TITLE 24, PART 6 | 2028 CODE CYCLE

# Indoor Lighting Power Density

## Codes and Standards Enhancement (CASE) Proposal

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CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

# Proposal Description

- Code Change Proposal
- Background Information
- Benefits

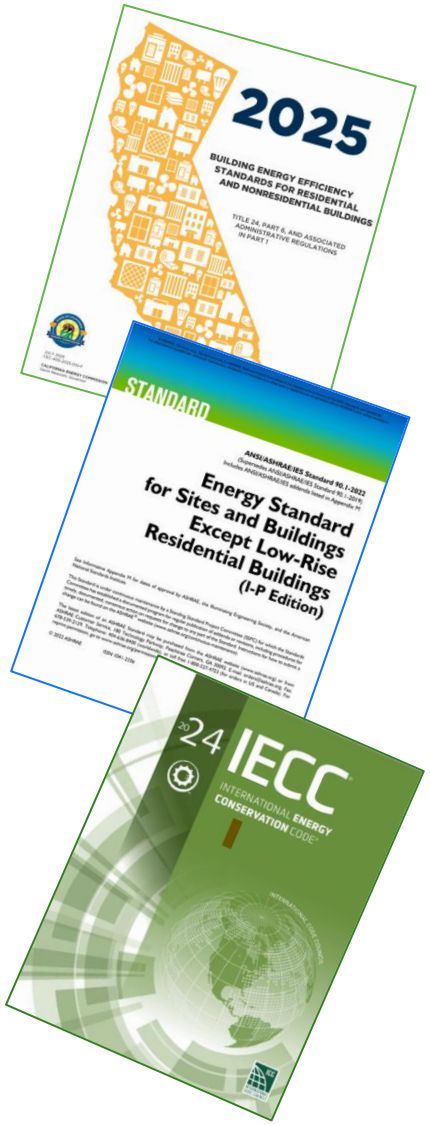
# Proposed Code Change

- Update the prescriptive requirements for **allowed lighting power density (LPD)** for nonresidential indoor spaces
  - New or modified space types and building types to reflect design patterns and market data (e.g., data centers)
  - Revisit data moved over from tailored lighting into area category (some could be simplified, similar to national codes)
  - Updates related to IES recommended practice, product updates, luminaire efficacy, and light loss factors
- Updates to luminaire classification and **adjusted indoor lighting power**.
  - Multi-wattage luminaires (color selectable minimal impact)
  - Luminaires containing removable lamps
- Applies to new construction, additions, and alterations of non-residential buildings

**See Title24stakeholders.com** for proposal description, justification, and requested data

# Background Information

- Title 24
  - 2019 code cycle – significant LPD updates, changing to the LED baseline
  - 2022 code cycle – moderate LPD updates LED to more efficient LED
  - 2025 code cycle – no LPD update except tailored method was removed, and tailored power allowances incorporated into the area category method LPD table for 5 applications.
- National standards (ASHRAE/IES 90.1) and other model codes (IECC) have made significant updates to the LPD values since 2022
  - ASHRAE 90.1 made recent updates (Addendum s to ASHRAE 90.1-2022) based on:
    - An average of 2% increase in luminaire efficacy
    - An across-the-board change in 0.85 lamp lumen depreciation (LLD) factor in the lighting model to 0.90
    - Revising the luminaire dirt depreciation (LDD) values using *IES RP-36 Methodology for Determining LDD* based on a 5-year cleaning cycle, dirtiness of the space, and luminaire type



# Poll

**What is the Lamp Lumen Depreciation (LLD) factor you typically apply in indoor lighting applications?**

LLD is the reduction in light output over the life of the luminaire (typically around 50,000 hours).
Select the closest one:

a. 0.90 or greater
b. 0.85
c. 0.80
d. 0.75 or less
e. Not applicable to me

# Poll

**What is the Total Light Loss Factor (LLF) you typically apply in indoor lighting applications that are clean (offices, etc.)?**

The initial illuminance multiplied by the LLF is the maintained illuminance. Typically, LLF is the product of lamp lumen depreciation, luminaire dirt depreciation, and room surface dirt depreciation.
Select the closest one:

a. 0.90 or greater
b. 0.80
c. 0.70
d. 0.60 or less
e. Not applicable to me

# Example General Lighting LPD Comparisons – Area Category Method

| 2025 Title 24 Area Category | 2025 Title 24 | ASHRAE 90.1-2022 Addendum s |
|---|---|---|
| Audience/Seating Area | 0.50 | 0.23 |
| Concourse and Atria Area vs 90.1 Atria | 0.60 | 0.29 – 0.49 |
| Concourse and Atria Area vs 90.1 Airport Concourse | 0.60 | 0.46 |
| Convention… Area vs 90.1 Convention Exhibit | 0.75 | 0.46 |
| Financial Transaction Area | 0.71 | 0.53 |
| Hair Care, Beauty Salon | 0.71 | 0.61 |
| Lounge, Breakroom, or Waiting Area | 0.55 | 0.50 |
| Parking Garage Area: Parking Zone and Ramps | 0.10 | 0.08 |
| Office Area: > 250 $ft^2$ | 0.60 | 0.52 |
| Religious Worship Area | 0.95 | 0.64 |

# Add more specific space types

Growth in certain space types (casinos, data centers)

Space types grouped with dissimilar lighting needs.

Sample separate space types
(suggest space types in Q&A window)

- Casino (Sportsbook, table game area, slots/digital games)
- Concourse separated from atrium area
- Control room including for process or entertainment
- Computer room or computer server room
- School or gym swimming pool (natatorium)
- Others??

https://commons.wikimedia.org/wiki/File:McCorkle_Aquatic_Pavilion,_diving_platforms,_at_the_Ohio_State_University.JPG
https://commons.wikimedia.org/wiki/File:CERN_Server_03.jpg

# Marked-up Code Language

**No preliminary LPD values are proposed at this stage**

## Title 24, Part 1

- No Changes

## Title 24, Part 6

- §130.0(c) Luminaire classification and power
- §140.6 Prescriptive Requirements for Indoor Lighting
- TABLE 140.6-B Complete Building Method LPD
- TABLE 140.6-C Area Category Method LPD

## Reference Appendices

- No Changes

# Benefits of Updated LPDs and Luminaire Power

**Saves Energy**

- Increased efficacy not sufficient to save energy (Jevons Paradox)
  - Proposal applies IES recommended illuminance and good design practice along with modern luminaires to develop LPDs

**Saves Money**

- Very cost-effective
- Reduces energy bills

**Environmental Benefit**

- Reduces pollution associated energy generation and resource extraction
- Proposal to allow re-use of luminaires with different lamps, reduces waste and embodied energy in replacement luminaires.

# Market and Technical Considerations

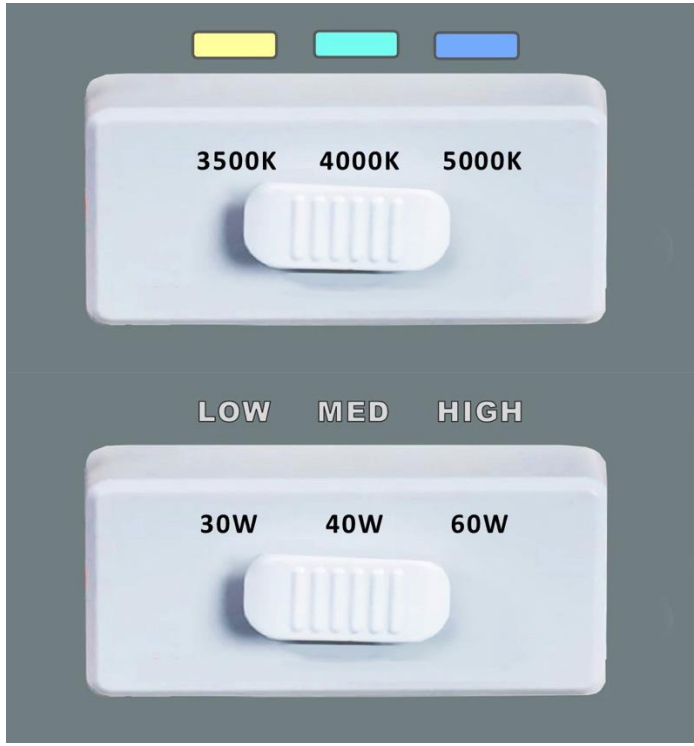
- Current Conditions and Trends
- Potential Barriers and Solutions
- Technical Feasibility

# Current Market Conditions – Preliminary Findings

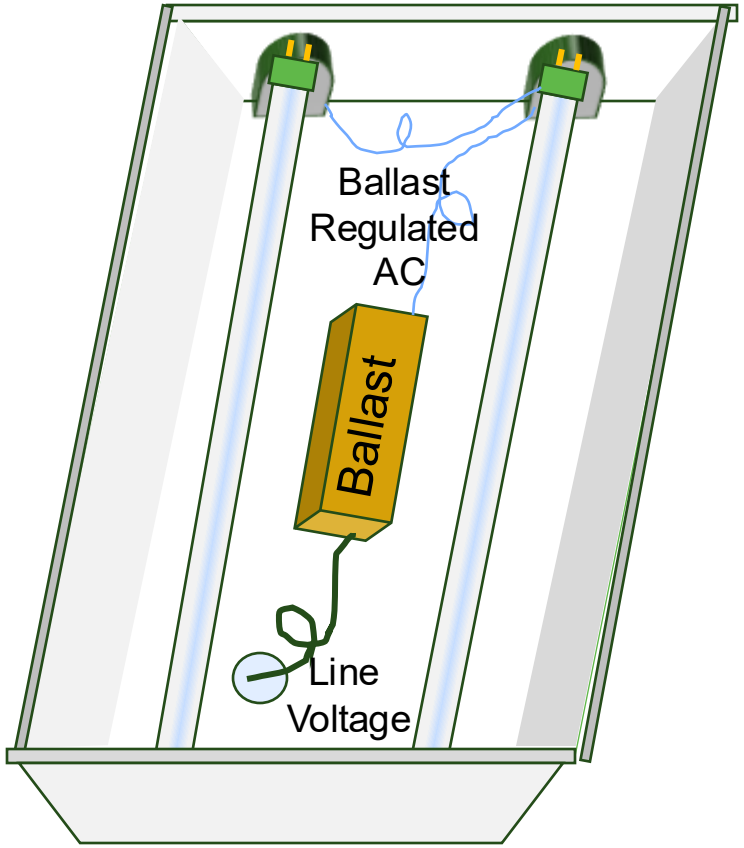
- DesignLights Consortium (DLC) is proposing a 4-19% (average 14%) increase in minimum efficacy for qualifying products across all eligible lamp and luminaire types, effective October 2026.
- ASHRAE 90.1-2025 and 2027 IECC have the same general lighting LPDs – many of which are lower than the general lighting LPDs in 2022/2025 Title 24
- Preliminary findings indicate significant efficacy improvement in high CRI products, exhibiting only 10-12% efficacy loss compared to 80 CRI products.
  - Super high CRI (95-97 CRI with 90+ R9), dim-to-warm, and color-tunable products still exhibit substantial efficacy losses (24%+) compared to 80 CRI products.
  - For display and accent lighting some of market now offers 90 CRI as the base case
- Luminaire (driver) expected life approximately 50,000 hours

# Current Market Conditions – Initial Impressions

- The lighting designers on the ASHRAE 90.1 committee broadly agreed they were using 90% LLD. This was a significant contribution to lower LPDs.
- Limited surveys show that cut-sheets may have outdated photometry including:
  - Light output, power and efficacy
  - Color temperature and CRI adjustment factors
- Few direct/indirect luminaires and typically only available in specifier grade.
- Workhorse for office spaces is the basket troffer.
- Specifier grade more options but very close band of efficacy variation.
- Commodity grade typically only one lensed troffer that was wattage selectable
- Many wattage (lumen) selectable luminaires
  - Some wattages programmed with NFC (near field communication)
  - Some wattages selected with manual dip switches
  - Great market benefit – less total luminaires needed to be stocked for different lumen outputs.

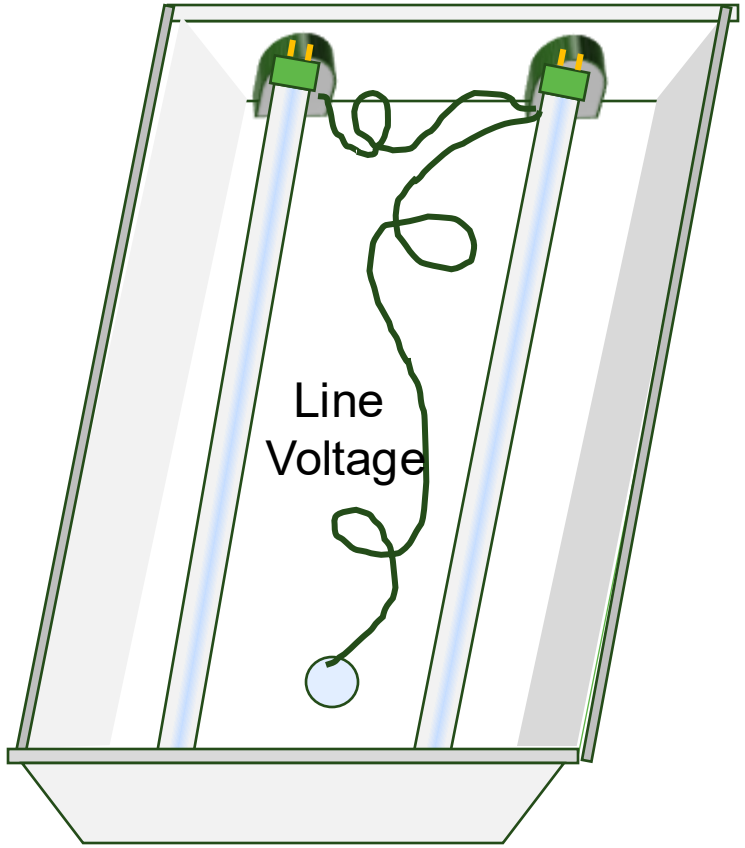


# Three Types of Tubular LED (TLED)



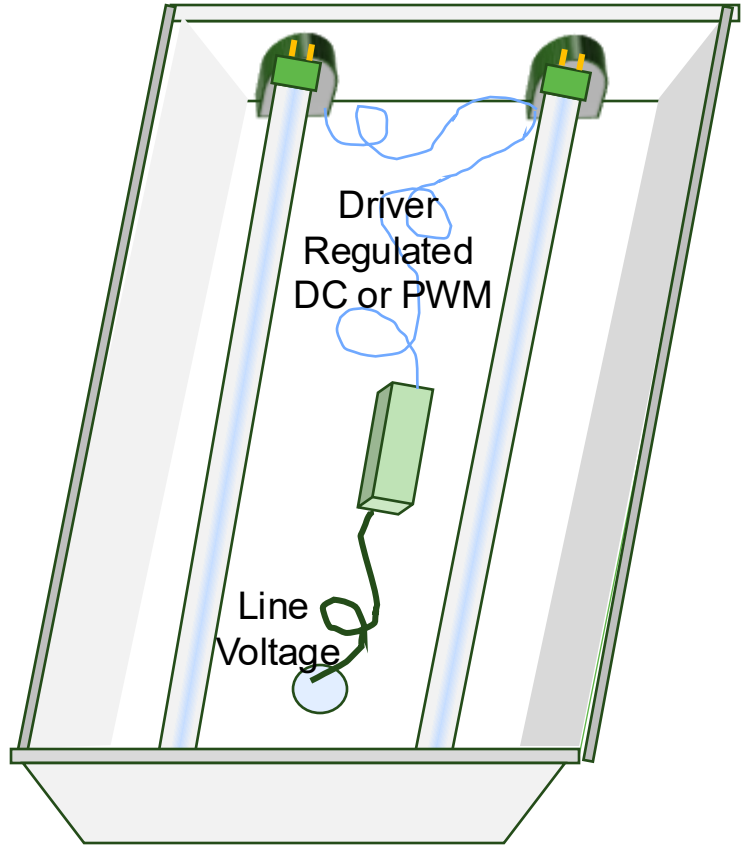

**Type A**

Includes ballast losses, no rewiring required, driver in tube




**Type B**

No ballast losses, rewiring line voltage to socket or directly to tube, driver in TLED




**Type C**

No ballast losses, rewiring to and from separate driver

# Addressing Wasteful Retrofit Options

**Tubular LED (TLED) Retrofit Options**

- Type A – Ballast is energized, ballast regulated voltage sent to fixture pins and voltage further regulated by TLED driver in lamp. Added 2-3 watts of power. Has to be replaced when ballast fails. Less initial labor.
- Type B – Ballast is disconnected. Line voltage sent directly to TLED driver in lamp (either through a separate wire or to luminaire pins). More efficient. Have to open up fixture to rewire.
- Type C - Ballast is disconnected. Remote driver connected to line voltage and regulated voltage sent to TLED. More efficient. Have to open up fixture to rewire.
- Proposal not to allow Type A. Wastes energy, lowest life cycle cost.

# Market Barriers and Solutions

## Market Barriers

1. Spec sheets may not keep up with updated product performance
    a) Some products seem to have older efficacies
2. Energy code definition of installed wattage being highest rated wattage of luminaire vs flexibility of multi-wattage luminaire
    a) Less different products needed to be stocked
    b) Market efficiency
    c) Highest wattage prevents increase in lighting power after inspection

## Potential Solutions

1. With more stringent standards:
    a) More pressure to use higher efficacy chipset
    b) Producers update spec sheet
2. Allow lower wattage if there is a barriers to changing wattage after installation
    a) Breakoff dip switch handle
    b) Switch on back of fixtures
    c) Current limiters
    d) ASHRAE 90.1 Addendum CK – maximum *field-adjustable* wattage

# Poll

**How frequently are your projects unable to comply using the lighting allowances and you must trade-off with other building components using the performance software approach?**

a. Never
b. Rarely
c. Sometimes
d. Usually
e. Not applicable to me

# Poll

**How frequently must you use the additional power allowances (decorative/display, tunable white etc.) to comply with the lighting budgets?**

a. Never
b. Rarely
c. Sometimes
d. Usually
e. Not applicable to me

# Poll

**How frequently must you use the power adjustment factors to comply with the lighting budgets?**

a. Never
b. Rarely
c. Sometimes
d. Usually
e. Not applicable to me

# Poll

**For a typical or average lighting project: What is the ratio of installed power to allowed power?**

a. Greater than 100% (i.e., need PAFs or performance trade-offs)
b. 90% – 100%
c. 80% – 89%
d. 70% to 79%
e. Lower than 70%
f. Not applicable to me

# Poll

## Which type of designs or design features have problems complying with the lighting power allowances?

Open ended question (please add text) _____

# Technical Considerations

- Limited surveys of manufacturers and lighting designers find that actual efficacy and lamp lumen depreciation factor is sometimes higher (more efficacious, less reduction in output) than what is published on cut-sheets.
  - Is this true?
  - If so, does this create a liability problem for the designer if they use a value other than what is on the cut-sheet?
- Recent increases in efficacy vary by light sources and color rendering.
- A popular product offering is multi-wattage (wattage-selectable) luminaires. This reduces the number of SKUs lighting distributors have to stock, and product wattage can be set at the time of installation. This is problematic for code enforcement.
  - ASHRAE 90.1 uses the highest field adjustable wattage. How is this defined?
  - Is there a way to limit the changing of wattages once sold from the distributor, or is there a way to disable the multiple wattage selection control?

# Per Unit Energy and Cost Impacts

***Methodology and Assumptions***

- Energy and Energy Cost Savings
- Incremental Costs

# LPD and Energy Cost Savings Methodology

- LPD - Inverse Lumen Method modeling methodology used in the 2019 and 2022 CASE Report
  - Inputs: Design illuminance (general, task, supplemental, wall wash), space geometry, reflectances, cleanliness, luminaire: efficacy, distribution, light loss factor
  - Compare results with projects and design experience
  - Key changes: Lamp Lumen Depreciation, Newer Luminaires
- .Energy = LPD x Area x Hours of Operation
  - Hours of operation from ACM schedules for area categories
- Energy Cost Savings = Lighting Power x Hourly Schedule x LSC hourly life cycle cost/kWh

https://idt.ies.org/

# Approach for Gathering Costs

- Incremental costs are developed from prototypical models of minimal compliance with the 2025 code with what is proposed for 2028.
- Different luminaire selection and design approach
- We ask for your engagement
  - Reviewing our approach
  - Providing input on equipment selection
  - Review of estimated costs

# Compliance Verification

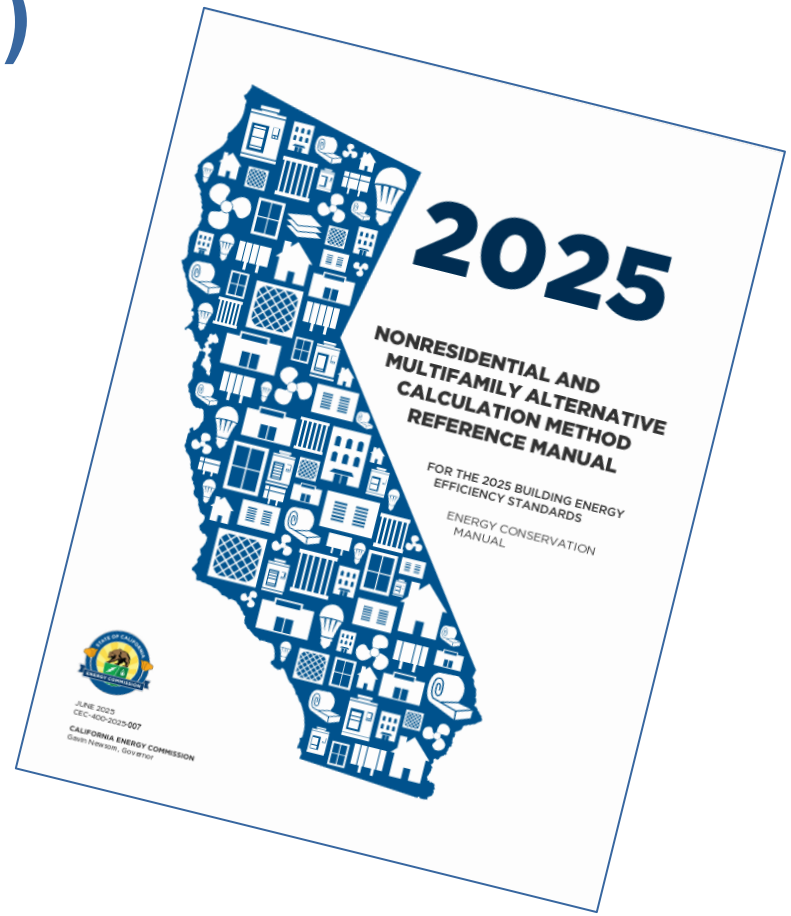
- Key Aspects of Compliance Verification
- Barriers and Solutions
- Revisions to Compliance Software

# Key Aspects of Compliance Verification

- Additions or revisions to area category names will affect the compliance verification process
  - Provide alignment with other parts of the code to make the compliance process smoother (e.g. space types in Section 130.1)
  - Building department personnel will need to know the new names and what they represent
- Bring the code to keep up with the current technology, e.g., wattage-selectable products
- Recognize lower wattage lamps installed in existing luminaires without current barrier of “factory installed label” for retrofits.

# Compliance Software Updates (NRACM)

- Nonresidential Alternative Compliance Method (NRACM) manual defines software rulesets
- Appendix 5.4 A contains baseline LPDs and Schedules
- New space category names
- New LPDs associated with existing and new categories
- Mapping existing schedules to new categories or creating new schedules for new categories.
- https://www.energy.ca.gov/publications/2025/2025-nonresidential-and-multifamily-alternative-calculation-method-reference



# Joining LPD Advisory Group

**Please add your name to Q&A window if you would like to be on LPD Advisory Group**

- Are you willing to be consulted (i.e., joining the advisory group) in the development of allowed LPD values or how luminaire wattage is calculated?
  - A strong intention is encouraged, but no firm commitment is required.
  - If so, please leave your name, organization, and contact info.

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More information on
CEC's 2028 proceeding website.

# We want to hear from you!

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