



Valuing Dimming in Energy Efficiency Programs

January 12, 2021

Agenda

- Member announcements (Lani Malapan, 1:00-1:05)
- Dimming Whitepaper Summary (Dan Mellinger, 1:05-1:45)
- Discussion (1:45-2:00)

Member Announcements

1. FEB 18 Member Meeting - Facilitated Brainstorm discussion: how to claim more savings in your programs.
 - **[Savings Brainstorm Topic Survey](#)**
2. Posted in Member Portal - UV Irradiation for Disinfection Whitepaper, Shareable Handout: Executive Summary and Essential Questions, and Webinar recording
3. Other industry events:
 - Jan 25-28 **[AESP 31st Annual Conference](#)**
 - Jan 27-28 **[EUCI Cannabis Energy Challenge](#)**
 - Feb 1-4 **[2021 DOE Lighting R&D Workshop](#)**



About The Presenter



- Dan Mellinger, Principal at Energy Futures Group
- Professional Engineer (PE) in Vermont and Lighting Certified (LC)
- Specializes in commercial program design, lighting technology, market analysis, and program strategy
- Technical resource DLC utilizes for technology and tools development specifically for Member Programs

Dimming Whitepaper

Background

Dimming Standards
Energy Savings from Dimming
Program Strategies

Dimming Whitepaper

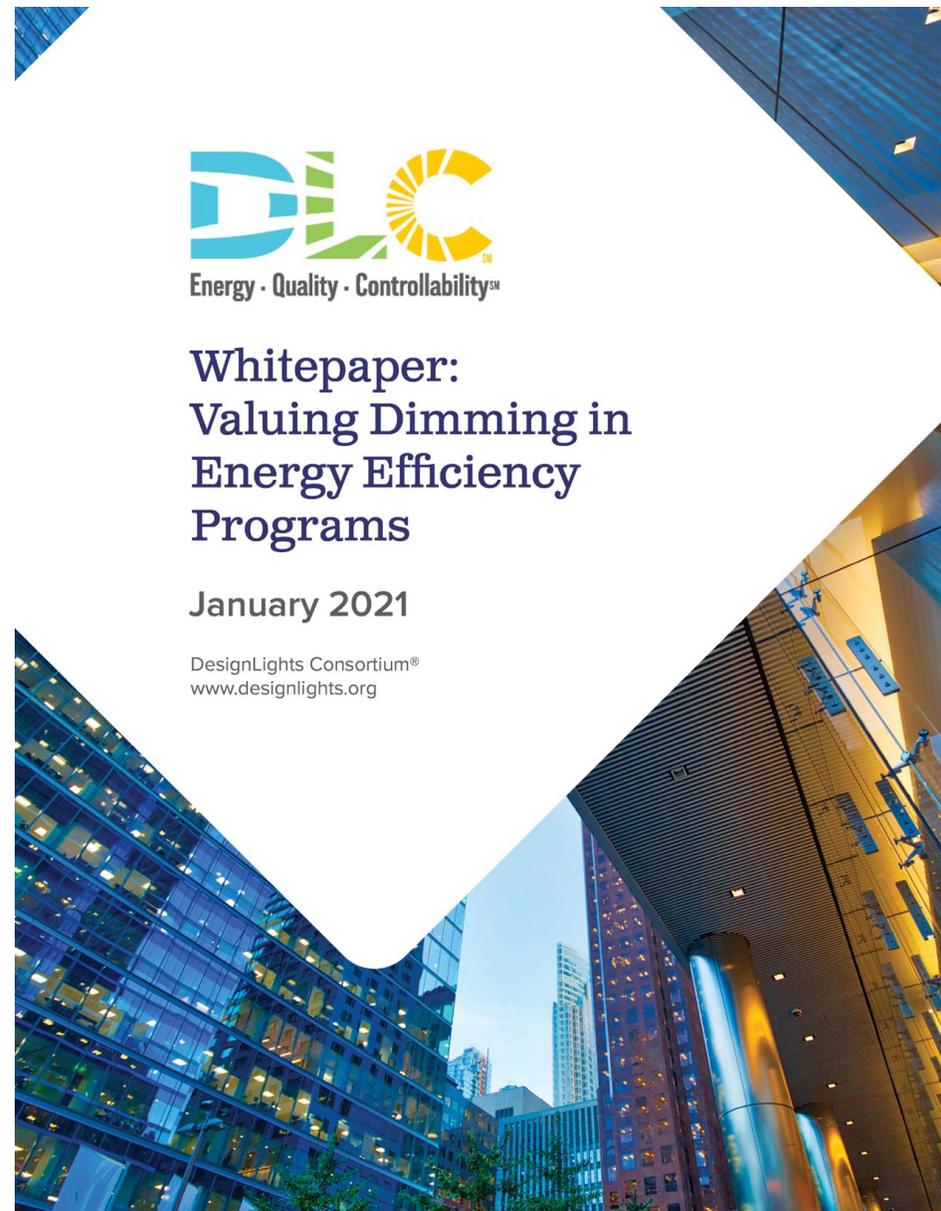
- Member-exclusive whitepaper that explores the untapped value of dimming savings in energy efficiency programs.
- Provides context and background on the V5 DLC dimming requirement and other dimming industry standards.
- Includes data and resources to justify and calculate additional energy savings that can be claimed from dimming LEDs.
- <https://www.designlights.org/members-home/member-news/member-exclusive-whitepaper-valuing-dimming-in-energy-efficiency-programs/>



Whitepaper: Valuing Dimming in Energy Efficiency Programs

January 2021

DesignLights Consortium®
www.designlights.org



DLC Dimming Background

- V3.0 (2015): Dimming introduced as a required *reported* capability



- V5.0 (2020): Dimming required for DLC Premium products
 - Products that do not meet this requirement will be demoted to DLC Standard on Feb 28, 2021
- V5.1 (2020): Dimming required for nearly all products*
 - Products that do not meet this requirement will be delisted on Dec 31, 2021

* The following products are exempt from the V5.1 DLC Standard tier dimming requirements: Case Lighting, Landscape/Accent Flood and Spot Luminaires, Specialty: Sports Flood, Specialty: Tunnel Lighting, and any Specialty Primary Use Designation intended for a hazardous location



What does it mean to be dimmable?

Dimmable (industry)

- The ability to change the luminous flux (and power used) of the electric lighting system. (IES, Title 24)

Dimmable (for V5 qualification)

- A product that (a) includes a dimmable driver and/or is capable of being dimmed by an external control signal, and (b) is identified as dimmable on the product specification sheet.

Continuous Dimming

- A lighting control strategy that varies the light output over a continuous range from full light output to a minimum light output without flickering in **imperceptible steps**. (NEMA LSD-64)
- Continuous dimming must be capable of reducing the light output to at least 20% of full light output.

Stepped Dimming

- A lighting control strategy that varies the light output in one or more steps of greater than one percent of full output. The changes between levels are **generally perceptible**. (NEMA LSD-64)
- Stepped dimming must be capable of reducing the light output to at least 70% of full light output.

How is the dimming requirement administered?

- The DLC does not set requirements for how dimmable products are installed and/or used in the field.
- There is no requirement that DLC products be used in a dimming application.
- There are no requirements relating to specific dimming control protocols (0-10V, DALI, etc.).
- A product listed as dimmable on the QPL may require the installation of additional components and/or building infrastructure to enable dimming.

Why require dimming?

- Prior research indicates that building occupants have a strong preference to control the light levels within their space.
- Low installation rate of dimmable lighting is rooted in the cost and challenges associated with fluorescent dimming, not user preference.
- Many control strategies can't be implemented without dimming.

Control Strategy	Dimming required	Dimming enhances
Manual dimming	✓	
Occupancy sensing		✓
Daylight dimming	✓	✓
High-end trim	✓	



Dimming Whitepaper

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Existing Dimming Requirements and Standards

- Numerous dimming performance requirements and standards are in place throughout the lighting industry.
- The DLC dimming requirements are intended to complement and build on these existing standards.
- Examples include:

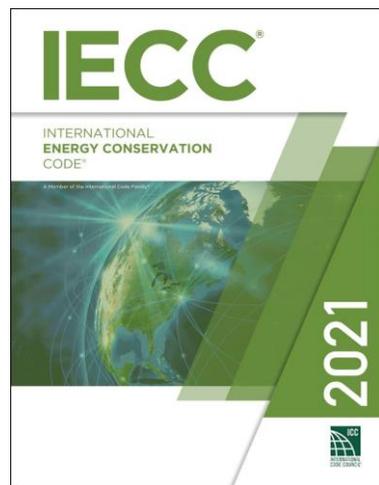


From California Title 24-2019, Part 6, Section 130:

- Continuous dimming 100% down to 10% is required for indoor LED luminaires.
- Occupancy sensing controls capable of partial-on or partial-off settings for certain spaces.
- Automatic daylighting controls capable of reducing light output by at least 65% via continuous dimming.
- Outdoor automatic scheduling controls capable of reducing the lighting power by at least 50% and no more than 90%.

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From IECC 2018 and beyond, Section C405.2:

- Indoor lighting capable of being reduced by at least 50% of maximum lighting power.
- Occupancy sensing controls capable of partial-on or partial-off settings for certain spaces.
- Daylight responsive lighting controls, with a continuous dimming requirement (15-100%) for offices and classrooms.
- Capability to reduce exterior lighting by 30% from midnight to 6am.

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From LEED Building Design + Construction (BD+C) v4.1:

- Additional points for interior lighting that includes dimmable lighting for 90% of occupant spaces

From ENERGY STAR Luminaires version 2.2:

- For products marketed as dimmable, the luminaire and its components shall provide continuous dimming from 100% to 20% of light output



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From GSA 2018 Facilities Standards P100, Section 6.3.2:

- All luminaires must be provided with replaceable dimmable drivers.
- LED lamps and retrofit kits must be dimmable using 0-10V and compatible with existing lighting control systems and future daylighting technologies.
- Ambient lighting must be adjusted per daylight availability and/or personal dimming.



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Claiming Savings from Dimming

- From an energy savings perspective, the importance of dimmable lighting is clear: the more an LED is dimmed, the less electricity it uses.
- Most programs have for many years offered incentives for occupancy sensors and daylight dimming systems.
- Increasingly, programs are offering incentives for Networked Lighting Controls (NLC), including Luminaire Level Lighting Controls (LLLC).
- Are there additional savings opportunities for dimmable lighting?

Manual Dimming

- Research has shown that when given the opportunity to dim lighting, occupants will often choose a light level lower than full output.
- The savings percentages shown below account for the load reduction due to manual dimming and the frequency of use.

Study Title	Organization	Manual Dimming Savings	Reference
Energy Savings Forecast of Solid-State Lighting in General Illumination Applications	U.S. Department of Energy	5-7%	(Navigant, 2019)
Energy Saving Lighting Control Systems for Open-Plan Offices	National Research Council Canada	11%	(Galasiu, Newsham, Suvagau, & Sander, 2007)
Comparison of Control Options in Private Offices in an Advanced Lighting Controls Testbed	Lawrence Berkeley National Laboratory	9%	(Jennings, Rubinstein, DiBartolomeo, & Blanc, 2000)
DELTA Snapshot: Private Office Lighting Controls	Lighting Research Center	6%	(Lighting Research Center, 1999)

High-end Trim

- High-end trim allows an installer, commissioning agent, or facility manager to set the maximum light output such that the average illuminance at the work plane is appropriate for the type of use.
- While high-end trim is often associated with more advanced controls, it can also be easily implemented through a wall dimmer.

Study Title	Organization	High-end Trim Savings	Reference
Energy Savings from Networked Lighting Control (NLC) Systems with and without LLLC	DLC and NEEA	27%	(Energy Solutions, 2020)
Evaluation of Advanced Lighting Control Systems in a Working Office Environment	U.S. Department of Energy	21%	(PNNL, 2018)
Adjusting Lighting Levels in Commercial Buildings	Seventhwave	22%	(Seventhwave, 2015)
A Meta-Analysis of Energy Savings from Lighting Controls in Commercial Buildings	Lawrence Berkeley National Laboratory	36%	(Williams, Atkinson, Garbesi, & Rubinstein, 2011)

Networked Lighting Controls

- With multi-strategy automated controls, such as NLC and LLLC, dimming is a prerequisite capability for high-end trim, continuous daylight dimming, and multi-level control.
- NLC savings risk being stranded if non-dimmable LED products are qualified, promoted, and installed.

Study Title	Organization	NLC Savings	Reference
Energy Savings from Networked Lighting Control (NLC) Systems with and without LLLC	DLC and NEEA	49%	(Energy Solutions, 2020)
Energy Savings Forecast of Solid-State Lighting in General Illumination Applications	U.S. Department of Energy	53-72%	(Navigant, 2019)
Evaluation of Advanced Lighting Control Systems in a Working Office Environment	U.S. Department of Energy	43%	(PNNL, 2018)
Energy Saving Lighting Control Systems for Open-Plan Offices	National Research Council Canada	42-47%	(Galasiu, Newsham, Suvagau, & Sander, 2007)

Recommended TRM Assumptions

Dimming-related Measure	Recommended Control Savings Factor (CSF)	Operating Hours	Measure Cost	Measure Life	Applicability to New Construction
Manual Dimming	5-7%, depending on space type (DOE)	Reported or deemed	Controls + labor	10 years	Yes, unless code requires dimming (e.g. CA Title 24)
High-end Trim	27% (Energy Solutions)	Reported or deemed	Controls + labor + \$0.06 per ft ²	Same as fixture life	Yes, beyond the code LPD allowances
NLC / LLLC	49% (Energy Solutions)	Reported or modified deemed	NLC: Varies LLLC: \$61/fixture	NLC: 15-16 years LLLC: same as fixture life	Yes, for high-end trim (as above) and spaces where code does not require occupancy and/or daylight sensors

TRM Algorithm

$$\Delta kWh = KW_{Controlled} * Hours * (CSF_{EE} - CSF_{Base}) * WHF_e$$

Where:

- $KW_{Controlled}$ = Total lighting load connected to the control in kilowatts. Savings is per control. The total connected load per control should be collected from the customer or a deemed value shall be used. $KW_{Controlled}$ shall not include any portion of the lighting load for which the control is not connected or applicable.
- Hours = Total operating hours of the controlled lighting circuit before the lighting controls are installed. If customer-specific information is not collected, a deemed annual operating hour estimate by building type is typically defined within TRMs.
- CSF = Control savings factor, representing the percentage reduction from the non-controlled lighting system. Where controls are already present prior to the new installation, the baseline control savings (CSF_{Base}) must be discounted from the new control savings (CSF_{EE}). A measured control savings factor should be used where energy monitoring data are available. In the absence of measured values, recommended deemed CSF values are presented in Table 4.
- WHF_e = Waste heat factor for energy to account for cooling energy savings from efficient lighting. If a building is un-cooled, the WHF_e value is 1.0. WHF_e will vary by climate zone and should be established independently for each energy efficiency program.³¹

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Incentives

- To the extent that additional energy savings can be claimed, higher incentives for dimmable and controllable LED products may be possible.
- Incentives to support high-end trim as a stand-alone measure, with post-installation commissioning/verification, should be considered in parallel with existing lighting control incentives.
- Incentives for energy monitoring, and reporting of the data, can be useful in verifying the energy savings from dimming, high-end trim, and NLC/LLLC.

Program Strategies

Education

- Communicate the non-energy benefits. Dimming can improve visual comfort, employee well-being, and is a desired capability by building occupants.
- Many programs sponsor lighting control training for installers, but a need exists for training that focuses on sales strategies and system operation.

Future Proofing

- When dimmable LED products are installed without controls, programs should develop methods to identify and revisit these customers at a future date to potentially unlock control savings if/when the costs, capabilities, and benefits meet the customer's needs and criteria.

Program Considerations

- Under V5.0, non-dimmable DLC Premium products will be demoted to DLC Standard on Feb 28, 2021
- Under V5.1, most non-dimmable products will be delisted on Dec 31, 2021
- While the capability to dim will be available on a greater number of products, the decision to install and use dimming controls to realize the benefit from dimming remains up to the customer, unless mandated by code.
- Dimming capability not only unlocks greater energy savings and flexibility to meet carbon reduction goals as LEDs replace legacy technology, but also gives occupants better control over their environment, reducing discomfort glare and allowing for customizable light levels. **Dimmable lighting is a first, and crucial, step toward better quality, smarter lighting.**

Program Resources

Title and Link	Description
Dimming Whitepaper	Member-exclusive whitepaper that provides data and resource references to justify additional energy savings that can be claimed from dimming LEDs.
Value of Dimming Blog Post	A DLC blog post that discusses why dimming can deliver benefits far beyond energy savings.
TLED Dimming FAQ	This document of frequently asked questions provides information regarding the V5.1 dimming requirement for T8 linear replacement lamps (TLEDs).
Member Talking Points	V5.0 and V5.1 background regarding the development of the policies, focus areas of each policy, timing, resources available, and more.

Discussion

Contact Us



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