TITLE 24, PART 6 | 2025 CODE CYCLE

Controlled Environment Horticulture

Codes and Standards Enhancement (CASE) Proposal

Nonresidential

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February 9, 2023

CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

Agenda

Background	*5 min*
Market Overview and Analysis	*10 min*
Technical Feasibility	*5 min*
Cost and Energy Methodology	*5 min*
Compliance and Enforcement	*5 min*
Proposed Code Changes	*5 min*
Discussion & Next Steps	*15 min*

Background

- Code Change Proposal
- 2022 Code Requirements
- Context and History

Controlled Environment Horticulture Proposal

I. Horticulture Minimum Lighting Efficacy

II. HVAC/D Equipment and Controls Integration

CEH Lighting: Build on existing code and explore increased minimum efficacy for greenhouse and indoor lighting

Explore horticultural lighting threshold for triggering code

HVAC/D: Identify combinations of HVAC/D equipment components and controls

Set minimum requirements for equipment and controls configurations

Indoor Horticultural Lighting Efficacy

2022 Requirements:

A minimum photosynthetic photon efficacy (PPE) of not less than 1.9 micromoles per joule for indoor CEH facilities with at least 40 kW of connected lighting load.

PPE is the rate of flow of photons between 400 to 700 nanometers in wavelength from a radiation source divided by Watts.

Current Proposal:

A minimum PPE of not less than 2.3 micromoles per joule for indoor CEH facilities with at least 40 kW of connected lighting load.

Greenway Magazine, June 10, 2021: https://mogreenway.com/2021/06/10/fluence-and-proper-cannabis-partner-introduce-advanced-led-lighting-to-rising-midwestern-cannabis-market/

Links to the current proposal and 2022 CA Energy Code are included in this slide for reference.
Proposal aligns with DLC Horticultural specification V3.0 minimum PPE requirements.

Greenhouse Horticultural Lighting Efficacy

2022 Requirements:

A minimum PPE to 1.7 for greenhouse facilities with at least 40 kW of connected lighting load.

Current Proposal:

Increasing the minimum PPE to 1.9 for greenhouse facilities with at least 40 kW of connected lighting load.

Growspan Greenhouse Structures. May 24, 2018. https://www.growspan.com/news/understanding-greenhouse-lighting/

Should greenhouses have a similar minimum PPE to indoor?
The initial reason for PPE requirements being lower in greenhouses was the different use cases seen for greenhouses, such as use of supplemental lighting for season extension and photoperiod adjustment. Given that these use cases have lower run hours, LEDs may not be cost effective for them.

HVAC/D Equipment and Controls Integration

Current Proposal:

- Understand common configurations of HVAC/D equipment and controls
- Potential for commissioning requirements
- Establish minimum efficiency requirements that remove the most inefficient configurations

Example specifications:
Modulating compressor, integrated temperature and humidity controls, heat recovery

Cannabis Business Times. February 8, 2018. https://www.cannabisbusinesstimes.com/article/determining-dehumidification-needs/

Context and History

Estimated statewide impacts of the CEH measures adopted into the 2022 Energy Code:

Construction Type	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (MMTherms)	Avoided GHG Emissions (Metric Tons CO2e/yr)
CEH Lighting	293.90	20.9	N/A	70,635
CEH Dehumidification	(0.03)	(0.0)	1.2	6,361
Total	293.87	20.9	1.2	76,996

Controlled Environment Horticulture: 2022 Final Statewide Codes and Standards Enhancement (CASE) Report. March 2021. https://title24stakeholders.com/wp-content/uploads/2021/03/2022-T24-NR-CEH-Final-CASE-Report_w-Addendum.pdf

Context and History

Why are we proposing these measures?

- **CEH Lighting:** ~93 GWh potential first-year energy savings from 2025 horticultural lighting proposed measure
- **CEH HVAC/D:** There's a lack of CEH-specific standardization in system design and commissioning in the industry
- High energy use intensity industry

Describe technology or design approach and how it saves energy:

- **Horticultural lighting:** increased minimum PPE efficacy
- **HVAC/D:** Eliminate inefficient designs and ensure proper system operation through commissioning

Market Overview

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

CEH Lighting

Current Market

- Double-ended HPS and LED are primary lighting technologies used for greenhouse and indoor horticultural lighting

Market Trends

- Increased market adoption of horticultural LEDs since the 2022 Energy Code Cycle
- $1.00-$1.50/W cost for horticultural LED fixtures
- Some manufacturers and distributors dropping HID product lines and focusing on LEDs

Do you agree with this description? What else should be known?

- Price was approx. $2.00-$2.50/W during 2022 code cycle
- Significant decrease in cost over the past three years
- Larger focus in LED grow lights, less contention around performance

CEH Lighting – *continued*

Market Barriers

- High equipment cost
- Limited access to capital for cannabis growers
- Issues with LED grow light incentives due to CPUC industry standard practice concerns

Potential Solutions

- Create path for LED grow light retrofit incentives in CA
- Explore financing mechanisms that could support transition to LED grow lights

Any barriers or solutions we missed?

- Price was approx. $2.00-$2.50/W during 2022 code cycle
- Significant decrease in cost over the past three years
- Larger focus in LED grow lights, less contention around performance
- Incentives for grow lights in CA are currently stalled due to CPUC concerns about industry standard practice

HVAC/D

Current Market

- Multiple different HVAC/D configurations available
- Not all systems designed to modulate capacity with plant growth stages
- Commissioning typically entails startup operation, difficult to put a false load on the facility and test latent load removal and performance

Market Trends

- ASHRAE X653 engineering design guide
- Industry is slow to develop CEH-specific test procedures

Do you agree with this description? What else should be known?

HVAC/D – *continued*

Market Barriers

- Stand-alone dehumidifier federal preemption concerns
- Lack of test procedures and standards specific to CEH HVAC/D industry
- User behavior and control algorithms have major effects on system energy performance
- HVAC/D working group convening to further refine measure

Potential Solutions

- Clarify federal appliance standard scope with DOE
- Develop commissioning and acceptance test requirements for CEH HVAC/D systems

Any ideas for potential solutions?

- The efficiency of equipment is only one piece of HVAC system performance. How the equipment is operated, user behavior, and controls strategies all have effects on efficiency as well.
- Federal preemption concerns make it difficult to increase equipment efficiency.
- Through our CEH HVAC working group, commissioning was identified as a potential way to address user behavior and overall system performance.

Technical Considerations

- Technical Considerations
- Potential Barriers and Solutions

CEH Lighting

Technical Considerations

- Performance of lighting technologies
- Incremental equipment cost of proposed technologies
- Spectral tuning and light wavelength metrics

Technical Barriers and Potential Solutions

- Technology performance studies
- CEH lighting sales survey
- Lighting equipment cost analysis

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

CEH HVAC/D

Technical Considerations

- What are the range of efficiencies of various HVAC/D equipment and controls configurations?
- What are most common design practices in CA?
- What designs can modulate with plant growth and different plant growth stages?

Technical Barriers and Potential Solutions

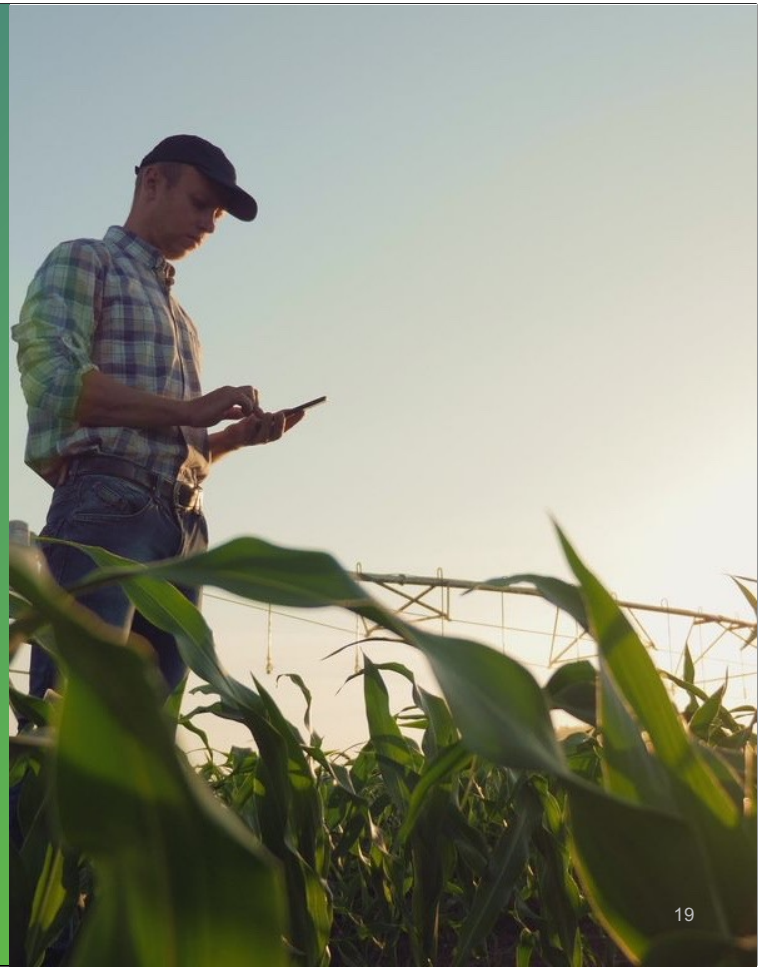
- No HVAC/D standards specific to CEH
- Variety of configurations and technology specifications available
- Work with industry to define common configurations

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

Energy & Cost Impacts Per Unit

Methodology and Assumptions

- Energy Savings Methodology
- Cost Impacts Methodology and Results
  - Incremental costs
  - Energy cost savings



Methodology for CEH Lighting Energy Impacts Analysis

- Consistent Photosynthetic Photon Flux Density (PPFD) for code and baseline cases
- PPFD = luminaire density x power x PPE x dimming level
- Energy Savings = (PPFD x Operating Hours) / PPE

- Calculate for all variations
  - Crop type
  - Growth stage

Assumptions for CEH Indoor Lighting

Parameter	Cannabis - Flower	Cannabis - Vegetative	Cannabis - Clone	Leafy Greens	Tomatoes
Canopy Area per Luminaire (ft^2)	20	24	10	58	56
Photoperiod (hours per day)	12	18	24	18	12
PPFD ($\mu Mol/m^2/s$)	1,000	600	200	200	350
Baseline PPE ($\mu Mol/J$)	1.9	1.9	1.9	1.9	1.9
Proposed PPE ($\mu Mol/J$)	2.3	2.3	2.3	2.3	2.3

Assumptions for CEH Greenhouse Lighting

Parameter	Cannabis - Flower	Cannabis - Vegetative	Cannabis - Clone	Leafy Greens	Tomatoes
Canopy Area per Luminaire (ft^2)	20	24	10	58	56
Photoperiod (hours per day)	12	18	24	18	12
PPFD ($\mu Mol/m^2/s$)	600	400	200	200	350
Baseline PPE ($\mu Mol/J$)	1.7	1.7	1.7	1.7	1.7
Proposed PPE ($\mu Mol/J$)	1.9	1.9	1.9	1.9	1.9

Preliminary Energy Savings Estimates Per Unit (sq ft of canopy)

Key Assumptions:

- Xx
- Xx
- Xx

Explain how savings presented vary by climate zone. Either use this slide to show a range of savings by Climate Zone or replace this slide with something that shows estimates by climate zone. Try to align presentation of results with how results are presented in CASE Report so readers don't have to

Add slides if you want to show savings for different prototypical buildings.

Annual Electricity Savings (kWh/yr)	
Annual Natural Gas Savings (Therms/yr)	
Peak Demand Reduction (W)	
Annual Life Cycle Energy Cost Savings (kBTU/yr)	
Annual Source Energy Savings (kBTU/yr)	

- Key assumptions

Clearly present key assumptions including:

- Baseline and proposed case (see example on next slide)
- Period of evaluation (30 years for residential and nonresidential envelope; 15 years for all other nonresidential)
- Operating schedules
- Other key assumptions needed to complete the analysis. Please the table on the next slide.

Clearly present assumptions on how you intend to translate per unit savings to statewide savings

What feedback are we looking for

Incremental Cost Information

How we will collect costs of base case technology and proposed technology:

Horticultural Lighting

- Online lighting sales
- Lighting manufacturers
- Lighting distributors

CEH HVAC/D

- HVAC/D manufacturers
- HVAC/D distributors

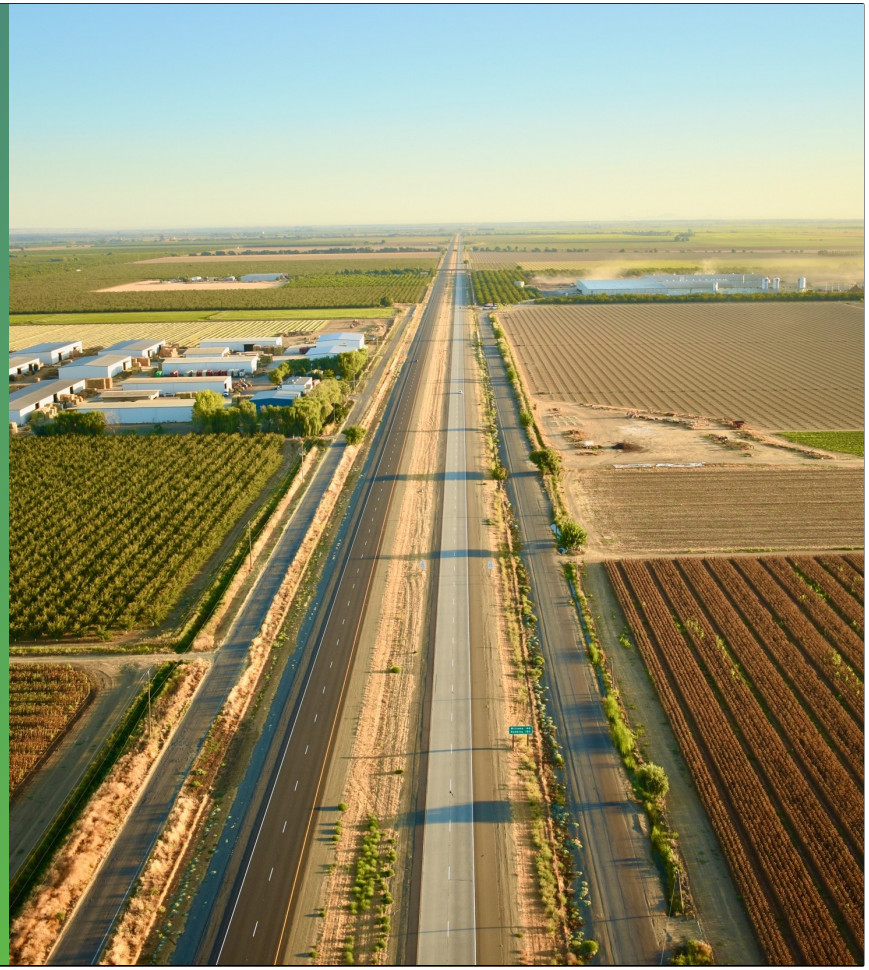
Prompts for discussion:

- What components of costs did we leave out?
- Do you find these costs to be reasonable?
  - Note because of anti-trust of competitive issues, participants may not be comfortable discussing costs outside of the most broad terms; indicate your willingness to discuss individually.

Statewide Energy Impacts

Methodology and Assumptions

- Statewide Energy Impacts Methodology



Statewide Energy Impacts Methodology

The Statewide CASE Team estimates annual statewide impacts by multiplying **A x B x C**:

A. per-unit energy impacts (discussed in previous section)

B. number of units of new construction/additions/alterations of each applicable building type

C. portion of affected units in each climate zone

Example:

Per Unit Impacts

Savings type	**Savings** per square foot
Electricity	[X] kWh
Peak demand	[X] Watts
Natural gas	[X] Therms
GHG emissions	[X] Tons CO_2e

×

Affected New Construction

Climate Zone	**Large Office** sq ft	**Assembly** sq ft
1	100	20
2	1,000	1,500
…		
16	5,000	3,000

=

Statewide Energy Impacts

Climate Zone	**Elec Savings** (GWh)	…	**GHG savings** (MT CO_2e)
1	20		1,500
2	50		3,000
…			
16	100		2,000

Detailed statewide savings calculations are not available yet, but I wanted to share the general methodology that will be used for informational purposes.

Compliance and Enforcement

- Process Overview
- Current Progress
- Request for Feedback

Compliance and Verification Process

1. **Design Phase**
   An owner, developer, architect, and other team members involved in the design of a CEH facility familiarize themselves with new code requirements and design the facility to meet the requirements. Architectural and basic mechanical systems currently go through plan review, so updating this process to account for new requirements would not be a profound change.

2. **Permit Application Phase**
   The permit applicant completes a certificate of compliance document and ensures building plans are consistent with the information in the certificate of compliance. A horticulture facility designer or general contractor usually fulfills the role of permit applicant. Plans examiners at an enforcement agency familiarize themselves with new code requirements to determine compliance.

3. **Construction Phase**
   Field changes resulting in noncompliance require an approval of the revised certificate of compliance document. As needed, the permit applicant coordinates approval of field changes with the plans examiner at the enforcement agency.

4. **Inspection Phase**
   An appropriate responsible party completes the certificate of installation document and submits the document to the enforcement agency. A general contractor normally submits the certificate of installation document. Enforcement agency field inspector reviews the certificate of installation and certificate of acceptance documents. The enforcement agency field inspector may conduct a visual inspection of the project upon project completion.

Compliance and Verification

We are currently working through some stakeholder questions on stand-alone dehumidifier compliance.

- **CEH Lighting:** No change to compliance process, just updated minimum PPE requirements
- **CEH HVAC/D:** Dependent upon refinement of code change proposal
  - May require acceptance test

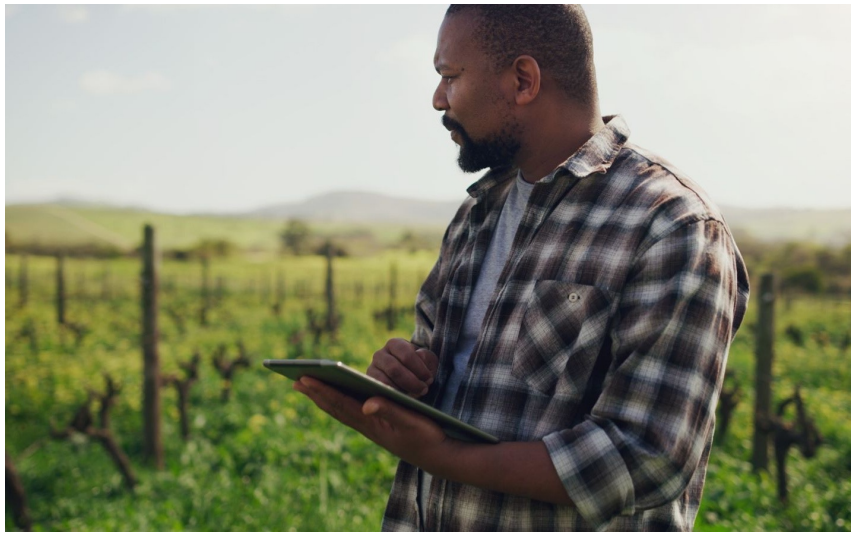
Energy Code Ace provides tools, training, and resources to support compliance: https://energycodeace.com/

- CEH lighting compliance will use the same process for the 2025 code cycle as it did in the 2022 code cycle.

Request for Feedback on Compliance

We want to hear your experiences with CEH compliance.

- **Have you been through the compliance process yet?**
- **What works well?**
- **Is there anything that needs more clarification?**



Review of Code Language Markup

- Draft Code Change Language

Draft code language available for review in Handouts and downloadable.
No language available for HVAC/D yet, but CEH Lighting is available

CEH Indoor Lighting

3. **Indoor Growing, Horticultural Lighting.** In a building with CEH spaces and with more than 40 kW of aggregate horticultural lighting load, the electric lighting systems used for plant growth and plant maintenance shall meet the following requirements:

A. Luminaires shall have with removable lamps shall contain lamps with a lamp photosynthetic photon efficacy of at least 2.3 ~~1.9~~ micromoles per joule rated in accordance with ANSI / ASABE S640 for wavelengths from 400 to 700 nanometers; all other luminaires shall have a luminaire photosynthetic photon efficacy of at least 2.3 ~~1.9~~ micromoles per joule.

B. Time-switch lighting controls shall be installed and comply with Section 110.9(b)1, Section 130.4(a)4, and applicable sections of NA7.6.2.

C. Multilevel lighting controls shall be installed and comply with Section 130.1(b).

Thoughts on lighting kW threshold?
Thoughts on PPE?
Thoughts on controls?

CEH Greenhouse Lighting

7. **Greenhouses, Horticultural Lighting.** In a greenhouse with more than 40 kW of aggregate horticultural lighting load, the electric lighting system used for plant growth and plant maintenance shall meet the following requirements:

A. Luminaires with removable lamps shall contain lamps with a lamp photosynthetic photon efficacy of at least ~~1.7~~ 1.9 micromoles per joule, all other luminaires shall have a luminaire photosynthetic photon efficacy of at least ~~1.7~~ 1.9 micromoles per joule.

B. Time-switch lighting controls shall be installed and comply with Section 110.9(b)1, Section 130.4(a)4, applicable sections of NA7.6.2.

C. Multilevel lighting controls shall be installed and comply with Section 130.1(b).

Thoughts on lighting kW threshold?
Thoughts on PPE?
Thoughts on controls?

Discussion and Next Steps

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 2025 Energy Code at https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2025-building-energy-efficiency

Comments on this measure are due by April 1. Please send comments to info@title24stakeholders.com and copy CASE Authors (see contact info on following slide).

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Thank You

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