DOCKETED	
Docket Number:	22-BSTD-01
Project Title:	2025 Energy Code Pre-Rulemaking
TN #:	252151
Document Title:	August 30, 2023 - 2025 Pre-Rulemaking Staff Workshop Presentation
Description:	Presentation from August 30, 2023, 2025 Energy Code Pre-Rulemaking Workshop on nonresidential lighting, commercial kitchen, laboratory, and nonresidential envelope requirements.
Filer:	Javier Perez
Organization:	California Energy Commission
Submitter Role:	Energy Commission
Submission Date:	9/6/2023 11:50:00 AM
Docketed Date:	9/6/2023

Good morning and thank you for joining us.

The workshop will begin shortly.

Housekeeping Rules

Public Comments

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	Daylighting	Simon Lee
3	Lighting Clean-Up	Simon Lee
4	Commercial Kitchens	Haile Bucaneg
5	Laboratories	Haile Bucaneg
6	Nonresidential Envelope	Michael Shewmaker
7	Adjourn	

Workshop Recordings

For recordings of previous workshops, visit:
https://www.energy.ca.gov/events/past-events

2025 Energy Code – Pre-Rulemaking

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

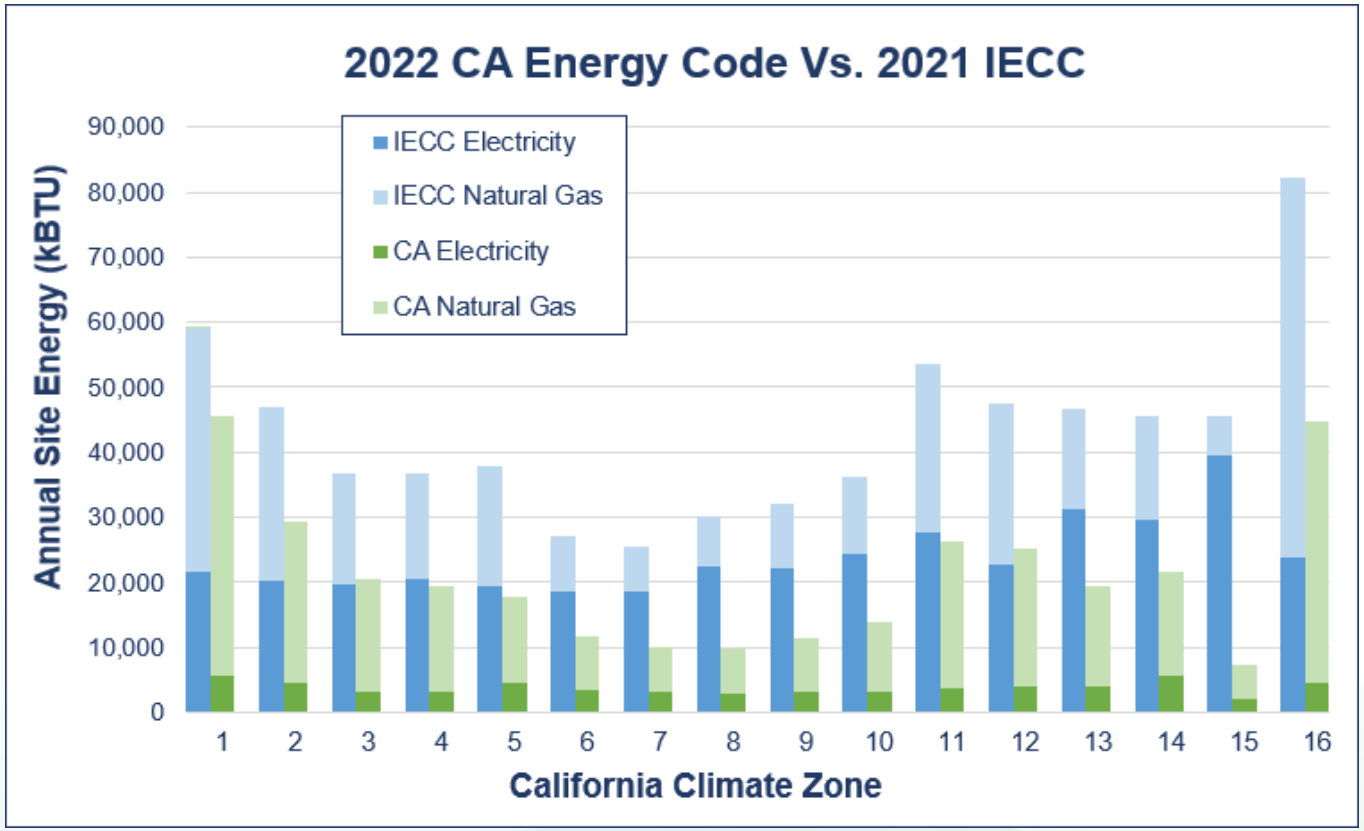
Javier Perez, Project Manager – 2025 Energy Code

August 30, 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

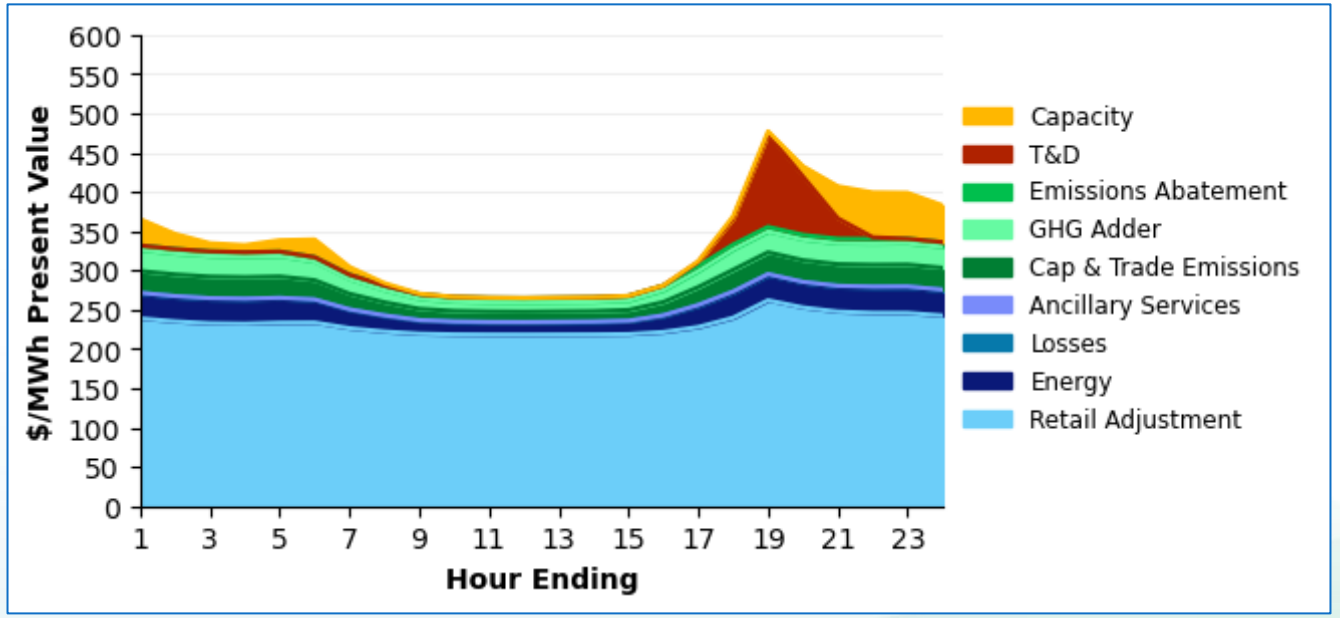
2025 Energy Code Strategies

- 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.



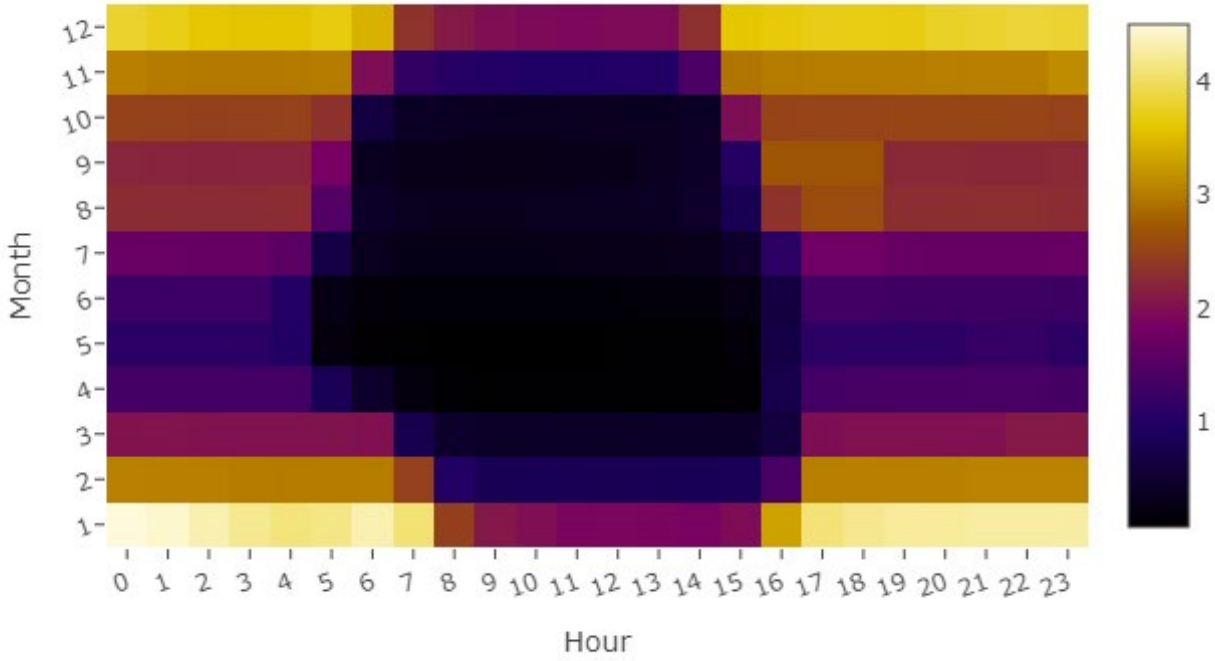
Sample LSC shape by component, average day, levelized 30-year residential, climate zone 12

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.

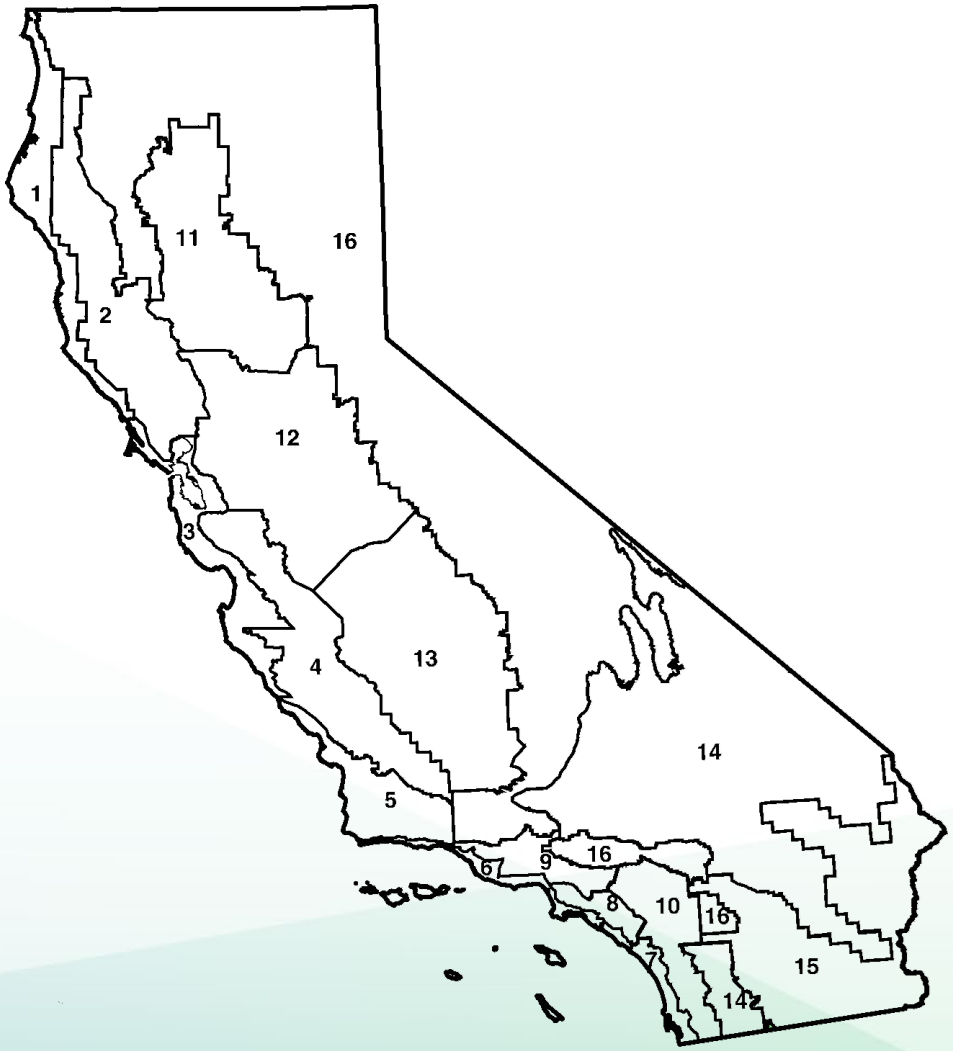
5-Month Average of electricity long run marginal source energy for 2025 Energy Code



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 Energy Code – Pre-Rulemaking

Daylighting

Simon Lee, P.E, Electrical Engineer

August 30, 2023

Existing Code Requirements

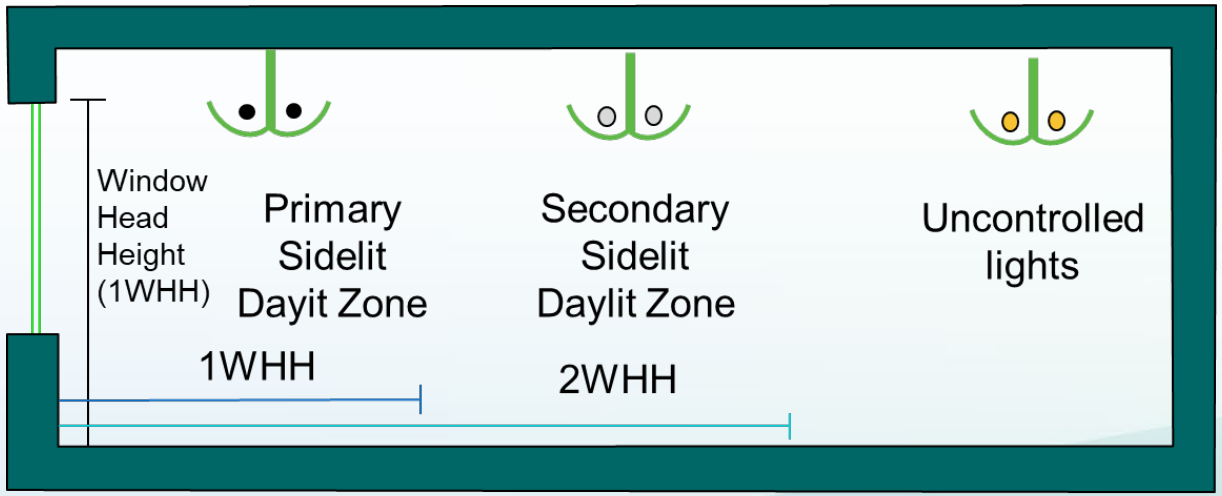
Daylighting Control Requirements for nonresidential buildings Section 130.1(d)3; multifamily buildings Section 160.5(b)4Diii:

The automatic daylighting controls shall:

A. For spaces required to install multilevel controls under Section 130.1(b), adjust lighting via continuous dimming …;

B. For each space, ensure the combined illuminance from the controlled lighting and daylight is not less than the illuminance from controlled lighting when no daylight is available;

C. For areas other than parking garages, ensure that, when the daylight illuminance is greater than 150 percent of the illuminance provided by the controlled lighting when no daylight is available, the controlled lighting power in that daylight zone shall be reduced by a minimum of 90 percent; and …



Exception 3 to Section 130.1(d):
Rooms where the combined total installed wattage of the general lighting in the skylit and primary sidelit zones is less than **120 watts** are not required to have daylighting controls for those zones. Rooms where the total installed wattage of the general lighting in the secondary sidelit zones is less than **120 watts** are not required to have daylighting controls for that zone.

2025 Proposed Changes

Daylighting Controls Requirements:

- Delete Exception 3 to Section 130.1(d) and add a wattage threshold as a trigger criteria to the main body of the daylighting section.
- Reduce the wattage threshold for triggering automatic daylighting controls from 120 watts to 75 watts for skylit, primary sidelit, and secondary sidelit daylit zones.
- General code language clean up
  - Segmentation of linear luminaires across daylit zones
  - Interactions with other lighting controls.

2025 Proposed Requirements

Automatic daylighting controls:

- In any enclosed space where the total installed wattage of general lighting luminaires completely or partially within skylit daylit zones is **75 watts** or greater, general lighting in skylit daylit zones shall be controlled by automatic daylighting controls.
- In any enclosed space where the total installed wattage of general lighting luminaires completely or partially within primary sidelit daylit zones is **75 watts** or greater, the general lighting in that primary sidelit daylit zones shall be controlled by automatic daylighting controls.
- In any enclosed space where the total wattage of general lighting luminaires in the secondary zones is **75 watts** or greater, the general lighting in secondary sidelit daylit zones shall be controlled by automatic daylighting controls. General lighting in the secondary sidelit daylit zones shall be controlled independently of the general lighting in the primary sidelit daylit zones.

Exception: Where automatic daylighting controls are not required for the primary sidelit daylit zones, and where the total wattage of general lighting luminaires in the secondary sidelit daylit zones is less than **85 watts**, automatic daylighting controls are not required for the secondary sidelit zone.

2025 Proposed Requirements

(continue) New proposed language

General lighting luminaires

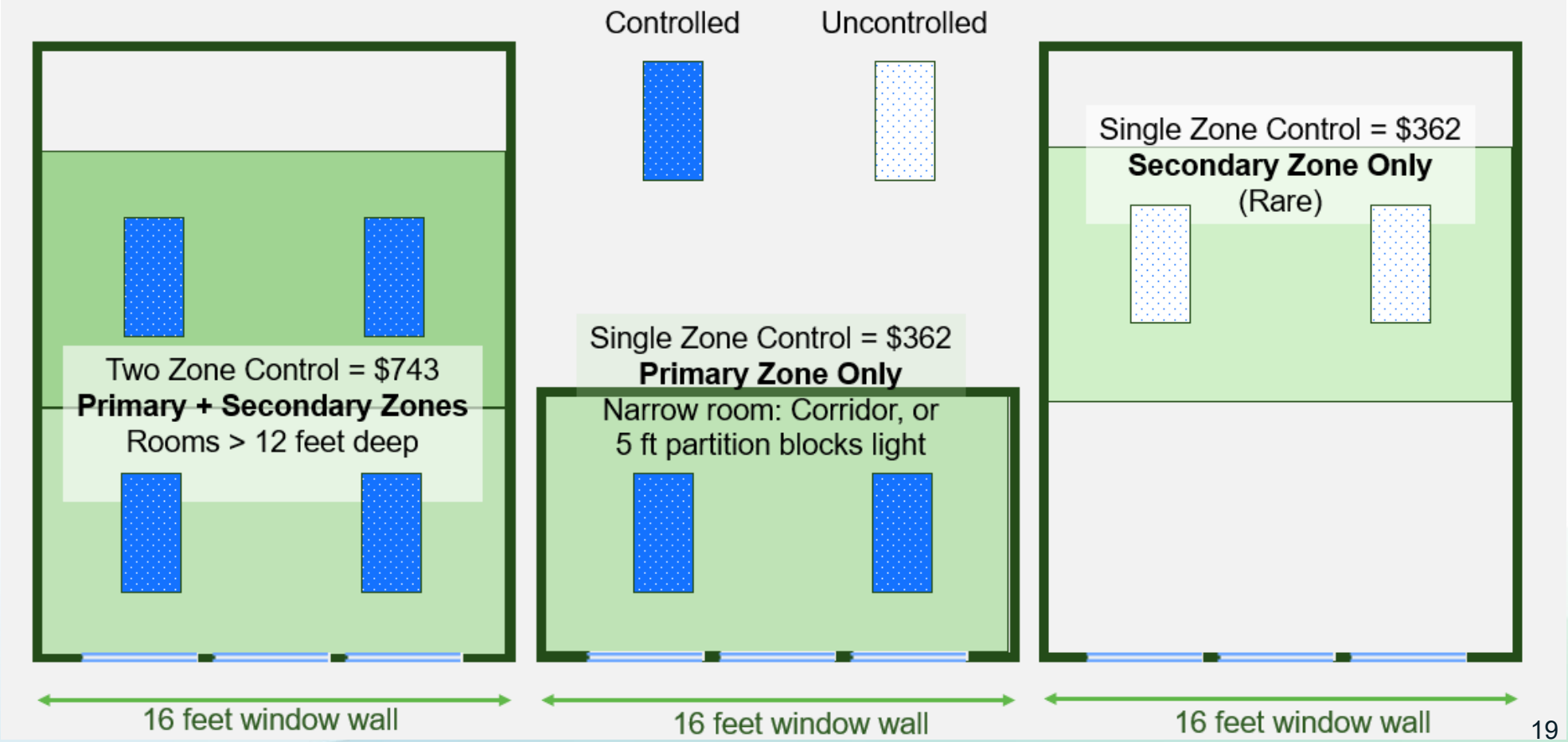
General lighting luminaires longer than 8 feet shall be controlled as segments of 8 feet or less according to the type of the daylit zone in which the segment is primarily located.

Interactions with other lighting controls

- Where area controls are required, area controls shall be capable of turning off or decreasing light levels to below the light levels set by the daylighting controls.
- Area controls shall be allowed to **temporarily increase** electric lighting light levels above the required levels in Section 130.1(d)3 if the controls are configured to reset electric lighting controls back to the Section 130.1(d)3 defaults after lights have been turned off or reduced by a manual control, occupancy sensor or timeclock.

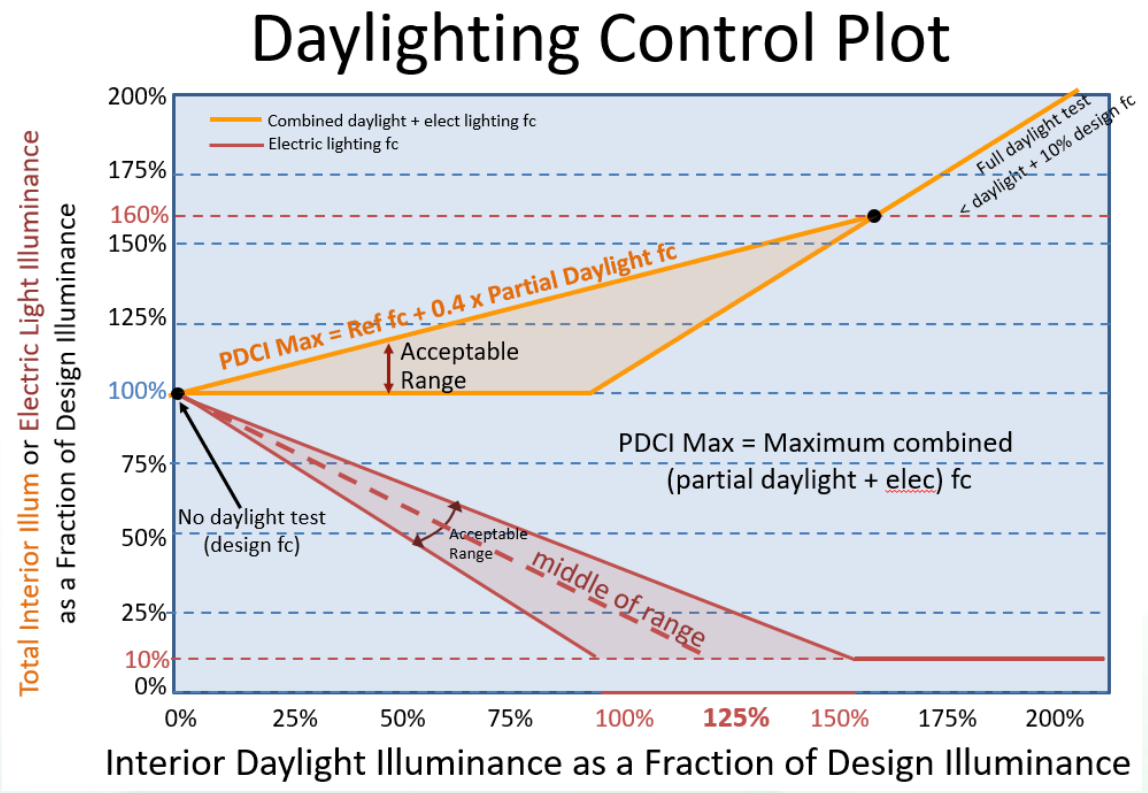
2025 Proposed Requirements

Example scenarios - about the proposed language - spaces with luminaires (40W each and 80 watts subtotal in each daylit zone)



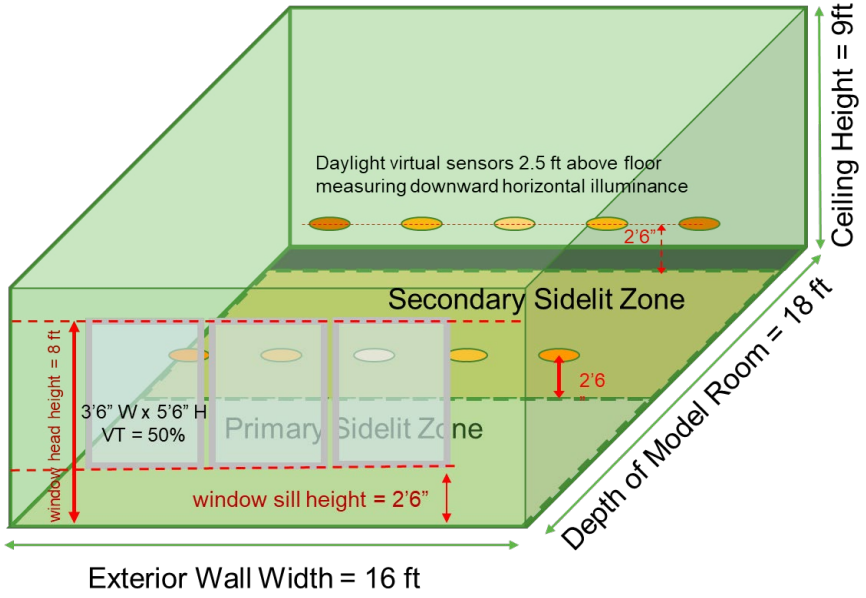
Analysis Key Assumptions

- Energy analysis based on IES design illuminance recommended for different spaces:
  - Offices, conference rooms, multipurpose rooms = 300 lux
  - Corridors = 100 lux
  - Exercise areas = 400 lux
- Continuously dimming from 100% input power to 12% input power at 10% light output
- Code-compliant electric light dimming
  - Target control illuminance in the middle of range 125% of design fc
- HVAC interaction effects not calculated
  - Would increase savings slightly
  - Net added benefit <10% (DEER, LBNL)



Software Used & Prototypes

- Model developed to represent spaces most likely be impacted by change from 120 W to 75 W threshold
  - 16’ x 18’ x 9’ (288 ft^2)
  - Space type agnostic
  - Reflectances: 80%/50%/20%
  - Windows:
    - Three: 3’-6”W by 5’-6”H
    - Visible transmittance = 50%
- Daylight simulated using Radiance raytracing analysis using LightStanza for the 16 CA climate zones
- Daylight illuminance for control:
  - Average of 5 sensors at rear of primary and secondary zone
  - 2.5 feet above finished floor
- Resulting unit energy savings represented in kWh per controlled watt



Energy Savings per Controlled Watt

	Primary and Secondary Sidelit Daylight Zone	Primary and Secondary Sidelit Daylight Zone	Primary Sidelit Daylight Zone Only	Primary Sidelit Daylight Zone Only	Primary Sidelit Daylight Zone Only	Secondary Sidelit Daylight Zone Only	Secondary Sidelit Daylight Zone Only
Climate Zone	Office / Conf Rm / Multipurpose Energy Savings (kWh/yr-W)	Exercise Rm Energy Savings (kWh/yr-W)	Corridor Energy Savings (kWh/yr-W)	Office / Conf Rm / Multipurpose Energy Savings (kWh/yr-W)	Exercise Rm Energy Savings (kWh/yr-W)	Office / Conf Rm / Multipurpose Energy Savings (kWh/yr-W)	Exercise Rm Energy Savings (kWh/yr-W)
1	1.52	1.36	1.88	1.72	1.62	1.31	1.09
2	1.59	1.43	1.91	1.79	1.70	1.39	1.15
3	1.61	1.45	1.92	1.80	1.71	1.42	1.18
4	1.64	1.47	1.92	1.82	1.73	1.45	1.21
5	1.64	1.48	1.92	1.82	1.73	1.46	1.22
6	1.65	1.49	1.91	1.82	1.75	1.47	1.23
7	1.64	1.47	1.91	1.82	1.74	1.46	1.20
8	1.63	1.47	1.91	1.81	1.73	1.45	1.20
9	1.63	1.47	1.91	1.81	1.73	1.45	1.20
10	1.64	1.48	1.91	1.81	1.73	1.46	1.22
11	1.57	1.41	1.90	1.76	1.66	1.38	1.15
12	1.58	1.42	1.90	1.77	1.68	1.39	1.16
13	1.59	1.43	1.88	1.77	1.68	1.41	1.17
14	1.66	1.50	1.91	1.83	1.75	1.48	1.24
15	1.66	1.50	1.90	1.82	1.75	1.49	1.25
16	1.57	1.40	1.90	1.76	1.66	1.37	1.14

Statewide Impacted Spaces by Building Type

Prototype Building	New Construction Impacted	Existing Buildings Impacted	New Construction Daylit (Mft²)	Existing Building Daylit (Mft²)	Office	Conference Room	Corridor	Multipurpose Room	Exercise Room	Lobby
Large Office	7%	7%	0.93	5.06	50%	40%	10%	-	-	-
Medium Office	7%	7%	1.08	3.16	60%	20%	20%	-	-	-
Small Office	7%	7%	0.23	1.12	80%	-	20%	-	-	-
Large Retail	5%	5%	0.42	1.52	40%	50%	10%	-	-	-
Medium Retail	2%	2%	0.15	0.75	50%	40%	10%	-	-	-
Mixed-use Retail	0.5%	0.5%	0.03	0.00	60%	20%	-	-	-	20%
Large School	7%	5%	0.51	1.39	40%	60%	-	-	-	-
Small School	2%	3%	0.09	0.66	50%	50%	-	-	-	-
Non-refrig. Warehouse	1%	1%	0.17	0.82	70%	30%	-	-	-	-
Hotel	0.5%	0.5%	0.04	0.13	40%	30%	10%	-	20%	-
Assembly	5%	3%	0.55	1.51	50%	30%	10%	10%	-	-
Hospital	6%	6%	0.35	1.68	50%	50%	-	-	-	-
Laboratory	10%	10%	0.54	1.16	60%	40%	-	-	-	-
Restaurant	1%	1%	0.04	0.13	100%	-	-	-	-	-
Grocery	1%	1%	0.01	0.03	70%	20%	10%	-	-	-
Refrigerated Warehouse	1%	1%	0.00	0.01	70%	30%	-	-	-	-
CEH	1%	1%	0.02	0.03	70%	30%	-	-	-	-
Vehicle Service	10%	10%	0.60	2.74	20%	-	80%	-	-	-
New Construction Total Daylit Area (Million ft²)	**-**	**-**	**5.76**	**-**	**2.89**	**1.84**	**0.95**	**0.05**	**0.01**	**0.01**
Existing Buildings Total Daylit Areas (Million ft²)	**-**	**-**	**-**	**21.90**	**10.83**	**6.94**	**3.95**	**0.15**	**0.03**	**0.00**

Statewide Savings: First Year's Construction

	Electricity Savings (GWh/yr)	Peak Elect Demand Reduction (MW)	Source Energy Savings (Million kBtu/yr)	30 Year LSC Elec Cost Savings (Million PV$)
New Construction & Addition	5.78	0.02	3.10	$24.01
Alterations	21.98	0.09	11.81	$91.34
Totals	**27.76**	**0.12**	**14.91**	**$115.35**

- No HVAC interaction effects calculated as they are small
  - Would result in increase energy savings
- As a result, no gas impacts (heating impacts) calculated

First-Year Statewide GHG Emissions Impacts

Construction Type	Statewide Area with Added Daylight Controls (1,000 feet^2)	Statewide Lighting Wattage Newly Controlled (kW)	First-Year Statewide Electricity Saving [a] (GWh/year)	Reduced GHG Emissions [b] (metric tons CO2e)	Monetary Value of Reduced GHG Emissions ($)
New Construction & Additions	5,753	3,548	5.79	164	20,219
Alterations	21,898	13,417	22.02	626	77,109
Totals	**27,651**	**16,965**	**16,965**	**790**	**97,328**

30-Year Electricity Savings

The information also applies as the 30-Year Long-Term System Cost (LSC) Savings.

Climate Zone	New Construction & Addition (Million PV$)	Alterations (Million PV$)
1	$0.07	$0.30
2	$0.59	$2.04
3	$3.33	$10.90
4	$1.69	$5.82
5	$0.28	$0.98
6	$1.96	$7.63
7	$1.33	$5.51
8	$2.74	$10.89
9	$4.95	$18.02
10	$1.99	$9.60
11	$0.48	$1.69
12	$2.73	$10.13
13	$0.88	$3.60
14	$0.50	$2.30
15	$0.31	$1.28
16	$0.16	$0.65
Total	**$24.01**	**$91.34**

Total Incremental Cost

- Material cost including photocontrols obtained from:
  - Quotes from manufacturer sales representatives
  - Included sales taxes, freight shipping, and markup
- Labor cost (installation, commissioning, replacement, and maintenance)
  - Assumed labor rates of licensed electricians
  - Sources included RSMeans (scaled for CA) and prevailing wages published by the California Department of Industrial Relations
  - Rates included overhead and profit
- Acceptance test cost
  - Cost data from certified acceptance test technicians
- Maintenance and replacement cost
  - Material and labor for changing batteries (wireless systems)
  - Material and labor for total luminaire changeouts (luminaire-level controls)

Incremental Costs

- Estimated based implementing automatic daylighting controls in the 16’ x 18’ x 9’ daylight model
- Estimated for different control solution types and photocontrol configurations

Two-zone (primary + secondary) automatic daylighting control implementation

Code	Control Solution Type	Photocontrol Configuration
R-WL-C	Wireless room control	Closed loop
R-WL-O	Wireless room control	Open loop
R-WD-C	Wired room control	Closed loop
R-WD-O	Wired room control	Open loop
LLLC	Luminaire-level control	Closed loop
BMS-O	Building management system	Open loop

Single-zone (primary or secondary) automatic daylighting control implementation

Code	Control Solution Type	Photocontrol Configuration
R-WD-C-SZ	Wired room control	Closed loop
R-WL-CO-SZ	Wireless room control	Closed loop
R-WL-O-SZ	Wireless room control	Open loop
R-WD-CO-SZ	Wired room control	Closed loop

Total Incremental Cost

Two-zone (primary + secondary) automatic daylighting control implementation

Code	First Cost Total	30-year Present Value Maintenance and Replacement Cost Total	30-year Present Value Incremental Cost Total
R-WL-C	$496.06	$269.98	$766.04
R-WL-O	$464.09	$137.37	$601.46
R-WD-C	$641.96	$0	$641.96
R-WD-O	$776.42	$0	$776.42
LLLC	$432.21	$277.42	$709.64
BMS-O	$851.80	$115.16	$966.96
Average	**$610.42**	**$133.32**	**$743.74**

Single-zone (primary or secondary) automatic daylighting control implementation

Code	First Cost Total	30-year Present Value Maintenance and Replacement Cost Total	30-year Present Value Incremental Cost Total
R-WD-C-SZ	$218.52	$0	$218.52
R-WL-CO-SZ	$389.02	$53.70	$442.73
R-WL-O-SZ	$298.03	$112.63	$410.65
R-WD-CO-SZ	$377.44	$0	$377.44
Average	**$320.75**	**$41.58**	**$362.34**

Cost Effectiveness: 150 W Combined Primary + Secondary Sidelit Zone

Climate Zone	Office/Conf Rm/ Multipurpose Rm LSC Savings (PV$/150 W)	Office/Conf Rm/ Multipurpose Rm Benefit/Cost Ratio	Exercise Rm LSC Savings (PV$/150 W)	Exercise Rm Benefit/Cost Ratio
1	$928	1.25	$824	1.11
2	$977	1.31	$872	1.17
3	$995	1.34	$890	1.20
4	$1,009	1.36	$906	1.22
5	$1,018	1.37	$914	1.23
6	$1,046	1.41	$942	1.27
7	$949	1.28	$853	1.15
8	$1,028	1.38	$924	1.24
9	$1,029	1.38	$924	1.24
10	$1,033	1.39	$930	1.25
11	$955	1.28	$852	1.15
12	$966	1.30	$862	1.16
13	$973	1.31	$871	1.17
14	$1,048	1.41	$946	1.27
15	$1,047	1.41	$946	1.27
16	$986	1.33	$880	1.18

Cost Effectiveness: 75 Watt Threshold Primary Sidelit Zone Only

Climate Zone	Office/Conf Rm/ Multipurpose Rm LSC Savings (PV$/75 W)	Office/Conf Rm/ Multipurpose Rm Benefit/Cost Ratio	Exercise Rm LSC Savings (PV$/75 W)	Exercise Benefit/Cost Ratio	Corridor LSC Savings (PV$/75 W)	Corridor Benefit/Cost Ratio
1	$928	1.25	$824	1.11	$590	1.63
2	$977	1.31	$872	1.17	$603	1.66
3	$995	1.34	$890	1.20	$604	1.67
4	$1,009	1.36	$906	1.22	$603	1.66
5	$1,018	1.37	$914	1.23	$605	1.67
6	$1,046	1.41	$942	1.27	$615	1.70
7	$949	1.28	$853	1.15	$560	1.55
8	$1,028	1.38	$924	1.24	$612	1.69
9	$1,029	1.38	$924	1.24	$611	1.69
10	$1,033	1.39	$930	1.25	$610	1.68
11	$955	1.28	$852	1.15	$593	1.64
12	$966	1.30	$862	1.16	$598	1.65
13	$973	1.31	$871	1.17	$591	1.63
14	$1,048	1.41	$946	1.27	$612	1.69
15	$1,047	1.41	$946	1.27	$608	1.68
16	$986	1.33	$880	1.18	$608	1.68

Cost Effectiveness: 85 W Threshold Secondary Sidelit Zone Only

Climate Zone	Office/Conf Rm/ Multipurpose Rm LSC Savings (PV$/85 W)	Office/Conf Rm/ Multipurpose Rm Benefit/Cost Ratio	Exercise Rm LSC Savings (PV$/85 W)	Exercise Rm Benefit/Cost Ratio
1	$451	1.25	$374	1.03
2	$478	1.32	$397	1.10
3	$493	1.36	$410	1.13
4	$504	1.39	$421	1.16
5	$510	1.41	$426	1.18
6	$527	1.45	$440	1.21
7	$476	1.31	$395	1.09
8	$515	1.42	$429	1.18
9	$516	1.42	$430	1.19
10	$519	1.43	$433	1.20
11	$472	1.30	$393	1.08
12	$476	1.31	$395	1.09
13	$484	1.34	$403	1.11
14	$530	1.46	$444	1.22
15	$532	1.47	$446	1.23
16	$486	1.34	$405	1.12

Comments

Comments on today's workshop due

September 15, 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: Simon.Lee@energy.ca.gov

Thank You!

Appendix

Daylighting Controls

First-Year Electricity Savings

Climate Zone	New Construction & Addition (GWh/yr)	Alterations (GWh/yr)
1	0.02	0.07
2	0.14	0.50
3	0.81	2.64
4	0.41	1.41
5	0.07	0.24
6	0.46	1.80
7	0.34	1.42
8	0.65	2.58
9	1.17	4.27
10	0.47	2.27
11	0.12	0.41
12	0.67	2.48
13	0.22	0.88
14	0.12	0.54
15	0.07	0.30
16	0.04	0.16
Total	**5.78**	**21.98**

First-Year Peak Electricity Demand Reductions

Climate Zone	New Construction & Addition (MW)	Alterations (MW)
1	0.000	0.000
2	0.000	0.002
3	0.003	0.010
4	0.002	0.005
5	0.000	0.001
6	0.002	0.008
7	0.002	0.006
8	0.003	0.011
9	0.005	0.019
10	0.002	0.010
11	0.000	0.001
12	0.002	0.009
13	0.001	0.003
14	0.001	0.002
15	0.000	0.001
16	0.000	0.001
Total	**0.024**	**0.091**

First-Year Source Energy Savings

Climate Zone	New Construction & Addition (Million KBtu/yr)	Alterations (Million KBtu/yr)
1	0.01	0.04
2	0.07	0.26
3	0.43	1.41
4	0.22	0.76
5	0.04	0.13
6	0.26	1.00
7	0.19	0.80
8	0.35	1.40
9	0.64	2.32
10	0.26	1.24
11	0.06	0.21
12	0.33	1.24
13	0.11	0.45
14	0.07	0.31
15	0.04	0.17
16	0.02	0.08
Total	**3.10**	**11.81**

15-minute Break

We will resume at 10:30

2025 Energy Code – Pre-Rulemaking

Lighting Code Language Cleanup

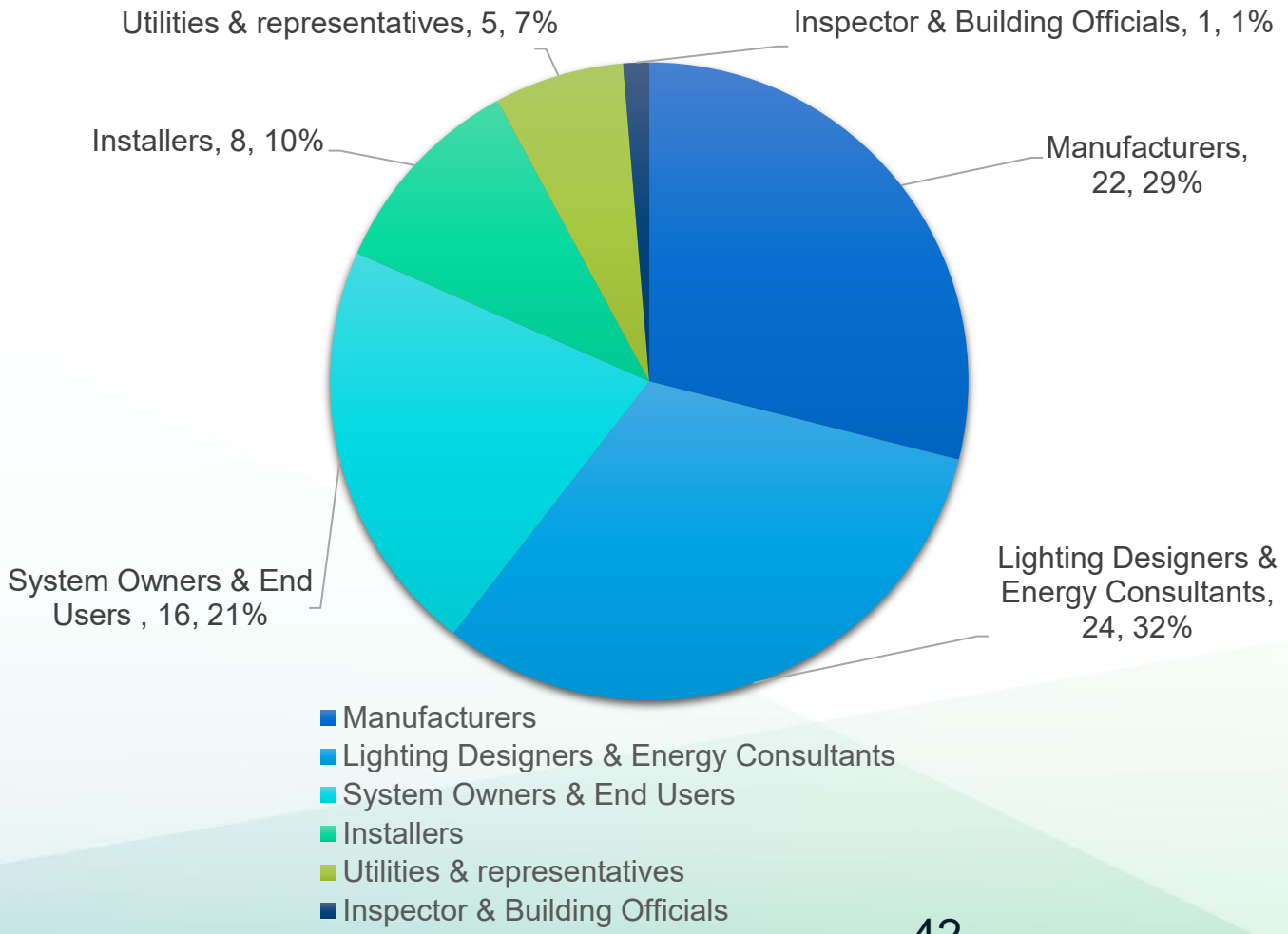
Simon Lee, P.E, Electrical Engineer

August 30, 2023

Stakeholder Participation

- A call to clarify lighting code language
- An effort requested by CEC, funded by SCE, managed by RMS and executed by CLTC.
- Stakeholder engagements:
  - Outreach thru invitation to the working group
  - Posting open invitation on CLTC website
  - Working Group was formed in 2022

Figure 1: Invitee's background & representation



2025 Proposed Requirements

The general theme of this effort is to cleanup the existing lighting code language. The proposal document is docketed as TN#250676 in Docket #22-BSTD-01.

The Sections being reviewed and presented in this Workshop:

- 100.1, 130.1, 130.2, 130.3, 130.5, 140.6, 140.8, 150.0, 160.5
- Appendix NA7, Appendix JA8

Code Change criteria to ensure clarity and consistency:

- Clarify without changing the essence of the requirements
- Reject proposed changes that are deemed to be new requirements
- Accept conditionally on proposed changes that coincides or overlaps with CEC's work in progress or CEC's future work plan for the Energy Code developments.

Lighting Topics Identified by stakeholders

Topic	Stakeholder Participants	Stakeholder Engagement (out of 34)
Automatic Daylighting Controls	10	29%
Demand Responsive Controls	10	29%
Multilevel Lighting Controls	9	26%
Outdoor Lighting	9	26%
Control Interactions	8	24%
Shut-OFF Controls	7	21%
Lighting Power Allowances	7	21%
Controlled Environment Horticulture Lighting	7	21%
Overall Structure of the Energy Code	6	18%
Residential	6	18%
Manual Area Controls	5	15%
Multifamily Buildings	5	15%
Sign Lighting	4	12%
Power Adjustment Factors	3	9%
Lighting Wattage Exclusions	3	9%
Acceptance Testing Requirements	3	9%
Electrical Power Distribution	3	9%
Compliance Manual	2	6%
Lighting Definitions	2	6%
Compliance Forms*	N/A	N/A

Energy Code Structure

Docketed proposal, TN#250676 in Docket #22-BSTD-01.

Specific considerations for staff:

- Digitize the Energy Code with modern digital features.
- Move Tables to follow the language where it is first introduced.

CEC Staff are also planning on formatting changes to the Energy Code. More details to come in future.

Other Lighting Measure

The 2025 Daylighting measure: (see the daylighting measure presentations for more information)

- Propose to revise and lower the wattage threshold from 120W to 75W.
- Reorganize the language and move the wattage threshold from Exception 3 to the beginning of Section 130.1(d).

2025 Proposed Requirements Section 100.1

Changes affecting the overall lighting code

- Move tables following the code section language
  Tables in Section 130's and 140's.
  Tables in Section 160's and 170's.

Section 100.1 Definitions:

- Modify and update several definitions (General Lighting; Multilevel Lighting Control; Temporary Lighting) - see next slide for the revised definition language.
- Add IES documents to Section 100.1. Include the following:
  LM-20 incandescent and halogen reflector lamps;
  LM-45 incandescent non-reflector lamps;
  LM-66 for induction lamps;
  LM-51 for high intensity discharge lamps.
- Indent "Lighting Definitions" to align with other formatting. (This editorial change is not likely to be in conflict with the CEC's Style Guide other document guidelines.)

2025 Proposed Language Section 100.1

Section 100.1 – Definitions:

General Lighting is ~~installed electric lighting that provides a uniform level of illumination throughout an area, exclusive of any provision for special visual tasks or decorative effect, exclusive of daylighting, and also known as ambient lighting~~ lighting designed to provide a substantially uniform level of illuminance throughout an area, exclusive of any provision for special local requirements. General lighting is installed electric lighting, exclusive of daylighting.

Multilevel Lighting Control ~~reduces power going to a lighting system in multiple steps~~ allows the level of lighting to be adjusted up and down.

Temporary Lighting is a temporary lighting installation, with plug-in connections, that ~~does not~~ persists ~~beyond 60 consecutive days or more than 120 days per year~~ within the time constraints specified in California Electrical Code Article 590.

2025 Proposed Requirements Section 110.12

Section 110.12 – Mandatory Requirements for Demand Management

Section 110.12(a) - Demand Responsive Controls

- Clarify the demand responsive controls requirements.
  - Replace “pathway” with “protocol”. Section 110.12(a)2
  - Replace “communication” with “demand response signal” for the situation when it is disabled or unavailable. Add “demand responsive” so that it reads “demand responsive” control. Section 110.12(a)4

Section 110.12(c) - Demand Responsive Lighting Controls

- Clarify the demand responsive lighting control requirements are about the general lighting in the spaces.

Section 110.12(e) – Demand Responsive Controlled Receptacles

- Propose to add language to DR controlled receptacle for that during a DR event, the DR controlled receptacles cannot be overridden.
- Clarify the exceptions to the demand responsive controlled receptacles requirement, 110.12(e). “Spaces without DR lighting controls” are exempted from the DR controlled receptacles requirement.

2025 Proposed Language Section 110.12

Proposed Language for Section 110.12:

Section 110.12(a)2. All demand responsive controls shall be capable of communicating with the VEN using a wired or wireless bidirectional protocol.

Section 110.12(a)4. When ~~communication~~ the demand response signal is disabled or unavailable, all demand responsive controls shall continue to perform all other control functions provided by the demand responsive control.

Section 110.12(c)2. For buildings where demand response controls are required, demand responsive controls shall control the general lighting in the spaces required to meet ~~that is subject to the requirements of~~ Section 130.1(b) and may control additional lighting.

Section 110.12(e). Demand Responsive Controlled Receptacles. Controlled receptacles in buildings shall be capable of automatically turning off all loads connected to the receptacle in response to a demand response signal. During a demand response event, the demand responsive controlled receptacle shall not be capable of being overridden to turn ON by automatic shut-off controls or any manual control.

Exception 1 to Section 110.12(e): ~~Buildings not required to have~~ Spaces without demand responsive lighting controls.

2025 Proposed Requirements Section 130.1(a)

Section 130.1(a) - Manual Area Controls:

Proposed Changes:
Rename the section to “Manual Controls”

- Simplify the term, “area enclosed by ceiling partitions” to “enclosed space”.
- Simplify and summarize Exception 1 and move it to Section 130.1(a)2. Remove the Exception.

Proposed Language:

Section 130.1(a). Manual ~~area~~ ~~c~~Controls. Each ~~area~~ enclosed space ~~by ceiling-height partitions~~ shall provide lighting controls that allow the lighting in that area to be manually turned on and off. The manual control shall:

...

Section 130.1(a)2. Be located in the same enclosed space, or be located ~~area with~~ such that the controlled lighting or status of the controlled lighting ~~it controls~~ can be seen when operating the controls; and

~~Exception 1 to Section 130.1(a)2: For malls and atria, main entry lobbies, auditorium areas, dining areas, retail merchandise sales areas, wholesale showroom areas, commercial and industrial storage areas, general commercial and industrial work areas, convention centers, arenas, psychiatric and secure areas in healthcare facilities, and other areas where placement of a manual area control poses a health and safety hazard, the manual area control may instead be located so that a person using the control can see the lights or area controlled by that control, or visually signal or display showing the current state of the controlled lighting.~~

2025 Proposed Requirements Section 130.1(b)

Section 130.1(b) - Multilevel Lighting Controls

Proposed Changes:

- Delete Table 130.1-A and move the “maintain illuminance uniformity … continuous dimming from 10-100 percent” to Section 130.1(b).
- Delete subsection (b)1 about the control steps and delete subsection (b)2 about uniformity.
- Revise the term “enclosed area” to “enclosed space” in Section 130.1(b) to ensure consistency in using the revised term.

2025 Proposed Language Section 130.1(b)

Proposed Language:

Section 130.1(b) - Multilevel lighting controls. The general lighting of any enclosed ~~area~~ space 100 square feet or larger with a connected lighting load that exceeds 0.5 watts per square foot shall provide multilevel lighting controls that allow the level of lighting to be adjusted up and down and maintain illuminance uniformity by providing continuous dimming from 10 to 100 percent of lighting power. ~~The multi-level controls shall:~~

~~1. Provide the number of control steps specified in Table 130.1-A; and~~

Exception 1 to Section 130.1(b): An ~~area~~ enclosed ~~by ceiling height partitions~~ space that has only one luminaire ~~with no more than two lamps or has only one inseparable SSL luminaire~~.

Exception 2 to Section 130.1(b): Restrooms.

Exception 3 to Section 130.1(b): Healthcare facilities.

Exception 4 to Section 130.1(b)1: Classrooms with a connected general lighting load of 0.6 watts per square foot or less shall have a minimum of one control step between 30 and 70 percent of full rated power, regardless of luminaire type.

Exception 5 to Section 130.1(b): The general lighting with light sources of HID and induction shall have a minimum of one control step between 30 and 70 percent of full rated power.

2025 Proposed Requirements Section 130.1(c)

Section 130.1(c) – Shut-OFF Controls

Proposed Changes
Add time delay language ‘Set to no more than a 20-minute time delay’ to Section 130.1(c)1A.

- Move means of egress exception from Sections 130.1(c)1 to 130.1(c) – to clarify the exemption.

  Proposed Language:

  Exception 2 to 130.1(c): Up to 0.1 watts per square foot of lighting in any area within a building may be continuously illuminated, provided that the area is designated for means of egress on the plans and specifications submitted to the enforcement agency …
- Clarify the exception **for** emergency lighting to shutoff controls requirement, Section 130.1(c).
- Add reference to ‘control zones’ as opposed to ‘controls’ in Section 130.1(c)1.
- Add requirement to show the occupant sensing control zones information on plans – for offices greater than 250 square feet. Revise the office occupant sensing controls language in Section 130.1(c)6Dii to align with the wordings of subsection D.iv., “operate at more than 20 percent of full power”.
- Consolidate stairwell and corridor requirements to 130.1(c)6. Move parking space requirements to Section 130.1(c)6. Remove Section 130.1(c)7.
- simplify wording by removing redundant phrasing.

2025 Proposed Language Section 130.1(c)

Proposed Language:

Section 13.1(c)1- ~~In addition to lighting controls installed to comply with Sections 130.1(a) and (b),~~ ~~all~~ All installed indoor lighting shall be equipped with controls that meet the following requirements:

A. Shall be controlled with an occupant sensing control set to no more than a 20-minute time delay, automatic time-switch control, or other control capable of automatically shutting OFF all of the lighting when the space is typically unoccupied; and …

C. Separate controls~~~~ zones for a space enclosed by ceiling height partitions not exceeding 5,000 square feet.

Exception 2 to Section 130.1(c)1: Lighting complying with Section 130.1(c)5; ~~or 7~~ lighting complying with Section 130.1(c)6E.

~~Exception 3 to Section 130.1(c)1 …~~

Exception 4 3 to Section 130.1(c)1 …

Exception ~~5~~ 4 to Section 130.1(c)1: Illumination provided by lighting equipment that ~~is designated for emergency lighting, connected to an emergency power source or battery supply, and~~ is intended to function in emergency mode only when normal power is absent.

2025 Proposed Language Section 130.1(c)

Proposed Language: ~~of Section 130.1(c):~~

Section 130.1(c)3- If an automatic time-switch control, ~~other than an occupant sensing control,~~ is installed to comply with Section 130.1(c)1, it shall incorporate a manual override lighting control that :

~~A. Complies with Section 130.1(a); and~~

~~B. Allows~~ allows the lighting to remain ON for no more than 2 hours when an override is initiated.

Exception 1 to Section 130.1(c)3: Areas where occupant sensing controls are installed.

Section 130.1(c)4- If an automatic time-switch control, ~~other than an occupant sensing control, L~~is installed to comply with Section 130.1(c)1, it shall incorporate an automatic holiday "shut-OFF" feature that turns OFF all loads for at least 24 hours, and then resumes the normally scheduled operation.

Exception 1 to Section 130.1(c)4: Areas where occupant sensing controls are installed.

Exception 2 to Section 130.1(c)4: Holiday shut-OFF features are not required In in retail stores and ~~associated~~ malls, restaurants, grocery stores, churches, and theaters~~, the automatic time-switch control is not required to incorporate an automatic holiday shut-OFF feature~~.

5. Occupant sensing controls are required for specified offices, …, lighting shall be controlled with occupant sensing controls to automatically shut OFF all of the lighting in 20 minutes or less after the ~~control zone~~space is unoccupied.

2025 Proposed Language Section 130.1(c)

Proposed Language:

Section 130.1(c)6D. In office spaces greater than 250 square feet …

i. The occupant sensing controls shall be configured so that lighting shall be controlled separately in control zones not greater than 600 square feet. ~~For luminaires with an embedded occupant sensor … each luminaire can be considered its own control zone~~All control zones in offices greater than 250 square feet shall be shown on the plans; and

ii. In 20 minutes or less after the control zone is unoccupied, the occupant sensing controls shall uniformly reduce lighting power in the control zone ~~by at least 80 percent of full power~~ to operate at not more than 20 percent of full power. Control functions that switch control zone lights completely off when the zone is vacant meet this requirement; and …

Section 130.1(c)6E. Lighting installed in the following shall meet the requirements below instead of complying with Section 130.1(c)1. In parking garages, parking areas and loading and unloading areas, general lighting shall be controlled by occupant sensing controls … No more than 500 watts … controlled together as a single zone. The occupant sensing controls shall be capable of automatically turning the lighting fully ON … all designed paths of egress. Interior areas of parking garages are classified as … Parking areas on the roof of a parking structure are classified as … in Section 130.2.

2025 Proposed Requirements Section 130.1(d)

Section 130.1(d) - Daylighting Controls

Proposed Changes:

- To change the section title to “Daylight Responsive Controls”. This is to match to the similar term of IECC Code. No change to the definition.
- A Daylighting proposal measure is developed by CA Statewide Utility Codes and Standards Enhancement Team. The measure is to revise and lower the lighting power wattage threshold of the automatic daylighting controls requirements (“Daylight Responsive Controls” requirements).

2025 Proposed Requirements Section 130.1(f) & (d)

Section 130.1(f) – Control Interaction

Proposed Changes:

- Delete the subsection 130.1(f). Move and revise those related to the daylighting controls to 130.1(d).

Section 130.1(d) – Automatic Daylighting Controls

Proposed Text:

Section 130.1(d)A- In spaces where ~~area~~ manual controls are required, the ~~area~~ manual controls shall be capable of turning off or decreasing light levels to below the light level set by the daylighting controls.

Section 130.1(d)B- ~~Area~~ Manual controls shall be permitted to temporarily increase electric lighting light levels above the light level set by the daylight responsive controls if the controls are configured to reset electric lighting controls back to the Section 130.d()3 defaults after lights have been turned off or reduced by a manual controls~~, occupancy sensor or timeclock~~.

Section 130.1(d)C - In spaces where multilevel lighting controls are required, the multilevel lighting controls shall be permitted to override the light level set by the daylight responsive control.

2025 Proposed Requirements Section 130.2(c)

Section 130.2(c) – Outdoor Lighting Controls And Equipment

Proposed Changes:

Clarifications to automatic scheduling controls and motion sensing controls requirements:

- Simplify the lighting power reduction language by removing “no more than 90 percent” – from the automatic scheduling controls and the motion sensing controls requirements. Sections 130.2(c)2B and 130.2(c)3B.

Clarifications to the motion sensing controls requirements:

- Rename ‘Bilaterally symmetric outdoor wall mounted luminaires’ to ‘wall pack luminaires.’ Section 130.2(c)
- Reorganize Section 130.2(c)3A to be requirements with exceptions.
- Move a permissible (maybe) language to the compliance manual. “Motion sensing controls may be installed for other outdoor lighting and in combination with other outdoor lighting controls.”

Reviewed item: A suggestion to add the BUG table information of CALGreen Code to the Energy Code.

2025 Proposed Language Section 130.2(c)

Section 130.2(c)2- Automatic Scheduling Controls

Proposed text:

Section 130.2(c)2B - Automatic scheduling controls shall be capable of reducing the outdoor lighting power by at least 50 percent ~~and no more than 90 percent~~ , and separately capable of turning the lighting OFF, during scheduled unoccupied periods.

Section 130.2(c)3 – Motion Sensing Controls

Proposed text:

Section 130.2(c)3A - Motion sensing controls shall be installed for the following luminaires where the bottom of the luminaire is mounted 24 feet above grade or lower. ~~Motion sensing controls may be installed for other outdoor lighting and in combination with other outdoor lighting controls.~~

i. Outdoor luminaires ~~other than those~~ providing lighting for general hardscape, parking lots, outdoor sales lot, vehicle service station canopies, and vehicle service station hardscape applications ~~building façade, ornamental hardscape, outdoor dining or outdoor sales frontage lighting, where the bottom of luminaire is mounted 24 feet above grade or lower~~; and

ii. Wall pack luminaires (bilaterally symmetric outdoor wall-mounted luminaires) ~~(typically referred to as "wall packs")~~ providing building façade lighting, ornamental hardscape lighting or outdoor dining lighting ~~that are mounted 24 feet above grade or lower.~~

2025 Proposed Requirements Section 130.5

Section 130.5 - Electrical Power Distribution
Proposed Changes:

- Clarified the controlled receptacles requirements. Section 130.5(d)
  - Replace “splitwired receptacle” with “multiple receptacle outlet”.
  - Simplify the marking language. Delete the wording “durable”. “Provide a permanent marking …”
  - Align the “time delay to off” period to 20 minutes. “the power is switched off no longer than 20 minutes …”.
  - Move the note about “hardwired power-strip, plug-in strips and plug-in devices” to the front of the section.

- Add a new category to Table 130.5-B for “Other load types not specified on this table”.

2025 Proposed Language Section 130.5(d)

Section 130.5(d)- Circuit Controls for 120-Volt Receptacles and Controlled Receptacles

Proposed Text:

2. Install … or install a ~~splitwired~~ multiple receptacle outlet with at least one controlled and one uncontrolled receptacle. …
3. Provide a permanent ~~and durable~~ marking for controlled receptacles ...
4. For hotel and motel guest rooms, … the power is switched OFF no longer than ~~30~~ 20 minutes after the guestroom has been vacated.

2025 Proposed Language Table 130.5-B

Table 130.5-B – Minimum Requirements For Separation of Electrical Load

Proposed language:

ELECTRICAL LOAD TYPE	ELECTRICAL SERVICES RATED 50 kVA OR LESS	ELECTRICAL SERVICES RATED MORE THAN 50 kVA AND LESS THAN OR EQUAL TO 250 kVA	ELECTRICAL SERVICES RATED MORE THAN 250 kVA AND LESS THAN OR EQUAL TO 1000 kVA	ELECTRICAL SERVICES RATED MORE THAN 1000 kVA
Other load types not specified on this Table,	All loads in aggregate	All loads in aggregate	All loads in aggregate	All loads in aggregate

2025 Proposed Requirements Section 140.6

Section 140.6 – Prescriptive Requirements for Indoor Lighting
Proposed Changes

- Section 140.6(a)2 – Reduction of Wattage through controls
  - Require occupancy sensor zones to be shown on plans.
  - Add a clarifying language for the demand responsive controls PAF. The proposed text: "If DR controls are required of Section 110.12(c), this PAF is not available for any lighting in the project."
- Section 140.6(a)3 - Lighting Wattage Excluded
  - Revise the definition of Temporary Lighting to align it with the temporary lighting definition of California Electrical Code Article 590 - for temporary up to 90 days. (See the Definition slide about this proposed definition language.)
  - Add a note about Group U buildings to aid code readers about the buildings.

Proposed Text:
Section 140.6(a)3O. Lighting in occupancy group U buildings (Utility and Miscellaneous Group U) less than 1,000 square feet."

- Propose to delete the Exception to Section 140.6(a) for portable lighting in office areas. There is already a provision in Table 140.6-C for portable lighting in offices.

2025 Proposed Requirements Section 140.7/8

Section 140.7 – Prescriptive Requirements for Outdoor Lighting
Proposed Changes:
Table 140.7-B Additional Lighting Power Allowance for Specific Application

- Add a note for “Special Security Lighting for Retail Parking and Pedestrian Hardscape”.
- Add a note to clarify "security camera" lighting allowances.

Section 140.8 – Prescriptive Requirements for Signs
Proposed Changes:

- Update the sign lighting light sources. Remove legacy light sources including high pressure sodium lamps, metal halide lamps and fluorescent lamps.

2025 Proposed Language Table 140.7-B

Table 140.7-B Additional Lighting Power Allowance for Specific Applications Proposed Language

WATTAGE allowance per specific area (W/ft2). May be used in addition to the building entrance or exit allowance.

	LZ0	LZ1	LZ2	LZ3	LZ4
Special Security Lighting for Retail Parking and Pedestrian Hardscape.	Not applicable	0.004 W/ft^2	0.005 W/ft^2	0.010 W/ft^2	No Allowance

WATTAGE allowance per hardscape area (W/ft2). May be used for illuminated hardscape area on the site.

	LZ0	LZ1	LZ2	LZ3	LZ4
Special Cameras.	Not applicable	No Allowance	0.018 W/ft^2	0.018 W/ft^2	0.018 W/ft^2

2025 Proposed Language Section 140.8

Section 140.8 – Prescriptive Requirements For Signs
Proposed Language:

Section 140.8(b) - Alternate lighting sources. The sign shall be equipped with one or more of the following light sources:

1. ~~High pressure sodium lamps; or~~
2. ~~Metal halide lamps that are:~~
3. Neon or cold cathode lamps with transformer or power supply …

~~4. Fluorescent lighting systems meeting one of the following requirements:~~

5. Light emitting diodes (LEDs) with a power supply having …

~~6. Compact fluorescent lamps that do not contain a medium screw base socket (E24/E26):~~

2025 Proposed Requirements Section 150.0 and JA8

Section 150.0 – Single-Family Residential Buildings – Mandatory Features and Devices

JA8 - Qualification Requirements for High Luminous Efficacy Light Sources

Proposed Changes:

Residential lighting requirements in Section 150.0(k) and JA8

- Revise Section 150.0(k)1A – "Luminaire Efficacy" and Section 150.0(k)1B – "Screw Based Luminaires" by adding "lamps and light sources" to (k)1A, luminaire efficacy. Delete Section 150.0(k)1B about screw-based luminaires. Delete reference to the table and refer directly to JA8.
- Delete Table 150.0-A - Classification of High Luminous Efficacy Light Sources,
  - move the automatically high efficacy light sources listed in the table to a new Exception 4.
- Add lighting integral to "ceiling fan kits" to Exception 1 to the luminaire efficacy requirements.
- Revise Section (k)1C and 1D to improve readability and clarity.

2025 Proposed Language Section 150.0(k)

Section 150.0(k) – Residential Lighting
Proposed Language:

Section 150.0(k)1. Luminaire requirements.

Section 150.0(k)1A - Luminaire efficacy. All installed luminaires, lamps and light sources shall meet the requirements in ~~Table 150.0-A~~ Joint Appendix JA8 .

Exception 1 to Section 150.0(k)1A: Integrated device lighting. Lighting integral to exhaust fans, kitchen range hoods, bath vanity mirrors, ~~and~~ garage door openers and ceiling fan kits that are subject to federal appliance.

Exception 4 to Section 150.0(k)1A: Light sources as follows:

- LED light sources installed outdoors;
- Inseparable solid state lighting (SSL) luminaires containing colored light sources that are installed to provide decorative lighting;
- High intensity discharge (HID) light sources including pulse start metal halide and high pressure sodium light sources; and
- Luminaires with hardwired high frequency generator and induction lamp.

2025 Proposed Language Section 150.0(k)

Section 150.0(k)1 - Luminaire requirements

Proposed Text:

Section 150.0(k)1C - Recessed downlight luminaires in ceilings. Luminaires recessed into ceilings shall meet all of the following requirements:

…

iv. Meet the clearance and installation requirements of California Electrical Code ~~Section~~ Article 410.116 ~~for recessed luminaires~~.

Section 150.0(k)1D - Light sources in enclosed or recessed luminaires. Lamps and other separable light sources in enclosed or recessed luminaires shall be in ~~that are not~~ compliant with the JA8 elevated temperature requirements, including marking requirements~~, shall not be installed in enclosed or recessed luminaires~~.

2025 Proposed Language Section 150.0(k)

Section 150.0(k)2 – Indoor Lighting Controls
Proposed Changes:

- Add subsection titles to:
  - Section 150.0(k)2C - No controls shall bypass a dimmer; and
  - Section 150.0(k)2D - Occupant sensor or vacancy sensor function.
- Relocate the requirements of Section 150.0(k)2B, the "No controls shall bypass a dimmer, occupant sensor or vacancy sensor function." to Section 150.0(k)2D to align with the requirement that exists for EMS and multiscene programable controls.

Proposed Clarifications:

- Section 150.0(k)2F - Diming Controls. Clarify the dimming controls requirements by adding information about the NEMA SSL-7A publication.
- Exception 1 to Section 150.0(k)2F: Add lighting integral to kitchen range hoods and bathroom exhaust fans to the exception. They would be exempted from the dimming controls requirements.
- Section 150.0(k)2G – Independent Controls. Clarify lighting integral to exhaust fans.

2025 Proposed Language Section 150.0(k)

150.0(k)2. Indoor lighting controls.
Proposed Text:

- **Section 150.0(k)2C.** All Lighting Controls. Lighting controls shall comply with the applicable requirements of Section 110.9.
- **Section 150.0(k)2D**. Controls permitted. An Energy Management Control System (EMCS), ~~or~~ a multiscene programmable control or other controls may be used to comply with… No controls shall bypass a dimmer, occupant sensor or vacancy sensor function where that dimmer or sensor has been installed to comply with Section 150.0(k)2E and 2F.
- **Section 150.0(k)2F**. Dimming controls.
  i. Lighting in habitable spaces, including ~~but not limited to~~ living rooms, dining rooms, kitchens and bedrooms, shall have readily accessible wall-mounted dimming controls that allow the lighting to be manually adjusted up and down.
  ii. Forward phase cut dimmers controlling LED light sources in these spaces shall comply with NEMA Standards publication SSL 7A-2015, Phase-Cut Dimming for Solid State Lighting: Basic Compatibility.
- **Exception 1 to Section 150.0(k)2F**: Ceiling fans may provide control of integrated lighting via a remote control. Lighting integral to kitchen range hoods and bathroom exhaust fans.
- **Section 150.0(k)2G**. Independent controls. ~~Integrated lighting of~~ Lighting integral to exhaust fans …

2025 Proposed Requirements Section 150.0(k)

Section 150.0(k)3 – Residential Outdoor Lighting

Proposed Changes

- Reorganize Section 150.0(k)3A. Clarify that energy management control system (EMCS) and other controls can meet the outdoor lighting control requirements.

Proposed Language:

- **Section 150.0(k)3A**. For single-family residential buildings, outdoor lighting … shall meet the following requirements ~~in item i … item ii or item iii~~:
  i. Controlled by a manual ON and OFF control switch that permits the automatic actions of item ii ~~or iii below~~; and
  ii. Controlled by one of the following controls:
    a) a photocell and a motion sensor; or
    b) a photocell and an automatic time switch control; or
    c) an astronomical time clock control.
- **Section 150.0(k)3 B.** Controls that override to ON shall not be allowed unless the override automatically returns the automatic control to its normal operation within 6 hours.
- **Section 150.0(k)3C**. An energy management control system (EMCS) or other controls that provides the specified lighting control functionality and complies with all requirements applicable to the specified controls may be used to meet these requirements. No controls shall bypass an outdoor lighting control function where that outdoor lighting control has been installed to comply with Section 150.0(k)3.

2025 Proposed Requirements Section 140.6

Section 140.6 Prescriptive Requirements for Indoor Lighting

- Simplify the indoor lighting power compliance methods.
  Propose Change:
  - Add additional lighting power allowances to the Area method (Area Category Method).
  - Remove the Tailored method.
  - A revised Table 140.6-C Area Category Method
  - Removal of tables 140.6-D, E, F, and G. (table used for the Tailored Method)
  - Removal of sections related to the Tailored method.
- Other cleanups and clarifications:
  - Remove duplication of portable lighting allowance. Exception to Section 140.6(a).
  - Add occupant sensing control information on the plans – add to the PAF requirements. “All control zones in offices greater than 250 square feet shall be shown on the plans.” Section 140.6(a)2I.

2025 Proposed Language Section 140.6

Code changes related to Tailored Method – Table 140.6-C (partial, part 1)

Primary Function Area	General Lighting Power	Additional Lighting Power	
Convention, Conference, Multipurpose and Meeting Area	0.75 (W/ft^2)	Decorative	0.25 (W/ft^2)
		Wall Display MH <= 10’6”	2 W/ft
		Wall Display MH 10’7”- 14’	2.35 W/ft
		Wall Display MH > 14’	2.66 W/ft
		Floor Display & Task MH <= 10’6”	0.30 (W/ft^2)
		Floor Display & Task MH 10’7”- 14’	0.35 (W/ft^2)
		Floor Display & Task MH > 14’	0.40 (W/ft^2)

Footnote 3: MH is the Mounting Height which is the height in feet above finished floor and bottom of the luminaire. If luminaires are mounted at more than one mounting height in the same space, the average mounting height shall be used to determine the additional allowance.

2025 Proposed Language Section 140.6

Code changes related to Tailored Method – Table 140.6-C (partial, part 2)

Primary Function Area	Subcategory	General Lighting Power	Additional Lighting Power	
Dining Area	Bar Lounge and Fine Dining	0.45 (W/ft^2)	Decorative Wall Display MH <= 10’6” Wall Display MH 10’7”- 14’ Wall Display MH > 14’ Floor Display & Task MH <= 10’6” Floor Display & Task MH 10’7”- 14’ Floor Display & Task MH > 14’ General Lighting Ceiling Height > 10’	0.35 (W/ft^2) 1.25 W/ft 1.5 W/ft 1.7 W/ft 0.45 (W/ft^2) 0.52 (W/ft^2) 0.60 (W/ft^2) 0.25 (W/ft^2)
Lobby		0.70 (W/ft^2)	Decorative Wall Display MH <= 10’6” Wall Display MH 10’7”- 14’ Wall Display MH > 14’	0.25 (W/ft^2) 3 W/ft 3.5 W/ft 4 W/ft

2025 Proposed Language Section 140.6

Code changes related to Tailored Method – Table 140.6-C (partial, part 3)

Primary Function Area	Subcategory	General Lighting Power	Additional Lighting Power	
Retail Sales Area	Grocery Sales	1.00 (W/ft^2)	Decorative	0.35 (W/ft^2)
			Wall Display MH <= 10’6”	6.6 W/ft
			Wall Display MH 10’7”- 14’	7.76 W/ft
			Wall Display MH > 14’	8.8 W/ft
			Floor Display & Task MH <= 10’6”	0.60 (W/ft^2)
			Floor Display & Task MH 10’7”- 14’	0.70 (W/ft^2)
			Floor Display & Task MH > 14’	0.80 (W/ft^2)
			General Lighting Ceiling Height > 10’	0.10 (W/ft^2)
	Retail Merchandise Sales	0.95 (W/ft^2)	Decorative	0.35 (W/ft^2)
			Wall Display MH <= 10’6”	9.5 W/ft
			Wall Display MH 10’7”- 14’	11.2 W/ft
			Wall Display MH > 14’	12.7 W/ft
			Floor Display & Task MH <= 10’6”	0.45 (W/ft^2)
			Floor Display & Task MH 10’7”- 14’	0.52 (W/ft^2)
			Floor Display & Task MH > 14’	0.60 (W/ft^2)
			Valuable Display Case	0.50 (W/ft^2)
			General Lighting Ceiling Height > 10’	0.10 (W/ft^2)

2025 Proposed Language Section 140.6

Tailored method and associated changes to Section140.6
Proposed changes:

Section 140.6(b) Calculation of allowed indoor lighting power: general rules.

Section 140.6(b)4. Allowed indoor lighting power allotments for all lighting power allotments other than general lighting shall be restricted as follows:

- When using the area category method, allowed indoor lighting power allotments for specialized task work; precision commercial and industrial work; white board or chalk board; accent, display and feature; decorative; ~~or~~ videoconferencing studio; wall display; floor display; task; or very valuable display case; may not be increased as a result of, or otherwise traded ~~off against, decreasing any other allotment; and~~ between any of the separate allotments.
- ~~When using the tailored method~~ …

Other 2025 Proposed Items

Acceptance Testing Requirements:

- Update and align requirements of Multifamily Buildings to those changes of the nonresidential and residential lighting sections.
- Several proposed edits including NA7.2, NA7.3 and NA7.6.5.2-to-110.12(e).

Multifamily Buildings Requirements:

- Update and align requirements of Multifamily Buildings to those changes of the nonresidential and residential lighting sections.
- Update Table 180.2-E to include some omitted information to the demand responsive control row and the automatic shut off control row.

Compliance Manuals:

- Update the Manuals with complementary notes about the Energy Code.

Questions

- Any questions?
- Do you think some of proposed items should not be changed or something else? We like to hear from you. Let us know.

Comments

Comments on today's workshop due

September 15, 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: Simon.Lee@energy.ca.gov

Thank You!

2025 Energy Code – Pre-Rulemaking

Commercial Kitchens

Haile Bucaneg, Senior Mechanical Engineer

August 30, 2023

Commercial Kitchens

Commercial Kitchens Agenda

1. What's being proposed
2. Cost comparison
3. Conclusion

2025 Proposed Requirements

- Add mandatory requirements to Section 120.6 for electrification readiness for newly constructed quick-service and institutional commercial kitchens:
  - 50-amp circuit conductors.
  - Service panel to accommodate an additional 208v or 240v 50-amp breaker.
  - 800 connected amps for quick-service and institutional kitchens.
- Add definitions to Section 100.1 to differentiate types of commercial kitchens:
  - Quick-service
  - Full-service
  - Institutional Kitchens
- Exception provided for healthcare facilities.

Justification

- Helps California towards its decarbonization goals.
- Demand for electric-ready products are increasing.
- Current all-electric kitchens are in service today.
- Removes barriers for all-electric cookline.
- Builds on previous electric readiness requirements for other building types.

Energy Savings

- No statewide impact for energy or GHG.
- Infrastructure improvement measure.
- **Does not** require installation of all-electric kitchen equipment.

Incremental Costs

- Costs based on 2022 CalNEXT Commercial Kitchens Electrification Study and include:
  - Materials
  - Shipping
  - Testing and Commissioning
  - Labor

Kitchen Type	Additional Amps	Total Cost for New Construction	Total Cost for Upgrade (Retrofit)
Quick- Service	247.9	$70,180.00	$123,224.06
Institutional Kitchens	196	$38,743.75	$40,292.71

Comments

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September 15, 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: Haile.Bucaneg@energy.ca.gov

Questions

- Definition input for quick-service commercial kitchens.

Thank You!

2025 Energy Code – Pre-Rulemaking

Laboratory HVAC Efficiency

Haile Bucaneg, Senior Mechanical Engineer

August 30, 2023

Laboratories

Laboratories Agenda

1. Existing code requirements
2. What's being proposed
3. Energy savings methodology
4. Energy impact results
5. Incremental costs
6. Conclusion

Existing 2022 Code Requirements – Occupancy L

Section 100.0 – SCOPE

- Buildings Covered:
  - Occupancy Group A, B, E, F, H, I, M, R, S, or U

2025 Proposed Requirements – Addition of Occupancy Group L

- Add Occupancy Group L to list of buildings covered under Energy Code.

Existing 2022 Code Requirements – Unoccupied Setback

Section 140.9(c)1 – Airflow reduction requirements

- Applies to building with laboratory exhaust systems with minimum circulation rate of 10 air changes per hour (ACH) or less:
  - Reduce zone exhaust and makeup airflow rates to regulated minimum or minimum required to maintain pressurization requirements, whichever is larger.
  - Variable exhaust and makeup airflow shall coordinate to achieve required space pressurization.
- Exceptions for systems where constant volume is required by authority having jurisdiction (AHJ) or for new zones on an existing constant volume system.

2025 Proposed Requirements – Unoccupied Setback

- Applies to all laboratory exhaust systems regardless of minimum circulation rate:
  - Occupied minimum exhaust airflow is the greater of:
    - 1.0 cfm/ft^2 (6 air changes per hour for a 10 foot high ceiling).
    - Minimum circulation rate to comply with code accreditation.
    - Minimum needed to maintain occupied pressurization.
  - Unoccupied minimum exhaust airflow:
    - 0.67 cfm/ft^2 (4 air changes per hour for a 10 foot high ceiling).
    - Minimum circulation rate to comply with code accreditation.
    - Minimum needed to maintain occupied pressurization.
- Remove exception for systems where constant volume is required by AHJ.

Key Assumptions – Unoccupied Setback

	Baseline	Proposed
Ventilation Rate Occupied	6 ACH	6 ACH
Ventilation Rate Unoccupied	N/A	4 ACH
Occupied Schedule	12 AM – 12 AM	8 AM – 5 PM
Unoccupied Schedule	N/A	5 PM – 8 AM

Software Used & Prototypes – Unoccupied Setback

EnergyPlus used to model building energy usage.

Prototype	Number of Stories	Floor Area (ft^2)	Description
Lab Only Single Story	1	17,876	1 story building with 5 zones and a ceiling plenum on each floor, window-to-wall ratio – 0.33.

Unoccupied Setback First Year Savings Summary – New Construction and Additions

Climate Zone	First Year Electricity Savings (GWh)	First Year Peak Electricity Demand Reductions (MW)	First Year Natural Gas Savings (Million Therms)	First Year Source Energy Savings (Million kBtu)
1	0.00	0.00	0.00	0.26
2	0.02	0.00	0.07	6.39
3	0.12	0.03	0.39	35.54
4	0.17	0.01	0.25	22.48
5	0.00	0.00	0.02	2.19
6	0.21	0.03	0.10	9.33
7	0.16	0.02	0.07	5.96
8	0.27	0.03	0.12	11.11
9	0.42	0.06	0.22	20.25
10	0.19	0.02	0.10	8.67
11	0.07	0.01	0.04	3.70
12	0.14	0.02	0.14	12.93
13	0.08	0.01	0.04	3.19
14	0.04	0.00	0.03	2.36
15	0.04	0.00	0.01	0.85
16	0.00	0.00	0.01	0.96

Unoccupied Setback Statewide First Year Savings Summary – Alterations

Climate Zone	First Year Electricity Savings (GWh)	First Year Peak Electricity Demand Reductions (MW)	First Year Natural Gas Savings (Million Therms)	First Year Source Energy Savings (Million kBtu)
1	0.00	0.00	0.01	0.50
2	0.03	0.00	0.12	10.68
3	0.26	0.06	0.90	81.26
4	0.53	0.04	0.78	70.76
5	0.00	0.00	0.04	3.69
6	0.49	0.07	0.24	21.88
7	0.81	0.11	0.34	30.58
8	0.73	0.09	0.33	30.08
9	0.77	0.10	0.41	37.12
10	0.46	0.05	0.24	21.46
11	0.03	0.00	0.02	1.57
12	0.32	0.03	0.32	28.94
13	0.23	0.03	0.11	9.66
14	0.06	0.01	0.04	4.03
15	0.03	0.00	0.01	0.66
16	0.01	0.00	0.02	1.40

Incremental Costs – Unoccupied Setback

- No additional equipment costs.
- Additional programming costs:
  - Bay Area controls contactors gave a price of approximately $1,000 per 1000 ft^2 zone.

Unoccupied Setback Long Term System Cost (LSC) Savings - Statewide

Climate Zone	30 Year Long Term System Cost (LSC) Savings – New Construction and Additions (Million $)	30 Year Long Term System Cost (LSC) Savings – Alterations (Million $)
1	$0.16	$0.30
2	$3.96	$6.62
3	$22.30	$50.99
4	$14.66	$46.12
5	$1.33	$2.25
6	$6.86	$16.09
7	$4.52	$23.20
8	$8.31	$22.51
9	$14.78	$27.09
10	$6.36	$15.75
11	$2.68	$1.14
12	$8.72	$19.51
13	$2.40	$7.28
14	$1.67	$2.85
15	$0.77	$0.60
16	$0.61	$0.90

Cost Effectiveness – Unoccupied Setback

Building Prototype	Benefits LSC Energy Savings + Other PV Savings (2026 PV$/ft^2)	Costs Total Incremental PV Costs (2026 PV$/ft^2)	Benefit-to-Cost Ratio
Unoccupied Setback– New Construction, Additions, and Alterations	25.25	1.00	25.25

Existing 2022 Code Requirements – Heat Recovery

Section 140.4(q) and 170.2(c)4O – Exhaust air heat recovery

- Sensible heat recovery ratio of 60%, or enthalpy recovery ratio of 50% for heating and cooling.
- Energy recovery bypass to directly economize with ventilation air.
- Exception for exhaust air heat recovery for systems meeting Section 140.9(c), prescriptive requirements for laboratory and factory exhaust systems.

2025 Proposed Requirements– Heat Recovery

- Exhaust air heat recovery for buildings greater than 10,000 cfm of laboratory exhaust:
  - Sensible energy recover ratio of at least 45% at heating design conditions and 25% at cooling design conditions.
  - Heat recovered at least 75% of lab exhaust air.
  - Run-around coil pump or other means to disable heat recovery.
  - Bypass dampers to ensure pressure drop does not exceed 0.4” w.g. when heat recovery is disabled.
- Exceptions
  - Additions or alterations where heat recovery is not already present.
  - Labs where total exhaust rate exceeds 20 CFM / ft^2 of roof area.
  - Climate zone 6 and 7 if gas heating is allowed.
  - Exhaust systems that requires a wash-down system.
  - Buildings with exhaust air heat recovery systems providing 40% of heating loads.

Key Assumptions – Heat Recovery

	Proposed Heat Recovery System
Sensible Heat Effectiveness at 100% heating air flow	45%
Sensible Heat Effectiveness at 75% heating air flow	55%
Sensible Heat Effectiveness at 100% cooling air flow	25%
Sensible Heat Effectiveness at 75% cooling air flow	75%

Software Used & Prototypes – Heat Recovery

EnergyPlus used to model building energy usage.

Prototype	Number of Stories	Floor Area (ft^2)	Description
Lab Only Single Story	1	17,876	1 story building with 5 zones and a ceiling plenum on each floor, window-to-wall ratio – 0.33.

Heat Recovery First Year Savings Summary – New Construction and Additions

Climate Zone	First Year Electricity Savings (GWh)	First Year Peak Electricity Demand Reductions (MW)	First Year Natural Gas Savings (Million Therms)	First Year Source Energy Savings (Million kBtu)
1	0.00	0.00	0.00	0.09
2	0.03	0.00	0.02	2.16
3	0.01	0.00	0.06	5.18
4	0.19	0.01	0.09	8.04
5	0.00	0.00	0.00	0.45
6	0.02	0.00	0.00	0.09
7	0.01	0.00	0.00	0.07
8	0.06	0.00	0.01	0.68
9	0.14	0.01	0.02	2.17
10	0.10	0.00	0.01	1.03
11	0.04	0.00	0.01	1.19
12	0.06	(0.00)	0.05	4.11
13	0.03	0.00	0.01	0.93
14	0.02	(0.00)	0.01	0.97
15	0.03	0.00	0.00	0.03
16	(0.00)	(0.00)	0.01	0.63

Heat Recovery Statewide First Year Savings Summary – Alterations

Climate Zone	First Year Electricity Savings (GWh)	First Year Peak Electricity Demand Reductions (MW)	First Year Natural Gas Savings (Million Therms)	First Year Source Energy Savings (Million kBtu)
1	(0.00)	(0.00)	0.00	0.11
2	0.03	0.00	0.02	2.26
3	0.01	(0.00)	0.08	7.40
4	0.37	0.02	0.17	15.82
5	0.00	0.00	0.01	0.47
6	0.02	0.00	0.00	0.13
7	0.02	0.00	0.00	0.22
8	0.10	0.00	0.01	1.16
9	0.17	0.01	0.03	2.49
10	0.15	0.01	0.02	1.59
11	0.01	0.00	0.00	0.32
12	0.09	(0.00)	0.06	5.75
13	0.07	0.00	0.02	1.77
14	0.02	(0.00)	0.01	1.04
15	0.01	0.00	0.00	0.02
16	(0.00)	(0.00)	0.01	0.57

Incremental Costs – Heat Recovery

First Cost Incremental Costs:

- Components that lowers the incremental cost:
  - Smaller chillers, smaller capacity cooling coils, smaller chiller pumps, smaller boilers, smaller hot water pumps, smaller VAV reheat coils.
- Components that increases the incremental cost:
  - Heat recovery coil, bypass damper, increased pressure drop across exhaust and supply fans, adding heat recovery pumps, adding heat recovery coils at the air handler.
- Incremental Costs against Natural Gas Baseline: $0.67 / ft^2

Maintenance Incremental Costs:

- $500 / year, or $10,000 over the life of the system.

Heat Recovery Long Term System Cost (LSC) Savings - Statewide

Climate Zone	30 Year Long Term System Cost (LSC) Savings – New Construction and Additions (Million $)	30 Year Long Term System Cost (LSC) Savings – Alterations (Million $)
1	$0.06	$0.07
2	$1.57	$1.64
3	$3.54	$5.05
4	$6.23	$12.26
5	$0.32	$0.34
6	$0.14	$0.21
7	$0.08	$0.27
8	$0.73	$1.24
9	$2.16	$2.47
10	$1.15	$1.78
11	$0.96	$0.26
12	$3.05	$4.27
13	$0.80	$1.51
14	$0.74	$0.80
15	$0.15	$0.07
16	$0.40	$0.37

Cost Effectiveness – Heat Recovery

Climate Zone	Benefits 30-year LSC Savings + Other PV Savings [a] (2026 PV$/ft^2)	Costs Total Incremental PV Costs [b] (2026 PV$/ft^2)	Benefit-to-Cost Ratio
1	29.11	1.00	29.11
2	28.34	1.00	28.34
3	23.71	1.00	23.71
4	28.22	1.00	28.22
5	25.20	1.00	25.20
6	22.63	1.00	22.63
7	23.17	1.00	23.17
8	24.76	1.00	24.76
9	24.09	1.00	24.09
10	25.01	1.00	25.01
11	28.82	1.00	28.82
12	27.60	1.00	27.60
13	28.44	1.00	28.44
14	28.39	1.00	28.39
15	26.66	1.00	26.66
16	26.97	1.00	26.97

Existing 2022 Code Requirements – Exhaust Fan Control

Section 140.9(c)3 – Fan system power consumption

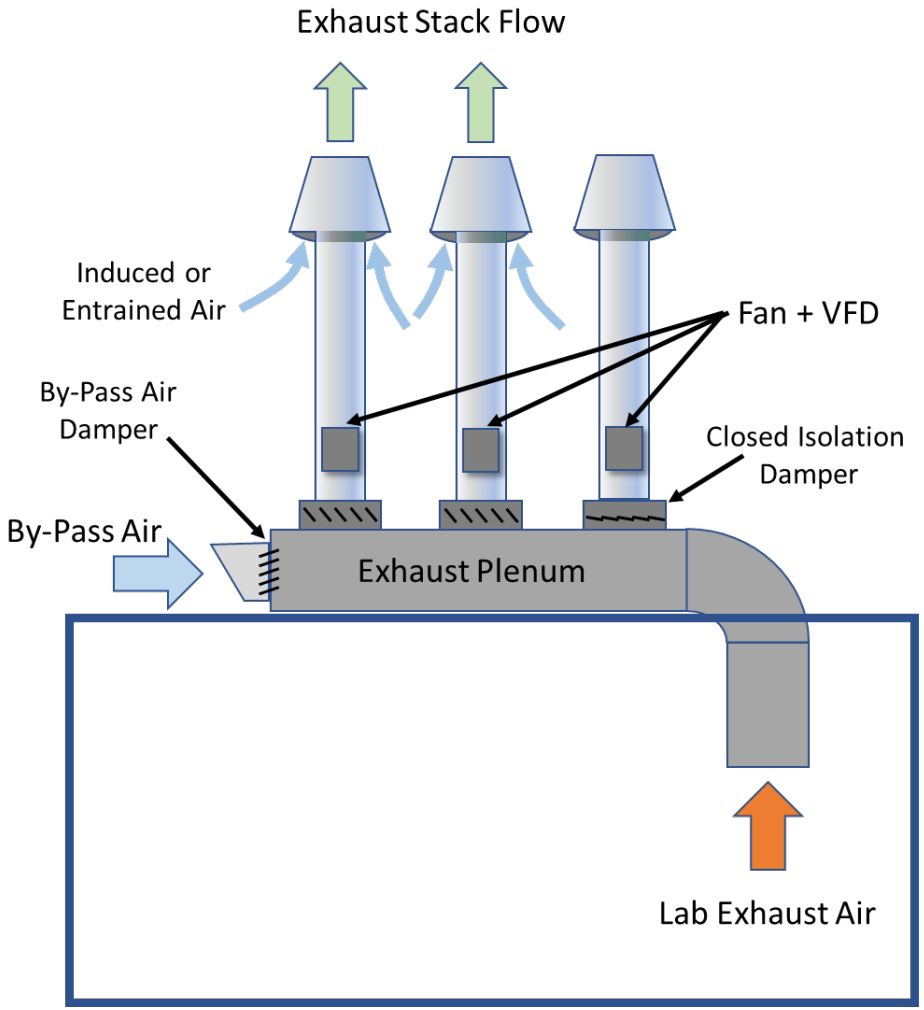
- ANSI Z9.5-2012 requirements, and
- Choose one of the following:
  - Exhaust fan system power (0.65 W/cfm or 0.85 W/cfm with filtration),
  - Unlimited fan power but fan speed control based on wind speed and direction, or
  - Unlimited fan power but fan speed control based on measured contaminant concentration.

2025 Proposed Requirements – Exhaust Fan Control

- Update reference to 2022 version of ANSI Z9.5.
- No control design W/cfm without controls additional option – Comply with 140.4(c)1.
- Fan control option design fan power ≤ 1.3 W/cfm.
- Fan control has specific energy limits:
  - Occupied minimum circulation rates shall be less than 60% of exhaust fan design airflow rate.
  - Variable speed controls so fan power ≤ 40% of design at 60% flow.
- New simple turndown control option.
- Specifications reference ANSI Z9.5-2022.

Key Assumptions – Simple Turndown Exhaust Fan Control

- Base case – constant exhaust stack flow.
  - As lab exhaust air flow is reduced by-pass air is increased
- Proposed case – exhaust stack flow tracks lab exhaust flowrate down to minimum exhaust rate
  - Minimum exhaust rate must be no great than 60%. Analysis uses 60%
  - Fan power calculated as the square of the fan flowrate



Software Used & Prototypes – Exhaust Fan Control

- Excel spreadsheet was used to calculate fan savings.
- No thermal savings are claimed
- Base case has constant stack flow.

Prototype	Number of Stories	Floor Area (ft^2)	Description
Lab Only Single Story	1	17,876	1 story building with 5 zones and a ceiling plenum on each floor, window-to-wall ratio – 0.33.

Exhaust Fan Control First Year Savings Summary – New Construction and Additions

Climate Zone	First Year Electricity Savings (MWh)	First Year Peak Electricity Demand Reductions (KW)	First Year Source Energy Savings (Million kBtu)
1	0.922	0.108	0.002
2	23.964	2.819	0.041
3	161.372	18.985	0.273
4	89.092	10.481	0.151
5	9.082	1.068	0.015
6	52.008	6.119	0.088
7	33.496	3.941	0.057
8	57.600	6.777	0.097
9	105.243	12.381	0.178
10	43.629	5.133	0.074
11	15.962	1.878	0.027
12	54.212	6.378	0.092
13	14.490	1.705	0.025
14	10.073	1.185	0.017
15	4.947	0.582	0.008
16	3.907	0.460	0.007

Exhaust Fan Control First Year Savings Summary – Alterations

Climate Zone	First Year Electricity Savings (MWh)	First Year Peak Electricity Demand Reductions (KW)	First Year Source Energy Savings (Million kBtu)
1	2.215	0.258	0.004
2	49.842	5.807	0.085
3	459.019	53.478	0.782
4	348.770	40.633	0.594
5	19.029	2.217	0.032
6	151.763	17.681	0.259
7	213.662	24.893	0.364
8	194.023	22.605	0.331
9	240.012	27.963	0.409
10	134.362	15.654	0.229
11	8.440	0.983	0.014
12	150.893	17.580	0.257
13	54.640	6.366	0.093
14	21.416	2.495	0.036
15	4.810	0.560	0.008
16	7.105	0.828	0.012

Exhaust Fan Control: Costs and Cost-Effectiveness

- Costs and cost-effectiveness are not calculated due to measure being an alternate pathway of measure that is already cost-effective.
- Main criteria for alternate approach is to show that it does not use more energy than primary pathway (no control 0.65 W/cfm).
  - This analysis shows that the system meeting the criteria saves energy.
- Equipment costs for simple turndown controls is relatively low:
  - Control system monitoring airflows, space pressurization etc (something it is already doing for safety).
  - Fan system has VSD controls, control system is coordinating fan speed, by-pass damper and making sure that fan flow does not drop below defined minimum.
- CFD and wind tunnel testing for contaminant dispersion model can be expensive, but required for systems that cannot use tall exhaust stacks.

Existing 2022 Code Requirements – Reheat Limitation

The current code does not place any requirement or limits on reheat for laboratories.

2025 Proposed Requirements – Reheat Limitation

Section 140.9(c)5 – Reheat Limitation

- Air handlers for labs with greater than 20,000 CFM of exhaust air flow and multiple space conditioning zones will have heating and cooling capacity at each zone, to prevent reheating air at the zones.
  - Mechanical cooling is not allowed at the main air handler.
  - Heating and cooling capability at each zone.
- Exceptions are made for alterations or additions to existing air handling systems serving zones without heating and cooling capacity, systems in climate zones 7 or 15, locations where the outdoor dew point temperature is greater than or equal to 66F, and systems dedicated to vivarium spaces or to spaces classified as Biosafety Level 3 or higher.

Key Assumptions – Reheat Limitation

- Baseline: Central PVAV system with DX cooling, gas-fired boiler for heating, and hot water reheat at the terminal units.
- Proposed System: Single Zone VAV system for each thermal zone.

Software Used & Prototypes – Reheat Limitation

EnergyPlus was used to model building energy usage.

Prototype	Number of Stories	Floor Area (ft^2)	Description
Lab Only Single Story	1	17,876	1 story building with 5 zones and a ceiling plenum on each floor, window-to-wall ratio – 0.33.

Reheat Limitation First Year Savings Summary – New Construction and Additions

Climate Zone	First Year Electricity Savings (GWh)	First Year Peak Electricity Demand Reductions (MW)	First Year Natural Gas Savings (Million Therms)	First Year Source Energy Savings (Million kBtu)
1	0.01	0.00	0.00	0.08
2	0.23	0.01	0.04	3.85
3	2.45	0.19	0.31	27.70
4	0.89	0.10	0.20	17.83
5	0.12	0.01	0.02	1.41
6	1.55	0.14	0.18	16.00
7	1.04	0.09	0.12	11.20
8	1.46	0.13	0.20	17.65
9	2.14	0.19	0.33	29.59
10	0.84	0.08	0.13	12.18
11	0.22	0.02	0.05	4.44
12	0.74	0.08	0.14	12.83
13	0.20	0.02	0.05	4.11
14	0.10	0.01	0.03	2.55
15	0.08	0.01	0.02	1.74
16	0.03	0.00	0.01	0.74

Reheat Limitation First Year Savings Summary – Alterations

Climate Zone	First Year Electricity Savings (GWh)	First Year Peak Electricity Demand Reductions (MW)	First Year Natural Gas Savings (Million Therms)	First Year Source Energy Savings (Million kBtu)
1	0.00	0.00	0.00	0.02
2	0.05	0.00	0.01	0.80
3	0.70	0.05	0.09	7.92
4	0.35	0.04	0.08	7.01
5	0.02	0.00	0.00	0.30
6	0.45	0.04	0.05	4.69
7	0.66	0.06	0.08	7.18
8	0.50	0.04	0.07	5.98
9	0.49	0.04	0.07	6.78
10	0.26	0.02	0.04	3.77
11	0.01	0.00	0.00	0.24
12	0.21	0.02	0.04	3.59
13	0.08	0.01	0.02	1.56
14	0.02	0.00	0.01	0.54
15	0.01	0.00	0.00	0.17
16	0.01	0.00	0.00	0.14

Incremental Costs – Reheat Limitation

First Cost Incremental Costs

- Components that lowers the incremental cost:
  - Smaller chillers, smaller chilled water pumps, AHU coil count reduced from 8 to 4, no chilled water pipes to AHU, smaller hot water piping.
- Components that raises the incremental cost:
  - Adding chilled water piping to zones, increased zone coils from 2 to 8 rows, adding condensate pans and lines, converting zone hot water valves from 2 way to 6 way.
- Incremental cost: $14.17 / ft^2

Reheat Limitation Long Term System Cost (LSC) Savings - Statewide

Climate Zone	30 Year Long Term System Cost (LSC) Savings – New Construction and Additions (Million $)	30 Year Long Term System Cost (LSC) Savings – Alterations (Million $)
1	$0.08	$0.02
2	$3.46	$0.72
3	$27.91	$7.98
4	$15.44	$6.07
5	$1.38	$0.29
6	$17.33	$5.08
7	$11.87	$7.61
8	$17.81	$6.03
9	$28.36	$6.50
10	$11.51	$3.56
11	$3.72	$0.20
12	$11.36	$3.18
13	$3.43	$1.30
14	$2.02	$0.43
15	$1.44	$0.14
16	$0.58	$0.11

Cost Effectiveness – Reheat Limitation

Climate Zone	Benefits LSC Savings + Other PV Savings [a] (2026 PV$/ft^2)	Costs Total Incremental PV Costs [b] (2026 PV$/ft^2)	Benefit-to-Cost Ratio
1	14.13	14.17	1.00
2	24.78	14.17	1.75
3	29.68	14.17	2.09
4	29.73	14.17	2.10
5	26.15	14.17	1.85
6	57.17	14.17	4.03
7	60.82	14.17	4.29
8	53.04	14.17	3.74
9	46.24	14.17	3.26
10	45.26	14.17	3.19
11	40.00	14.17	2.82
12	35.96	14.17	2.54
13	40.64	14.17	2.87
14	34.33	14.17	2.42
15	50.10	14.17	3.54
16	25.64	14.17	1.81

Comments

Comments on today's workshop due

September 15, 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: Haile.Bucaneg@energy.ca.gov

Questions

Thank You!

Lunch

We will resume at 1:00

2025 Energy Code - Pre-Rulemaking

Nonresidential Envelope

Michael Shewmaker, Supervisor, Building Standards Development Unit

August 30, 2023

Acknowledgement & Thanks

A big thanks to the Nonresidential Envelope CASE Team:
Maureen Guttman, Alamelu Brooks,
Melissa Schellinger Gutierrez, Aru Sau,
Julia Forberg, and Zyg Kunczynski of Energy Solutions
&
Michael Hsueh of RDH Building Science

Items covered in this presentation

Measure proposals:

1. Opaque Assemblies – Prescriptive U-factors for Walls and Roofs
2. Vestibules – Mandatory Requirement
3. Windows – Mandatory U-factor

Information included for each proposal:

- Key Assumptions, Software & Prototypes Used
- First-Year Energy Savings
- 30-Year Energy Savings
- Incremental Cost
- Cost Effectiveness

Opaque Assemblies

Opaque Assemblies – Existing vs 2025 Proposed Requirements

PRESCRIPTIVE Envelope Assembly	California Climate Zone	2022 Baseline U-factor	2025 Proposed U-factor
Roof/Ceiling – Metal Building	ALL	0.041	**0.038**
Roof/Ceiling – Wood Framed and Others	6, 7, 8	0.049	**0.047**
Roof/Ceiling – Wood Framed and Others	ALL OTHERS	0.034	**0.028**
Walls – Metal Building	1, 3, 6, 7	0.113	**0.098**
Walls – Metal Building	15	0.057	**0.050**
Walls – Metal Building	ALL OTHERS	0.061	**0.053**

Opaque Assemblies – Existing vs 2025 Proposed Requirements (cont.)

PRESCRIPTIVE Envelope Assembly	California Climate Zone	2022 Baseline U-factor	2025 Proposed U-factor
Walls – Mass Light	1	0.196	**0.170**
Walls – Mass Light	3	0.278	**0.227**
Walls – Mass Light	4	0.227	**0.196**
Walls – Mass Light	5-9	0.440	**0.364**
Walls – Mass Light	ALL OTHERS	0.170	**0.138**
Walls – Mass Heavy	1, 12	0.253	**0.211**
Walls – Mass Heavy	2-5, 10	0.650	**0.575**
Walls – Mass Heavy	6-9	0.690	**0.650**
Walls – Mass Heavy	11, 14, 15	0.184	**0.160**
Walls – Mass Heavy	13	0.211	**0.184**
Walls – Mass Heavy	16	0.160	**0.153**
Walls – Wood Framed and Other	1	0.095	**0.078**
Walls – Wood Framed and Other	3, 6, 7	0.110	**0.102**
Walls – Wood Framed and Other	5, 8	0.102	**0.095**
Walls – Wood Framed and Other	11	0.045	**0.042**
Walls – Wood Framed and Other	15	0.042	**0.038**
Walls – Wood Framed and Other	ALL OTHERS	0.059	**0.053**

Opaque Assemblies – Key Assumptions

- Two roof assemblies and four wall assemblies modeled on eleven prototype buildings in all climate zones

- Modeled assemblies on most appropriate building types

Opaque Assemblies - Software & Prototypes Used

- **Software Used:** EnergyPlus v9.4.0

- **Prototypes used:**
  1. Hospital: 5-story hospital + basement, 241,501-ft^2
  2. Non-refrigerated Warehouse: 1-story warehouse, 42,554-ft^2
  3. Office Large: 12-story office building + basement, 498,589-ft^2
  4. Office Medium: 3-story office building, 53,628-ft^2
  5. Office Small: 1-story office building, 5,502-ft^2
  6. Restaurant Fast Food: 1-story fast food restaurant, 2,501-ft^2

Opaque Assemblies - Software & Prototypes Used (cont.)

- **Prototypes used (continued):**
  7. Retail Large: 1-story big-box type retail building, 240,000-ft^2
  8. Retail Medium: 1-story similar to a Target or Walgreens, 24,563-ft^2
  9. Retail Strip Mall: 1-story strip mall building, 9,375-ft^2
  10. School Large: 2-story high school, 210,866-ft^2
  11. School Small: 1-story elementary school, 24,413-ft^2

Opaque Assemblies – Prototypes Used for Proposals

Title 24, Part 6 – 2025 – Buildings and Opaque Assembly Mapping

Building Type	Roofs - Wood-framed and Other	Roofs - Metal Building	Walls - Mass, Heavy	Walls - Mass, Light	Walls - Metal Building	Walls - Wood-Framed and Other
Hospital	x		x			
Non-Refrigerated Warehouse	x	x		x	x	
Office Large			x	x		
Office Medium	x			x		x
Office Small						x
Restaurant Fast-food						x
Retail Large	x		x			
Retail Medium	x	x	x			
Retail Strip Mall	x					x
School Large						
School Small	x					x

Roofs –
Wood Framed and Other Roof

Opaque Assemblies - First Year Electricity Savings (kWh/ft²)

Wood-Framed and Other ROOF*

Climate Zone	Warehouse	Medium Office	Large Retail
1	0.01	0.00	0.03
2	0.01	0.00	0.05
3	0.01	0.00	0.03
4	0.01	0.00	0.04
5	0.00	0.00	0.03
6	0.00	0.00	0.00
7	0.00	0.00	0.00
8	0.00	0.00	0.03
9	0.00	0.00	0.04
10	0.00	0.00	0.04
11	0.01	0.01	0.03
12	0.01	0.00	0.05
13	0.01	0.01	0.05
14	0.01	0.01	0.05
15	0.00	0.01	0.06
16	0.02	0.00	0.02

*Includes steel framing

Opaque Assemblies - First Year Peak Elec. Demand Reductions (kW/ft²)

Wood-Framed and Other Roof*

Climate Zone	Warehouse	Medium Office	Large Retail
1	0.00	0.00	0.00
2	0.01	0.00	0.01
3	0.00	0.00	0.00
4	0.01	0.00	0.01
5	0.00	0.00	0.00
6	0.00	0.00	0.00
7	0.00	0.00	0.00
8	0.00	0.00	0.00
9	0.00	0.00	0.00
10	0.00	0.00	0.00
11	0.01	0.00	0.01
12	0.01	0.00	0.01
13	0.01	0.00	0.00
14	0.01	0.00	0.01
15	0.00	0.00	0.00
16	0.01	0.00	0.00

*Includes steel framing

Opaque Assemblies - First Year Natural Gas Savings (kBtu/ft²)

Wood-Framed and Other ROOF*

Climate Zone	Warehouse	Medium Office	Large Retail
1	0.54	0.17	0.24
2	0.40	0.13	0.00
3	0.28	0.11	0.00
4	0.33	0.10	0.00
5	0.31	(0.07)	0.00
6	0.05	(0.02)	0.00
7	0.05	(0.15)	0.00
8	0.06	0.11	0.00
9	0.22	0.06	0.00
10	0.19	0.07	0.00
11	0.34	0.08	0.00
12	0.35	0.12	0.00
13	0.28	0.06	0.00
14	0.32	0.10	0.00
15	0.12	0.06	0.00
16	0.63	0.17	0.68

*Includes steel framing

Opaque Assemblies - First Year Source Energy Savings (kBtu/ft²)

Wood-Framed and Other ROOF*

Climate Zone	Warehouse	Medium Office	Large Retail
1	0.49	0.15	0.22
2	0.36	0.12	0.00
3	0.25	0.10	0.00
4	0.30	0.09	0.00
5	0.28	(0.06)	0.00
6	0.04	(0.02)	0.00
7	0.04	(0.14)	0.00
8	0.05	0.10	0.00
9	0.20	0.06	0.00
10	0.17	0.06	0.00
11	0.31	0.08	0.00
12	0.32	0.11	0.00
13	0.25	0.06	0.00
14	0.29	0.09	0.00
15	0.11	0.05	0.00
16	0.57	0.15	0.61

*Includes steel framing

Opaque Assemblies - 30-Year Electricity Savings (2026PV$/ft²)

Wood-Framed and Other ROOF*

Climate Zone	Warehouse	Medium Office	Large Retail
1	0.11	0.01	0.29
2	0.08	0.01	0.30
3	0.06	0.01	0.24
4	0.09	0.02	0.24
5	0.04	(0.02)	0.18
6	0.01	0.00	0.01
7	(0.01)	(0.02)	0.00
8	0.01	0.03	0.15
9	0.00	0.01	0.21
10	0.02	0.02	0.25
11	0.08	0.02	0.18
12	0.08	0.02	0.29
13	0.07	0.04	0.33
14	0.12	0.04	0.31
15	0.02	0.06	0.28
16	0.13	0.02	0.53

*Includes steel framing

Opaque Assemblies - 30-Year Natural Gas Savings (2026PV$/ft²)

Wood-Framed and Other ROOF*

Climate Zone	Warehouse	Medium Office	Large Retail
1	0.30	0.09	0.00
2	0.23	0.07	0.00
3	0.16	0.06	0.00
4	0.20	0.06	0.00
5	0.18	(0.03)	0.00
6	0.03	(0.01)	0.00
7	0.03	(0.09)	0.00
8	0.04	0.07	0.00
9	0.14	0.04	0.00
10	0.12	0.04	0.00
11	0.20	0.05	0.00
12	0.21	0.07	0.00
13	0.17	0.04	0.00
14	0.20	0.06	0.00
15	0.07	0.04	0.00
16	0.37	0.10	0.41

*Includes steel framing

Opaque Assemblies - 30-Year Long-Term System Cost (LSC) Savings (2026PV$/ft²)

Wood-Framed and Other ROOF*

Climate Zone	Warehouse	Medium Office	Large Retail
1	0.41	0.11	0.00
2	0.32	0.08	0.00
3	0.22	0.07	0.24
4	0.29	0.08	0.24
5	0.21	(0.06)	0.18
6	0.04	(0.01)	0.01
7	0.01	(0.11)	0.00
8	0.04	0.09	0.15
9	0.14	0.05	0.21
10	0.14	0.06	0.25
11	0.29	0.07	0.18
12	0.29	0.09	0.29
13	0.24	0.07	0.33
14	0.31	0.10	0.31
15	0.10	0.10	0.28
16	0.50	0.11	0.53

*Includes steel framing

Walls –
Light Mass Walls

Opaque Assemblies - First Year Electricity Savings (kWh/ft²)

Light Mass WALL

Climate Zone	Warehouse	Medium Office	Hospital
1	0.02	0.00	0.00
2	0.01	0.05	0.00
3	0.02	0.00	0.00
4	0.02	0.01	0.01
5	0.02	0.00	0.01
6	0.01	0.01	0.02
7	0.01	0.01	0.02
8	0.02	0.03	0.04
9	0.02	0.03	0.04
10	0.01	0.02	0.01
11	0.03	0.03	0.01
12	0.02	0.01	0.01
13	0.03	0.03	0.02
14	0.03	0.02	0.01
15	0.04	0.06	0.03
16	0.03	0.01	0.00

Opaque Assemblies - First Year Peak Elec. Demand Reductions (kW/ft²)

Light Mass WALL

Climate Zone	Warehouse	Medium Office	Hospital
1	0.01	0.00	0.00
2	0.01	0.00	0.00
3	0.01	0.00	0.00
4	0.00	0.00	0.00
5	0.01	0.00	0.00
6	0.00	0.00	0.00
7	0.00	0.00	0.00
8	0.00	0.00	0.00
9	0.00	0.00	0.00
10	0.00	0.00	0.00
11	0.01	0.00	0.00
12	0.01	0.00	0.00
13	0.01	0.00	0.00
14	0.01	0.00	0.00
15	0.00	0.00	0.00
16	0.01	0.00	0.00

Opaque Assemblies - First Year Natural Gas Savings (kBtu/ft²)

Light Mass WALL

Climate Zone	Warehouse	Medium Office	Hospital
1	0.52	0.30	0.42
2	0.48	2.03	0.35
3	0.54	0.29	0.51
4	0.40	0.19	0.33
5	0.60	0.35	0.78
6	0.23	0.16	0.44
7	0.18	0.12	0.38
8	0.25	0.20	0.52
9	0.33	0.17	0.63
10	0.18	0.32	0.15
11	0.51	0.24	0.32
12	0.45	0.23	0.31
13	0.38	0.19	0.23
14	0.45	0.09	0.32
15	0.10	0.05	0.10
16	0.96	0.54	0.57

Opaque Assemblies - First Year Source Energy Savings (kBtu/ft²)

Light Mass WALL

Climate Zone	Warehouse	Medium Office	Hospital
1	0.47	0.27	0.38
2	0.43	1.84	0.32
3	0.49	0.26	0.46
4	0.36	0.17	0.30
5	0.54	0.32	0.71
6	0.20	0.14	0.40
7	0.16	0.11	0.34
8	0.22	0.18	0.47
9	0.30	0.16	0.56
10	0.16	0.29	0.13
11	0.46	0.22	0.29
12	0.41	0.21	0.28
13	0.35	0.17	0.21
14	0.41	0.08	0.29
15	0.09	0.04	0.09
16	0.86	0.48	0.51

Opaque Assemblies - 30-Year Electricity Savings (2026PV$/ft²)

Light Mass WALL

Climate Zone	Warehouse	Medium Office	Hospital
1	0.11	0.01	(0.01)
2	0.10	0.33	0.02
3	0.13	0.02	0.01
4	0.10	0.09	0.07
5	0.12	0.03	0.05
6	0.06	0.08	0.12
7	0.07	0.13	0.20
8	0.12	0.22	0.26
9	0.14	0.22	0.25
10	0.07	0.15	0.08
11	0.21	0.19	0.11
12	0.12	0.11	0.08
13	0.20	0.19	0.13
14	0.19	0.13	0.07
15	0.19	0.32	0.18
16	0.20	0.09	0.02

Opaque Assemblies - 30-Year Natural Gas Savings (2026PV$/ft²)

Light Mass WALL

Climate Zone	Warehouse	Medium Office	Hospital
1	0.30	0.17	0.24
2	0.28	1.20	0.21
3	0.32	0.17	0.29
4	0.24	0.11	0.19
5	0.35	0.20	0.44
6	0.14	0.09	0.26
7	0.11	0.07	0.23
8	0.15	0.12	0.30
9	0.21	0.11	0.36
10	0.11	0.20	0.09
11	0.31	0.15	0.19
12	0.27	0.14	0.19
13	0.23	0.11	0.14
14	0.28	0.06	0.20
15	0.06	0.03	0.06
16	0.57	0.32	0.33

Opaque Assemblies - 30-Year Long-Term System Cost (LSC) Savings (2026PV$/ft²)

Light Mass WALL

Climate Zone	Warehouse	Medium Office	Hospital
1	0.41	0.18	0.23
2	0.39	1.20	0.23
3	0.45	0.19	0.31
4	0.33	0.20	0.26
5	0.46	0.24	0.49
6	0.20	0.18	0.38
7	0.18	0.20	0.43
8	0.27	0.33	0.56
9	0.34	0.33	0.61
10	0.18	0.35	0.17
11	0.52	0.33	0.30
12	0.39	0.24	0.27
13	0.43	0.31	0.27
14	0.47	0.18	0.27
15	0.25	0.35	0.25
16	0.77	0.41	0.35

Opaque Assemblies - Incremental Costs

- Assumed increase of R-2 insulation value
  - ROOF: $0.288/square foot
  - WALL: $0.10/square foot
- No additional labor cost
- No maintenance/replacement costs included
  - Assumed 30-year roof replacement period

Opaque Assemblies - Statewide Cost Effectiveness

Assembly – All Prototypes Modeled	Benefits (2026PV$/ft^2)	Costs (2026PV$/ft^2)	Total Benefit-to-Cost Ratio*
Wood/Other Roof	0.13	0.08	1.51
Metal Bldg. Roof	0.10	0.12	0.85
Mass Walls Heavy	0.18	0.03	6.76
Mass Walls Light	0.30	0.04	6.66
Metal Bldg. Walls	0.13	0.06	2.05
Wood/Other Walls	0.09	0.06	1.55

*Weighted average across all climate zones

Opaque Assemblies - 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 September 15, by 5:00pm**

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

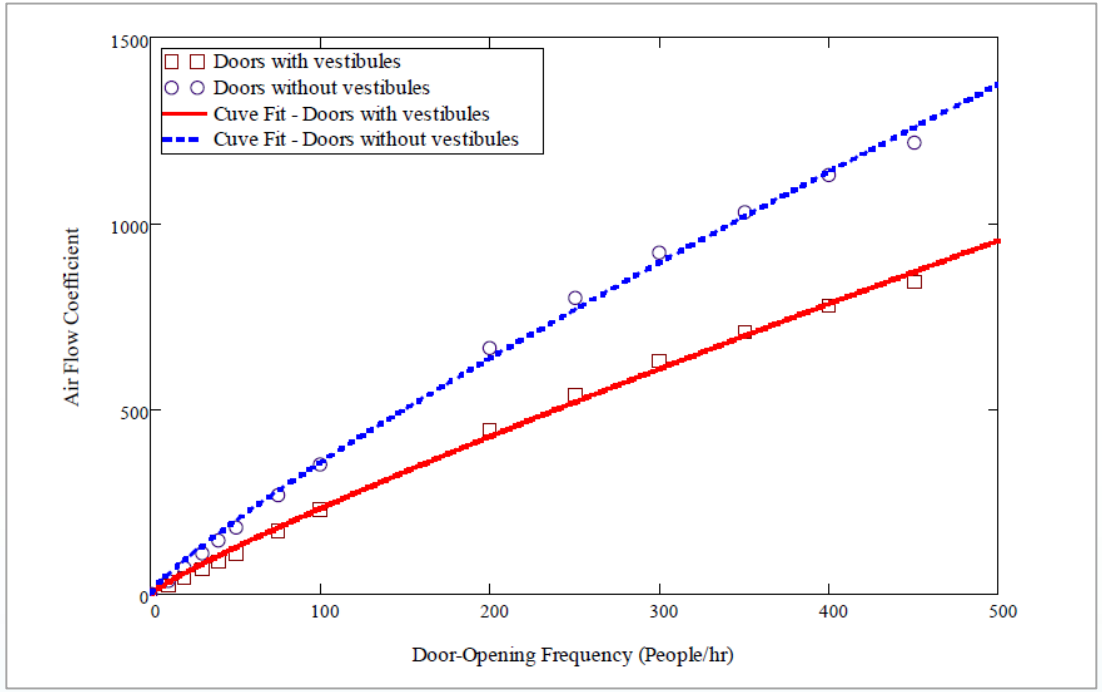
Thank you for participating!

Vestibules

Vestibules - 2025 Proposed Requirements

- Vestibules will be required (mandatory requirement) in occupancy types A, B, E, I, and M for *public entrances*
- Where allowable by code, revolving doors or air curtains may be used instead
- EXCEPTIONS:
  - Non-public doors
  - Doors for vehicular access
  - Entrance areas less than 3,000 square feet

Vestibules - Key Assumptions



- Used a methodology for the energy savings analysis similar to that used by the Pacific Northwest National Laboratory (PNNL) for their study of ASHRAE 90.1 vestibule requirements

Vestibules - Key Assumptions
Air Infiltration Rates (across all CZs)

Building Type	Proposed Design– Peak Rate with Vestibule (cfm)	Standard Design– Peak Rate without Vestibule (cfm)	Proposed Design– Off-Peak Rate with Vestibule (cfm)	Standard Design– Off-Peak Rate without Vestibule (cfm)
OfficeLarge	11,862	16,856	1,465	1,953
OfficeMedium	3,350	5,481	457	548
RetailLarge	37,091	52,708	3,654	5,481
RetailMedium	3,959	6,090	609	914
SchoolSmall	4,568	7,613	761	1218

Vestibules - Software & Prototypes Used

- **Software Used:** EnergyPlus v9.4.0

- **Prototypes used:**
  1. Office Large: 12-story office building + basement, 498,589-ft^2
  2. Office Medium: 3-story office building, 53,628-ft^2
  3. Retail Large: 1-story big-box type retail building, 240,000-ft^2
  4. Retail Medium: 1-story similar to a Target or Walgreens, 24,563-ft^2
  5. School Small: 1-story elementary school, 24,413-ft^2

Vestibules - First-Year Electricity Savings (kWh/ft²)

Prototype	CZ1	CZ2	CZ3	CZ4	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	CZ11	CZ12	CZ13	CZ14	CZ15	CZ16
Office Large	0.19	0.21	0.20	0.22	0.20	0.21	0.21	0.22	0.22	0.23	0.22	0.21	0.22	0.22	0.25	0.21
Office Medium	0.21	0.23	0.22	0.25	0.23	0.24	0.25	0.26	0.26	0.27	0.26	0.25	0.27	0.26	0.32	0.23
Retail Large	0.33	0.61	0.55	0.65	0.56	0.57	0.59	0.64	0.64	0.66	0.70	0.65	0.70	0.71	0.80	0.57
Retail Medium	0.58	0.69	0.62	0.73	0.62	0.63	0.65	0.66	0.70	0.69	0.75	0.73	0.78	0.81	0.83	0.00
School Small	0.03	0.29	0.26	0.31	0.27	0.27	0.27	0.29	0.29	0.31	0.32	0.30	0.33	0.33	0.36	0.25

Vestibules - First-Year Peak Electric. Demand Reductions (kW/ft^2)

Prototype	CZ1	CZ2	CZ3	CZ4	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	CZ11	CZ12	CZ13	CZ14	CZ15	CZ16
Office Large	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Office Medium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Retail Large	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01
Retail Medium	0.01	0.02	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.01	0.00
School Small	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00

Vestibules - First-Year Natural Gas Savings (kBtu/ft²)

Prototype	CZ1	CZ2	CZ3	CZ4	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	CZ11	CZ12	CZ13	CZ14	CZ15	CZ16
Office Large	0.51	0.44	0.37	0.43	0.40	0.14	0.11	0.16	0.18	0.20	0.39	0.37	0.30	0.39	0.10	0.58
Office Medium	0.60	0.44	0.32	0.40	0.35	0.12	0.10	0.14	0.16	0.17	0.40	0.38	0.31	0.40	0.09	0.63
Retail Large	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Retail Medium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
School Small	-0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.29

Vestibules - First-Year Source Energy Savings (kBtu/ft^2)

Prototype	CZ1	CZ2	CZ3	CZ4	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	CZ11	CZ12	CZ13	CZ14	CZ15	CZ16
Office Large	0.47	0.40	0.34	0.39	0.36	0.13	0.10	0.15	0.16	0.18	0.36	0.33	0.27	0.35	0.09	0.52
Office Medium	0.54	0.40	0.29	0.37	0.31	0.11	0.09	0.13	0.15	0.15	0.36	0.34	0.28	0.36	0.08	0.56
Retail Large	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06
Retail Medium	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
School Small	-0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.16

Vestibules - 30-Year LSC Savings

New Construction & Additions, All Modeled Prototypes

Climate Zone	30-Year LSC Electricity Savings (2026 PV$/ft^2)	30-Year LSC Natural Gas Savings (2026 PV$/ft^2)	Total 30-Year LSC Savings (2026 PV$/ft^2)
1	2.84	0.11	2.95
2	3.58	0.06	3.63
3	1.88	0.14	2.02
4	2.20	0.16	2.36
5	3.08	0.04	3.12
6	2.16	0.05	2.21
7	2.25	0.04	2.29
8	2.20	0.06	2.26
9	2.23	0.07	2.30
10	3.26	0.04	3.30
11	3.67	0.06	3.73
12	3.14	0.08	3.22
13	4.23	0.02	4.25
14	3.01	0.11	3.12
15	4.43	0.01	4.44
16	1.69	0.20	1.89

Vestibules - Total Incremental Costs

- Based on typical storefront glazing system construction
  - Size: 80 square feet typical for most prototypes; or
    160 square feet for Large Retail
  - Cost: $250 per square foot
    (average cost of new building construction)

- No maintenance or replacement costs anticipated

Vestibules - Statewide Cost Effectiveness

Building Prototype	Benefits: LSC Savings + Other PV Cost Savings (2026 PV$/ft^2)	Costs: Total Incremental PV Costs (2026 PV$/ft^2)	Benefit-to-Cost Ratio*
OfficeLarge	1.18	0.04	29.36
OfficeMedium	1.36	0.37	3.66
RetailLarge	4.06	0.17	24.35
RetailMedium	4.44	0.81	5.46
SchoolSmall	2.54	0.82	3.10
Total	**2.52**	**0.23**	**10.77**

*Weighted average across all climate zones

Vestibules - Cost Effectiveness for All Prototypes

Climate Zone	Benefits: Lifecycle Energy Cost Savings + Other PV Savings (2026 PV$)	Costs: Total Incremental PV Cost (2026 PV$)	Benefit-to-Cost Ratio
1	2.95	0.70	4.20
2	3.63	0.71	5.10
3	2.02	0.17	11.93
4	2.36	0.18	13.13
5	3.12	0.37	8.39
6	2.21	0.22	10.12
7	2.29	0.21	10.90
8	2.26	0.21	10.88
9	2.30	0.20	11.51
10	3.30	0.37	8.97
11	3.73	0.28	13.43
12	3.22	0.29	11.23
13	4.25	0.44	9.73
14	3.12	0.30	10.42
15	4.44	0.36	12.43
16	1.89	0.36	5.27

Vestibules - 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 September 15, by 5:00pm**

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

Thank you for participating!

Windows

Windows – 2025 Proposed Requirements

New Construction and Additions – Mandatory

Building Types	Climate Zone	Parameter(s)	2022 Baseline Mandatory Value(s)	Code 2025 Proposed Value(s)
All	All	U-factor	0.58	**0.47**

Alterations – Mandatory

Building Types	Climate Zone	Parameter(s)	2022 Baseline Mandatory Value(s)	Code 2025 Proposed Value(s)
All	All	U-factor	0.86	**0.58**

Windows - Key Assumptions

- Fixed fenestration assembly was modeled for eight prototype buildings in all climate zones
- Modeled assemblies on most appropriate building types from the CEC Construction Forecast

Windows - Software & Prototypes Used

- **Software Used:** EnergyPlus v9.4.0

- **Prototypes used:**
  1. Office Large: 12-story office building + basement, 498,589-ft^2
  2. Office Medium: 3-story office building, 53,628-ft^2
  3. Office Small: 1-story office building, 5,502-ft^2
  4. Restaurant Fast Food: 1-story fast food restaurant, 2,501-ft^2
  5. Retail Large: 1-story big-box type retail building, 240,000-ft^2
  6. Retail Medium: 1-story similar to a Target or Walgreens, 24,563-ft^2
  7. Retail Strip Mall: 1-story strip mall building,
  8. School Small: 1-story elementary school, 24,413-ft^2

Results for New Construction

Windows – New Construction First-Year Electricity Savings (kWh/ft²)

Prototypes	CZ1	CZ2	CZ3	CZ4	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	CZ11	CZ12	CZ13	CZ14	CZ15	CZ16
OfficeLarge	0.03	0.07	0.06	0.07	0.07	0.08	0.08	0.08	0.08	0.09	0.07	0.07	0.08	0.08	0.10	0.05
OfficeMedium	0.05	0.10	0.09	0.11	0.10	0.12	0.11	0.13	0.13	0.14	0.13	0.11	0.14	0.14	0.21	0.09
OfficeSmall	0.03	0.06	0.05	0.08	0.05	0.07	0.07	0.08	0.09	0.09	0.10	0.08	0.10	0.10	0.15	0.05
Restaurant FastFood	0.00	0.06	0.04	0.08	0.05	0.07	0.07	0.10	0.10	0.11	0.11	0.08	0.11	0.10	0.18	0.05
RetailLarge	0.00	0.08	0.05	0.10	0.06	0.09	0.08	0.15	0.11	0.11	0.09	0.07	0.11	0.11	0.26	0.04
RetailMedium	0.00	0.11	0.06	0.08	0.09	0.16	(0.01)	0.10	0.14	0.16	0.17	0.07	0.18	(0.03)	0.45	0.07
RetailStripMall	(0.01)	0.02	0.01	0.04	0.02	0.07	0.08	0.06	0.06	0.12	0.09	0.05	0.09	0.08	0.20	0.07
SchoolSmall	0.08	0.24	0.17	0.30	0.18	0.27	0.23	0.35	0.36	0.39	0.39	0.31	0.42	0.43	0.59	0.27

Windows – New Construction First-Year Peak Electricity Demand Reductions (kW/ft²)

Prototypes	CZ1	CZ2	CZ3	CZ4	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	CZ11	CZ12	CZ13	CZ14	CZ15	CZ16
OfficeLarge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OfficeMedium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
OfficeSmall	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.01	0.00
Restaurant FastFood	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RetailLarge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RetailMedium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	(0.01)	0.00	0.00
RetailStripMall	0.00	(0.01)	0.00	(0.01)	(0.01)	0.00	0.00	0.00	(0.01)	0.00	0.00	0.00	0.00	(0.01)	0.00	0.00
SchoolSmall	0.01	0.02	0.01	0.01	0.00	0.01	0.00	0.01	0.01	0.01	0.03	0.03	0.03	0.02	0.01	0.02

Windows – New Construction
First-Year Natural Gas Savings (kBtu/ft²)

Prototypes	CZ1	CZ2	CZ3	CZ4	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	CZ11	CZ12	CZ13	CZ14	CZ15	CZ16
OfficeLarge	0.40	0.39	0.31	0.33	0.35	0.21	0.17	0.03	0.18	0.19	0.40	0.32	0.24	0.32	0.14	0.49
OfficeMedium	0.38	0.23	0.16	0.17	0.18	0.07	0.06	0.08	0.10	0.09	0.27	0.13	0.20	0.19	0.05	0.38
OfficeSmall	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23
Restaurant FastFood	(0.20)	(0.15)	(0.24)	(0.18)	(0.26)	(0.18)	(0.15)	(0.13)	(0.14)	(0.13)	0.02	(0.09)	(0.05)	(0.18)	(0.08)	0.01
RetailLarge	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
RetailMedium	(0.01)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(0.02)
RetailStripMall	(0.39)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(0.47)
SchoolSmall	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67

Windows – New Construction First-Year Source Energy Savings (kBtu/ft²)

Prototypes	CZ1	CZ2	CZ3	CZ4	CZ5	CZ6	CZ7	CZ8	CZ9	CZ10	CZ11	CZ12	CZ13	CZ14	CZ15	CZ16
OfficeLarge	0.37	0.35	0.28	0.30	0.32	0.19	0.15	0.03	0.16	0.17	0.36	0.29	0.22	0.29	0.13	0.44
OfficeMedium	0.35	0.21	0.14	0.15	0.16	0.07	0.05	0.07	0.09	0.08	0.24	0.12	0.18	0.17	0.05	0.34
OfficeSmall	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21
Restaurant FastFood	(0.18)	(0.14)	(0.22)	(0.16)	(0.24)	(0.16)	(0.14)	(0.12)	(0.12)	(0.12)	0.02	(0.08)	(0.04)	(0.16)	(0.08)	0.01
RetailLarge	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
RetailMedium	(0.01)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(0.02)
RetailStripMall	(0.36)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(0.42)
SchoolSmall	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.61

Windows – 30-Year LSC Savings – New Construction & Additions

Climate Zone	30-Year LSC Electricity Savings (2026 PV $)	30-Year LSC Gas Savings (2026 PV $)	Total 30-Year LSC Savings (2026 PV $)
1	0.13	0.07	0.19
2	0.33	0.02	0.35
3	0.21	0.06	0.26
4	0.36	0.06	0.42
5	0.30	0.03	0.33
6	0.36	0.02	0.38
7	0.34	0.02	0.35
8	0.39	0.01	0.40
9	0.42	0.03	0.45
10	0.43	0.01	0.44
11	0.48	0.04	0.52
12	0.39	0.03	0.42
13	0.55	0.02	0.57
14	0.35	0.03	0.38
15	0.86	0.01	0.86
16	0.26	0.06	0.32

Results for Alterations

Windows – Alterations – First-Year Electricity Savings (kWh/ft²)

Prototypes	CZ01	CZ02	CZ03	CZ04	CZ05	CZ06	CZ07	CZ08	CZ09	CZ10	CZ11	CZ12	CZ13	CZ14	CZ15	CZ16
OfficeLarge	0.07	0.15	0.12	0.18	0.15	0.19	0.19	0.21	0.19	0.23	0.19	0.18	0.19	0.20	0.29	0.12
OfficeMedium	0.11	0.24	0.22	0.30	0.24	0.30	0.28	0.35	0.34	0.36	0.35	0.29	0.37	0.37	0.55	0.22
OfficeSmall	0.09	0.17	0.13	0.20	0.14	0.19	0.18	0.21	0.24	0.23	0.25	0.19	0.25	0.24	0.37	0.14
Restaurant FastFood	0.02	0.17	0.11	0.23	0.14	0.22	0.20	0.29	0.29	0.30	0.29	0.24	0.31	0.29	0.47	0.15
RetailLarge	(0.03)	0.06	0.03	0.08	0.04	0.09	0.06	0.11	0.14	0.13	0.14	0.11	0.13	0.12	0.29	0.06
RetailMedium	(0.05)	0.01	0.00	0.04	0.01	0.04	0.09	0.17	0.11	0.16	0.18	0.06	0.08	0.10	0.41	0.04
RetailStripMall	(0.01)	0.05	0.02	0.06	0.04	0.14	0.10	0.16	0.16	0.16	0.15	0.09	0.15	0.08	0.28	0.04
SchoolSmall	0.12	0.33	0.25	0.42	0.27	0.38	0.35	0.47	0.50	0.52	0.51	0.44	0.53	0.56	0.80	0.39

Windows – ALT – First-Year Peak Electric. Demand Reductions (kW/ft²)

Prototypes	CZ01	CZ02	CZ03	CZ04	CZ05	CZ06	CZ07	CZ08	CZ09	CZ10	CZ11	CZ12	CZ13	CZ14	CZ15	CZ16
OfficeLarge	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
OfficeMedium	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
OfficeSmall	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.01	0.01	0.01	0.01	0.01
Restaurant FastFood	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
RetailLarge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RetailMedium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
RetailStripMall	0.00	0.00	(0.01)	(0.01)	(0.01)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(0.01)	0.00	0.00
SchoolSmall	0.01	0.02	0.01	0.02	0.00	0.01	0.01	0.01	0.01	0.01	0.04	0.03	0.03	0.02	0.02	0.02

Windows – Alterations – First-Year Nat. Gas Savings (kBtu/ft²)

Prototypes	CZ01	CZ02	CZ03	CZ04	CZ05	CZ06	CZ07	CZ08	CZ09	CZ10	CZ11	CZ12	CZ13	CZ14	CZ15	CZ16
OfficeLarge	0.99	0.69	0.64	0.67	0.60	0.38	0.34	0.37	0.45	0.43	0.75	0.66	0.46	0.72	0.31	1.07
OfficeMedium	0.44	0.45	0.49	0.36	0.31	0.14	0.11	0.27	0.31	0.17	0.57	0.39	0.29	0.38	0.15	0.81
OfficeSmall	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.44
Restaurant FastFood	(0.53)	(0.41)	(0.56)	(0.45)	(0.65)	(0.41)	(0.37)	(0.32)	(0.33)	(0.32)	0.04	(0.23)	(0.16)	(0.45)	(0.20)	(0.03)
RetailLarge	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
RetailMedium	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
RetailStripMall	(0.52)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(0.63)
SchoolSmall	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.68

Windows – Alterations – First-Year Source Energy Savings (kBtu/ft²)

Prototypes	CZ01	CZ02	CZ03	CZ04	CZ05	CZ06	CZ07	CZ08	CZ09	CZ10	CZ11	CZ12	CZ13	CZ14	CZ15	CZ16
OfficeLarge	0.89	0.63	0.58	0.61	0.54	0.34	0.31	0.33	0.40	0.39	0.68	0.60	0.42	0.64	0.28	0.96
OfficeMedium	0.40	0.40	0.44	0.32	0.28	0.12	0.10	0.24	0.28	0.15	0.52	0.36	0.26	0.34	0.13	0.73
OfficeSmall	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40
Restaurant FastFood	(0.48)	(0.37)	(0.50)	(0.41)	(0.59)	(0.37)	(0.34)	(0.29)	(0.29)	(0.29)	0.04	(0.21)	(0.15)	(0.40)	(0.18)	(0.03)
RetailLarge	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
RetailMedium	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
RetailStripMall	(0.47)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(0.57)
SchoolSmall	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.61

Windows – 30-Year LSC Savings - Alterations

Climate Zone	30-Year LSC Electricity Savings (2026 PV $)	30-Year LSC Gas Savings (2026 PV $)	Total 30-Year LSC Savings (2026 PV $)
1	0.26	0.00	0.26
2	0.74	0.09	0.84
3	0.49	0.16	0.65
4	0.90	0.16	1.06
5	0.67	0.05	0.73
6	0.88	0.07	0.95
7	0.91	0.06	0.97
8	1.09	0.09	1.18
9	1.07	0.11	1.19
10	1.19	0.04	1.23
11	1.45	0.09	1.54
12	1.02	0.12	1.14
13	1.32	0.04	1.36
14	1.07	0.10	1.17
15	2.06	0.02	2.09
16	0.65	0.18	0.83

Windows – Cost Effectiveness

- The proposed change is for new mandatory requirements that are less stringent than the current prescriptive requirements.

- As the current prescriptive requirements are deemed to be cost-effective, no cost-effectiveness analysis was required for this proposal.

Windows – Total Incremental Cost

- Negligible incremental first cost – proposed requirement is already easily met by insulated glazing units already available on the market.
- No additional labor cost
- No maintenance/replacement costs included
  - Assumed 30-year window replacement period

Windows - 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 September 15, by 5:00pm**

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

Thank you for participating!

Thank You!

Comments

Comments on Todays Workshop

- Due date: September 15, 2023, by 5:00 PM
- Comments to be submitted to: https://efiling.energy.ca.gov/Ecomment/Ecomment.aspx?docketnumber=22-BSTD-01

Workshop Recordings

- For recordings of previous workshops, visit: https://www.energy.ca.gov/events/past-events

Thank you for participating in today's workshop!

15-minute Break

We will resume at 2:45

The CNRA building is being evacuated.