Retrofits for Controlled Environment Agriculture

California Efficient Yields Workshop Series
March 14, 2023

Brought to you by:

RESOURCE INNOVATION INSTITUTE

PG&E®

SECTION 01

MEETING CONTEXT

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Safety

Earthquake:
Drop
Cover
Hold

Evacuation
Plan

Review Emergency
Plan & Pack Go-Bag

Stretch,
Get Up & Move

Practice Social Distancing,
Wear A Mask &
Follow CDC Guidelines

Visit: www.pge.com/emergencypreparedness

Class Survey (feedback)

- Click on the survey link in the chat box
- Written comments are very helpful
- Other topics? Other classes you want?
- Survey also sent in follow up email after the class

SECTION 03

INTRODUCTION

POLL ALERT!

What size is your operation or standard operation you work with?

- < 2,500 ft^2
- 2,501 - 5,000 ft^2
- 5,001 - 10,000 ft^2
- 10,001 - 22,000 ft^2
- >22,000 ft^2

Purpose of Today's Workshop

- Encourage cultivators to participate in PG&E and California efficiency programs.
- Convey scientific insights and industry expertise directly to producers and find the best ways to translate them in the context of their local ecosystem.
- Assist craft producers and their design and construction project partners, with what they need to know to stay competitive and comply with regulations

Efficient Yields
Best practices on energy, water efficiency, and productivity

Agenda

Introduction & Purpose

Retrofits 101

Evaluating Your Site

Previous Cannabis Facility Considerations

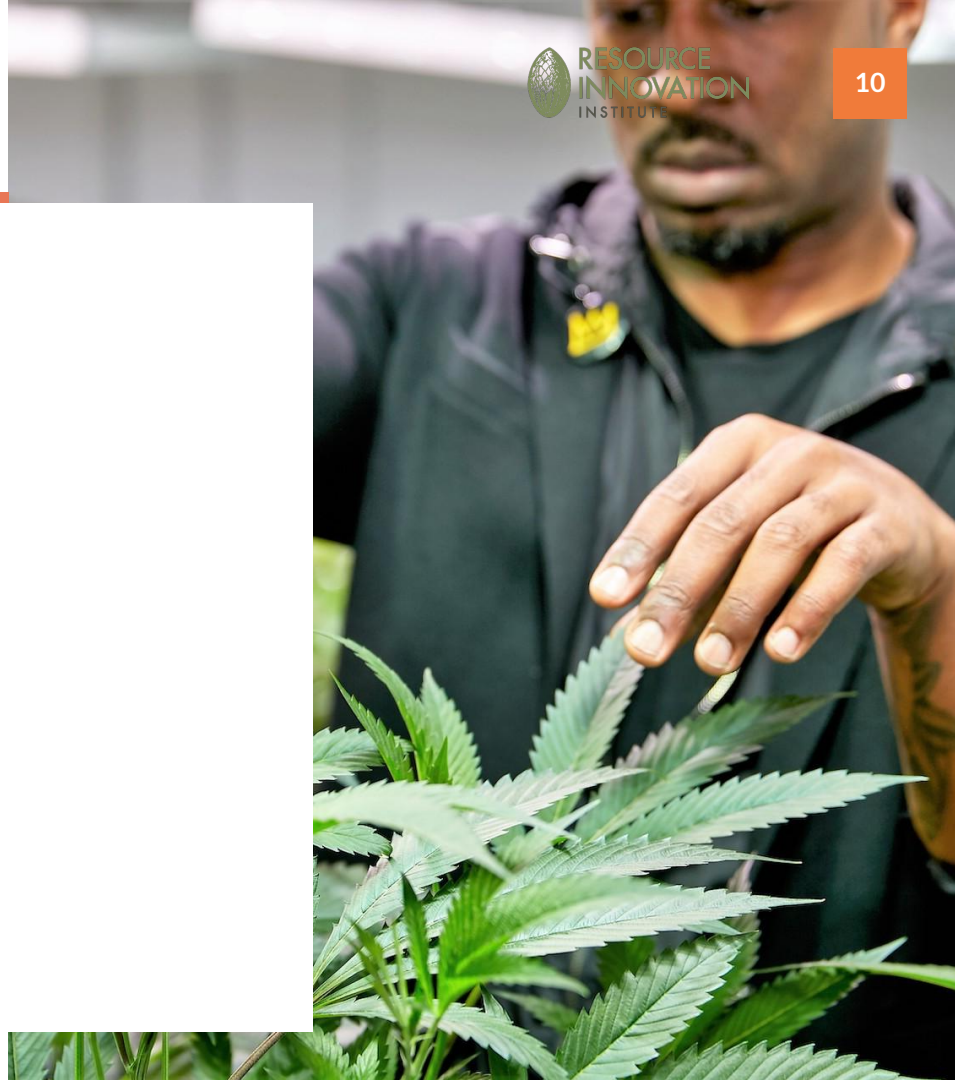
Warehouse Considerations

Greenhouse Considerations

Utility & State Assistance

Tips & tools slide

Q&A



Today's Experts

Rob Eddy

RESOURCE INNOVATION INSTITUTE

Aaron Fellabaum

FLUENCE

Joe Cavallero

NIMBUS

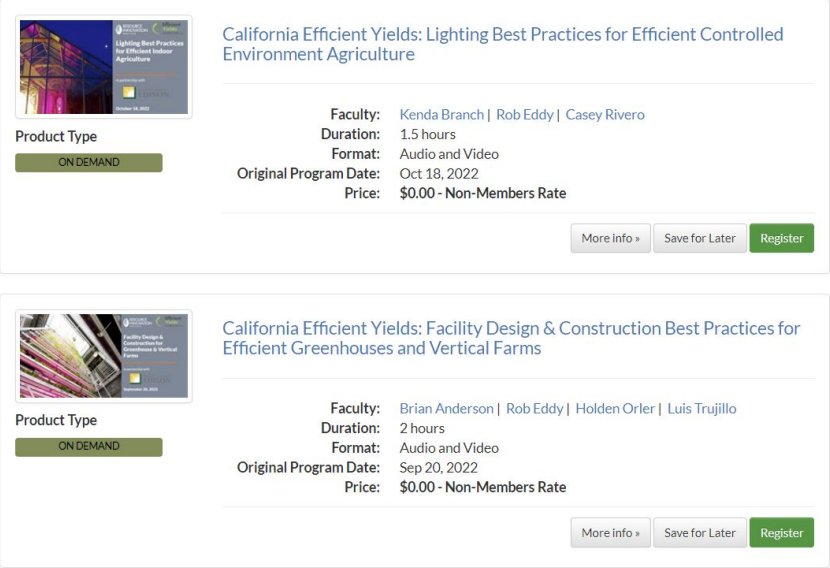
Access Your California Virtual Classroom

Continue Learning Online

Free guidance on efficient cultivation

All live workshops are available for on-demand viewing!

- Recordings of live workshops
- Tip Clips
- Downloadable resources
- PG&E and state program tools



Create an account at resourceinnovation.org/California

Register for Upcoming Workshops

PG&E funded Workshops:

- March 28 | Irrigation & Water Reuse
- April 18 | Managing Peak & Renewables
- May 2 | Case Studies in Efficiency

Register and access other free resources on the RII catalog

POLL ALERT!

What size is your operation or standard operation you work with?

Discuss Results

SECTION 03

RETROFITS 101

POLL ALERT!

What kind of facility are you considering retrofitting?

- My existing indoor/warehouse facility
- My existing greenhouse
- Acquired facility previously used for cannabis
- Acquired facility previously used for other veggies, flowers

California Cannabis Space

Licence Types

- Specialty cottage
- Specialty
- Small
- Medium
- Large
- Nursery
- Processor

Lighting Types

- Tier 1 – Up to 6 watts per sq. ft.
- Tier 2 – 6 to 25 watts per sq. ft.

Market Size

$4 billion legal market
$8 billion illicit market

Environment

- Indoor
- Greenhouse / Mixed Light
- Outdoor

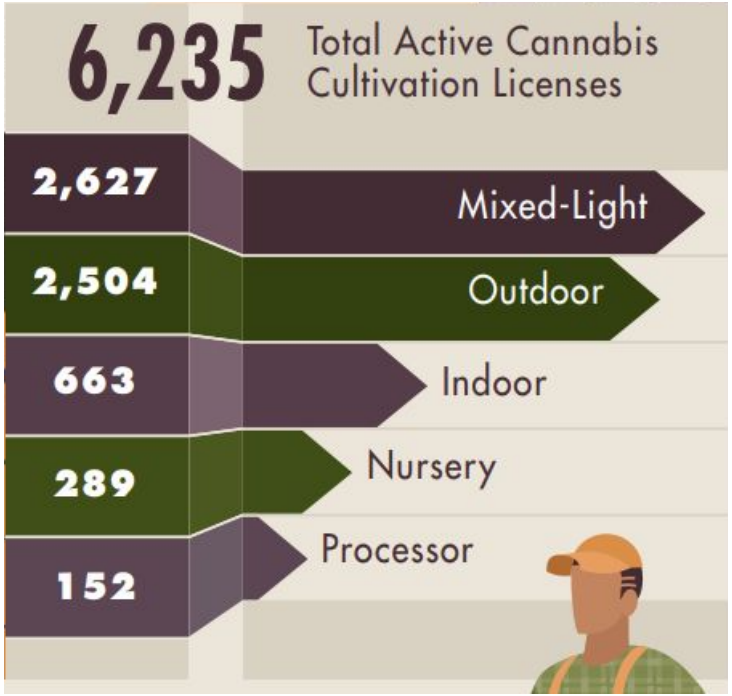


Image credit: CDFA 2020. License info: Cannabis.CA.gov

Companies Dying Out In a Mature Market

- Overproduction
- High state and local taxation
- Red tape
- Additional fees for product placement
- $/Lb
- Large amount of gray market production

Retrofit Projects

Former Cannabis Facilities

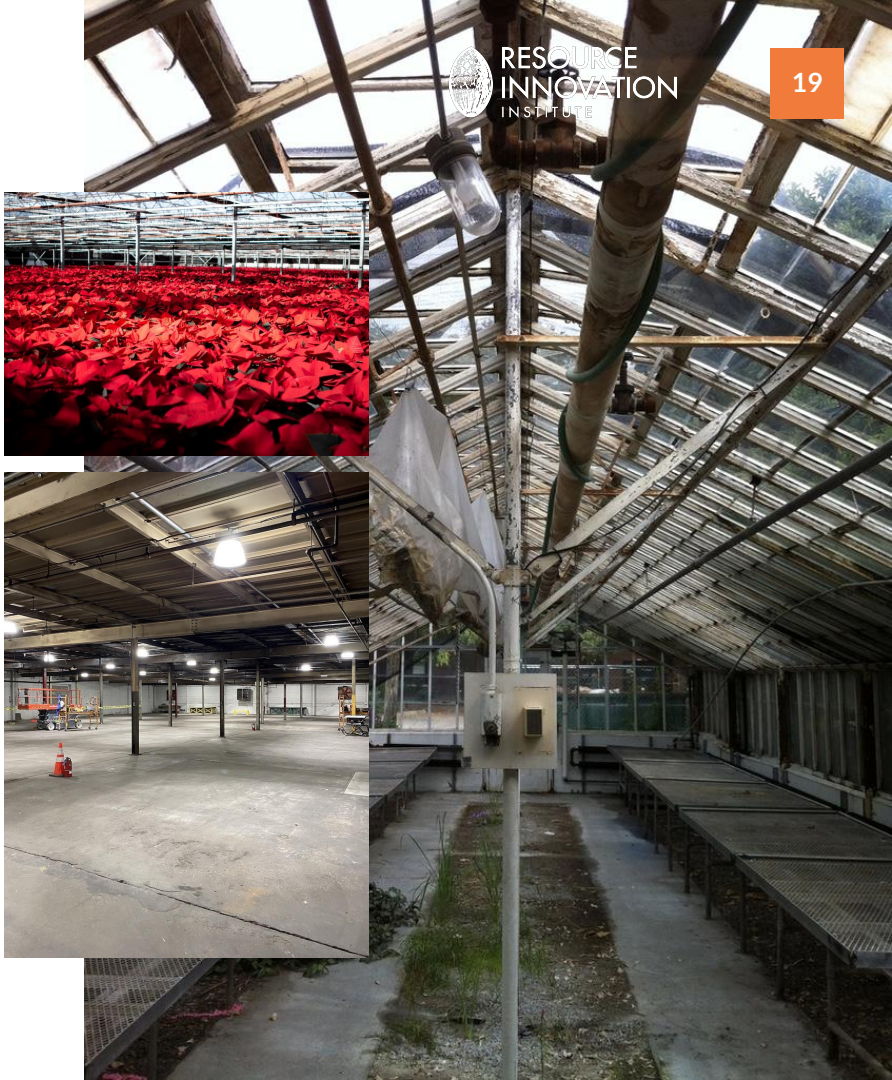
- Cultivation sites that are purchased as distressed assets and have legacy or underperforming equipment

Warehouses

- Either due to regulation, zoning, and or tax incentives that are intended to spur structural, community and local taxation improvements

Large Floriculture Greenhouses

- Structures that have served Chrysanthemum and Rose crops
- Typically lower overall headroom that more appropriately fits the morphology and growing SOPs of the original crop



POLL ALERT!

What kind of facility are you considering retrofitting?

Discuss Results

SECTION 04

EVALUATING YOUR SITE

POLL ALERT!

Have you taken advantage of a regional incentive program from a utility before?

- Yes
- No, but I am interested
- No, I do not want to use one

California Cannabis Incentives

Program Types

- ***Prescriptive*** - Predetermined dollar amount typically set by wattage
- ***Custom*** - Dollar amounts are calculated based of energy savings and will vary based on project scope (lighting and HVAC)
    - ***Yearly kWh reduction against baseline*** - Define your baseline!

Amount

Up to 50% or greater reduction in total project cost in some areas.

https://www.encentivenergy.com/products/encentivizer/

Equipment Coverage

- Lighting
- HVAC
- Controls
- Thermal curtains
- GH materials

Availability

Owners/Growers can sometimes take advantage by splitting the scope of work into two or more years.

Utilities have yearly budgets that determine a timeline for allocated funds. Most programs are defined and start at the beginning of each year, some follow fiscal year.

Current Infrastructure

Building /Room Envelope

- ***Height***: multi-tier / single tier
- ***Support Posts***: new benching / racking
- In-room mechanical equipment
- Structural load capacity (PPF/Lb of luminaire)

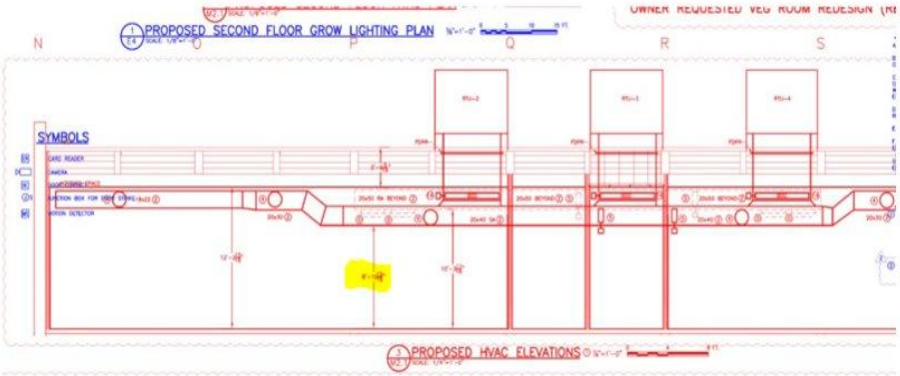
Lighting & HVAC

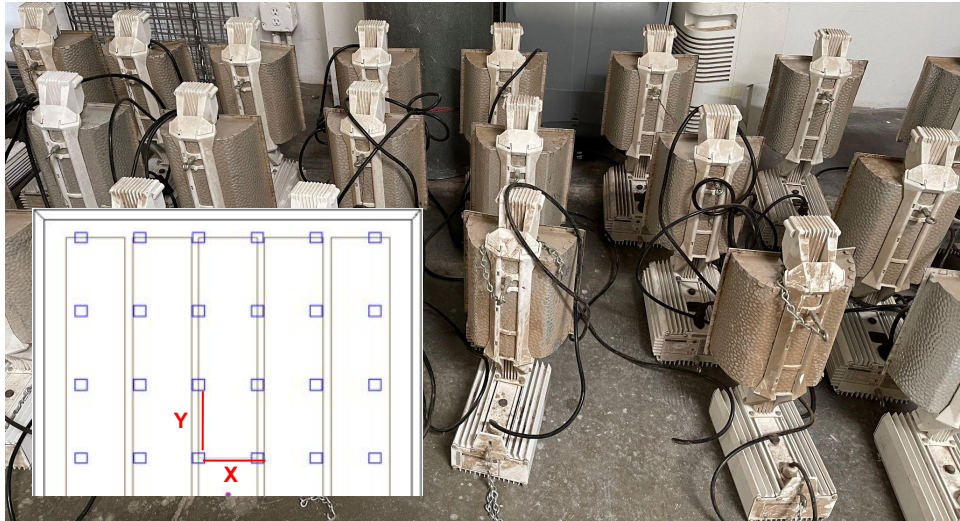
- Gantry height / gantry height from target (Z)
- X & Y Axis & Z!
- HPS - form fit function, lamp depreciation
- HVAC form factor and sensible / latent load tolerances

Outdated infrastructure

Often left behind by previous operator, producers can integrate lighting with a hybrid approach

- Checkerboard
- Perimeter
- Intercanopy
- Subcanopy





Building Envelope

Insulation

- Damage, ease of addition, current materials
- Temp and humidity extremes

Permeable Surfaces

Roofing materials, Wood, drywall, floors and foundation

Seal

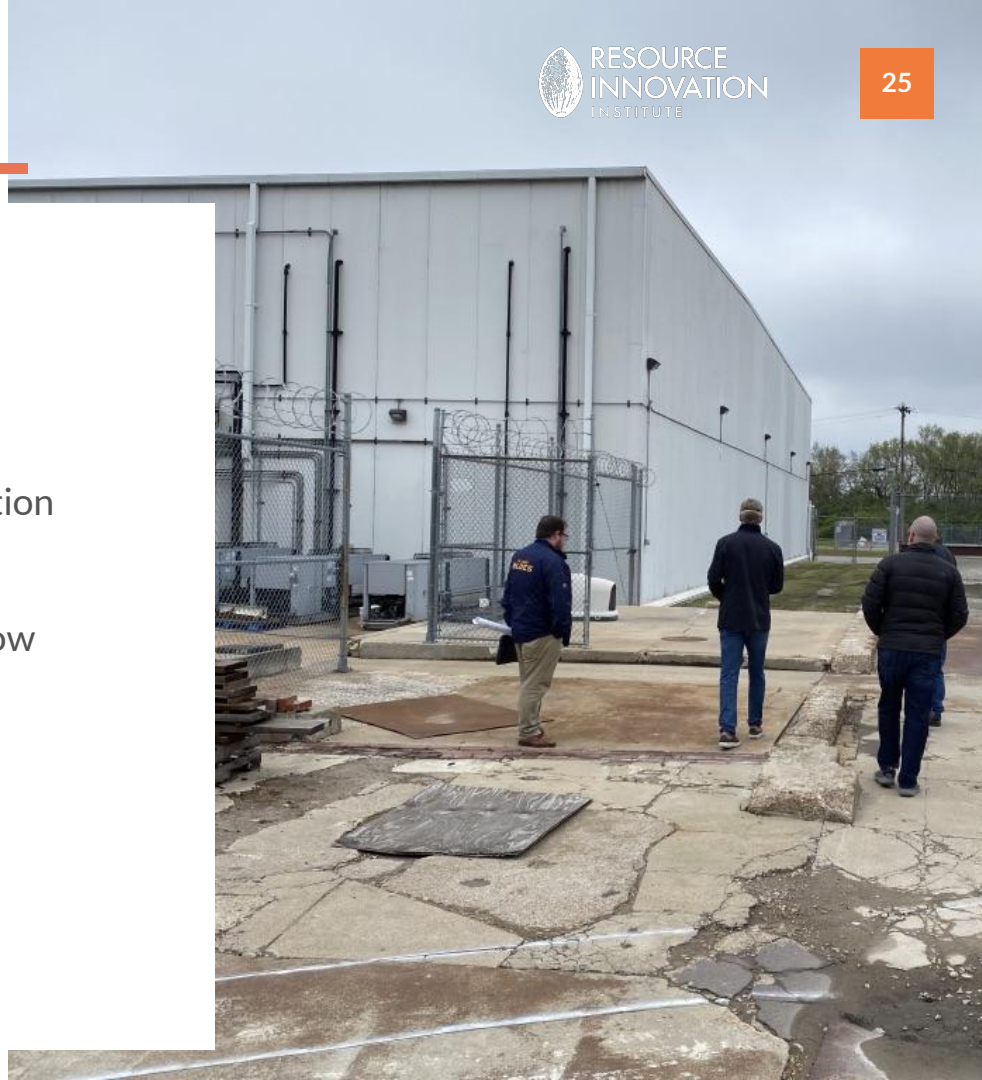
Seams and cracks, foams and paints, door seals, airflow

Structural Load Considerations

Reinforcement, new equipment

Codes

Research and consult, get the right team together



POLL ALERT!

Have you taken advantage of a regional incentive program from a utility before?

Discuss Results

SECTION 08

PREVIOUS CANNABIS FACILITY CONSIDERATIONS

POLL ALERT!

What area is your biggest concern for retrofitting?

- HVAC
- Lighting
- Facility construction and sanitation
- Controls

Rip It Out or Modify?

All 6 Sides of the Box

Contamination can be hidden many places

Lighting

- Warranty transfer
- Manufacturer support
- PPFD for specific lighting types

HVAC

- Age of system, design, historic data
- Obvious and hidden damage

DIY or Contracting

Expertise

- Specialized skill sets
- Industry relationships
- Benefits of licensed work

Supply Chain

- Equipment lead times
- Product lifecycle support

Code and commissioning

- Commissioning starts well before day 1
- Experience with other systems can save you headaches and money

Your Unique Cultivation Requirements

3g Soilless + ~2000 µmol/m2/s Retrofit

Strains and Planting Density

- Plant morphology and the distance to your lighting
- Planting density and room transpiration
  - Larger media zones offer buffer when familiarizing with high PPFD

Environmental Parameters

- Does the current system work? If not what is over/undersized?
- What are the existing systems set point tolerances

Fertigation Practices

- Increased transpiration
- Media choice
- Volume

HVAC & Dehumidification

- If you can meet your economic goals, don't touch it!
- Serviceability of “off-the-shelf”

Lighting Preferences

- Close Proximity
- High Bay
- Wattage

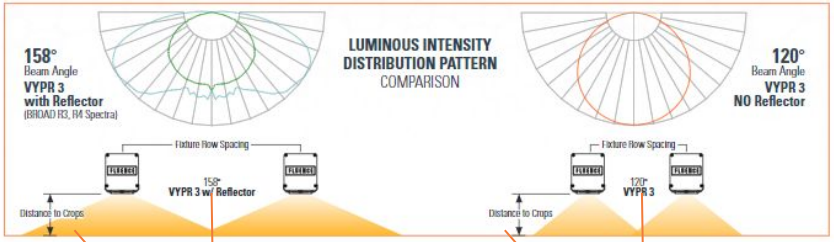
Your Unique Cultivation Requirements: Lighting

Power and luminaire position and its impact on uniformity

- 5'x4' Typical Grid for HID = 700-800 µmol/m2/s depending on lamp hours
- Does my retrofit lighting solution fit into this infrastructure? If so are the new lights optically correct for the given spacing and how do I measure uniformity?

Electrical considerations

- Does my solution fit within the existing electrical infrastructure?
- If not what are the additional costs of conversion?



2:1 Spacing Criteria

1:1 Spacing Criteria

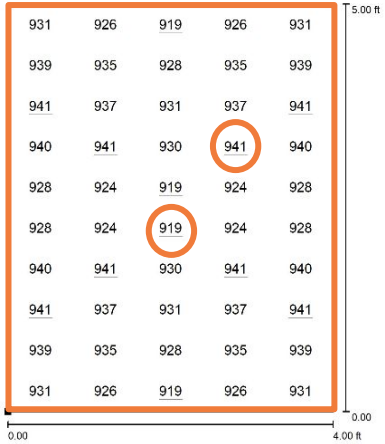
Uniformity Measurements (µmol/m2/s)

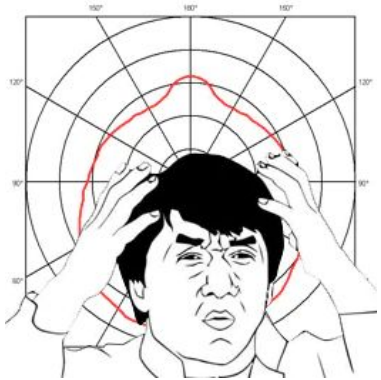
Measurements taken between the 4 most inner lights and full target (bench) provide best assessment

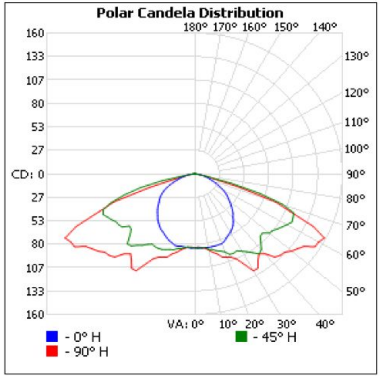
Min/Max = 919/941 = .977

U0, Min/Avg = 919/933 = .985

What is considered optimal? Planting densities dictate this. Smaller plants = higher degree of importance.







Controls

Method of Control / Signal Types

- HID = Step Level , Continuous
  - Primarily relays, signaling to reduce DC current
- LED = Low Voltage Signal
  - Primarily 0-10v, Pulse Width Modulation less common

Integrated vs Standalone

- Common control platforms are custom and can be augmented ($$)
- Standalone offered by most manufacturers, cheaper but less intelligent
- Using relays to control HID and integrating them to work with 0-10v/PWM systems (photo reference to the right)

Logging & Benchmarking

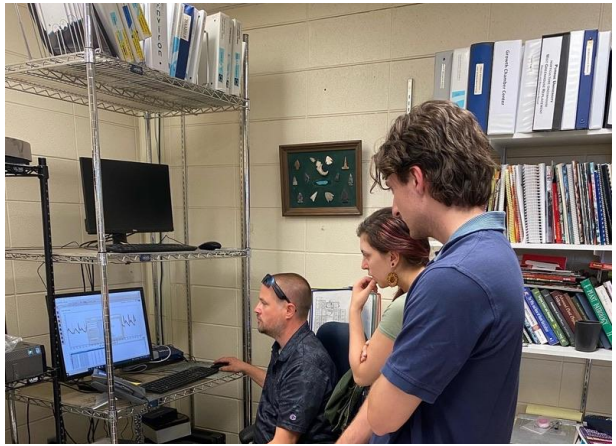
- HVAC & irrigation analysis for increasing transpiration rates

Alarming

- Shut off sensors should control at breaker level

Improvements to Legacy

- Important performance issues related to HID lamp dimming include efficacy, lamp life, color, compatibility, and flicker
- More linear control for both mechanical and lighting



POLL ALERT!

What area is your biggest concern for retrofitting?

Discuss Results

SECTION 06

WAREHOUSE CONSIDERATIONS

Roof Structural Considerations

Load

- High load = high retrofit cost
- Consider alternative placements

Penetrations

- Existent roofing material
- Every penetration a failure point

Area

- Ease of serviceability
- Exposure to the elements

Materials and Permeability

All 6 Sides of the Box

- Often overlooked - Ceilings and floors
- Foundation and slabs
- Walls and doors

Aspergillus and other toxic contaminants

- Surface testing and site records
- Cleanup vs tear out

Cleanability and Sanitizer Compatibility

FRP, drywall, refrigerator walls

Odor Mitigation and Neighborhood Citizenship

Odor Mitigation

- Air treatment options
- Nature of VOCs
- Carbon, neutralizers, biofiltration

Cleanliness

Waste storage and disposal

Noise

- Air compressors
- Generators
- Chippers

SECTION 05

GREENHOUSE CONSIDERATIONS

Pop Quiz!
What is positive pressure?

- Air supply exceeding exhaust, “inflating” the room, preventing contaminants from being blow in.
- Exhaust exceeding air supply, creating a vacuum, sucking contaminants in.
- Happy attitude towards your coworkers.

Greenhouse Utility Considerations

Greenhouses electrical supply will most likely need to be upgraded for cannabis lighting and dehumidification

Profit margin of flower and vegetable crops do not justify the cost of such equipment

Greenhouse dehumidification is relatively new technology and typically incompatible with standard construction

Opportunity for on-site renewable energy

Pesticide Design Considerations

Greenhouse and vegetable greenhouses were not designed to be used without pesticides

Seal

- Owner often has to seal seams, cracks and holes in covering
- Negative pressure
- Gravel/dirt floors

Vents

- Open, often unscreened
- Screening requires “boxes” to increase surface area
- Poor seal

Layout

Interconnected compartments

Scheduling

Cropping “down times” between seasons used to sterilize; no perpetual harvest

Retrofit to Insect Screen

- Construct anteroom
- Increases surface area
- Eases cleaning of screen
- Fans may need resizing

Glazing material	Initial light transmittance (%)*	Material cost (US$)		Life expectancy (years)	Flammability
		per ft²	per m²		
Glass (single layer)	90	0.50- 1.00	5.40- 10.80	30	Non-flammable
Acrylic (twin wall)	85	2.00- 2.50	21.60- 27.00	20	High
Polycarbonate (twin wall)	82	1.00- 1.50	10.80- 16.20	10-15	Low
Polyethylene (double layer)	80	0.14- 0.20	1.51- 2.16	3-4	High

*Measured using a light beam positioned perpendicular to the surface of the glazing material.

Glazing material	Heat loss coefficient (Btu/hour per ft² per °F)
Single layer glass	~~1.1~~
Double layer glass	0.7
Acrylic (twin wall)	0.6
Polycarbonate (twin wall)	0.6
Single layer polyethylene	~~1.1~~
Double layer polyethylene	0.7
Double layer polyethylene + energy curtain	0.3-0.5

*U-values are the reciprocal (inverse) of R-values that are commonly reported for residential and commercial insulation materials.

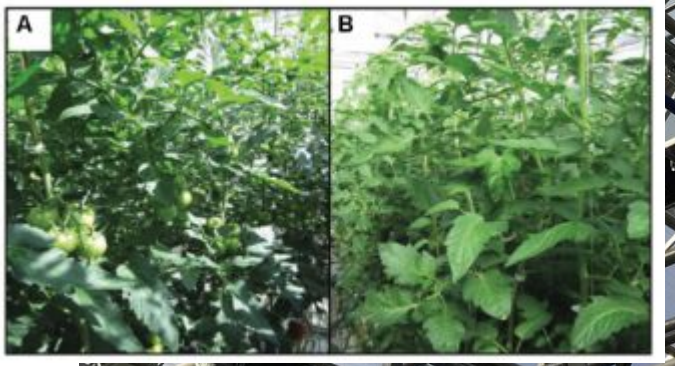
— California Title 24: Non-opaque roof assemblies must have a combined U-factor of 0.7 or less.

Source: Lopez, 2017

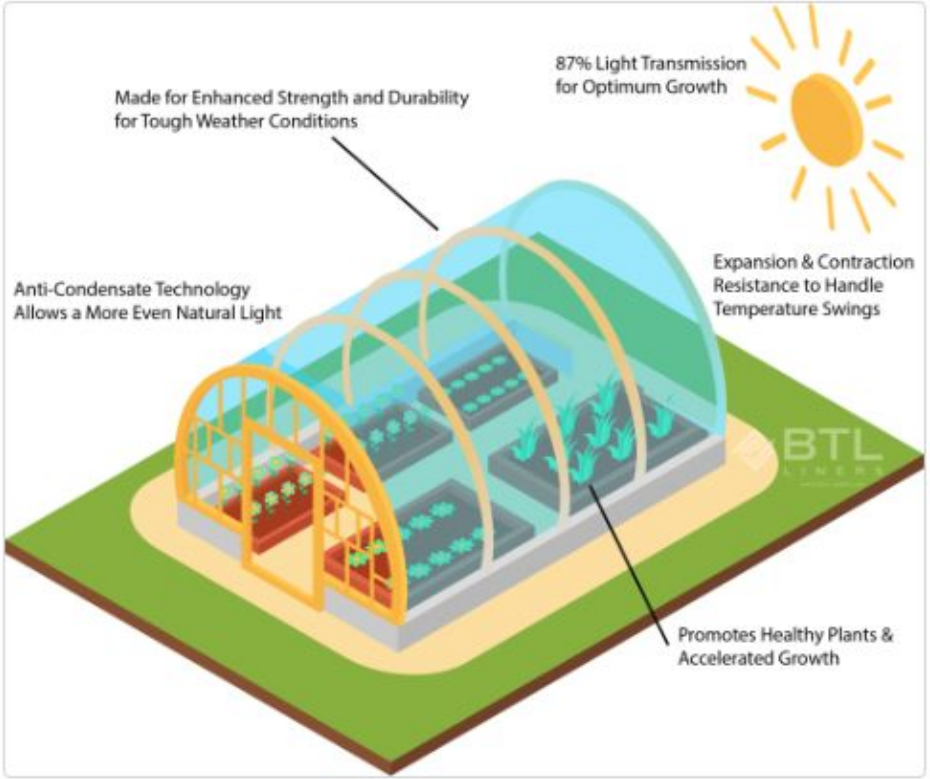
Diffused Light

Light interception is an important concept, not just amount!

- Light diffusing glass or shade curtains
- Polyethylene film / polycarbonate panels
- Improves uniformity over area
- Scatters light for more photons reach lower foli
- Increases yield 8-9%
- Reduces leaf temp of canopy 5-9℉



Location	Current Glazing Materials	Recommended Replacement
Roof Area	Poly, Double	Poly, Double, IR inhibited
Side Walls	Poly, Double	Poly, Double, IR inhibited
End Walls	Poly, Double	Poly, Double, IR inhibited
Est. Energy Savings	162,639,700	Btu
Fuel Savings	1,626	Therm or CCF
Est. Annual Savings	$569	
% Savings	29%	
Greenhouse Gas Reduction	19,029	lbs. CO_2/year



Source: Hortitech Direct

Thermal Curtain

The potential savings for installing a thermal curtain that will provide 52% energy savings (semi-porous 55% light transmission) covering 100% of the roof area and 50% of the gable ends.

Est. Energy Savings	143,585,944	Btu
Fuel Savings	1,436	Therm or CCF
Est. Annual Savings	$503	
% Savings	26%	
Greenhouse Gas Reduction	16,800	lbs. CO_2/year

Source: Michigan State University

Pop Quiz Results
What is positive pressure?

- Air supply exceeding exhaust, “inflating” the room, preventing contaminants from being blow in
- ~~Exhaust exceeding air supply, creating a vacuum, sucking contaminants in~~
- ~~Happy attitude towards your coworkers~~

SECTION 10

UTILITY & STATE ASSISTANCE

New Service Installation or Upgrade

- ✔ Submit and track your application at www.yourprojects-pge.com
- ✔ Design your project in accordance with PG&E Greenbook www.pge.com/greenbook
- ✔ Call Customer Service to determine best billing rate 1-800-743-5000
- ✔ Questions? Call Building and Renovation Service Center at 1-877-743-7782

PG&E Market Access Program

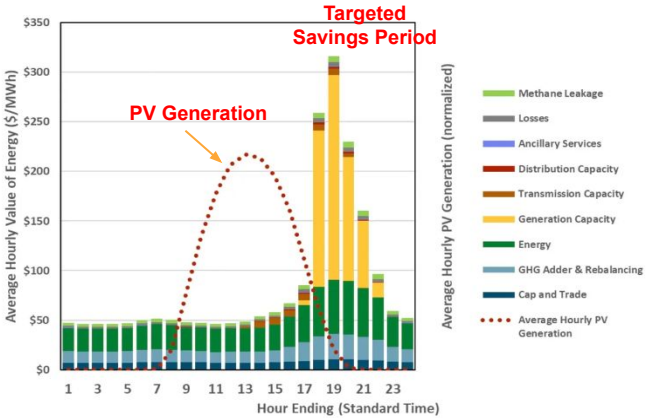
How CEA customers Can Leverage PG&E's Market Access Program (MAP) Incentives to Fund Retrofit Projects

Patsy Dugger
AESC

What is the Market Access Program (MAP)?

- **Emergency EE/load shift program**
  - Reduce grid constraints in peak periods (Summer 4-7, 7-9pm)
  - Avoid outages, high carbon peaker plants, T&D costs
- **Pay for Performance Program**
  - Delivered by enrolled MAP Aggregators
  - MAP pays incentives to aggregators based on measured energy savings at the meter in the year following project installation, compared to the meter's prior year baseline.
- **Three Key Advantages of MAP**
  - High incentives - + kickers for summer 4-9pm savings. No incentive cost caps.
  - Fast project approval - (<1 week)
  - Broad measure eligibility – anything that saves energy
- **Timeline**
  - Project installation deadline <u>March 31, 2024</u>
  - Funds are first come, first served

Average Hourly Value of Energy



MAP targets reductions in the (yellow) summer Peak Period (June-September, 4-9pm), when capacity is short and energy costs increase significantly

Who is Eligible to participate in MAP?

Eligibility is based on each specific site and meter:

1. **Commercial or light industrial sites**

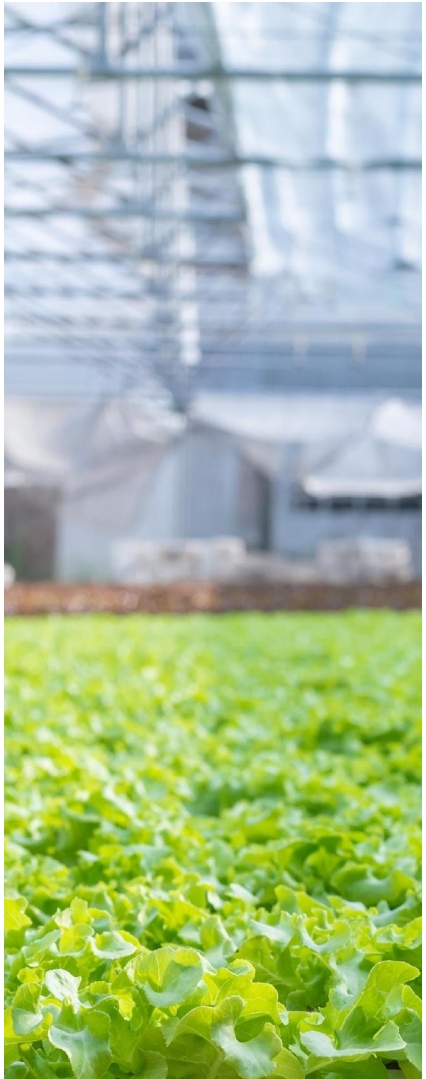
   - CEA qualifies as a site type

2. **12 months baseline energy data**

3. **Model Fit:** Meter's energy use must be predictable and meet statistical requirements of the program for measurement purposes.

4. **EE Participation** – Site/meter has not participated in EE in past year and does not have a project actively enrolled in another program.

You can contact Tyrra Adams at AESC to request a site eligibility check. We'll need the Service Agreement ID (SAID) and Meter # from your PG&E bill.
Tyrra Adams: 760-889-8664 or tadams@aesc-inc.com



Enrolled PG&E MAP Aggregators Serving CEA

Aggregator	Contact Name	Contact Email	Contact Phone
Energy Resources Integration	Rich Ross	rich@eripacific.com	989-284-0437
Total Grow Light	Jeffrey Mastin	jeff.mastin@totalgrowlight.com	313-372-9716
Seinergy	Postyn Smith	postyn@seinergy.com	360-230-8013
EcoGreen Energy Solutions	Corey Brophy	corey.b@ecogreen-solutions.net	949-395-8821
LED Green Light International	James Dugan	james@ledgreenlight.com	949-544-9522

You can also reach out to Tyrra Adams: 760-889-8664 or tadams@aesc-inc.com to request an up-to-date list of aggregators serving the CEA market.

If you have a preferred vendor you work with not listed above, they can partner with an enrolled aggregator, or enroll as an aggregator by going to www.aesc-inc.com/map.

MAP Process Overview for Customers

- ❑ **Verify site eligibility**
- ❑ **Interview and select an Aggregator**
- ❑ **Aggregator provides scope of work, estimates the MAP incentives, and proposes a price and structure that meets your business needs**
- ❑ **Sign MAP project application provided by Aggregator**
- ❑ **Aggregator receives approval for installation from AESC**
- ❑ **Project installation**
- ❑ **1 Year of M&V Begins**
  - AESC Tracks project performance and measures energy savings to calculate actual incentive
- ❑ **Aggregator receives quarterly incentives for 1 year based on actual measured savings**

Thanks to aggregator ERI for this project data

Project Example: Cannabis Horticultural Lighting Retrofit

- Retrofitted 476 HPS fixtures to LED fixtures (Flower Room)
- Retrofitted 92 CMH fixtures to LED fixtures (Veg Room)
- Additional HVAC system savings from decreased lighting heat load estimated.

kWh Savings/year **1,014,640 kWh**
Annual Cost Savings : **$223,220/year**
Total Est. Incentives* : **$802,535**

*Final incentives are paid to aggregators based on measured savings.

Cannabis Cultivator: CMH & HPS to LED Retrofit	1) Flower Room		2) Veg Room	
	Existing HPS (Flower)	Proposed LED (Flower)	Existing CMH (Veg)	Proposed LED (Veg)
Fixture	DE HPS	LED	CMH	ROI-E200
Watts/fixture	1050	750	315	200
Annual Hours	4320	4320	6480	6480
Fixture Quantity	476	476	92	92
Current Hours of Operation	6:00 AM	10:00 PM	7:00AM	1:00 PM
Proposed Hours of Operation	6:00 AM	10:00 PM	7:00AM	1:00 PM
	Savings	**Incentive**	**Savings**	**Incentive**
Peak (Summer 4-7 pm)	343,529 kWh	$ 520,652	25,452 kWh	$ 38,574
Net Peak (Sumer 7-9 pm)	0	$ 0	16,968 kWh	$ 54,801
Off peak	567,914 kWh	$ 165,808	77,745 kWh	$ 22,698
Total kWh and Incentives	**911,433 kWh**	**$ 686,461**	**103,197 kWh**	**$ 116,074**

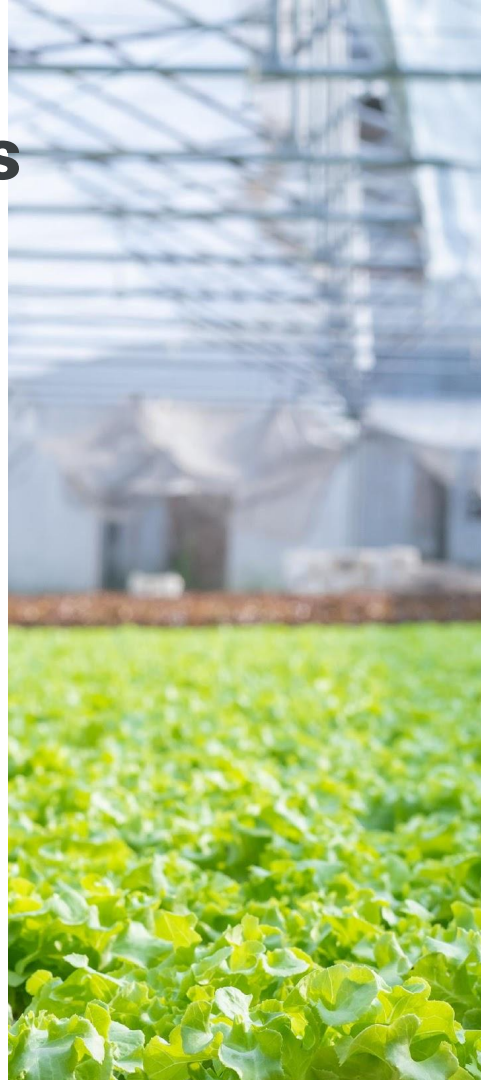
California Summer Reliability Programs

PG&E's Market Access Program (MAP)
https://www.aesc-inc.com/map/

SCE's Summer Reliability Program (SRP)
www.sce.com/SRP

SDG&E's Summer Reliability Market Access Program (SRMAP)
www.sdge.com/SR-MAP

Marin Clean Energy Flexmarket
https://www.mcecleanenergy.org/flexmarket/



What is AESAP

TRC's **Agriculture Energy Savings Action Plan (AESAP)** offers incentives and financing for energy-saving projects involving the retrofit or installation of energy consuming equipment.

CEA Rebate and Incentives for:

- Grow lighting and controls
- Greenhouse heat curtains and IR film
- Boiler, pipe insulation, heat recovery
- Irrigation upgrades and more!

AESAP:

- Provides rebates and incentives on energy efficient equipment upgrades
- Offers technical assistance and incentives for more complex projects
- Provides Integrated Demand Side Management support and services
- Provides services at no cost to customer

www.AgEnergySavings.com

Connect@AgEnergySavings.com | 1-833-987-7283

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AESAP Greenhouse Incentives

www.agenergysavings.com/types-of-incentives/

Greenhouse Heat Curtain

Description	Incentive Amount
Double layer polyethylene with IR greenhouse with overhead gas furnace	$0.50 per square feet of building area
Double layer polyethylene with IR greenhouse with radiant heat furnace	$0.50 per square feet of building area
Single layer polycarbonate greenhouse with overhead gas furnace	$0.50 per square feet of building area
Single layer polycarbonate greenhouse with radiant heat furnace	$0.50 per square feet of building area
Double layer polyethylene greenhouse with overhead gas furnace, AOE	$0.04 per square feet
Double layer polyethylene g	
Double layer polyethylene g	
Double layer polyethylene g	

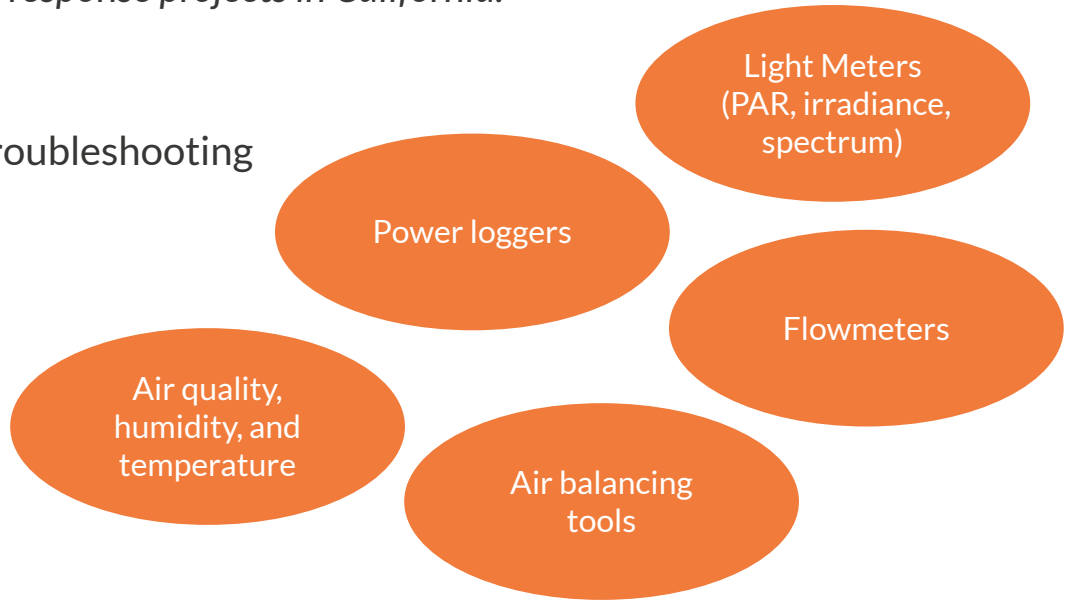
Greenhouse Infrared Film

Description	Incentive Amount
Double layer polyethylene greenhouse with overhead gas furnace, NC	$0.02 per square feet
Double layer polyethylene greenhouse with overhead gas furnace, AOE	$0.04 per square feet
Double layer polyethylene greenhouse with radiant heat furnace, NC	$0.02 per square feet
Double layer polyethylene greenhouse with radiant heat furnace, AOE	$0.04 per square feet

Energy Measurement Tool Lending Libraries

Wide selection of energy and building measurement tools to customers and professionals working on energy efficiency, demand reduction and demand response projects in California.

- FREE tool lending programs
- Assistance in tool selection and troubleshooting
- PG&E: pge.com/tools
- SCE: sce.myturn.com/library



Statewide Programs for Producers

California Energy Design Assistance (CEDA)

Statewide program serving PG&E, SCE, SoCal Gas, SDGE

- Program participants receive the following complimentary services:
  - Comprehensive Whole Building Energy Analysis
  - Assistance identifying and evaluating energy-saving measures
  - Analysis of energy costs and paybacks
  - Incentives for New Construction and Major Renovations projects

- CEDA Pathways: Mixed Fuels or All-Electric
  - Mixed Fuels for customers who want the option of both gas and electricity
  - All-Electric program option offers higher incentives if customers do not install gas service
- Learn more: CaliforniaEDA.com

California Department of Tax and Fee Administration (CDTFA)

Cannabis producers qualify for some equipment exemptions under agricultural programs

Learn more: cdtfa.ca.gov/industry/cannabis.htm

Panel Q & A

Actionable Takeaways

- Consider splitting the scope of work in two for optimizing utility incentives
- Larger root media volume is a buffer against crop stress
- Evaluate warehouse for structural loads, penetrations and permeable surfaces
- Consider the option of removing equipment from previous cultivation facilities to decontaminate
- Seal and screen openings in existing greenhouses
- Greenhouses electrical supply will most likely need to be upgraded for cannabis lighting/dehumidification

Feedback Welcomed!

CONTACT US

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