



**TITLE 24, PART 6**

**2025 CODE CYCLE**



# Daylighting

Codes and Standards Enhancement (CASE) Proposal  
Nonresidential | Lighting  
Round 2 Stakeholder Meeting



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May 16, 2023



# Agenda

Overview of Code Change Proposal

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Cost-effectiveness, Energy Savings and Statewide Impacts

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Data Gaps and Additional Feedback Requested

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Next Steps



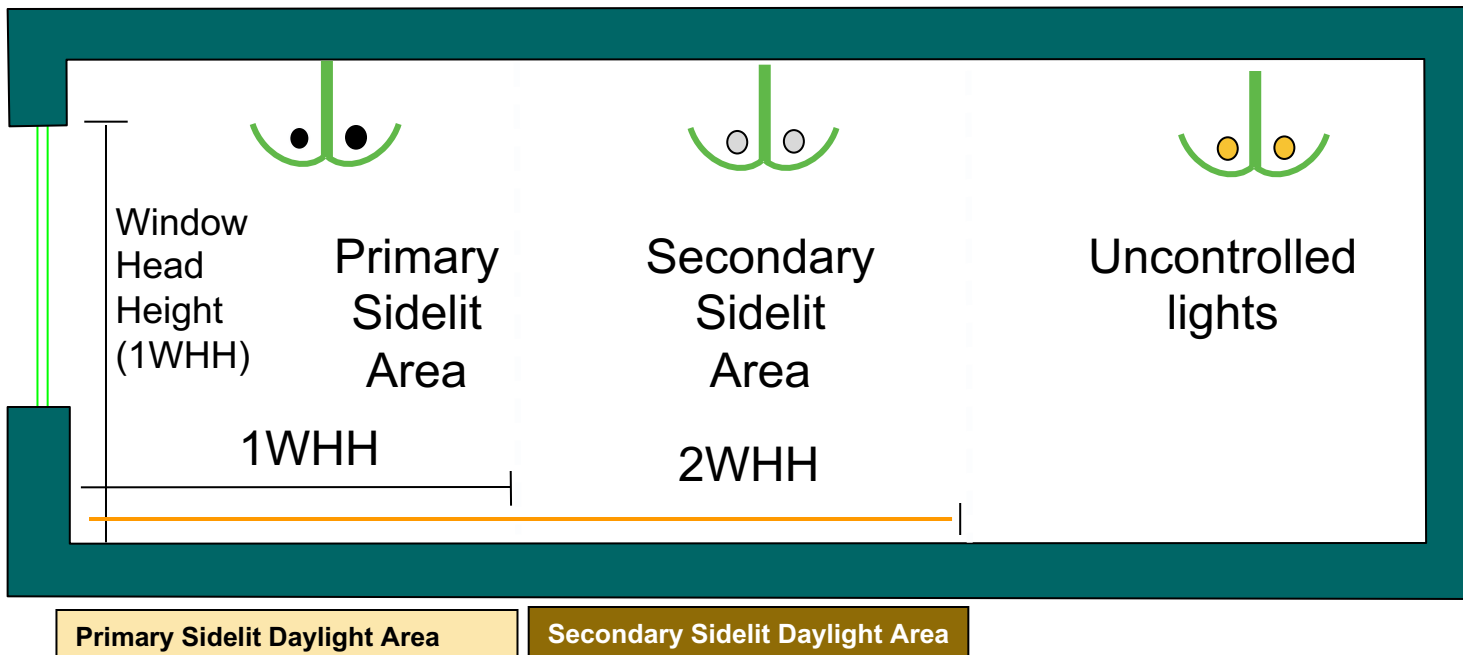


# Code Change Proposal

# Daylighting Control Requirements [§130.1(d)]

3. 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.

# Proposed Code Change

**Reduce the total installed general lighting wattage for requiring automatic daylighting controls from 120 watts to 75 watts.**

- The 120-watt threshold was designed for legacy light sources
- Title 24, Part 6 indoor lighting power densities are now based on LED efficacy since 2019
- 120-watt threshold represents significantly higher lighting power for LEDs
- LEDs have lowered dimming control costs

# Draft Code Change Language

Draft code language available for review in Handouts and downloadable on [Title24Stakeholders.com](https://Title24Stakeholders.com).

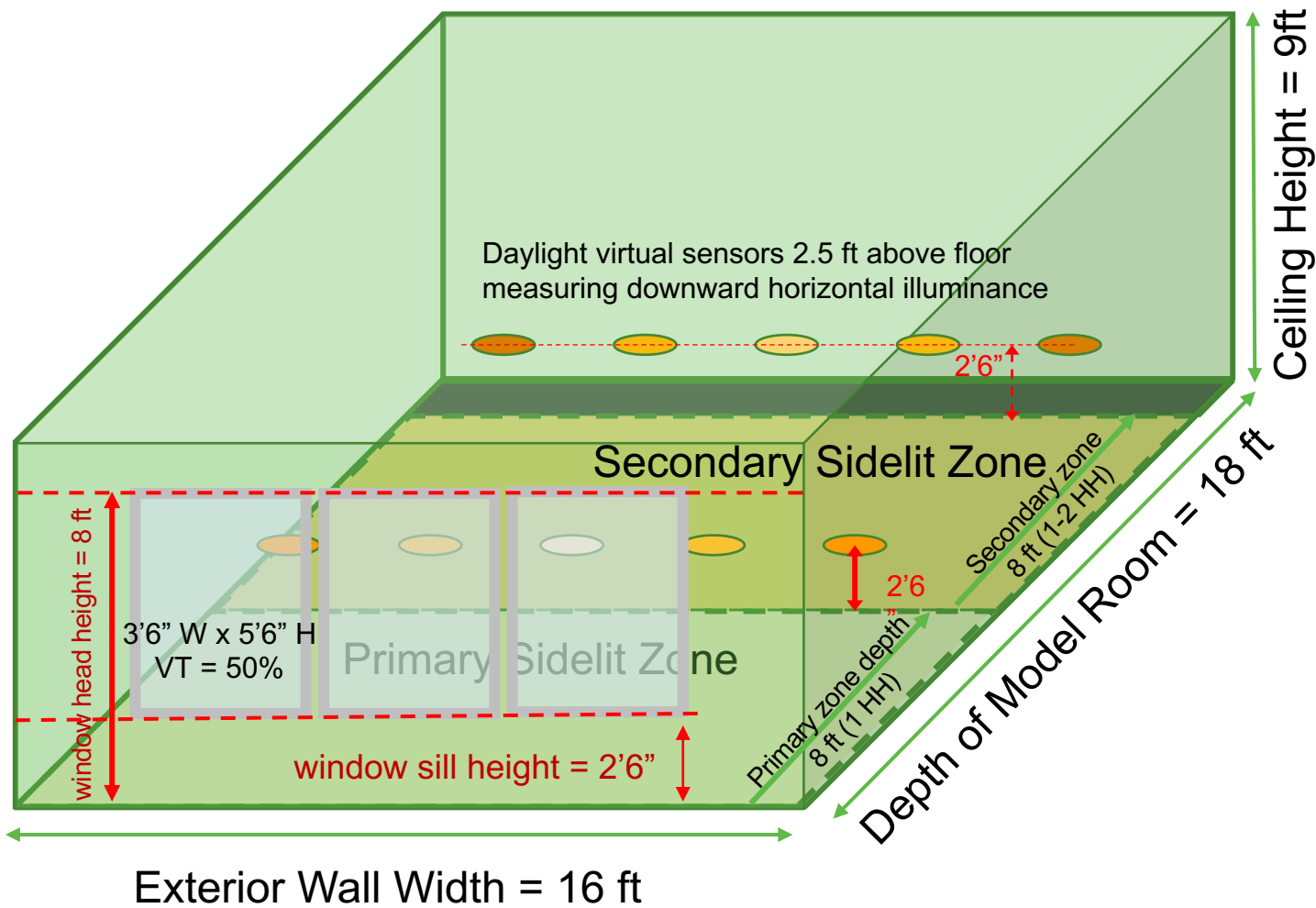
# Cost Effectiveness and Energy Savings

## *Methodology and Assumptions*

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



# Daylighting Simulation Model

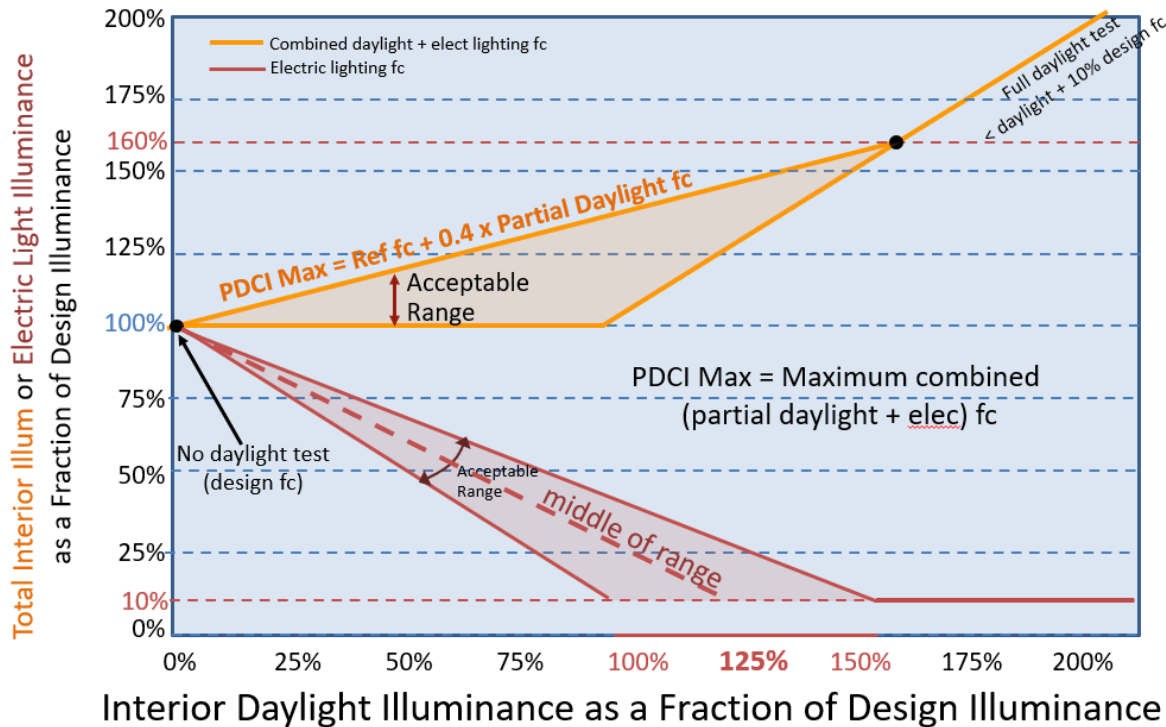


- Daylight simulated with LightStanza front-end to Radiance ray tracing
- Daylight illuminance for control
  - Average of 5 sensors at rear of primary and secondary zone,
  - 2.5 feet above finished floor
- Model configuration designed for spaces impacted by change from 120 W to 75 W threshold
  - 16' x 18' x 9' (288 ft<sup>2</sup>)
  - Space type agnostic
- Reflectances: 80%/50%/20%
- Windows:
  - Three: 3'-6"W by 5'-6"H
  - Visible transmittance = 50%



# Assumptions: Convert Daylight Illuminance to Energy Savings

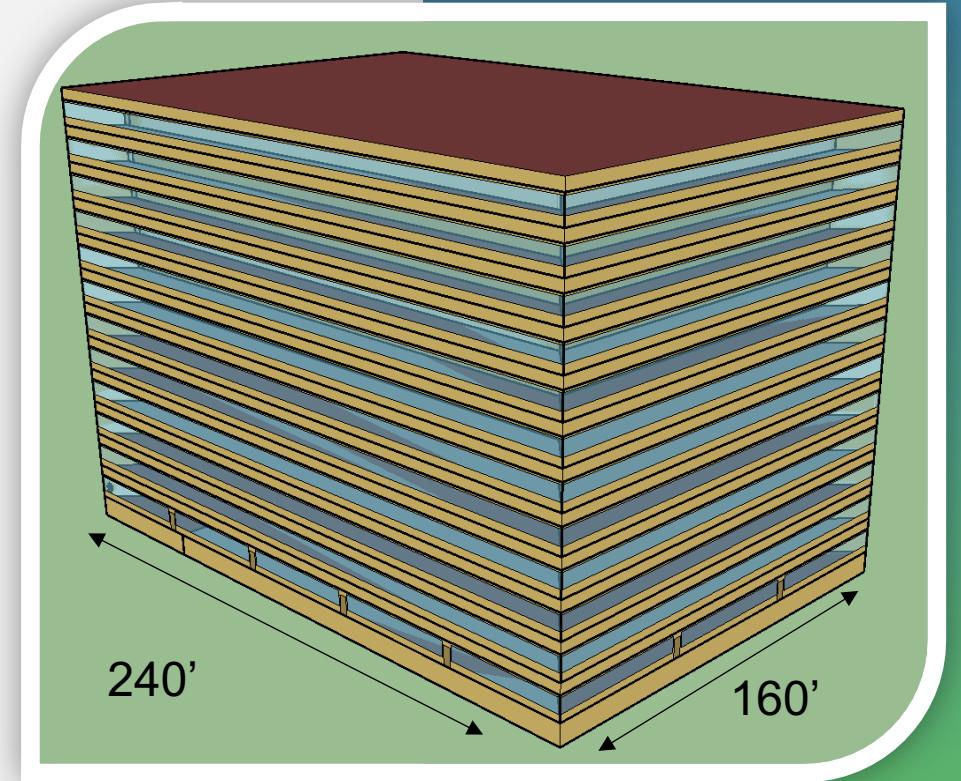
## Daylighting Control Plot



- Electric lighting is modeled as light emitting diode (LED)
- Continuously dimming from 100% of input power at full light output to 12% of input power at 10% light output
- Code requires electric light not over-dimming (too dark) or under-dimming (not enough energy savings).
  - Not over-dimming:
    - daylight + electric light  $\geq$  100% of design fc
  - Not under-dimming:
    - daylight + electric light  $\leq$  150% of design fc
- Target control illuminance assumed to be in middle of range  $\rightarrow$  125% of design fc

# Modeling of Energy Impacts: Large Office

- 7% of floorspace impacted by measure
  - Impacted floorspace represented by Daylight Model
  - Impacted space breakdown assumptions:
    - 50% Medium-size offices (300 lux, 0.60 W/ft<sup>2</sup>)
    - 40% Conference rooms (300 lux, 0.75 W/ft<sup>2</sup>)
    - 10% Corridors (100 lux, 0.40 W/ft<sup>2</sup>)



# Full-Load Hour (FLH) Savings

- Based on large office occupancy schedule
- Design illuminance
  - Office/conference room: 300 lux
  - Corridor: 100 lux
- Daylight in secondary zone ~1/2 of primary zone

Climate Zone	No Daylighting Control FLH	PDZ Office / Conference Room		SDZ Office / Conference Room		PDZ Corridor	
		FLH	Savings	FLH	Savings	FLH	Savings
1	2,949	1,228	58%	1,635	45%	1,066	64%
2	2,949	1,159	61%	1,562	47%	1,036	65%
3	2,949	1,147	61%	1,527	48%	1,033	65%
4	2,949	1,131	62%	1,496	49%	1,031	65%
5	2,949	1,132	62%	1,489	50%	1,031	65%
6	2,949	1,126	62%	1,475	50%	1,035	65%
7	2,949	1,132	62%	1,491	49%	1,039	65%
8	2,949	1,141	61%	1,502	49%	1,039	65%
9	2,949	1,140	61%	1,501	49%	1,041	65%
10	2,949	1,136	61%	1,490	49%	1,043	65%
11	2,949	1,193	60%	1,569	47%	1,053	64%
12	2,949	1,174	60%	1,557	47%	1,045	65%
13	2,949	1,181	60%	1,536	48%	1,072	64%
14	2,949	1,121	62%	1,465	50%	1,037	65%
15	2,949	1,131	62%	1,457	51%	1,046	65%
16	2,949	1,185	60%	1,577	47%	1,051	64%

## Poll

Do the full-load hour savings from adding automatic daylighting controls seem believable?

# Preliminary Energy Savings Estimates Per Controlled Watt

## Office spaces with both primary and secondary daylight zones

<b>Annual Electricity Savings (kWh/yr)</b>	1.52-1.66
<b>Annual Natural Gas Savings (Therms/yr)</b>	N/A
<b>Peak Demand Reduction (W)</b>	0.0051-0.0071
<b>Annual Source Energy Savings (kBtu/yr)</b>	0.76-0.92
<b>Annual Life Cycle Energy Cost Savings (PV\$/yr)</b>	6.18-6.99

\* See Draft CASE Report for estimates for corridor spaces and office spaces with primary and secondary daylight zones estimated separately.

### Key assumptions:

- 300 lux design illuminance
- Occupancy/Lighting schedule includes occupant sensing controls

# Control Solutions Considered

Code	Control Solution	Photocontrol Type	Ease of Installation & Commissioning	Maintenance Access
R-WL-C	Wireless room control	Closed loop	Easy	Moderate
R-WL-O	Wireless room control	Open loop	Easy	Moderate
R-WD-C	Wired room control	Closed loop	Moderate	Easy
R-WD-O	Wired room control	Open loop	Difficult	Moderate
LLLC	Luminaire-level control	Closed loop	Easy	Easy
BMS-O	Building management system	Open loop	Difficult	Easy

## Poll

Are there other common control solutions for implementing automatic daylighting controls we should consider?

# Incremental Cost Per 150W Controlled

Over 30 Year Period of Analysis

Control Solution Code	Incremental First Cost (\$/150W)			
	Equipment	Installation	Commissioning	Total
R-WL-C	\$636.50	\$59.34	\$59.34	\$755.19
R-WL-O	\$365.76	\$59.34	\$59.34	\$484.45
R-WD-C	\$366.79	\$237.37	\$118.69	\$722.85
R-WD-O	\$632.09	\$118.69	\$59.34	\$810.12
LLLC	\$664.07	\$59.34	\$59.34	\$782.75
BMS-O	\$765.51	\$237.37	\$118.69	\$1,121.57
<b>Average</b>	<b>\$571.79</b>	<b>\$128.58</b>	<b>\$79.12</b>	<b>\$779.49</b>

Equipment cost data:

- Based on the daylight simulation model
- Includes 22 solutions from 11 manufacturers
- Includes taxes, freight, and markup

Labor cost based on CA electrician rates

Average across all 6 control solution types



## Poll

Do the first cost numbers seem reasonable?

## Poll

Is it appropriate to use CA electrician rate for installation, commissioning, and maintenance?

\$86-\$158/hr (non-unionized)

\$107-\$198/hr (unionized)

# Incremental Cost Per 150W Controlled

Over 30 Year Period of Analysis

Control Solution Code	Incremental Maintenance Cost (\$/150W)		
	Replacement	Maintenance	Total
R-WL-C	-	\$166.29	\$166.29
R-WL-O	-	\$133.47	\$133.47
R-WD-C	-	-	-
R-WD-O	-	-	-
LLLC	\$502.42	-	\$502.42
BMS-O	-	\$83.15	\$83.15
<b>Average</b>	<b>\$83.74</b>	<b>\$63.82</b>	<b>\$147.55</b>

Key assumptions:

- LLLC replaced at the 15<sup>th</sup> year
- Maintenance for wireless (WL) controls includes battery changeout every 10 years

Total incremental cost over 30 year period of analysis: **\$927.04**

## Poll

Do photosensors or other components need to be replaced during the 30-year period of analysis?

# Cost Effectiveness

- Medium size office or conference room with two-zone daylighting controls
  - 75 watts primary
  - 75 watts secondary
- Corridor with single-zone daylighting controls
  - 75 watts primary

Climate Zone	PDZ + SDZ Office / Conf Rm Life Cycle Energy Cost Savings (PV\$/150 W)	Office / Conf Rm Benefit/Cost Ratio for \$927 Total Incremental Cost (B/C)	PDZ Corridor Life Cycle Energy Cost Savings (PV\$/75 W)	Corridor Benefit/Cost Ratio for \$ TBD Total Incremental Cost (B/C)
1	\$928	1.00	\$590	TBD
2	\$977	1.05	\$603	TBD
3	\$995	1.07	\$604	TBD
4	\$1,009	1.09	\$603	TBD
5	\$1,018	1.10	\$605	TBD
6	\$1,046	1.13	\$615	TBD
7	\$949	1.02	\$560	TBD
8	\$1,028	1.11	\$612	TBD
9	\$1,029	1.11	\$611	TBD
10	\$1,033	1.11	\$610	TBD
11	\$955	1.03	\$593	TBD
12	\$966	1.04	\$598	TBD
13	\$973	1.05	\$591	TBD
14	\$1,048	1.13	\$612	TBD
15	\$1,047	1.13	\$608	TBD
16	\$986	1.06	\$608	TBD

# Statewide Impacts

## *Methodology and Assumptions*

- Statewide Energy Impacts  
Methodology and Results



# Statewide Economic Impacts Methodology

The Statewide CASE Team estimates annual statewide impacts by multiplying **A x (B x C x D)**:

- A. per-watt energy impact (discussed in previous slide)
- B. number of sq.ft. of new construction/additions/alterations of each applicable building type
- C. portion of affected sq.ft. in each climate zone
- D. lighting power allowances of affect sq.ft.

## Example:

Per Unit Impacts

Savings type	Savings per W
Electricity	[X] kWh
Peak demand	[X] Watts
Natural gas	[ ] Therms
GHG emissions	[X] Tons CO <sub>2</sub> e



Affected New Construction

Climate Zone	Large Office kW	Assembly kW
1	100	20
2	1,000	1,500
...		
16	5,000	3,000



Statewide Energy Impacts

Climate Zone	Elec Savings (GWh)	...	GHG savings (MT CO <sub>2</sub> e)
1	20		1,500
2	50		3,000
...			
16	100		2,000

# 2026 Construction Forecast

Construction Forecast Building Type		Newly Constructed Floorspace Impacted (%)	Existing Floorspace Impacted (%)
Non- residential	Large Office	7.00%	0.47%
	Medium Office	7.00%	0.47%
	Small Office	7.00%	0.47%
	Large Retail	5.00%	0.33%
	Medium Retail	2.00%	0.13%
	Strip Mall	0.00%	0.00%
	Mixed-use Retail	1.00%	0.07%
	Large School	7.00%	0.33%
	Small School	2.00%	0.20%
	Non-refrigerated Warehouse	1.00%	0.07%
	Hotel	<1%	<0.07%
	Assembly	5.00%	0.20%
	Hospital	7.00%	0.47%
	Laboratory	10.00%	0.67%
	Restaurant	1.00%	0.07%
	Enclosed Parking Garage	0.00%	0.00%
	Open Parking Garage	0.00%	0.00%
	Grocery	1.00%	0.07%
	Refrigerated Warehouse	1.00%	0.07%
	Controlled-environment Horticulture	1.00%	0.07%
	Vehicle Service	10.00%	0.67%
	Manufacturing	3.00%	0.20%
Unassigned	1.00%	0.07%	



# Affected space types across building prototypes

Space Type	General Lighting Design Illuminance (Lux)	General Lighting Power Allowance (W/ft <sup>2</sup> )
(Mid-size) Office	300	0.60
Conference Room	300	0.75
Study Space	300	0.80
Corridor	100	0.40
Lobby	150	0.50
Exercise Room	400	0.50

# Statewide Savings

*From One Year's New Construction and Alterations*

Construction Type	Statewide Area with Added Daylight Controls (1,000 sf)	Statewide Lighting Wattage Newly Controlled (kW)	Statewide Electricity Savings (GWh/yr)	Reduced GHG Emissions (Metric Tons CO2e)
New Construction & Additions	5,465	3,352	5.5	157
Alterations	21,720	13,283	22.0	625
<b>Total</b>	<b>27,186</b>	<b>16,635</b>	<b>27.5</b>	<b>782</b>

Results for all buildings:

- Medium-size Offices
- Conference Rooms
- Corridors

Simulated with:

- Office Building Lighting Schedule
- Daylight model w/ 30% gross WWR & 50% VT windows
- Daylight Dimming to 10%



# Data Gaps and Additional Feedback Requested

- Additional Data Needs
- Feedback Requested

# Data Gaps & Additional Feedback Requested

- Are there other common control solutions for implementing automatic daylighting controls we should consider?
- Are there any incremental costs we missed?
  - How will luminaire types (general lighting) affect the incremental costs?
  - Specific sensor compatibility?
  - Review posted costs for two-zone photocontrol system
  - Data for single-zone photocontrol system costs
  - Specific trends – what is becoming predominant system types for offices, conference rooms, and daylighted corridors and stairwells
- Is the proposed code language clear and unambiguous? Is there a way to make it more concise?
  - Window height impact on daylight zone size
  - Wattage threshold per single daylight zone (75 watts in either primary or secondary)
  - Combined wattage threshold in primary and secondary daylight zone (150 watts)

# We want to hear from you!

- Provide **any last comments or feedback** on this presentation now verbally or over the GoTo Webinar Questions Pane
- More information on pre-rulemaking for the 2025 Energy Code at <https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2025-building-energy-efficiency>

**Comments on this measure are due by May 31.** Please send comments to [info@title24stakeholders.com](mailto:info@title24stakeholders.com) and copy CASE Authors (see contact info on following slide).

# Thank You

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