



CALIFORNIA STATEWIDE UTILITY CODES AND STANDARDS PROGRAM

2019 Title 24 Codes & Standards Enhancement (CASE) Proposal

Nonresidential Indoor Controls



September 8, 2016

Energy Solutions



**Pacific Gas and
Electric Company**



SDGE

A Sempra Energy utility



SoCalGas

A Sempra Energy utility



**SOUTHERN CALIFORNIA
EDISON**

An EDISON INTERNATIONAL Company



Proposed Code Change Overview

Mandatory Requirements to be Proposed

- Automatic daylight dimming plus OFF controls to align with ASHRAE 90.1
- Occupancy-based full OFF controls in nonresidential restrooms to align with ASHRAE 90.1





Proposed Code Change History

Automatic daylight dimming controls

- Mandatory auto daylighting controls were first introduced in the 2005 Title 24 Standards (not requiring OFF function).
- 2016 Title 24 Standards added a power adjustment factor (PAF) for daylighting plus OFF



Current Code Requirements



Existing 2016 Title 24 Requirements

- **Auto daylight dimming plus OFF controls**

PAF of 0.10 for daylight dimming plus OFF control¹

- **Occupancy controls for restrooms**

All indoor lighting is required to be “controlled with an occupant sensing control, automatic time-switch control, or other control capable of automatically shutting OFF all of the lighting when the space is *typically* unoccupied.”²

¹ Code reference: Title 24, Part 6, Section 140.6 Prescriptive Requirements for Indoor Lighting, Table 140.6-A

² Code reference: Title 24, Part 6, Section 130.1 Mandatory Indoor Lighting Controls, Section (c) part 1 and 5.



Existing Model Code Requirements

Daylighting Controls – ASHRAE 90.1-2013 Standards

- Section 9.4.1.1 (e) and (f): “The photocontrol shall reduce electric lighting in response to available daylight using continuous dimming or with at least one control point between 50% and 70% of design lighting power, a second control point between 20% and 40% of design lighting power or the lowest dimming level the technology allows, and **a third control point that turns off all the controlled lighting.**”
- Table 9.6.1 lists a nonresidential space types required to have automatic daylight responsive controls for sidelighting and toplighting.



Existing Model Code Requirements, *cont.*

Restrooms – ASHRAE 90.1-2013 Standards

- Section 9.4.1.1 (h) **Automatic full OFF** requires that “All lighting shall be automatically shut off within 20 minutes of all occupants leaving the space.”
- Table 9.6.1 lists nonresidential space types required to have automatic full OFF, including restrooms.



Existing Model Code Requirements, *cont.*

Restrooms – ASHRAE 90.1-2013 Standards

TABLE 9.6.1 Lighting Power Density Allowances Using the Space-by-Space Method and Minimum Control Requirements Using Either Method (*Continued*)

Informative Note: This table is divided into two sections; this first section covers space types that can be commonly found in multiple building types. The second part of this table covers space types that are typically found in a single building type.

The control functions below shall be implemented in accordance with the descriptions found in the referenced paragraphs within Section 9.4.1.1. For each space type:
 (1) All REQs shall be implemented.
 (2) At least one ADD1 (when present) shall be implemented.
 (3) At least one ADD2 (when present) shall be implemented.

Common Space Types ¹	LPD, W/ft ²	RCR Threshold	Local Control (See Section 9.4.1.1[a])	Restricted to Manual ON (See Section 9.4.1.1[b])	Restricted to Partial Automatic ON (See Section 9.4.1.1[c])	Bi-level Lighting Control (See Section 9.4.1.1[d])	Automatic Daylight Responsive Controls for Side-lighting (See Section 9.4.1.1[e] ⁶)	Automatic Daylight Responsive Controls for Top-lighting (See Section 9.4.1.1[f] ⁶)	Automatic Partial OFF (See Section 9.4.1.1[g] [Full Off complies])	Automatic Full OFF (See Section 9.4.1.1[h])	Scheduled Shutoff (See Section 9.4.1.1[i])
Office											
... enclosed and ≤250 ft ²	1.11	8	REQ	ADD1	ADD1	REQ	REQ	REQ	—	REQ	—
... enclosed and >250 ft ²	1.11	8	REQ	ADD1	ADD1	REQ	REQ	REQ	—	ADD2	ADD2
... open plan	0.98	4	REQ	ADD1	ADD1	REQ	REQ	REQ	—	ADD2	ADD2
Parking Area, Interior	0.19	4					See Section 9.4.1.2.				
Pharmacy Area	1.68	6	REQ	ADD1	ADD1	REQ	REQ	REQ	—	ADD2	ADD2
Restroom											
... in a facility for the visually impaired (and not used primarily by the staff) ³	1.21	8	REQ	—	—	—	REQ	REQ	—	REQ	—
... all other restrooms	0.98	8	REQ	—	—	—	REQ	REQ	—	REQ	—



Typical Practices

Trends

- Occupancy sensors in multi-stall restrooms are becoming more common
- Daylight dimming plus OFF controls are becoming more common. This strategy has been installed in major retail chains (e.g., WalMart and Costco stores)
- Lighting controls are being integrated into Building Energy Management System



Audience Question

- Do you agree with this description?



Market Overview and Analysis

Current Market

- **Automatic daylight dimming plus OFF controls**

Dimming plus OFF controls are available from multiple manufacturers. The market for these controls has been growing. Smaller end-users and designers have not transitioned to dimming plus OFF controls.

Examples

- WalMart and COSTCO lighting fixtures turn OFF when the daylight illuminance exceeds the design illuminance.
- COSTCO stores began integrating daylighting controls and skylights in the late 1980s.

- **Occupancy controls**

The market for nonresidential occupancy sensors is well established. Occupancy sensing technology has been implemented in various nonresidential space types.



Market Overview and Analysis, *cont.*

Market Impact for Proposed Measures

- No significant impacts to the product manufacturing or specification is expected for occupancy sensors in new construction restrooms

Market Barriers for Proposed Measures

- Sensor cost

Audience Question

- Are there any user acceptability remaining related to nonresidential restroom occupancy sensors or daylight dimming + OFF?
- Other market barriers that we should know about?



Incremental Cost Estimation

Sources of Cost Data

- PNNL Cost-Effectiveness studies of ASHRAE 90.1 2010 and 2013
- Online sources: Grainger 2016 catalog, Amazon, BuyLightFixtures, Goodmart, etc.
- Past CASE Reports
- Interviews with manufacturers, distributors, and contractors by CASE Team



Audience Question

Do you find these methods to gather costs to be reasonable?



Methodology for Savings Analysis – Daylighting

- PNNL's Daylighting Analysis of ASHRAE 90.1
 - Medium Office prototype model used in study
 - Daylighting analysis: Radiance
 - Energy analysis: EnergyPlus
 - 56% of perimeter assumed to be daylit
 - Control strategies simulated include continuous dimming control down to 10% of full power and continuous dimming plus OFF.
- Conduct literature review and interviews of industry stakeholders to validate baseline conditions, threshold of daylight sufficiency, and other key assumptions.



Methodology for Savings Analysis – Restrooms

Methodology for Energy and Demand Impacts

- Use public datasets such as CEUS and DEER databases.
- Conduct literature review and interviews of industry stakeholders to validate baseline conditions and other key assumptions.
- Perform spreadsheet-based analysis to estimate energy savings.

Note that this measure does not require whole building modeling to establish the savings estimates for each space and climate zone.



Methodology for Savings Analysis – Restrooms *cont.*

Spreadsheet-based analysis will take into account:

- Reductions in power requirements of lighting in a 'OFF' setting (100% of full power)
- Reductions in hours of operation for affected space types
- Breakdown of impacted space types within various building types
- Occupancy and use profiles for various building use types
- Projections of new construction per building use type in California
- TDV calculations as required to provide a consistent analysis basis for cost-effectiveness



Assumptions for Energy Impacts Analysis – Key Assumptions

- Operating hours: Title 24 Alternative Calculation Method (ACM) and Database for Energy Efficient Resources (DEER)
- Fraction of buildings or building types containing targeted technology:
 - CEUS database (2006)
 - New construction square footage forecasts by building type to be provided by CEC for 2019
- For reference, average energy savings potential:
 - 28% for daylighting controls
 - 24% for occupancy sensor controls
 - 38% for multiple control approaches¹

¹ LBNL “A Meta-Analysis of Energy Savings from Lighting Controls in Commercial Buildings, 2011.



Assumptions for Energy Impacts Analysis – Data Sources

- LBNL “A Meta-Analysis of Energy Savings from Lighting Controls in Commercial Buildings” 2011
- PNNL “Analysis of Daylighting Requirements within ASHRAE Standards 90.1” August 2013
- PNNL Cost-Effectiveness studies of ASHRAE 90.1 2010 and 2013
- Technical Resource Manuals such as the “Savings Estimation Technical Reference Manual for the California Municipal Utilities Association” 2014.

Audience Question

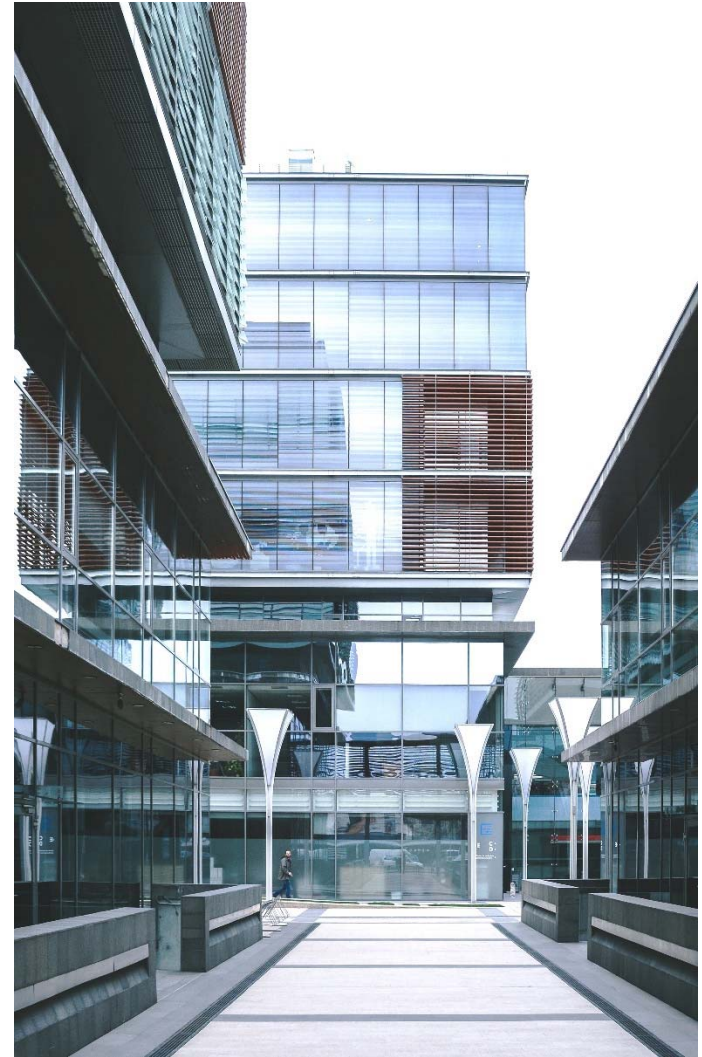
- Do you have additional data?



Incremental Cost Savings

Approach

- Calculate incremental cost savings based on 2019 Time Dependent Valuation of Energy (TDV) over the entire period of analysis
- Use PNNL's cost-effectiveness analyses of ASHRAE 90.1-2010 and ASHRAE 90.1-2013





Initial Data and Findings

Based on the interviews with stakeholders to date, the proposed measures that are aligning Title 24 with ASHRAE 90.1 have broad acceptance in the industry.





Preliminary Energy Impacts – Daylighting

2013 PNNL analysis of ASHRAE 90.1 Daylighting requirements found:

- The addition of the OFF stage to the daylighting controls can result in an increase of an additional 30% of lighting energy savings (when the window VT is around 40%).
- Strategies where lights turn off consistently performed better than strategies where lights remain on at reduced levels
- “the stepped plus off strategy saved nearly the same amount of energy as the continuous dimming plus off strategy.”¹

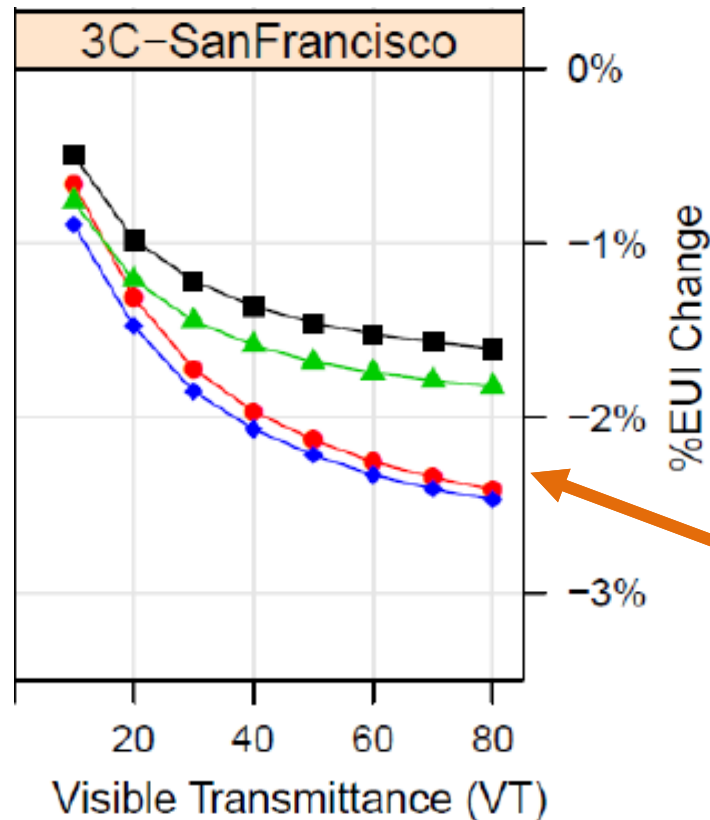
¹ Pacific Northwest Laboratories “Analysis of Daylighting Requirements within ASHRAE Standard 90.1” August 2013. 19



Preliminary Energy Impacts – Daylighting cont.

Impact of Control Strategy

2-Step	■	Dimming to 10%	▲
2-Step+OFF	●	Dimming to 10%+OFF	◆



The ratio of blue to green = savings from OFF step of 30%

33% WWR
Primary+Secondary Daylighted Area
Urban Obstructions

Source: PNNL "Analysis of Daylighting Requirements within ASHRAE 20 Standard 90.1"



Preliminary Energy Impacts – Occupancy Restrooms

Preliminary Energy Savings Estimate					
Measure	Annual per Unit Electricity Savings (kWh/ft ²)	Annual per Unit Natural Gas Savings* (Therms/ft ²)	First Year Statewide Electricity Savings (GWh/yr)	First Year Statewide Natural Gas Savings (Million Therms/yr)	Confidence Level (high, medium, low)
NR Restrooms Occupancy Sensors	0.56	0	3.0	0	Medium





Preliminary Cost-Effectiveness Estimates

ASHRAE 90.1 lighting subcommittee evaluated the costs and savings associated with multi-level plus OFF daylighting controls and multi-stall restroom occupancy sensors before adopting these control strategy into ASHRAE 90.1-2010 and ASHRAE 90.1-2013





Compliance and Enforcement—Tasks

Market Actor	Task(s)	Success Criteria
Lighting Designers	<ul style="list-style-type: none">- Design lighting system to meet Title 24 code- System performs to owner specifications & needs.- Compliance forms	<ul style="list-style-type: none">- System meets owner needs- Do this quickly and within budget and schedule- Do this cost-effectively- System is Title 24 compliant
Contractor/Builder	<ul style="list-style-type: none">- Build system exactly as designed to meet code- Purchase system from retailers/distributors- Coordinate with other market actors- Work on-site	<ul style="list-style-type: none">- Do this quickly and within budget and schedule- Do this with minimal paperwork- System is Title 24 compliant



Compliance and Enforcement—Tasks

Market Actor	Task(s)	Success Criteria
Electrician	<ul style="list-style-type: none">- Install lighting system- Follow lighting design- Coordinate with contractor/builder	<ul style="list-style-type: none">- System is Title 24 compliant- Install to meet owner specifications- System functions properly- On schedule and within budget
Energy Consultant/Modeler	<ul style="list-style-type: none">- Generate compliance documentation and fill out paperwork- Provide assistance in code interpretation- Run compliance model if necessary	<ul style="list-style-type: none">- Compliance documents are properly filled out and system is compliant- Avoid redesigning related code requirements- Minimal energy code related plan check comments- Do this virtually/ remote



Compliance and Enforcement – Market Actors, Tasks, Success Criteria, Resources, and Tools

- Who would be involved in implementing this measure?
 - Lighting Designers
 - Contractor/Builder
 - Electrician
 - Energy Consultant/Modeler
 - Others?
- What Compliance and Enforcement Tasks or Success Criteria are missing?
- What resources or tools are typically used for compliance?



Compliance and Enforcement

- CASE Team will be interviewing stakeholders to identify potential barriers to code compliance and enforcement
- Will need to update existing compliance forms related to nonresidential indoor controls



Strawman Code Change Language – Daylighting

- We propose to remove the PAF in Section 140.6, Prescriptive Requirements for Indoor Lighting, Table 140.6-A.
- We propose to add a mandatory requirement for daylight dimming plus OFF controls in Section 130.1, Mandatory Indoor Lighting Controls and update Table 130.1-A



Strawman Code Change Language – Daylighting

Title 24 Section 130.1 – Mandatory Indoor Lighting Controls

D. Automatic Daylighting Control Installation and Operation.

iv. In areas served by lighting that is daylight controlled, when the daylight illuminance is greater than 150 percent of the design illuminance received from the general lighting system at full power, the general lighting power in that daylight zone shall be reduced by ~~a minimum of 65~~ 100 percent.

TABLE 140.6-A LIGHTING POWER ADJUSTMENT FACTORS (PAF)

TYPE OF CONTROL	TYPE OF AREA		FACTOR
<div>a. To qualify for any of the Power Adjustment Factors in this table, the installation shall comply with the applicable requirements in Section 140.6(a)2</div> <div>b. Only one PAF may be used for each qualifying luminaire unless combined below.</div> <div>c. Lighting controls that are required for compliance with Part 6 shall not be eligible for a PAF</div>			
1. Daylight Dimming plus OFF Control	Luminaires in skylit daylight zone or primary sidelit daylight zone		0.10
2. Occupant Sensing Controls in Large Open Plan Offices	In open plan offices > 250 square feet: One sensor controlling an area that is:	No larger than 125 square feet	0.40
		From 126 to 250 square feet	0.30
		From 251 to 500 square feet	0.20



Strawman Code Change Language – Occupancy Restrooms

- We propose to update Title 24, Part 6, Section 130.1 (c)5, Mandatory Indoor Lighting Controls, Shut-OFF Controls

Areas where Occupant Sensing Controls are required to shut OFF All Lighting. In offices 250 square feet or smaller, multipurpose rooms of less than 1,000 square feet, classrooms of any size, ~~and~~ conference rooms of any size, and restrooms, lighting shall be controlled with occupant sensing controls to automatically shut OFF all of the lighting when the ~~room~~ space is unoccupied.



Other Measures that may be Considered for 2019 Title 24 Code Cycle

Power Adjustment Factor (PAF)	Additional Information
Adaptation compensation controls in retail	<ul style="list-style-type: none">Adaption compensation control strategy provides lower light levels at night to account for the eye's adaption to night conditions outside. This control strategy provides energy savings and improved visual comfort. This design strategy has been in use for over 15 years, including at several other major retail chains.
Occupancy controls in retail	<ul style="list-style-type: none">Reduce power for portion of lighting layer when occupancy is not sensed.

All PAFs are potential 2019 code-readiness projects to access performance, customer satisfaction, and energy savings

Audience Question:

Are you aware of any data to support these PAFs that will further the long-term ZNE goals and have the potential to transform the market?



Other Measures that may be Considered for 2019 Title 24 Code Cycle

Power Adjustment Factor (PAF)	Additional Information
Lumen management controls	<ul style="list-style-type: none">• Lumen management control provides design illuminance throughout fixture life. When this type of control is used, the space does not have to be overlit initially to account for lumen depreciation over time (standard industry practice).• Dedicated controls or provided as part of a smart lighting system.• Potential 2019 code-readiness project to access performance, customer satisfaction, and energy savings
Smart lighting system/luminaire level lighting controls	<ul style="list-style-type: none">• Examine needs for data reporting. Consider the measure as part of whole building approach to building energy management.

All PAFs are potential 2019 code-readiness projects to access performance, customer satisfaction, and energy savings

Audience Question:

Are you aware of any data to support these PAFs that will further the long-term ZNE goals and have the potential to transform the market?



Other Measures that may be Considered for 2022 Title 24 Code Cycle

- Mandatory occupancy-based full OFF controls in dressing rooms to align with ASHRAE 90.1
- Mandatory occupancy-based full OFF controls for open office plans



Feedback Request from Stakeholders

We would appreciate feedback and/or data on the proposed measures:

- Auto daylight dimming plus OFF controls to align with ASHRAE 90.1
- Occupancy-based full OFF controls in nonresidential restrooms to align with ASHRAE 90.1
- PAFs for the 2019 code cycle

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Questions?