



# Trust But Verify: Commissioning CEA Buildings and Systems

---

October 26, 2023



# POLL ALERT!

## What role do you play in the cultivation space?

- Equipment provider / Vendor
- Owner
- Grower
- Operations Manager
- Consultant / Advisor



# Agenda

---

Welcome, Introductions and Context

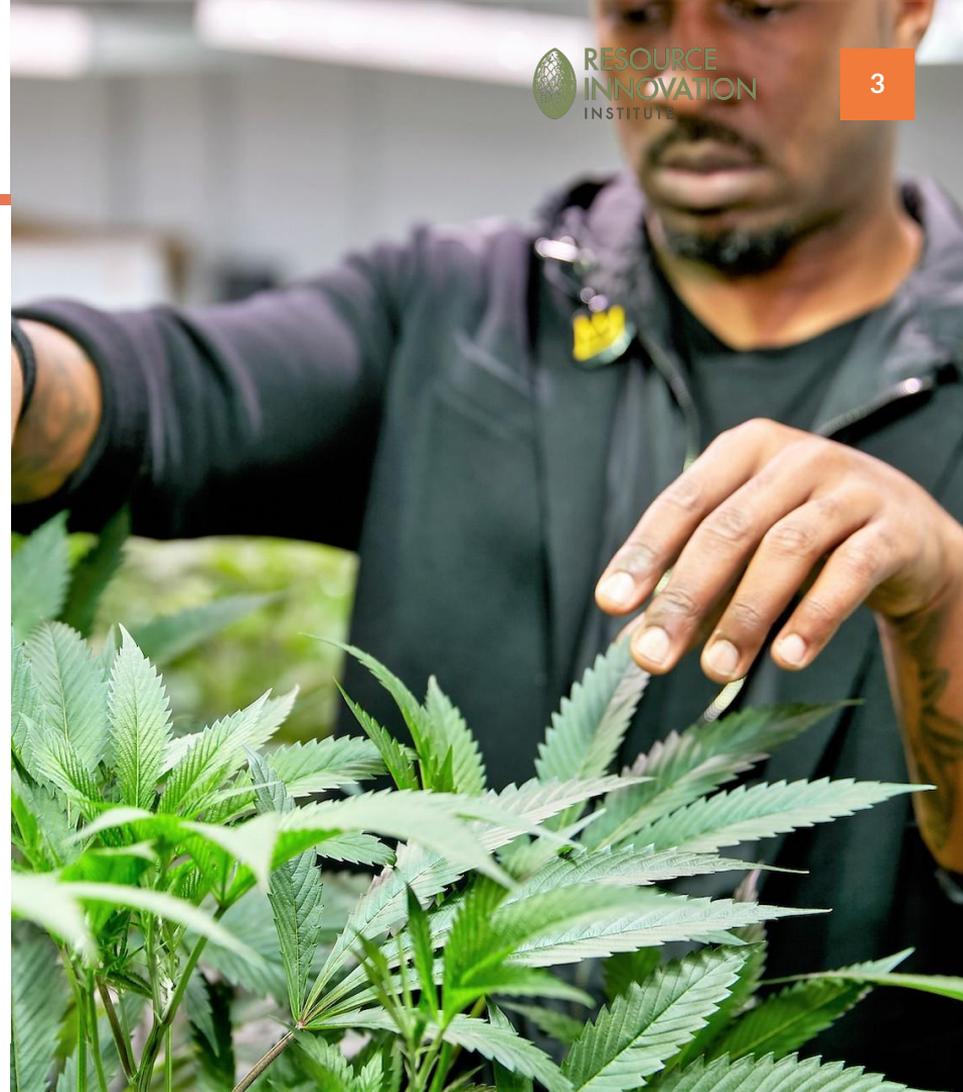
Understand How To Commission Integrated Equipment

Commissioning from Design Phase to Post-Planting

Commissioning from a Grower Perspective

Incentives Overview

Q&A



A person wearing a dark jacket and a watch is shown from the chest up, focused on examining a cannabis plant. Their hands are positioned to inspect the leaves, with one hand holding a stem. The background is a blurred indoor grow room with other plants. The overall image has a dark, semi-transparent overlay.

SECTION 01

---

# INTRODUCTION

# Today's Experts



Rob Eddy



Chris Andronoy



Mike Zartarian



Josh Gerovac



Caleb Hayhoe



# Access Your California Virtual Classroom

## Continue Learning Online

*Free guidance on efficient cultivation*

- Recordings of live workshops
- Tip clips
- Downloadable resources

Create an account at  
[resourceinnovation.org/California](https://resourceinnovation.org/California)



**Product Type**  
ON DEMAND

**California Efficient Yields: Lighting Best Practices for Efficient Controlled Environment Agriculture**

**Faculty:** Kendra Branch | Rob Eddy | Casey Rivero  
**Duration:** 1.5 hours  
**Format:** Audio and Video  
**Original Program Date:** Oct 18, 2022  
**Price:** \$0.00 - Non-Members Rate

[More info »](#) [Save for Later](#) [Register](#)



**Product Type**  
ON DEMAND

**California Efficient Yields: Facility Design & Construction Best Practices for Efficient Greenhouses and Vertical Farms**

**Faculty:** Brian Anderson | Rob Eddy | Holden Orler | Luis Trujillo  
**Duration:** 2 hours  
**Format:** Audio and Video  
**Original Program Date:** Sep 20, 2022  
**Price:** \$0.00 - Non-Members Rate

[More info »](#) [Save for Later](#) [Register](#)

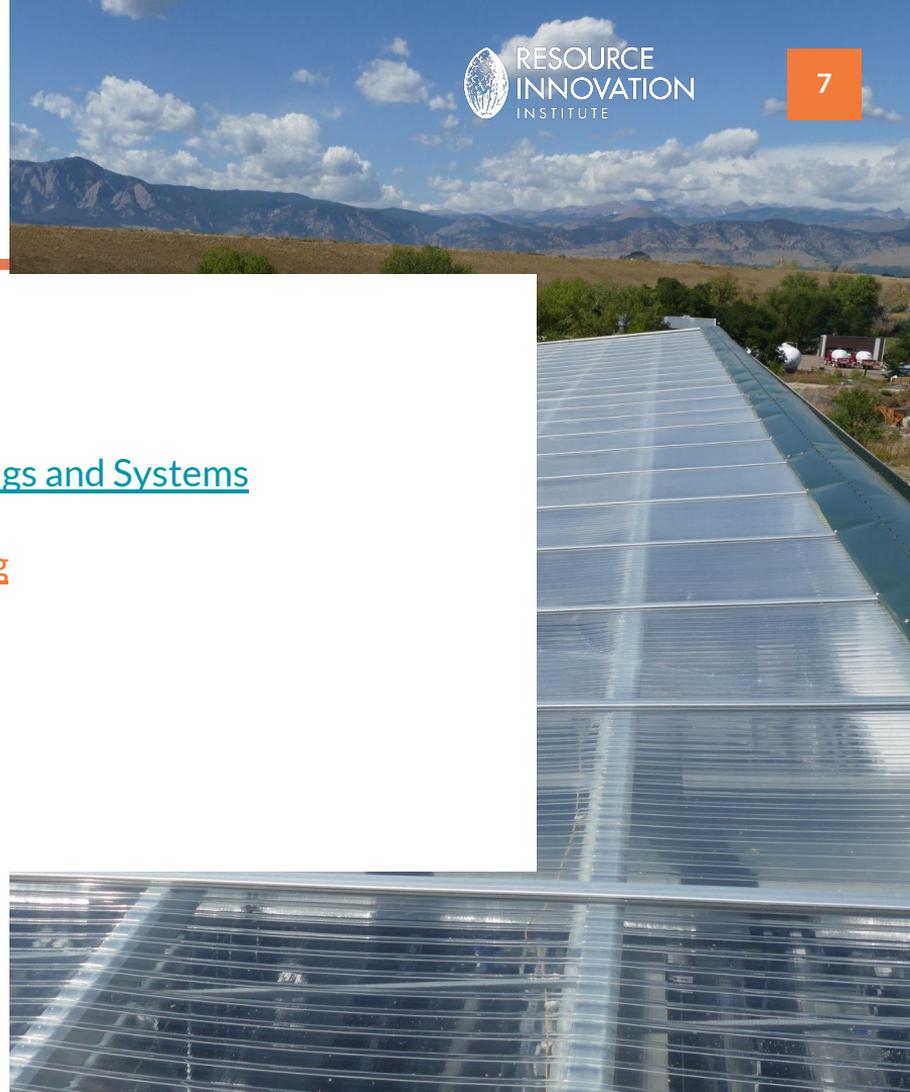
All live workshops are available for on-demand viewing!

# Register for Upcoming Workshops

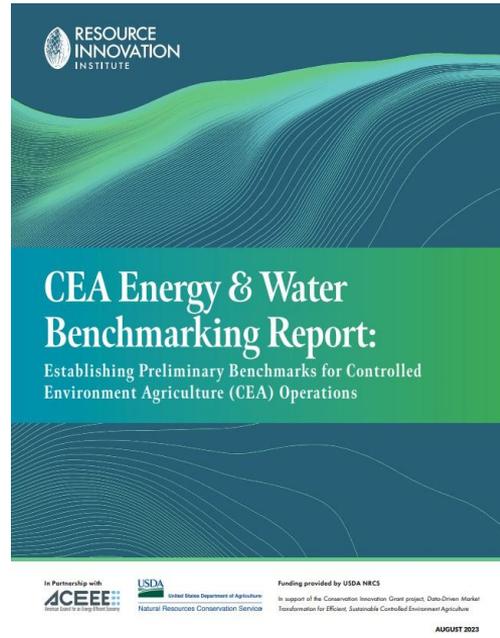
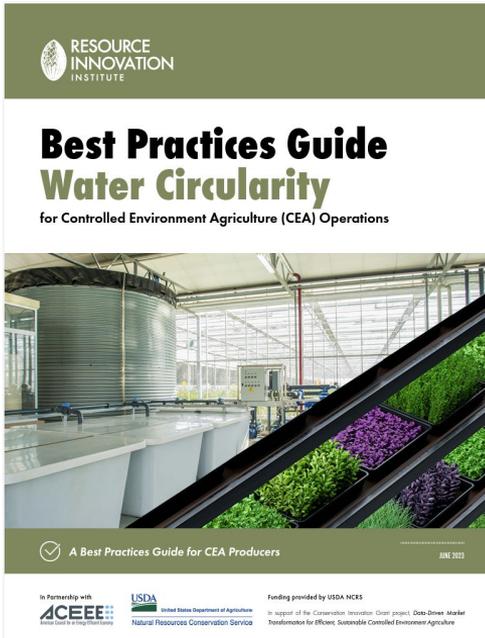
SCE funded Workshops:

October 26 | [Trust But Verify: Commissioning CEA Buildings and Systems](#)

Register and access other free resources on the [RII catalog](#)



# CEA Resources



**Best Practices Guide** Featuring contributions from 15 Working Group member companies

**Benchmarking Report** Featuring annual resource consumption and productivity of twelve producers growing a variety of crops in greenhouse and indoor facilities across the US.

Access the reports for free on the [RII catalog](#)

# Start Collecting Data: Benchmarking

## What data should you collect?

- Energy consumption (all fuel types)
- Water consumption
- Water quality
- Production
- Use controls & automation systems to improve data collection (improve understanding of subsystems)

### Calculated PowerScore

#47974088-21, Indoor, Grantsville, MD, Climate Zone 5A, July 2020 - June 2021

Get Verified

#### Whole Facility

##### Energy

45<sup>th</sup> percentile

Non-Electric Efficiency 188 kBtu / sq ft ↑ 30% better  71<sup>st</sup> percentile

Emissions Efficiency 13.4 kg CO<sub>2</sub>e / sq ft ↑ 31% better  100<sup>th</sup> percentile

Lighting Efficiency 2,820 kWh / day ↑ 87% better  81<sup>st</sup> percentile

HVAC Efficiency 392 kBtu / sq ft ▬ 0% change  3<sup>rd</sup> percentile

##### Water

94<sup>th</sup> percentile

Water Efficiency 0.523 gal / sq ft ↓ 8.2% worse  97<sup>th</sup> percentile

##### Waste

68<sup>th</sup> percentile

Waste Efficiency 0.24 lbs / sq ft ▬ 0% change  80<sup>th</sup> percentile

##### Year-Over-Year



24.4% better

Select a second PowerScore for comparison snapshot or [add another](#)

#47974085-21, Motown Gro

##### Overall: Middle-of-the-Pack

Your operation's overall performance within the data set of indoor facilities in PowerScore's Ranked Data Set:



45<sup>th</sup>  
percentile

Come back to check your PowerScore regularly to see how your rank changes as more facilities benchmark their performance!

#### Oldies

##### Facility

Canopy Productivity 0.243 kg / sq ft ▬ 0% change  50<sup>th</sup> percentile

# POLL ALERT!

What role do you play in the cultivation space?

Discuss Results





**SECTION 02**

---

# Understand How to Commission Integrated Equipment

# POLL ALERT!

How many zones do you typically look to control?

- 1-3
- 4-6
- 7-10
- 10+
- N/A



# What do we need to successfully commission a greenhouse?

- Integration is key!
- Be prepared!
- Does it work in manual?
- What do we need to have ready for commissioning?
- Who are the key people involved?
- Post commissioning – what do we do now ?



Climate Screens

Fans

Lighting

Ventilation

Sulphur

PAR Sensor

Sensors

Temperature

EC & pH Monitoring

CO<sub>2</sub>

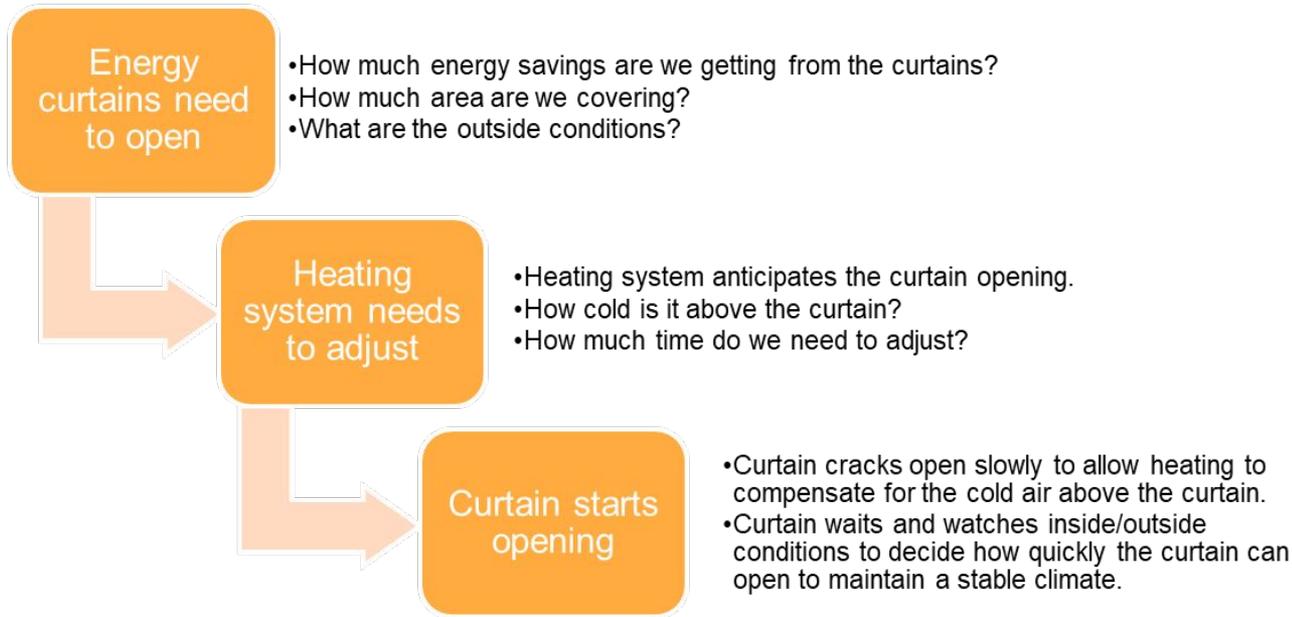
Evaporation

Heating

Humidity

**What makes an efficient installation? Integration!**

# Example – Energy Curtains Opening in the Morning



What makes an efficient installation? Integration!  
 Properly commissioned equipment ensures integration works seamlessly

# Be Prepared for Commissioning

## Greenhouse Info Needed:

- How large are the growing areas?
- What type of materials are used?
- What type of heating equipment? Hot water, forced air, HVAC?
- What type of cooling equipment? Active, passive cooling?
- What irrigation is used? Flood floors, overhead, drippers?



## Equipment Info Needed:

- Motor specs – vents, pumps, etc.
- Curtain specs – energy savings, radiation savings.
- Lighting specs – LEDs, HID.
- Irrigation – flow information, recipe specs, pump information.
- Energy – boiler specs, chiller specs, co-gen specs.



What makes an efficient installation: integration!

# Does the equipment work in Manual?

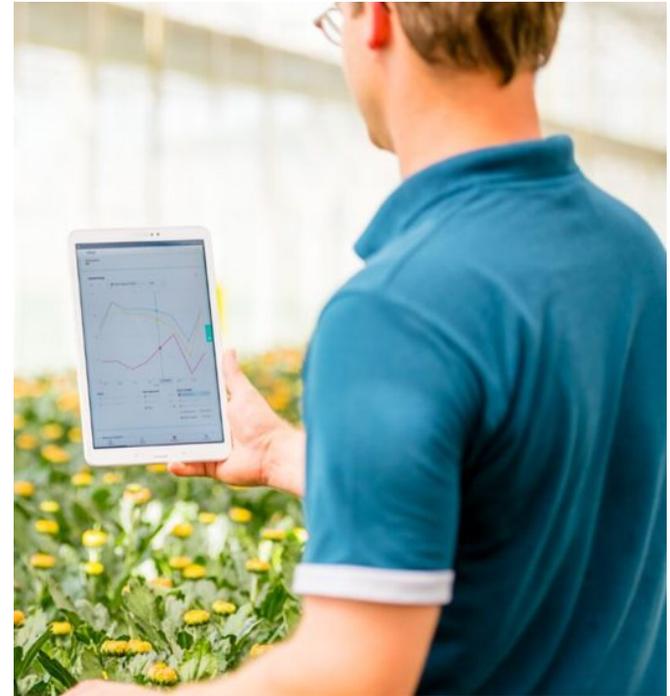
- Pre-checking equipment from manual controls saves time during commissioning.
- Are limits set? Pump rotations checked? Has irrigation been flushed? Has a pressure test been performed?
- Has point to point been done to verify sensors have been wired correctly?
- Pre-check is key for commissioning to run efficiently.



What makes an efficient installation from integration!

# What else do we need for commissioning?

- Have a growing plan in place – temperature, humidity, what climate settings are we going to use?
- What is our irrigation strategy?
- Be prepared to test irrigation – have nutrients/acid/lye on site ready for test runs.
- Have handheld meters on hand for verification: temperature, humidity, EC, pH.
- Have areas prepped and ready for climate condition tests, test irrigation cycles to ensure everything is running optimally.



What makes an efficient installation? Integration!

# What else do we need for commissioning?



- Having the key end users on site for training is invaluable.
- Face to face interaction allows for practical training and discussion.
- On-site training lets end users benefit from a blend of theory and hands-on learning.
- Building a relationship with your control providers is important for networking.

What makes an efficient installation? Integration!

# What if the installation isn't ready?

---

- If providers / suppliers are scheduled too early, controls can't be commissioned properly.
- Follow up visits may be needed which lead to delays and unexpected costs.
- The proper personnel cannot be trained properly or on time.
- Unexpected crop issues can be a result.
- Plan for the unexpected!



# What if the installation isn't ready?



- Verification continues post commissioning
- Once plants move into a space, conditions change. Fine tuning post commissioning is a must.
- A maintenance SOP should be developed – do sensors need to be checked? Calibrated?
- Is equipment running properly?
- Are there any other resources available from vendors to continue learning about the systems?

What makes an efficient installation? Integration!

# POLL ALERT!

How many zones do you typically look to control?

Discuss Results



**SECTION 03**

---

**Commissioning from Design  
Phase to Post-Planting**

# POLL ALERT!

## What controls systems do you use?

- Water treatment plant
- Fertigation injection and distribution
- Environmental controls
- Lighting controls
- CO<sub>2</sub> monitoring and controls



# Horticultural Commissioning - Indoor Facilities

Hort Commissioning focuses on making sure all of the building systems work properly together to support the main function of the facility - growing plants.

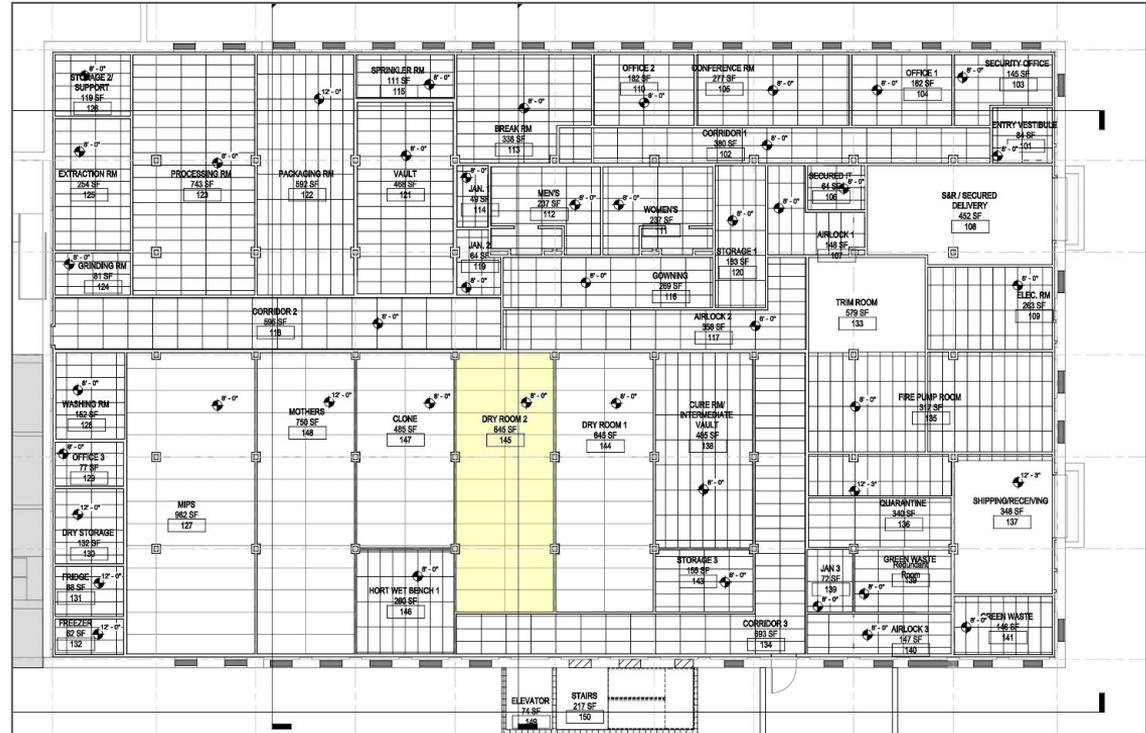


# Commissioning Begins During Design...

- Mantra: 'Bad News Early is Good News'

## Key Considerations:

- Will this system do what the owner / grower want it to do?
- How will this system be used?
- How will it be tested before and after plant load-in?
- How will it be maintained?



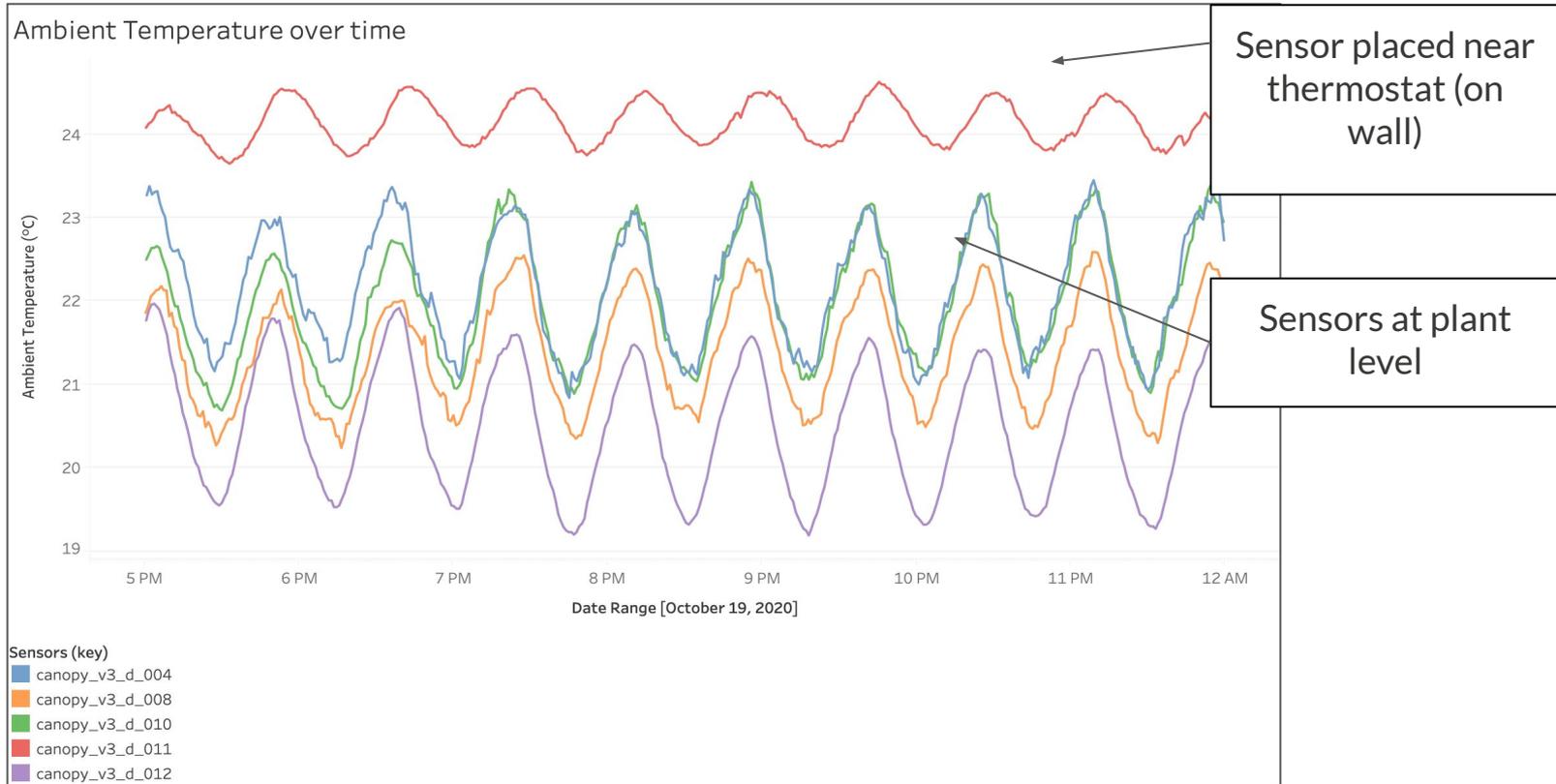
## ...and Continues During Construction

- Details can be inspected as they are completed - like room sealing
- If changes are needed they can be done 'off the critical path' as construction continues
- Changes happen during construction - imperative to make sure these changes don't collide with other systems!



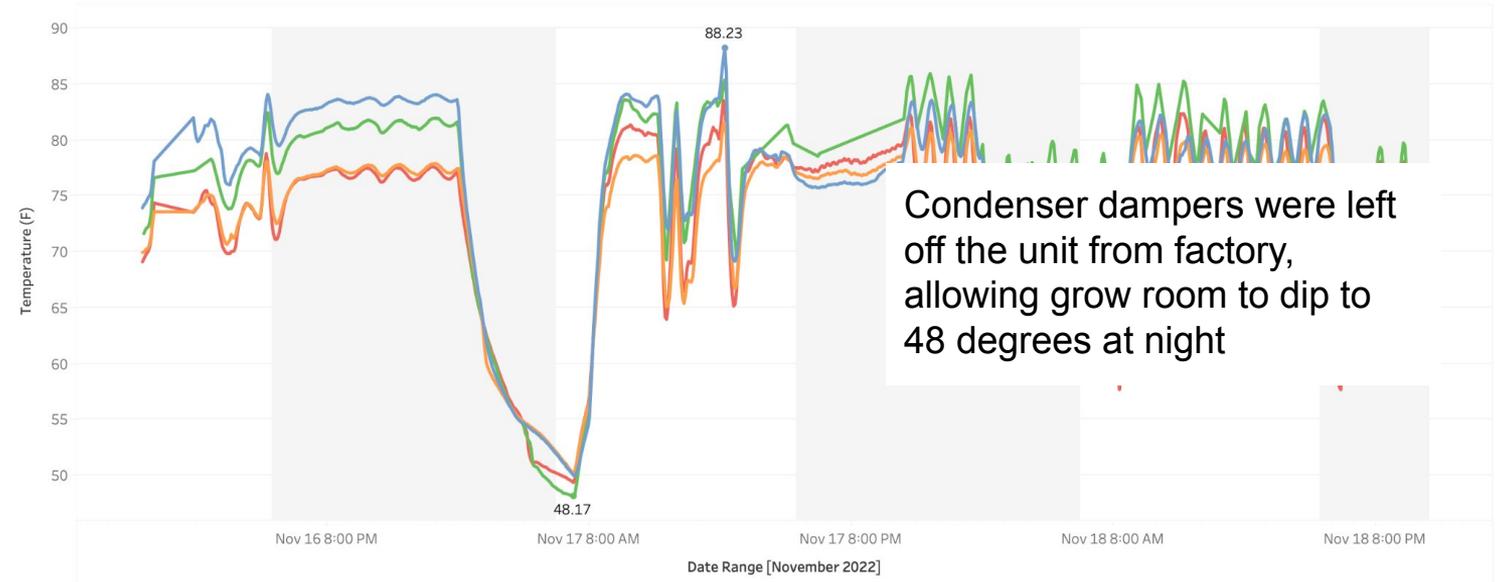


# Details: Sensor Placements



# Looking for HVAC Anomalies at Startup

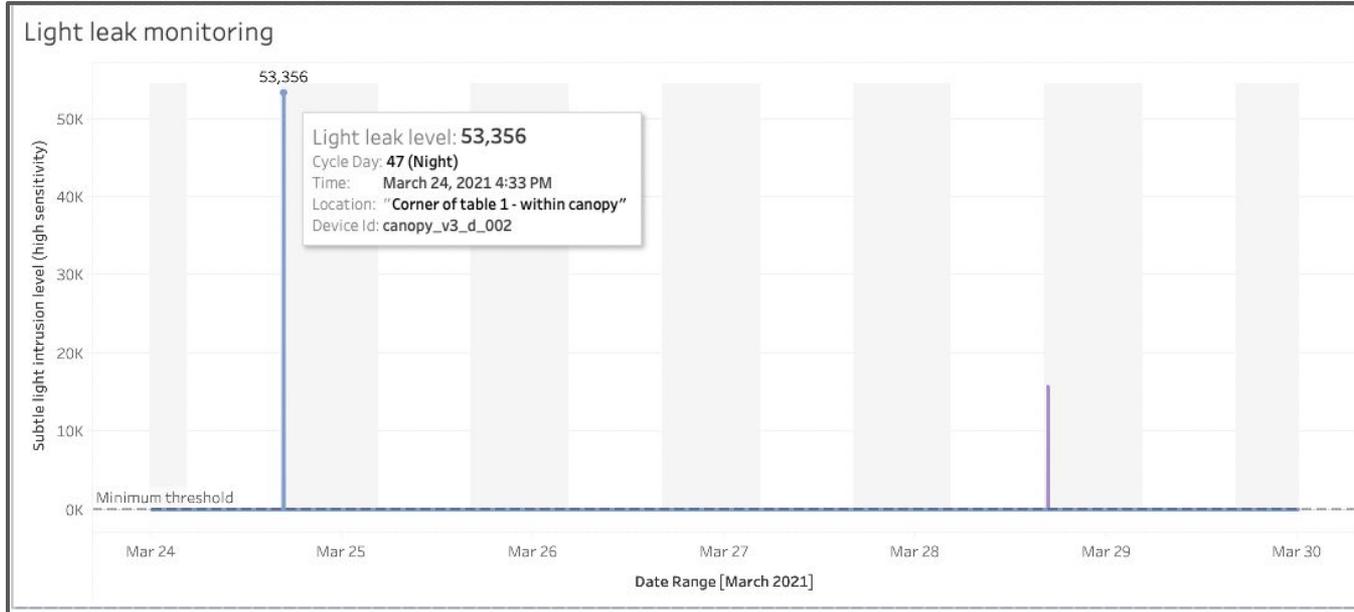
Ambient Temperature over time



Device Description

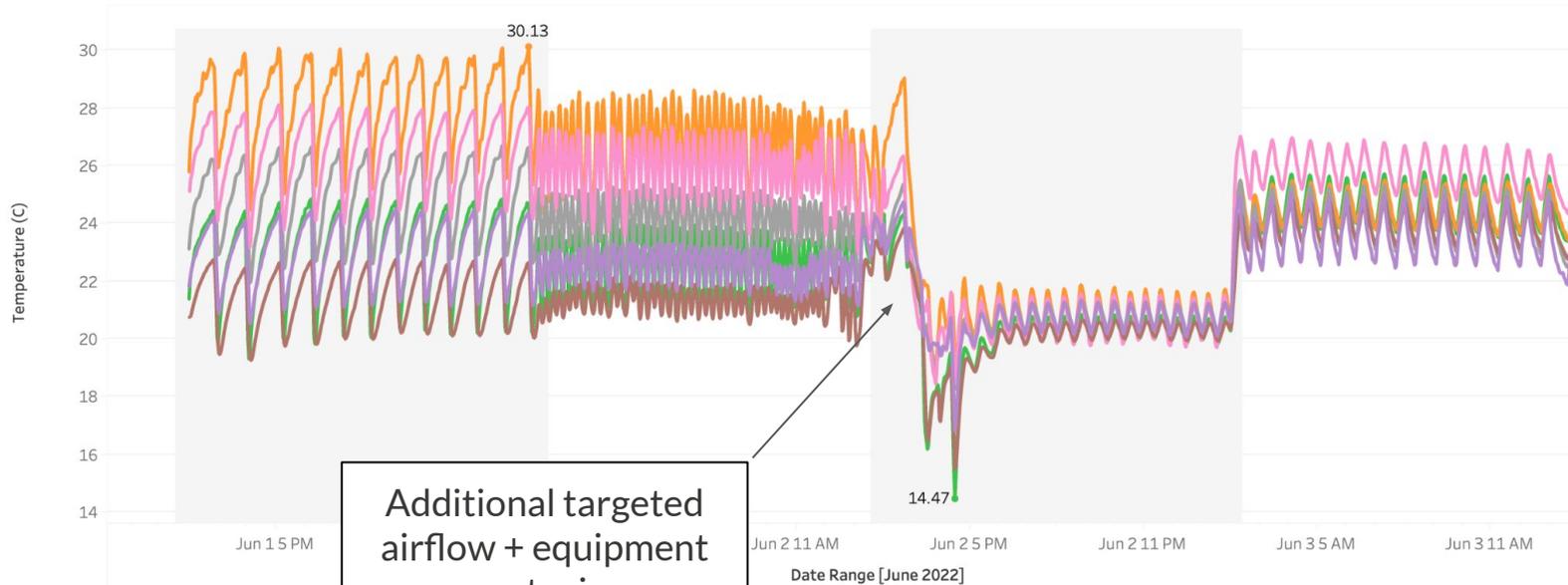
- canopy-v4-d-002: Bench #3 - Tier #1 - \_ (Top-canopy)
- canopy-v4-d-003: Bench #3 - Tier #1 - \_ (Canopy)
- canopy-v4-d-013: Bench #10 - Tier #1 - \_ (Canopy)
- canopy-v4-d-019: Bench #11 - Tier #2 - \_ (Canopy)

# Details: Are you sure there are no light leaks?



# Details: Controls Tuning

Ambient Temperature over time





**POLL ALERT!**

**What controls systems do you use?**

Discuss Results



**SECTION 04**

---

**Commissioning from a  
Grower Perspective**

# POLL ALERT!

Please select the types of webinars you are interested in.

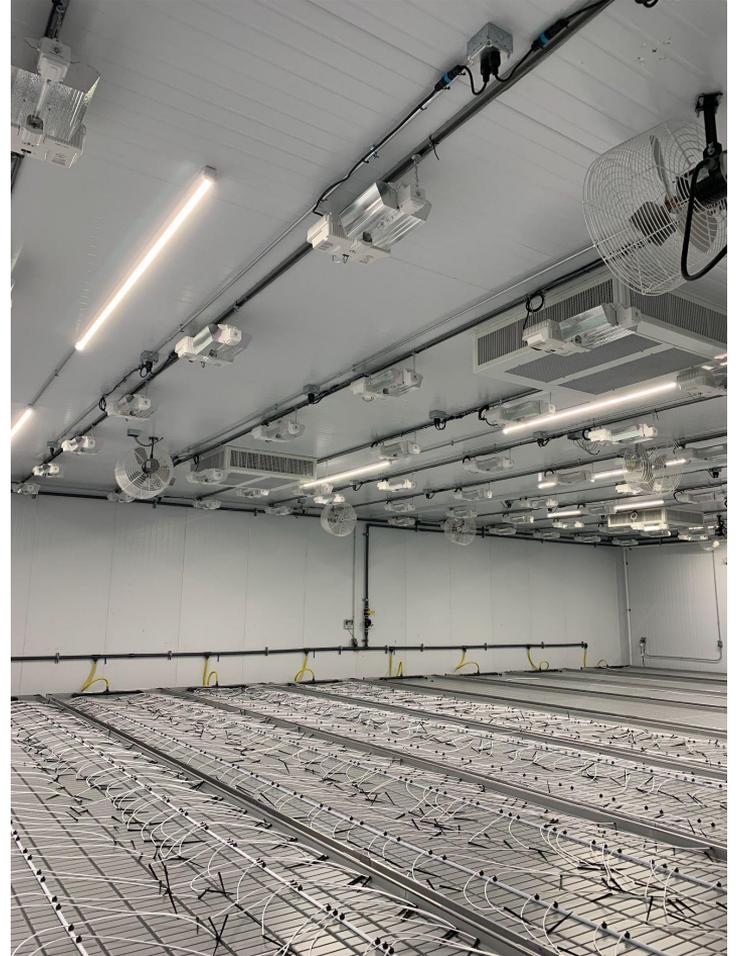
- 30 minute webinars
- 60 minute webinars
- Informal round table on a specific topic
- Multiple topics in one session
- Podcast, no visuals!
- Topic specific webinars



# Avoid Catastrophic Failures!

---

- HVAC
- Lighting
- Irrigation/Fertigation



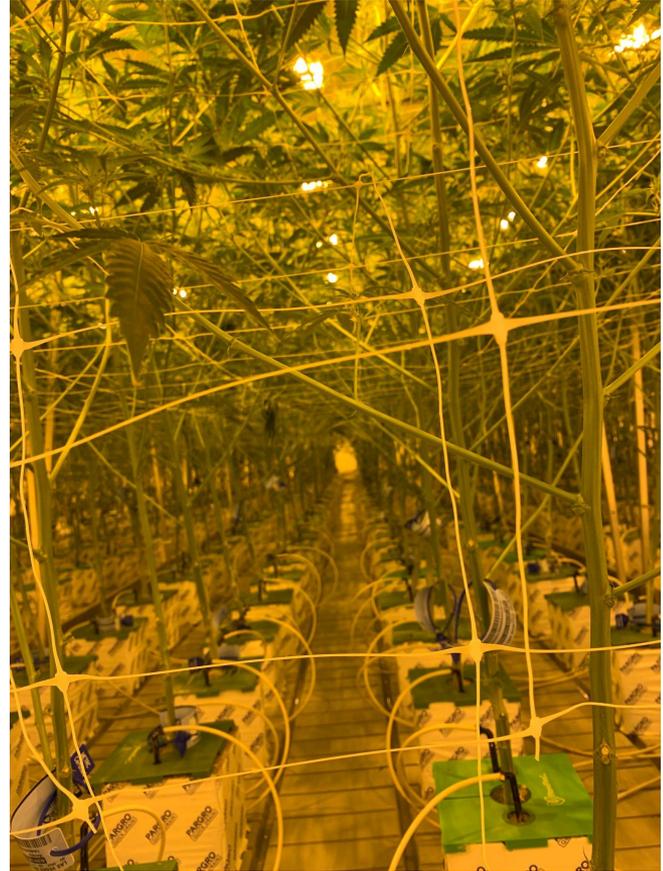
# Commissioning HVAC



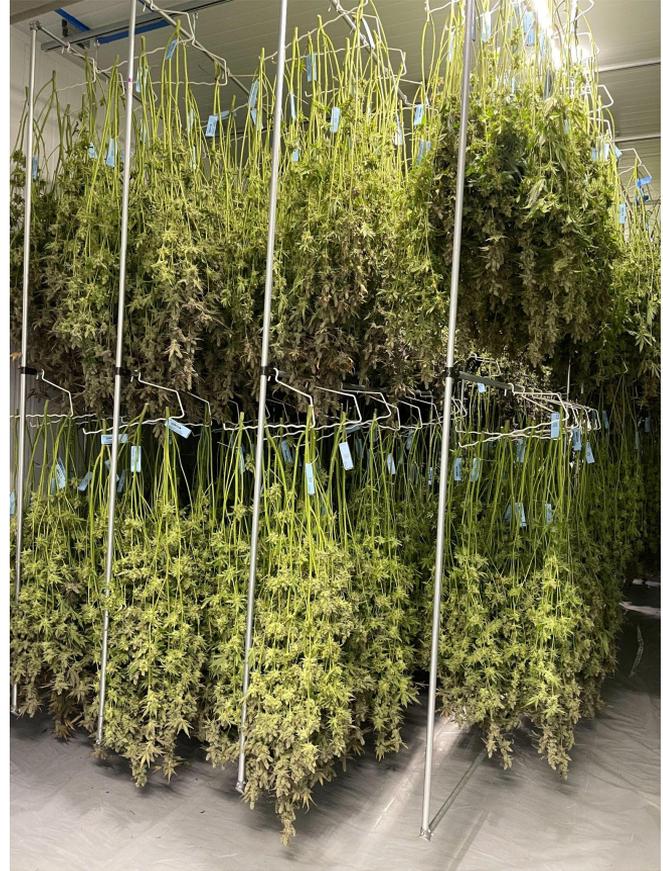
# Commissioning Lighting



# Commissioning Fertigation



# Dry Rooms



A photograph of a large indoor grow room. The ceiling is high and features a complex network of metal trusses, pipes, and electrical conduits. Several large, white, circular fans are suspended from the ceiling. Rows of plants are visible in the foreground, and the overall lighting is dim, with some pinkish-red light emanating from the overhead fixtures.

**SECTION 06**

---

# Incentives Overview

# Measure and Incentive Details Deemed



Measure	Measure Sizes	Incentive
<b>Glycol Pump VFD</b>	3hp – 25hp	\$1,500 - \$5,000 / unit
<b>High-Low Bay LED Horticultural Lighting</b>	4500 lumens – 65,900 lumens 130 LPW – 150+ LPW	\$30 - \$55 / unit
<b>Efficient Ag Ventilation Fans</b>	24 – 48 inch VSD	\$200 / unit \$195 / hp for VSD
<b>Dust Collection Fan VSD</b>	VFD on 10hp – 150hp motor	\$2,000 - \$15,000 / unit
<b>VFD on Ag Well and Booster Pumps</b>	<75 hp – 600hp	\$75 - \$200 / hp
<b>Enhanced VFD on Ag Well and Booster Pumps</b>	<75 hp – 600hp	\$150 / hp

# Measure and Incentive Details Custom + NMEC\*



Measure	Measure Examples	Incentive per kWh	Incentive per kW
<b>Lighting</b>	<ul style="list-style-type: none"> <li>• Lighting controls</li> <li>• Horticulture lighting</li> <li>• Exterior LED lighting</li> <li>• Interior high/low bay LED lighting</li> </ul>	\$0.15	\$150
<b>HVAC</b>	<ul style="list-style-type: none"> <li>• Horticulture HVAC system improvement</li> <li>• HVAC controls and VFDs</li> <li>• HVAC retro-commissioning</li> <li>• Chiller (HVAC) compressor – VFD</li> <li>• Ventilation fan – VFD</li> <li>• Efficient dehumidification system</li> </ul>	↓	↓
<b>Refrigeration</b>	<ul style="list-style-type: none"> <li>• Refrigeration system insulation</li> <li>• Refrigeration system controls and VFDs</li> <li>• Condenser fan – VFD</li> <li>• Chiller (process) compressor – VFD</li> <li>• Evaporator coil fan – VFD</li> <li>• Efficient refrigeration condensing unit</li> <li>• Oversized air-cooled condenser</li> <li>• Efficient refrigeration compressors</li> </ul>		

# Measure and Incentive Details Custom + NMEC\*



Measure	Measure Examples	Incentive per kWh	Incentive per kW
<b>Irrigation</b>	<ul style="list-style-type: none"> <li>• Sprinkler/flood to drip irrigation</li> <li>• Distribution uniformity improvement</li> <li>• Irrigation scheduling</li> </ul>	\$0.15	\$150
<b>Compressed air</b>	<ul style="list-style-type: none"> <li>• Compressed air controls</li> <li>• Compressed air system optimization</li> </ul>		
<b>Pumping</b>	<ul style="list-style-type: none"> <li>• Pump controls and VFDs</li> <li>• Pumping system retro-commissioning</li> <li>• Agricultural pumping system upgrades</li> <li>• VFD on Ag well pump serving non-pressurized system (add-on equipment)</li> <li>• VFD on Ag pump serving non-pressurized system</li> <li>• Milk transfer pump – VFD</li> <li>• Vacuum pumps – VFD</li> <li>• Milking vacuum pumps - VFD</li> </ul>		
<b>Wastewater</b>	<ul style="list-style-type: none"> <li>• Wastewater system controls and VFDs</li> <li>• High efficiency blowers</li> <li>• High efficiency pumps</li> <li>• High efficiency aerators</li> <li>• Wastewater treatment management system</li> <li>• Wastewater chemically enhanced primary treatment/sedimentation</li> </ul>		

# Deemed & DI Water Heating Requirements & Incentives



Customers who located within a Disadvantaged Community (DAC) as defined by CalEnviroScreen 4.0 will receive a higher incentive than customers who are not. Customers who are classified as Hard-to-Reach (HTR) will be offered measures at no-cost.

Measure	Requirements	Standard Deemed Rebate	Increased Rebate for DAC Customers	DI Cost to Customer (for HTR and DAC customers only)
<b>Steam Traps</b>	<ul style="list-style-type: none"> <li>• &gt;= 12 hours of average daily use</li> <li>• Any pipe size</li> </ul>	\$150 each	\$300 each	Not eligible
<b>Storage Water Heaters</b>	<ul style="list-style-type: none"> <li>• 40 Gallon</li> <li>• &gt;= 0.64 UEF</li> <li>• Input rating &lt;= 75 kBtu/hr</li> </ul>	\$20 per rated MBtuh	\$27 per rated MBtuh	No Cost
<b>Storage Water Heaters</b>	<ul style="list-style-type: none"> <li>• 40 Gallon</li> <li>• &gt;= 0.68 UEF</li> <li>• Input rating &lt;= 75 kBtu/hr</li> </ul>	\$22 per rated MBtuh	\$29 per rated MBtuh	No Cost
<b>Process Boiler</b>	<ul style="list-style-type: none"> <li>• &gt;=90% CE Hot Water</li> <li>• Must replace standard efficiency process boiler</li> <li>• Input rating &lt;=20,000 kBtu/hr</li> </ul>	\$6 per rated MBtuh	\$10 per rated MBtuh	Not eligible
<b>Process Boiler</b>	<ul style="list-style-type: none"> <li>• &gt;=85% CE Hot Water</li> <li>• Must replace standard efficiency process boiler</li> <li>• Input rating &lt;=20,000 kBtu/hr</li> </ul>	\$2 per rated MBtuh	\$2.95 per rated MBtuh	Not eligible
<b>Process Boiler</b>	<ul style="list-style-type: none"> <li>• &gt;= 83% CE Steam</li> <li>• Must replace standard efficiency process boiler</li> <li>• Input rating &lt;=20,000 kBtu/hr</li> </ul>	\$3 per rated MBtuh	\$4.35 per rated MBtuh	Not eligible

# Deemed & DI Insulation Requirements & Incentives



Customers who located within a Disadvantaged Community (DAC) as defined by CalEnviroScreen 4.0 will receive a higher incentive than customers who are not. Customers who are classified as Hard-to-Reach (HTR) will be offered measures at no-cost.

Measure	Requirements	Standard Deemed Rebate	Increased Rebate for DAC Customers	DI Cost to Customer (for HTR and DAC customers only)
Tank Insulation	<ul style="list-style-type: none"> <li>• 1" temperature application 120–170 degrees F solution</li> </ul>	\$2.50/ square foot	\$4.00/ square foot	No Cost
Tank Insulation	<ul style="list-style-type: none"> <li>• 2" temperature application 170–200 degrees F solution</li> </ul>	\$3.25/ square foot	\$6.00/ square foot	No Cost
Fitting Insulation (no steam for DI)	<ul style="list-style-type: none"> <li>• 1" minimum insulation thickness</li> <li>• &lt;= 1 inch pipe</li> <li>• &lt;=15 and &gt;15 PSIG Steam or Hot Water</li> <li>• ½" minimum pipe diameter</li> </ul>	\$10.00–\$15.00/fitting	\$15.00–\$22.50/fitting	No Cost (Hot Water only)
Fitting Insulation (no steam for DI)	<ul style="list-style-type: none"> <li>• 1" minimum insulation thickness</li> <li>• &gt; 1 inch pipe</li> <li>• &lt;=15 and &gt;15 PSIG Steam or Hot Water</li> </ul>	\$14.00–\$40.00/fitting	\$22.00–\$60.00/fitting	No Cost (Hot Water only)
Pipe Insulation (no steam for DI)	<ul style="list-style-type: none"> <li>• One inch minimum insulation thickness</li> <li>• &lt;= 1" inch pipe, &lt;=15 and &gt;15 PSIG Steam, Hot Water, Indoor, and Outdoor – ½" minimum pipe diameter</li> <li>• 1 inch – &gt; 4 inch, &lt;=15 and &gt; 15 PSIG Steam, Hot Water, Indoor, and Outdoor</li> </ul>	\$2.50/ foot	\$4.00/ foot	No Cost (Hot Water only)

# Deemed & DI Greenhouse Requirements & Incentives



Customers who located within a Disadvantaged Community (DAC) as defined by CalEnviroScreen 4.0 will receive a higher incentive than customers who are not. Customers who are classified as Hard-to-Reach (HTR) will be offered measures at no-cost.

Measure	Requirements	Standard Deemed Rebate	Increased Rebate for DAC Customers	DI Cost to Customer (for HTR and DAC customers only)
<b>Greenhouse Heat Curtain – Existing or New Construction</b>	<ul style="list-style-type: none"> <li>Natural gas savings rating <math>\geq 40\%</math></li> <li>Single layer interior curtain</li> <li>The heat curtain must have a warranty/product life of five years</li> <li>The installation must allow the curtain to be automatically or manually moved into place.</li> </ul>	\$0.35/ square foot floor area	\$0.50/ square foot floor area	No Cost
<b>Greenhouse Infrared Film - Existing</b>	<ul style="list-style-type: none"> <li>Must be infrared, anti-condensate, polyethylene plastic</li> <li>Minimum thickness of six thousandths of an inch</li> <li>Cannot be installed on greenhouse walls</li> </ul>	\$0.05/ square foot film area	\$0.10 / square foot film area	No Cost
<b>Greenhouse Infrared Film – New Construction</b>	<ul style="list-style-type: none"> <li>Must be infrared, anti-condensate, polyethylene plastic</li> <li>Minimum thickness of six thousandths of an inch</li> <li>Cannot be installed on greenhouse walls</li> </ul>	\$0.02/ square foot film area	\$0.02/ square foot film area	No Cost

# Custom Measure Incentives



Measures	Standard Incentive (\$/Therm Savings)	DAC Incentive (\$/Therm Savings)
Boiler System Upgrades	\$2.50	\$3.00
Condensing Unit Heater	\$2.50	\$3.00
Direct Contact Water Heater	\$2.50	\$3.00
Greenhouse Environmental Controls	\$2.50	\$3.00
Greenhouse IR Space Heating	\$2.50	\$3.00
Greenhouse Under-Bench Heating	\$2.50	\$3.00
Heat Recovery, Dehumidification Air Reheat	\$2.50	\$3.00
Process Heat Recovery	\$2.50	\$3.00
Process Pump VFD	\$2.50	\$3.00
Combined Heat and Power	\$2.50	\$3.00
Infrared Heating for Post-Harvest	\$2.50	\$3.00
Greenhouse Envelope Upgrades	\$2.50	\$3.00
Ozone Cleaning and Laundry	\$2.50	\$3.00
Greenhouse Retro commissioning	\$1.25	\$1.25

# Measure and Incentive Eligibility



## Basic Requirements for All Measures

- Customers must meet [general program eligibility](#) requirements to apply for AgEE Program incentives
- All equipment must be new electric powered equipment
- Qualifying equipment must be purchased and installed between July 5, 2022, and December 31, 2025. The purchase date of the equipment must be within the calendar year that the application is submitted unless indicated otherwise.
- All required efficiencies must exceed Title 20 and 24 standards.

## Training and education on broader participation benefits

- Energy savings
- Non-energy benefits (e.g., increased yield, worker safety, animal comfort, etc.)
- Building energy assessments
- Energy benchmarking
- Technical support in selecting the most beneficial measures
- Ongoing guidance regarding measure installation and usage
- Financing assistance through incentives and promotion of on-bill financing
- Provide customers with education on accessing grants such as those from the USDA
- Dedicated outreach for DAC and HTR customers

# Program Delivery and Customer Services





Get in touch with us:

**Caleb Hayhoe**  
AgEE Program Manager  
[caleb.hayhoe@icf.com](mailto:caleb.hayhoe@icf.com)

**Ben Cooper**  
AgEE Program Manager  
[benc@ensave.com](mailto:benc@ensave.com)

---

[icf.com](http://icf.com)

 [linkedin.com/company/icf-international/](https://www.linkedin.com/company/icf-international/)

 [twitter.com/icf](https://twitter.com/icf)

 <https://www.facebook.com/ThisIsICF/>

---

# Actionable Takeaways

- Integrate equipment for most effective installation
- Commission to validate that integration of equipment has been done properly
- Once plants are in place, commissioning will need to be fine-tuned
- Commissioning needs to start in design phase
- Mantra: “Bad news early is good news.”
- Changes during construction phase are more likely to be troublesome



# Panel Q & A

# Today's Experts



Rob Eddy



[rob@resourceinnovation.org](mailto:rob@resourceinnovation.org)



Chris Androny



[chris.androny@priva.com](mailto:chris.androny@priva.com)



Mike Zartarian



[z@zartarianengineering.com](mailto:z@zartarianengineering.com)



Josh Gerovac



[josh@symbiescent.com](mailto:josh@symbiescent.com)



Caleb Hayhoe



[caleb.hayhoe@icf.com](mailto:caleb.hayhoe@icf.com)

# CONTACT US

---



Visit us at  
[www.ResourceInnovation.org](http://www.ResourceInnovation.org)

P.O. Box 5981  
Portland, Oregon 97228  
[rob@resourceinnovation.org](mailto:rob@resourceinnovation.org)  
[bryce@resourceinnovation.org](mailto:bryce@resourceinnovation.org)

