RESOURCE INNOVATION INSTITUTE

CANNABIS ENERGY & ENVIRONMENT POLICY PRIMER

FOR FEDERAL, STATE AND LOCAL POLICY MAKERS AND REGULATORS

BY DEREK SMITH

Part of RII's Resource Efficiency Best Practices Series

APRIL 2021

CANNABIS ENERGY & ENVIRONMENT POLICY PRIMER FOR FEDERAL, STATE AND LOCAL POLICY MAKERS AND REGULATORS

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A report from Resource Innovation Institute

By Derek Smith

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OVERVIEW

As a primer, this document seeks to:

- **Offer background information** and pose questions for policy makers, governmental agencies, municipalities, and other stakeholders to consider when designing and implementing cannabis policies
- **Provide policymakers with guidance** on the complex topics related to energy and the environment

As a policy maker considering how to regulate cannabis energy and environmental issues, you have a lot of subject matter to contemplate, from land use to air quality to resource usage. Each of these issues has connections to other issues you are likely considering in your broader cannabis policy framework, including racial and social equity, public health and constituent attitudes toward the plant's historic association as an illicit drug.

Creating resource efficiency policies from scratch may feel daunting. Approaches and systems used for growing cannabis are diverse. Efficient equipment and strategies are evolving, and data is scarce. These factors provide challenges to government efforts to create high-performance benchmarks for equipment and resources used in cannabis cultivation around energy (lighting, HVAC, and dehumidification) water, and waste. Yet developing these policies may present opportunities for achieving meaningful energy and carbon reduction goals in your jurisdiction, continuing energy efficiency and decarbonization efforts already underway, or aligning with existing water and waste policies.

The decisions you make are important at a larger level. In a very real way, regulatory frameworks you establish, particularly those around energy use, may reverberate through many agricultural sectors well beyond cannabis into the future. For example, California's Title 24, Part 6, controlled environment horticulture codes and standards, expected to

take effect in 2023, apply not just to cannabis cultivation operations but to any "indoor" cultivation operation with a certain amount of energy load, be it a warehouse or a greenhouse, regardless of crop grown.

CALIFORNIA ENERGY COMMISSION

The California Energy Commission is preparing codes and standards for controlled environment horticulture as part of its Title 24, Part 6, Building Energy Efficiency Standards, to take effect January 2023

RESOURCE INNOVATION INSTITUTE

The Resource Innovation Institute (RII) is here to help. As an objective, data-driven non-profit organization, RII's mission is to advance resource efficiency to cultivate a resilient agricultural future. We achieve our mission by establishing standards, facilitating best practices and advocating for effective policies and incentives that accelerate resource efficiency. Our policy principles include:

1. Ensuring environmental outcomes and racial and social equity are advanced
2. Transforming the market toward a resource-efficient production model
3. Supporting producers in their efficiency transition

RII is available to provide free briefings to governments considering the issues in this primer.

RII Technical Advisory Council

RII's Technical Advisory Council (TAC) is a multi-disciplinary body facilitated by RII to aggregate knowledge and data to support producers, governments, utilities, standards bodies and other stakeholders with objective, peer-reviewed information on cultivation resource use and quantification of performance. RII's TAC:

- Provides guidance on development of standards
- Shapes tools and resources to support best practices
- Informs advocacy on policies, incentives and regulations

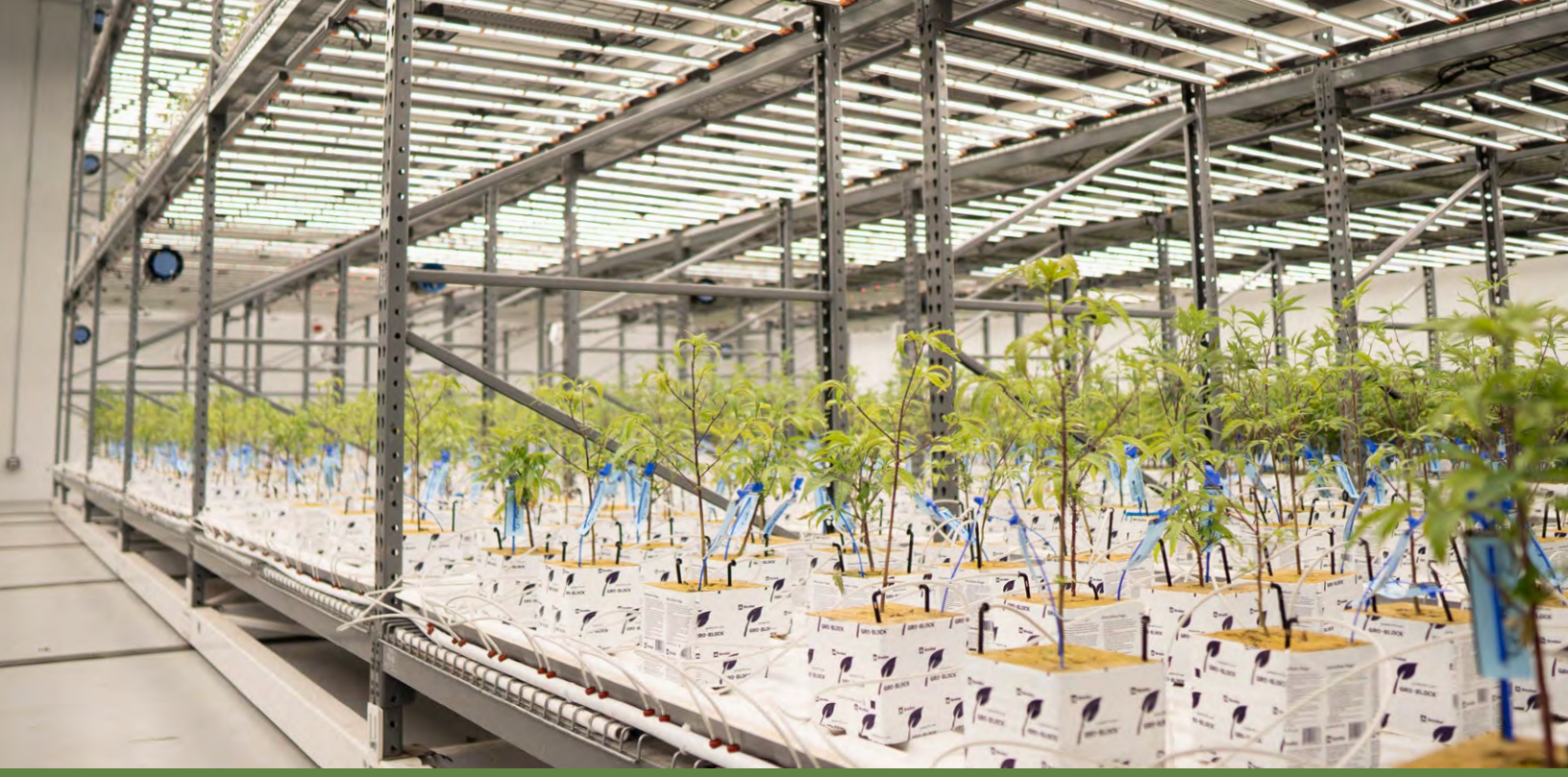
The RII Policy Working Group

The RII Policy Working Group (PWG) was convened in October 2020 with a charter to:

- Help articulate RII policy positions on topics related to cannabis cultivation, including energy, climate, water and waste
- Advise RII on strategies to share effective and consistent policies and frameworks
- Influence, respond and react to policy actions by different jurisdictions

The PWG met monthly through Q4 2020 and Q1 2021 to discuss topics related to energy, water, and waste as it influences cannabis operations and developed this primer for policy makers. The Policy Working Group is made up of policy makers, cultivators, design and construction professionals, non-profit organizations and other subject matter experts. A full list of Policy Working Group members is included in this document.

Members of RII's Technical Advisory Council HVAC and Lighting Working Groups gather at the 2019 MJBizCon to release peer-reviewed best practices guides.



PURPOSE

The purpose of the Cannabis Energy & Environment Policy Primer is to support you, the policy maker, and your government as you consider how to engage in energy and environmental issues related to commercial cannabis cultivation.

This primer emphasizes policy actions taken in the United States because there are multiple active efforts being undertaken in several states. However, this primer is also relevant to other countries as well as local jurisdictions. Multiple technologies, policy considerations and implementation pathways are discussed throughout.

While the intent of this primer is to provide an objective assessment that can guide your decision-making, as opposed to overly prescriptive recommendations, we do have strong opinions about how you should approach policy making on energy and environmental issues.

1 Be clear about your goals

Is your main policy objective energy, or are you identifying energy issues as important because of climate leadership ambitions expressed by elected leaders? Are job creation and economic development considerations top of mind? Or is advancing racial and social equity pre-eminent? It will be in your interest to align your energy and environmental policies with your larger policy objectives.

2 Be data-driven

Because of the nascency of the market and the historical secrecy among cultivation operations, it is critically important to consider requiring energy and water

reporting. This is far and away the strongest and most universal feedback among stakeholders. It is typical that baseline studies precede regulatory action, yet the pace and scale of this market may encourage you to move more quickly. The efforts of market actors to work together to inform various audiences should provide confidence that usage reporting along with reasonable requirements is a fair approach.

3 Engage with a broad range of stakeholders

Rely on many sources of input given the early stage of the market and its history as a shadow economy. In particular, consider the impact on licensed operators who are not only attempting to run companies in what many have called the "most regulated market they've seen" yet also competing with unregulated illicit businesses. A wide set of market actors has experience with energy and environmental issues along a continuum of perspectives and is willing to contribute to well-facilitated dialogues that advance solutions.

4 Learn from the approaches of leading states

Stakeholders have had opportunities to engage in these early experiments. The long term implications of these policies are yet to be known, although advantages and disadvantages of the various approaches have emerged.

5 Recognize the importance of incentives, financing and training in addition to mandates

Because of the pace of innovation, the higher upfront costs of efficiency technology, and the need for cultivator and supply chain education and training, consider opportunities to coordinate code requirements, financing options and utility incentives so businesses have support affording efficient technologies. Also, look to incentive-based policy approaches like those advanced by some European governments.

6 Advance your economic interests

No matter the policy challenges these issues present, know that solutions to meet your interests exist. Perhaps most instructive, keep in mind that the more efficient the producers in your jurisdiction become, the more they will be able to compete as borders open for regulated commerce, and therefore the more likely they will return tax proceeds to your community for years into the future.

Cannabis cultivation comes in a variety of forms and provides tax proceeds to urban and rural communities.

EXECUTIVE SUMMARY

Energy, water, and waste can be significant factors and costs in cannabis operations. Many jurisdictions have greenhouse gas and other sustainability focused policies, and it can be a challenge for cannabis policy makers to understand these complex topics and ensure alignment with other policies.

This report is for policy makers seeking to understand these topics. It was prepared by the non-profit Resource Innovation Institute (RII). The report was guided by RII's Policy Working Group, and it includes input from a broad range of industry stakeholders.

Energy is one of the largest costs for cultivation operations along with real estate and labor, and a significant controllable cost. Lighting is a significant energy user, and effective LED technology that can reduce energy use has come to the horticulture market and is seeing greater adoption. Heating, ventilation, air conditioning, and dehumidification (HVACD) systems are essential for maintaining a proper environment for plant growth, and by installing and automating efficient systems, along with using LED lighting solutions, producers can reduce the energy from these uses. Some states have adopted regulations on both lighting and HVACD systems to reduce energy usage, and education for producers to better understand and utilize these technologies can help with adoption of efficient equipment.

- Consider adoption of lighting standards based on equipment efficacy and/or energy usage.
- Underscore importance of HVAC and dehumidification efficiency by including equipment specification as part of application process and through outreach to other regulators and policy makers.
- Consider strategies to preserve utility energy efficiency incentives.

- Provide training opportunities for operators to learn how to reduce energy usage through equipment choices and efficient operations.

Water is important for cannabis operations, and essential for plant growth. Understanding existing regulations around water sources, water uses like irrigation, and water discharge is important. Plant irrigation is the primary driver of water use, and grower implementation of efficient watering methods and water reuse can decrease water impacts. Waste water can also be a challenging topic, though an understanding that most water discharged from cannabis operations is organic waste, similar to many other sectors, can help reduce concerns about waste water processing. Working with local regulators to understand existing laws and educate growers on water efficiency are good places to start.

- Understand existing water regulations and work with regulator peers in the jurisdiction.
- Consider policies and education pathways that encourage water efficiency and reuse.
- Work with waste water regulators to understand considerations around cannabis operations and to develop informed monitoring policies.

Waste in cannabis operations can come from plants, consumer packaging and other sources. Policy makers may want to consider how plant waste can be processed though methods like composting to decrease impact on landfills. Security is important to ensure plant materials are not diverted, and it is also important to understand that parts of plants like roots and stems have negligible amounts of THC and may not require the same scrutiny. Security requirements also have an impact on consumer packaging, and policy makers may want to consider policies that maintain security, while allowing for packaging reductions, reuse and recycling.

- Work with waste regulators to understand current policies and to be in line with existing regulations.
- Preserve policy pathways that allow for composting and other alternative plant waste disposal pathways that do not require material mixing. Not all plant waste contains THC, so not all plant waste needs to be regulated.
- Consider policy pathways that encourage packaging materials to be made of recycled materials, be able to be reused, and be recycled. Allow for packaging flexibility for products in line with health and safety issues.
- Provide education resources for licensees.

Benchmarking and reporting can help regulators and producers understand and track energy and water usage in cultivation facilities, while also providing data to inform industry direction. Annual energy and water reporting is used in other industries and should be considered for cannabis operations by using online tools designed specifically for agriculture operations. RII is committed to a data collection and analysis policy that follows strict standards on data security, privacy and anonymization.

- Consider requiring annual benchmarking as part of license renewal process using agriculture specific benchmarking tools like the Cannabis PowerScore.

Racial and social equity is an important component of overall cannabis policy, and it is also an important consideration for energy and environmental topics. Compliance with energy and environmental regulations can place a financial, social, and resource burden on undercapitalized entrepreneurs.

- Policy makers may want to consider implementation support, varied implementation thresholds and timelines, and financial funding strategies when engaging with these applicants.

In general, **producer support systems such as education, incentives and financing** are critical policy tools to deploy alongside any regulatory requirements specifying the adoption of new technologies.



IMPORTANCE OF RESOURCE EFFICIENCY

(ENERGY, WATER, WASTE)

Governments have been involved with cannabis policy for decades, primarily through prohibition of cultivation, distribution and personal use. Prohibition led to clandestine means of production, often indoors, with cultivation practices passed down through an informal network. The general lack of regulated competition meant that producers could capture large profit margins. Optimizing resource efficiency has historically taken a backseat to stealth.

Now, as governments address regulation of legal cannabis commerce, including cultivation resource usage, there are a range of important associated topics to consider, from drug policy to social equity to access to healthcare.

Regulated cannabis is grown in a range of methods outdoor, indoor and greenhouse - and in a variety of environments, from hot arid climate zones to cold weather geographies. When considering policy decisions, it should be understood that, in general, regulated cannabis cultivation has less environmental impact than illicit cannabis cultivation.

That said, cannabis cultivation can result in a range of environmental impacts, from significant energy use, to carbon and other greenhouse gas emissions, to water usage and waste diversion. Energy is generally the third largest cost for cannabis producers behind rent and labor, and the largest controllable cost. This means that a more resource efficient producer can have lower costs,

making them more competitive, and more likely to support ongoing job creation and tax proceeds that can flow to local communities.

Range of Impacts

Cannabis cultivation can have a range of impacts, from land use to air quality to light pollution and more. This document zeroes in on the topics most called out by governments to date: Energy, water and waste.

Some cannabis cultivators prefer to grow indoors to enable better control over environmental conditions, in pursuit of a higher quality product and to realize additional harvests and higher yields than outdoor cultivation. Indoor grows have been used for decades as a means to remain clandestine, and some legalized jurisdictions only allow for indoor cultivation without allowing for outdoor cultivation

Indoor cannabis cultivation uses significant amounts of energy and is one of the most energy intensive processes used in buildings, rivaled by data centers. Energy use in cannabis is driven by the use of intense horticultural lighting, heating ventilation and air conditioning (HVAC), and dehumidification systems.

Greenhouse and warehouse cultivation are similar in that they provide greater control of the environment, though their sources of energy often differ. Greenhouses use natural daylight to grow crops, though in many cases they also use supplemental electric lighting. Greenhouse cultivation can produce high-quality cannabis; some operators use the sun as the lowest cost lighting technology available to them. Greenhouses can come in many forms from seasonal hoop houses to ventilated structures to highly sophisticated and automated year-round operations that require heating and cooling. It is important to understand that simple statements like "greenhouses are more efficient than indoor grows" may not be true across a range of geographies, fuel mixes and cultivation methodologies.

Water is necessary for plant growth and is used throughout cultivation operations. Waste is produced from discarded plant material, cultivation supplies and packaging for a range of finished products.

Impact of Resource Efficiency on Producers and the Community

Efficient practices related to energy, water and waste can have a significant impact on a producer's bottom line, and using fewer resources can make a company more competitive. Additionally, resource efficiency aligns with energy and environmental goals put forth by states, municipalities, federal governments and the United Nations. Managing natural resources is important to building healthy local economies, ensuring the consistency of long term tax revenues, and making sure there are adequate resources to support multiple community and commercial uses.

The Challenge of Getting Resource Efficiency Policy Right

This primer is designed to be a document that raises topics, poses questions, provides information, and shares stakeholder positions. In 2021, the cannabis industry still

ENERGY AND WATER BENCHMARKS FOR NORTH AMERICA INDOOR, GREENHOUSE AND OUTDOOR CULTIVATION "ALL FUELS."

	Facility Energy Efficiency (kBtu / flowering canopy square foot per year)	Facility Energy Productivity (grams per kBtu)	Facility Water Efficiency (gal / flowering canopy square foot per year)	Facility Water Productivity (grams per gallon)
Indoor	2,450	0.1	187	5
Greenhouse	8,130	0.16	80	2
Outdoor	3.5	3.3	10	3

Source: Resource Innovation Institute Cannabis PowerScore Ranked Data Set efficiency and productivity KPIs.

faces challenges on many fronts, and resource efficiency is no exception. This is not a best practices guide because the industry is still working to develop standards and highlight exemplars.

This is a fast moving and dynamic industry, and it is being re-sculpted using many of the practices of the illicit industry that came before it. This new period of legalization is the first time there has been broad convening of groups focused on best practices in facility design and resource efficiency. Governments and utilities are often not considered by producers as trustworthy partners. Likewise, producers express frustrations about being treated like criminals despite newfound legal status. These relationship dynamics have made productive dialogue challenging.

Typical grow operations have evolved in their technology use over time by adapting technologies from other uses and industries. This means that there is not yet standardization in this industry, and it is common to see different growers specifying different technologies and environmental conditions when specifying their operations. On top of that, new more efficient technologies are being introduced, and the industries that serve the cultivation sector (HVAC manufacturers, architects and others) are continuing to develop standards for cannabis cultivation.

It is important to consider the position of producers, policy makers and the industries serving cultivation operations. The goals are aligned - make the highest quality product using the optimal amount of resources in order to create a long term and stable industry. However, there are still questions on all sides about how best to accomplish this. Because of this state of the market, it is important to encourage resource efficiency while balancing with an understanding that practices are still being worked out by multiple actors. It is for these reasons that this primer explicitly brings forward generally consensus views from multiple stakeholders while refraining from overly prescriptive recommendations.

Cultivator Sam Johnson (far right) presents alongside HVAC engineers and manufacturers who contributed to RII's peer-reviewed HVAC Best Practices Guide in Las Vegas at an event associated with MJBizCon 2019.

Several US states that have taken action on energy and environmental issues are profiled in this primer.

WORK OF US STATES TO DATE

This primer is published in April 2021 and contains a summary of programs and policies implemented to date. This industry is changing and evolving rapidly as more states and countries legalize cannabis. At this time, multiple US states have implemented or considered regulations on energy, water, and waste for cannabis cultivation including the following:

Energy

- California
- Illinois
- Massachusetts

Water

- California
- Illinois
- Most states rely on existing state and local water and wastewater regulations

Waste

- California
- Colorado
- Oregon
- Maine
- Massachusetts
- Washington

RII's Policy Working Group has reviewed the policies in place or being considered in leading states and has developed a compendium of these policies along with an analysis of these approaches.

California

California has adopted regulations for cannabis water and waste and is in the process of adopting building energy codes for energy use in indoor cultivation. California's enabling statute, proposition 64, makes note of mitigating and regulating water and other environmental impacts.

California started work on the energy front by hosting a state-sponsored stakeholder workshop exploring the energy impacts of cannabis cultivations. From that point, California has focused on addressing the energy use from all controlled environment horticulture (cannabis included) operations through its building codes process. This process is currently underway and if enacted, would take effect in 2023.

California has proposed energy standards for horticultural lighting. Photosynthetic photon efficacy (PPE) is a compliance path where lighting fixtures will need to meet efficacy standards based on the industry standard measure of micromoles per joule (µmol /J) and code standards would need to meet thresholds of indoor 1.9 µmol/J, greenhouse 1.7 µmol/J for facilities with more than 40 kW connected load. Other standards include dehumidification that must meet specific efficiency standards, and conditioned greenhouses building envelope standards are being updated (more details can be found via this link). This codes process requires up front research to prove cost effectiveness, approval from the state energy agency, and then approval from the state Building Standards Commission overseeing building codes.

Advantages of this approach include the clear and open stakeholder process, focus on the primary drivers of energy use in indoor cultivation, development of clear code standards, regular updates to the code process, and ease of replicability. Disadvantages of this process include the longer time to vet and implement as opposed to a legislative process, and that the code will only apply to new facilities, additions, and use type alterations built after the code is enacted.

California has enacted standards around water use for cannabis cultivation. These standards focus on maintaining instream flows and protecting water quality.

California has also enacted policies related to waste, though has different paths for cultivation, manufacturers, and testing facilities. Cannabis licensees are responsible for tracking plant waste that is generated from cannabis cultivation operations and can compost waste from their operations without mixing with other waste, whereas cannabis processors have different waste requirements.

Cannabis and stonewool growing media are considered organic solid waste and need to meet state requirements for composting of organic waste materials. California has goals for landfill diversion of 75% of organic waste by 2020. Cannabis producers that generate two or more cubic yards of organic waste per week must either compost on-site, self-haul to a facility that recycles organic waste, or have it picked up by a hauler that recycles organic waste.

Colorado

Colorado has addressed water, waste, energy and air either through regulations or best practices. The enabling legislation in Colorado, constitutional amendment 64, does not specify energy or environmental considerations.

Energy use for cannabis cultivation is not regulated in Colorado, however the state and municipalities have studied the topics and started programs to help growers become more energy efficient. In 2018 the Colorado Energy Office commissioned a report entitled Energy Use in the Colorado Cannabis Industry, which explored energy and water efficiency and made recommendations on best practices for producers to consider.

Additionally, in 2020 the energy office launched the Colorado Cultivators Energy Management program, which provided no-cost resources to cannabis producers and rural electric cooperatives to better understand opportunities and best practices for energy use. The Colorado Department of Public Health and Environment provides several resources for cannabis operations to explore best practices on energy, air, water and waste and has also launched a program that promotes reuse of carbon dioxide from breweries into cannabis operations.

The City of Denver Department of Public Health & Environment convened a Cannabis Sustainability Working Group in 2016 that explored topics around energy, air, water and waste and how to encourage compliance with the city's climate, energy and sustainability goals. As a result of this working group, the city of Denver has adopted amendments to their building codes for lighting (Section C405.3.3 on page 548) and cooling/dehumidification (Section C403.13 on page 546). For lighting, the city requires that 80% of total watts of lighting used for plant growth to be provided by lighting fixtures/luminaires meeting efficacy of 1.6µmol/J or bulbs/lamps that meet 1.9 µmol/J with efficacy verified by either listing on the Design Light Consortium's Horticultural Qualified Products List or third party verification. This code will allow the use of double ended HPS lighting and is in line with a proposal in the 2021 International Energy Conservation Code.

Boulder County implemented the Energy Impact Offset Fund in 2018, which requires producers to offset their electricity use with local renewable energy, or pay a 2.16 cent charge per kWh. Boulder County also sponsored a voluntary "Carbon Conscious" certification that will allow consumers to select certified products.

Advantages of the Colorado approach include strong involvement from state and local energy and environmental offices, a thorough stakeholder approach, and encouragement of best practices. Disadvantages of this process include lack of clear requirements on topics other than waste, with most information being provided as suggestions or best practices.

Colorado has focused on developing and sharing best practices related to water use. In Colorado there are ongoing discussions on topics related to water rights from sources, and what can be used as a source. Existing laws allow for reuse of water in hemp operations, however, it is unclear how reuse of water inside THC-containing cultivation operations is regulated.

Colorado has emerged as a leader on topics related to waste in cannabis operations. In 2020 Colorado undertook a stakeholder process to update their regulations (see pages 96 and 102), and made a number of changes specifically related to waste. Colorado allows multiple paths for plant waste including 50/50 mixing with other materials, as well as composting and anaerobic digestion of unmixed waste. Colorado also made changes to their consumer waste regulations to allow for reuse of consumer packaging.

Colorado will continue to pursue energy efficiency strategies and incentives for the cannabis industry to support its aggressive climate change goals.

Illinois

Illinois passed an adult use cannabis law though HB1438 which included specific provisions for energy, water, and waste related to cannabis operations.

Energy use standards are explicitly stated in the statute text and provide requirements for cultivation lighting and HVAC systems. The lighting requirements include requirements to meet a 36 watts per square foot lighting power density of active and growing space canopy standard or 2.2 µmol/J efficacy standard and be listed on the Design Lights Consortium (DLC) Qualified Products List (QPL). Depending on size, HVAC systems must be high-efficiency ductless split HVAC units or variable refrigerant flow HVAC units, or other more energy efficient equipment. Energy use reporting is also required in statute.

Advantages of this approach are that energy and water standards are specified in statute and may be updated by rule. However, the stakeholder process that led to the development of the requirements is unclear, some of the prescriptive HVAC technologies are difficult for producers to understand and effectively implement to meet cultivation needs, and the process for revisions and rule making is unclear. It should be noted that setting energy standards effectively creates equipment baseline measurements, which can impact the amount of financial incentives that utility energy efficiency programs can offer to offset costs for more efficient equipment.

The statute in Illinois also requires a plan that discusses how a cultivation operation will meet their water needs, including estimated water draw and if it will adopt a sustainable water use and conservation policy. Cultivation operations commit to using water efficiently and commits to using automated water systems including drip irrigation and flood tables. Cultivation water use runoff must be measured and limited to no more than 20% runoff. Finally, a producer commits that wastewater including HVAC condensate, dehumidification, and watering runoff will be captured and filtered for subsequent irrigation use.

Illinois requires that plant waste be rendered unusable and disposed of in line with state standards. Consumer packaging must be accepted by the licensee for recycling.

Massachusetts

Massacusetts has taken the most comprehensive approach to setting regulations and promoting best practices in the areas of energy, water and waste, including requirements for annual energy and water benchmarking and reporting. The statute in Massachusetts gives the Cannabis Control Commission authority to set energy and environmental standards, and also created an Energy and Environmental Working Group made up of the Commission and executive agencies to develop policies and seek stakeholder feedback.

All facilities, from retail to cultivation, have to meet certain energy requirements as part of licensure. These include identifying energy use reduction opportunities, considering renewable energy opportunities, engaging in strategies to reduce electrical demand, and participating in utility run energy efficiency programs.

For producers, energy regulations and guidance address several areas including building envelope, lighting, HVAC / dehumidification, and annual benchmarking and reporting. Information on how these standards are being met by producers must be submitted as part of initial licensure.

All cultivation facilities, except greenhouses, must meet building code requirements for building envelope and demonstrate compliance.

Massachusetts was the first to deploy lighting standards and has proposed two paths for producer compliance. Cultivators may choose to meet a standard of 36 watts per square foot for horticultural lighting (or 50 watts per square foot for operations under 10,000 square feet), which gives flexibility for growers to choose technologies to meet the standard.

Alternatively, producers can meet the standard by using LED lights that are listed on DLC QPL, and meet a threshold of 15% above the minimum DLC QPL threshold (currently that means the requirement is 2.2 µmol /J). HVAC / dehumidification equipment is required to meet state building code and substantiated by a letter from a mechanical professional engineer. Cultivators may be exempted from the lighting and HVACD regulations if they can demonstrate that 80% of energy use is generated onsite.

Massachusetts also requires annual energy and water reporting, specifies the Cannabis PowerScore platform, and documentation needs to be submitted as part of annual licensure. This approach benefitted from a comprehensive strategy, engagement with state agencies, stakeholder feedback in developing policies, use of regulations and guidance to give flexibility for updates, and the use of annual reporting to keep producers focused on energy.

Importantly, Massachusetts also invested in producer support systems, including funding a series of efficient cultivation workshops as well as upgrades to the Power-Score that enabled streamlined energy and water reporting.

While Massachusetts's energy requirements established a useful model for how other jurisdictions may consider addressing energy issues, the market challenges resulting from these unprecedented actions should not be overlooked. Confusion about how to comply, and frustration with being steered toward unfamiliar technology at higher costs, coupled with impacts on utility incentives at a stage in the market when financing was hard to come by, were expressed by stakeholders.

Massachusetts has issued guidance on best management practices for water use, with which producers must comply. This document provides background information and considerations on multiple topics related to water. Information is given in regard to water sources and existing regulations. There is a discussion about best practices for irrigation. The document also discusses wastewater considerations including water reuse. Finally, the document points producers to other resources offered by the state. Regulations in the state also address water use, with reference to existing regulations around water and wastewater.

Waste is also addressed in regulations and guidance. Massachusetts has a waste disposal ban regulations which require composting for certain types of waste, and cannabis is subject to this waste ban if more than one ton of waste is generated per week. This means that cannabis would need to be composted or submitted to an anaerobic digestion facility. Massachusetts requires that cannabis waste be mixed with other types of waste to render it unusable before disposal or composting. The state also requires that records be kept for three years documenting waste disposal, and that the disposal process be witnessed by two agents of the licensee. The guidance document provides resources on how to meet mixing requirements and partner with waste haulers who can provide these services. The document also provides information on how to manage hazardous waste generated by licensees. Finally, there is guidance provided regarding materials selection for consumer packaging.

Other US states

Oregon

Oregon requires that new cannabis licensees estimate their energy use and the state Department of Energy has developed an Indoor Cannabis Cultivator Energy Use Estimator for this purpose. The legislature is also considering a bill that would support energy and water use benchmarking for cannabis and hemp cultivation and the establishment of usage baselines, performance standards and leadership recognition opportunities.

Vermont

The bill to legalize adult use cannabis sales in Vermont includes specific provisions for energy efficiency and water uses to be studied. The Executive Director of the Cannabis Control Board, will consult with state agencies and will recommend energy or efficiency requirements or standards for the operation of cannabis establishments in the State. The recommendations shall include: 1) Recommended building energy standards for cannabis establishments if different from existing commercial building standards; 2) Recommended energy audits for cannabis establishments, including the recommended frequency of audits and who should perform the audits; and 3) Energy efficiency and conservation measures applicable to cannabis establishments.

IMPLEMENTATION PATHWAYS

As policy makers consider taking steps around resource efficiency it is helpful to consider the multiple tools at their disposal and which tools serve the best purposes.

Statute

Some states introduced the concept of resource efficiency in their enabling statute. Statutes are good for introducing a framework to consider or to require resource efficiency without being overly specific. Some of the states that have addressed resource efficiency in their statute include Massachusetts, Vermont, and Illinois.

Massachusetts, though the law at M.G.L. Chapter 94G, addresses resource efficiency by granting the Cannabis Control Commission authority to set energy and environmental standards, and further the enabling statute at St. 2017, c. 55, § 78 (a) & (b) requires the Commission to establish energy and environmental standards and convene a working group to provide recommendations to the Commission. This process brought in state energy and environmental agencies and relevant stakeholders to shape regulations and guidance.

Vermont, through Act 164, includes specific provisions for energy and water use to be studied by state officials, and then makes recommendations to the General Assembly for requirements or standards.

Illinois took a different approach in Public Act 101-0027, which inadvertently has created some confusion in the marketplace. The statute prescribes specific equipment standards for lighting and HVAC, but does not make clear how these standards can be updated. As a result,

some facilities are moving forward with their own solutions that may meet the needs of growers, though may not be in compliance with statute. Reporting is also required, though without specificity.

Regulations, Rules, etc.

Some states have addressed resource efficiency implementation more specifically in state regulations, also known as rules in some jurisdictions. These allow agencies to build on existing laws, and because regulations can be updated without the legislature, this allows policy makers to set specific requirements and then update if the need arises. Massachusetts, Oregon and Maine, and California are four states that have used this pathway.

Massachusetts published 935 CMR 500 and has updated these regulations more than once since adult use sales have commenced. The regulations outline a pathway for energy and environmental compliance from the application phase through operations, and provide specific requirements for compliance.

Colorado has included information about cannabis waste as part of their rulemaking in 1 CCR 212-3, and through workgroups with stakeholders was able to update the rules to better align with the industry.

Maine, through 18-691 C.M.R. ch. 1, made specific rules in how to process cannabis waste.

California has undertaken the process of considering cost effective codes for adoption in the Controlled Environment Horticulture (CEH) space. The California Energy Commission (CEC) is the state's primary energy policy and planning agency. The Codes and Standards Enhancement (CASE) initiative, sponsored by five of the state's utilities presents recommendations to support the CEC as they update the California Energy Code (Title 24, Part 6) to include new requirements or to upgrade existing requirements for various technologies, including Controlled Environment Horticulture. The proposals under consideration include standards for horticultural lighting, efficient dehumidification, and greenhouse envelope standards. This standards process was started in 2018, and if codes are adopted they will go into effect in 2023.

Local building codes, like those adopted in Denver, can also be a path for states and municipalities to address resource efficiency.

Voluntary certifications like Boulder's "Carbon Conscious" certification or the Massachusetts Energy and Environmental leader designation can also complement regulatory requirements.

Guidance

Guidance is a place where some parts of rules and regulations can be further specified, or used to provide more specific explanations of how to comply with the state's regulations. As an example, Massachusetts used their Energy and Environment Compiled Guidance to specify the use of RII's PowerScore tool as the annual energy and water reporting mechanism. This guidance also provided best practices and more clarity on how to comply with energy, water and waste regulations, provided information about other regulations in the state, and linked to educational resources.

Best Practices

Some resource efficiency items may be best addressed in best practices. Some states, like Massachusetts, require licensees to comply with state published best practices in areas including Integrated Pest Management. Other states, like Colorado, have provided educational resources, not requirements, in a number of subject areas to help advise license holders into steps they can take to conserve resources. Also some municipalities, like Denver, have published the "Cannabis Environmental Best Practices Guide" as a resource to growers in the City.

Educational resources can be very helpful for producers to navigate government regulations and to learn about best practices in cultivation. RII has developed a number of best practice guides in the areas of LED lighting and HVAC. Further RII received a grant from the Commonwealth of Massachusetts which led to the publication of "Energy Efficiency Best Practices for Massachusetts Marijuana Cultivators" as well as RII working with energy efficiency program administrators to organize the Massachusetts Efficient Yields workshop series focused on energy efficiency, LED lighting, and HVAC best practices.

In Michigan, Consumers Energy and the Lansing Board of Water and Light worked with RII to engage their producer customers via three virtual Efficient Yields workshops focused on energy efficient facility design, lighting, and HVAC.

Funding Support

It is also important to consider how implementation and enforcement of any regulations on resource efficiency will be funded. A regulation may meet a policy maker's needs, though if it is not enforced, then compliance may not be a priority for growers.

RACIAL AND SOCIAL EQUITY

Throughout this document there are references to equity applicants and undercapitalized entrepreneurs (UEs). Undercapitalized entrepreneurs are small businesses, though not all small businesses are UEs and not all equity licensees are truly UEs in some states. Here's how UEs are defined according to a NuLeaf Project definition:

- Small businesses owned by Black, Indigenous and Latinx entrepreneurs
  NOTE: These groups are called out specifically and are not synonymous with Black, Indigenous and People of Color (BIPOC) entrepreneurs, or entrepreneurs of color. Both terms, BIPOC and entrepreneurs of color, include all non-white entrepreneurs, including several highly capitalized racial/ethnic groups. For example, Asian-American entrepreneurs invest the most capital in their startup businesses, outpacing the capital investment of white entrepreneurs by 1.5 times.
- Veterans
- People living with disabilities
- To some degree female entrepreneurs, especially if the female entrepreneur is facing another socio-economic hurdle like LGBTQ+ identifying

This document has been written with the intent of addressing topics that pertain to racial and social equity and ensuring that considerations be given to undercapitalized entrepreneurs. RII has partnered with NuLeaf Project to review this document and add areas of consideration for policy makers.

NuLeaf™ PROJECT

NuLeaf Project is an Oregon-recognized non-profit who describes its work as unapologetically building generational wealth for Black and Brown people through the legal cannabis industry. NuLeaf is supported by the City of Portland's historic reinvestment of cannabis tax revenue into repairing the disproportionate harm done to Black and Brown communities as a result of cannabis prohibition and the war on drugs.

Each section of the document has a segment titled Racial and Social Equity that highlights specific considerations for policy makers. A number of these emerged including:

- Providing high touch and medium touch implementation support for undercapitalized entrepreneurs. Regulations around energy, water and waste can incur additional costs for operators, and may require specific expertise to implement and be in compliance with regulations. Undercapitalized entrepreneurs may not have significant social capital, financial capital, or the bandwidth to understand these topics and ensure compliance. No-cost implementation support will help these operations bridge the gap and be in compliance.
- Consideration of different requirements and implementation timelines. Some requirements can create burdens on undercapitalized entrepreneurs, and allowing flexibility in requirement thresholds and implementation timelines can help mitigate these burdens.
- Reducing costs for undercapitalized entrepreneurs. Compliance with energy and environmental regulations can create additional costs for operators, and consideration should be given to implementing policies that help reduce these costs for undercapitalized entrepreneurs. Options may differ based on the topic, and some areas of consideration include: preserving energy efficiency incentives for more efficient equipment, creating financial grant pools funded by cannabis taxes, allowing for flexibility with some packaging requirements to reduce costs, and reducing license and/or application fees for compliance with energy and environmental regulations.

ENERGY POLICY TOPICS

Energy is a critical topic to address because of the significant consumption by indoor producers, the stresses on energy delivery systems, and the associated carbon emissions impacts.

To minimize energy consumption, you should consider allowing outdoor cultivation of cannabis, particularly if your jurisdiction is in a climate zone where outdoor cultivation is normal practice for other crops. As you contemplate the allowance of field cannabis farming, know that solutions to constituent concerns, such as odor and safety, can be found through a range of technologies and techniques. Also, consider that other agricultural operations generate similar issues (e.g., manure fertilizer, dairy operations). And, if climate policy is your aim, promotion of regenerative soil practices will be important. Outdoor cultivation operations may have issues complying with testing requirements due factors that include soil contamination and pesticide drift and these topics should be discussed with stakeholders in your jurisdiction.

The reality is the allowance of field farming will likely not eliminate consideration of energy issues given general trends across agriculture of field farmers turning toward various forms of indoor cultivation to deal with climate risk and to advance productivity.

The importance of local zoning decisions

Local governments are critically important to advancing energy and environmental issues because they make decisions associated with time, place and manner of production. Many cities choose to concentrate indoor cultivation operations in industrial zones.

Sometimes, this co-location strategy results in unintended consequences. The City of Denver has studied air quality and environmental justice impacts related to the mix of pollutants generated

by a combination of cultivation facilities, other industrial operations, freeway interchanges in proximity to communities of color. Communities in Oregon have experienced power outages because of overloaded electricity infrastructure.

In Santa Barbara County, where wineries have become a major economic force over the past few decades, nuisance complaints stemming from outdoor and greenhouse grown cannabis odors have pitted farm operations against farm operations. In Southern Oregon and Humboldt County California there have been battles between farmers of the same plant - THC farmers concerned with genetic and pollen drift from CBD hemp farmers that can impact THC crops.

It should be understood that your decisions don't need to be as simple as "allow" or "don't allow." Coordination across regional layers of governments, zoning decisions, cultivation best practices, required filtration and other strategies can mitigate these types of challenges.

Lighting

As you wade directly into energy issues, lighting will be a logical place to start. Lighting is the primary driver of energy use in a facility. Lighting is a critical part of cultivation because it is needed for plant photosynthesis and growth. Cannabis plants in indoor grow operations may receive light 12-24 hours a day, depending on the growth stage and cultivator preferences.

Typical lighting used for indoor cultivation (above left) is considered high intensity lighting. When compared to a standard 60w equivalent LED screw in lightbulb, a double ended high pressure sodium (HPS) grow light can be 50 times brighter and use significantly more energy (~1050 watts vs. ~9.5 watts).

Lighting technologies - LED Lighting

LED lighting is an efficient full spectrum lighting technology that is rapidly innovating. LED lighting for horticultural uses has been available in the market for about 10 years, though only recently has been generally considered to meet the needs of commercial growers and started replacing traditional HPS technologies on a large scale. This means that many growers are in favor of the technology, though at the same time, many still have trepidation about adopting the technology.

Proponents of the technology point to increased yields, quality of the plant, and reduced energy costs. Opponents of LED technology believe it does not generate the same plant quality, point to higher initial costs for LEDs, think it is an unproven technology, and have concerns about the lighting spectrum that LEDs generate not being as effective as HPS.

Looking at pros and cons of LED technology, pros include that it is the most energy efficient technology available, and the technology is still progressing. Lighting equipment efficacy (the amount of light made per unit of energy) is measured in micromoles per joule (µmol /J). Many LED fixtures (luminaires) can meet thresholds of 1.9 µmol /J, with LEDs on the market in 2021 going as high as 3.7 µmol /J. Horticultural lighting technology is advancing rapidly toward its theoretical limit between 3.4 µmol /J to over 4 µmol /J (depending on the spectrum), and advances in the efficacy of this technology will continue. In contrast, double ended HPS luminaires will perform around 1.7-1.9 µmol /J, which is approximately the limit of this technology. This means LEDs use electricity more efficiently to create the same amounts of light the plant needs for growth.

Other pros of the technology include that LEDs generate less heat than legacy technologies, which has multiple impacts. HVAC systems can be smaller and not have to run as much to counteract the heat generated from the

lights, thus in turn saving the operator capital expenditures on construction as well as ongoing operating expenses. This also means that LED lighting will have the lowest lifetime energy costs among lighting technologies, and these fixtures can have a life of 5-10 years compared to HPS technology which sees bulbs replaced every 1-2 years. Because the heat generation is low, it means plants can be close to lights, which means that multi-layer (vertical) farming is possible with this technology. Over time, there will be more innovations with LEDtechnology that will lead to greater efficiency.

A study of the impacts of different lighting types on cannabis plants was published in March 2021 in the journal PLOS ONE. This study compared HPS and LED light fixtures and found that the lower percentage of blue photons found in HPS lighting led to 4.6% higher plant yield per unit area when using the same light levels. However, when comparing on a per dollar of electricity basis, LED fixtures produced as much as 27% higher yields than HPS. Cannabinoid production between both lighting types was comparable, with higher yields observed at higher light levels. This study suggests that efficacy of the lighting used and the light intensity at which it is operated is the more important consideration to improve return on investment than the spectral distribution.

Cons of LED lighting technology include higher initial costs, which can range from 2-5 times as much as HPS options. While these higher capital expenditures (CapEx) will be offset by lower operational expenditures (OpEx), the more substantial up front investment can be a barrier, especially for smaller operations owned by undercapitalized entrepreneurs who are often equity applicants.

LED solutions require newer cultivation techniques with which not all growers have comfort. Education and outreach to growers is important so they better understand how to grow with LEDs. RII has conducted training seminars and published resources for growers on how to adopt LEDs in their grows.

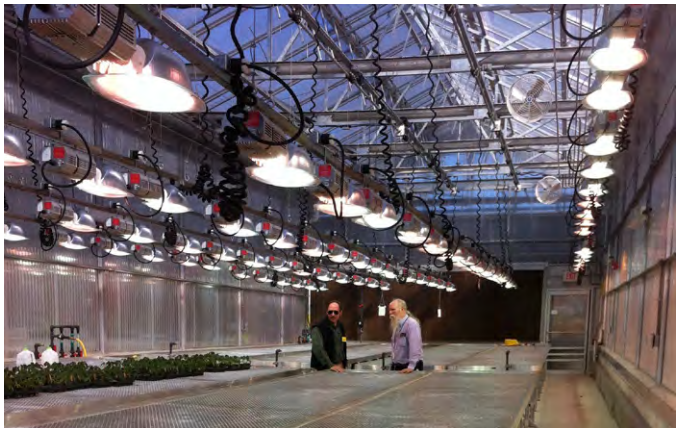
More information on LED technology for cannabis cultivation can be found in RII's LED Lighting for Cannabis Cultivation & Controlled Environment Agriculture Best Practices Guide and independent studies on horticultural lighting that have been compiled by RII on RII's website.

Lighting technologies - High Pressure Sodium and Metal Halide

HPS and Metal Halide (MH) technologies have been in use for nearly 50 years, and were adapted from 1970s streetlight technologies. Since then this lighting has been an industry standard in cannabis, with innovations made through the years to increase light output and make the fixtures more energy efficient.

Pros of this technology include that this technology has been an industry standard for so long that many growers are familiar with how to use this technology. HPS lights create a golden color profile, which many growers look for and believe makes a better product in the flowering phase. MH lights have been popular for use in vegitative phases due in part to its different spectrum from HPS. Also, HPS/MH lights tend to have lower initial costs than LED when assembling the fixtures.

Cons of this technology include the higher energy costs compared to LED, and there are also more regular replacement of consumable pieces; these consumables include bulbs/lamps (most growers replace them annually) and reflectors. These lamps don't have the same efficacy as LEDs, with HPS lamps ranging from 1.6 - 2.1 µmol/J,



Cultivating with high-intensity discharge (HID) lighting fixtures, as shown above, has long been an industry standard practice, particularly in the medical, grey and illicit markets. The more recent regulated market is quickly adopting LED lighting solutions.

metal halide lamps from 1.2 - 2.0 µmol/J, and fluorescent lamps about 0.9 µmol/J. This technology also creates more significant heat than LEDs, and plants need to be about three feet from the lighting fixture which means that vertical farming is not feasible. Because of this heat generation, most grows will require HVAC systems for cooling to offset the heat generated by the lights. Finally, HPS technology has essentially reached the limit of technology innovations, with ongoing enhancements being minor.

Safety guidelines for residential growing

Home growers operate high-wattage equipment in buildings not designed for cannabis cultivation. Some best practices for home grow electrical safety and maintenance:

- Verify service to residence with utility service providers and an electrician
- Ensure equipment complies with national standards and is properly maintained
- Growers should ask utility or electrician for help understanding how many circuits and outlets are needed to power your equipment and identifying necessary upgrades
- Keep plants happy with well-maintained HVAC systems; clean filters, verify controls perform
- Don't work 'hot'; turn off breakers
- Ensure grow areas are dry; turn off water
- Wear appropriate clothes & personal protective equipment like safety glasses and gloves
- Employ the right size components like fuses
- Avoid fire hazards by not stripping or splicing wires, splicing junction boxes together, or overloading circuit breakers and electrical outlets
- Avoid using metal ladders or touching metal piping
- Have a professional certify the safety of installations

Lighting Policy Compliance Paths

There are three different compliance paths that policy makers could consider for lighting regulations: lighting power density, photosynthetic photon efficacy, and energy productivity. Each will be explored below.

Lighting Power Density

Lighting Power Density (LPD) is a methodology used in building codes that measures the number of watts of lighting used per square foot. Because this is a standard used in many building codes, there is familiarity with lighting designers, and it is technology agnostic, which allows growers to choose a mix of technologies to meet a standard. This standard has been adopted in Massachusetts and Illinois, where 36 watts per square foot has been called out as a maximum threshold for the largest licensed facilities.

Applying LPD to horticultural operations requires a clear definition of canopy for the calculation (e.g., are aisles included, or just plant grow surfaces?). There is not an industry standard for this, and the calculation can vary by state. Lower LPD levels may encourage more efficient technologies and may push growers more specifically toward using LEDs to meet compliance. Manufacturers have their own industrial processes to make their products, similarly lighting is considered part of a cannabis operator's "process load" and as a significant contributor to the success of a cultivation operation, it is important to consider potential business impacts when establishing LPD limits.

Photosynthetic Photon Efficacy

Photosynthetic photon efficacy (PPE) is a compliance path where lighting fixtures will need to meet efficacy standards based on the industry standard measure of micromoles per joule (µmol /J). Massachusetts and Illinois use this as a compliance path, and California is considering this path as part of their energy codes process. The 2021 International Energy Conservation Code model language has a requirement that 95% of permanently installed fixtures/luminaires meet a photon efficacy of not less than 1.6 µmol/J.

Stakeholders generally consider this the best, most consistent metric the industry has at this time, and it is a more straightforward standard with simpler enforcement. This standard is also more applicable to both indoor and greenhouse scenarios. However, higher efficacy levels (1.9+) may limit growers to LED technologies, and there may be push back from some growers who resist being forced into one category. Also, setting a standard for efficacy can set a new energy equipment baseline, which can then impact the incentives utility energy efficiency programs can provide; these incentives can reduce initial costs for growers.

Specifying a PPE standard means that operators could choose more dense fixture placement and still be in line with a PPE equipment standard, but still using significant

energy. Therefore policy makers may want to consider compliance with both a PPE and LPD standards; PPE ensures efficient lighting equipment, LPD ensures that installation meets energy thresholds.

Growers sometimes use low-watt fluorescent lights in the early stages of growing (propagation), which are lower cost than LEDs though are likely to perform at PPE around 1 µmol/J.

One of the primary organizations working in the horticultural lighting space is the **DesignLights Consortium** (DLC). The DLC is a non-profit organization that promotes high quality lighting solutions in collaboration with utilities and others, establishes technical requirements for different LED lighting equipment types, and verifies manufacturer claims.

The DLC has established a Horticulture Lighting Qualified Products List (QPL) which has specific technical requirements for horticultural lighting fixtures in order to be listed. Some of these requirements for equipment currently include a minimum Photosynthetic Photon Efficacy (PPE) of 1.9 µmol/J, 5 year product warranty, ≥50,000 hours driver lifetime, and safety certification among others. DLC's technical requirements are typically updated every 12 to 24 months.

Massachusetts and Illinois regulations both require that fixtures be listed on the Horticultural Lighting QPL, and both have set higher efficacy standards than the DLC minimum requirements. Some industry stakeholders applaud the more aggressive targets, others think the DLC thresholds were more appropriate for the stage of market evolution, and yet others believe the QPL offers too few choices, though the list is growing. Some innovative light fixtures take time to be placed on the QPL because of the need for test method development. The City of Denver has lighting requirements that can be demonstrated by DLC compliance or a third-party test report for PPE generated by an accredited facility. Some utilities are providing incentives for DLC-listed and non-DLC listed lighting.

Energy Productivity

A compliance metric tied to energy productivity brings the focus on energy usage and plant output; an example would be grams of product per kWh used. This method would allow technology choices for growers, however, this may be the metric of the future. Industry standard metrics and standard production data is not yet available. Also, there are still many questions about which metrics to use; are these standards tied to weight of plant yields, or tied to THC production, or tied to other factors? There may be concerns about assuming the business decisions of a grower - are they more focused on yield or THC production? Different strains may have different yields with the same energy inputs. Also, this path may require public disclosure of production data which could have confidentiality concerns for growers, especially smaller ones.

Enforcement of Standards

Standards can require compliance at different points. In Massachusetts and Illinois, new operations are required to be in compliance at the beginning of operations, and are required to submit supporting energy documentation as part of the initial application. Massachusetts also allowed a period for existing operations to come into compliance for enforcement, and there was a set date when all facilities needed to be in compliance. The code proposal in California would apply to any new construction that happens after the start of 2023, and would not apply to existing facilities, unless they undertake renovations above a set threshold.

Staggered enforcement timelines can also benefit undercapitalized entrepreneurs, and policy makers may consider allowing for incremental improvements over time for these licensees to reduce the unintended outcomes associated with enforcement of energy standards.

PPE pathways are straightforward for enforcement because compliance officers would be able to verify that lighting technologies meet the brand and model specified in an application. LPD pathway may require more effort to verify measurements because it requires a calculation of watts of lighting per square footage as well as measurements of the space.

Standards Organizations

The American Society of Agricultural and Biological Engineers (ASABE) is an educational and scientific organization dedicated to the advancement of engineering applicable to agricultural, food, and biological systems. ASABE Standards Committees have developed standardized testing methods for LED products that are used for plant growth. They are actively working to update their standards and collaborate with other organizations in areas of plant growth.

The Illuminating Engineering Society (IES) is a community of lighting experts to improve the lighted environment by bringing together those with lighting

knowledge and by translating that knowledge into actions that benefit the public. The IES Horticultural Lighting Technical Committee researches and develops best practices for horticultural lighting. The committee is producing a Recommended Practices document for professional lighting designers who are tasked with horticultural lighting.

UL has also published UL standard 8800 for horticultural lighting safety. In 2021, for fixtures to be listed on the DLC's Horticulture Lighting QPL they will need to meet the UL safety standard.

Racial and Social Equity

Mandating LED lighting standards may put an upfront strain on undercapitalized operators, who tend to be female and Black, Indigenous and Latinx operators, because higher initial costs present a financial challenge for these operators, despite the benefit of lower lifetime equipment costs. To mitigate these concerns policy makers can consider different standards for smaller, equity and undercapitalized entrepreneurs applicants, as well as strategies to preserve utility energy efficiency incentives to reduce initial costs.

Other considerations include adopting staggered or incremental timelines for these applicants to come into compliance. Massachusetts adopted a higher LPD threshold for operations under 10,000 square feet. California's proposed lighting code will only apply to facilities with connected horticultural lighting load greater than 40 kW, which allows for smaller growers to not meet these requirements.

A strategy to consider is high- to medium-touch implementation support for undercapitalized entrepreneurs to adopt energy efficiency technologies like lighting. When highly capitalized entrepreneurs are too busy and/or lack the technical knowledge to implement a new technology, they can resolve the issue with capital by outsourcing. Providing implementation support for undercapitalized entrepreneurs, free of charge, would go a long way to reducing inequities in adopting energy efficiency.

This implementation support can also act as a way to ensure that undercapitalized entrepreneurs have the support needed to comply with regulations; support that may not otherwise have because of the lack of social and/or financial capital. A system that creates violations through the enforcement process can create inequitable outcomes for undercapitalized entrepreneurs who may not have the social capital to avoid a violation, or the financial capital to challenge a violation. To reduce costs for undercapitalized entrepreneurs, policy makers may consider funding pools from state cannabis taxes, direct support from LED manufacturers, or reducing costs in other places like licensing renewal or application for implementing LEDs.

Lighting Policy Pathways for Consideration

Enabling statutes can include exploration of energy mitigation strategies, and if considerations around technologies are part of the strategy, then lighting may be the primary one to include. At this time, if policy makers are considering implementing a policy based on lighting, then equipment standards based on the industry standard measure of micromoles per joule (µmol /J) are the most straightforward for compliance and enforcement.

Thresholds below 1.7 µmol /J will allow many technologies, including outdated inefficient technologies. 1.7 µmol /J will allow double ended HPS luminaires, which is the approximate limit of this technology. Luminaire standards above 1.9 µmol /J would push growers to adopt LEDs, which have higher initial costs and use less energy than other technologies, and can help reduce energy use used in the entire cultivation operation.

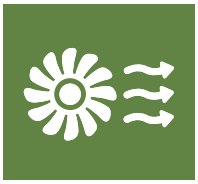
If LED objective performance information is desired, consider incorporating compliance with the DLC QPL or other third party verification so there are minimum verified performance and safety standards. One note is that setting a photosynthetic photon efficacy standard will likely set a minimum energy equipment baseline, which can impact the amount of incentives that utility energy efficiency programs can offer for this equipment, thereby impacting upfront costs for businesses.

At the same time, LPD standards could be considered a secondary pathway to give more flexibility for growers to choose technologies, while also working to save energy. As more data is collected by the industry on existing successful grow operations, that information can be used to determine thresholds that can save energy and help growers be compliant with regulations. Policy makers may want to consider compliance with both PPE and LPD standards given that PPE ensures efficient lighting equipment while LPD ensures that installation meets energy thresholds.

Utilities are important partners for both providing energy to facilities as well as providing energy efficiency incentives that can help offset initial equipment costs. Many utilities have developed energy efficiency programs that have successfully worked with operators to reduce their equipment costs. Utilities should be invited in as stakeholders in the policy making process and policy makers should consider strategies that preserve energy

efficiency incentives.

Finally, training programs for growers are an important consideration, particularly for growers to understand how to grow successfully with LED technologies.



Heating, Ventilation, Air Conditioning, and Dehumidification

Heating, ventilation, air conditioning, and dehumidification (HVACD) are important parts of indoor cultivation operations because they help maintain an optimal environment for plant growth. Plants grow best in specific temperature and humidity ranges, and HVACD equipment helps maintain these environmental conditions. If systems fall out of range there can be issues like mold, pests, and other plant pathogens which can negatively impact crops.

HVACD systems can be a major upfront cost for growers and are significant energy users. Designing and operating HVACD systems can be challenging, with different plant growth cycles needing different conditions. Optimized HVACD systems can reduce energy costs and make growers more competitive. More details on optimized HVAC systems can be found in RII's HVAC for Cannabis Cultivation & Controlled Environment Agriculture Best Practices Guide.

HVACD Technologies

Depending on the size of the grow there are a host of small and large HVAC technologies that can be used for maintaining proper growing conditions in a space. Facility designers will design systems to meet the environmental conditions specified by the growers, and equipment will be sized to meet these needs. Lighting choices and cultivator-selected equipment set points can influence HVAC sizing. If systems are not sized or operated properly there is the potential for significant energy waste.

HVAC systems are usually based around centralized technology to provide heating and cooling to a space. These systems are designed to efficiently meet the large needs of a cultivation facility.

Dehumidification systems are important because plants transpire water throughout the day (like sweat), which can lead to hundreds or thousands of gallons of water that needs to be removed from the air in a grow space daily to maintain proper conditions. Dehumidification technologies depend on the size and design of the system; there may be standalone dehumidifiers in the rooms at some grows, others have HVAC systems with integrated dehumidification, and another may use a chemical desiccant as part of their dehumidification systems.

There are innumerable combinations of HVAC systems, sizes, and controls, and they tend to be unique to every operation. The HVAC industry is working to develop standards and solutions, and this space is evolving rapidly.

A variety of HVAC and dehumidification systems are used in cultivation operations, with varying energy impacts.

HVACD Policy Compliance Paths

As of 2021, three US states have implemented or are considering standards for HVACD systems, all taking different approaches.

Building Codes

Both Massachusetts and California have explored paths that include code compliance for cannabis cultivation operations. Massachusetts has required that HVAC systems for cultivation facilities comply with state building codes, including energy. As part of the application process the applicant needs to furnish a letter from a registered professional mechanical engineer that says the system complies with code, sized for the needs of the facility, and also providing information on the specifications of the system.

California as part of its Title 24 energy codes proposal is proposing standards specifically related to dehumidification systems for newly constructed facilities with newly installed HVAC / dehumidification systems. These standards mandate one of four dehumidification systems be used for indoor grow facilities:

- Standalone dehumidifiers that meet specific efficiency regulations based on the size of the system
- Integrated HVAC systems with on-site heat recovery for reheating dehumidified air
- Chilled water systems with on-site heat recovery for reheating dehumidified air
- Solid or liquid desiccant dehumidification system for system designs that require a 50°F dewpoint or less

These systems require that on-site heat recovery be designed to meet 75% of a facility's annual reheat needs. There is also an exemption from installing economizers for systems using carbon dioxide enrichment as part of the grow process. The California codes proposal is still under consideration by the state, with stakeholders both for and against the proposal.

The City of Denver has developed building code requirements for lighting and dehumidification in horticultural applications. Humidification requirements are outlined in section C403.13 on page 546 and include three compliance pathways similar to California including standalone dehumidification meeting specified efficiency requirements, chilled water systems requiring heat recovery, and integrated HVAC HVAC systems with heat recovery. Requirements also exist for backup systems as well.

Another consideration of codes is building envelope for buildings and greenhouses. The building envelope

Construction materials and air infiltration rates of various building shells can impact energy usage.

is everything that separates the outside from the inside of a building including, walls, windows, roof, insulation and foundation. Having a good building envelope is important to maintaining the environment within, and the building envelope should be considered as part of the building efficient strategy. Greenhouses have very different considerations from other types of buildings because they are largely transparent structures and are not able to provide insulation in the same way as a solid building. Both California and Massachusetts have references to building envelope as part of their approaches. The 2021 International Energy Conservation Code contains building envelope standards for heated or cooled greenhouses, and will require compliance as states adopt this code.

Prescriptive Requirements

The enabling statute in Illinois contains specific equipment requirements for HVAC systems for producer facilities. For operations less than 6,000 square feet, systems must be high-efficiency ductless split HVAC units, or other more energy efficient equipment. Over 6,000 square feet, systems are required that all HVAC units will be variable refrigerant flow HVAC units, or other more energy efficient equipment.

This approach to mandate specific equipment types has led to stakeholder feedback that these system types are not appropriate for the needs of cultivation facilities, and this means that the industry is moving toward solutions that may meet the needs of growers, though may not comply with the state statute. The process to clarify the HVAC requirements or statute is unclear at this time, and this is creating some confusion in the marketplace.

Productivity Based Standards

At this time no states have adopted productivity based standards that could measure something like grams of production per kBtu of HVAC or total building energy. Productivity based regulations, particularly on a whole building basis, could allow for producers to consider an array of technologies to consider when developing their systems. However, the consensus among stakeholders is that there is not sufficient data at this time for this type of compliance path.

Enforcement of Standards

Standards that are in place right now are focused on the equipment that is used in spaces, as opposed to its performance. Massachusetts asks for information about specific equipment that is installed in a space and the pathway to compliance would likely be built around verifying that the equipment specified has been installed. The pathways for compliance in California and Illinois would likely be similar in that they would revolve around verifying the equipment installed based on matching equipment information sheets and equipment nameplates. Going forward, if productivity based standards are considered there will likely have to be a reporting mechanism set up to verify that the specified equipment is installed alongside data regarding energy use and production.

Standards Organizations / State of the Market

Standards organizations as they relate to HVACD are very important because HVACD is a less mature market than lighting when it comes to indoor agriculture. Lighting standards have been under development for years as the technology has evolved, however, this is not the same in the HVACD space. Energy efficiency standards are still under development for HVACD, and there is work that is underway now by standards organizations to close this gap, however, industry standards may still be 2 or more years away as of 2021.

Some items that are being researched include agreement on load calculations for indoor agriculture and performing independent scientific studies on many crops. Also there are barriers to designing and operating systems that the industry is dealing with, like workforce training to better understand load calculations and the calculation of different loads for light and dark periods. The industry is also working toward more purpose built equipment for indoor agriculture.

One of the key organizations in the HVACD space is ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers), which is shifting more of its focus toward the indoor agriculture space. They have efforts underway on many different tracks including: consolidating existing research on indoor agriculture and HVACD; developing technical handbooks, standards, research and programs; researching the specific needs of plant environments; and conducting research on plant transpiration rates, which is a critical part of sizing calculations. ASHRAE's commitment to researching topics around indoor plants is demonstrated through having a dedicated technical track at its upcoming 2021 annual conference that will feature presentations, papers, seminars and workshops which will likely lead to further development of standards.

Another group working in this space is American Society of Agricultural and Biological Engineers (ASABE). ASABE has convened a committee to develop recommended practices for HVACD for indoor plant growth. This work provides recommendations and guidelines to calculate energy and performance characteristics of HVACD systems while taking into account many different design considerations. The work will likely lead to the development of efficiency standards, however the work of this committee is still underway.

Racial and Social Equity

Policy makers may want to consider the impact that HVACD regulations could have on smaller growers and operators of color. Should there be requirements that all equipment meets specific standards, or, if a grower moves into an existing space, should they be allowed to use and adapt existing systems and building envelope to save costs? The initial costs of HVAC equipment is very high, so consideration of how to mitigate these costs through utility energy efficiency incentives or other means could be helpful.

Also, education is a key component for growers to build and operate their systems. Growers may not always be cognizant that their specifications for the grow environment conditions could have a major impact on system design, and that system design should go hand in hand with operations to be optimally efficient.

Consideration should be given to the development of training programs, grant programs, and/or high- to medium-touch implementation support to help undercapitalized operators adopt these systems. Undercapitalized entrepreneurs can be small operations with zero employees, meaning there is a lack of resources to engage in training programs, and implementation support can help bridge this gap.

HVACD Policy Pathways for Consideration

The general thinking among stakeholders is that the HVACD market is advancing rapidly to meet the needs of the indoor agriculture market, yet standards are still in development and will be for the next few years. At this point the industry needs more data on how systems are designed and operated, more information about how plants interact with these systems, and more information about the specific environmental needs of different types of plants. This does not mean policy makers should ignore this space, rather they should consider sending signals to growers and the HVACD marketplace that this is an important area of focus.

A primary tool for this signal is through education of growers and the industry. Growers can benefit from educational resources and training on the impacts their decisions make on system design and operations. For example, a grower may specify specific temperature and humidity goals for their grow operations, however, if they adjust them slightly, it could mean that half as much HVACD equipment is necessary to maintain the new conditions as opposed to their original specifications. This can lead to significant cost and energy savings for the grower. Further, equipment that is designed to meet certain specifications will operate more efficiently than a system that is too big and working at half capacity.

Another tool for policy makers to consider is reporting on energy and water use. This serves two purposes: 1) It makes growers focus on their energy use, and 2) it can provide aggregated data to the marketplace to help them better understand the sizing and operations of efficient HVAC systems. Reporting sends a signal to the market that policy makers believe resource efficiency, particularly as it relates to HVACD, is important and should be an area of industry focus and development.

Policy makers can also request information about HVACD systems and building envelope as part of reporting, or as part of applications for licensure and expansion. This sends a signal that policy makers are interested in this topic and that it is an important consideration for licensure. At the same time policy makers should consider how to maximize resource efficiency through HVACD and building envelope, while considering the impact of equipment and building retrofits on social equity and undercapitalized entrepreneur applicants.

Finally, policy makers can send signals to state and industry organizations focused on HVACD through the building codes process. Building codes do not have a use type for indoor agriculture, and greenhouse standards are not clear. Policy makers can request that state code bodies explore this topic which will indicate to national code organizations and the HVACD industry organizations that this is an important area for standards and progress.

Energy efficiency solutions can include elegant approaches such as duct socks, which reduce temperature loss as air flows throughout the facility.

WATER POLICY TOPICS

Water is essential in all stages of cannabis growth and all growing environments (indoor, greenhouse and outdoor). Cannabis is an emerging agricultural crop, especially compared to other crops which have benefitted from decades of research and innovation. Irrigation makes up the majority of water use in the cannabis sector, and irrigation practices can vary widely from hand watering to automated systems which deliver small bursts of water twenty times a day.

Expansion of the legal market is leading to greater transparency into cannabis cultivation practices and greater prioritization of efficiency and operational cost reductions. As a result, growers have begun to transition to smaller pot sizes and integration of more precise irrigation techniques such as high-frequency irrigation. No matter how water is applied the opportunities to increase efficiency of water use across the industry are considerable.

Benchmarking water use, defining water use best practices, and educating growers on the economic and environmental benefits of reducing their water use will be key to ensuring that water efficiency is a priority that is integrated into the legal cannabis market's growth. More information about cannabis water use, including benchmark data can be found in the *Cannabis H2O: Water Use and Sustainability in Cultivation* report which is published by New Frontier Data in partnership with RII and the University of California Berkeley Cannabis Research Center.

Water uses in cannabis operations can be considered in three categories; water sources, water used on-site, and water discharge.

Water Sources

Cannabis producers need to consider the location of their facilities for many reasons, one of which is access to a water supply with sufficient capacity. Sources can include municipal water, well water, rainwater, reclaimed water, stored water, or other natural sources. Indoor growers are more likely to use municipal water, while outdoor and greenhouse growers are more likely to use onsite wells, surface water and rainwater.

Depending on the source and volumes of water used, producers may need permits or have other regulatory requirements (e.g. inspection) to meet, including requirements tied to water extraction and discharge. It is important for producers to be aware of any requirements before they site their facility, and it is helpful for water officials to be engaged with producers as well. Water regulations may be local and overseen by officials called "Watermasters."

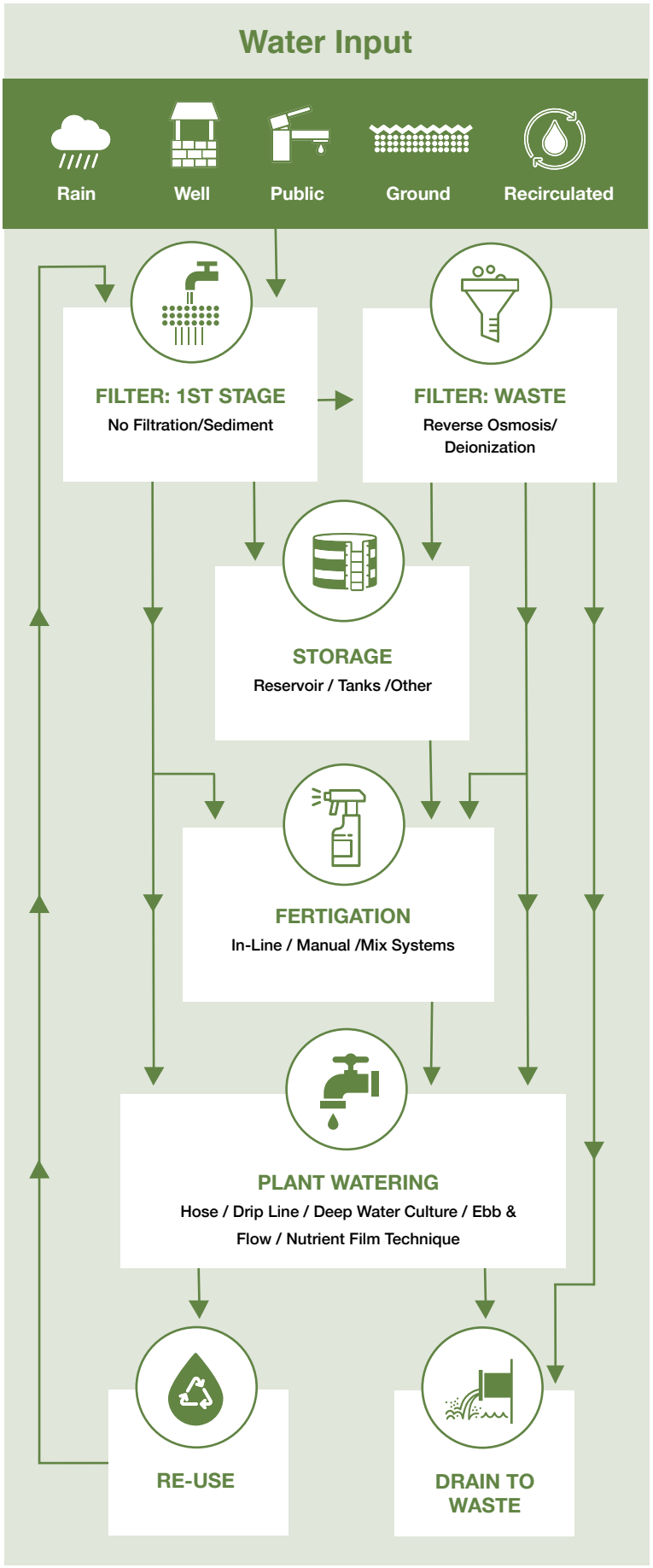
California has established requirements specifically for cannabis growers aimed at ensuring that water quality is protected. Many jurisdictions experience water scarcity from drought conditions which can increase costs for water. Cannabis policy makers should engage with water regulators as a stakeholder to understand topics and regulations related to water sources.

Water Used On Site

Water use for cannabis on-site is primarily driven by irrigation uses, however, water may be used in other ways including storage, applying nutrients, humidification, cooling, cleaning, pest control, and domestic water uses.

When growers consider ways to reduce their water use, irrigation strategies are a key consideration. There are many methods growers can use to water plants, and plants have different watering needs based on their stage of growth, type of cultivation used, and environmental conditions. Water use in cultivation can be reduced significantly depending on the techniques and technology used. Indoor facilities tend to use more water than outdoor facilities, in large part because indoor facilities have multiple harvests per year, veruses a single outdoor harvest.

Hand (hose) watering is one method used, though it can be an inconsistent method of watering, which leads to it being an inefficient way to conserve water. Perhaps the most widely used water efficiency solution, drip irrigation systems, allow growers to direct water to each plant without having to irrigate the entire cultivation area which



can save as much as 15%.

A more advanced variant of drip irrigation systems are sensor-based systems that deliver steady microbursts of water to each plant. These systems can direct water and nutrients using 20 times less water than than hose watering with the same results. This type of system has additional benefits like fewer pests, and better control of growing conditions to stimulate different aspects of plant production.

There are also methods to capture water used in operations for reuse. When watering there is inevitably irrigation runoff which can be captured before it reaches the drain. While this can save up to 25% of water used, producers should monitor how the nutrient profile of the water has changed. There is also a potential risk of distributing pathogens and other contaminants, but more effective water recycling solutions are being used and addressing these concerns. HVAC condensate can also be a source of reclaimed water with similar considerations around storage solutions, and purification strategies to prevent the potential for copper or zinc contamination.

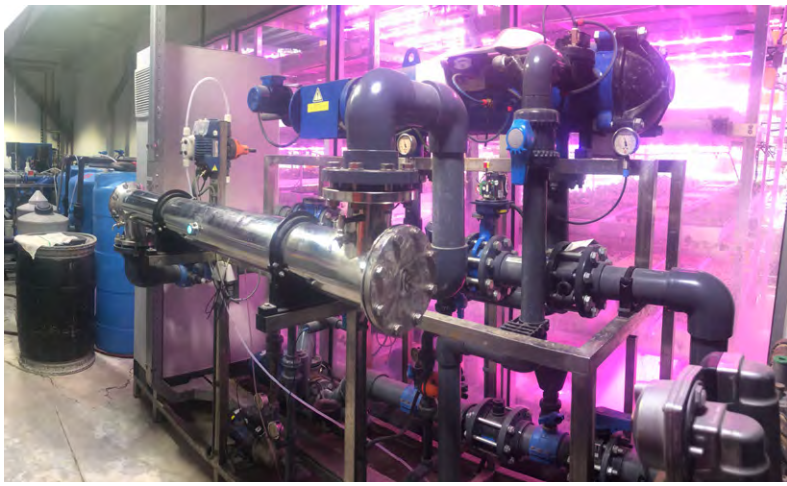
Many producers also use reverse osmosis systems to process off site or reclaimed water. These systems remove contaminants from water, particularly as a method to ensure that cannabis will meet state testing standards. Cannabis is one of the only agricultural industries that uses reverse osmosis. The process generates water waste, is energy intensive, and the clean water requires management and supplemental nutrients.

Measuring water used in cultivation operations may also be challenging. Many producers can measure facility-wide water usage from meter readings, however this includes all water usage including domestic water uses. Tools are available to measure water specifically used for irrigation, although absent regulations many producers do not measure cultivation water use separately.

Some existing statutes have raised water efficiency as part of a licensee's compliance strategy. The enabling statute in Illinois requires efficient use of watering including the use of automated watering systems with no more than 20% water runoff, and also that HVAC condensate, dehumidification water, excess runoff, and other wastewater be filtered and reused.

Massachusetts has issued Guidance on Best Management Practices for Water Use which lays out different state regulations and other considerations for producers to consider when selecting a site. This guidance also provides information on multiple options for producers to consider for water efficiency and managing wastewater.

The enabling statute in Montana also includes provisions for reporting of water use, the potential for regulations on water use, and that a portion of collected tax can be used for water conservation programs.



Water recirculation is a profitable and increasingly common technique in cultivation environments.

Water Discharge

Water applied to plants and other uses in cultivation operations drains through as runoff, and depending on the grow media, composition of the runoff, and rate of runoff, water may be able to be disposed of in drains like other organic waste, or may be disposed of through other means. Regulations on wastewater and hazardous waste may be implemented at the state level, but producers should also be aware of discharge regulations at their local level as well.

Typically, wastewater from cannabis facilities can be processed through local wastewater treatment plants because much of the waste is organic, similar to human waste. These local treatment facilities may have specific regulations and capacities for processing organic waste. It is important for producers to be aware of requirements and thresholds for local wastewater processing facilities. With that, it is also important for both cannabis producers and water treatment plants to be aware of the nature of wastewater that comes out of a cannabis cultivation facility. For instance, THC is fat soluble and does not dissolve in water; this means testing water for THC levels would be unnecessary.

Regulations on water effluent can provide a question of jurisdiction. While some may expect that the US Environmental Protection Agency would set regulations, the reality is that it is more likely to be set by local standards. A best practice for discharge may be

monitoring effluent leaving a facility, as opposed to purifying effluent, though then the question would be what is being measured? Based on the waste water generated as part of cannabis cultivation, measuring pH, turbidity, and nitrate levels should be sufficient to understand the makeup of wastewater leaving a cultivation facility.

Recirculation and reuse of runoff from plants and HVAC condensate can provide an opportunity to reduce water usage. This technology to recirculate water can be expensive, so policy makers should consider whether it is appropriate to require water reuse. Education on this topic, and understanding local water rights laws are important things to consider in this area. For example some jurisdictions may restrict the number of water storage tanks that can be allowed onsite, which could be a barrier to enabling water reuse. Some jurisdictions may not allow for water reuse in all cases.

Ontario, Canada and the Netherlands have made purification of drain water mandatory. The Netherlands program was enacted in 2018 with greenhouse drain water needing to be processed to meet 95% purification efficiency with a goal of being emission free by 2027. The Ontario Water Resources Act requires that water be cleaned before it is discharged to prevent adding nitrates to natural water systems. These policies have been implemented over time and have encouraged facilities to recirculate water.

Cannabis operations may generate liquid waste that is hazardous and cannot be processed in wastewater plants. For example, during the extraction process volatile solvents may be used, and when these solvents have gone through their useful life they may need to be disposed of as a hazardous waste. This could mean storing materials and hauling the materials off site as opposed to disposal down the drain.

Regulations in California regarding cannabis water use are focused on protecting other water sources from discharges from cannabis operations. Maine's cannabis regulations specifically call out the need for compliance with all applicable state and local laws and regulations. For wastewater, it is important to policy makers to understand state and local regulations to create cannabis policies in line with these regulations.

Racial and Social Equity

Undercapitalized entrepreneurs can benefit from water efficiency in their operations, though they may lack the social/financial capital and bandwidth to understand and implement these measures. High- to medium-touch implementation support can help undercapitalized operators adopt efficient systems. Funding support through grants or reductions in license and application fees for implementation of water efficiency measures can also assist undercapitalized entrepreneurs to take advantage of these benefits, and be in compliance with regulations.

Water Policy Pathways for Consideration

Policy maker's work in the water space should start by understanding state and local laws and regulations and ensuring that cannabis policies are in line with state and local goals. There can be many variations on water laws by jurisdiction, so working closely with water regulators as part of the cannabis policy making process is very important.

Water efficiency is an important consideration as well. Cultivators may not be aware of different methods for water efficiency, and education on different methods can be helpful for them to consider different options. Policies can be made that encourage more efficient systems, however requiring specific irrigation systems may put an undue burden on producers.

When contemplating policies around water use, consideration should be given to the metrics used. Some policies have used a gallons per plant metric, however this encourages cultivators to grow larger plants in larger pots, as opposed to being optimally efficient. Estimating the water used per cannabis plant is challenging due to the wide variability of plants grown per acre, and sizes of plants. Outdoor growers seeking to maximize the size of their plants may grow as few as 300 plants per acre, whereas indoor growers may choose a far more densely packed approach, with thousands of plants per acre.

Gallons per square foot of canopy presents a metric that takes into account the different ways that growers may choose to grow in indoor and outdoor spaces and does not create an incentive to grow larger plants. Growing media, such as soil or various substrates, can impact the types of irrigation methods used. Consideration should also be given to measuring water used specifically for plant cultivation.

Regulations around reclaimed water could also be considered, particularly if it would be allowed in the jurisdiction. Requiring water reuse may be expensive for many producers and present racial and social equity concerns. At the same time, if a pathway to use reclaimed water is allowed, consideration should be given to understanding indoor vs. outdoor use as it relates to

processing water and preventing pathogens. Also, there are different treatment requirements for plant runoff vs HVAC condensate, with condensate recovery being simpler to process.

Regarding waste water, cannabis cultivation is a new area for waste water regulators, and effort should be made for them to understand the impact cannabis can have on their systems. In addition to working with cannabis policy makers, waste water regulators should work with their peers in other jurisdictions to understand the relative impact of cannabis operations as well as the measurements and monitoring required from cannabis operations. In many cases, cannabis operations do not pose a significant change to existing waste water operations, and monitoring requirements built around pH, turbidity, and nitrate levels should be sufficient.

Consideration should also be given to undercapitalized entrepreneurs and potentially providing grants and implementation support for them to better understand water topics and take advantage of efficiency benefits.

Stonewool (or rock wool) granulate, the by product of the grow media, can be composted and turned into bricks.

WASTE POLICY TOPICS

Waste is created by almost any business, however waste generated by cannabis operations has special considerations related to the security of waste materials, and this makes waste an important area of focus for policy makers. While there are these security considerations, there are many opportunities for sustainable waste disposal and recycling and policy makers can make decisions that will allow producers to dispose of waste safely, sustainably, and in a way that helps strengthen the licensee's financial bottom line.

As part of this Primer, three areas of focus will be explored that relate to waste; plant waste; consumer packaging waste; and other waste.

PLANT WASTE

Plant waste can take many forms including cannabis leaves, buds, stems, stalks, root balls, and growing media. A primary area of focus for cannabis policy makers is security - cannabis from licensed producers is generally tracked seed to sale to ensure that there is no diversion to the illicit market, and this includes processing and tracking waste generated. Waste can also be tied to the topic of tax revenue; operators may dispose of good crops and report it as waste which would have an impact on the ju-

risdiction's collection of taxes. Seed to sale tracking can also track over-reporting of waste.

Many states have approached this topic related to security of plant waste, and one of the primary tools used is the 50/50 mixing method to render waste unusable by mixing plant waste in equal quantities with other solid waste. Multiple states have included this compliance path as part of their programs, including California (for manufacturers and testing, not cultivation), Maine, Massachusetts, and Washington. This path will ensure that cannabis is rendered unusable, yet will also increase the amount of waste sent to landfills.

In many cases, the waste mixed with cannabis will result in difficulties related to using the waste for alternative processing methods like composting or anaerobic digestion. Consideration should also be given to what is classified as waste that needs to be mixed. Maine allows for exemptions for root balls, soil/growing media, stalks, and leaves and branches, provided they are free from visible trichomes. There are negligible amounts of THC in stems, root balls and growing media, and these items cannot be used to grow new plants, so there is low risk of these items being diverted or used illicitly.

Some states have also implemented policy paths that provide incentives for producers to render their plant waste using more sustainable methods like composting. Both California and Colorado allow producers to compost waste (onsite or offsite) without having to do the 50/50 mix. This helps reduce costs for producers because they do not have to obtain waste to mix with the cannabis, and it can also provide them with organic matter that they can use in the cultivation process. Reduced costs and composting plants for reuse can present an incentive for producers to consider this pathway if it is enabled by policy makers.

Some waste haulers will not pickup cannabis waste because of concerns about federal prohibition. In places like California, some haulers have a franchise right to collect all commercial waste in an area, and if this hauler decides to not accept cannabis waste, it can put the producer in a grey area where they have to seek out other waste haulers.

Further, landfill fees can influence how waste is processed. If tipping fees are lower than recycling/composting fees, a hauler may opt to landfill plant waste. This can create issues for producers who prefer to recycle their waste.

Another important topic around cannabis waste is physical security and documentation. Oregon requires that cannabis waste be held at the licensed premises for three days under camera coverage. Massachusetts requires that two agents of the cannabis establishment witness and document how the waste is handled, and that records be maintained for three years. The worst case scenario is that cannabis waste is replaced with hay or another material and cannabis is diverted to the illicit market, so tracking, monitoring, and security around waste should be a consideration for policy makers.

Consumer Packaging Waste

Consumer packaging waste can take many forms including child proof packaging, vape batteries and cartridges, pre-roll packaging, security bags, and other packaging like boxes. Most of this packaging is necessary in order to meet other mandates, and there are opportunities to make sustainable decisions through selection of packaging materials and exploring reuse and recycling options. This topic is explored through the adage of reduce, reuse, recycle.

Reduce - Secure, child proof packaging is often deemed by governments as an important part of maintaining safety for cannabis products, though there are stakeholder concerns about the standards for this type of packaging for products that are not "activated" (such as flower) and thus may not pose a health or safety risk to children. If bags can be reused, or there is more flexibility in packaging requirements, it can reduce the financial impact for undercapitalized entrepreneurs where packaging costs can be a financial burden.

Because of requirements for packaging, reducing the amount of packaging may pose a challenge for cannabis business owners, which means the area of focus may be on material selection, and policy flexibility. Education may be a path for policy makers to encourage licensees to understand the types of packaging that can be recycled or composted. Some Canadain provinces (including Alberta and Ontario) and US states are advancing legislation related to extended producer responsibility (EPR) which in part mandates certain amounts of recycled content across all industries over a multi year period of time. Massachusetts provides some information on material selection as part of their best practices on waste.

Reuse - Many jurisdictions do not allow for, or may have structural barriers associated with reuse of cannabis packaging, which creates a cycle of obtaining new packaging for each consumer transaction. Based on feedback from stakeholders, Colorado and Oregon have developed programs where packaging can be submitted to a dispensary and be processed for reuse. For this path, policy makers should consider how these programs can be enabled and encouraged rather than being overly prescriptive. Emphasis should be placed on ensuring that packages are sanitized and in good working order. It should be noted that some states like Washington do not allow vertical integration of cultivation and retail operations, thus presenting additional challenges for reuse.

Recycle - This ties back to the previous point about making the right decisions around packaging materials. Providing information to licensees to ensure they are selecting materials that can be recycled or composted in the jurisdiction may be a best practice for policy makers.

There are some other considerations around where consumers can submit packaging for reuse or recycling. These packages may contain trace amounts of cannabis, and submitting them at a dispensary is a logical place to turn in these materials. However, secure, behind the counter space in a facility is at a premium, so policy makers may want to consider if these materials can be submitted into a secure container located in front of the counter.

Other considerations include licensing requirements for waste haulers. Some major waste haulers are concerned about being involved in this industry, and licensing requirements may present another barrier. Consideration should be given to the necessity of licenses for waste haulers, recyclers, and others who may process waste that is rendered unusable or packaging with trace amounts of cannabis.

Other Waste

There are other types of waste that are generated from cannabis businesses that policy makers should be aware of. Many states have regulations or programs available for processing some of these types of waste, so collaboration with waste regulators in the jurisdiction to ensure compliance is a worthwhile path.

Some items like lighting, pesticides, and other chemicals may be considered hazardous waste and need to be disposed of properly to not introduce contaminants into the waste stream. Other things like extraction solvents may be flammable and need to be disposed of with other hazardous waste.

Another area of waste is around personal protective equipment. It is important for producers to maintain a clean grow environment and so they must take steps to avoid contamination between space. This means disposable clothing and masks may be used multiple times a day by a single person, which can create large amounts of waste. Encouraging the use of reusable clothing/uniforms, providing places for employees to change clothes, as well laundry services can help reduce waste in this area.

Racial and Social Equity

Packaging costs can be a significant cost for undercapitalized entrepreneurs and can pose a significant cost burden for the operations with the thinnest margins and hardest path to profitability. Policy makers may consider that packaging reductions for non-activated products, as well as reuse, and recycling options may reduce costs for these operators. Waste regulations may also be a challenging area to understand and comply with, so policy makers may want to consider providing education and implementation support for undercapitalized entrepreneurs.

Waste Policy Pathways for Consideration

Managing the solid waste coming from cannabis operations can present opportunities for policy makers to ensure security in the marketplace by preventing illicit diversion, while also encouraging licensees to make waste decisions that also contribute to their financial bottom line. The first step is working with waste regulators in the policy maker's jurisdiction and including them as stakeholders in the policy making process. This will allow the cannabis

policy maker to leverage resources from those agencies, and develop policies in line with existing regulations (for example, some states now require organics recycling).

Policy makers may want to consider ways to allow for plant waste to be processed and disposed of to ensure resource efficiency and not burden licensees. Cannabis needs to be securely disposed of to ensure that THC containing materials do not get diverted to the illicit market. To that end, hemp plants that contain trace amounts of THC compared to cannabis may not need to be subjected to the same security standards. Since cannabis THC content is an important factor, considerations should be given to which parts of plants are subject to security standards; root balls, stalks and immature plants may not need to meet the same standards as mature plant buds.

50/50 mixing regulations can serve a place as part of regulations to ensure there is a path for processing waste that renders plant waste unusable. This 50/50 strategy can be supplemented by other pathways which allow for anaerobic digestion, composting, biocharring, biomass gasification, fiber recovery without the mixing requirements. This will allow pure plant materials to be processed, which are preferable for these alternative processes. Having multiple compliance paths gives producers a choice how to process their plant waste in line with their business and sustainability goals; some producers may choose to take a composting path instead of 50/50 mix for financial and cultivation reasons, so having both provides an incentive to explore more sustainable paths.

Packaging materials are a part of meeting child safety and other security requirements, so opportunities for policy makers may be around allowing flexibility in packaging requirements, making sustainable materials choices, and encouraging reuse and recycling. This path may include education for licensees and undercapitalized entrepreneurs to help them make materials choices that are suitable for recycling, requirements around percent of recycled content, and developing policies that allow for flexibility on things like the thickness of bags. Consideration could also be given to packaging reuse and creating a policy structure that encourages participation by customers, licensees and waste processors. Some of these considerations may be around where materials can be submitted, where these receptacles are located in a dispensary, and if waste processors working with trace amounts of cannabis are required to be license holders.

Other types of waste should be considered as well. It is important for policy makers to consider the impacts of chemical, lighting, personal protective equipment and other types of waste generated by cannabis operations. Education of licensees of other waste requirements in the jurisdiction as well as best practices for a business can be a valuable tool to ensure compliance.

BENCHMARKING & REPORTING TOPICS

Energy and water benchmarking and reporting can be a powerful tool for policy makers to consider as they develop regulations for the cannabis market. Resource benchmarking is the process of tracking and reviewing a property's energy and water use over time to determine its efficiency performance in relation to itself and/or similar buildings. Benchmarking is the first step in the energy and water management process and it is used commonly in commercial and industrial buildings.

Benchmarking and reporting can provide benefits to many different parties:

- Cultivators and Owners. Benchmarking allows them to understand the energy and water use of their operations and how it compares to others. This gives them insight into where they can make upgrades and undertake a cycle of continuous improvements.
- Policy makers. Reporting energy and water metrics to a regulatory agency sends a signal to the marketplace that resource efficiency is important and something that is tracked by regulators to understand how efficient licensees are in the jurisdiction.
- Industry. Aggregated data from producers can provide information to industry about the types of equipment being used, and performance levels of various operations. This can give the market information when developing purpose-built equipment for indoor agriculture, and setting industry standards.

Benchmarking in the commercial real estate space is common, with many cities requiring benchmarking for different types of commercial buildings. In some cases, this energy benchmarking information is disclosed publicly. To benchmark a building, an owner or property manager collects information including square footage, energy and water use, and building use type, and then this information is entered into an online benchmarking platform. For industrial building operations, production information is used to correlate resource use and manufacturing productivity. At this point, the owner or property manager can then compare their building's performance to others in their portfolio or competitors. Benchmarking is usually done on an annual basis.

Benchmarking and Reporting Policy Compliance Paths

There are two tools that are used in the market to benchmark cannabis facilities; the Cannabis PowerScore and conventional building benchmarking platforms like ENERGY STAR Portfolio Manager. PowerScore is specialized to benchmark indoor, greenhouse, and outdoor operations, while other platforms are designed for conventional buildings.

Cannabis PowerScore

The Cannabis PowerScore is a free online platform built and maintained by the Resource Innovation Institute and is designed and curated for the unique needs of benchmarking cannabis cultivation operations and other plant production facilities. PowerScore measures and tracks energy and water consumption, as well as emissions such as waste and energy-related greenhouse gas emissions. Benchmarking reports use facility-level information to calculate impacts of the specific equipment used in cannabis cultivation. There are many data transfer options available, and the survey option streamlines the reporting process.

Because PowerScore is developed for the needs of the cannabis industry it also records crop production data, which helps provide a full understanding of how productive a facility is with their resources (energy and water). The tool calculates key performance indicators for operators to measure energy productivity (kBtu/sq ft, grams/kBtu) and water productivity (gallons/sq ft, grams/gallon), and provides comparisons to similar grow facilities.

PowerScore is free to use and confidential for growers sharing facility information. RII is committed to a data collection and analysis policy that follows strict standards on data security, data privacy and data anonymization. RII data practices have been informed by Federal data security protocols, including the Health Insurance Portability and Accountability Act (HIPAA) and the associated HIPAA Privacy Rule and HIPAA Secrecy Rule.

The US Dept. of Agriculture recognizes RII's PowerScore as the platform for benchmarking controlled environment agriculture facilities where a range of crops are grown, as noted in a three-year funded scope of work.

ENERGY STAR Portfolio Manager

ENERGY STAR Portfolio Manager is a free online tool developed and maintained by the US Environmental Protection Agency to measure and track energy and water consumption, as well as greenhouse gas emissions. It gives the user a 1-100 energy score used to compare buildings, and is available for use in the US, Canada, Japan, Switzerland and Taiwan. This tool can be used to verify and track savings and provides secure data storage. While it is considered an industry standard for commercial buildings, it is not focused on industrial processes akin to cannabis cultivation. Consequently, it does not collect production information like yield (weight of cannabis biomass), nor does it have cannabis specific key performance indicators like grams per kBtu.

State Policies to Date

Multiple states have included benchmarking or reporting requirements as part of their programs. The cannabis regulations in Massachusetts require annual reporting to be included as part of license renewals. In 2019, the Cannabis Control Commission specified the Cannabis PowerScore as an approved compliance vehicle and the Dept. of Energy Resources funded the upgrade of the tool to support streamlined reporting for producers. As part of efforts in the state there has been training for producers to learn how to use the tool, and a specific landing page for Massachusetts has been developed.

Oregon is considering legislation that creates a voluntary certification system for cannabis and hemp farms. The bill will support energy and water use benchmarking for cannabis and hemp cultivation and the establishment of usage baselines and performance standards.

Ann Arbor, Michigan also includes annual reporting of water usage and sanitary sewer discharge submitted to the City Clerk. Grand Rapids, Michigan specifies use of ENERGY STAR Portfolio Manager, and has explored using the Cannabis PowerScore tool as well.

Boulder County in Colorado implemented the Energy Impact Offset Fund in 2018, which requires producers to offset their electricity use with local renewable energy, or pay a $0.0216 charge per kWh. As part of this program, energy use is reported to the County, and the county has made anonymized electrical energy use data available to the public.

Ventura County in California passed legislation in 2020 requiring cannabis business license applicants to prepare an energy conservation plan to reduce consumption below 'conventional energy use'. To comply, plans must include an analysis of energy use if the operation uses conventional energy sources, and share how the pre-construction benchmark demonstrates a 25% reduction.

Statutes adopted in Illinois, New Jersey, and Montana include mention of reporting in different capacities.

Benchmarking and Reporting Policies for Consideration

Benchmarking and reporting policies can have multiple benefits to owners, policy makers and industry and should be considered as part of cannabis programs. Benchmarking requirements are common in many jurisdictions for both cannabis and commercial real estate, and are not overly burdensome to owners.

Consideration should be given to the frequency of benchmarking and the method to use for reporting. As a best practice, building benchmarking is completed on an annual basis, which can be made to align and be submitted to regulatory agencies with annual license renewals.

From a regulatory perspective, it could be best to include the need for reporting in statute, and further define specifics in rules, regulations, or guidance.

When specifying how reporting requirements can be achieved, consider a trusted platform like PowerScore that is specialized for indoor, greenhouse, and outdoor cannabis cultivation operations and collects both resource consumption, facility details, and production information.

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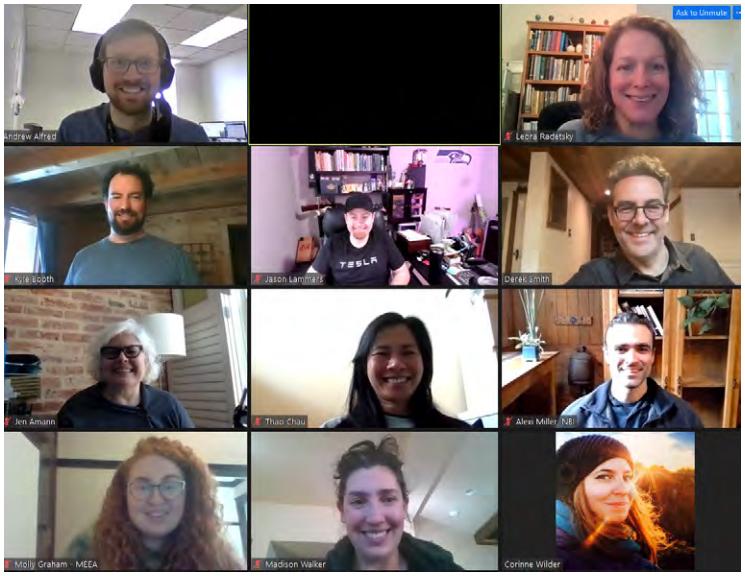

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The Resource Innovation Institute (RII) is a non-profit organization whose mission is to advance resource efficiency to cultivate a resilient agricultural future. RII provides best practices guidance on resource efficient cultivation technologies and techniques via peer-reviewed reports and curated events. RII's performance benchmarking service, the Cannabis PowerScore, enables cultivators to gain insights about how to reduce energy expenses and improve their competitive position. Resource Innovation Institute is funded by foundations, governments, utilities and industry leaders. For more information, go to ResourceInnovation.org.