



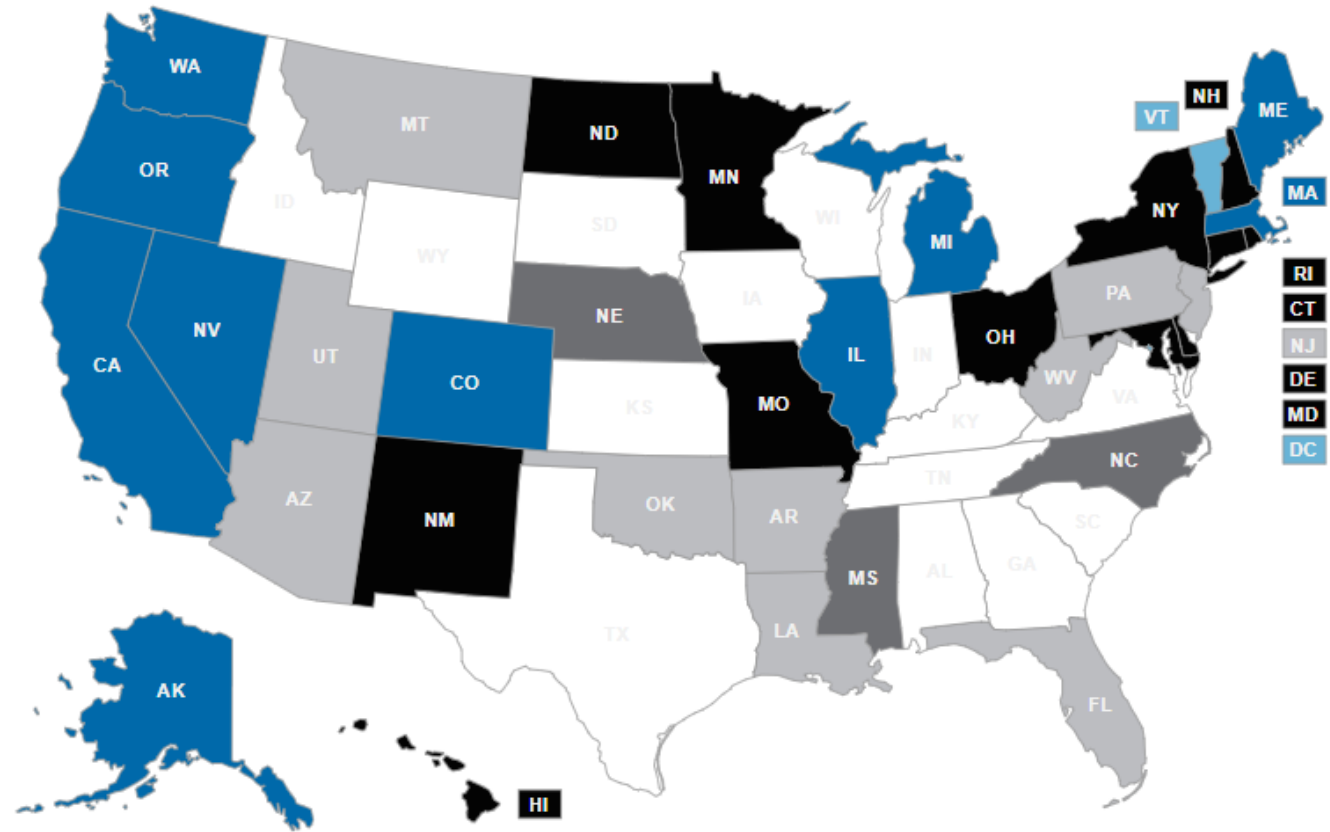
Policies and data driving energy optimization in cannabis production facilities

Controlled Growth: Indoor Agriculture and Building Energy Efficiency Session

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Marijuana Policy Project



- 10 States with medical marijuana laws
- 3 States that have removed jail time for possessing small amounts of marijuana
- 12 States that have both a medical marijuana law and have removed jail time for possessing small amounts of marijuana
- 10 Marijuana is legal for adults and is taxed and regulated similarly to alcohol; state also has a medical marijuana law
- 2 Marijuana is legal for adults (no sales); medical marijuana law

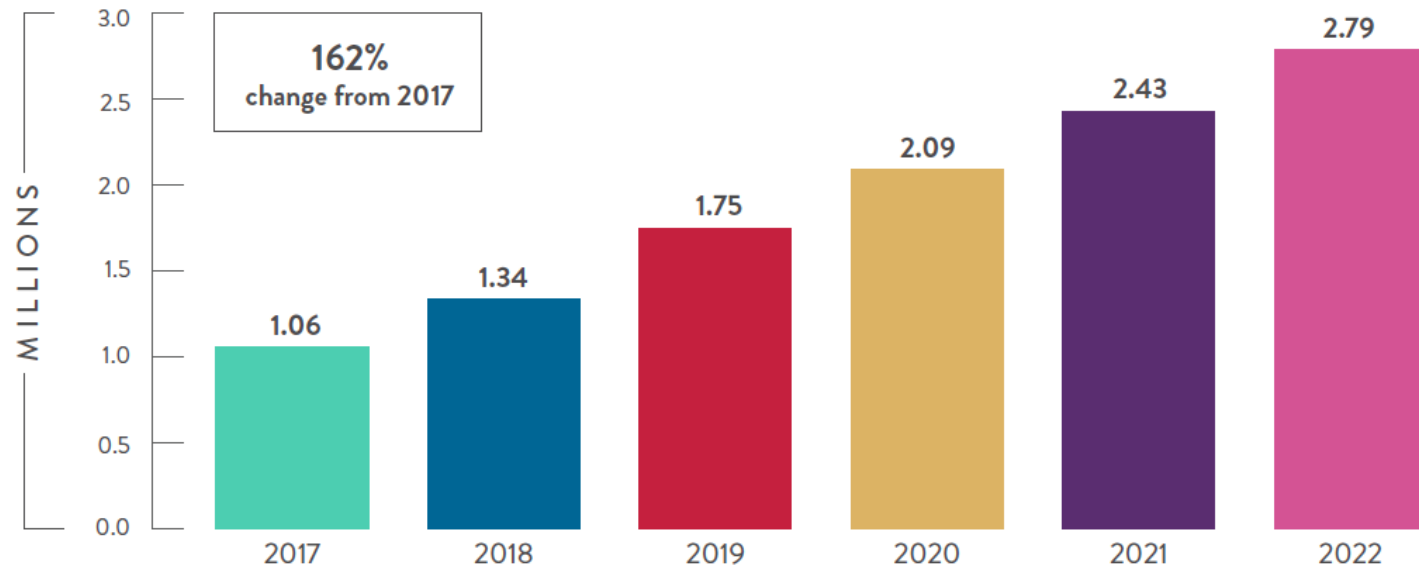
THE 2018

CANNABIS ENERGY REPORT

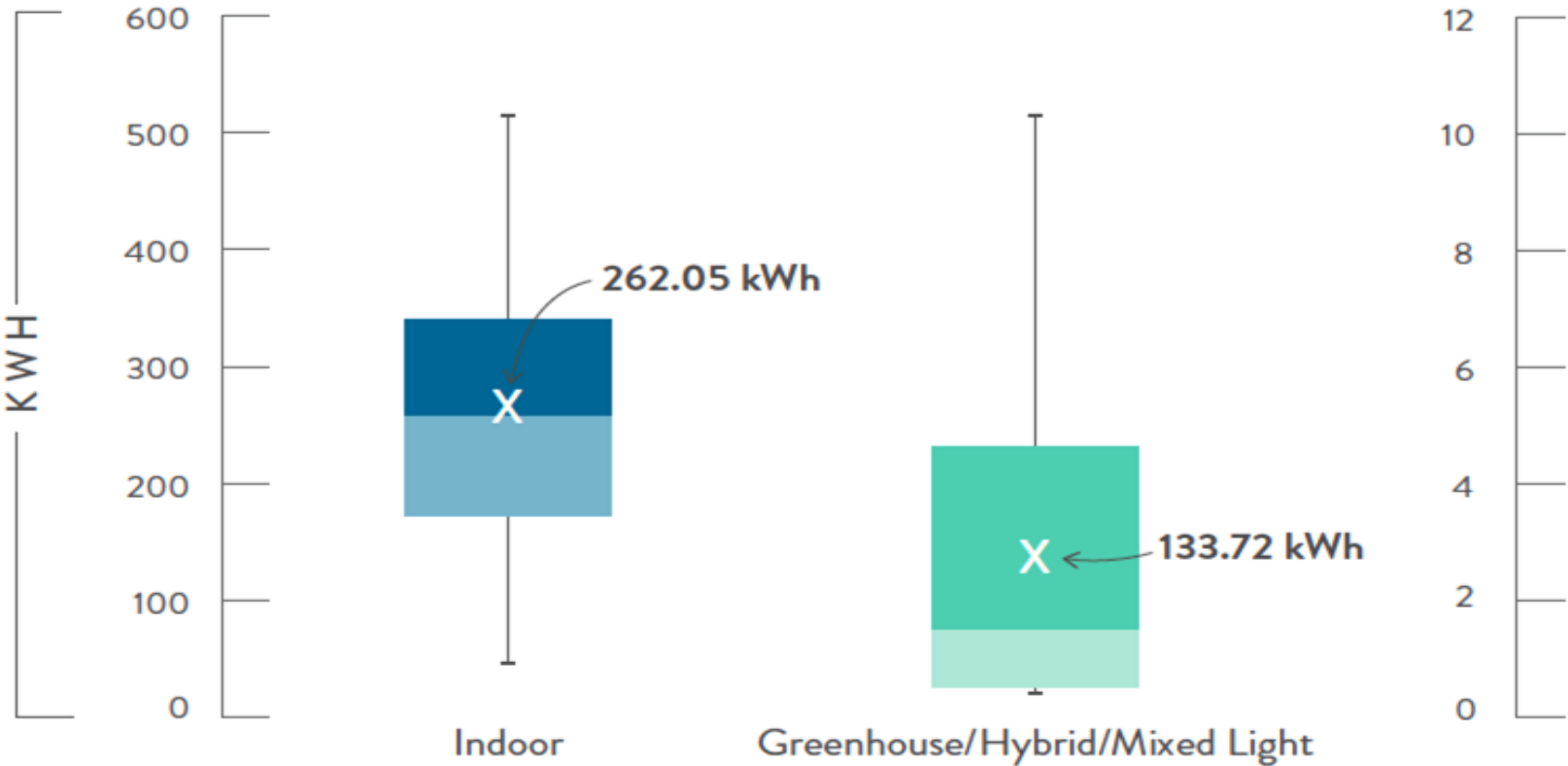
“ By 2020, legal and illicit cannabis production will produce more than 2.6 million tons of electricity-based CO₂e emissions.



TOTAL ELECTRICITY USAGE FOR LEGAL CULTIVATION (MWh)



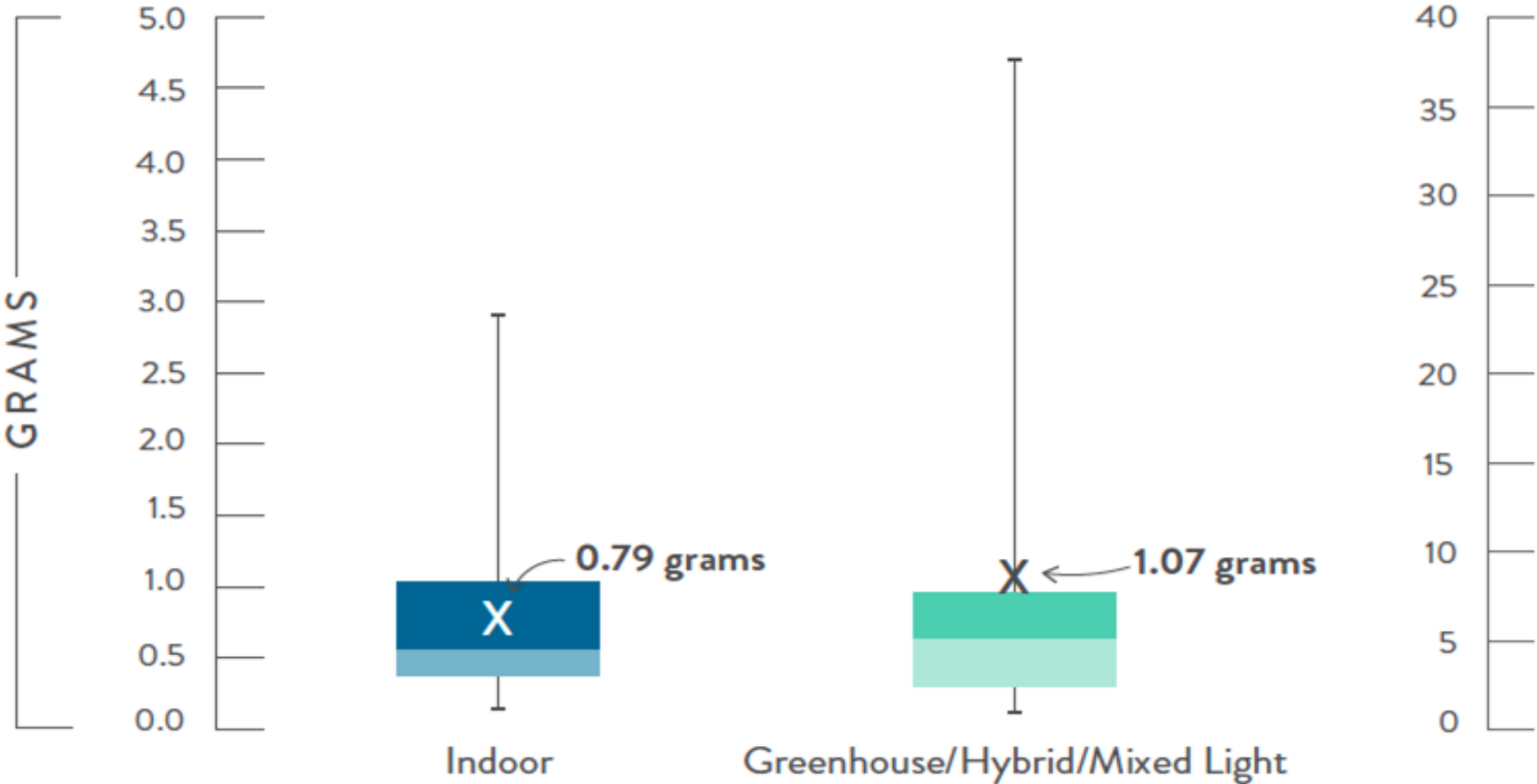
Benchmarks: kWh/square foot



The world's largest dataset on cannabis energy use
CannabisPowerScore.org

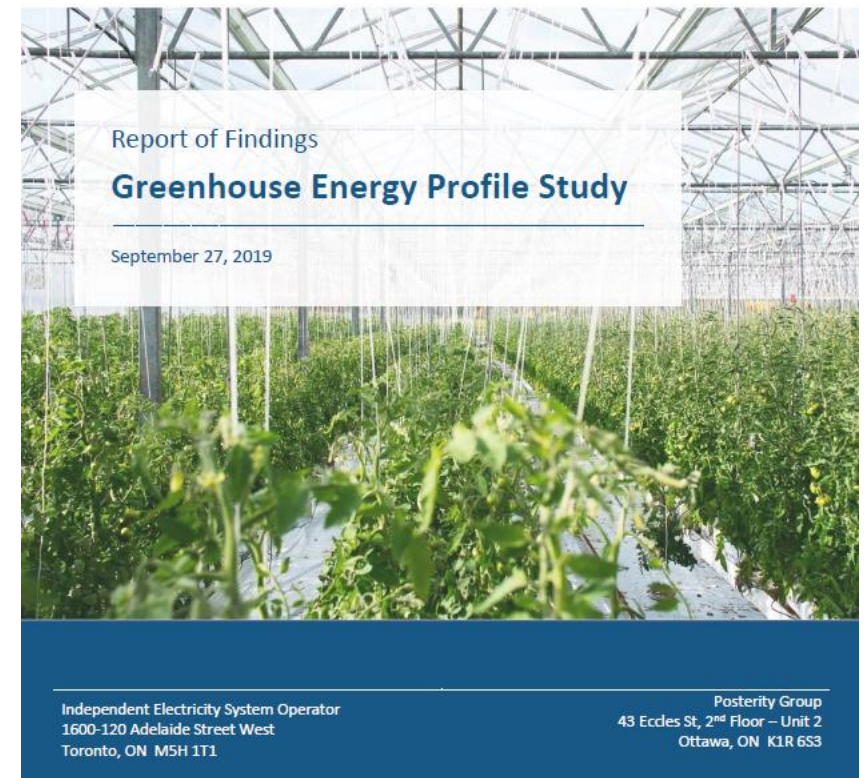


Benchmarks: grams/kWh



EISO CA Greenhouse Energy Profile Study

- One of the largest producers of greenhouse products in NA
- Ontario has the largest greenhouse sector in CA, with 60% of total national greenhouse area, and 70% of farm gate value.
- In 2016, Ontario greenhouse sector contributed \$3.2 billion to GDP and over 80,000 jobs.

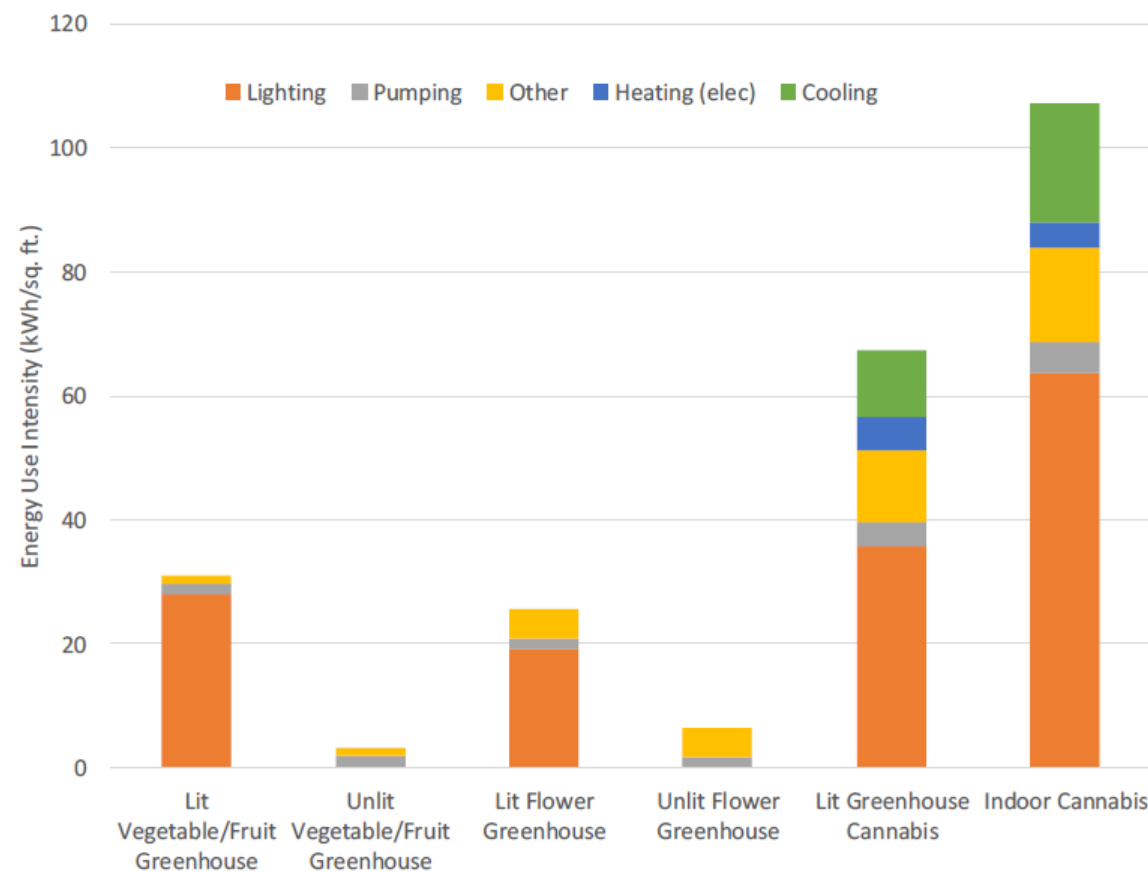


<http://ieso.ca/-/media/Files/IESO/Document-Library/research/Greenhouse-Energy-Profile-Study.pdf?la=en>

EISO CA Greenhouse Energy Profile Study

- Energy use in 4 Ontario CEA sub-sectors:
 - vegetables & fruits
 - flowers & potted plants
 - greenhouse cannabis
 - indoor cannabis
- Vegetable greenhouses are increasing being lit to meet increasing demand.
- Existing vegetable greenhouses that are being lit are expected to be a significant driver of electricity growth over the next six years.

Exhibit 6 – Electricity End Use Intensity by Facility Type (kWh/ft²)



Indoor cannabis facilities use more almost 3.5 times more electricity per square foot than lit vegetable greenhouses

Critical challenges to market transformation

- Lack of data + culture of secrecy
 - No documented best practices
- No existing policies or codes
 - To be applied to horticultural production facilities
- Inconsistent engagement by utilities and governments
 - Stakeholder engagement is needed
 - No financing for cannabis
 - Incentives are important



What are states doing in response?

- Cannabis regulations
 - Illinois
 - Massachusetts
 - California (Title 24 rulemaking process is ongoing)
- Proposed Photosynthetic Photon Efficacy (PPE) regulations
 - 2021 IECC (proposed by NBI)
 - C405.4 Lighting for plant growth and maintenance (Mandatory). Not less than 95 percent of the permanently installed luminaires used for plant growth and maintenance shall have a photon efficiency of not less than 1.6 $\mu\text{mol/J}$ as defined in accordance with ANSI/ASABE S640.
 - Will there be stranded assets?

Illinois Cannabis and Regulation Tax Act

Statute language (410 ILCS 705)



Lighting

1. The Lighting Power Densities (LPD) for cultivation space commits to not exceed an average of 36 watts per gross square foot of active and growing space canopy, or
2. all installed lighting technology shall meet a photosynthetic photon efficacy (PPE) of no less than 2.2 micromoles per joule fixture and shall be featured on the DesignLights Consortium (DLC) Horticultural Specification Qualified Products List (QPL).
3. In the event that DLC requirement for minimum efficacy exceeds 2.2 micromoles per joule fixture, that PPE shall become the new standard.



HVAC

1. For cannabis grow operations with less than 6,000 square feet of canopy, the licensee commits that all HVAC units will be high-efficiency ductless split HVAC units, or other more energy efficient equipment.
2. For cannabis grow operations with 6,000 square feet of canopy or more, the licensee commits that all HVAC units will be variable refrigerant flow HVAC units, or other more energy efficient equipment.

Massachusetts Cannabis Control Commission Regulations (935 CMR 500.000 and 935 CMR 501.000)

Lighting

Lighting used for Cannabis Cultivation must meet one of the following compliance requirements:

1. Horticulture Lighting Power Density must not exceed 36 watts per square foot, except for Tier 1 and Tier 2 which must not exceed 50 watts per square foot; or
2. All horticultural lighting used in a facility is listed on the current Design Lights Consortium Solid-state Horticultural Lighting Qualified Products List ("Horticultural QPL") or other similar list approved by the Commission as of the date of license application, and lighting Photosynthetic Photon Efficacy (PPE) is at least 15% above the minimum Horticultural QPL threshold rounded up to the nearest 0.1 $\mu\text{mol/J}$ (micromoles per joule).
3. A facility seeking to use horticultural lighting not included on the Horticultural QPL or other similar list approved by the Commission shall seek a waiver pursuant to 935 CMR 500.850 and provide documentation of third-party certification of the energy efficiency features of the proposed lighting.
4. All facilities, regardless of compliance path, shall provide third-party safety certification by an OSHA NRTL or SCC-recognized body, which shall certify that products meet a set of safety requirements and standards deemed applicable to horticultural lighting products by that safety organization.



Massachusetts Cannabis Control Commission Regulations (935 CMR 500.000 and 935 CMR 501.000)

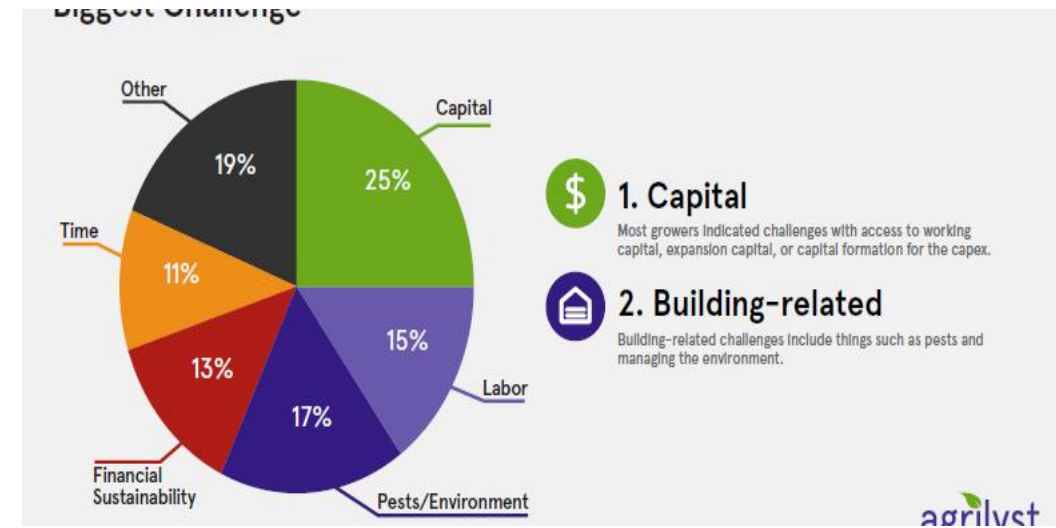
HVAC

1. Heating Ventilation and Air Condition (HVAC) and dehumidification systems must meet Massachusetts Building Code requirements and all Massachusetts amendments (780 CMR State Building Code), IECC Section C403 or ASHRAE Chapter 6 as applied or incorporated by reference in (780 CMR: State Building Code).
2. As part of the documentation required under 935 CMR 500.120(11) (b), a Marijuana Cultivator must provide a certification from a Massachusetts Licensed Mechanical Engineer that the HVAC and dehumidification systems meet Massachusetts building code as specified in this 935 CMR 500.120(11) (c) and that such systems have been evaluated and sized for the anticipated loads of the facility.
3. Safety protocols shall be established and documented to protect workers and Consumers (e.g., eye protection near operating Horticultural Lighting Equipment).



HVAC and CEA

- Growers need flexibility in choosing HVAC and dehumidification equipment
 - Engineers and manufacturers may not understand plant requirements
 - Growers may not understand HVAC limitations or design challenges
 - Capital and building related costs are grower's largest challenge
- Plants are complicated, dynamic organisms
 - Temperature, CO₂, humidity affect photosynthesis and evapotranspiration
 - Optimum vapor pressure deficit differs by crop and growth stage (vegetative vs. flowering)



☒	Cannabis Climate Solutions														
Temp °F	Relative Humidity														
	100%	95%	90%	85%	80%	75%	70%	65%	60%	55%	50%	45%	40%	35%	
87°	0.00	0.22	0.44	0.66	0.88	1.10	1.32	1.54	1.76	1.98	2.19	2.41	2.63	2.85	
86°	0.00	0.21	0.42	0.64	0.85	1.06	1.27	1.48	1.70	1.91	2.12	2.33	2.55	2.76	
85°	0.00	0.20	0.41	0.61	0.82	1.02	1.23	1.43	1.64	1.84	2.05	2.25	2.46	2.66	
84°	0.00	0.20	0.40	0.60	0.80	1.00	1.19	1.39	1.59	1.79	1.99	2.19	2.39	2.59	
83°	0.00	0.19	0.38	0.58	0.77	0.96	1.15	1.35	1.54	1.73	1.92	2.12	2.31	2.50	
82°	0.00	0.19	0.37	0.56	0.75	0.93	1.12	1.31	1.49	1.68	1.87	2.05	2.24	2.43	
81°	0.00	0.18	0.36	0.54	0.72	0.90	1.08	1.26	1.44	1.62	1.80	1.98	2.16	2.34	
80°	0.00	0.18	0.35	0.53	0.70	0.88	1.05	1.23	1.40	1.58	1.75	1.93	2.10	2.28	
79°	0.00	0.17	0.34	0.51	0.68	0.85	1.01	1.18	1.35	1.52	1.69	1.86	2.03	2.20	
78°	0.00	0.16	0.33	0.49	0.66	0.82	0.98	1.15	1.31	1.48	1.64	1.81	1.97	2.13	
77°	0.00	0.16	0.32	0.48	0.63	0.79	0.95	1.11	1.27	1.43	1.58	1.74	1.90	2.06	
76°	0.00	0.15	0.31	0.46	0.61	0.76	0.92	1.07	1.22	1.38	1.53	1.68	1.83	1.99	
75°	0.00	0.15	0.30	0.44	0.59	0.74	0.89	1.04	1.19	1.33	1.48	1.63	1.78	1.93	
74°	0.00	0.14	0.29	0.43	0.57	0.71	0.86	1.00	1.14	1.29	1.43	1.57	1.72	1.86	
73°	0.00	0.14	0.28	0.42	0.56	0.69	0.83	0.97	1.11	1.25	1.39	1.53	1.67	1.80	
72°	0.00	0.13	0.27	0.40	0.54	0.67	0.80	0.94	1.07	1.20	1.34	1.47	1.61	1.75	
71°	0.00	0.13	0.26	0.39	0.52	0.65	0.78	0.91	1.04	1.17	1.30	1.43	1.56	1.69	
70°	0.00	0.13	0.25	0.38	0.50	0.63	0.75	0.88	1.00	1.13	1.25	1.38	1.50	1.63	
69°	0.00	0.12	0.24	0.36	0.49	0.61	0.73	0.85	0.97	1.09	1.21	1.33	1.46	1.58	
68°	0.00	0.12	0.23	0.35	0.47	0.58	0.70	0.82	0.94	1.05	1.17	1.29	1.40	1.52	
67°	0.00	0.11	0.23	0.34	0.45	0.56	0.68	0.79	0.90	1.01	1.13	1.24	1.35	1.46	
66°	0.00	0.11	0.22	0.33	0.44	0.55	0.65	0.76	0.87	0.98	1.09	1.20	1.31	1.42	
65°	0.00	0.11	0.21	0.32	0.42	0.53	0.63	0.74	0.84	0.95	1.05	1.16	1.26	1.37	
Dr. GreenHouse															
Vegetative, VPD=0.80 to 0.95					Flowering, VPD=0.96 to 1.15					Stress, VPD=1.16 to 1.35					

Hort Lighting QPL:

- Supports a variety of stakeholders with verified performance metrics
- Brings clarity to an industry that has lacked standardization
- DLC invites stakeholder input
- Requires high-quality products:
 - 5 year warranty
 - Driver / fan lifetime: $\geq 50,000$ hours
 - $Q_{90} \geq 36,000$ hours

My grow light
is better than
yours



DLC Hort QPL helps Code Bodies and Utilities

- QPL ensures commercial products and licensees comply with lighting regulations
- Objective, 3rd party verified list limits staff need to be domain experts in horticultural lighting jargon and methods.
- Minimizes risk of misleading information or poor quality products

DLC Hort QPL helps Growers


- Objective, 3rd party verified list to use for product selection
- Consistent, relevant product information allowing an “apples to apples” comparison
- All products are high efficacy (1.9+ $\mu\text{mol/J}$)
- All products certified for horticultural environments
- Eligibility for utility rebates where available


DLC Hort QPL helps Manufacturers

- 3rd party verification adds credibility to product performance
- Single technical specification and QPL that provides eligibility to the utility rebate market
- DLC qualified fixtures may be referenced or required by new horticultural energy codes



<https://www.designlights.org/horticultural-lighting/search/>

Solid State LightingHorticultural LightingLighting ControlsCurrent EffortsNews and EventsResources



Horticultural Lighting

Search Results:

38

Results Per Page: 10

Customize ColumnsSort ByDisplay As Tiles

FILTER RESULTS

Clear All Filters

Manufacturer

Technical Requirements Version Number

Product Function

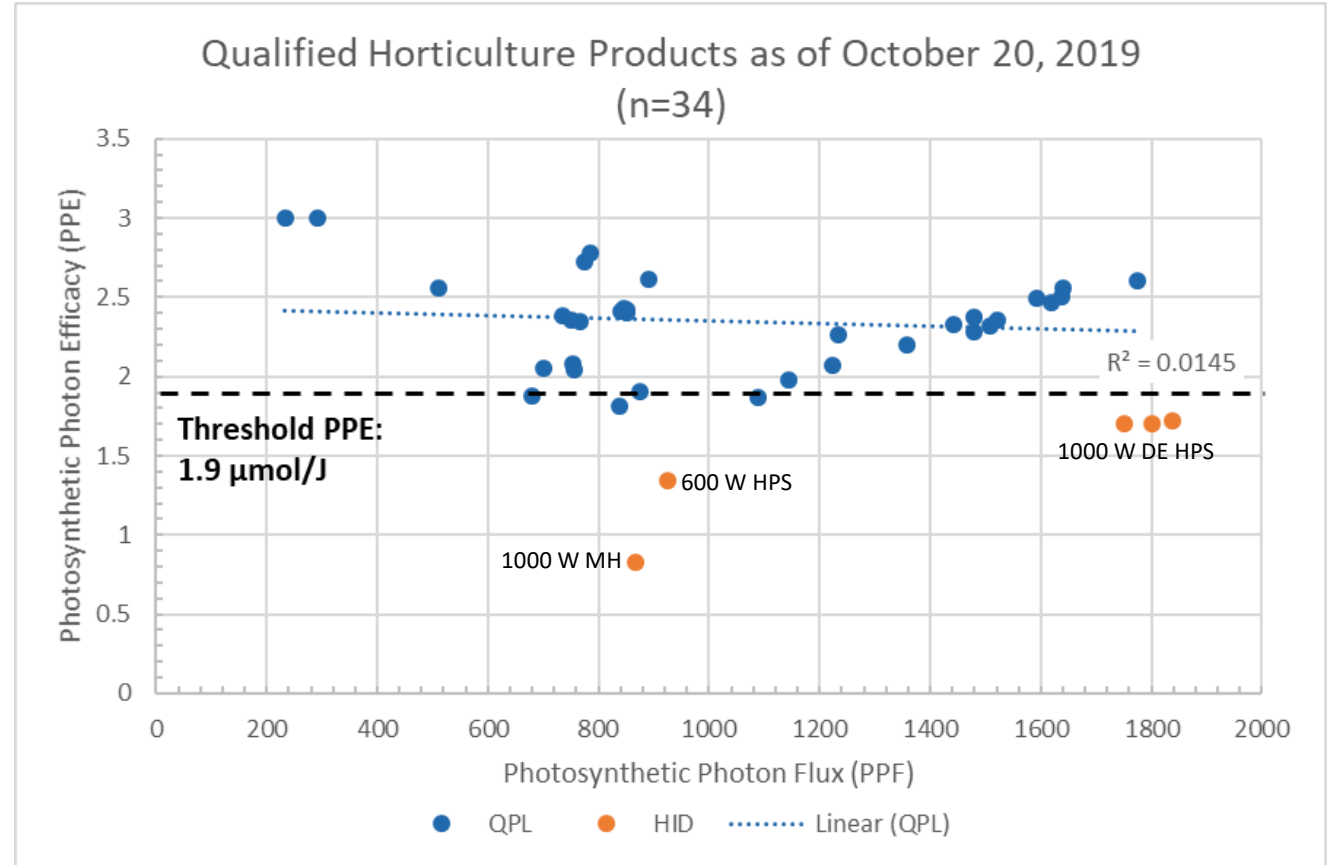
Product Categories

Company	Brand Name	Model Number	Photosynthetic Photon Efficacy (PPE)	Photosynthetic Photon Flux
All purpose LED Grow Lights international ltd	AELIUS LED	APGL-MGL-6-I-1	2.39	1519.15
All purpose LED Grow Lights international ltd	AELIUS LED	APGL-AELIUS-3-I-1-M-NL	2.38	734.52
California LightWorks	California LightWorks	GHPRO 340	2.61	890.09
Fluence Bioengineering	Fluence Bioengineering Inc.	SR-2X-I-x-xx-xxx-xx-x	2.4	851.04
Fluence Bioengineering	Fluence Bioengineering Inc.	VR-2X-G-x-xx-xxx-x-xx-x	2.43	844.9
Fluence Bioengineering	Fluence Bioengineering Inc.	VR-2P-I-x-xx-xxx-xx-x	2.47	1619.59

38 horticultural lighting products currently listed

PPF vs. PPE

- No systematic trend in PPE as a function of PPF
- Many available products that have comparable performance (flux) to incumbent 600 W – 1000 W HID
- Average QPL PPE is 2.35 $\mu\text{mol/J}$, which is 38% higher than 1000 W DE HPS





Thank you

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