
and Michael Mutmansky of TRC Companies

Items Covered In This Presentation

- **Cool Roofs**
  - Key Assumptions, Software & Prototypes Used
  - First-Year Energy Savings
  - 30-Year Energy Savings
  - Incremental Cost
  - Cost Effectiveness
- **Mandatory Wall U-factors**
  - Key Assumptions
  - Incremental Cost
- **Window – U-factor & RSHGC**
  - Key Assumptions, Software & Prototypes Used
  - First-Year Energy Savings
  - 30-Year Energy Savings
  - Incremental Cost
  - Cost Effectiveness

Cool Roofs

Existing 2022 Code Requirements

Cool Roofs

- Option B (high performance attic) & Option C (ducts in cond. space)
  - Low-sloped: ASR=0.63 & TE=0.75 in CZs 13 & 15
  - Steep-sloped: ASR=0.20 & TE=0.75 in CZs 10-15

- Option D (non-attic roofs)
  - Low-sloped: ASR=0.63 & TE=0.75 in CZs 9-11 & 13-15
  - Steep-sloped: ASR=0.20 & TE=0.75 in CZs 2-15

2025 Proposed Requirements

Cool Roofs

- Option B (high performance attics)
  - Low-sloped: **no proposed changes*
  - Steep-sloped: **ASR=0.25 & TE=0.80 in CZs 10, 11, 13 & 15**

- Options D (non-attic roof)
  - Low-sloped: ASR=0.63 & TE=0.75 in **CZs 2, 4, 6-8, & 9-15**
  - Steep-sloped: **no proposed changes*

Key Assumptions

- The Low-Rise Garden prototype energy model was used to model steep-sloped roof with an attic.

- For the low-sloped roof proposals the other three multifamily prototypes (Loaded Corridor, Mid-Rise Mixed Use, and High-Rise Mixed Use) were used.

Software Used & Prototypes

- **Software used:** CBECC 2025 RV

- **Prototypes used:**
  1. Low-Rise Garden: 2-story, 8-unit apartment building, 7,320 ft^2
  2. Loaded Corridor: 3-story, 36-unit apartment building, 39,264 ft^2
  3. Mid-Rise Mixed Use: 5-story, 88-unit mixed use bldg., 112,641ft^2
  4. High-Rise Mixed Use: 10-story, 117-unit mixed use bldg., 125,400 ft^2

First-Year Electricity Savings – kWh Per Dwelling Unit

	Steep-sloped	Low-sloped		
Climate Zone	Low-Rise Garden	Loaded Corridor	Mid-Rise Mixed Use	High-Rise Mixed Use
2	-	22.8	35.7	6.7
4	-	36.1	34.6	10.0
6	-	24.0	25.4	3.7
7	-	68.8	38.8	6.8
8	-	67.1	57.1	19.6
10	10.8	-	-	-
11	11.4	-	-	-
12	-	63.0	48.6	14.8
13	12.6	-	-	-
15	24.0	-	-	-

First-Year Peak Electricity Demand Reductions – W Per Dwelling Unit

Climate Zone	Low-Rise Garden	Loaded Corridor	Mid-Rise Mixed Use	High-Rise Mixed Use
2	-	(1.7)	0.7	(0.6)
4	-	(3.4)	(1.9)	(0.9)
6	-	0.5	1.2	0.1
7	-	1.9	1.5	0.2
8	-	1.3	2.4	0.3
10	(0.5)	-	-	-
11	(0.2)	-	-	-
12	-	0.8	1.1	0.0
13	(0.1)	-	-	-
15	0.8	-	-	-

First-Year Natural Gas Savings – kBtu Per Dwelling Unit

Climate Zone	Low-Rise Garden	Loaded Corridor	Mid-Rise Mixed Use	High-Rise Mixed Use
2	-	0.0	0.0	0.0
4	-	0.0	0.0	0.0
6	-	0.0	0.0	0.0
7	-	0.0	0.0	0.0
8	-	0.0	0.0	0.0
10	0.0	-	-	-
11	0.0	-	-	-
12	-	0.0	0.0	0.0
13	0.0	-	-	-
15	0.0	-	-	-

First-Year Source Energy Savings – kBtu Per Dwelling Unit

Climate Zone	Low-Rise Garden	Loaded Corridor	Mid-Rise Mixed Use	High-Rise Mixed Use
2	-	0.7	33.8	0.8
4	-	(5.8)	17.9	2.3
6	-	16.9	31.7	2.7
7	-	57.8	50.9	7.1
8	-	50.1	74.0	18.2
10	3.5	-	-	-
11	5.9	-	-	-
12	-	43.7	52.9	10.4
13	7.7	-	-	-
15	22.3	-	-	-

30-Year LSC Savings Per Dwelling Unit – Steep-Sloped Roofs

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Savings (2026 PV$)
10	62.68	0.00	62.68
11	71.19	0.00	71.19
13	80.98	0.00	80.98
15	149.79	0.00	149.79

30-Year LSC Savings Per Dwelling Unit – Low-Sloped Roofs

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Savings (2026 PV$)
2	161.91	0.00	161.91
4	218.93	0.00	218.93
6	164.32	0.00	164.32
7	336.31	0.00	336.31
8	375.50	0.01	375.51
12	347.36	0.00	347.36

Incremental Costs

Category	Measure	Incremental Material Cost ($/ft^2)	Incremental Replacement Cost ($/ft^2)
Steep-Sloped roof	0.20/0.75 → 0.25/0.80	0.07	0.04
Low-Sloped roof	0.10/0.75 → 0.63/0.75	0.33	0.17

- Material costs only, no incremental labor costs.
- Replacement Cost, at year 20, same as First Cost

Total Incremental Cost – Per Dwelling Unit

Climate Zone	Low-Rise Garden	Loaded Corridor	Mid-Rise Mixed Use	High-Rise Mixed Use
1	$187	$149	$105	$44
2	$189	$151	$106	$44
3	$195	$156	$110	$46
4	$195	$156	$110	$46
5	$203	$162	$114	$48
6	$197	$157	$111	$46
7	$203	$162	$114	$48
8	$193	$154	$109	$45
9	$191	$113	$80	$33
10	$52	$115	$81	$34
11	$52	$115	$81	$34
12	$55	$162	$114	$48
13	$55	$120	$85	$35
14	$50	$111	$78	$33
15	$50	$111	$78	$33
16	$187	$149	$105	$44

Cost Effectiveness

Steep-Sloped Roofs

(ASR=0.25/TE=0.80)

Climate Zone	Benefits: LSC Savings + Other PV Cost Savings (2026 PV$/dwelling unit)	Costs: Total Incremental PV Costs (2026 PV$/dwelling unit)	Benefit-to-Cost Ratio
10	$62.7	$52.5	1.2
11	$71.2	$52.5	1.4
13	$81.0	$54.7	1.5
15	$149.8	$50.3	3.0

Low-Sloped Roofs

(ASR=0.63/TE=0.75)

Climate Zone	Benefits: LSC Savings + Other PV Cost Savings (2026 PV$/dwelling unit)	Costs: Total Incremental PV Costs (2026 PV$/dwelling unit)	Benefit-to-Cost Ratio
2	$161.9	$118.4	1.4
4	$218.9	$122.2	1.8
6	$164.3	$123.5	1.3
7	$336.3	$127.3	2.6
8	$375.5	$120.9	3.1
12	$347.4	$127.3	2.7

Mandatory Wall U-factor

Existing 2022 Code Requirements

Mandatory Wall U-factor

- Wood framed
  - 2x4: maximum U-factor = 0.102
  - 2x6 or greater: maximum U-factor = 0.071

- Metal framed
  - Maximum U-factor = 0.151

2025 Proposed Requirements

Mandatory Wall U-factor

- Wood framed
  - 2x4: maximum U-factor = **0.095**
  - 2x6 or greater: maximum U-factor = **0.069**

- Metal framed
  - Maximum U-factor = **0.148**

Key Assumptions

- This code change proposal introduces mandatory requirements that are less stringent than the existing prescriptive requirements. And since the proposal will not change the overall energy budget, nor standard design, **no energy savings can be claimed.**

- Though no energy savings can be claimed, this proposed change in mandatory wall insulation requirements will raise the bar for overall building envelope performance by creating a backstop to ensure a minimum level of envelope efficiency.

Incremental Costs

Category	Sub-category	Incremental Cost Range ($/ft^2)	Average Incremental Cost ($/ft^2)
Wood-framed	2x4 framing	0.13 – 0.45	0.36
	2x6 framing	0.01 – 0.20	0.16
Metal-framed	N/A	0.13 – 0.45	0.36

NOTE: The incremental cost data collected was aligned with the 2025 Single Family High-Performance Windows and Walls CASE Report for their similar measure.

Windows

Existing 2022 Code Requirements

Window – U-factor & RSHGC

- U-factor:
  - All Other Fenestration:
    - ➢ New construction & alterations:
      - ❖ U=0.30 in CZs 1-5 & 8-16
      - ❖ U=0.34 in CZs 6 & 7
- RSHGC:
  - All Other Fenestration:
    - ➢ Three stories or less: RSHGC=0.23 in CZs 2, 4, 6-15
    - ➢ Four stories or more: RSHGC=0.35 in CZ 1; and RSHGC=0.23 in CZs 2-16

2025 Proposed Requirements

Window – U-factor & SHGC

- U-factor
  - All Other Fenestration:
    - New construction: **U=0.28 in CZs 1, 3-5, 11 & 13-16**
    - Alterations: **U=0.28 in CZs 1, 3-5, 11, 13, 14 & 16**
- RSHGC – **remove requirement in CZs 1, 3, 5 & 16 for four or more habitable stories.**
  - This change would apply to Curtain Walls/Storefront, NAFS Class AW, and All Other Fenestration types in heating dominated climates.

Key Assumptions

- All three fenestration categories were modeled for cost and energy savings, with the following assumptions:
  - All Other Fenestration – simulated across all climate zones
    - Modeled using High-Rise Mixed Use, Mid-Rise Mixed Use, Loaded Corridor, and Low-Rise Garden prototypes
  - Curtain Wall/Storefront & NFS Class AW – simulated in CZs 1, 3, 5 & 16
    - Modeled using High-Rise & Mid-Rise Mixed Use prototypes

- For alterations analysis, existing building models for the Low-Rise Garden and High-Rise Mixed Use prototypes were developed based on 1990s vintage assumptions.

Software Used & Prototypes

- **Software used:** CBECC 2025 RV

- **Prototypes used:**
  1. Low-Rise Garden: 2-story, 8-unit apartment building, 7,320 ft^2
  2. Loaded Corridor: 3-story, 36-unit apartment building, 39,264 ft^2
  3. Mid-Rise Mixed Use: 5-story, 88-unit mixed use bldg., 112,641ft^2
  4. High-Rise Mixed Use: 10-story, 117-unit mixed use bldg., 125,400 ft^2

Results for New Construction

First-Year Electricity Savings – NCB – kWh Per Dwelling Unit

Climate Zone	Low-Rise Garden	Loaded Corridor	Mid-Rise Mixed Use	High-Rise Mixed Use
1	16.3	14.3	4.9	7.3
3	11.4	10.5	10.6	22.9
4	16.5	17.4	10.8	18.6
5	13.3	11.4	12.2	16.3
11	17.8	14.7	8.4	11.2
13	15.9	12.4	7.0	7.4
14	18.3	16.9	11.0	14.0
15	18.6	11.6	8.7	6.6
16	(2.4)	(5.7)	(72.3)	(50.3)

First-Year Peak Electricity Demand Reductions - NCB - W/Dwelling Unit

Climate Zone	Low-Rise Garden	Loaded Corridor	Mid-Rise Mixed Use	High-Rise Mixed Use
1	3.1	3.1	1.8	2.8
3	3.7	3.9	11.1	12.6
4	5.1	5.8	4.8	7.4
5	4.2	4.1	11.7	12.6
11	4.0	4.5	3.2	5.6
13	3.2	3.4	2.4	4.3
14	4.7	5.4	4.0	6.3
15	0.5	0.7	0.5	0.7
16	0.0	(0.2)	1.1	(0.1)

First-Year Natural Gas Savings – NCB – kBtu Per Dwelling Unit

Climate Zone	Low-Rise Garden	Loaded Corridor	Mid-Rise Mixed Use	High-Rise Mixed Use
1	28.8	29.8	20.3	29.2
3	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0
16	254.7	265.3	342.0	162.3

First-Year Source Energy Savings – NCB – kBtu Per Dwelling Unit

Climate Zone	Low-Rise Garden	Loaded Corridor	Mid-Rise Mixed Use	High-Rise Mixed Use
1	66.3	65.0	36.5	53.3
3	35.7	36.3	86.2	111.8
4	51.1	57.4	43.9	70.1
5	38.5	37.3	90.5	97.2
11	42.8	44.6	29.8	49.3
13	34.1	34.2	21.2	31.2
14	47.1	50.8	37.0	57.4
15	14.2	11.6	9.7	5.1
16	227.8	234.8	247.8	91.5

30-Year LSC Savings Per Dwelling Unit – New Const. & Additions

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Savings (2026 PV$)
1	68.59	30.64	99.23
3	112.68	0.00	112.68
4	110.63	0.00	110.63
5	118.04	0.00	118.04
11	92.42	0.00	92.42
13	78.40	0.00	78.40
14	107.89	0.00	107.89
15	67.91	0.00	67.91
16	(262.58)	378.55	115.97

Results for Alterations

First-Year Electricity Savings – ALT – kWh Per Dwelling Unit

Climate Zone	Low-Rise Garden	Loaded Corridor	Mid-Rise Mixed Use	High-Rise Mixed Use
1	1.3	1.3	(1.8)	(1.8)
3	(0.3)	(0.3)	(24.3)	(15.8)
4	(2.2)	(2.2)	(2.7)	(2.7)
5	(0.2)	(0.2)	(36.0)	(22.4)
11	(1.3)	(1.3)	(1.7)	(1.7)
13	(0.9)	(0.9)	(1.3)	(1.3)
14	(0.9)	(0.9)	(1.1)	(1.1)
16	(1.9)	(1.9)	(95.4)	(68.6)

First-Year Peak Electricity Demand Reductions – ALT – W/Dwelling

Climate Zone	Low-Rise Garden	Loaded Corridor	Mid-Rise Mixed Use	High-Rise Mixed Use
1	0.1	0.1	(0.1)	(0.1)
3	0.0	0.0	(0.5)	(0.3)
4	0.0	0.0	0.2	0.2
5	0.1	0.1	(0.5)	(0.4)
11	(0.2)	(0.2)	(0.2)	(0.2)
13	(0.2)	(0.2)	(0.2)	(0.2)
14	(0.1)	(0.1)	(0.1)	(0.1)
16	(0.1)	(0.1)	(1.3)	(0.9)

First-Year Natural Gas Savings – ALT – kBtu Per Dwelling Unit

Climate Zone	Low-Rise Garden	Loaded Corridor	Mid-Rise Mixed Use	High-Rise Mixed Use
1	268.3	268.2	256.8	256.8
3	110.0	110.0	913.8	673.0
4	157.6	157.6	279.3	279.3
5	110.6	110.6	916.0	707.5
11	141.5	141.5	210.6	210.6
13	110.9	110.9	160.0	160.0
14	163.4	163.4	231.8	231.8
16	284.0	284.0	1504.3	1096.7

First-Year Source Energy Savings – ALT – kBtu Per Dwelling Unit

Climate Zone	Low-Rise Garden	Loaded Corridor	Mid-Rise Mixed Use	High-Rise Mixed Use
1	245.6	292.7	277.0	231.9
3	100.2	119.4	968.8	598.3
4	141.6	168.8	302.6	253.4
5	100.7	120.0	958.0	624.8
11	127.8	152.4	229.1	191.9
13	100.2	119.4	173.8	145.5
14	146.9	175.2	249.9	209.2
16	255.0	304.0	1533.4	936.5

30-Year LSC Savings Per Dwelling Unit – Alterations

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Savings (2026 PV$)
1	1.49	347.17	348.67
3	(52.73)	533.20	480.47
4	(15.56)	281.23	265.67
5	(75.60)	541.05	465.46
11	(6.19)	230.73	224.54
13	(0.07)	178.47	178.40
14	(5.43)	260.97	255.54
16	(214.01)	940.79	726.78

Incremental Costs

Window type	Building type	Measure Description	2022 T24 Base Case	2025 T24 Proposed	Incremental Cost ($/ft^2)	Incremental Cost ($/dwelling unit)
All-other (Typ., CZ2 Shown)	Mid-Rise Mixed Use	U-factor decrease	0.30/0.23	0.28/0.23	$0.50	$57.61
All-other (Typ., CZ3 Shown)	Mid-Rise Mixed Use	U-factor decrease & RSHGC increase	0.30/0.23	0.28/0.35	~$0.00	$0.43

Cost Effectiveness – NCB/ADD

Climate Zone	Benefits: LSC Savings + Other PV Cost Savings (2026 PV$/dwelling unit)	Costs: Total Incremental PV Costs (2026 PV$/dwelling unit)	Benefit-to-Cost Ratio
1	$99.23	$56.34	1.76
3	$120.86	$22.22	5.44
4	$110.63	$58.79	1.88
5	$126.56	$23.15	5.47
11	$92.42	$58.79	1.57
13	$78.40	$61.24	1.28
14	$107.89	$56.34	1.91
15	$67.91	$56.34	1.21
16	$123.81	$21.30	5.81

Cost Effectiveness – Alterations

Climate Zone	Benefits: LSC Savings + Other PV Cost Savings (2026 PV$/dwelling unit)	Costs: Total Incremental PV Costs (2026 PV$/dwelling unit)	Benefit-to-Cost Ratio
1	$348.67	$59.80	5.83
3	$499.67	$30.89	16.18
4	$265.67	$62.41	4.26
5	$485.45	$32.17	15.09
11	$224.54	$62.41	3.60
13	$178.40	$65.01	2.74
14	$255.54	$59.80	4.27
16	$745.18	$29.60	25.18

Questions

Comments can be submitted to the Pre-Rulemaking docket: https://efiling.energy.ca.gov/Ecomment/Ecomment.aspx?docketnumber=22-BSTD-01

Comments on today's workshop are **due August 30, by 5:00pm**

Contact information: Michael.Shewmaker@energy.ca.gov

Thank you for participating!

Thank You!

Lunch

We will resume at 1:00

2025 Pre-Rulemaking Workshop

Multifamily Restructuring

Javier Perez, Project Manager – 2025 Energy Code

August 17, 2023

Multifamily Restructuring Measures

- Slab Perimeter Insulation
- Visible Transmittance (VT)
- Skylight Properties
- Central Ventilation Shaft Sealing
- Verification Clean Up
- Additions and Alterations Clean Up

Multifamily Slab Perimeter Insulation

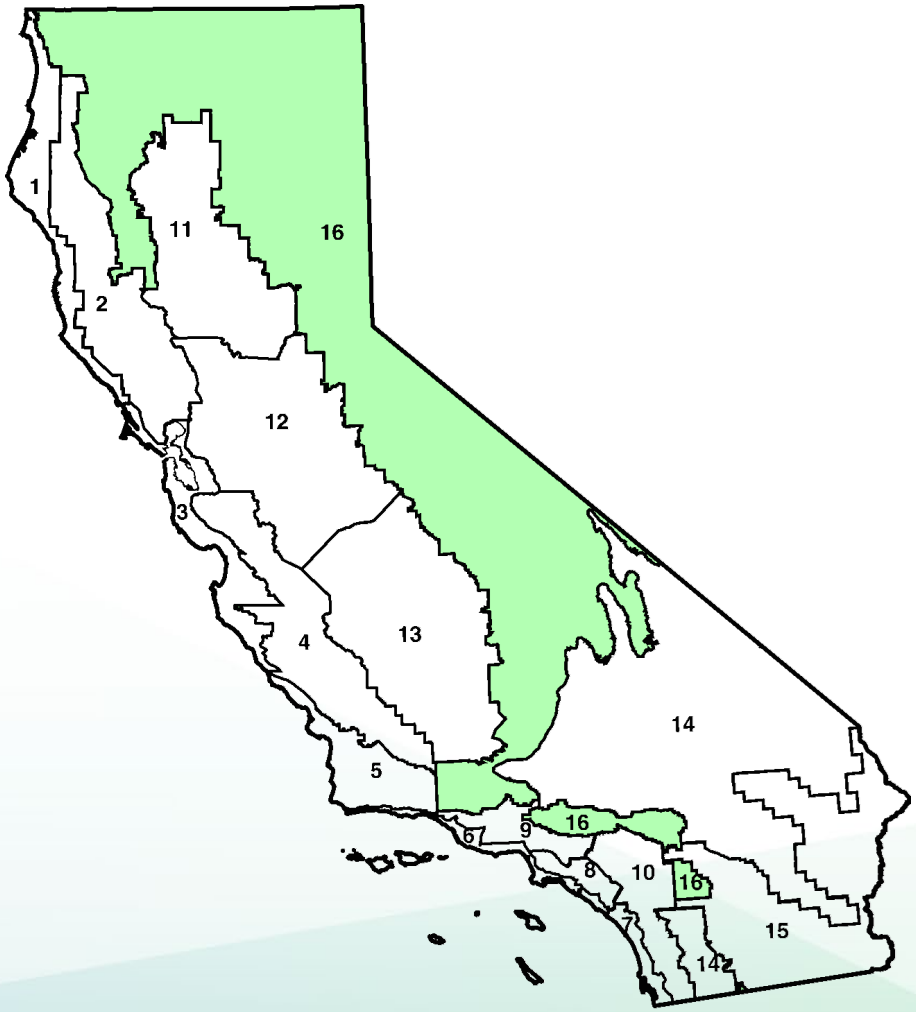
Existing Code Requirements

Multifamily Prescriptive Requirements

- Three or fewer habitable stories
  - Climate zones 1-15: No slab perimeter insulation requirements
  - Climate zone 16: slab perimeter insulation **R ≥ 7.0, or F-factor ≤ 0.58**
- Four or more habitable stories
  - No slab perimeter insulation requirements

2025 Proposed Requirements

- Extend prescriptive slab perimeter insulation requirement to all multifamily buildings, including those with 4+ habitable stories in climate zone 16



Software Used & Prototypes

- Modeled in CBECC 2025 software
- Modified Low-Rise Loaded Corridor prototype
  - 4-story multifamily building with a slab-on-grade foundation
- Climate zone 16 only
- Standard design: no slab-edge insulation
- Proposed design: with R-7 slab-edge insulation

First-Year Energy Savings

Slab Perimeter Insulation — Loaded Corridor Prototype, Climate Zone 16	Estimated Savings
First-year Electricity Savings (kWh) Per Dwelling Unit	(3)
First-Year Peak Demand Reduction (kW) Per Dwelling Unit	(0.07)
First-Year Natural Gas Savings (kBtu) Per Dwelling Unit	310
First-Year Source Energy Savings (kBtu) Per Dwelling Unit	277

30-Year Energy Savings

Slab Perimeter Insulation — Loaded Corridor Prototype, Climate Zone 16	Estimated Savings (2026 PV$)
30-Year LSC Electricity Savings	(18)
30-Year LSC Natural Gas Savings	384
Total 30-Year LSC Energy Savings	366

Incremental Costs

- Cost estimates from contractor working in Climate Zone 16
  - Insulation materials and labor
  - Costs adjusted for geometry of prototype
  - $8,743 for 522 linear feet of perimeter
- Costs from RS Means
  - Additional protection board for building's exterior system
  - Costs adjusted for Climate Zone 16
  - $5,807 for cement siding, including labor
- Total: $14,550 incremental first cost for building
  - $297 per dwelling unit
- No maintenance or replacement costs

Cost Effectiveness

Slab Perimeter Insulation — Loaded Corridor Prototype	Climate Zone 16
Benefits LSC Savings + Other PV Savings (2026 PV$)	366
Costs Total Incremental PV Costs (2026 PV$)	297
B/C Ratio	1.23

Questions

Any questions on this prescriptive slab-edge insulation proposal for climate zone 16?

Multifamily Fenestration Visible Transmittance (VT)

Existing 2022 Code Requirements

Multifamily Prescriptive Fenestration Visible Transmittance Requirements

- Three or fewer habitable stories
  - No visible transmittance (VT) requirement for any window type
- Four or more habitable stories
  - Curtain wall/storefront = VT of 0.46
  - North American Fenestration Standard (NAFS) Performance Class architectural window (AW) = VT of 0.37
  - “All Other” window type = No VT requirement
- No automatic daylighting control requirements for dwelling units
- Automatic daylighting control requirements for daylit zones in common use areas

2025 Proposed Requirements

For curtain walls and architectural windows

- Apply prescriptive visible transmittance (VT) requirements fenestration to common use areas only in all multifamily buildings
  - Expanding VT requirements to windows that serve low-rise multifamily common use areas
    - These windows were found to be very uncommon in low-rise multifamily buildings
  - Removes VT requirement for dwelling units in buildings with four or more habitable stories
- This is language clean-up and does not result in energy savings or measurable change for multifamily buildings
  - NAFS performance class AW and curtain wall/storefront windows not expected in multifamily buildings up to three habitable stories

Key Assumptions

- Proposal generally does not increase stringency due to the rarity of curtain wall/storefront and NAFS performance class AW windows in multifamily buildings up to three habitable stories

- Energy and cost-effectiveness analysis not conducted for this measure

Questions

Any questions on the VT unification requirements for multifamily buildings?

Multifamily Skylights in Existing Buildings

Existing 2022 Code Requirements

Multifamily Skylight Requirements for Existing Buildings

- Alterations (see table)
  - Exception for added skylights: under 50 ft^2 total, or under 16 ft^2 per dwelling unit
  - No exception for replaced skylights (removed in 2022 code)
- Additions
  - Same requirements also apply to skylights in **additions** of 700 ft^2 or less

Building Size	U-factor	Solar Heat Gain Coefficient (SHGC)	Visible Transmittance (VT)
≤ 3 habitable stories	0.30	N/A or 0.23*	N/A
> 4 habitable stories	0.46	0.25*	0.49

* Some CZ's show higher values in published requirements due to a clerical error

2025 Proposed Requirements

Multifamily Skylight Requirements for Existing Buildings

- Apply the requirements for maximum U-factor for four or more habitable stories to all multifamily buildings
- Apply minimum VT to all common use areas
- Remove maximum SHGC requirements for four or more habitable stories in CZs 1, 3, 5 and 16
- Single exception for replacements or additions under 50 ft^2 of skylight

Climate Zones	U-factor	SHGC	VT (common use area only)
1, 3, 5, and 16	0.46	N/A	0.49
2, 4, 6-15	0.46	0.25	0.49

Key Assumptions

Multifamily Skylight Requirements for Existing Buildings

- Limited impact at statewide level, as skylights are uncommon in multifamily buildings
- Proposal does not result in increase stringency of the requirements
  - **U-factor -** Requirements for existing skylights for low-rise multifamily buildings are proposed to be lessened to address technical feasibility concerns
  - **VT -** Requirements expanded to skylights in low-rise multifamily buildings that serve common areas
  - **SHGC -** Removal of requirement in high-rise residential buildings in Climate Zones 1, 3, 5, and 16
    - Energy savings calculated only for removal of SHGC requirement

First-Year Energy Savings

Skylight maximum SHGC removal for low-rise multifamily buildings

Climate Zone	First-year Electricity Savings Per Unit (kWh)	First-Year Peak Demand Reduction Per Unit (kW)	First-Year Natural Gas Savings Per Unit (kBtu)	First-Year Source Energy Savings Per Unit (kBtu)
1	(0.03)	(0.01)	5.30	4.72
3	(0.08)	(0.01)	6.41	5.68
5	0.04	0.00	8.03	7.40
16	(0.56)	(0.15)	6.84	5.79

30-Year Energy Savings

Skylight maximum SHGC removal for low-rise multifamily buildings

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Savings (2026 PV$)
1	(0.11)	6.43	6.32
3	(0.54)	7.82	7.29
5	0.32	9.75	10.07
16	(3.11)	8.36	5.25

Cost Effectiveness

Skylight maximum SHGC removal for low-rise multifamily buildings

Climate Zone	Benefits LSC Savings + Other PV Savings (2026 PV$)	Costs Total Incremental PV Costs (2026 PV$)	B/C Ratio
1	6.32	$0	> 1
3	7.29	$0	> 1
5	10.07	$0	> 1
16	5.25	$0	> 1

Questions

Any questions on the skylight unification proposal for existing multifamily buildings?

Central Ventilation Shaft Sealing

Code Requirements

Existing 2022 Energy Code Requirements

- **Four or more habitable stories:** Central ventilation systems in multifamily buildings with
  - Mandatory field verification of duct leakage using a fan pressurization test
  - 6% allowable leakage of rooftop fan airflow
  - Applies to central exhaust shafts and central ventilation shafts
- **Three or fewer habitable stories:** Central ventilation systems in multifamily buildings
  - No requirement

Proposed 2025 Energy Code Requirements

- **Three or fewer habitable stories:** Extend mandatory requirement
  - Exception for climate zone 6 with ≤ 3 habitable stories

Software Used & Prototypes

- Modeled in CBECC 2025 software
- Modified Low-Rise Loaded Corridor prototype
  - Central supply ventilation shaft
  - Individual exhaust system for each dwelling unit
- Standard design: 39% duct leakage
- Proposed design: 6% duct leakage

First-Year Energy Savings – Per Unit

Climate Zone	First-year Electricity Savings (kWh)	First-Year Peak Demand Reduction (kW)	First-Year Natural Gas Savings (kBtu)	First-Year Source Energy Savings (kBtu)
1	49.17	12.69	-	140.91
2	36.39	10.63	-	107.76
3	36.34	9.46	-	110.92
4	37.37	8.57	-	95.98
5	35.68	9.66	-	101.21
6	11.54	1.21	-	20.4
7	14.19	0.42	-	18.43
8	34.95	1.98	-	47.77
9	34.31	3.66	-	60.86
10	40.27	5.81	-	56.17
11	57.21	11.45	-	114.63
12	41.49	10.58	-	104.05
13	52.4	7.86	-	87.14
14	48.74	10.89	-	106.56
15	56.57	0.26	-	27.59
16	14.7	0.36	427.58	401.8

30-Year Energy Savings – Per Unit

Climate Zone	30-Year LSC Electricity Savings (2026 PV$)	30-Year LSC Natural Gas Savings (2026 PV$)	Total 30-Year LSC Savings (2026 PV$)
1	$377.04	$0.00	$377.04
2	$284.77	$0.00	$284.77
3	$283.46	$0.00	$283.46
4	$287.50	$0.00	$287.50
5	$269.50	$0.00	$269.50
6	$80.60	$0.00	$80.60
7	$103.40	$0.00	$103.40
8	$221.08	$0.00	$221.08
9	$231.98	$0.00	$231.98
10	$264.27	$0.00	$264.27
11	$413.80	$0.00	$413.80
12	$320.77	$0.00	$320.77
13	$373.99	$0.00	$373.99
14	$352.18	$0.00	$352.18
15	$335.71	$0.00	$335.71
16	$87.80	$530.28	$618.08

Incremental Costs

- Material costs = $403
  - Mastic used to seal the ducts
  - Manufacturer costs and coverage, adjusted for geometry and quantity of shafts
- Labor costs = $1,267
  - Contractor labor to apply duct sealing mastic from RS Means
- Verification costs = $1,350
  - Used sampling requirements and ATT hourly rate
- No maintenance or replacement costs
- Total incremental first cost = $3,020, or $84 per dwelling unit

Cost Effectiveness

Climate Zone	Benefits: LSC Savings + Other PV Savings (2026 PV$)	Costs: Total Incremental PV Costs (2026 PV$)	B/C Ratio
1	$377.04	$81.55	4.62
2	$284.77	$107.84	2.64
3	$283.46	$95.81	2.96
4	$287.50	$106.72	2.69
5	$269.50	$104.26	2.58
6	$80.60	$81.38	0.99
7	$103.40	$80.99	1.28
8	$221.08	$81.16	2.72
9	$231.98	$81.05	2.86
10	$264.27	$81.27	3.25
11	$413.80	$82.72	5.00
12	$320.77	$83.90	3.82
13	$373.99	$83.17	4.50
14	$352.18	$80.82	4.36
15	$335.71	$80.82	4.15
16	$618.08	$83.73	7.38

Questions

Any questions on the central shaft ventilation proposal for low-rise multifamily buildings?

Verification Clean Up

Compliance Options Removal

Existing 2022 Energy Code Options

Compliance Options	Buildings ≤ 3 Stories	Buildings ≥ 4 Stories
• Evaporatively Cooled Condensers • Whole House Fan • Central Fan Ventilation Cooling System • Pre-Cooling	Available with HERS verification	Not available

Proposed 2025 Energy Code Change

- Remove compliance options that are not applicable or common in multifamily buildings

Compliance Option Expansion

Existing 2022 Energy Code Options

Compliance Options	Buildings ≤ 3 Stories	Buildings ≥ 4 Stories
• Low Leakage Air-handling Units • Variable Capacity Heat Pump (VCHP)	Available with field verification and diagnostic testing verification	Not available

Proposed 2025 Energy Code Change

- Extend these field verification and diagnostic testing compliance credits to all applicable multifamily buildings, regardless of number of habitable stories

Rational

- Removing uncommon compliance options for multifamily will avoid poor compliance and verification challenges that result from HERS raters not practicing these verifications regularly

- Energy savings and cost-effectiveness not analyzed for compliance options

Questions

Any questions on the proposed changes to compliance options for multifamily buildings?

Multifamily Additions & Alterations Clean Up

Existing Code Requirements

- Creation of 2022 Multifamily additions, alterations, and repairs chapter borrows code language and structure from residential and nonresidential chapters

- This left some gaps and misalignments in the new chapter
  - Requires clarity about application of various requirements
  - References to other chapters requires jumping from chapter to chapter to understand requirements

2025 Proposed Requirements

No intent to change existing requirements

- Restructure additions and alterations requirements for ease of use
- Consistency with structure of Sections 160s and 170s
- Add mandatory requirements subsection to additions (Section180.1) to align with alterations (Section180.2)
- Remove generic references and include direct references
- Move duplicated requirements to appropriate section
- Add subsections for dwelling unit and common use area requirements
- Add Table 180.1-A summary table for envelope requirements by climate zone
- General language clean up for clarification

Comments

Comments on today's workshop due

August 30, 2023, by 5:00 PM

Submit comments to CEC Docket 22-BSTD-01
https://efiling.energy.ca.gov/Ecomment/Ecomment.aspx?docketnumber=22-BSTD-01

Contact: Javier.Perez@energy.ca.gov

Thank You!

15-minute Break

We will resume at 2:45

Comments

- **Comments on Todays Workshop**
- **Due Date: August 30, 2023, by 5:00 PM**

- **Comments to be submitted to: https://efiling.energy.ca.gov/Ecomment/Ecomment.aspx?docketnumber=22-BSTD-01**

- Thank you for participating!

Next Workshop

Our next workshop is scheduled for Wednesday, August 23rd, from 9am – 3pm

- Topics covered will include:
  - Cooling Towers
  - Process Load Pipe Insulation
  - Solar Pool and Spa Heating Systems
  - Residential HVAC System Performance
  - Multifamily Domestic Hot Water Systems

Draft and final Codes and Standards Enhancement (CASE) reports can be found at https://title24stakeholders.com/2025-cycle-case-reports/

Thank you for participating in today's workshop!

The CNRA building is being evacuated.