Proposal Summary

Controlled Environmental Horticulture: Lighting Efficacy & Language Clean-up

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Measure Description

Currently, the Title 24 Part 6 code requires luminaires and lamps that are used for plant growth to have a minimum photosynthetic photon efficacy (PPE) of 2.3 micromoles per joule (µmol/J). The proposed code change would increase the mandatory PPE requirement for controlled environment horticulture (CEH) to a minimum threshold of 2.5 µmol/J. The proposal references the ANSI/ASABE S640 standard for measuring horticultural lighting performance within the photosynthetically active radiation (PAR) range of 400-700 nanometers and aligns with the Design Lights Consortium (DLC) Horticultural Technical Requirements V4.0.

The proposed requirement would apply to new construction, additions, and alterations in greenhouse and indoor CEH spaces with an aggregate horticultural lighting load of 40 kW or greater. The minimum PPE requirement would apply uniformly across all crop types. The proposal would revise the mandatory requirements outlined in Section 120.6 (mandatory requirements for Covered Processes). The increased efficacy requirement is intended to reflect the current lighting performance industry standard. As documented through the adoption of 2.5 µmol/J as the efficacy level in standards such as ASHRAE 90.1 and product listings in the upcoming version 4.0 of the DLC Horticultural Qualified Products List (QPL), this alignment demonstrates the availability of the products in the marketplace.

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

The proposal builds upon the 2025 code cycle requirement and is expected to provide incremental energy savings with minimal cost impact, as 2.5 µmol/J fixtures are now widely available throughout the market. The updated efficacy threshold will set required efficacy more than 45% above the most efficacious non-LED horticultural lighting option, the double-ended high-pressure sodium light.

This measure is expected to have a straightforward compliance pathway, as most growers who have already adopted, or will be planning to adopt, LED technology will use fixtures with an efficacy of at least 2.5 µmol/J. The incremental increase from 2.3 to 2.5 µmol/J would disqualify only about 12% of products that were previously compliant. Additionally, CEH operators seeking utility rebates for horticultural LEDs are already required to use fixtures listed on the DLC Horticulture QPL, further aligning this proposal with California utility program incentive requirements.

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 %).
- Estimated percentage of greenhouses with supplemental lighting by crop type.
- 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.

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 a greenhouse spaces, the electric lighting system used for plant growth and plant maintenance shall meet the following requirements:

A. Luminaire PPE. Horticultural lighting shall have a luminaire photosynthetic photon efficacy (PPE) of at least 2.5 µmol/J.

~~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.