TITLE 24, PART 6 | 2028 CODE CYCLE

Controlled Environment Horticulture (CEH)

Codes and Standards Enhancement (CASE)
Prototype Workshop

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CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

Purpose and Agenda

1. Explain concept of building energy prototype models
2. Provide overview and typical layout of CEH facilities
3. Explain scope and purpose of CEH prototype
4. Share **preliminary** assumptions used in CEH prototype
5. **Solicit feedback about user inputs vs. in compliance model**
6. **Solicit feedback on prototype assumptions (Excel workbook)**

Introduction

Building Energy Modeling

Building Energy Modeling: Introduction

What is BEM?

- Physics-based simulation of building systems and loads.
- Annual analysis using 8,760 hourly weather data (TMY).
- Inputs include: Envelope, HVAC, Lighting, Occupancy, Plug Loads, Process Loads.

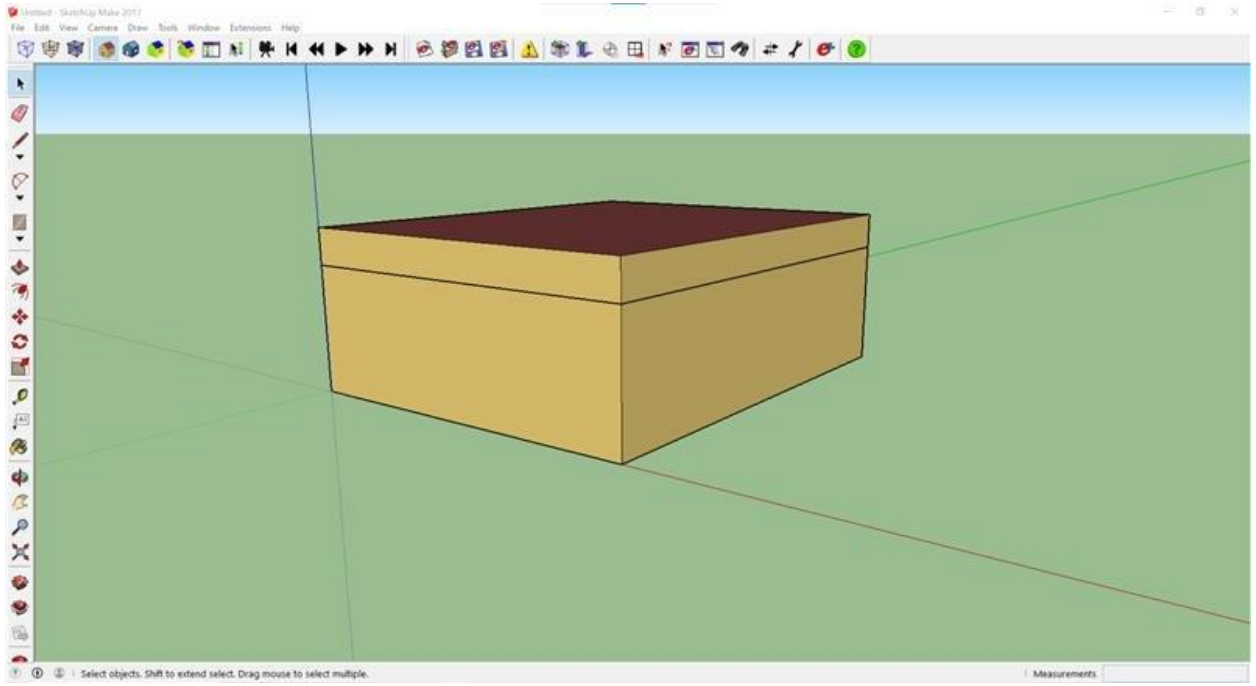
Applications

- New Construction: Design optimization and code compliance.
- Retrofits: Assessing upgrades for existing facilities.

Introduction: Building Energy Model Prototypes

What is a Prototype?

- Standardized Model
- Typical Characteristics
- Code Aligned
- Climate Specific



Introduction: Building Energy Model Prototypes

Why create BEM **prototypes**?

- Reflect typical conditions for a specific occupancy type, including:
  - Construction practice
  - Dimensions
  - Schedules
  - Internal and external loads
  - Code requirements
- Test and validate proposed T24 code changes

Why create a **CEH prototype**?

- Existing prototypes are inappropriate for CEH, because they:
  - Assume space used for human occupancy/comfort
  - Underestimate lighting power density by factor of ~100
  - Include partly transparent envelope (windows)
  - Assume outdoor air exchange (ventilation/economizing)
  - Underestimate latent loads by factor of ~100
- Ensure that code change proposals accurately reflect savings
- Ensure that performance-based compliance accurately reflects measures

Benefits of BEM Prototype to CEH industry

1. Provides a tool to facility designers and energy consultants to evaluate different efficiency measures
2. Vastly improves model accuracy by integrating variable cooling and dehumidification loads
3. Provides much more accurate representation of industry practices
4. Provides flexibility when selecting equipment and demonstrating compliance with code requirements
5. Improve modeling capabilities for equipment used in CEH

CEH Facilities

Floorplans

Process Loads

Indoor Cannabis Facility Floorplan Example

Flower room: ~100x latent load in typical warehouse

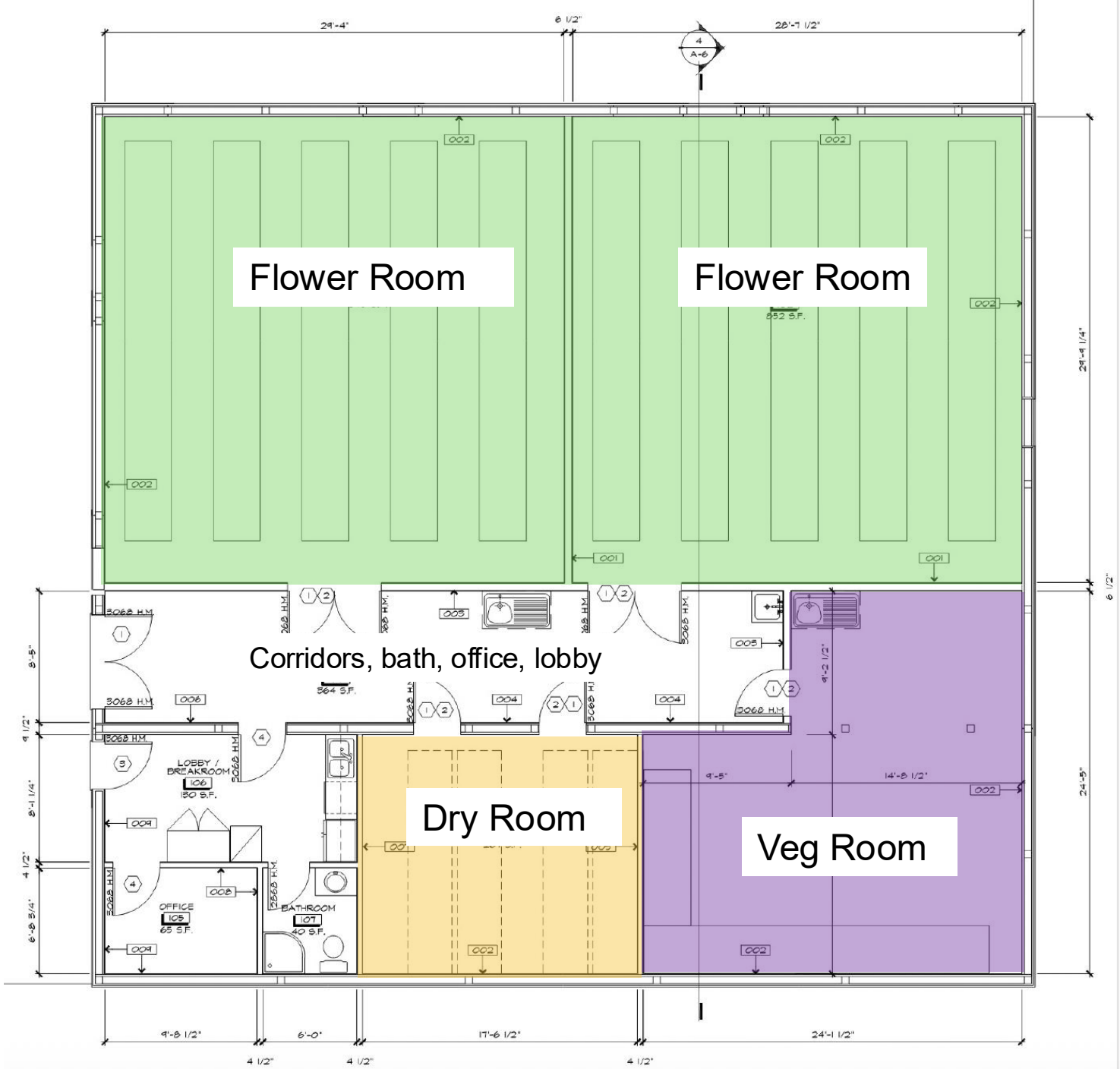
Veg room: ~50x typical latent load

Dry room: ~20x typical latent load

Corridors, bath, office, lobby, etc.: loads typical of warehouses

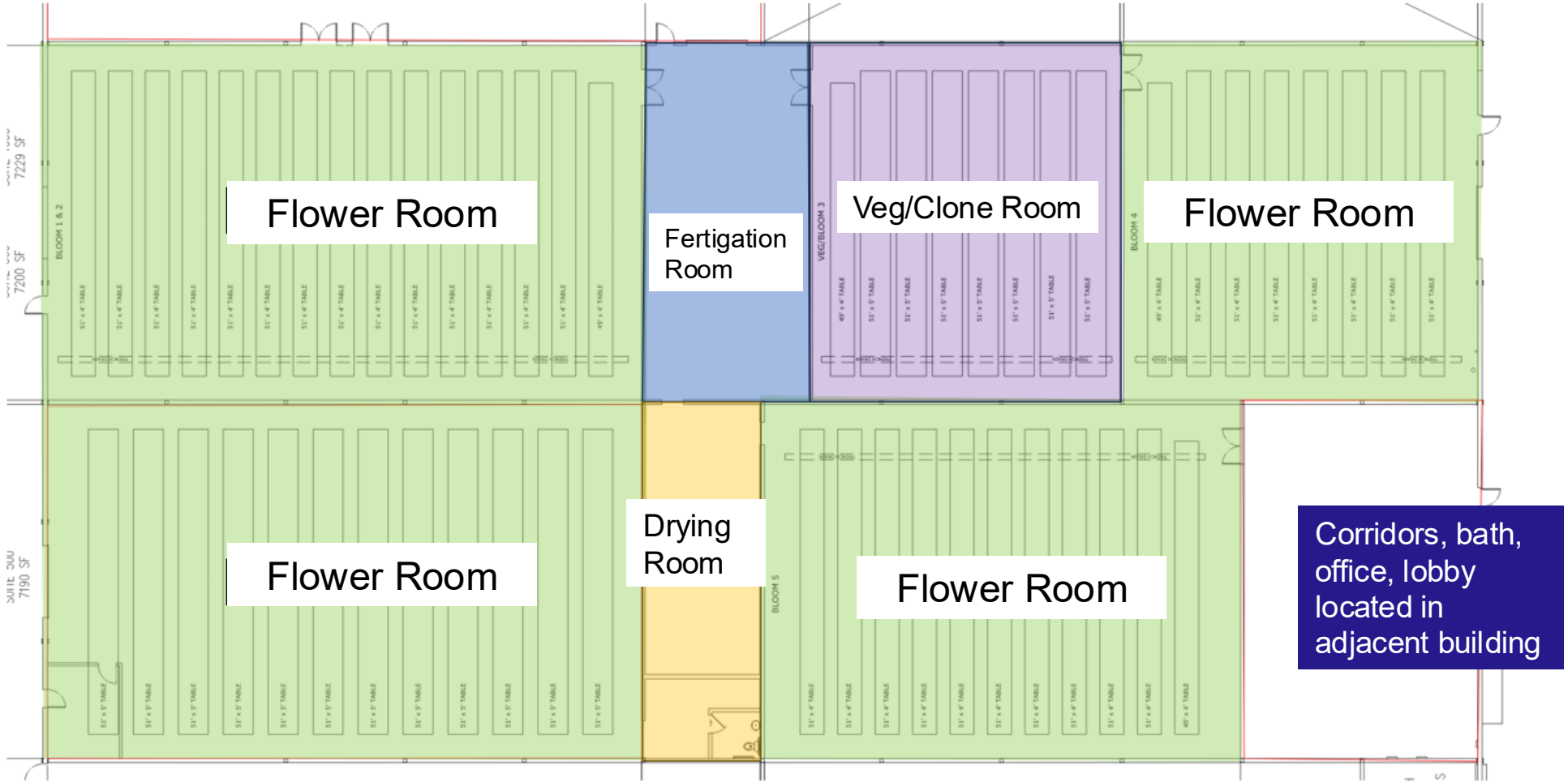
Some facilities also include extraction or retail packaging areas.

Allocation of space to flowering, vegetation, and drying is generally consistent.



Michael Gillespie, "Two Real World Application Case Studies of Novel HVAC&D Systems in Controlled Environmental Agriculture. Case Study 1: Use of Water Source Heat Pumps for Energy Recovery in CEA," *2025 ASHRAE Annual Conference, SMNR 33*, Phoenix, AZ, June 21–25, 2025.

Indoor Cannabis Facility Floorplan Example 2



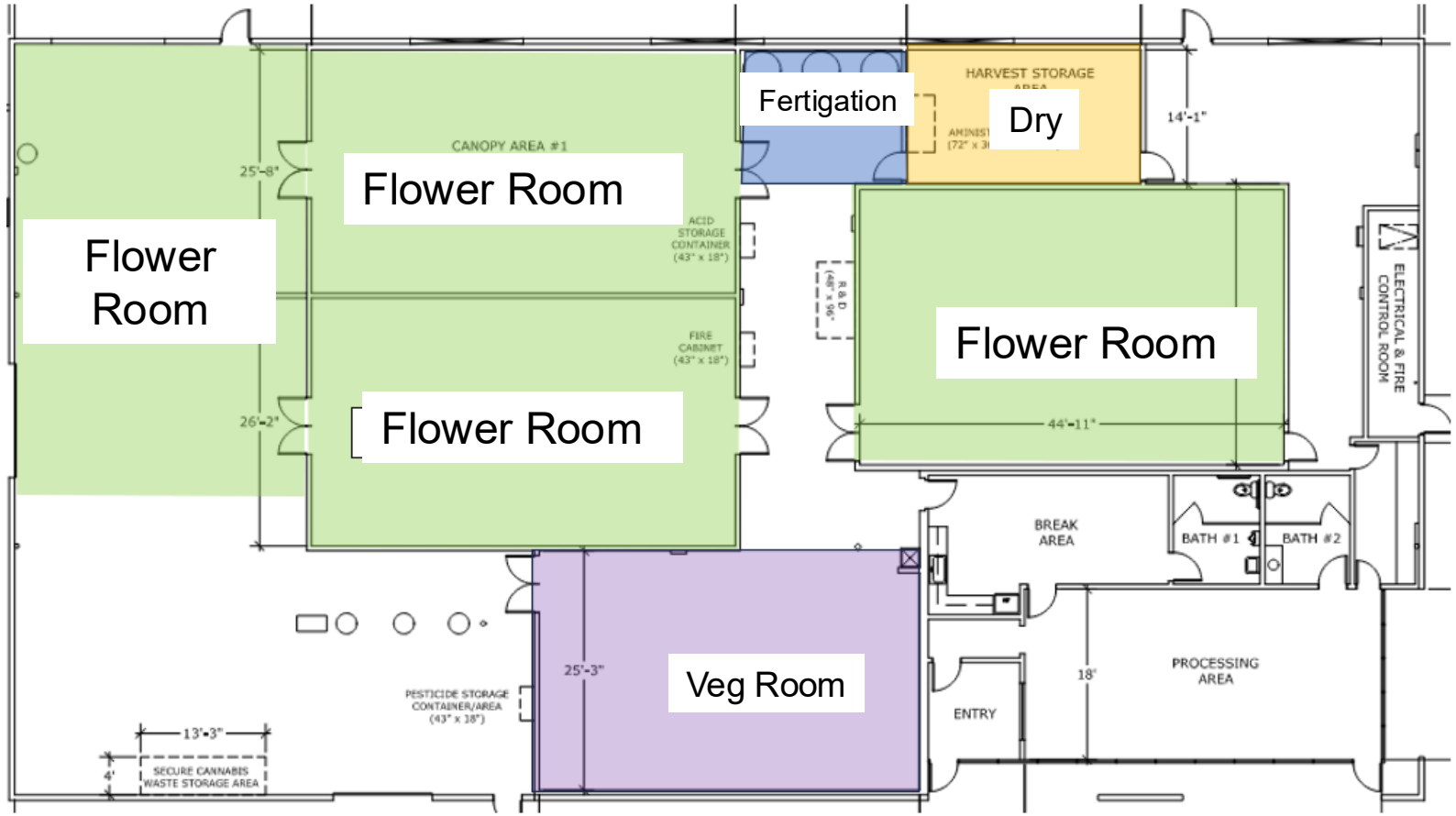
Stober, Willy, and Hillary Weitze. *Final Project Report: Controlled Environment Horticulture—Energy Consumption and Environmental Control Field Study*. CR22PGE0101-1. Issued July 2024. Pacific Gas and Electric Company.

Indoor Cannabis Facility Floorplan Example 3

Flower rooms in cannabis facilities:

~50% of floor space
~85% of total energy use

Controlled to exacting specifications
(tight temp and humidity deadbands)



Stober, Willy, and Hillary Weitze. *Final Project Report: Controlled Environment Horticulture—Energy Consumption and Environmental Control Field Study*. CR22PGE0101-1. Issued July 2024. Pacific Gas and Electric Company.

Not a typical “Conditioned Warehouse”: High energy intensity indoor Farms

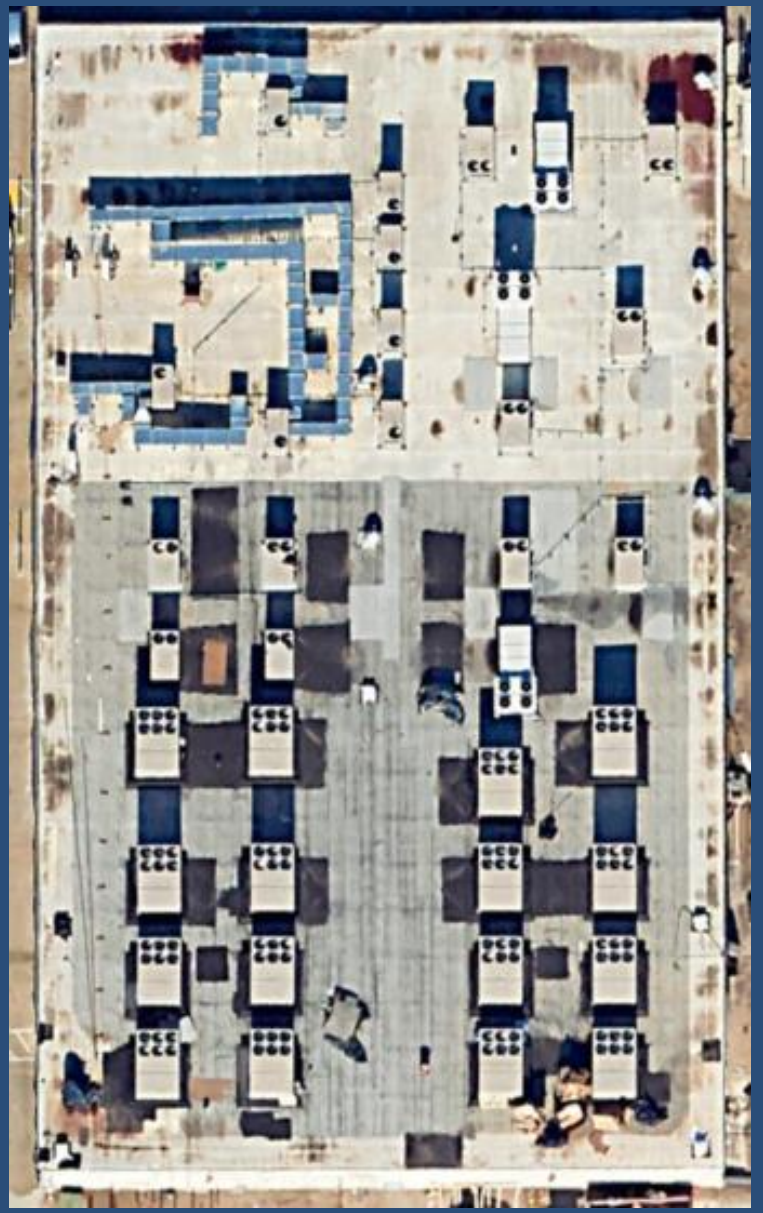
May 2021

~5 tons cooling capacity

Feb 2022

~200 tons cooling capacity

Nov 2023



~1000 tons cooling capacity

Proposed CEH Prototype

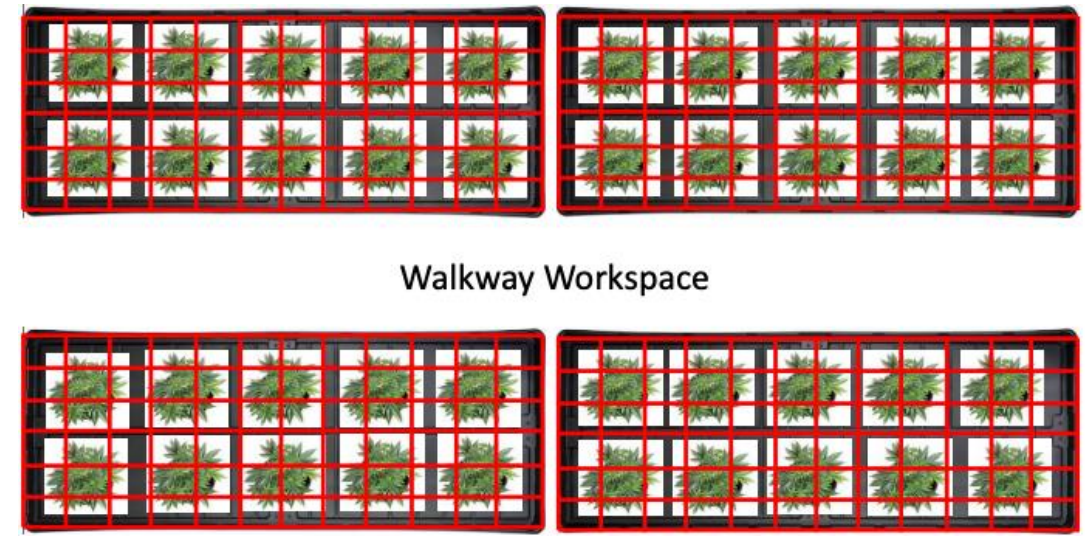
For which facilities is the prototype applicable?

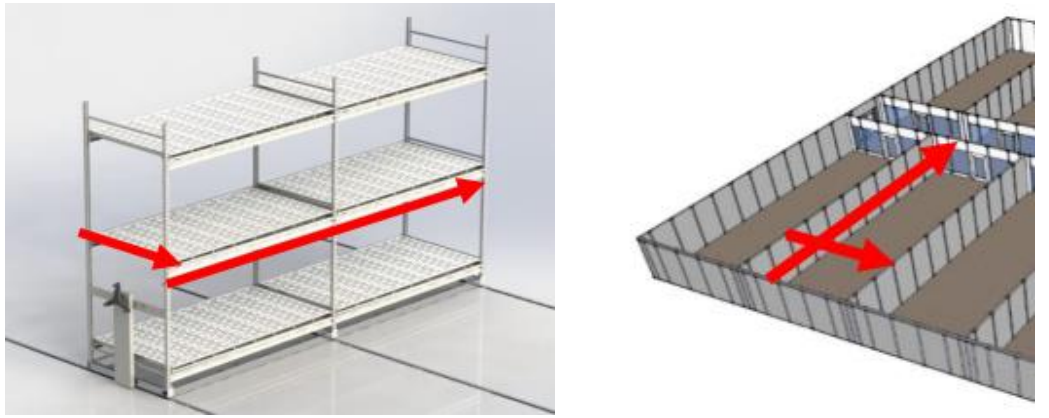
Prototype assumptions

For which CEH facilities is this prototype intended?

- This prototype is intended to reflect **typical construction and operational practices** in buildings with indoor growing CEH spaces that have a Lighting Power Density greater than 30 Watts per square foot of plant canopy area.
- Prototype assumes facility is used for **cannabis cultivation**, drying, processing, and packaging of dried product (over 90% of indoor farms in California).
- **Indoor growing** has a skylight ratio <50% (greenhouses have a skylight ratio >50%).
- **Plant Canopy Area** is the area, in square feet, where mature, or flowering, plants are grown.
- Although some of the assumptions are representative of other indoor crops, a different prototype would be needed for non-cannabis crops.

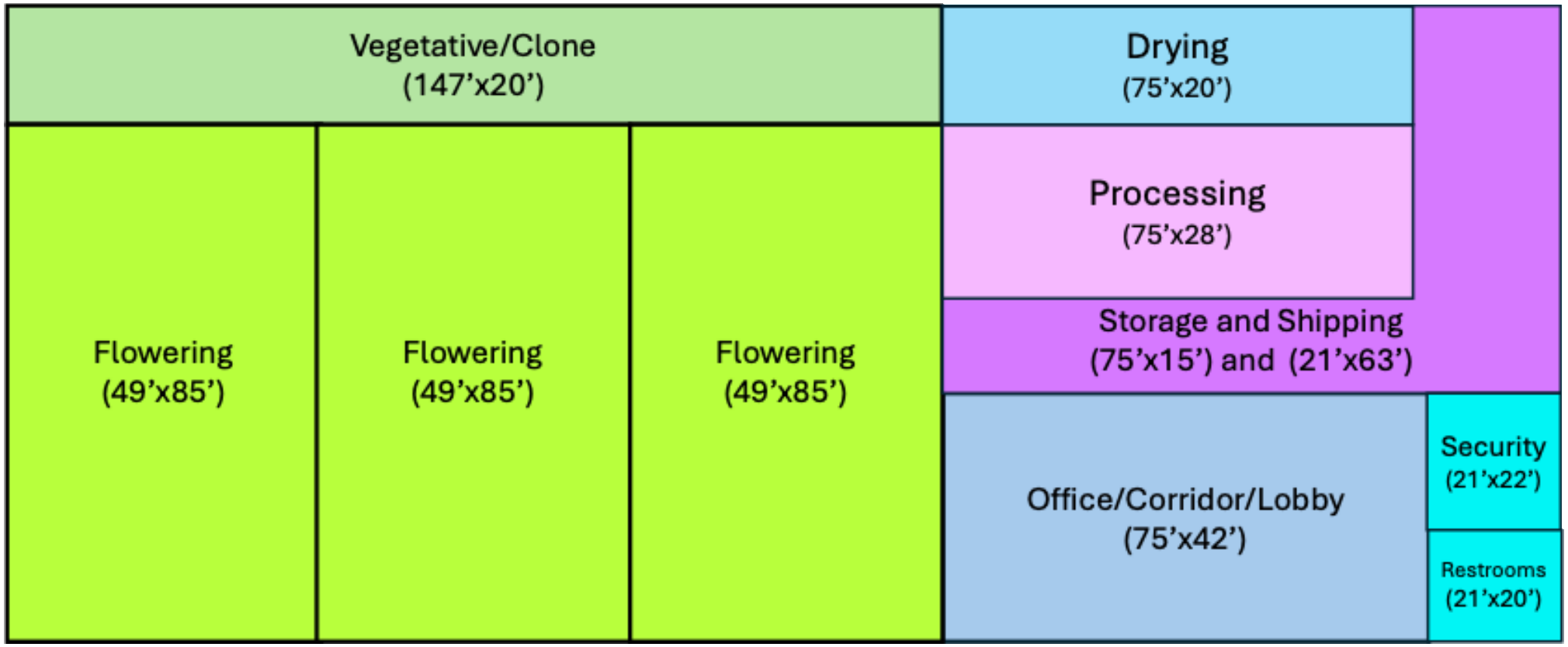
https://sonomacountylawlibrary.org/Main%20County%20Site/Administrative%20Support%20%26%20Fiscal%20Services/CAO/Documents/Projects/Cannabis/Determining%20Canopy%20Comprehensive.pdf





Graphics illustrating canopy area calculations for indoor cannabis farms. Source: Sonoma County Law Library

Prototype CEH Facility Layout



- 3 single-zone flower rooms with staggered flower cycle start dates
- Vegetative/clone room will be 2-tier to provide enough plants for the flowering rooms.
- Processing area including trimming, curing, and packaging.
- 25,515 total square feet; approximately 13,000 square feet of plant canopy area
- Does the allocation of square footage by space type align with industry practice?

Temperature and Humidity Setpoint Assumptions

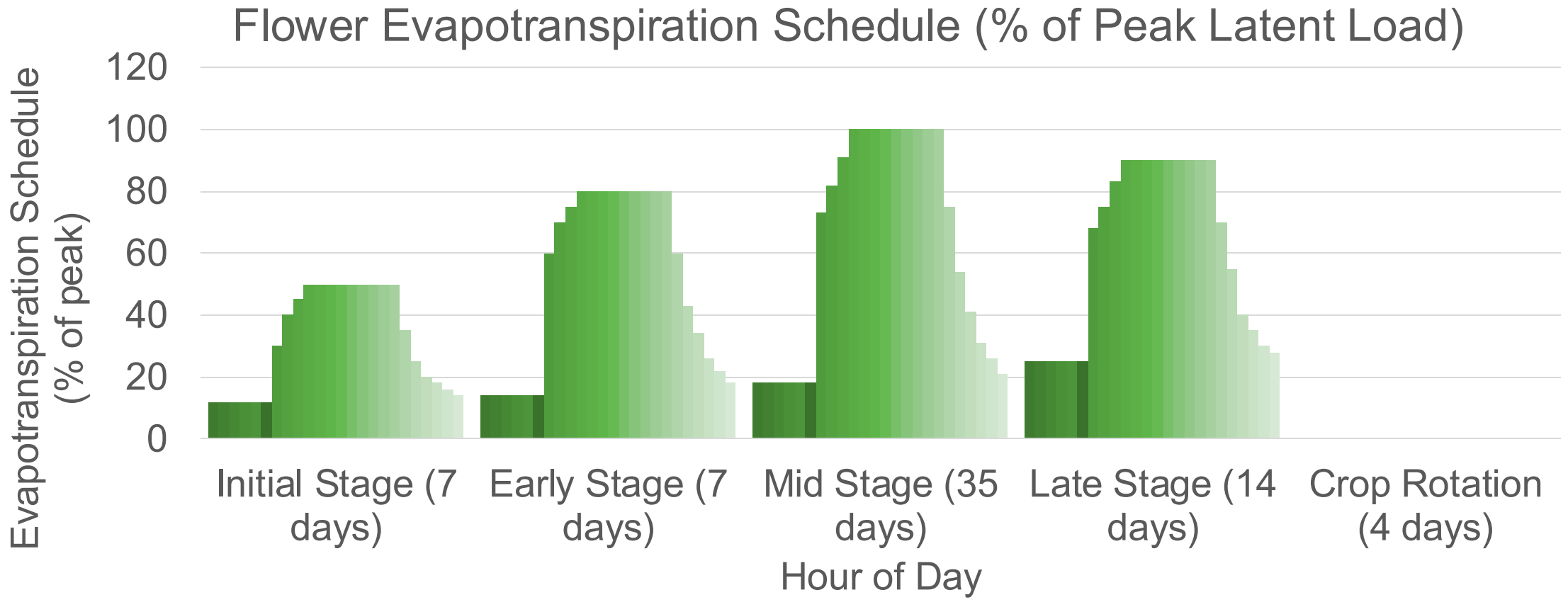
	Heating Setpoint (F)	Heating Setback (F)	Cooling Setpoint (F)	Cooling Setback (F)	Humidity Setpoint (%RH)
Office	70	60	75	80	N/A
Security	70	60	75	80	N/A
Restrooms	70	60	75	80	N/A
Storage and Shipping	60	50	65	70	60%
Processing	65	60	65	70	60%
Horticulture Drying	60	N/A	60	N/A	60%
Horticulture Vegetative	82	N/A	82	N/A	65%

Flower Room	Early (weeks 1-2)	Mid (weeks 3-7)	Late (weeks 8-9)
Lights on	82°F/ 67%RH	79°F/ 57%RH	73°F/ 48%RH
Lights off	79°F/ 65%RH	75°F/ 54%RH	70°F/ 46%RH

- Storage is typically cool & dry to preserve product.
- Drying room is not typically occupied
- Horticulture Flowering setpoints vary through the grow cycle.
- Are the setpoint assumptions typical of industry practice?

Energy Modeling – CEH Flower Room Prototype

- Hourly latent loads based on field data from PG&E Code Readiness field study
- Latent load shapes for each stage of plant growth throughout the grow cycle



Key differences vs. non-res building prototypes

Attribute	Conditioned Warehouse	Cannabis Facility (flower rooms)
Envelope	Same (T24)	Same (T24)
Occupancy Schedules	Weekday / Sat / Sun	5 nine-week cycles with 4-day breaks between crops
Lighting Power Density	0.4 watts/foot	40 watts/foot
Latent Loads / evaporative cooling	Ave. 0.8 Btuh / foot	Max. 80 Btuh / foot, highly variable
HVAC	Fixed-capacity RTU with gas furnace	Variable capacity RTU with modulating hot gas reheat
Temperature setpoints	Day/night, weekday/weekend, cooling season / heating season	Varies by stage in the grow cycle, day night, humidity setpoints
Outdoor Air	Economizing, OA ventilation	Little-to-no air exchanged outdoors

Are the assumptions typical of industry practice in high-lighting intensity indoor farms (i.e. cannabis)?

Proposed Inputs and Assumptions

User-modifiable inputs	Fixed assumptions
Envelope	Lighting schedules
Geometry	Temperature and humidity setpoints and schedules
Plant canopy area	Circulation fan CFM
HVAC/D system type and configuration	Latent load shape/schedule
HVAC/D sizing	Max evapotranspiration (calculated value)
HVAC/D efficiency	
Lighting PPE and PPFD	
Circulation fan efficiency	
Outdoor air exchange	
Climate zone	

Which of the assumptions should be fixed vs. user inputs?

What is the role of the prototype in T24 compliance?

- Fixed assumptions and user-inputs for geometry, lighting intensity, envelope, etc. will be used to calculate the standard design budget.
  - PPFD and canopy area will determine max evapotranspiration, but the shape of the load profile will be fixed.
- Proposed 2028 prescriptive requirements for mechanical (HVAC/D) system **in flower rooms** would set the standard design budget.
- Users can model other space conditioning systems (e.g. decoupled) **in flower rooms** that meet or beat the standard design budget.
- Other CEH rooms (e.g. veg/clone, drying) would not have prescriptive requirements.
- Non-CEH spaces (office/corridor) will follow the same rules for typical non-res buildings.

Input and feedback needed

Where do we need your feedback?

1. Which of the assumptions should be fixed vs. user inputs?
2. Are the fixed assumptions representative of industry practice in high-lighting intensity indoor farms (i.e. cannabis)?
3. What other measures should be part of the energy budget for flower rooms?
4. What inputs should be used to characterize HVAC/D equipment efficiency?

How can you provide feedback?

1. Download and comment in the Excel file, return via email
2. Request EnergyPlus prototype model (available January 2026)
3. Discussion at end of presentation, send email, set up a call

Share Information From Prototype Excel

Tutorial: Navigating the CEH Prototype Workbook

Discussion of Workbook Values

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More information on
CEC's 2028 proceeding website.

We want to hear from you!

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