EQ Research

A Chronic Problem: Taming Energy Costs and Impacts from Marijuana Cultivation

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September 2016

About EQ Research

EQ Research, LLC provides clean energy intelligence for clients in the nonprofit, business, and government sectors. Our analysts monitor energy policy and regulations in all fifty states, staying abreast of trends in distributed solar programs, utility rate cases, energy storage, grid modernization, and other areas. We offer both monthly subscription services and specialized consulting, including policy analysis and expert testimony.

EQ Research's staff is located in Denver, Colorado; Cary, North Carolina; and Oakland, California. Our presence in two states with growing marijuana industries—and our monitoring of energy regulatory proceedings in which the marijuana industry is just beginning to be discussed—led us to issue this report.

Acknowledgments

Review, fact-checking, and support came from Laurel Passera, Justin Barnes, and Blake Elder with EQ Research. Jacob Schlesinger, Jason Keyes, Kevin Fox, and Joe Wiedman with Keyes, Fox & Wiedman LLP also provided review and comments. Thank you as well to the following reviewers, who contributed to both the factual grounding of this paper and helped shape its solutions: Bruys Henderson, Ron Flax with Boulder County, and Kendra Tupper with the City of Boulder. Additionally, thank you to the anonymous marijuana growers and industry consultants I have spoken with over the years for informing this effort. Any errors that remain are my own.

INTRODUCTION

Although marijuana cultivation and extraction has historically operated under the radar, the newly legal industry is now in the spotlight for consuming massive amounts of energy. This energy is used to power intense, 1,000-watt ("W") grow lights, cooling and ventilation systems, scrubbers, filters, extraction equipment, and state-of-the-art security measures. In Colorado, approximately 1,350 licenses to operate medical and recreational cultivation facilities[1] comprise a significant amount of new demand for power in the state. Other states are similarly checking their forecasts for how much energy demand to expect in coming years.[2] A 2011 study estimated that U.S. marijuana growing operations ("grows") consumed $6 billion in energy per year. At the time the study was released, 15 states and the District of Columbia had passed laws legalizing medical marijuana. Currently, 25 states have such laws, and Alaska, Colorado, Oregon, and Washington further legalized recreational marijuana.[3]

Utilities and local and state regulators have yet to consider the energy impacts of marijuana cultivation comprehensively. Some local jurisdictions have implemented carbon taxes on growers to compensate for energy increases that would otherwise jeopardize their climate goals. Utilities, concerned about their ability to provide reliable power, are considering charging marijuana growers different energy rates and implementing stricter service connection practices. Because the majority of U.S. electric customers are served by investor-owned utilities ("IOUs"),[4] the public utility commissions that regulate them may soon be faced with balancing utilities' incentives to increase their sales of electricity versus other societal goals for efficient, affordable, and clean energy. Marijuana cultivation may be viewed as a burden that will lead to higher costs and larger environmental footprints.

About Public Utility Commissions ("PUCs")

Each state's PUC regulates the costs that investor-owned utilities in the state can recover from customers and the rates that customers pay for electricity, as well as setting performance standards for reliability (to prevent outages) and sustainability (sometimes requiring certain amounts or types of renewable energy). Because PUCs regulate rates, when a utility wants to change its prices, it generally has to initiate a lengthy legal proceeding called a rate case that may involve multiple different entities representing different interests, ranging from residential customers to energy efficiency providers to large manufacturers.

Undoubtedly, marijuana cultivation will be a game changer for utilities and communities across the country. Yet electric rates can be designed to incentivize energy management in grows, utilities can provide better data on how energy is used, and governments can offer new options for financing efficient equipment and rooftop solar. This emerging challenge thus presents an

opportunity to enhance the marijuana industry's access to clean energy, and to encourage the industry to use this energy more efficiently, making their products that much "greener."

Because marijuana cultivation remains federally illegal, removing barriers will require collaboration between various entities within states. This paper offers a series of recommendations for how utilities, public utility commissions, state and local governments, and the marijuana industry can work together to manage marijuana cultivation's energy impact. Each of these recommendations is elaborated later in this report.

Recommendations for Utilities

1. Make sure marijuana growers know how much energy they are using, when they are using it, and when it is most expensive to use.
2. Tailor energy efficiency rebates and services to marijuana growers.
3. Design electric rates to incentivize efficient energy use within grow facilities.
4. Create fair policies for connecting grow facilities to the grid and assessing costs for upgrades.

Recommendations for Public Utility Commissions ("PUCs")

1. Set appropriate policy direction to support collaboration between utilities and growers.

Recommendations for State and Local Government Entities

1. Ensure that zoning, building, and electrical codes encourage clean energy.
2. Convene marijuana industry working groups on energy and sustainability to develop best practices, and act as a centralized repository for educational materials.
3. Provide additional financing opportunities so marijuana growers can invest in renewable energy and energy efficiency.
4. Work with businesses and utilities before marijuana grows are built to make sure energy management is incorporated from the start.
5. If you regulate, consider how rules can be directed to further break down barriers to clean and efficient energy use in the marijuana industry.

Recommendations for Marijuana Industry Associations and Entities

1. Invest in energy management.
2. Support research on the impacts of efficient equipment on marijuana growth.
3. Engage at public utility commissions.
4. Work with utilities to provide information about how and when energy is used.

MARIJUANA REGULATION AND ENERGY IMPACTS

Marijuana use and cultivation remains federally illegal.[5] However, 25 states and the District of Columbia have authorized it for medical use and Alaska, Colorado, Oregon, Washington, and the District of Columbia have further legalized it for recreational use (see **Figure 1**).[6] The Marijuana Policy Project is supporting 2016 ballot initiatives for medical or legal marijuana in a further five states, including legalization in California.[7] *USA Today* identified an additional seven states that may be candidates for marijuana legalization within the coming years due in part to their current decriminalization laws.[8]

The states that have legalized recreational marijuana have introduced competing models for its regulation. While Colorado, Alaska, and Oregon do not limit the number of licenses issued to producers who follow state and local regulations, Washington only accepted applications for marijuana cultivation licenses during a limited window of time after the law went into effect.[9] Ohio considered an "oligopoly" structure that would have strictly limited marijuana cultivation to ten large facilities.[10] Because Colorado has been on the forefront of legalization, much of this report's data focuses on its local industry.

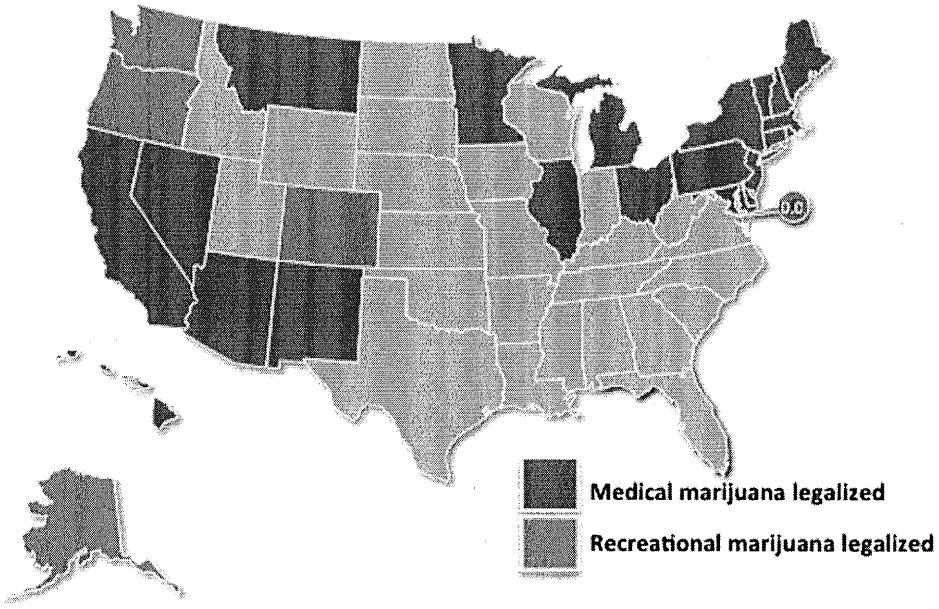

Figure 1: States that have legalized medical and recreational marijuana

The Marijuana Industry is Growing Rapidly.

While Colorado authorized medical use of marijuana in 2001, state voters first approved recreational use in 2012. The first full calendar year of recreational use and cultivation was 2014. Since that time, the industry has continued to bloom, increasing to 1,358 total cultivation licenses as of July 2016 (see **Figure 2**). This likely translates to around 1,000 unique facilities. In

its first year, sales taxes derived from recreational sales exceeded anticipated state spending by $66 million, sufficient to trigger a ballot measure to determine whether the excess should be refunded to voters.[11] Together, medical and recreational sales took in nearly $1 billion in sales in 2015, leading to over $135 million in taxes and fees for the state.[12]

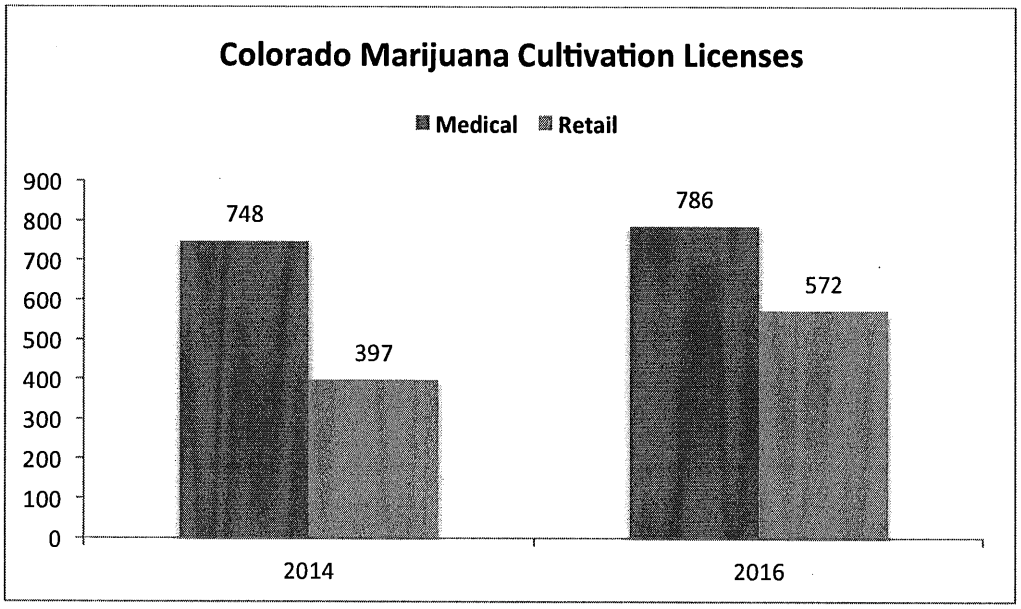

Figure 2: Marijuana Cultivation Licenses in Colorado[13]

Marijuana Cultivation Facilities Are Energy-Intensive.

Much of marijuana's energy impact comes from indoor cultivation—a natural result of a traditionally underground industry, but also a frequent requirement of local and state regulations. Generally, the largest energy consumer is lighting, but air conditioning, ventilation, dehumidification, and other climate control measures follow close behind.[14] Before being stored or sold, marijuana plants generally must be dried and cured, a process which may require additional equipment (and energy) in large grows. Moreover, the field of tetrahydrocannabinol ("THC") extracts and oils is expanding, and certain extraction methods may use high-powered compressors or trigger building code requirements for laboratory-style ventilation equipment.[15]

Assessing the energy needs of a "typical" indoor grow can be challenging. Indoor grow facilities may use lights ranging from 600 - 1,200 W each, which can generate a significant amount of waste heat that must be addressed. Maintaining desired indoor temperatures often necessitates the addition of cooling and ventilation systems, which may take the form of rooftop units, portable air conditioning, or wall units.[16] As a result, indoor grows can have energy intensities of 2,000 W/m^2.[17] This is on par with data centers, which are themselves 50 to 200 times more energy-intense than a typical office building, depending on the study consulted. A typical plant growth cycle involves vegetation and flowering stages, in which the plants may require 8-18 hours of light per day for eight weeks.[18] Compared to an outdoor grow, which can

achieve one to two growth cycles per year, an indoor grow can achieve over five cycles per year.[19]

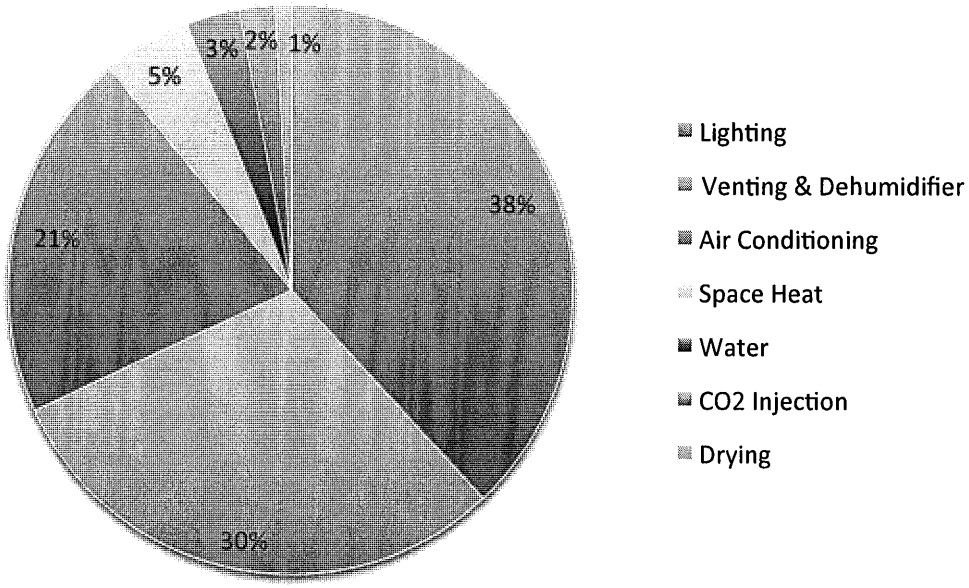

Figure 3: Proportion of Energy Consumption by End Use for Indoor Marijuana Cultivation[20]

Marijuana Cultivation Has a Measureable Energy Impact.

The impact of such an energy-intense industry is significant. In 2012, Evan Mills issued a pioneering *Energy Policy* article, "The carbon footprint of indoor *Cannabis* production," which estimated that marijuana cultivation may comprise as much as 1% of U.S. electricity use, valued at $6 billion.[21] At the time Mills completed his analysis, marijuana cultivation was legal in 15 states and the District of Columbia; as discussed above, 25 states now allow medical marijuana use, and full legalization in four states only went into effect after Mills issued his article.

Colorado and Washington have begun to grapple with marijuana's implications for energy use on a state and regional basis. Reportedly, marijuana grow facilities used 200,000 MWh in Colorado in 2014, or about 0.4% of the state's electricity usage.[22] Colorado utilities have acknowledged the challenges that marijuana cultivations create for their energy planning. Public Service Company of Colorado ("Xcel") explained that its electricity sales to marijuana businesses have been growing by 40-60 percent each year, meaning that marijuana cultivation may have grown from 0.8% of commercial and industrial electricity sales in 2013 to 1.4% in 2015.[23] Xcel was required to achieve about 390,000 MWh of energy savings from energy efficiency programs in 2014, so a 60,000 MWh increase in that year would erode 15% of the target.[24] Staff of the City and County of Denver, which is the largest community served by Xcel, recently stated that marijuana cultivation consumed 2.2% of electricity within the city in 2014.[25]

In Washington, the Northwest Power and Conservation Council ("NPCC") forecasts that regional energy loads associated with indoor cultivation of marijuana could grow from an estimated 80-102 MW in 2014 (about 1% of total demand in Washington) to 180-300 MW by 2035.[26] To put that in context, the NPCC forecasts that data center load could reach 900 MW[27] and electric vehicle load could reach 160-625 MW[28] by 2035. The NPCC's latest plan explains that aggressive energy efficiency investment will be key to managing growth over time.[29]

This discussion is not meant to exaggerate the impact of marijuana cultivation. It appears to remain less than 1% of loads and energy sales on a state-by-state basis, even where legal for recreational use. However, as a witness for Black Hills Energy recently stated in a Colorado rate case, the industry creates uncertainty for utilities in identifying their power needs.[30]

Energy Is a Significant Cost for Marijuana Grow Operations.

Utility bills for marijuana cultivators can range from $3,000 to $100,000 per month, according to news reports and anecdotes.[31] While in Boulder County, a typical grow is around 5,000 square feet,[32] a CBRE study found that a typical grow in the Denver area is 10,000 to 20,000 square feet, and that as much as 3.7 million square feet of industrial space may have been dedicated to cannabis cultivation in Denver alone in 2015.[33] Industry consultant Canna Advisors states that a typical monthly energy bill for a Denver-area grow ranges from $20,000 to $50,000.[34] Accordingly, the cost for energy in indoor cultivation could vary from $0.60 - $1.20 per square foot of space per month.[35] On an annual basis, that puts marijuana-related energy costs at roughly $10 per square foot as compared to the national average of $2-3 per square foot for commercial buildings more broadly.[36] (In contrast, marijuana cultivation in a greenhouse setting could cost less than $0.10 per square foot, according to one source.[37])

These high utility bills contribute to the large operating costs needed to cultivate marijuana. While some marijuana businesses are looking to manage energy to cut costs or reduce carbon, the impetus so far is coming from external players, like utilities and local governments.

WHY REGULATORS ARE LOOKING AT MARIJUANA CULTIVATION'S ENERGY INTENSITY

Marijuana cultivators are subject to an enormous breadth of regulation, including "clone to cure" plant tracking, ordinances addressing marijuana odors in public areas, and pesticide restrictions.[38] To date, energy- and climate-related regulation has been limited to a few specific instances by utilities and local governments.

Utilities Report Impacts to Their System Operations from Marijuana Grows.

While the focus of this paper is large-scale legal marijuana cultivation, utilities have openly discussed reliability impacts they have experienced due to illegal grow operations or home

grows in residential neighborhoods. For example, BC Hydro, a utility located in British Columbia, identified capturing $100 million per year in lost revenues due to electricity theft—a significant amount of which it attributed to illegal marijuana cultivation—as the single biggest benefit of installing a smart metering system.[39] For its part, in Oregon, Pacific Power & Light estimated that seven outages were attributable to indoor grows in late 2015, and Portland General Electric has estimated that about 10% of its 400 annual transformer replacements are due to grows.[40]

Local Governments Report Impacts on Their Climate and Energy Goals.

Local governments engaged in climate action planning have reacted to marijuana's increasing impact on their carbon reduction goals. The City of Boulder and Boulder County, both in Colorado, require medical and recreational marijuana cultivators to offset 100% of their electricity use with either installation of on-site renewables, purchases of renewable energy or carbon offsets, or participation in a community solar garden (Boulder County's program is discussed in more detail later).[41] The City of Arcata, California took a different approach. It passed a ballot measure in 2012 that assess a 45% tax on residences using more than 600% of a baseline level of energy.[42] While the primary impetus was to help get the city back on track to reaching its climate action goals, shutting down residential marijuana cultivation was reportedly also a strong consideration.[43]

WHAT BARRIERS ARE THERE TO CLEAN, EFFICIENT ENERGY USE IN THE MARIJUANA INDUSTRY?

The overriding barrier to marijuana businesses conserving energy, investing in renewable energy, and reducing their carbon emissions is that marijuana cultivation remains federally illegal. This can create or exacerbate several practical barriers, of which three are particularly important to energy. First, utilities and PUCs lack information about how the marijuana industry uses energy, and the marijuana industry may not yet have the expertise to engage at PUCs. Second, the high cost of capital for marijuana businesses continues to prevent investments in energy efficiency and renewable energy. Finally, a "split incentive" exists in that better energy practices may benefit business owners by reducing their costs, but may need to be implemented by growers, who are under pressure to maximize yield and potency. The recommendations in this paper are tailored to address these challenges, to the extent it is possible to address them without changes to federal law.

No One Has Sufficient Information.

The nature of the marijuana industry, which is both new and traditionally illegal, creates barriers in sharing information that lead to inefficient energy consumption. There is an information vacuum both about, and within, the marijuana industry. Utilities may not have good data about how marijuana growers use energy or what their future energy needs may be.

Furthermore, organizations that may traditionally have a role in certifying equipment for efficiency and safety, or offering industry-specific energy guidance, may be barred (in the case of national laboratories) or limited by policy (in the case of other certification organizations) from providing that function to the marijuana industry.

There are also informational barriers within the marijuana industry. Marijuana businesses may not have enough information about how utilities and PUCs operate to understand their rights. Even if they did get involved in energy regulatory processes, as a formerly underground industry, and one that is still federally illegal, this process may be uncomfortable. Participation in PUC proceedings may mean sharing information about their operations or subjecting themselves to discovery, which may be uncomfortable for businesses that are used to operating discreetly. Moreover, because marijuana cultivation is highly competitive in states like Colorado, businesses can be disincentivized from sharing information and best practices with potential competitors. However, without marijuana industry participation in PUC proceedings, there is little impetus for other parties to develop rules for the industry that will lead to more efficient use of electricity.

The High Cost of Capital Discourages Spending Money on Energy Management.

Marijuana businesses have limited access to capital due to Federal Deposit Insurance Corporation ("FDIC") restrictions and limitations on federal tax deductions,[44] which may reduce their ability to invest in renewable energy facilities or energy efficiency measures. The financing they receive to build or expand their businesses comes with extremely high-interest rate loans—anecdotally, as much as 15 to 20 percent—meaning producing marijuana in high quantities is paramount. This discourages marijuana growers from spending more to install energy-efficient equipment or on-site renewable generation, such as solar panels.

This problem is exacerbated because of federal illegality. For example, Pacific Northwest utilities that purchase power from the Bonneville Power Administration, the federal energy agency, are not allowed to provide energy efficiency rebates to marijuana growers.[45] Upfront rebates can be a critical component of helping customers select energy-efficient equipment, which can be more expensive. Even where energy efficiency rebates are not explicitly prohibited, they may be discouraged. In a 2015 evaluation of Xcel's Lighting Efficiency Program, the Cadmus Group acknowledged both the interest in Colorado for lighting efficiency in marijuana grows, as well as the challenges Xcel will face in providing programs because it operates in several states, not all of which have loosened marijuana restrictions.[46]

There Are Numerous Split Incentives Throughout the Industry.

A split incentive occurs when one party must take action but the benefits accrue to a different party. The classic energy example is that if a building owner invests in energy-efficient equipment, her tenant receives the benefit in the form of a lower energy bill. The analogue in the marijuana industry is that owners and investors of marijuana businesses may benefit from changing practices in ways that reduce energy costs, but this involves extra burdens on the

managers of the grow facilities, who must configure an indoor grow area differently or manage more employees on alternative shifts. These "master growers," who are in charge of cultivating large volumes of high-quality marijuana, may be disengaged on the financial impacts of their energy use, be unaware of energy management tools, or be uninterested in modifying the workflow and operational practices they have created and that have so far worked for them.

Moreover, in some cases, several marijuana businesses may lease space in the same building and be on the same electric meter. In such situations, if one grow operation makes changes in its business practices to reduce electricity use, the benefits of that reduction may flow to the other grow operations that share the utility bill. This operates as a disincentive to spend money on energy efficiency improvements. Leasing also creates barriers to installing onsite solar. In such circumstances, the individual marijuana operations may not want to incur the cost of building improvements that may benefit other occupants or outlast the individual grow operation's tenancy.

THE ENERGY REGULATORY SOLUTION

A comprehensive solution to increasing the efficiency and decreasing the carbon intensity of the energy used by the marijuana industry would emphasize education, information sharing, incentives, and collaboration. Utilities, public utility commissions, other governmental entities (such as local governments and state energy offices[47]), and marijuana industry organizations will all need to be involved. Our recommendations are organized by the entity best positioned to implement them, although many of these recommendations involve multiple players.

Recommendations for Utilities

1. ***Make sure marijuana growers know how much energy they are using, when they are using it, and when it is most expensive to use.***

The first step to managing energy is understanding how and when it is being used. Anecdotally, most marijuana grows do not install energy management tools as part of their operations. However, learning how energy is used—which equipment uses it most, and how behavior factors in—is a key step in managing energy better. As we discuss in more detail below, most Colorado grow facilities are on a tariff that includes a demand charge, which means that they should have metering capabilities sufficient to measure their electricity demand in 15-minute intervals.[48] However, it is unclear whether grow facilities have access to that data, much less in real time (or near real-time), so that they can see what activities are driving their utility costs.

As an initial step, we strongly recommend that utilities provide marijuana growers with online access to detailed information about their energy usage, in as close to real time as possible. This data should be downloadable and ideally transferrable to energy management applications. In Colorado, for example, Xcel has implemented an energy data portal by which building owners can request that their energy consumption data be automatically uploaded

into ENERGY STAR Portfolio Manager, an online tool that allows them track building energy performance.[49] However, this data is often uploaded only monthly or annually, which undermines the usefulness of the data. As well, the data may not be sufficient for marijuana cultivators in rented spaces that do not have their own electric meters.

2. Tailor energy efficiency rebates and services to marijuana growers.

Utilities should offer tailored energy efficiency rebate programs and outreach that specifically address the industry's needs. Reportedly, Xcel became the first utility in the country to offer lighting rebates to marijuana growers, but Xcel does not appear to market directly to the industry. The Energy Trust of Oregon—a nonprofit, not a utility—currently offers a suite of energy management tools for growers, including free technical studies to identify the potential for energy efficiency measures.[50] Some utilities also offer free or discounted energy modeling for commercial buildings in the facility design phases. However, the unique design requirements of grow facilities may necessitate seeking out or cultivating special skills on the part of the utilities or their contractors.

In many cases, tailoring energy efficiency rebates and services is less about investigating specific products, and more about helping marijuana companies understand that there are energy-efficient options available to them, as well as engaging them earlier in the process of designing grow facilities. Materials tailored to marijuana cultivators and outreach to trade associations would help ensure information about energy-efficient products gets into the right hands.

3. Design electric rates to promote efficient energy use within grow facilities.

In keeping with the objectives of this paper, good electric rate design should incentivize marijuana growers to use electricity more efficiently, and it should not disincentivize investments in renewable energy and energy efficiency. Promoting efficiency in electricity use is a longstanding goal of rate design,[51] but achieving that goal can be complicated. In this case, it is even more challenging because there is so little data on hourly electricity usage by marijuana grows. The data that is available—such as that shown in **Figure 4**—suggests that the load profile for marijuana cultivation is highly dependent on the relative timing of lighting and HVAC operation. However, despite this barrier, we can make some preliminary assessments as to what types of rate design may be preferable for promoting energy efficiency and renewable energy use.

Commercial customers typically receive electric utility service under rate schedules that assess charges based on both the total amount of electricity consumed during a billing period in kilowatt-hours ("kWh") and the maximum amount of electricity used by the customer at any point in time during the billing period in kilowatts ("kW"). Anecdotally, most marijuana grow operations in Xcel's Colorado service territory are on a Secondary General ("SG") tariff. In keeping with traditional rate design for commercial customers, Xcel's SG tariff assesses a kW charge based on a customer's maximum 15-minute peak demand during a month (called a non-coincident demand charge). This means that if all grow equipment comes on at the same

time—such as lights, HVAC, and dehumidification—the grower will be charged based on needing that much energy at once, even if that is not how the grow typically operates.

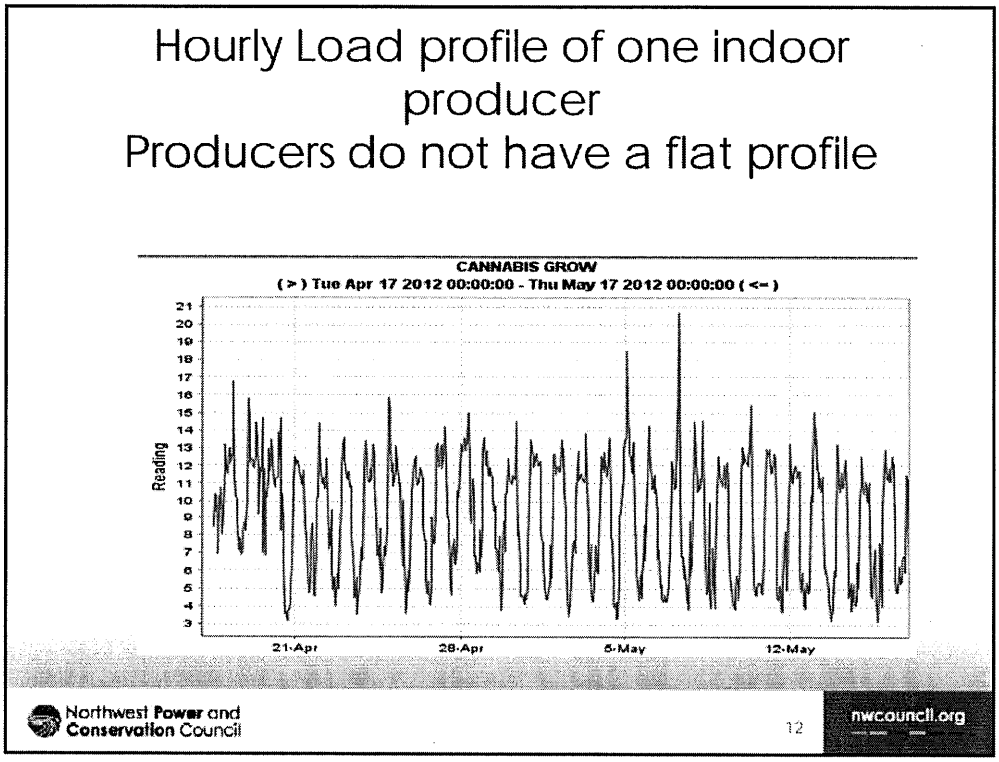

Figure 4: Hourly Load Profile[52]

Existing practice within the industry is to divide plants into smaller, contained rooms to prevent the spread of diseases. This means that theoretically, marijuana cultivators could reduce costs under this current rate design by staggering the operating schedules of lighting and other equipment in different rooms.[53] However, there are three other rate design features that may contribute to greater efficiency and more use of renewable energy.

First, this aspect of marijuana operations—alternating rooms—could contribute to creating a higher and more consistent load factor. A load factor is the ratio of the average load to the peak load. Customers with high, consistent load factors are desirable to utilities because they have predictable energy demands and sales. Data centers are a common example of an industry with a high load factor, while football fields may have very low load factors because they are irregularly used. Some utilities provide special rates to customers with higher and more consistent load factors, because they can improve utilities' ability to forecast energy needs and prevent reliability issues.

Second, time-of-use rates may be useful to prevent energy consumption associated with marijuana from contributing to periods of peak demand. During peak periods, large numbers of customers all draw power at the same time, which leads to the use of more expensive "peaker"

plants that are operated infrequently. Utilities' peak periods can differ, but are often in the late afternoon during the summer, due to air conditioning usage. Many utilities implement time-of-use rates that are intended to encourage customers to move their electricity use to other times of the day. Even where lights are run for as long as 18 hours per day during growth stages, they could likely be programmed to avoid various peak periods.

Finally, many commercial and industrial customers that are on demand charges are subject to demand "ratchets." A demand ratchet will lock in a certain level of demand charges, often for a year, based on the customer's historic energy consumption. For example, if a grow operation has one inordinately high peak demand in a particular month, the kW charge that results will stay in place for a year before it can be adjusted downward to reflect a more typical maximum peak electricity demand.[54] This practice can disincentivize investments in rooftop solar, battery storage, and energy efficiency, because customers may not see the impacts of those investments for some time after they are made.[55] Changing demand ratchet provisions would provide customers with greater opportunities to make those investments.

Ultimately, should there be marijuana-specific electric rates? Not enough information exists publicly to determine whether marijuana cultivation operations are distinct enough from other industrial or agricultural operations to justify a unique rate. A longstanding principle of electric utility rate design is that electric rates must be just and reasonable, and non-discriminatory.[56] Electric rates are typically designed for broad customer "classes," such as residential, commercial, and industrial. When rates differ for different customer classes, the basis can be the cost to serve a particular type of customer, the voltage at which the customer takes power, or the sophistication with which the customer is able to respond to price signals. Generally, rates tailored for particular end uses, such as a particular type of industry, are discouraged, unless one or more of these justifications are present. For instance, many utilities have separate rates for agricultural customers, but not residential customers in apartments.

Utilities have considered industry-specific rates for marijuana growers, with public utility districts ("PUDs") in Washington being the most experienced in this respect. For example, in 2014, the Mason County PUD adopted a special Schedule 24 for cannabis cultivation, which includes a system charge of $2.04/day and a non-coincident peak demand rate of $7.86/kW.[57] Large commercial and industrial customers pay higher demand rates and system charges, but lower energy rates.[58] Jefferson County PUD has considered charging marijuana growers higher rates than other agricultural customers, but believes itself to be barred by state law provisions that prohibit discriminatory rates.[59] However, industry-specific rate designs have been adopted for other energy-intense customers, like data centers, which the Chelan PUD just placed on an industry-specific rate.[60]

There are many ways that utilities and regulators can approach rate design, depending on the objectives to be accomplished. An important feature of the rate designs suggested here is that they can promote efficient energy usage among different types of customers without specifically targeting marijuana cultivators. Widespread use of these rate designs would lead to

more efficient electricity usage patterns at marijuana grow operations, and rates tailored to the industry might be even more effective, if they are justified by data.

4. ***Create fair policies for connecting grow facilities to the grid and assessing costs for upgrades.***

Most utilities have a formalized process for extending service lines to new customers in unserved areas, or for upgrading utility distribution systems to meet customers' needs. This can involve multiple stages of engineering analysis and require customers to pay an upfront cost for construction.[61] However, these line extension policies can cause sticker shock for marijuana growers. Reportedly, Xcel has quoted as much as $500,000 for a grow facility to install new transformers.[62]

Xcel affirmatively changed its line extension policies in 2013 to clarify its policy towards marijuana cultivation facilities. It defines an "indoor plant growing facility" as a "High Density Load," like a data center, in which "the customer's load requirements are increased substantially over normal load per square foot ratios. . . ."[63] Under these policies, marijuana grows pay the difference for any construction requirements that go beyond what a "normal" customer would pay to have service extended to a premise.[64]

Line extension policies that require upgrades to be paid by the entity causing the upgrade are not uncommon, and they are not necessarily unfair. They may be applied to customer-sited renewable resources above a certain size, such as commercial rooftop solar. However, utilities should not penalize marijuana cultivators seeking line extensions due to uncertainty associated with the industry's legality, and they should treat those applicants fairly once they have requested a line extension. Finally, utilities' websites should include information tailored to the industry on what to expect in the line extension process, including cost ranges and timelines, and should be clear about dispute resolution processes.

Recommendations for Public Utility Commissions

1. ***Set appropriate policy direction to support collaboration between utilities and growers.***

According to EQ Research's analysis, PUCs have not yet significantly dealt with the energy supply impacts of marijuana cultivation in major proceedings. But where utilities are dealing with marijuana-related energy challenges, PUCs will inevitably end up dealing with them too. The impact of indoor marijuana cultivation on electric utilities is already being discussed at meetings of the National Association of Regulatory Utility Commissioners ("NARUC").[65]

Where marijuana-related questions arise, PUCs should encourage utilities and the marijuana industry to produce empirical data on which they can base their decisions. If marijuana cultivation begins to have a noticeable impact on peak utility load or carbon emissions, PUCs may need to take action to require utilities to explore energy efficiency and renewable energy

options, as the traditional utility business model encourages selling more electricity. This could include setting specific policy direction or authorizing special accounting mechanisms for utilities that operate across multiple states, to ensure that any work they do to promote energy efficiency and clean energy within the marijuana industry is restricted to those states where marijuana is medically or recreationally legal.

Recommendations for State and Local Government Entities

1. ***Ensure that zoning, building, and electrical codes encourage clean energy.***

State and local governments should streamline aspects of their zoning, building, and electrical codes that impact energy use in marijuana grows. For example, whether an area is zoned commercial, industrial, or agricultural can sometimes determine the level of enclosure required for the grow space.[66] Ideally, local governments would establish land-use regimes that allow growers to utilize greenhouses rather than warehouses. However, this is not a panacea: there could be a trade-off between the use of greenhouses and the ability to fully manage energy, and depending on the structure, poor insulation may lead to excessive natural gas use for heating during the winter in states like Colorado.[67]

Building and electrical codes may create challenges for growers as well. For example, a common practice in the marijuana industry is to raise and lower light ballasts to keep them close to growing plants, sometimes using ropes and pulleys. However, local building and electrical codes require non-combustible materials, like cables and chains, to be used with light ballasts.[68] Because the practice of raising and lowering lights reduces the number of lights that are needed (and the electricity used) to achieve a desired light intensity,[69] miscommunications over what materials are allowed could have energy impacts. To address issues like this, a recent partnership between the City and County of Denver and the University of Colorado Law School recommended integrating four local agencies' permitting information and answers to frequently asked questions onto one website to reduce the number of violations and re-inspections.[70]

2. ***Convene marijuana industry working groups on energy and sustainability to develop best practices, and act as a centralized repository for educational materials.***

State and local governments have begun working with the marijuana industry to understand sustainability barriers and opportunities. An Oregon task force exploring energy and water use by the marijuana industry is considering recommending that the state require growers to complete a third-party sustainability certification process.[71] Additionally, the City and County of Denver is coordinating a Cannabis Sustainability Working Group that may develop a best practices manual for industry sustainability.[72] Ultimately, this kind of collaboration could be used to develop a single point of access for energy and sustainability information for marijuana businesses, hosted by state or local government agencies. A centralized repository could include information about best practices related to sustainability, address how to select energy-efficient products and renewable energy options, and provide "know your rights" materials with regard to interactions with utilities.

3. ***Provide additional financing opportunities so marijuana growers can invest in renewable energy and energy efficiency.***

State and local governments may be the best positioned to address the industry's financing challenges in creative ways. Some communities see marijuana cultivation as an economic development issue. Walsenburg, Colorado, is developing a "marijuana campus" to centralize grow operations and replace jobs lost from mining and extraction industries.[73] Public-private partnerships might be used to develop renewable energy programs and products specific to the marijuana industry. Boulder County, for example, initially considered a community solar garden dedicated to unincorporated county grows in lieu of a carbon offset program.[74] Unfortunately, Colorado's Commercial Property Assessed Clean Energy ("PACE") financing program—which was developed by the Colorado Energy Office and offers low-cost financing for eligible energy efficiency, renewable energy, and water conversation improvements—explicitly precludes marijuana businesses from participating.[75] However, state or local PACE programs may not need to exclude marijuana businesses from participating if the PACE program is not accepting federal funding.

4. ***Work with businesses and utilities before marijuana grows are built to make sure energy management is incorporated from the start.***

Currently, marijuana businesses must work separately with municipal governments on building and construction issues and with utilities on line extensions and metering. A better process might connect marijuana businesses with municipal code staff, municipal sustainability staff, utility engineering staff, and utility account managers before marijuana grows are built so that energy management systems, efficient equipment, and renewable energy can be integrated in building design from the start. This recommendation could inform the engineering analysis performed to determine any required distribution system upgrades. An upfront investment of $50,000 in energy modeling may not eliminate an upfront $500,000 transformer upgrade, but it has potential to reduce that cost, as well as utility costs over time.

5. ***If you regulate, consider how rules can be directed to further break down barriers to clean and efficient energy use in the marijuana industry.***

This paper focuses primarily on "carrot" approaches, rather than "sticks." However, where local governments opt to regulate electricity usage by marijuana companies to promote clean energy, regulation should be based on whether energy usage is wasteful. Engagement with the industry to define how this could be measured is critical in making this determination.

As mentioned earlier, in 2015, Boulder County implemented a new energy management program for marijuana cultivation. Commercial marijuana growers in unincorporated Boulder County must offset 100% of energy consumption through on-site renewable energy, community solar, or equivalent, or pay approximately 2 cents per kWh into an offset fund, roughly based on the federal Social Cost of Carbon.[76] Based on industry feedback, the fee is only assessed on energy usage that is more intense than that of standard commercial buildings.[77] Moreover, the fees that go into this program are being applied to install energy management tools in marijuana cultivation facilities to help bring awareness of how energy is

used. In other words, while marijuana cultivation is being assessed a fee for wasteful energy use, the program funds are being redirected to eliminate that waste.

Recommendations for Marijuana Industry Associations and Entities

1. ***Invest in energy management.***

Trade associations should encourage their members to install tools that monitor energy consumption at the circuit level within the customer's electrical panel. Professional growers already use timers to maintain the light cycles required by plant growth. However, building energy management tools can go beyond monitoring energy usage and setting simple timers to optimize how lighting, HVAC, and other systems interact. Circuit-level energy monitoring may also be useful for marijuana cultivators who do not have individual electric or natural gas meters, as it can help them determine whether monthly bills are being allocated fairly between their facility and the facilities of other tenants.

2. ***Support research on the impacts of efficient equipment on marijuana growth.***

Anecdotally, there is interest within the marijuana industry in making grow operations more energy efficient, but informational barriers remain. Utilities that engage in energy efficiency programs conduct measurement and verification to make sure that energy-efficient products lead to actual savings over time, creating reliable sources of information about equipment performance and payback periods. Xcel in Colorado is working with the University of California-Davis to test the efficiency of dehumidification equipment commonly used in indoor agriculture.[78] However, efficient products may be perceived (sometimes accurately) as negatively impacting plant growth, as well as the content of THC and other cannabinoids.[79] In other words, lighting products need to be validated not only for their energy efficiency performance, but also for their impact on marijuana plants themselves. Marijuana industry groups would likely need to lead the research and development associated with validating the performance of energy-efficient products in this capacity.

3. ***Engage at public utility commissions.***

Marijuana industry associations may be well positioned to advocate for their members' interests at PUCs, just as associations representing other industries and entities representing customer groups regularly participate. However, marijuana cultivators may have unique interests that are not well represented by existing PUC participants. For example, the Colorado Office of Consumer Counsel ("OCC") represents agricultural customers, residential customers, and small business customers when advocating at the PUC.[80] However, the OCC does not represent marijuana cultivators, which are large energy users with different needs and interests.

Because marijuana businesses are not currently engaged at PUCs, all the information that regulators receive regarding service rates and terms for marijuana cultivators comes from utilities. This creates risk to the marijuana industry because no other party is looking for ways to use energy efficiency, renewable energy and time-of-use rates to lower growers' electric bills (and lower utility costs).

4. ***Work with utilities to provide information about how and when energy is used.***

The NPCC and utilities have flagged that uncertainty associated with the marijuana industry—including the risk that state and federal actions may force businesses to close, and the variations in how individual marijuana cultivators use energy—can make it difficult to determine its impact on future energy needs and on distribution planning. Marijuana trade associations may be able to provide utilities with generic, anonymized data on how energy is used in marijuana grows to help with resource planning and distribution engineering. This data could include information about plant needs, common types of equipment, operations and management practices for grows, etc. Better information would help utilities with planning for power needs and also ease the process of getting marijuana grow facilities connected to the grid in the future.

CONCLUSION

As states move forward with removing barriers to marijuana cultivation, it will be critical to get ahead of the resulting growth in indoor marijuana cultivation to address the impact it may have on growth in energy demand and carbon emissions. Utilities, PUCs, state and local governments, and the industry itself must work together to improve the dissemination of information, increase awareness of energy impacts, break down barriers to efficient use of energy, and provide incentives for efficient and renewable energy use. Because the marijuana industry is in its nascent stages in the U.S., making this a coordinated effort could go a long way to turning this "green" industry into a truly verdant one.

END NOTES

[1] Colorado Department of Revenue. *Marijuana Enforcement Division Licensed Facilities*. Accessed July 27, 2016. *Available at* https://www.colorado.gov/pacific/enforcement/med-licensed-facilities.

[2] Mills, E. (2012). The carbon footprint of indoor Cannabis production. *Energy Policy, 46*, 58–67. *Available at* http://evanmills.lbl.gov/pubs/pdf/cannabis-carbon-footprint.pdf.

[3] The Marijuana Policy Project. *State Policy*. Accessed August 11, 2016. *Available at* https://www.mpp.org/states/. This does not count states that have only decriminalized the possession of small amounts of marijuana. The District of Columbia also approved recreational marijuana use, but congressional actions have barred aspects of its regulation and implementation.

[4] *See generally* Lazar, J. (2011) *Electricity Regulation in the U.S.: A Guide* from The Regulatory Assistance Project. http://www.raponline.org/wp-content/uploads/2016/05/rap-lazar-electricityregulationintheus-guide-2011-03.pdf

[5] Cole, J. (2013) *Guidance Regarding Marijuana Enforcement* [Memorandum]. Washington, DC: U.S. Department of Justice. https://www.justice.gov/iso/opa/resources/3052013829132756857467.pdf.

[6] NORML. *State Info*. Accessed July 27, 2016. *Available at* http://norml.org/states.

[7] Marijuana Policy Project. *Ballot Initiative Campaigns*. Accessed July 27, 2016. *Available at* https://www.mpp.org/initiatives/.

[8] Stebbins, S., Frohlich, T. C., & Sauter, M. B. (2015, August 19). The next 11 states to legalize marijuana. *USA Today*. Retrieved from http://www.usatoday.com/story/money/business/2015/08/18/24-7-wall-st-marijuana/31834875/ (Connecticut, Delaware, Maryland, Minnesota, New York, Ohio, Rhode Island and Vermont).

[9] Moreland, M. (2015, October 6). Ohio's Marijuana Oligopoly Concerns. Retrieved from https://uclawreview.org/2015/10/06/ohios-marijuana-oligopoly-concerns/.

[10] *Id*.

[11] Frank, J. (2015, September 12). Ahead of 2015 vote, campaign pushes marijuana tax question in Colorado. *The Denver Post*. Retrieved from http://www.denverpost.com/2015/09/12/ahead-of-2015-vote-campaign-pushes-marijuana-tax-question-in-colorado-2/. Voters overwhelmingly rejected refunds, and the additional tax revenue was dedicated to school construction, substance abuse programs, and other initiatives.

[12] Baca, R. (2016, February 9). Colorado marijuana sales skyrocket to more than $996 million in 2015. The Cannabist. Retrieved from http://www.thecannabist.co/2016/02/09/colorado-marijuana-sales-2015-reach-996-million/47886/.

[13] A single cultivation may have more than one license. For 2014 data, see Brohl, B., Kammerzell, R., & Koski, W. L. (2015) *Annual Update* from Colorado Department of Revenue, Enforcement Division – Marijuana, pp. 3, 8. *Available at* https://www.colorado.gov/pacific/sites/default/files/2014%20MED%20Annual%20Report_1.pdf. For 2016 data, see Colorado Department of Revenue. *Marijuana Enforcement Division Licensed Facilities*. Accessed July 27, 2016. Retrieved from https://www.colorado.gov/pacific/enforcement/med-licensed-facilities.

[14] SDG&E Cannabis Agriculture Energy Demand Study Final Report. (2016, July 15) p. 10. *Available at* http://www.energydataweb.com/cpuc/search.aspx. *See also* note 52.

[15] *See* Tennant, N. (2015). An Education in Extraction. *Marijuana Venture*. Retrieved from http://www.marijuanaventure.com/an-education-in-extraction/; Kemsley, J. (2015). Making Legal Marijuana Safe. *Chemical & Engineering News*, *93*(16), 27–28. Retrieved from http://cen.acs.org/articles/93/i16/Making-Legal-Marijuana-Safe.html; R. Flax (personal communication, July 21, 2016); Lukus, B. (2015). Fire Codes and Standards: Denver's Legalized Marijuana Industry and the Fire Code. *Fire Engineering*, *168*(2). Retrieved from http://www.fireengineering.com/articles/print/volume-168/issue-2/features/fire-codes-and-standards-denver-s-legalized-marijuana-industry-and-the-fire-code.html.

[16] M. Jourabchi (personal communication, April 12, 2016).

[17] Mills, E. (2012). The carbon footprint of indoor *Cannabis* production. *Energy Policy, 46*, 58–67. *Available at* http://evanmills.lbl.gov/pubs/pdf/cannabis-carbon-footprint.pdf.

[18] B. Henderson (personal communication, February 4, 2016).

[19] *Seventh Northwest Conservation and Electric Power Plan, Appendix E.* p. E-60 (Document No. 2016-02). February 25, 2016, from Northwest Power and Conservation Council. *Available at* http://www.nwcouncil.org/energy/powerplan/7/plan/.

[20] Evergreen Economics. (2016, July 15). SDG&E Cannabis Agriculture Energy Demand Study: Final Report, p. 10. *Available at* http://www.energydataweb.com/cpuc/search.aspx.

[21] Mills, E. (2012). The carbon footprint of indoor Cannabis production. *Energy Policy, 46*, 58–67. *Available at* http://evanmills.lbl.gov/pubs/pdf/cannabis-carbon-footprint.pdf.

[22] Finley, B. (2016, July 1). Marijuana-growing spikes Denver electric demand, challenges clean-power plan. *The Denver Post*. Retrieved from http://www.denverpost.com/2015/07/01/marijuana-growing-spikes-denver-electric-demand-challenges-clean-power-plan/; Energy Information Administration, Retail sales of electricity to ultimate consumers, http://www.eia.gov/electricity/data.cfm#sales (Colorado, 2014, Annual).

[23] Colorado Public Utilities Commission, Proceeding No. 14AL-0660E, Rebuttal Testimony of Jannell E. Marks, Dec. 17, 2014, at p.6 (stating that electricity sales increased by 40%, or 50,000 MWh, from 2013 to 2014, and were expected to grow by another 60,000 MWh from 2014 to 2015). The denominator for this calculation is the electricity sales in megawatts from Xcel's FERC 2013-2015 FERC Form 1 filings (adding the Commercial (C), Primary General (PG), and Secondary General (SG) rate classes).

[24] 2014 Demand-Side Management Annual Status Report (2015) Public Service Company of Colorado. *Available at* https://www.xcelenergy.com/staticfiles/xe-responsive/Admin/Managed%20Documents%20&%20PDFs/2014-CO-DSM-Annual-Status-Report.pdf.pdf. (p. 6, showing approximately 392,000 MWh energy savings)

[25] Ashlock, A. (Producer) (2016, May 13) *Colorado's Lucrative Pot Industry Has Huge Energy Footprint* [Audio Podcast]. Retrieved from http://www.wbur.org/hereandnow/2016/05/13/colorado-pot.

[26] *Seventh Northwest Conservation and Electric Power Plan, Appendix E.* p. E-60-65 (Document No. 2016-02). February 25, 2016, from Northwest Power and Conservation Council. *Available at* http://www.nwcouncil.org/energy/powerplan/7/plan/.

[27] *Id.* at E-24.

[28] *Id.* at E-28.

[29] *Seventh Northwest Conservation and Electric Power Plan, Chapter 1.* p. 1-1 (Document No. 2016-02). February 25, 2016, from Northwest Power and Conservation Council. *Available at* http://www.nwcouncil.org/media/7149937/7thplanfinal_chap01_execsummary.pdf.

[30] Colorado PUC, Proceeding 16AL-0326E, Direct Testimony of Christopher K. Burke, filed May 3, 2016, at p. 10 ("While the Company will continue to monitor growth of this new industry and its energy needs, it is the Company's belief that the lack of sustainable load data combined with the uncertainties surrounding the new industry's legal and regulatory environment preclude the Company's ability to accurately forecast future growth patterns at this time.")

[31] Anecdotally, the low end is $3,000 with a typical range of $6,000-10,000. 3-D Cannabis is $6,000/month for 10,000 SF ($0.60/SF), http://mjbizdaily.com/zapped-by-escalating-energy-costs-marijuana-growers-seek-alternatives/; Medicine Man is $40,000/month for 40,000 SF ($1.00/SF), http://www.bizjournals.com/denver/print-edition/2015/08/07/colorado-pot-growers-face-sky-high-power-bills.html; and Colorado Harvest Room is $12,000/month for 10,000 SF ($1.20/SF), http://www.cpr.org/news/story/how-much-electricity-does-it-take-grow-marijuana-colo-cities-are-finding-out. $100,000 from here: http://www.utilitydive.com/news/this-is-the-grid-this-is-the-grid-on-legalized-marijuana-any-questions/233103/; http://denver.cbslocal.com/2013/12/03/marijuana-warehouses-creating-massive-energy-demand-emissions/

[32] *Boulder County Energy Impact Offset Fund.* Retrieved from http://www.bouldercounty.org/env/sustainability/pages/mjimpactoffset.aspx

[33] Rusch, E. (2015, October 19). Marijuana industry drives Denver metro area's real estate recovery. *The Denver Post*. Retrieved from http://www.denverpost.com/2015/10/19/marijuana-industry-drives-denver-metro-areas-real-estate-recovery/. A different study estimated 4.5 million square feet in 2014. Raabe, S. (2014, March 10). Pot-growing warehouses in short supply as demand for legal weed surges. *The Denver Post*. Retrieved from http://www.denverpost.com/2014/03/10/pot-growing-warehouses-in-short-supply-as-demand-for-legal-weed-surges/.

[34] Proctor, C. (2015, August 7). Colorado pot growers face sky-high power bills. *Denver Business Journal*. Retrieved from http://www.bizjournals.com/denver/print-edition/2015/08/07/colorado-pot-growers-face-sky-high-power-bills.html (requires free subscription).

[35] Based on data in fn. 35 [starts "Anecdotally, the low end is..."]

[36] U.S. Department of Energy. *Average Annual Energy Expenditures per Square Foot of Commercial Floorspace*. Retrieved from http://buildingsdatabook.eren.doe.gov/TableView.aspx?table=3.3.8.

[37] Anderson, L. (2014, April 19). Weed greenhouses are so hot right now. *The Verge*. Retrieved from http://www.theverge.com/2014/4/19/5618624/weed-greenhouses-popularity-increase. (River Rock says 27,000 SF greenhouse = $2,500/mo. electricity).

[38] See, e.g., 1 C.C.R. 212-2, Rule 309 (describing the seed to sale Inventory Tracking System), at https://www.sos.state.co.us/CCR/GenerateRulePdf.do?ruleVersionId=6781&fileName=1%20CCR%20212-2 at p. 59-60; Hickenlooper, J. (2015) *Directing State Agencies to Address Threats to Public Safety Posed by Marijuana Contamination by Pesticide* [Executive Order D 2015-15] Denver CO, Office of the Governor. Retrieved from https://www.colorado.gov/pacific/sites/default/files/D%202015-015%20MJ%20Pesticides_2_1.pdf; Denver, Colorado, Municipal Code Ch. 4, art. 2, § 4-10. *Available at* https://www.municode.com/library/co/denver/codes/code_of_ordinances?nodeId=TITIIREMUCO_CH4AIPOCO_ARTIIAD_S4-10NU;

[39] Smart Metering & Infrastructure Program Business Case (2010) BC Hydro. *Available at* https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/projects/smart-metering/smi-program-business-case.pdf.

[40] Terry, L. (2015, November 4). Marijuana grows causing blackouts, power company says. *The Oregonian/OregonLive*. Retrieved from http://www.oregonlive.com/marijuana/index.ssf/2015/11/marijuana_grows_cause_power_bl.html

[41] Boulder, Colorado, Municipal Code § 6-14-8(i) and § 6-16-8(i). *Available at* https://www.municode.com/library/co/boulder/codes/municipal_code?nodeId=TIT6HESASA_CH14MEMA.

[42] City of Arcata, California. (2015) *Sales & Use Tax*. Retrieved from http://www.cityofarcata.org/438/Sales-Use-Tax

[43]Rodriguez, L. (2013, August 25). Arcata marijuana growers to face excessive electricity tax: Officials hopeful new tax will deter growers. *The Times-Standard*. Retrieved from http://www.times-standard.com/article/ZZ/20130825/NEWS/130828988; Hoover, K. L. (2013, December 31). Arcata Collects First Grow House Taxes. *Mad River Union*. Retrieved from http://madriverunion.com/arcata-collects-first-grow-house-taxes/.

[44] See, e.g., McVay, R. (2015, February 11). Marijuana Banking Roundup. *Canna Law Blog*. Retrieved from http://www.cannalawblog.com/marijuana-banking-roundup/.

[45] See, e.g., Ferris, D. (2014, August 8). Utilities struggle to control appetites in energy-hungry marijuana industry. *EnergyWire*. Retrieved from http://www.eenews.net/stories/1060004230; Bermant, C., & Leach, L. (2014, July 6). Peninsula utilities wait for decision on electricity for marijuana-growing operations. *Peninsula Daily News*. Retrieved from http://www.peninsuladailynews.com/article/20140707/NEWS/307079995; Radil, A. (2016, January 22). Northwest Marijuana Growers Try to Go Green (But It's Hard). *Jefferson Public Radio*. Retrieved from http://ijpr.org/post/northwest-marijuana-growers-try-go-green-its-hard#stream/0; Pacific Power. *Marijuana Legalization & Your Power Bill*. Retrieved from https://www.pacificpower.net/about/rr/cannabis.html; Bonneville Power Administration. (2015). *Clarification on BPA's EE Programs and Marijuana* [Press Release]. Retrieved from https://www.bpa.gov/EE/NewsEvents/ee-announcements/Documents/Marijuana_guidance_12_2_15.pdf.

[46] Colby, J., Winch, C., Savkar, R., Fredi, A., & Kolp, D. (2015) *Evaluation of Xcel Energy's Lighting Efficiency Program* (Cadmus Group report). Retrieved from https://www.xcelenergy.com/staticfiles/xe/PDF/Regulatory/CO-DSM/CO-Regulatory-DSM-Lighting-Efficiency-Evaluation.pdf.

[47] State energy offices can have different missions, but they are generally tasked with developing economic and environmental policies related to states' energy extraction, generation, and use. They may also advise legislators and the governor on energy issues. See http://www.naseo.org/state-energy-offices.

[48] SG tariff, PDF p. 61 ("The billing demand...shall be the maximum fifteen (15) minute integrated kilowatt demand used during the month"), https://www.xcelenergy.com/staticfiles/xe-responsive/Company/Rates%20&%20Regulations/CO-rates%20rights%20and%20rules-psco_elec_entire_tariff.pdf.

[49] Xcel Energy. *Energy Benchmarking*. Retrieved from https://www.xcelenergy.com/Programs_and_Rebates/Business_Programs_and_Rebates/New_Construction_and_Whole_Building/Energy_Benchmarking. This is the approach being required by the City of Boulder to verify compliance with requirements to purchase energy offsets. *See* City of Boulder, Colorado. *Boulder Marijuana Facility Energy Requirements*. Retrieved from https://bouldercolorado.gov/planning/boulder-marijuana-facility-energy-requirements. Additionally, Xcel has adopted the Green Button standard to allow customers to download their own data in machine-readable formats, although it has not yet invested in the additional functionality to allow customers to transfer their data electronically to third-party energy management applications. See recent settlement filing on Xcel's 14R-0394EG compliance, saying it would cost $1.5-2 million to convert to Green Button Download My Data functionality, Proceeding No. 15A-0789E.

[50] Energy Trust of Oregon. (2016). *Incentives for Cannabis Cultivation* [Fact Sheet]. Retrieved from https://energytrust.org/library/GetDocument/3774.

[51] Bonbright, J.C. *Principles of Public Utility Rates* (1961) p. 291 (describing "Criteria of a Sound Rate Structure").

[52] Jourabchi, M. & Lahet, M. (2014, September 3). Memorandum to the Northwest Power and Conservation Council: Electrical load impacts of indoor commercial cannabis production, at Slide 12. Retrieved from https://www.nwcouncil.org/media/7130334/p7.pdf.

[53] Denver Environmental Health, *Cannabis Cultivation: Managing Peak Demand, Available at* https://www.denvergov.org/content/dam/denvergov/Portals/771/documents/EQ/MJ%20Sustainability/Cannabis%20Cultivation%20-%20Managing%20Peak%20Demand.pdf; R. Flax (personal communication, July 22, 2016).

[54] Public Service Company of Colorado (Xcel Energy), Electric Rate Book, Secondary General Service, Sheet 44. *Available at* http://www.xcelenergy.com/staticfiles/xe/PDF/Regulatory/CO-Rates-&-Regulations-Entire-Electric-Book.pdf.

[55] See, e.g., Commonwealth of Massachusetts Department of Public Utilities, D.P.U. 15-155, Direct Testimony of Tim Woolf and Melissa Whited on behalf of the Energy Freedom Coalition of America, filed March 18, 2016, at p. 44-55, *available at* http://www.synapse-energy.com/sites/default/files/Woolf-Whited-Direct-Testimony-National-Grid-16-011.pdf.

[56] Phillips, Jr., C.F. (1988) *The Regulation of Public Utilities* (2nd ed.) p. 62-63.

[57] Mason Co. PUD No. 3. *Rates*. Retrieved from http://www.pud3.org/service/billing-options/rates. Adopted http://www.masonpud3.org/newsdisplay.aspx?NewsID=1453.

[58] Mason Co. PUD No. 3. *Rates*. Retrieved from http://www.pud3.org/service/billing-options/rates.

[59] Arthur, A. (2015, March 18). PUD won't say no to selling electricity to pot growers. *The Leader*. Retrieved from http://www.ptleader.com/news/pud-won-t-say-no-to-selling-electricity-to-pot/article_5b15434c-ccf2-11e4-be73-cfd11bea60c1.html.

[60] Pratt, C. (2016, January 14). Bitcoiners call for PUD to change high-density proposal. *The Wenatchee World*. Retrieved from https://www.wenatcheeworld.com/news/2016/jan/13/bitcoiners-call-for-pud-to-change-high-density-rate-proposal/.

[61] Phillips at 338.

[62] Proctor, C. (2015, August 7). Colorado pot growers face sky-high power bills. *Denver Business Journal*. Retrieved from http://www.bizjournals.com/denver/print-edition/2015/08/07/colorado-pot-growers-face-sky-high-power-bills.html (requires free subscription); Martin, J. (2013, January 5). Rocky Mountain high: Pot a $200M industry in Colorado. *The Seattle Times*. Retrieved from http://www.seattletimes.com/seattle-news/rocky-mountain-high-pot-a-200m-industry-in-colorado/.

[63] See generally Colorado Public Utilities Commission, Proceeding No. 13AL-0695E. AL 1663 approved R13-1555, C14-0151, effective Feb. 15, 2014.

[64] Proceeding No. 13AL-0695E, Direct Testimony of Ted L. Niemi, at p. 32-33.

[65] National Association of Regulatory Utility Commissioners. (2015) 127th Annual Meeting Program. Retrieved from http://pubs.naruc.org/pub/4A8BF663-2354-D714-5162-05D32B71F9D2.

[66] See, e.g., Spokane Valley, Washington, Municipal Code Chap. 19.85.010(B) *Available at* http://www.codepublishing.com/WA/SpokaneValley/html/SpokaneValley19/SpokaneValley1985.html#19.85) ("Marijuana production in the regional commercial and community commercial zones shall only be permitted indoors"), Municipal Research and Services Center. *Marijuana Regulation in Washington State*. Retrieved from

http://mrsc.org/Home/Explore-Topics/Legal/Regulation/Marijuana-Regulation-in-Washington-State.aspx; State of Colorado. *Marijuana Retailers & Home Growers*. Retrieved from https://www.colorado.gov/pacific/marijuanainfodenver/marijuana-retailers-home-growers. (Does not require indoor cultivation but does require that the space be locked and enclosed).

[67] R. Flax (personal communication, July 22, 2016) Anecdotally, there can also be greater security issues associated with greenhouse arrangements.

[68] R. Flax (personal communication, July 22, 2016).

[69] Epic Gardening. (2016, June 23). *Inverse Square Law for Light and Hydroponics*. Retrieved from http://www.epicgardening.com/inverse-square-law-for-light-and-hydroponics/.

[70] Retail Regulation Compliance Project, presented at Governmental Entrepreneurial Leadership Accelerator Pitch Night, July 21, 2016, in Denver, CO (more information on GELA at: http://www.silicon-flatirons.org/initiatives.php?id=GELA).

[71] Crombie, N. (2016, June 8). Task force looks at energy, water use related to marijuana production. *The Oregonian/OregonLive*. Retrieved from http://www.oregonlive.com/marijuana/index.ssf/2016/06/task_force_looks_at_energy_wat.html. (Discussing Resource Innovation Institute). There are other groups, such as http://cleangreencert.com/home/about-us/. The U.S. Department of Agriculture cannot certify marijuana for organic status.

[72] Fialka, J. (2016, April 27). Colo. struggles with marijuana's huge carbon footprint. *ClimateWire*. Retrieved from http://www.eenews.net/stories/1060036287.

[73] Hughes, T. (2015, November 2). Tiny Colorado town turns to cannabis. *The Coloradoan*. Retrieved from http://www.coloradoan.com/story/news/2015/11/02/tiny-colorado-town-turns-cannabis/75036326/.

[74] R. Flax (personal communication, July 21, 2016)

[75] Colorado Commercial Property Assessed Clean Energy Assessment and Financing Agreement, p. 6. *Available at* http://copace.com/wp-content/uploads/CoPACE_Assessment-and-Financing_Agreement_Final_10-06-15.pdf.

[76] *Boulder County Energy Impact Offset Fund.* Retrieved from http://www.bouldercounty.org/env/sustainability/pages/mjimpactoffset.aspx; *Boulder County Marijuana Licensing Regulations*. *Available at* http://www.bouldercounty.org/records/licenses/pages/mmj.aspx.

[77] Boulder County, Colorado. *A Resolution Creating the Boulder County Energy Impact Offset Fund* [Resolution 2014-41] p. 2. Retrieved from http://www.bouldercounty.org/doc/landuse/res201441.pdf. ("subtract baseline consumption factor"); R. Flax (personal communication, July 21, 2016).

[78] Western Cooling Efficiency Center at University of California-Davis. (2016, May 18). WCEC New and Upcoming Projects, p. 5. Retrieved from http://wcec.ucdavis.edu/wp-content/uploads/2016/05/AF2016_New-and-Upcoming-Projects.pdf.

[79] Fialka, J. (2016, April 27). Colo. struggles with marijuana's huge carbon footprint. *ClimateWire*. Retrieved from http://www.eenews.net/stories/1060036287.

[80] Colorado Department of Regulatory Agencies. (n.d.). *What We Do*. Retrieved from https://www.colorado.gov/pacific/dora/what-we-do-OCC.