Indoor Cannabis Cultivation

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SMUD

Agenda

- Lighting 101
- Loads
- SMUD's Territory
- R&D Tests

SMUD's Stance

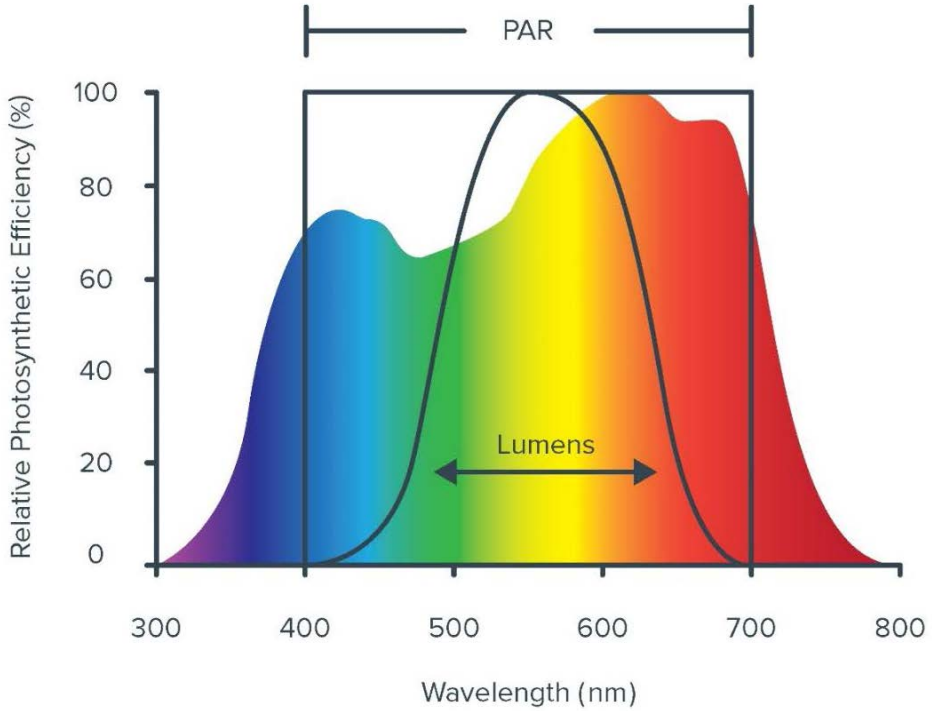
SMUD is committed to partnering with our customers to ensure safe, reliable and efficient energy distribution.

To help meet our customers' electricity needs, whether simple or unique, we promise to deliver cost-effective energy utilizing renewable energy sources with the quality our customers have come to expect and value.


Lighting 101

Lighting 101

Photopic Vision
- Lumens
- Lux / Foot-Candles
- Lumens / Watt



Horticulture
- PPF
- PPFD
- µmol / J

Source: Nick Klase, Fluence Bioengineering, 2017 DOE SSL Conference

Lighting 101

TYPICAL PPFD REQUIREMENTS

Lighting Application	PPFD (µmol/m²/s)	Foot-candle (lumen/ft²)	LUX (lumen/m²)
Office Space	6 - 10	30 - 50	324 - 540
Lettuce	200 - 300	1002 - 1503	10,800 - 16,200
Herbs	300 - 500	1503 - 2505	16,200 - 27,000
Tomatoes	500 - 700	2505 - 3507	27,000 - 37,800
Cannabis	700 - 900	3507 - 4509	37,800 - 48,600

* Conversion factors based on the spectrum of sunlight

Source: Nick Klase, Fluence Bioengineering, 2017 DOE SSL Conference


Loads

Lighting Load, HPS

Example 1000W DE HPS

- Current 4.42A @277VAC
- Power max 1200W
- Heat 4,000btus
- Covers 16 to 25 sqft

HVAC Load

Example Daikin 20ton

- Current max 41.2A @460VAC
- Power max 32.8kW
- EER 9.8

Additional Load

- Fans
- Filters
- Pumps
- General, Exterior Lighting
- Office

Watts/sqft Assumptions

(1) 1200W light per 20 sqft of planted area
.33 ton HVAC per light
Additional 20% load

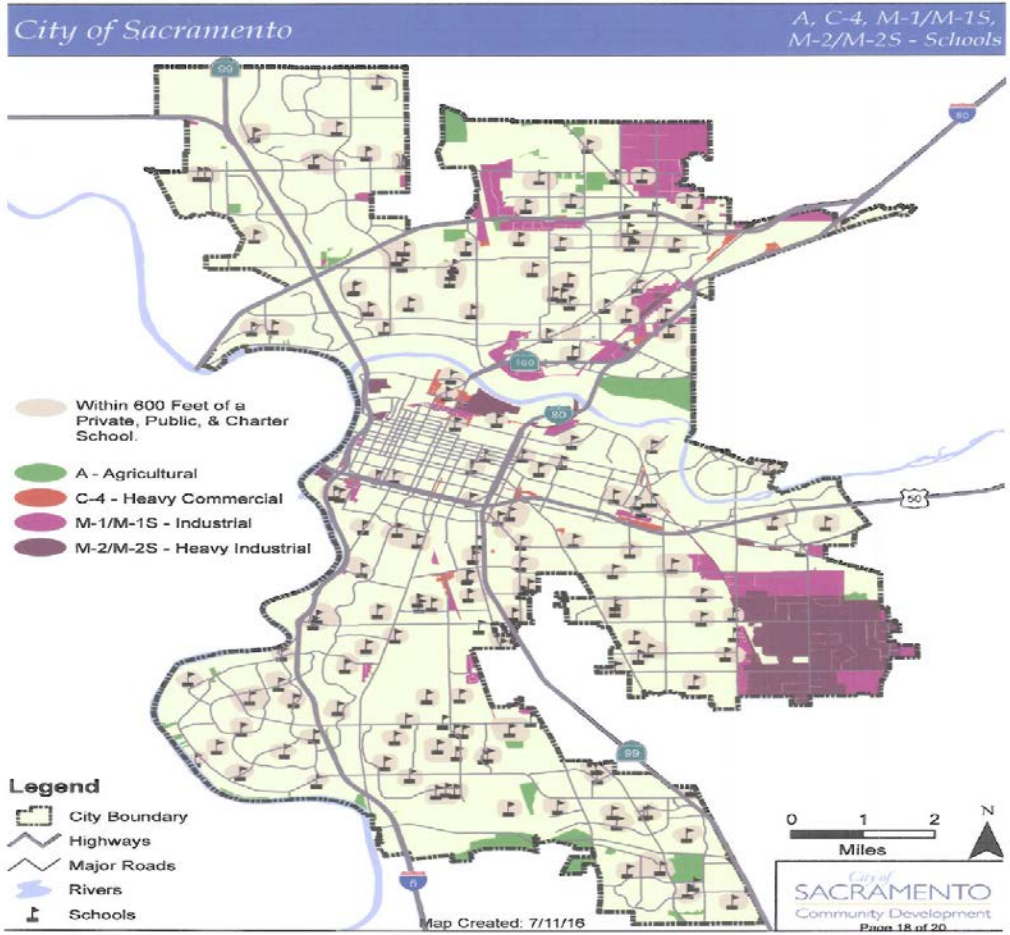
$$\frac{1200W}{20sqft} + \frac{400W}{20sqft} \times \text{Additional } 20\% =$$

96W/sqft of planted area


SMUD's
Territory

City of Sacramento

Feb 2, 2016	city adopts “certain properties” allowed commercial cultivation of cannabis
Nov 22, 2016	city adopts regulation for commercial cultivation of cannabis
April 3, 2017	city starts accepting conditional use permits


City of Sacramento
A, C-4, M-1/M-1S, M-2/M-2S - Schools
Within 600 Feet of a Private, Public, & Charter School.
A - Agricultural
C-4 - Heavy Commercial
M-1/M-1S - Industrial
M-2/M-2S - Heavy Industrial
Legend
City Boundary
Highways
Major Roads
Rivers
Schools
0 1 2
Miles
N
Map Created: 7/11/16
SACRAMENTO
Community Development
Page 18 of 20

Green Zone

Applications

In 2017, SMUD received:

- 139 Conditional Use Permit applications for review
- 66 applications for new/upgraded service
- Most in saturated areas

Current proposed square feet of canopy?

>2,700,000


R&D Tests

What we wanted to know

- What are the energy (kWh) and electrical demand (kW) savings?
- Does using LED lighting instead of HPS affect the quality or quantity of the product? If so, in what ways?
- What are the financial cost savings for the customer? What is the simple payback?
- Should SMUD provide energy efficiency incentives?
- Is the technology viable for this application? What is needed for wider adoption?

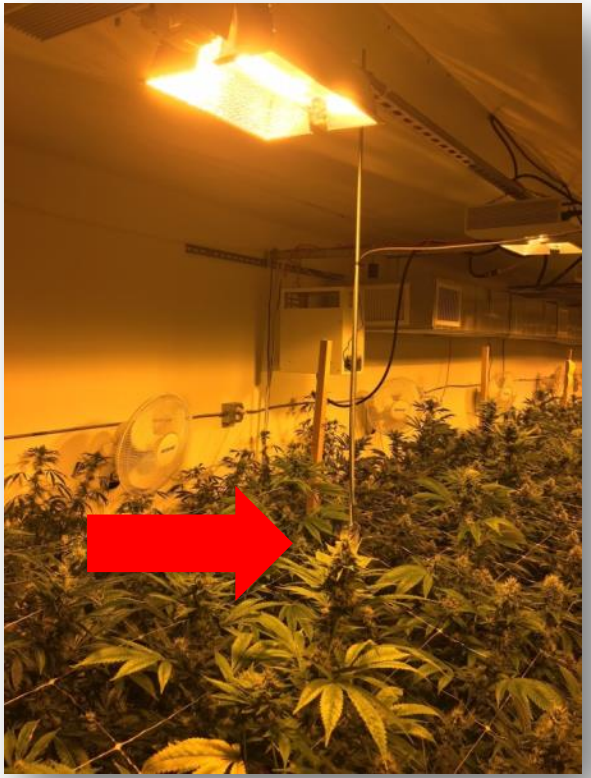
What we did

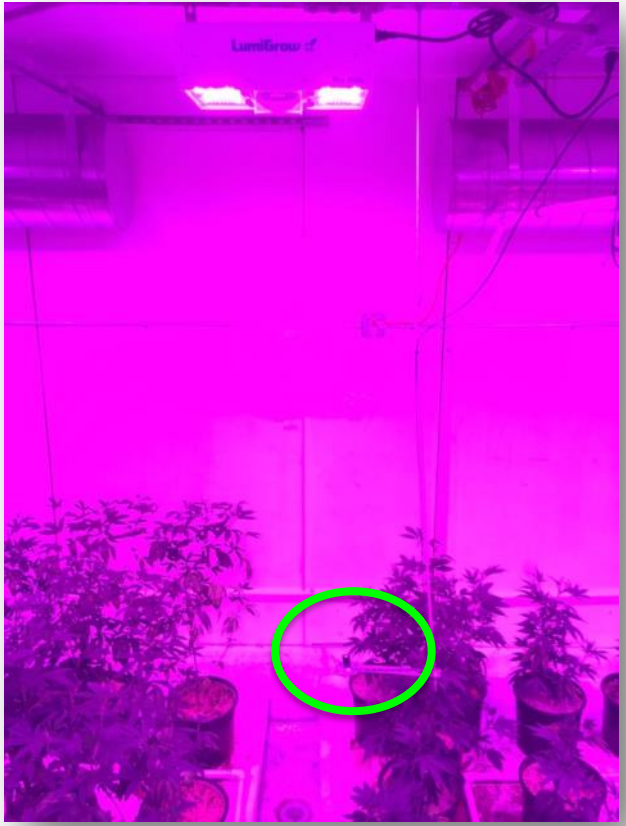
Worked with two local cannabis cultivators to test LED lighting for indoor cultivation applications.

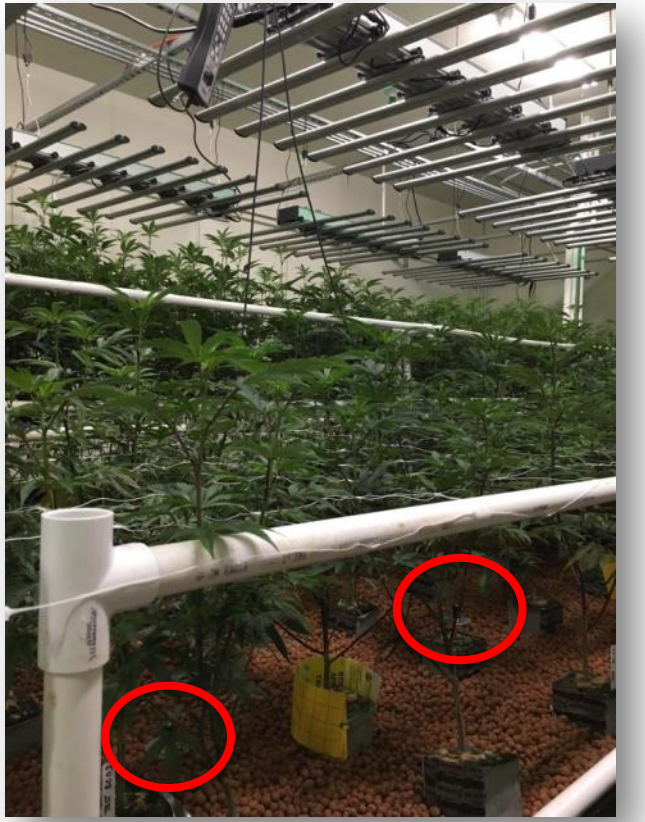
- Two rooms with HPS lighting
- Two rooms with LED lighting
- Cadmus performed the energy savings and cost-effectiveness analysis
- Cultivators determined quality of crop

What we tracked

- Lighting kW and kWh
- PAR (LI-COR loggers)
  - -Below light fixtures
  - -Plant bed
- Plug loads (fans, portable dehumidifiers, etc.)
- HVAC system kW & kWh
- Room conditions
  - CO^2 levels
  - Relative humidity
  - Room temperature





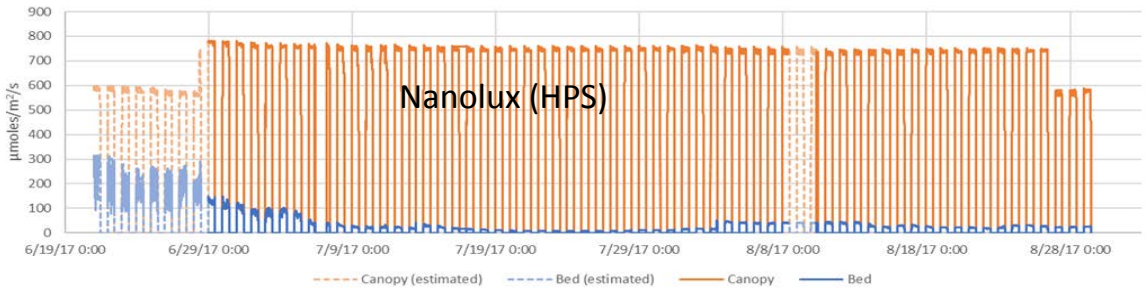


Max Canopy Level

Max Bed Level

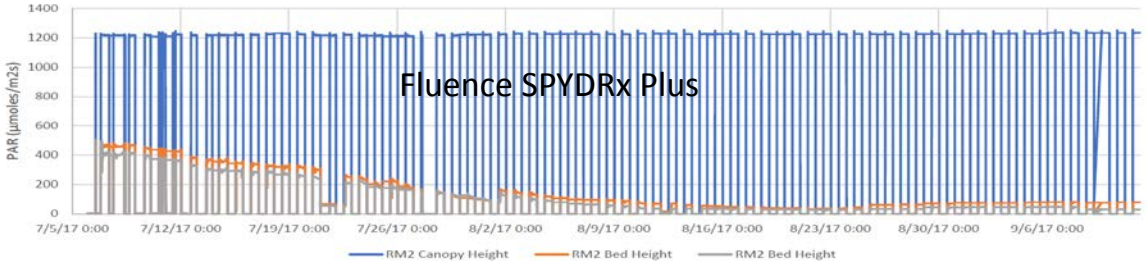
783 µmol

316 µmol



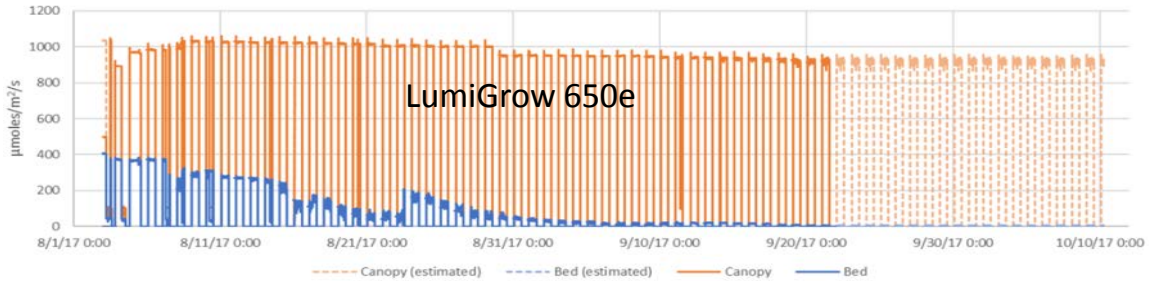
1256 µmol

503 µmol

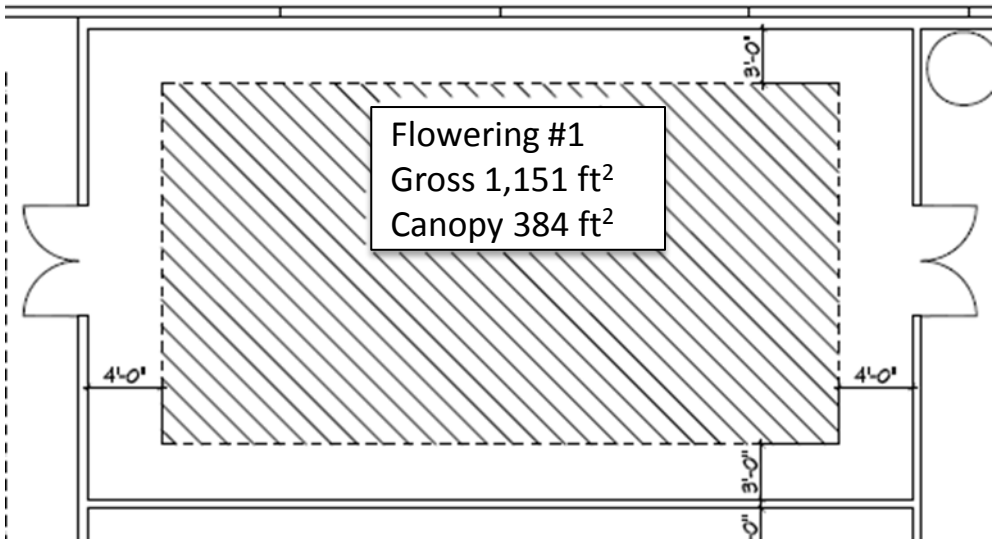


1060 µmol

406 µmol



Amplified Farms: HPS Room



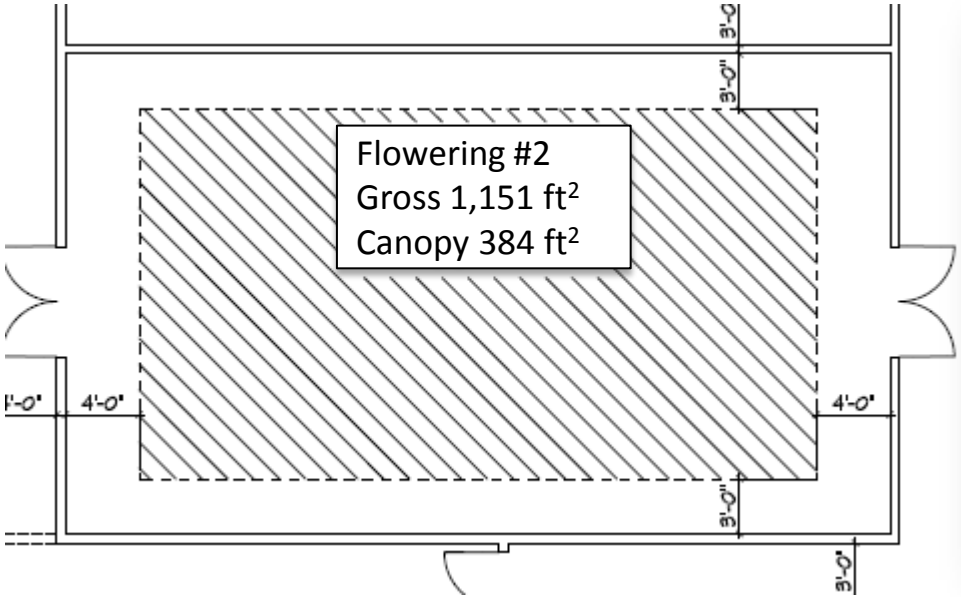
Amplified Farms: HPS room

Nanolux 1000W DE
Lighting: 21 HPS fixtures
Lighting power (measured): 22,008 Watts
Canopy LPD: 57.31 Watts/ ft^2
Room LPD: 19.12 Watts/ ft^2

10-ton heat-pump (variable speed)

- 5 HP variable speed supply fan
- 22.5 kW 2-stage heat strips
- Peak demand (measured): 33.4 kW

Amplified Farms: LED room



Amplified Farms: LED room

Fluence SPYDRx Plus
Lighting: 21 LED fixtures (@ 660 Watts)
Lighting power (measured): 14,700 Watts
Canopy LPD: 38.28 Watts/ ft^2
Room LPD: 12.77 Watts/ ft^2

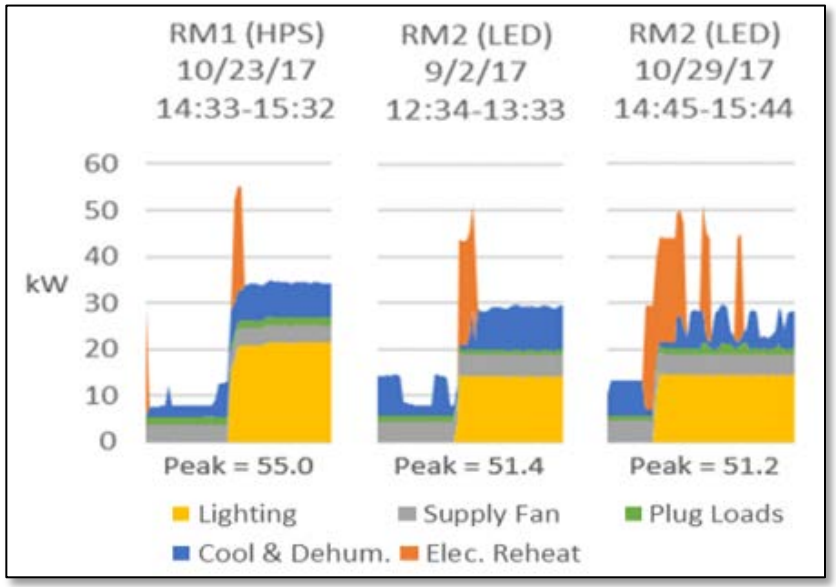
10-ton heat-pump (variable speed)

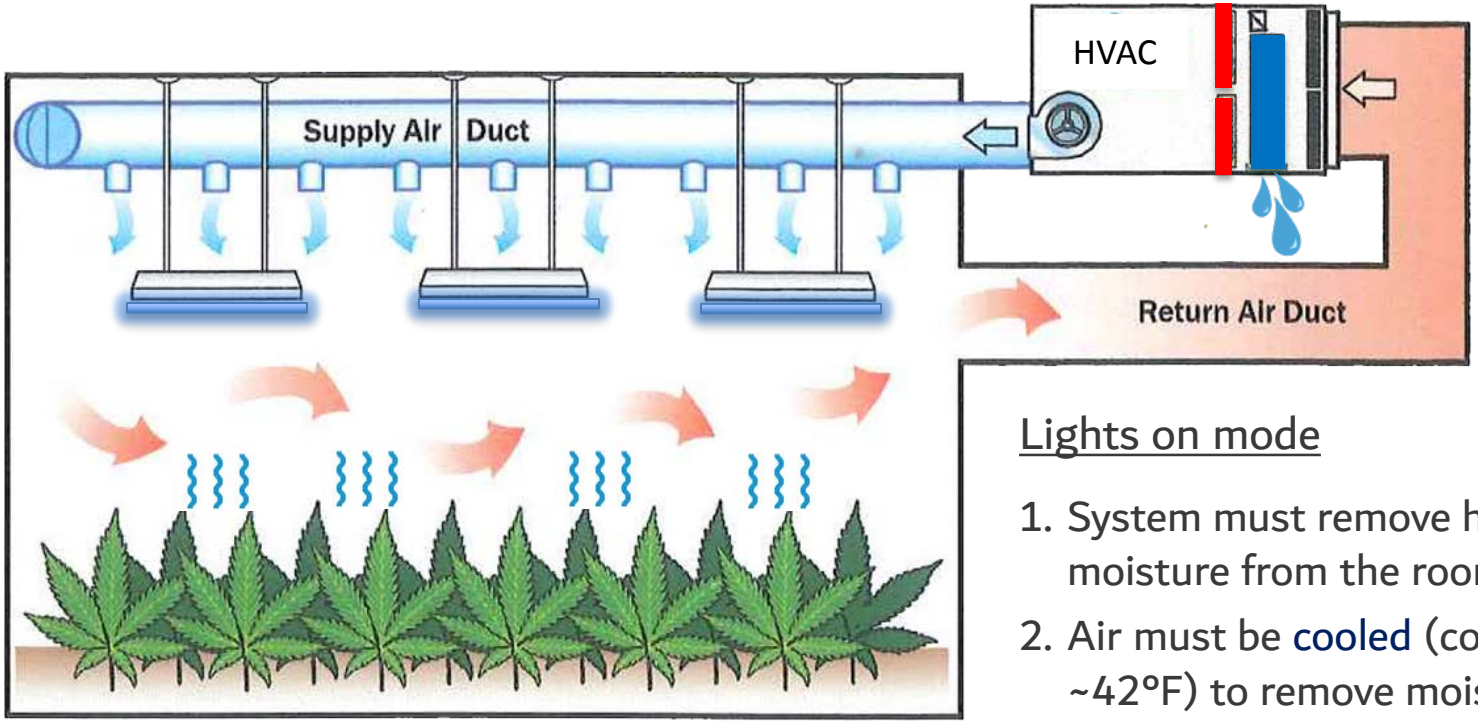
- 5 HP variable speed supply fan
- 22.5 kW 2-stage heat strips
- Peak demand (measured): 36 kW

Amplified Farms: electrical demand

Lighting demand was 33% lower yet the overall demand reduction was only around 3%.

Why?

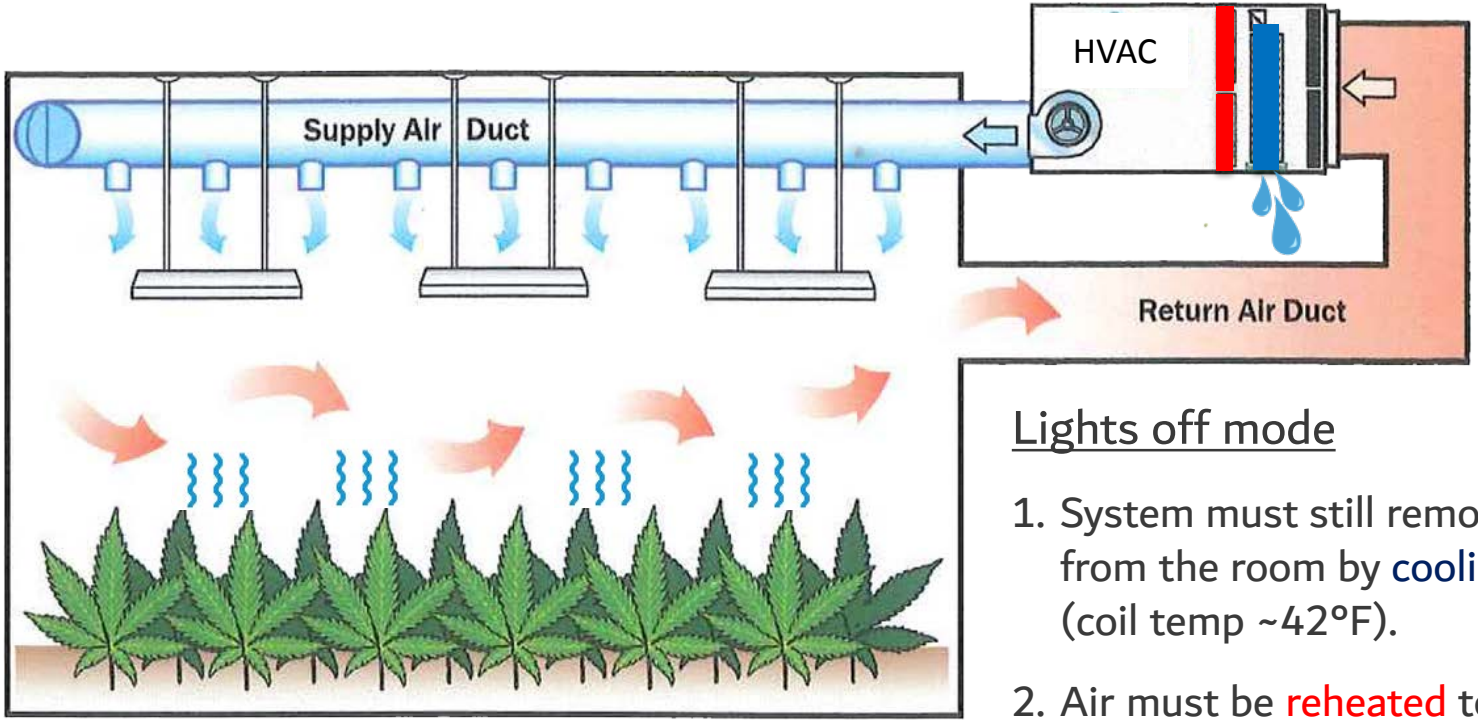




Graphic used with permission from the DesertAire Corporation

Lights on mode

1. System must remove heat & moisture from the room.
2. Air must be cooled (coil temp ~42°F) to remove moisture.
3. Air must be reheated to prevent overcooling room. This can be done with hot gas reclaim and/or electric resistance heat strips.



Lights off mode

1. System must still remove moisture from the room by cooling the air (coil temp ~42°F).
2. Air must be reheated to prevent overcooling room. More reheat is necessary since the lights are off.

Graphic used with permission from the DesertAire Corporation

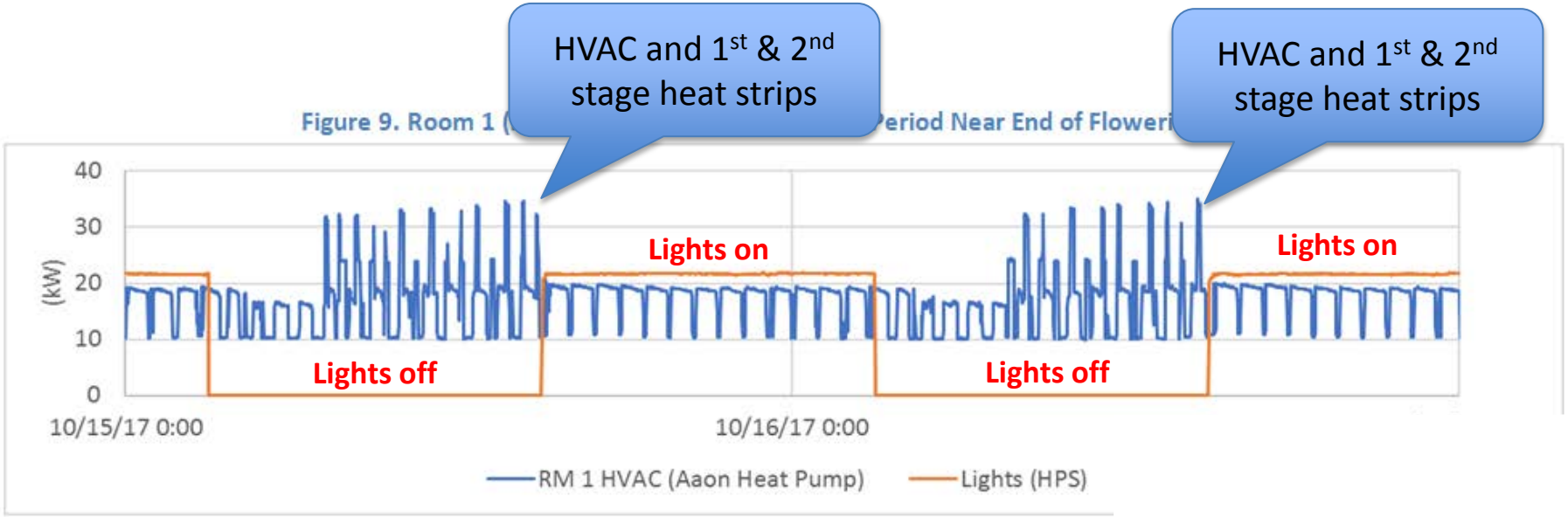


Figure 9. Room 1 (eriod Near End of Floweri

Lights on mode: 42 kW

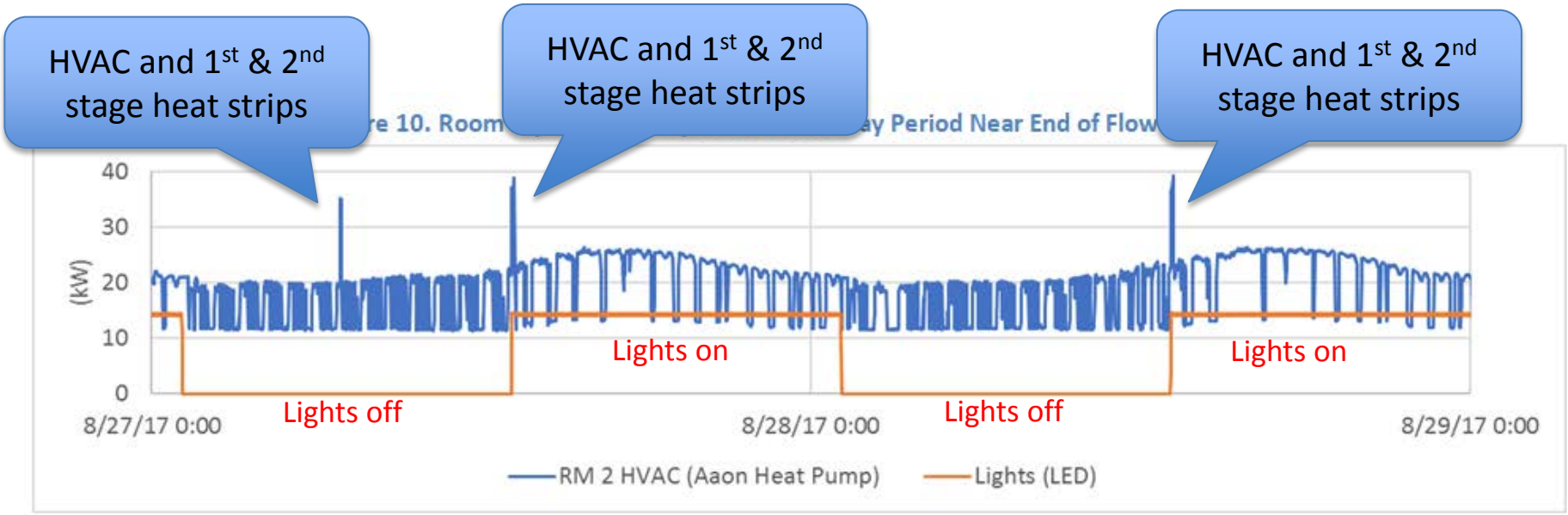
Room: 36.5 Watts/ft^2

Canopy: 109.4 Watts/ft^2

Lights off mode: 33.4 kW

Room: 29 Watts/ft^2

Canopy: 87 Watts/ft^2



Lights on mode: 40.7 kW

Room: 35.4 Watts/ft^2

Canopy: 106 Watts/ft^2

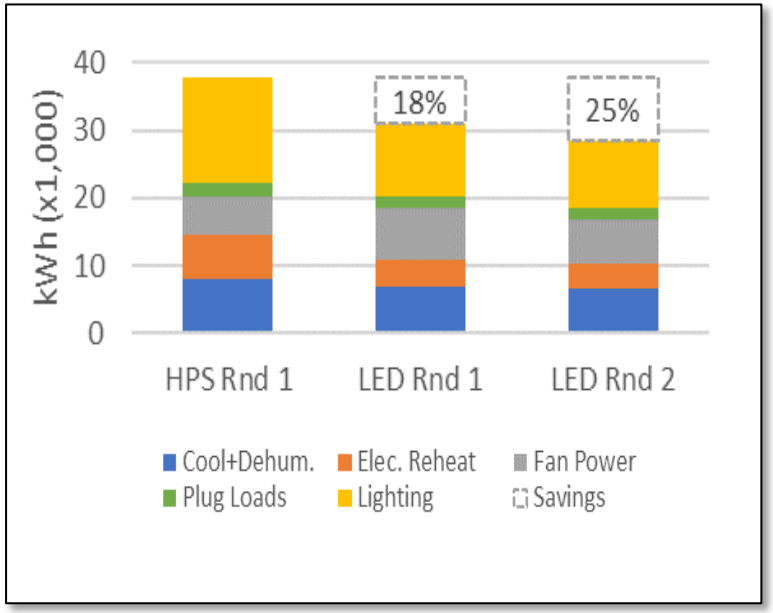
Lights off mode: 39.5 kW

Room: 34.3 Watts/ft^2

Canopy: 102.9 Watts/ft^2

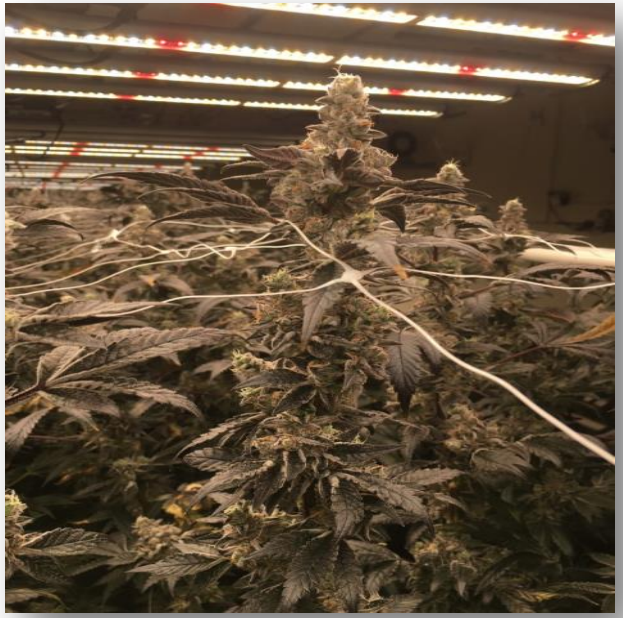
Amplified Farms: energy consumption

- Lighting energy savings was an average of 34%
- Plug loads were 7% lower
- Total HVAC system usage was slightly lower (2%)
- Overall energy consumption was 18 to 25% lower

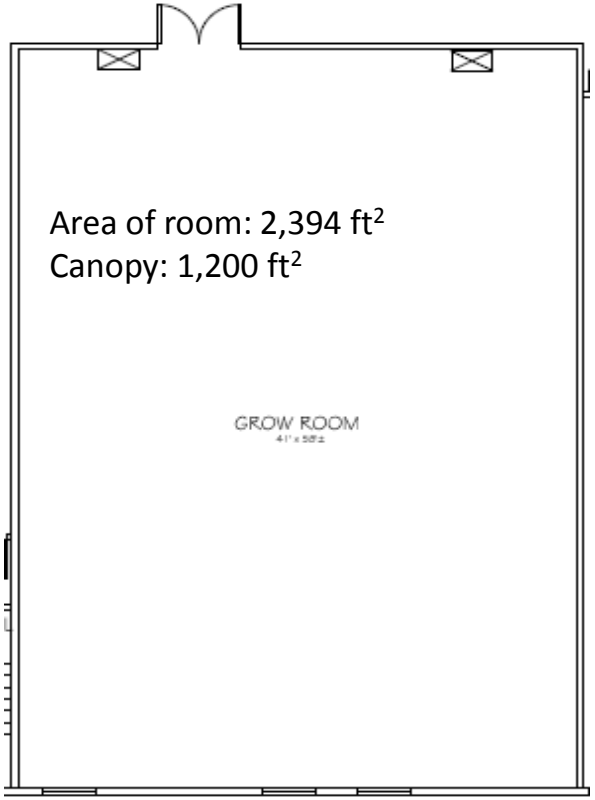


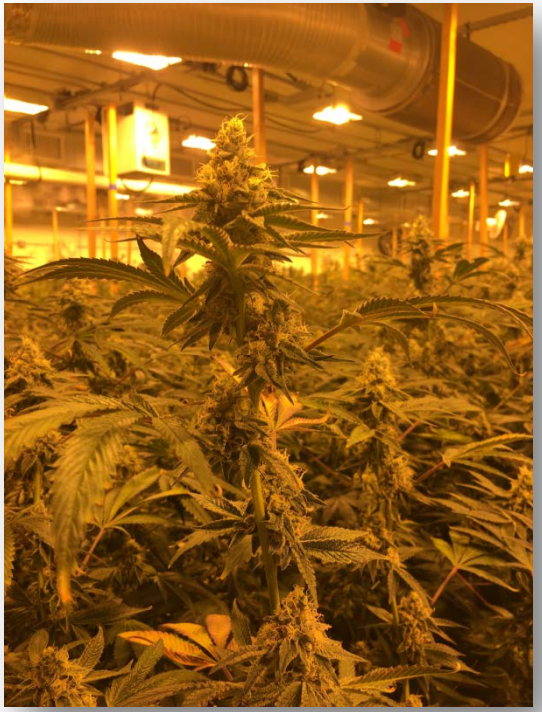
Amplified Farms: grow results

- LED Grow number #1
  - Awful start: 3-days without cooling or lights
  - Overall yield was still within normal ranges for two of the three varieties
  - THC levels were slighter higher
- LED Grow number #2
  - Overall yield was within normal ranges
  - THC levels were slighter higher
  - Overall quality was excellent!



Seven Leaves HPS room





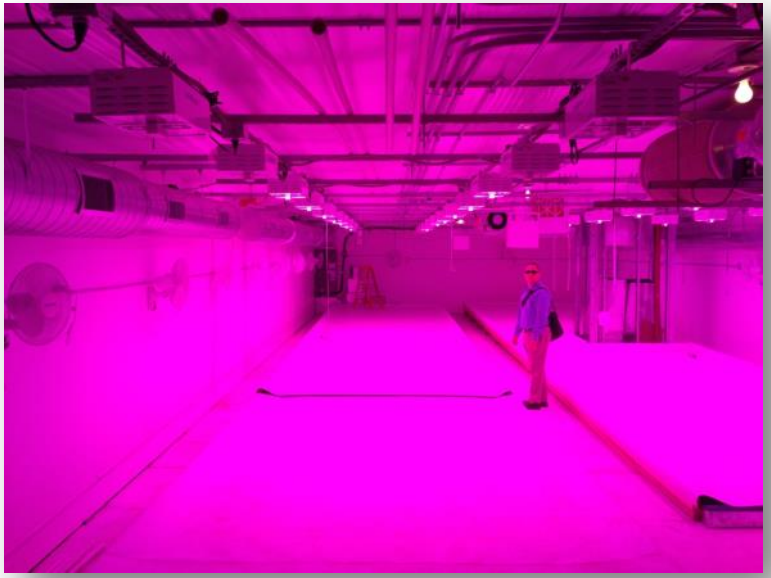
Seven Leaves: HPS room

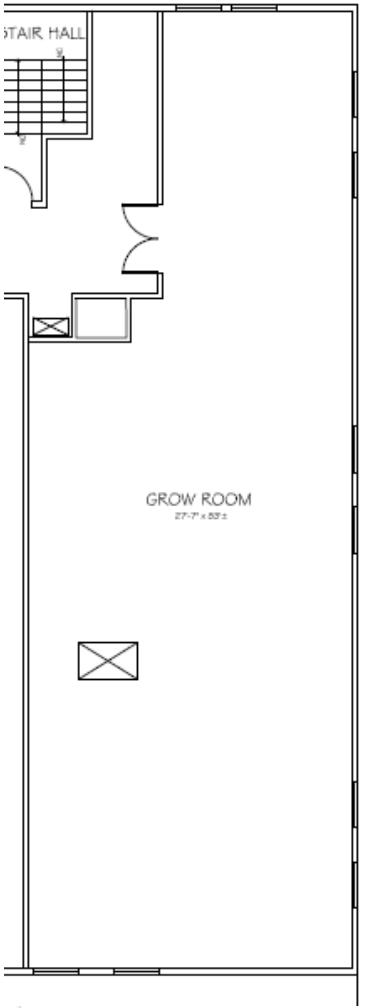
Nanolux 1000W DE
Lighting: 54 HPS fixtures
Lighting power (measured): 53,600 Watts
Canopy LPD: 44.7 Watts/ ft^2
Room LPD: 22.39 Watts/ ft^2

HVAC (22.5 tons total)

- 5-ton heat pump (rooftop unit)
- Two 5-ton heat pumps (split systems)
- 7.5 ton heat pump (split system)
- Peak demand (measured): 18,300 Watts

Seven Leaves LED room





Area of room: 1,731 ft^2
Canopy: 1,231 ft^2

Seven Leaves LED room

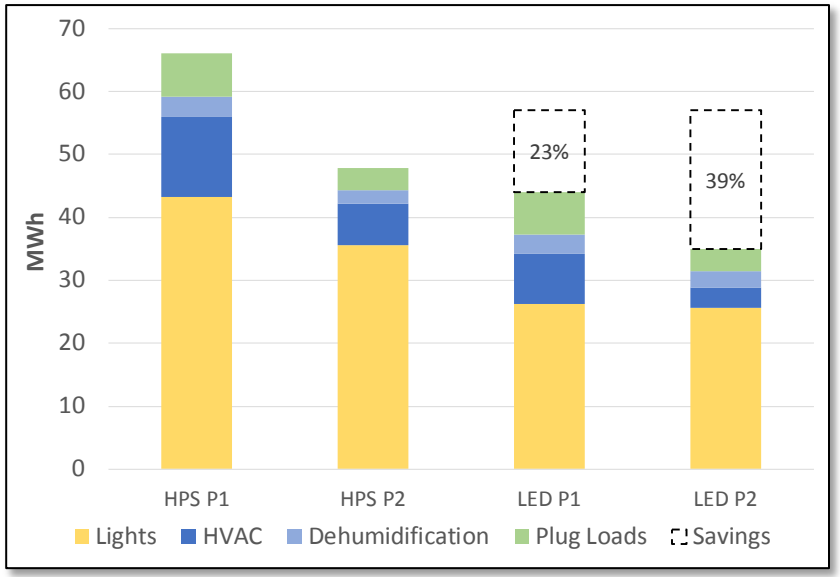
LumiGrow Pro 650e
Lighting: 49 LED fixtures (rated @ 585 Watts)
Lighting power (measured): 31,600 Watts
Canopy LPD: 25.7 Watts/ ft^2
Room LPD: 18.26 Watts/ ft^2

HVAC (15 tons total):

- 5-ton heat pump (rooftop unit)
- Two 5-ton air conditioners (split systems)
- Peak demand: 13.5 kW (measured)

Seven Leaves: energy consumption

- Lighting energy savings was 36%
- Overall HVAC system usage was 37.5% lower
- Plug loads were 10.5% higher
- Overall energy savings was 30.3% (17,720 kWh / cycle)



Seven Leaves: grow results

- LED Grow number #1
  - Awful start: plants in shock from too much light
  - Overall yield was 40% lower than our target
  - THC levels were slighter higher
- LED Grow number #2
  - Overall yield was 35% lower than our target
  - THC levels were slighter higher
  - Overall quality was excellent!

SMUD reports

Full reports for these projects are available for download via the Customer Advanced Technologies Program webpage:

https://www.smud.org/en/Business-Solutions-and-Rebates/Business-Rebates/Advanced-Tech-Solutions


Thank You!

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