Proposal Summary

Controlled Environmental Horticulture: Horticultural Lighting Efficacy

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Measure Description

The proposed code change would increase the mandatory photosynthetic photon efficacy (PPE) requirement for luminaires and lamps used for controlled environment horticulture (CEH) from 2.3 micromoles per joule (µmol/J) to a luminaire photosynthetic photon efficacy (PPE) requirement of 2.5 µmol/J. The updated requirement would align with the DesignLights Consortium (DLC) Horticultural Technical Requirements V4.0 for consistency with current industry performance criteria.

This proposal updates the definition of photosynthetic photon efficacy (PPE) to luminaire photosynthetic photon efficacy (PPE), so there is an even playing field for all products. The rating of all products will account for the optical efficiency of the luminaire and the thermal impacts of luminaire design. Otherwise, the remainder of the definition is aligned with the metric developed by the American Society of Agricultural and Biological Engineers (ASABE) for the ANSI/ASABE S640 standard. This definition will be inclusive of luminaires with replaceable, serviceable lamps.

The updated horticultural lighting efficacy requirement would apply to new construction, additions, and alterations of greenhouse and indoor CEH facilities with an aggregate horticultural lighting load of 40 kilowatts (kW) or greater. The minimum PPE threshold would apply to all crop types and system configurations meeting this load threshold. The proposal would revise the mandatory requirements in Section 120.6 (Covered Processes) of Title 24, Part 6. Since the lighting efficacy requirements are mandatory, if the California Energy Commission adopts a performance approach for space conditioning systems, the Standard Design horticultural lighting efficacy would be equal to the proposed horticultural lighting efficacy.

In addition, this measure clarifies and carries forward existing requirements already established in the 2025 Energy Code for the dimmability of horticultural lighting. Specifically, the proposed dimming functionality language is derived from the language previously contained in Section 120.6(h)5C, which requires luminaires to adhere to the multilevel lighting controls requirements in 130.1(b). The proposed language is intended

to improve clarity and consistency in the interpretation and application of this existing requirement, ensuring that stakeholders clearly understand the expectations for compliant systems. This clarification does not expand the scope of regulated products or introduce new performance obligations beyond those already adopted in the 2025 Energy Code.

Table 1 summarizes the scope of the proposed code change.

Table 1: Scope of Proposed Code Change

An "X" indicates the proposed code change is relevant.

Building Type(s)		single family	**Construction Type(s)**	X	new construction
		multifamily		X	Additions
	X	nonresidential		X	Alterations
Type of Change	X	mandatory	**Updates to Compliance Software**	X	no updates
		prescriptive			update existing feature
		performance			add new feature
Third Party Verification	X	no changes to third party verification			
		update existing verification requirements			
		add new verification requirements			

Justification for Proposed Change

California's CEH sector is rapidly expanding to meet demand for locally grown, high-value crops produced all year. As these facilities rely heavily on electric lighting, improving fixture efficacy is one of the most effective strategies to reduce energy use. The proposed increase in the minimum PPE requirement from 2.3 µmol/J to 2.5 µmol/J ensures that new and retrofitted CEH lighting systems meet the current performance standard already commercially common.

By setting a higher efficacy threshold, the measure will deliver incremental, yet meaningful, energy savings with minimal cost impact because high-performance fixtures at or above 2.5 µmol/J are already widely available. The new threshold represents an efficacy level approximately eight percent higher than the current standard, which

equates to an anticipated annual statewide energy savings of 8.1 GWh for new constructions, additions and alterations.

The proposal also enhances alignment with the DLC Horticultural Technical Requirements V4.0, ensuring that Title 24 continues to reflect the leading edge of horticultural lighting practice (DesignLights Consortium, 2025). This step builds on the 2025 iteration of the Energy Code, advancing a multi-cycle strategy to improve CEH efficiency, reduce emissions, and maintain California's leadership in sustainable agriculture technology.

Data Needs / Information Requests

The Statewide CASE Team is seeking the following information to inform the code change proposal. Data may be provided anonymously. To participate or provide information, please email Nicole Hathaway (nicolehathaway@2050partners.com), Joe Sullivan (JSullivan@FranklinEnergy.com) directly, and copy info@title24stakeholders.com.

Energy Savings

- Confirmation & verification of modeling parameters for all crop types & stages:
  - Canopy Area per Luminaire (ft^2)
  - Photoperiod (hours per day)
  - Photosynthetic Photon Flux Density (PPFD) ($\mu Mol/m^2/s$)
  - Existing PPE (µmol/J) levels in facilities 3 years or older
  - Existing or proposed PPE (µmol/J) levels newer than 3 years or to be installed next year.
  - Baseline Mounting Height Above Canopy (ft^2)
  - Proposed Mounting Height Above Canopy (ft^2)
- Statewide construction forecast and existing facility stock by crop type and climate zone:
  - The CASE team is interested in data sources that provide up-to-date statewide facility stock for each individual crop type and building type (indoor and greenhouse). Primarily focused on cannabis, leafy greens, tomatoes, and other vine crops (e.g. beans, floral, etc.) but interested in all plant types.
- Greenhouse envelope light transmissivity rates/factors (glazing type, age, material, light transmission %).
- Prevalence of supplemental lighting in greenhouses by crop type.

- Weather-normalized solar radiation variability by climate zone to support modeling of available sunlight and supplemental lighting needs for various greenhouse crop types.
- Actual hourly kW draw curves for CEH lighting

First Costs

- Incremental equipment costs between 2.3 and 2.5 µmol/J LEDs at various input wattages.
- Typical installation and labor costs to install LEDs in both indoor and greenhouse facilities.
- Variability in first cost by canopy size, configuration, and crop type.

Technical Feasibility

- Current adoption of 2.5 µmol/J lighting across all facility sizes, with a focus on facilities ≤40 kW to assess whether the current exemption threshold remains appropriate.
- Are current lighting design strategies focusing more on maximizing crop yield per square foot, minimizing energy use per unit area, both, or neither?

Market Readiness

- Number of LED products that would no longer meet compliance under a 2.5 µmol/J threshold.
- Do sub-2.5 µmol/J fixtures serve specific horticultural needs or niche applications for growers?

Non-Energy Benefits

- Grower reported benefits; examples of these are reduced maintenance, improved reproduction cycle length, actual % gains in crop yield or shelf-life extension, etc.
- Potential for carbon or GHG reduction attributable to optimized supplemental lighting use.
- Would introducing performance-based metrics—such as “Watts per square foot,” "yield per kWh" or "energy cost per unit production"—be useful?

Expected Useful Life and Maintenance Costs

- Expected life, long-term performance, and replacement interval of LEDs with PPE ≥ 2.5 µmol/J.

- Typical 70% and 90% Photon Flux Maintenance timelines, driver lifetime, and diode/array lifetime.
- Availability of LEDs with serviceable and replaceable components.

Economic Impacts

- Potential cost barriers and access to skilled labor for small scale growers when adopting compliant LED fixtures.
- Do growers of specific crop types face similar challenges when adopting compliant LED fixtures? Is this the same for both greenhouse and indoor applications?
- Historical participation rates in utility rebate programs for high-efficacy LEDs in CEH applications.
- Availability of leasing or on-bill financing for CEH lighting upgrades, especially for small growers.

Draft Code Language

1.1 Guide to Marked Up Language

The proposed changes to the Standards and Reference Appendices are provided below. Changes to the 2025 documents are marked with blue underlining (new language) and ~~strikethroughs~~ (deletions).

1.2 Title 24, Part 1

There are no proposed changes to Title 24, Part 1.

1.3 Title 24, Part 6

100.1 Definitions

LUMINAIRE PHOTOSYNTHETIC PHOTON EFFICACY (PPE) is photosynthetic photon flux emitted by a luminaire between 400 and 700 nm divided by input electric power in units of micromoles per second per watt, or micromoles per joule as defined by ANSI/ASABE S640. Luminaire is inclusive of both integrated and luminaires with removable, serviceable lamps.

120.6 (h) Mandatory requirements for Controlled Environment Horticulture (CEH) spaces.

…

120.6(h)5. Horticultural lighting. ~~In a building with CEH spaces or a greenhouse with more than~~ Where more than 40 kW of aggregate horticultural lighting load is installed to serve indoor growing spaces or greenhouse spaces, the electric lighting system used for plant growth and plant maintenance shall meet the following requirements:

A. Luminaire PPE and Dimmability. Horticultural lighting shall have a luminaire photosynthetic photon efficacy (PPE) of at least 2.5 µmol/J when tested at the manufacturer-designed state with the highest power consumption. Horticultural lighting shall be capable of continuous dimming between 100% and 10% of full power in response to a line voltage, low voltage, or wireless signal.

~~A. The horticultural lighting systems shall have a photosynthetic photon efficacy (PPE) rated in accordance with ANSI/ASABE S640 for wavelengths from 400 to 700 nanometers and meet one of the following requirements:~~

~~i. Integrated, non-serviceable luminaires shall have a rated PPE of at least 2.3 micromoles per joule; or~~

~~ii. Luminaires with removable or serviceable lamps shall have lamps with a rated PPE of at least 2.3 micromoles per joule.~~

There are no changes proposed to Title 24 Part 6, section 141.1(c). The section is shown for reference.

141.1(c) Controlled Environment Horticulture Spaces.

…

3. Indoor Growing and Greenhouses, Horticultural Lighting. When alterations to horticultural lighting systems increase lighting wattage or include adding, replacing, or altering 10 percent or more of the horticultural luminaires serving an enclosed space, the newly installed, replaced, or altered lighting shall meet the requirements of Section 120.6(h)5.

EXCEPTION to Section 141.1(c)3: Any alteration limited to adding lighting controls or replacing lamps, ballasts, or drivers.

1.4 Reference Appendices

There are no proposed changes to the reference appendices.