Welcome to the California Statewide Codes and Standards Enhancement (CASE) Team's Stakeholder Meeting on

Nonresidential Indoor Lighting

We'll get started shortly.

In the meantime, please fill out the polls below.

CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

Pacific Gas and Electric Company

SOUTHERN CALIFORNIA EDISON
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LA DWP Los Angeles Department of Water & Power

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Audio – there are **three** options for connecting to the meeting audio:

To view options, click on the  icon on the top ribbon, then select *Connect My Audio.*

1. **Dial-out:** receive a call from the meeting. *Please note this feature **requires a direct line.***
2. **Dial-in:** dial-in to the conference via phone. Conference phone number and room number code provided. *Please then **identify your line** by entering your unique user ID on your phone.*
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***Above**: audio conference settings pop-up box*

2022 TITLE 24 CODE CYCLE, PART 6

First Utility-Sponsored Stakeholder Meeting

Nonresidential Indoor Daylighting

Statewide CASE Team

September 12, 2019

CALIFORNIA ENERGY CODES & STANDARDS

A STATEWIDE UTILITY PROGRAM

Meeting Guidelines

Muting Guidelines

Once you turn on your preferred audio connection please **MUTE** your microphone.

- Please keep yourself **MUTED.**
- Wait for instructions and/or permission to unmute yourself during designated Q&A periods.

Phone users – please mute your phone line.

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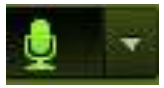


NOT MUTED

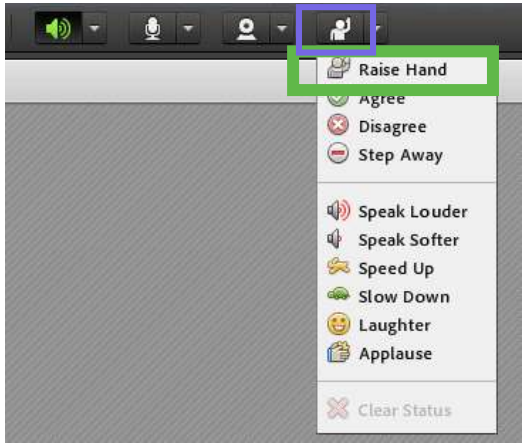
MUTED

Meeting Guidelines

Participation Guidelines

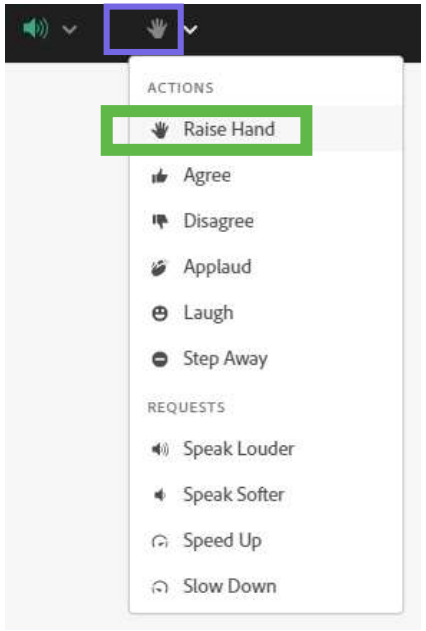
- **Questions & Comments**
  - Click **“*Raise Hand*”** if you would like to speak. Those with a hand raised will be called on by the speaker.
  - All questions and comments are also welcome via the chat window.

- **Other Meeting Feedback**
  - Provide live meeting feedback from the **top toolbar drop-down**.



***Above**: feedback view for Adobe Connect app users.*

***Below**: feedback view for HTML users.*



Meeting Ground Rules

- **We want to hear your thoughts**
  - Supporting and opposing viewpoints are welcome
- **When making comments**
  - Unmute yourself
  - Clearly state your name and affiliation prior to speaking
  - Speak loudly for the phone audio
  - Place yourself back on mute
- **Calls are recorded** for note development, recordings will not be publicized
- Notes and presentation material will be posted on Title24Stakeholders.com

Agenda

1	**Meeting Guidelines**	*8:30 am*
2	**Opening Remarks** from the California Energy Commission	*8:35 am*
3	**Overview & Welcome** from the Statewide Utility Team	*8:40 am*
4	**Presentation I:** Indoor Sources Proposal	*8:45 am*
5	Wrap Up and Action items	*10:25 pm*
6	Closing	*10:30 pm*

Opening Remarks: California Energy Commission

Payam Bozorgchami
Project Manager
California Energy Commission

Policy Drivers: Building Standards

The following policy documents establish the goal for new building standards:

- **2008 CPUC/CEC Energy Action Plan** – ZNE for Residential buildings by 2020 and nonresidential buildings by 2030
- **SB 100** – Clean electricity by 2045
- **B-55-18** – Governor Jerry Brown's Executive Order to achieve carbon neutrality
- **AB 3232** – Assess the potential for the state to reduce the emissions of greenhouse gases from the state's residential and commercial building stock by at least 40% below 1990 levels by January 1, 2030

2022 Standards Schedule

ESTIMATED DATE	ACTIVITY OR MILESTONE
November 2018 - April 2019	Updated Weather Data Files
November 2018 - July 2019	Measures Identified and Approved (Internal at the Energy Commission)
November 2018 - July 2019	Compliance Metrics Development
April 24, 2019	Efficiency Measure Proposal Template for public to submit measures
October, 2019	Compliance Metrics and Climate Data workshop
November, 2019	Final Metrics Workshop
November, 2019	Research Version of CBECC Available with new weather data files and updated Metrics
July 2019 - March 2020	Utility-Sponsored Stakeholder Workshops
March, 2020	All Initial CASE/PUBLIC Reports Submitted to Commission
March - August 2020	Commission-Sponsored Workshops
July, 2020	All Final CASE/PUBLIC Reports Submitted to the Commission
July - September 2020	Express Terms Developed
January, 2021	45-Day Language posted and set to list serve, Start of 45-Day review/comment period
January, 2021	Lead Commissioner Hearing
April, 2021	Adoption of 2022 Standards at Business Meeting
May - November 2021	Staff work on Software, Compliance Manuals, Electronic Documents
May - November 2021	Final Statement of Reasons Drafted and Approved
October, 2021	Adoption CalGREEN (energy provisions) - Business Meeting
December, 2021	CBSC Approval Hearing
January, 2022	Software, Compliance Manuals, Electronic Documents Available to Industry
January - December 2022	Standards Training (provided by 3rd parties)
June 1, 2022	6 Month Statutory Wait Period Deadline
January 1, 2023	Effective Date

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More information on pre-rulemaking for the 2022 Energy Code at:
https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2022-building-energy-efficiency

Title 24, Part 6 Overview

Kelly Cunningham
Codes and Standards
Pacific Gas & Electric

Statewide Utility Codes and Standards Team

- **Actively supporting the California Energy Commission** in developing proposed changes to the California Energy Code (Title 24, Part 6)
- Achieve significant energy savings through the development of **feasible**, **enforceable**, **cost-effective, and non-proprietary** code change proposals for the 2022 code update, and beyond

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LA DWP Los Angeles Department of Water & Power

Requirements for a Successful Code Change Proposal

The utilities support the California Energy Commission by proposing changes to the Energy Code that are:

Feasible | Cost effective | Enforceable | Non-proprietary

Utility-Sponsored Stakeholder Meetings

- All meetings can be attended **remotely**
- Check Title24Stakeholders.com/events for information about meetings and topic updates
- Sign up to receive email notifications

First Round Utility-Sponsored Stakeholder Meetings

**To allow more time for discussion, lighting topics are presented across two days this fall.*

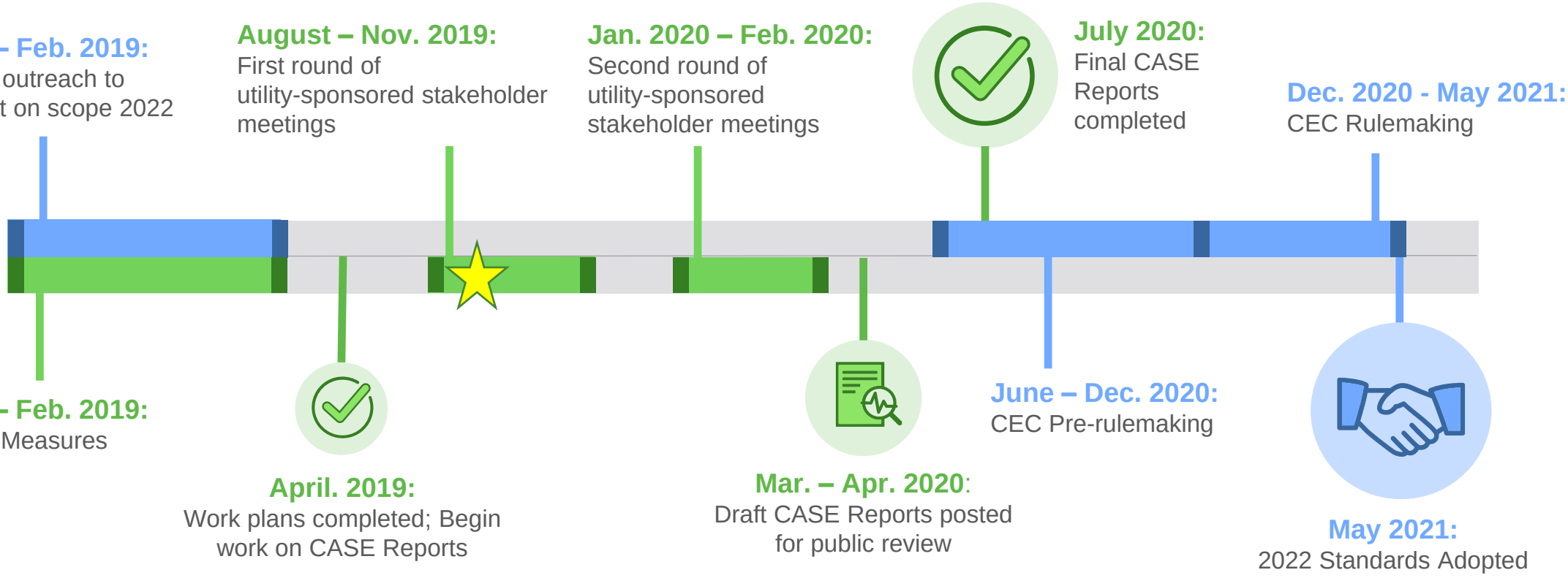
Meeting	Building Type	Date
~~**Multifamily HVAC and Envelope**~~	~~MF~~	~~Thursday, August 22, 2019~~
~~**Lighting – Outdoor Sources and Daylighting***~~	~~MF, NR~~	~~Thursday, September 5, 2019~~
~~**Grid Integration**~~	~~MF, NR, SF~~	~~Tuesday, September 10, 2019~~
NEW: Lighting – Nonresidential Indoor Lighting*	NR	Thursday September 12, 2019
Covered Processes	NR	Thursday, September 19, 2019
Multifamily and Nonresidential Water Heating	MF, NR	Thursday, October 3, 2019
Single Family HVAC	SF	Thursday, October 10, 2019
Nonresidential HVAC	NR	Thursday, October 17, 2019
Nonresidential Envelope	NR	Thursday, October 24, 2019
Single Family Whole Building and Nonresidential Software Improvements	NR, SF	Tuesday, November 12, 2019

Sign up for all meetings at title24stakeholders.com/events/

2022 Code Cycle – Key Milestones

CEC Milestone

Utility Team Milestone



Oct. 2018 – Feb. 2019:
Stakeholder outreach to request input on scope 2022 code cycle

August – Nov. 2019:
First round of utility-sponsored stakeholder meetings

Jan. 2020 – Feb. 2020:
Second round of utility-sponsored stakeholder meetings

July 2020:
Final CASE Reports completed

Dec. 2020 - May 2021:
CEC Rulemaking

Oct. 2018 – Feb. 2019:
Select 2022 Measures

April. 2019:
Work plans completed; Begin work on CASE Reports

Mar. – Apr. 2020:
Draft CASE Reports posted for public review

June – Dec. 2020:
CEC Pre-rulemaking

May 2021:
2022 Standards Adopted

SDGE A Sempra Energy utility® SoCalGas A Sempra Energy utility® Southern California Edison An EDISON INTERNATIONAL® Company PG&E Pacific Gas and Electric Company®

This program is funded by California utility customers and administered by Pacific Gas and Electric Company (PG&E), San Diego Gas & Electric Company (SDG&E®), Southern California Edison Company (SCE), and Southern California Gas Company (SoCalGas®) under the auspices of the California Public Utilities Commission.

EnergyCode Ace™
Helping you play your cards right

The **Codes and Standards Reach Codes Program** provides technical support to local jurisdictions considering adopting a local energy efficiency ordinance.

www.LocalEnergyCodes.com

This program is funded by California utility customers under the auspices of the California Public Utilities Commission and in support of the California Energy Commission.

Contribute to the Lighting Code Cleanup Initiative!

Submit Code Correction Requests at title24stakeholders.com/contact-us/2019-code-cleanup-initiative/

Thank You

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CALIFORNIA ENERGY CODES & STANDARDS
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2022 CALIFORNIA ENERGY CODE (TITLE 24, PART 6)

Indoor Lighting

Codes and Standards Enhancement (CASE) Proposal

Nonresidential | Lighting

Yao-Jung Wen, *Energy Solutions*
Christopher Uraine, *Energy Solutions*
Jon McHugh, *McHugh Energy Consultants*
Bernie Bauer, *Integrated Lighting Solutions*

September 12, 2019

CALIFORNIA ENERGY CODES & STANDARDS
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Agenda

1. Networked Lighting Controls
2. Update Lighting Power Densities
3. Multi-Zone Occupancy Sensing in Open Plan Offices

Submeasure A: Networked Lighting Controls

Submeasure B: Update Lighting Power Densities

Submeasure C: Multi-Zone Occupancy Sensing in Open Plan Offices

Background

- Context and History
- 2019 Code Requirements
- Code Change Proposal

Code Change Proposal – Summary

This proposal seeks to introduce new Power Adjustment Factors (PAFs) to encourage the deployment of networked lighting controls.

Building Types	System Type	Type of Change	Software Updates Required
Nonresidential	Lighting	PAF	No

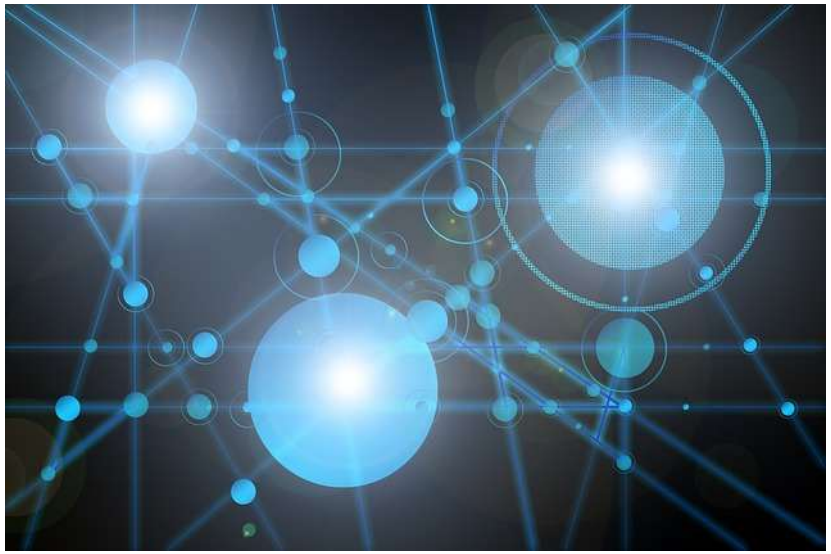
Context and History

- **What are Networked Lighting Controls (NLCs)?**
  - A communication network of light points, sensors, control interfaces, and network interfaces.
  - The network is established to exchange digital data for the purposes of

Changing lighting status

Reporting current status

Setting commissioning and configuration parameters



Context and History

- Benefits of NLCs beyond current code control requirements

Beyond-Code Benefits	Synergy with Current Code
Adaptability/reconfigurability	
Flexible control interactions	
Energy reporting	Circuits are segregated by end-use but monitoring not required
Granular controls	PAFs for small zone occupant sensing controls in large open plan offices
Easier Demand Response (DR) integration	PAFs for demand responsive control
Simplified institutional tuning implementation	PAFs for institutional tuning

2019 Code Requirements

2019 Title 24, Part 6

No explicit requirement for NLCs

NLCs are commonly used to

- Meet demand responsive lighting control requirement
- Claim control PAFs

Model Code Requirements

2018 IECC
Enhanced Digital Lighting Controls

WA State Energy Code
Luminaire level lighting controls (LLLCs)

Qualifying Products List

DesignLights Consortium (DLC) NLC Technical Requirements V4.

Qualified NLCs can be used to meet Title 24, except for demand responsive lighting controls

Proposed Code Change Overview

- See the proposal summary and mark-up language in **resources tab**

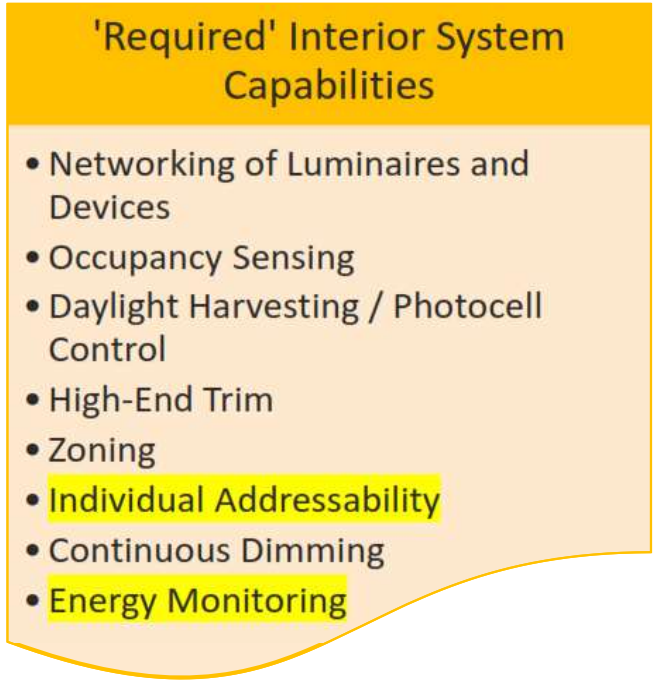
Sections Impacted	Proposed Changes
Section 100.1	Add NLC definition
Section 100.9 (e)	ADD qualifications for NLC capabilities/functionalities
Section 140.6 (a) & Table 140.6-A	Use NLC to implement • Mandatory lighting controls in Section 130.1 (a) Manual area controls (b) Multi-level lighting controls (c) Shut-OFF controls (d) Automatic daylighting controls (e) Demand responsive controls • Additional controls, including – Institutional tuning – Granular occupancy sensing controls in large areas

DLC Definition (Scope of Technical Requirements) for NLCs

- NLC systems are defined as the combination of sensors, network interfaces, and controllers that affects lighting changes in luminaires, retrofit kits or lamps.
- The Technical Requirements are built on
  - ✱ “Required” system capabilities – mandatory
  - ☑ “Reported” system capabilities – optional

Luminaires, retrofit kits and lamps are not part of an NLC system in the context of the Technical Requirement.

Demand Response Control is a “Reported” system capability.



Curtesy of DLC Networked Lighting Control V4.0 Technical Requirements

DLC Networked Lighting Control V4.0 Technical Requirements.
https://www.designlights.org/default/assets/File/Lighting%20Controls/DLC_Networked-Lighting-Controls-Technical-Requirements-V4-0.pdf

Title 24, Part 6 Proposed Definition for NLCs

The proposed definition will differ from DLC's definition

- Luminaires, retrofit kits and lamps will be included as elements of an NLC system.
  (Not to specify additional photometric, energy, electrical and thermal performances.)
- The definition will be based on capabilities
  - (1) Can meet the current mandatory control requirements
  - (2) Can meet additional control requirements
    - Institutional tuning
    - Granular zone controls in large areas
      (open plan offices, large retails, large grocery stores, etc.)
  - (3) Other capabilities for achieving the ultimate goal of making a lighting system an integral part of the building as a flexible and responsive load that continues to operate at the maximum efficiency with traceable and verifiable performance.

Do you agree with the direction for defining NLCs?
What else should we consider?

Poll

Which of the Title 24 methods do you recommend for increasing the energy benefits of Networked Lighting Controls (NLCs)? (Pick one)

A. Equipment credit – PAF for lighting attached to an NLC?
B. Functional credit – PAF table expanded to include more control strategies but remain equipment neutral?
C. Prescriptive or Mandatory – through energy monitoring requirement for connected lighting?
D. Prescriptive or Mandatory – through more mandatory controls with advanced capabilities (e.g. multi-zone occupancy sensing control in open plan offices)?

Market Overview

- Current Market Conditions
- Market Trends
- Potential Market Barriers and Solutions

Market Overview and Analysis

- **Current Market**
  - DLC NLC Qualified Product List (QPL) lists 39 NLC systems for interior lighting controls
  - No current Statewide IOU program
  - Several out-of-state programs
    (notably ComEd and AEP Ohio, who require NLC energy reporting)

- **Market Trends**
  - Application guides from NLC manufacturers provide dedicated literature on using products to meet Title 24, Part 6 control requirements.

Market Overview and Analysis

- **Market Barriers**
  - First cost, especially for retrofit projects
  - Larger fixed cost limits NLCs to larger buildings
  - Complexity/skill to set up and operate
  - Lack of data demonstrating long term energy savings
  - Lack of data supporting customer value and acceptance

Do you agree with this observation? What else should we know?

Technical Considerations

- Technical Considerations
- Potential Barriers and Solutions

Technical Considerations

- ~ 40 NLC products available on the market
  - All capable of institutional tuning and zoning (for granular zone occupancy controls)
  - 27 with energy monitoring capabilities
  - 17 with demand response capabilities

- Input from initial outreach to specifiers and energy consultants:

> *"NLC basic functions, such as those required to comply with Title 24, Part 6, are not likely to cause performance issues."*

Technical Considerations

- **Remaining uncertainties**
  - Skill sets required to operate NLCs beyond basic controls
  - Cybersecurity
  - Variability in details and implementations
  - Interoperability

Do you agree with this assessment? What else should we know?

Poll

Which of the following building types will benefit most from NLCs as they are available today? (Choose all that apply)

A. Offices
B. Industrial/Manufacturing Facility
C. Healthcare
D. Grocery
E. School
F. Retail

Poll

What is the lighting system threshold size above which NLCs are cost-effective and/or where it is likely that facility staff will be able to make use of the advanced features of the NLCs? (Pick one)

A. No threshold
B. 5,000 square feet
C. 10,000 square feet
D. 25,000 square feet
E. 50,000 square feet
F. 100,000 square feet
G. Too facility dependent to pick a size threshold

Energy and Cost Impacts
Methodology Ideas

- Energy Impacts Methodology
- Cost Impacts Methodology

Methodology for Energy Impacts Analysis

- Impacts will be characterized as the differences between the Baseline and Proposed conditions
- Sources of impact include additional control requirements for this PAF
  - Institutional tuning
  - Granular zone occupancy sensing control
- The analysis will consider 12 building types aligning with the California statewide new construction forecast

Note: The analysis will not capture NLC long-term energy benefits, such as sustained savings due to reconfigurability for space turnover. But we will explore the possibilities/practicability to include them.

Definition of Baseline and Proposed Conditions

Baseline Conditions

- Minimally compliant with 2019 Code
- No control strategy is implemented using NLC

Proposed Conditions

- NLC is used to meet current mandatory lighting control requirements
- Initial lighting power is tuned to 85%
- In applicable spaces* (e.g. offices, retails, grocery stories, etc.), granular occupancy sensing controls

* The applicable spaces will be determined as part of the CASE study.

Incremental Cost Information

- How can we collect costs for base case technology and proposed technology?
  - Interview distributors, manufacturers representative agencies, lighting designers and energy consultants
  - Characterize costs by $ / sf, including:
    - Installation
    - Commissioning and start-up
    - On-going service subscriptions, if any
    - Markups & taxes
  - Capture cost variances due to project types or sizes
  - Exclude costs of optional NLC functionalities and other value-added services that are not essential for meeting the PAF requirements

Do you agree with the approach? What is missing?

Proposed Code Changes

- Draft Code Change Language

Draft Code Change Language

- Please take a minute review the draft code language available in the **resources tab**

- **How can the NLC definition be improved?**
- **Are the additional control requirements for utilizing this PAF feasible?**
- **Are there other energy efficiency opportunities from NLC that we should capture?**

Submeasure A: Networked Lighting Controls

Submeasure B: Update Lighting Power Densities

Submeasure C: Multi-Zone Occupancy Sensing in Open Plan Offices

Background

- Context and History
- 2019 Code Requirements
- Code Change Proposal

Code Change Proposal – Summary

This proposal seeks to update indoor LPDs and wattage calculations

Building Types	Section Number	System Type	Type of Change	Software Updates Required
Nonresidential	140.6	Lighting	Prescriptive	Yes NRCC-PRF
Nonresidential	130.0(c)	Lighting	Mandatory	No

- Consider updates to LPDs on case-by-case basis.
- Installed wattage rules improve clarity and evaluate wattage ratings of new technology

Context and History

- Indoor LPD allowances were updated in the Title 24, Part 6 2019 code cycle – overall ~15% reduction in LPDs (varied by application)
- Clarify other adjustment factors: Lighting Mounting Height Lighting Power Adjustment.
- Clarification and Refinement of Additional Allowances (no longer footnotes)
- Accommodation for recent technology changes:
  - Small Aperture Tunable-White and Dim-to-Warm Luminaires (Adjustment Factor)
  - Tunable white or dim-to-warm additional lighting power allowance provided for any size luminaire for healthcare facilities and hospital occupancies.
  - **Are these accommodations still required?**

LPD Analysis Process

- Surveys of Recent Designs
- Interviews with Design Practitioners, Contractors and Manufacturers
- Interviews with the IES and IALD, 90.1 LSC
- Inverse Lumen-Method Spreadsheet
  - Normalized wall washing method based on simple AGI-32 calculation
- Detailed AGI-32 models

Technology Advancements

- Tunable white
- Dim to warm
- Smaller aperture and mini-linear
- Modular fixtures
- Power over Ethernet (PoE)
- Quality metrics (DLC)
  - CRI/TM-30
  - Flicker
  - Melanopic Lumens
  - Glare (UGR)

2019 Title 24, Part 6 NR Lighting Requirements

- Lighting Power Allowance Requirements in Section 140.6
  - (a) Calculation of Adjusted Indoor Lighting Power: power adjustment factors, etc.
  - (b) Calculation of Allowed Indoor Lighting Power: how to multiply LPD times area and allowed trade-offs
  - (c) Calculation of Allowed Indoor Lighting Power: specific methodologies
    - Tables 140.6-B, Whole Building
    - Tables 140.6-C, Area Category Method
    - Tables140.6-D through G Tailored Method.
- Luminaire classification and power Section 130.0(c)
  - What is the installed watts for different configurations
- Compliance Forms for LPDs

Proposed Code Change Overview

See the proposal summary and mark-up language **resources tab**

- Not much here except the potentially affected sections
- Any edits would be based upon the findings of the analysis and data collection

Description of change

- Evaluate adjustment factors for technologies that may have matured (dim-to-warm, tunable white, etc.)
- Revisit use-it-or-lose-it adders
  - Small-aperture luminaires adder
- Revisit surface/cavity reflectances in the model for specific spaces, e.g. classrooms
- Revisit assumptions on wall washer applications in the model
- Selectively revisit LPDs for certain space types based on new information

Poll

How frequently do you see dim-to-warm controls being specified on projects?

A. Never
B. Rarely
C. Occasionally
D. Frequently

Poll

How frequently do you see tunable white controls being specified on projects?

A. Never
B. Rarely
C. Occasionally
D. Frequently

Poll

How frequently do you see round and square luminaires with less than 4 inch apertures specified on projects?

A. Never
B. Rarely
C. Occasionally
D. Frequently

Poll

How frequently do you see linear luminaires with less than 4 inch apertures specified on projects?

A. Never
B. Rarely
C. Occasionally
D. Frequently

Market Overview

- Current Market Conditions
- Market Trends
- Potential Market Barriers and Solutions

Market Analysis

- LEDs have become the primary choice for new lighting systems or retrofits
- LED prices have decreased since 2017/18 when the 2019 code cycle analysis was being completed.
- Current data collected indicates that the cost reductions vary significantly:
  - Commodity products such as 2x2 and 2x4 troffers currently cost the same as fluorescent legacy products they replaced.
  - Some products are still costlier than legacy MH or fluorescent they replaced, but not as significant as several years ago. (previously 100% or more, but now 30%-50%)

DOE LED Lamp and Luminaire Efficacy Projections by Application (lm/W). Not the basis of our analysis

Application Submarkets		2015	2020	2025	2030	2035
LED Lamps	A-Type Lamps	79	97	111	123	133
	Downlight/Track - Large	67	81	92	101	108
	Downlight/Track - Small	61	72	80	87	93
	Linear Fixture	112	137	157	174	187
	Low and High Bay	83	109	129	145	159
	Decorative	66	89	108	122	135
	Area and Roadway	71	97	117	133	147
	Parking Lot	71	97	117	133	147
	Garage	112	137	157	174	187
	Building Exterior	69	89	104	117	127
LED Luminaires	Decorative	72	90	105	116	126
	Downlight/Track - Large	77	101	120	135	148
	Downlight/Track - Small	77	101	120	135	148
	Linear Fixture	99	123	142	158	171
	Low and High Bay	100	121	138	152	164
	Area and Roadway	86	105	120	132	142
	Parking Lot	86	105	120	132	142
	Garage	89	105	118	128	136
	Building Exterior	89	115	136	153	167

CASE evaluation based on commercially available products at time of analysis.

Sources include databases and data collected through outreach.

Energy Savings Forecast of Solid-State Lighting in General Illumination Applications. September 2016.
https://www.energy.gov/sites/prod/files/2016/09/f33/energysavingsforecast16_2.pdf

Market Barriers

- Wide differential between costs for some types of luminaires
- Diminishing availability of legacy incandescent product
  - Opportunity for significant energy reduction and less maintenance through use of LED lamps as a very low first cost versus the dedicated LED path.
    - Hardwired LEDs in many cases increases first costs, decreases flexibility, creates a barriers for technology upgrades as more efficient or better quality lamps become available and is less resource efficient.
  - LED lamps are especially attractive for minor remodels and lighting upgrades on limited budgets.
  - Luminaire relabeling – is this compliance cost necessary?

Technical Considerations

- Technical Considerations
- Potential Barriers and Solutions

Technical Considerations

- 2019 code cycle was “target rich” (moving from legacy light sources to LED) that so much savings achieved, not all applications were fine tuned to maximize energy savings.
- Review LPDs and compare against other standards, common good lighting practices, etc.
- Update LPD requirements based upon updates to illuminance standards
- Compare luminaires in lighting models against current product availability and performance.
  - Especially white color tuning and dim to warm light sources for large and small aperture sizes.

Energy and Cost Impacts
Methodology Ideas

- Energy Impacts Methodology
- Cost Impacts Methodology

Methodology for Energy Impacts Analysis

- Compare new calculated LPD versus 2019 LPD to yield kW/sf savings
  - Starting with prior Title 24 analysis for illuminance for general, task, ornamental, and wall washing and compare against IES Handbook.
  - Calculate W/sf based on recent high performance, high efficacy luminaires, good design practice and characterization of prototypical spaces.

Incremental Cost Information

- Luminaire costs from distributor pricing for base case and proposed technology.
  - Contractor mark-up added.
- No incremental labor costs unless there is a difference in number of luminaires installed (not typical).

Proposed Code Changes

- Draft Code Change Language
- Proposed Software Updates

Draft Code Change Language

- Please take a minute review the draft code language available in the **resources tab**.
  - No specific changes at this time.
- Lighting wattage calculation changes would occur in Section 130.0(c)
- Adjustment factor changes would occur in Section 140.6(a)4
- LPD changes would occur in Table 140.6-B through 140.6-G

Submeasure A: Networked Lighting Controls

Submeasure B: Update Lighting Power Densities

Submeasure C: Multi-Zone Occupancy Sensing in Open Plan Offices

Background

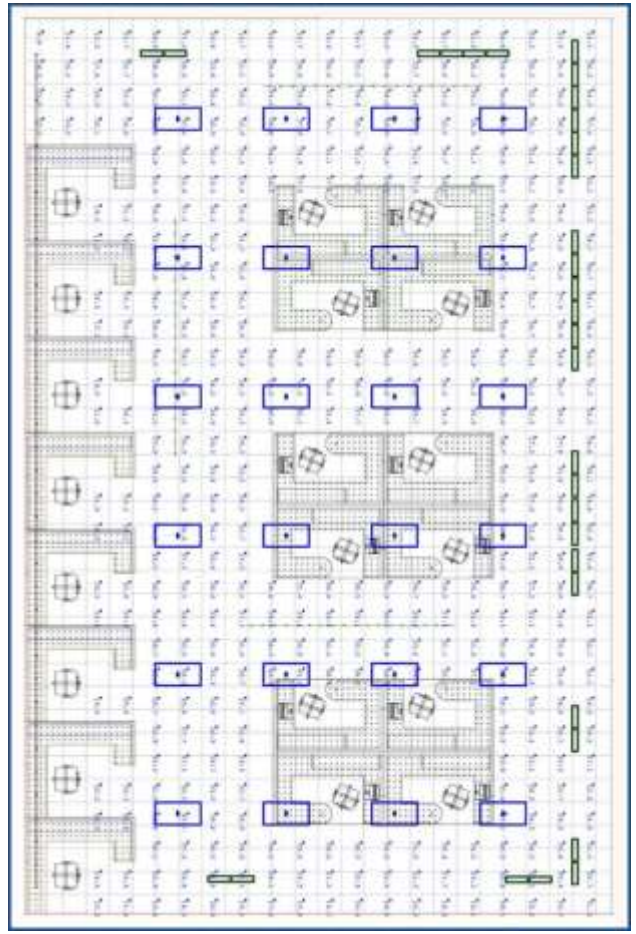
- Context and History
- 2019 Code Requirements
- Code Change Proposal

Open Plan Office Controls Proposal – Summary

This proposal would harmonize with the 2018 IECC

- Require multi-zone occupancy sensing of general lighting in open plan offices.
- When the subzones (≤ 600 sf in IECC) are unoccupied, each subzone must dim lights to no greater than 20% of power or light, and
- When all subzones or unoccupied in an enclosed space, the lights must be completely shut off.
- Open plan offices would qualify for occupied standby HVAC control (t-stat setpoints reset and ventilation turned off when entire room is empty).

Building Types	System Type	Type of Change	Software Updates Required
Open Plan Office	Lighting	Mandatory	Schedule



IECC 2018 §C405.2.1.3 Multi-Zone Occupancy Sensing in Open Plan Office Areas

Context and History

- **Currently 2019 Title 24, Part 6** does not have a specific mandatory automatic shut-off controls requirement for open plan offices > 250 sf. Shut-off options include: [§130.1(c)]
  - Time switch controls with two hour timed manual override (minimal compliance)
  - Occupancy sensor (can be whole space but sensor limitations typically limit to less than 1,200 sf). If less than 0.5 W/sf on/off occ sensing is acceptable, otherwise partial on or vacancy (manual on) control.
- ASHRAE 90.1-2019 has similar mandatory control requirements (either a timeclock or occ sensor)
- **IECC 2018 has a mandatory requirement for Multi-Zone Occupancy Sensing in Open Plan Office Areas [§C405.2.1.3]**
- 2019 Title 24, Part 6 has a Power Adjustment Factor (PAF) for occupant sensing controls in large open plan offices, the smaller the subzone the greater than PAF. [§140.6 (a)2I]

TABLE 140.6-A LIGHTING POWER ADJUSTMENT FACTORS (PAF)

TYPE OF CONTROL	TYPE OF AREA		FACTOR
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 b. Only one PAF may be used for each qualifying luminaire unless combined below. c. Lighting controls that are required for compliance with Part 6 shall not be eligible for a PAF			
1. Daylight Dimming plus OFF Control	Luminaires in skylit daylit zone or primary sidelit daylit 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

Open Office Occupancy Sensing State Diagram

Entire Office Status	Sub-Zone Status	Sub-Zone Lighting	HVAC Mode
Vacant	Vacant	OFF	Occupied Stand-by
Occupied	Occupied	ON	Normal
Occupied	Vacant	≤ 20% Power	Normal

Daylighting + Occupancy controls: power does not exceed the lesser of the allowed power by either control.

Multiple Design Paths

On/OFF Occupancy sensor for subzones

- Low Cost but non-uniform general lighting in space
- Still need dry contact on occ sensor for occupied standby HVAC control. When all subzones vacant – Occupied Standby

Occupancy Sensor with dimming and dry contact

- Relatively uniform general lighting 20% to 100% light
- Dry contact turns all lights off and occupied standby HVAC

Proposed Code Change Overview

- See the proposal summary and mark-up language in **resources tab**
  - Occupant sensor controls in open plan offices shall be configured so that general lighting can be controlled separately in control zones with floor areas not greater than 400? sf
  - General lighting in each control zone shall be allowed to automatically turn on upon occupancy within the control zone, and general lighting in adjacent zones in the same room are allowed to increase to 20 percent of full light output.
  - General lighting in each control zone shall tum off or uniformly reduce lighting power to no more than 20 percent of full power within 20 minutes after all occupants have left the control zone
  - The controls shall automatically turn off general lighting in all control zones within 20 minutes after all occupants have left the open plan office space.
  - Lighting controlled by automatic daylighting controls and by occupant sensing controls, the controls shall be configured so that power does not exceed the lesser of the allowed power by either control.
  - *There may be some relaxation of the control requirements for alterations.*

Market Overview

- Current Market Conditions
- Market Trends
- Potential Market Barriers and Solutions

Market Overview and Analysis

- **Current California Market**
  - Occ sensors required in small offices, classrooms, conference rooms, restrooms, multipurpose rooms, aisleways, warehouses, library book stacks, stairwells, corridors, and parking garages.
- **Market Trends**
  - Question for stakeholders. Frequency of use of occupancy sensors nationwide and in California for open plan offices.
- **Market Barriers**
  - Cost relative to time sweep control.
  - Effort to commission
  - Concern about false vacancy and turning lights off
  - Non-uniform look to space
  - Encourages people to leave private office after open plan offices are vacant
- **Do you agree with this description? What else should we know?**

Technical Considerations

- Technical Considerations
- Potential Barriers and Solutions

Technical Considerations

- Cubicles – all but smallest zones sensing not in line of sight
  - requires dual technology or non-PIR sensors
- If very small zones consideration of signal interference (use different frequencies)
- Interaction of all controls especially if dimming instead of on/off
  - Subzone if vacant – dim to < 20%
  - If all subzones in room vacant – turn all lights off
  - Daylighting – dim or turn off lights in response to daylight
  - Demand response – dimming in response to signal
  - Pushes design to lighting control panel.
- **Do you agree with this description? What else should we know?**

Poll

Which of these statements do you agree with? (pick **all** that apply)

A. When no occupancy is detected in a subzone, it is acceptable to turn off lights in that portion of an open plan office when anyone is in the rest of the office space.

B. Dimming to 20% of light output will be noticeable and render the space less inviting

C. Occupancy sensing in relatively small (20 x 20 ft zones) will have problems with sensor interference

D. Occupant sensing in small zones will provide more accurate control as small motions will be easier to pick up

E. Full off control of the entire open plan offices should allow inclusion of occupancy of nearby enclosed offices

F. Full off control of 8’ wide path of egress in open plan office near enclosed offices also being controlled by occupancy of the enclosed offices.

G. Full off control should allow the option of 8’ wide egress pathways in open plan offices near enclosed offices being controlled by a timeclock

Poll

Which comments do you agree with for the proposed open plan office control, **not considering DR or daylighting control**? (pick all that apply)

A. Control is possible to be implemented with stand-alone occupancy controls (on/off controls)

B. Control is possible to be implemented with stand-alone dimming occupancy controls (20% dimming and occ sensors tied together to turn off lights)

C. Control is difficult with luminaire level lighting controls unless on-board occupancy sensors are turning lights on/off or if timeclock is used for full off.

D. Control is difficult to implement without a lighting control panel (central panel combines control signals for groups of luminaires)

E. Control is difficult to implement without a networked control system (each luminaire could be controlled by different combinations of controls).

Poll

Which comments do you agree with for the proposed open plan office control when **including DR and daylighting control**? (pick all that apply)

A. Control is possible to be implemented with stand-alone occupancy controls (on/off controls)

B. Control is possible to be implemented with stand-alone dimming occupancy controls (20% dimming and occ sensors tied together to turn off lights)

C. Control is difficult with luminaire level lighting controls unless on-board occupancy sensors are turning lights on/off or if timeclock is used for full off.

D. Control is difficult to implement without a lighting control panel (central panel combines control signals for groups of luminaires)

E. Control is difficult to implement without a networked control system (each luminaire could be controlled by different combinations of controls).

Energy and Cost Impacts

Methodology and Assumptions

- Energy Impacts Methodology
- Cost Impacts Methodology
  - Incremental costs
  - Energy cost savings

Methodology for Energy Impacts Analysis

- Make use of data used to develop the PAFs for small occupancy sensing controls zones in open plan offices.
- Evaluate the cost-effectiveness of different subzone sizes for occupancy control. Sensitivity analysis of first cost and savings relative to subzone size.
- Baseline design is timeclock control with 2 hour override. Recommendations for typical open office timeclock schedules? What is common practice for office cleaning (frequency, how long, average time lights are left on after cleaning staff has left).
- Reduced full load operating hours are multiplied by LPD for open office space to yield kWh/sf –yr electricity savings.
- Added savings due to occupied standby control (t-stat setpoints reset and ventilation turned off when entire room is empty). Thermal simulation of space. Cooling, heating and fan energy savings. [Pre-existing requirement in §120.1(e)3]

Assumptions for Energy Impacts Analysis

- 15 year period of analysis and expectation that controls last 15 years
- Installed general lighting wattage is at open plan office LPD of 0.6 W/sf
- Base case is using minimally compliant control (timeclock) for all new construction.
- Base case hours of operation to be determined from best available data for timeclocks operating hours including overrides for open plan offices.
- Proposed case uses data from studies of occupancy sensing.
- Controls are working similar to controls in referenced studies over their expected useful life.

2023 Construction Forecast

- Open plan office around 20% of total office space. Will confirm with PNNL their best estimate of mapping of space fractions to different building types.
  - This is potentially conservatively low fraction, but only affects statewide savings estimate
- For the 2019 Title 24, Part 6 Standards the new construction forecast for offices buildings was 43 Million sf/yr.
- Order of magnitude estimate is this measure would impact 8.6 Million sf.
- If cost-effective, subzone size is 400 sf this would result in sales of 21,000 extra occupancy sensors per year.

Open Plan Office Lighting Controls
Definition of Baseline and Proposed Conditions

Baseline Conditions

- Timeclock control
- Cleaning adds 2 hours/day
- Looking for data from ECMS and timeclock schedules on typical timeclock settings.

Proposed Conditions

- Small zone occupancy controls
- Reduced operating hours comparable to PAFs for small size occupancy sensing zones but based on dimming to 20%
- Added hours entire space is vacant: lights off, t-stat reset and ventilation off

Initial Data and Findings

2013 Title 24, Part 6 Statewide CASE Report: Indoor Lighting Controls

Referenced 3 studies:

- Rubinstein. 2009. Achieving 60-80% Lighting Energy Savings in Open Plan Offices With Intelligent Workstation Lighting (Unpublished study). Personal communication November 2009.
- Galasiu,A, Newsham, G, Suvagau, C, and Sander, D. 2007. Energy Saving Lighting Control Systems for Open-Plan Offices: A Field Study. Leukos Vol 4 No 1 July 2007 Pages 7–29.
- PG&E (Pacific Gas and Electric Company). 2009a. High Efficiency Office: Low Ambient/ Task Lighting Pilot Project. Large Office Site Report. Report prepared by Heschong Mahone Group.

USDOE 2018 IECC open plan office occupancy sensing proposal

- Hart, R., and Liu, B. (2015). Methodology for Evaluating Cost-effectiveness of Commercial Energy Code Changes. PNNL for USDOE; Energy Efficiency & Renewable Energy. PNNL-23923 Rev1. https://www.energycodes.gov/development/commercial/methodology
- Hart, R. and R. Athalye. September 2015. "Cost-effectiveness Analysis of Expanding use of Occupancy Sensors.“ https://www.energycodes.gov/development/2018IECC

If stakeholders have data to share, please state in chat box our send an email to info@title24stakeholders.com

Preliminary Energy Savings Estimates

$ES_{lighting}$ = LPD x FLH x SF x 0.001 kW/W

$ES_{lighting}$ = 0.6 x 3,000 x 0.25 x 0.001 = 0.45 kWh/sf

$ES_{statewide}$ = 0.45 kWh/sf x 8.6 Million sf = 3.9 GWh

Preliminary Energy Savings Estimate				
Annual Electricity Savings per sf (kWh/sf-yr)	Annual Natural Gas Savings per sf (Therms/sf-yr)	First Year Statewide Electricity Savings (GWh/yr)	First Year Statewide Natural Gas Savings (Million Therms/yr)	Confidence Level (high, medium, low)
0.45		3.9		Medium

Interaction effects result in small increase on heating energy and decrease in cooling energy

Occupied standby HVAC controls result in heating, cooling and fan energy savings TBD

Incremental Cost Information

- How we collect costs of base case technology and proposed technology
  - Primary equipment cost source is from interviews with electrical distributors
  - Supplement equipment cost data with manufacturer interviews on equipment configurations
  - Primary labor source is RS Means data – verified from interviews with electrical contractors and others. Will also compare RS Means mark-up with contractor feedback.
- Costing conducted for stand alone and networked lighting controls
- Proposed case costing conducted for minimum cost compliance (On/Off occ sensing) and for higher amenity option (20% dimming and then off when entire space is unoccupied)
- Base case costing conducted for minimum current compliance (time clock control with timed override switch).
- Do you find these method to be reasonable?
- Recommendations on methods or sources for cost data?

RS Means Proposed Case Costing

Dual technology Occupant sensor

- Material cost $138.
- Labor electrician (**no helper or apprentice**) 1.2 hours, bare labor cost $74
- (CA Index 120 to 158, use **CA average130**) Adjusted labor = $96
- Unadjusted total is $212 w/ O&P = $261 (**23% overhead & profit**).
- Adjusted about **$280/occ sensor**.

Control cable (2 conductor #18 stranded, shielded PVC jacket) per 100 lin feet

- Material $25.50, Labor 1.14/hr, $68.50, CA labor $89, CA inc O&P = **$153/CLF**

Control cable (3 conductor #18 stranded, shielded PVC jacket) per 100 lin feet

- CA inc O&P = **$190/CLF**

Poll

What problems do you see with RS Means Cost estimate? (Pick all that apply)

A. Too high
B. Too low
C. Dual technology sensor not needed
D. Material Cost of occupancy sensor is too high
E. Material Cost of occupancy sensor too low
F. Would be installed by crew with less costly workers (helpers/apprentices)
G. California labor cost multiplier higher than 130% of US average
H. California labor cost multiplier lower than 130% of US average
I. Overhead and profit is more than 23%
J. Overhead and profit is less than 23%

Proposed Code Changes

- Draft Code Change Language
- Proposed Software Updates

Draft Code Change Language

- Please take a minute to review the draft code language available in the **resources tab**
- **Is 20 minutes still the appropriate time delay for occupancy controls?**
- **Is 20% of full light output a reasonable maximum light level for the unoccupied portion of an open plan office?**
- **What accommodation should there be for the following situation of an open plan office surrounded by enclosed offices? Someone working in the enclosed office could be surrounded by darkness if everyone has left the open plan office. Should the first 8 feet adjacent to the enclosed offices be considered a corridor?**

Software Updates

- Mandatory lighting and HVAC controls requirements are the same in the base case and proposed case design
- Lighting usage profile might be updated in TABLE SpaceFunctionData from App 5_4A_SpaceBySpace file documenting lighting hourly usage profile.
- Mandatory occupied standby controls for open plan office are perhaps noted as an exceptional features to be verified.

Compliance Documentation Changes

1. Certificate of compliance NRCC-LTI would have to be revised to remove PAF, and add this to the mandatory control table
2. Certificate of installation can remain as is
3. Certificate of Acceptance would have to be revised to remove testing criteria for PAF and add the testing requirements for this new mandatory control requirement since it is not the same as the PAF.

Compliance and Enforcement

- Design
- Permit Application
- Construction
- Inspection

Compliance Verification Process

1. Design Phase

- Designers add new mandatory controls to their design for large open offices and consider use of NLC systems as an PAF providing design flexibility
- (No new tasks associated with revised LPDs)

2. Permit Application Phase

- Confirm design includes new mandatory control for open plan offices, and NLC is incorporated into design if PAF is utilized
- (No new tasks associated with revised LPDs

Compliance Verification Process

3. Construction phase

- Install controls as designed including occupancy controls for open plan offices, and NLC systems if included in design
- Commissioning provider performs system commissioning and start-up
- Engage a certified Acceptance Test Technician (ATT) to test all applicable lighting controls before final inspection
- (No new tasks associated with revised LPDs)

4. Inspection Phase

- Confirm mandatory controls for open offices have been installed
- Confirm NLC is installed, if included in the design documents.
- Confirm that the ATT verifications has been completed.
- (No new tasks associated with revised LPDs)

Market Actors

Who is involved in implementing this measure?

- Building owners, property/facility managers and operators
- Manufacturers, manufacturers sales representatives, distributors
- Lighting designers, electrical engineer
- Energy consultants/modelers, electrical contractors, builders
- Commissioning providers, controls integrators
- Lighting Controls Acceptance Test Technicians (ATT), ATT certification providers
- Plans examiners and building inspectors

Discussion and Next Steps

Stakeholder Survey

The lighting measure stakeholder survey will be sent out soon, and we appreciate your participation!

- Indoor Lighting
- Outdoor Light Source
- Daylighting

We want to hear from you!

- Provide **any last comments or feedback** on this presentation now verbally or over the chat
- More information on pre-rulemaking for the 2022 Energy Code at https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2022-building-energy-efficiency

Comments on this measure are due by September 26, please send to info@title24stakeholders.com and copy CASE Authors (see contact info on following slide).

Thank you for your participation today

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Please complete the closing polls below

Upcoming Meetings

Meeting	Building Type	Date
~~Multifamily HVAC and Envelope~~	~~MF~~	~~Thursday, August 22, 2019~~
~~Lighting – Outdoor Sources and Daylighting~~	~~MF, NR~~	~~Thursday, September 5, 2019~~
~~Grid Integration~~	~~MF, NR, SF~~	~~Tuesday, September 10, 2019~~
~~**NEW:** Lighting – Nonresidential Indoor Lighting~~	~~NR~~	~~Thursday September 12, 2019~~
Covered Processes	NR	Thursday, September 19, 2019
Multifamily and Nonresidential Water Heating	MF, NR	Thursday, October 3, 2019
Single Family HVAC	SF	Thursday, October 10, 2019
Nonresidential HVAC	NR	Thursday, October 17, 2019
Nonresidential Envelope	NR	Thursday, October 24, 2019
Single Family Whole Building and Nonresidential Software Improvements	NR, SF	Tuesday, November 12, 2019