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# Sustainable Cannabis Policy in California: Addressing the Legal Cannabis Industry's Carbon Footprint

Genevieve Yip
*San Jose State University*

# Sustainable Cannabis Policy in California:
# Addressing the Legal Cannabis Industry's Carbon Footprint

by
Genevieve Yip

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Professor Frances L. Edwards, Ph.D.
Advisor

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# BACKGROUND

This research study explored how California cities have developed regulations to address the growing energy use for cannabis production following the passage of Senate Bill (SB) 94, the Medicinal and Adult Use Cannabis Regulation and Safety Act (MAUCRSA).

As California state law allows local governments to regulate commercial cannabis activities in their respective jurisdictions, cities have begun developing and implementing local cannabis regulations (ICMA, 2019). The nascence of the legal cannabis industry provides California cities an opportunity to develop strategies or regulatory policies that support energy efficiency and reduce the cannabis industry's environmental impact in the years ahead. Given the energy-intensive nature of the industry, this research study sought to determine how the 50 most populous California cities, excluding the City of Los Angeles, because of its size, have developed local policy to mitigate the environmental effects of indoor cannabis cultivation. The purpose of this project was to give policymakers insight into how California cities have addressed the carbon footprint associated with the energy consumption for cannabis cultivation, and to provide guidance as they incorporate new state regulations into local law. As California cities adopt local regulations in accordance with state regulations, they must address the industry's high energy consumption and adopt local regulations that minimize the environmental impact of this emergent industry.

## Problem Statement

As cannabis cultivation can be highly energy-intensive, the legalization of cannabis growing has created concerns for energy forecasting, electric system reliability, rate design, and energy efficiency policies, as well as possible ramifications for the state's electricity grid (California Energy Commission, 2018b). Indoor cannabis cultivation in California accounts for 3% of the

state's total energy consumption (Mills, 2012), and as the industry continues to grow, its energy consumption will result in significant greenhouse gas emissions, unless otherwise mitigated (Warren, 2015). The addition of a new industry that is highly energy-intensive, such as the legalized cannabis industry, is a problem for California. The legalized cannabis industry's high demand for energy consumption will result in significant greenhouse gas emissions, leading to higher concentrations in the atmosphere, and may adversely affect local governments' climate goals, if renewable energy and energy efficiency standards are not incorporated when developing local cannabis regulations in accordance with new state regulations.

**Research Question**

The research question of this study is, *have municipalities in California developed local regulations to address the high energy consumption of cannabis cultivation and its resulting carbon footprint?*

**Cannabis Legislation Timeline**

In 1996, California voters passed the nation's first voter-approved state ballot initiative for medical marijuana, Proposition 215, the Compassionate Use Act (CUA). The CUA permitted qualified patients and approved caregivers to possess and cultivate medical cannabis for the purpose of medical treatment and "ultimately led to the formation of collectives and cooperatives to serve medical patients throughout the state" (California Cannabis Portal, 2020, para. 5).

In October 2015, the California State Legislature enacted a series of three bills, Assembly Bills 243 and 266 and Senate Bill 643, to establish a comprehensive state licensing regulatory system for the existing medicinal cannabis market. The three bills collectively established the Medical Cannabis Regulation and Safety Act (MCRSA), which was enacted in June 2016. The MCRSA created the state's first framework for the licensing, regulation, and enforcement of

commercial medicinal cannabis activity, and established the state's three cannabis licensing authorities: the Bureau of Cannabis Control, CalCannabis Cultivation Licensing, and Manufactured Cannabis Safety Branch. The three licensing agencies and their respective roles are displayed in Table 1.

In November 2016, California voters passed Proposition 64, the Adult Use of Marijuana Act (AUMA), legalizing the growing, possession, and use of cannabis for non-medicinal purposes for adults who are 21 years of age or older. The AUMA also legalized the sale and distribution of cannabis through a regulated business as of January 1, 2018 (Bureau of Cannabis Control, 2020).

In June 2017, the California State Legislature passed SB 94, which integrated MCRSA with AUMA to create the Medicinal and Adult Use Cannabis Regulation and Safety Act (MAUCRSA), combining regulations into one single regulatory system to govern the medicinal and adult-use cannabis industry (California Cannabis Portal, 2020). MAUCRSA combines and unifies regulations for both medicinal and non-medicinal commercial cannabis activities and the personal use of cannabis. The passage of MAUCRSA established a dual licensing structure in which both the state and local governments participate in setting guidelines and public health and safety standards for the cannabis industry; the state sets minimum requirements that all licensees must follow, and local governments are able to set additional requirements to regulate commercial cannabis activities in their respective jurisdictions (California Cannabis Portal, 2020).

**Table 1: State Licensing Authorities**

| State Licensing Authorities | |
|---|---|
| Bureau of Cannabis Control | The Bureau of Cannabis Control (Bureau), under the California Department of Consumer of Affairs, is the lead agency in regulating commercial cannabis licenses for medical and adult-use cannabis in California.<br><br>The Bureau is responsible for licensing retailers, distributors, testing labs, microbusinesses, and temporary cannabis events. |
| CalCannabis Cultivation Licensing | CalCannabis Cultivation Licensing, a division of the California Department of Food and Agriculture (CDFA), ensures public safety and environmental protection by licensing and regulating commercial cannabis cultivators in California. CalCannabis also manages the state's track-and-trace system, which tracks all commercial cannabis and cannabis products, from cultivation to sale.<br><br>CalCannabis is organized into two branches: the Licensing Branch and the Compliance and Enforcement Branch. |
| Manufactured Cannabis Safety Branch | The California Department of Public Health's Manufactured Cannabis Safety Branch (MCSB) is one of three state licensing authorities charged with licensing and regulating commercial cannabis activity in California.<br><br>MCSB is responsible for the regulation of all commercial cannabis manufacturing in California. MCSB strives to protect public health and safety by ensuring commercial cannabis manufacturers operate safe, sanitary workplaces and follow good manufacturing practices to produce products that are free of contaminants, meet product guidelines, and are properly packaged and labeled. |

(California Cannabis Portal, 2020)

**California Regulations for Indoor Cultivation**

While California was the first state to impose renewable energy requirements on the cannabis industry at the state level, the state's new medicinal and adult-use commercial cannabis regulations revised the requirement to reduce the regulatory burden on the industry (Browne, 2018). The state's pre-2018 MCRSA required indoor and mixed-light grow facilities to utilize 42% renewable energy; however, the final MAUCRSA relaxed the regulatory burden and only requires that cultivators meet the average electricity greenhouse gas emissions intensity required of their local utility program (Browne, 2018).

On January 16, 2019, the California Department of Food and Agriculture adopted final regulations for state cannabis cultivation licensing, which are contained in Title 3 of the California Code of Regulations (CalCannabis, 2019b). With respect to cultivation-site requirements for energy consumption for indoor cultivation, the final regulations modified the types of carbon-offset sources available to the license to cover excess emissions from the previous annual-license period (CalCannabis, 2019b). Applicants for indoor cannabis cultivation licenses are required to submit a lighting diagram with their application, including the aggregate wattage per square foot of each canopy, location of all lights in the canopy area(s), and maximum wattage of each light (CalCannabis, 2019a). Indoor cultivation refers to the cultivation of cannabis within a permanent structure using artificial light exclusively, or within any type of structure using artificial light at a rate above 25 watts per square foot (CalCannabis, 2019a).

**California Regulations for Energy Usage of Indoor Cultivation Beginning January 2023**

Under §8305 of Title 3 of the California Code of Regulations, the state will enact renewable energy requirements beginning January 1, 2023 (3 CCR §8305). §8305 will require that all indoor, tier 2 mixed-light license types of all sizes, and nurseries using indoor or tier 2 mixed-light techniques, shall ensure that electrical power used for commercial cannabis activity meets the average electricity greenhouse gas emissions intensity required by their local utility provider pursuant to the California Renewables Portfolio Standard Program of the Public Utilities Code (3 CCR § 8305). As evidence of complying and meeting the standard, licensees are required to comply with the following:

(a) If a licensee's average weighted greenhouse gas emission intensity as provided in section 8203(g) (4) is greater than the local utility provider's greenhouse gas emission intensity, the licensee shall provide evidence of carbon offsets from any of the following sources to cover the excess in carbon emissions from the previous annual licensed period:

(1) Voluntary greenhouse gas offset credits purchased from any of the following recognized and reputable voluntary carbon registries:

(A) American Carbon Registry;

(B) Climate Action Reserve;

(C) Verified Carbon Standard.

(2) Offsets purchased from any other source are subject to verification and approval by the Department.

(b) New licensees, without a record of weighted greenhouse gas emissions intensity from the previous calendar year, shall report the average weighted greenhouse gas emissions intensity, as provided in section 8203(g)(4), used during their licensed period at the time

of license renewal. If a licensee's average weighted greenhouse gas emissions intensity is greater than the local utility provider's greenhouse gas emissions intensity for the most recent calendar year, the licensee shall provide evidence of carbon offsets or allowances to cover the excess in carbon emissions from any of the sources provided in subsection (a) (3 CCR §8305).

# LITERATURE REVIEW

Three percent of the state's total electricity for indoor cannabis cultivation equates to the electricity use of 1 million average California homes, greenhouse gas emissions equal to those from 1 million average cars, and energy expenditures of $3 billion per year (Mills, 2012). Most California cities and county governments have either banned cannabis cultivation altogether or are still in the process of developing land use requirements and regulatory programs for cannabis (Mulqueen et al., 2017). According to Mills (2012), there is little indication that public policymakers have incorporated energy and environmental considerations into the deliberations on cannabis cultivation. Given the significant carbon footprint of indoor cannabis cultivation, California municipalities will need to address and plan for the industry's projected impacts on energy demand and subsequent impact to the climate.

## Highly Energy-Intensive Nature of Indoor Cannabis Cultivation

As one of the most highly energy-intensive industries in the United States, indoor cannabis cultivation is estimated to consume 1% of national electricity use, or $6 billion in energy costs annually (Mills, 2012), and it is expected that energy consumption will increase substantially as cannabis becomes legalized throughout the United States (Warren, 2015). Multiple government agencies have written reports on the high energy consumption of indoor cannabis cultivation and its negative impacts on the environment (Boulder County Sustainability Office, 2018; California Energy Commission, 2018b; DDPHE, 2019; Northwest Power and Conservation Council, 2019). As cannabis agriculture is a multi-billion-dollar industry in the United States that is changing rapidly with policy liberalization, many public organizations have taken steps to create regulations in their respective jurisdictions (Bustic and Breener, 2017).

**Energy Use Aspects of Indoor Cannabis Cultivation**

Indoor cannabis cultivation uses highly energy-intensive processes to control environmental conditions during cultivation. Specific energy uses for indoor cannabis cultivation include high-intensity lighting, air conditioning and ventilation, maintaining average temperatures and humidity levels day and night, dehumidification to remove water vapor and avoid mold formation, and space heating and cooling during non-illuminated periods and drying (Mills, 2012), and accounts for about 90% of energy consumption in indoor cannabis cultivation facilities (Crandall, 2016).

Traditional indoor cultivation facilities use highly energy-intensive sodium floodlights to grow the cannabis plants. Light, both the quality (spectrum) and quantity (intensity), plays an important role in indoor cannabis cultivation (or controlled environmental systems,) because the plants capture energy from light and assimilate carbon dioxide ($CO_2$) and water into dry matter through photosynthesis (Jin, et al, 2019). Since the lights generate heat, indoor facilities use air-conditioning to reduce the temperature. As cannabis plants create water vapor, energy-intensive ventilators and dehumidification systems are used to control moisture and maintain indoor conditions required for cannabis cultivation (California Energy Commission, 2018b).

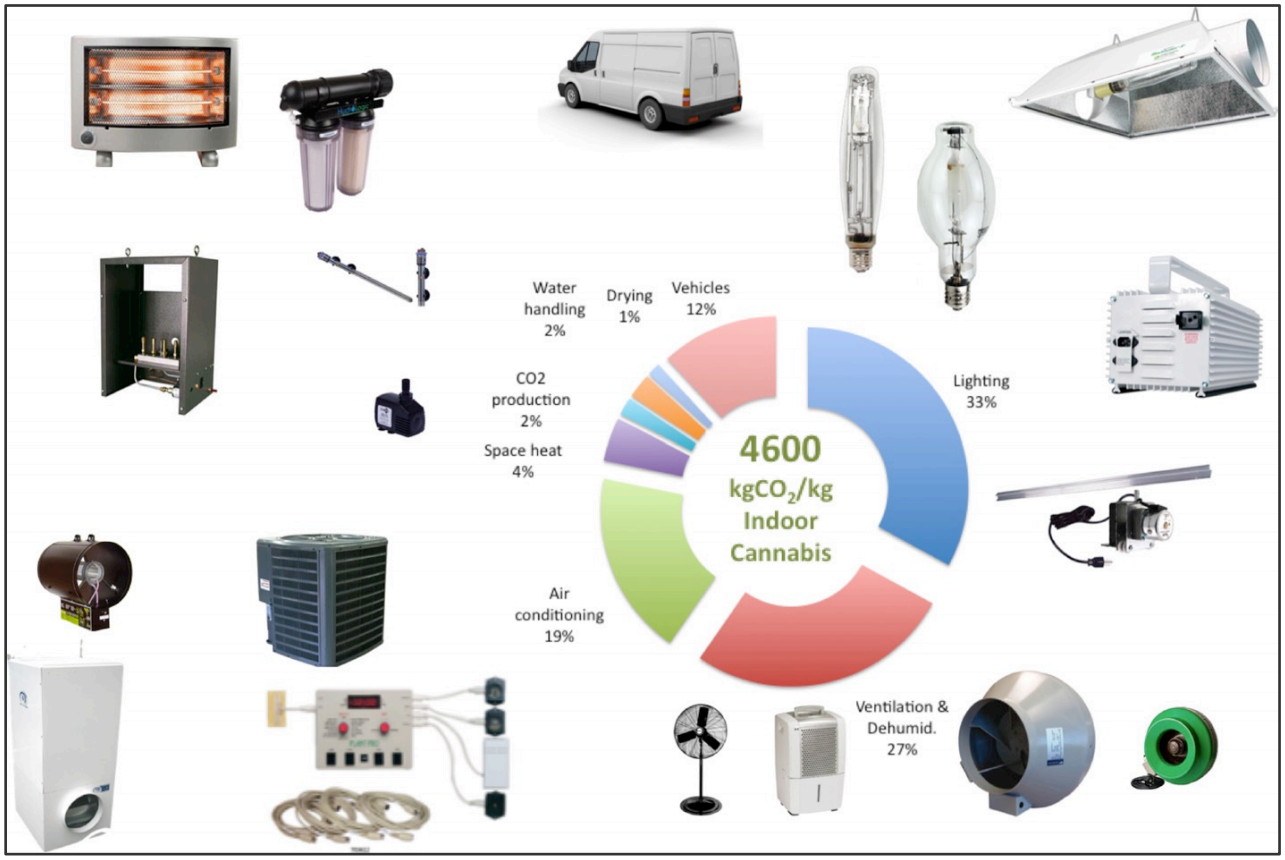
**Energy Use Implications of Indoor Cannabis Cultivation**

There has been accelerated electricity demand growth in areas that have indoor cannabis cultivation. Mills (2012) used the example of how Humboldt County experienced a “50% rise in per-capita residential electric use compared to other parts of the state” following the legalization of cultivation for medicinal purposes in California in 1996 (Mills, 2012, p. 59). An unexplained increase in the growth rate for residential electricity in California was identified during the time period when indoor cannabis cultivation grew as an industry (Mills, 2012). In a 2012 study, Mills

found that producing one kilogram of cannabis results in 4600 kg of $CO_2$ emissions, which is the equivalent of driving across the United States 11 times in a 44-mpg car (Mills, 2012).

Figure 1 below depicts the 4600 kg of $CO_2$ emissions emitted as result of indoor cannabis cultivation.

**Figure 1: Carbon Footprint of Indoor Cannabis Cultivation**




(Mills, 2012, p.60)

**Preference for Indoor Versus Outdoor Cultivation**

In August 2016, CalCannabis conducted a statewide industry survey on the location and type of licenses cannabis cultivators planned to seek and to reflect interest in cultivation across all counties in California. The 2016 survey was sent out all counties in California and resulted in 45% of respondents indicating preferences for indoor cultivation (Mulqueen et al., 2017).

Indoor cultivation is generally accepted as the most energy-intensive cultivation method; however, indoor cultivation practices are preferred among cultivators due to the methods for higher yield potential and industrialized quality control offered by indoor facilities (Mulqueen et al., 2017). Indoor cultivation enables the grower to control light, humidity, and temperature, which enables cloning of plants that have the highest levels of delta-9-tetrahydrocannabinol (THC), the psychoactive component of cannabis (Martyny et al., 2013). In addition to having better control on lighting and temperature, commercial cannabis producers generally prefer indoor production facilities as they can achieve five or more cycles per year, whereas outdoor production typically has one to two growth cycles per year (California Energy Commission, 2018b).

Though California's agricultural environment, rich sun exposure, and temperate climate provide an ideal setting for outdoor cannabis cultivation, cultivators may be shifting from lower-yield outdoor cultivation (one-two crop yield/year) to higher-yield indoor cultivation (multiple crop yields/year) in order to increase revenue to either offset or avoid regulatory compliance costs (Mulqueen et al., 2017). While indoor cannabis cultivation offers advantages over outdoor cannabis cultivation, it is also highly energy-intensive and results in significant greenhouse gas emissions at the power generation point, which is a major negative externality of the industry.

**Local Land Use Policy on Indoor and Outdoor Cannabis Cultivation**

Land-use decisions by local and city governments "predominantly determine the method of cultivation within a municipal jurisdiction" (Mulqueen et al., 2017, p. 18). While California's natural climate is conducive for outdoor cultivation, land-use restrictions by local and city governments have further encouraged indoor production of cannabis (California Energy Commission, 2018b), and "the majority of localities have banned outdoor cultivation" (Barajas, 2018, para. 4). While California state law provides for the cultivation and manufacture of cannabis and its sale in retail stores, cities and counties may adopt local regulations banning these activities altogether (Goldstein & Sumner, 2019). California authorities often cite aesthetic concerns or have declared outdoor cultivation as a public nuisance (Anaheim Municipal Code §4.100.045), and have disregarded "the environmental impact of indoor cultivation when passing local ordinances prohibiting outdoor and mixed-light commercial cultivation facilities" (Mulqueen et al., 2017, p. 18). While shifting cannabis cultivation outdoors could nearly eliminate energy use (Mills, 2012), outdoor cultivation may not be an option due to urban planning bans, and cities will need to develop local policies or programs that address the high energy use of indoor cannabis cultivation. Only a limited number of California counties and cities have allowed outdoor cultivation (Crowder, 2019a).

**Commentary on Alternate Energy for Indoor Cannabis Cultivation**

To mitigate the energy externalities and high climate risks of indoor cannabis cultivation, policymakers may consider establishing local regulations that require indoor cannabis cultivators to power their operations with carbon-free electricity. As a condition of licensing, policymakers can require the use of climate-friendly electricity for indoor cannabis cultivation (Warren, 2015). Utilities are generally state mandated to provide a certain percentage of their electricity from

qualifying renewable energy sources; however, most do not generate all of their electricity from renewable energy sources. In the event that utility companies cannot supply the electricity needed, cultivators would need to "install on-site distributed generation (i.e. solar panels, micro-wind, micro-hydro) or connect to a community solar, wind, or hydropower project" (Warren, 2015, p. 427).

**Commentary on Limited Availability Energy Use Data**

The ambiguous status of cannabis in the United States has limited research and the availability of data. Since the passage of the U.S. Controlled Substances Act of 1970, cannabis has been classified as a Schedule I narcotic, reserved for controlled substances that have no currently accepted medical use and a high potential for abuse (U.S. Drug Enforcement Administration, n.d.).

The nature of the cannabis industry, as new and traditionally illegal, has caused barriers to sharing information on energy demand, leading to inefficient energy consumption (Crandall, 2016). Sufficient information is not available as there is an information vacuum both about, and within, the cannabis industry; as a result, utility companies may not have sufficient data on the energy needs for indoor cannabis operations or what future energy needs may be (Crandall, 2016).

While cannabis is legal in California, it is illegal under federal law in the United States. Institutions that receive federal funding, such as the University of California, are required, under the Drug-Free Workplace Act and the Safe and Drug-Free Schools and Communities Act, "to implement policies prohibiting on-campus activities such as possession or use of controlled substances" and therefore prohibited in their professional capacities to make direct or indirect contact (e.g., using cannabis in medical studies without first fulfilling federal and state

requirements) with cannabis (Crowder, 2019b, p. 104). In contrast to other agricultural commodities in California, the cannabis industry has not benefitted from publicly funded agricultural research on how to better optimize production in various cultivation settings (Mulqueen et al., 2017).

As the emerging legal cannabis industry continues to grow, better and more reliable data is needed to evaluate cannabis cultivation's effect on the environment (California Energy Commission, 2018b). The lack of baseline data reflecting energy consumption for indoor cannabis cultivation represents a significant challenge to efforts in making the cannabis industry more energy efficient; as such, the California Public Utilities Commission concluded that the available data on energy usage was not sufficient to support specific policy recommendations, but recommended "engagement with the cannabis industry, California regulators, utility companies, local jurisdictions, and other stakeholders to explore options for ensuring that California cannabis cultivation is energy efficient" (Mulqueen et al., 2017, p. 21).

**Climate Change**

Over the past century, California had a greater drop in average annual precipitation compared to any other state in the nation (USA Facts, 2020). The greenhouse gas emissions released into the atmosphere from the energy consumption of indoor cannabis cultivation is a major negative aspect of the industry, as larger emissions of greenhouse gasses will lead to higher concentrations in the atmosphere. In order to reduce the carbon footprint of indoor cannabis cultivation, "cannabis policy must consider and account for the energy intensity and climate impacts of all types of cannabis cultivation, manufacturing, and distribution, and establish industry standards to ensure that this tax-generating industry does not run afoul of a state's climate goals" (Brown, 2018, p. 43). Climate change is the most devastating externality of

electricity generation; as such, policymakers should consider "the need for comprehensive state licensing schemes that assess energy usage and climate risk prior to issuing business licenses" and "mandat[ing] that indoor marijuana cultivators utilize carbon-free electricity generation" (Warren, 2015, p. 412).

## Policy Considerations

It is imperative for policymakers to thoroughly consider energy use in all legal cannabis operations in order to effectively address the complex and dynamic implementation process for well-regulated local cannabis commercial activities. Cannabis policy must consider and account for the energy intensity of indoor cannabis cultivation and establish industry standards to ensure that climate goals are not negatively impacted (Browne, 2018).

### *Lighting*

Given possible information problems and a lack of incentives available for energy efficient production methods, the legalization of cannabis could provide opportunities for both utilities and regulators to design policies that reduce energy consumption and minimize carbon emissions (California Energy Commission, 2018b). Policymakers may consider "energy efficiency audits and information campaigns by utilities [which] could be effective in educating grow house operators about more efficient production techniques and emerging new technologies (e.g., incentive payments and rebate programs for grow houses to switch to light emitting diode (LED) lights could have measurable impact on energy usage)" (California Energy Commission, 2018b, p. B-3).

Indoor cannabis cultivators have traditionally used high-intensity discharge (HID) lighting and high-pressure sodium (HPS) lighting. The U.S. Department of Energy (2017) estimated the potential energy savings opportunity offered by LED horticultural lighting relative

to traditional lighting choices, and determined that "if all horticultural lighting today was converted to LED technology, horticultural lighting consumption would be reduced to 3.6 terawatt-hours (TWh), or 37 trillion British thermal units (tBtu) annually, which represents energy savings of 40% or $240 million annually" (U.S. Department of Energy, 2017, p. 10).

An indoor horticulture lighting study conducted by the Sacramento Municipal Utility District (2018a) suggests that LEDs can provide the lighting necessary to successfully cultivate cannabis while reducing energy use and cost. LED technology also offers advanced control options, giving cultivators the opportunity to optimize crops in ways not possible with HPS technology (Sacramento Municipal Utility District, 2018a). Incentivizing commercial cultivators to use LEDs can help lessen the impact on electrical grids (Sacramento Municipal Utility District, 2018b).

### *Design*

In recent years, additional research has "further analyzed the electricity use of indoor facilities, with a focus on identifying areas where energy efficiency and cost-saving measures could reduce the electricity use and cost" (Browne, 2018, p. 46). A 2018 survey of cannabis producers conducted by the Northwest Power and Conservation Council found that cannabis cultivation has become less energy-intensive with the use of better designed facilities and more energy-efficient lighting and HVAC technologies (Jourabchi, 2018). Establishing energy efficiency requirements and renewable energy requirements can help moderate the intense energy consumption of the cannabis industry.

### *Incentives*

Offering incentives to commercial cultivators to use LEDs can help lessen the impacts on the grid and minimize the demand for fossil-fuel-generated-energy (Sacramento Municipal Utility District, 2018a). Policymakers may also consider supporting efficient rate design (e.g., time of use rates), incentivizing cultivators to adopt energy efficient growing techniques.

Scholars have recommended that policymakers consider the energy impacts of indoor cannabis cultivation to reduce the industry's energy consumption and resulting carbon footprint (Browne, 2018; Bustic et al., 2017; Mills, 2012). To reduce the undesirable impacts of energy consumption from indoor cannabis cultivation, Mills recommends the application of energy performance standards, efficiency incentives and education, and enforcement of appropriate codes (Mills, 2012). To entice cultivators to move toward energy efficiency, municipalities could offer incentives for shifting demand to "coincide with peak renewable energy generation" and establish "renewable energy standards that mandate operations to meet electricity demands by self-generated renewable resources" (Browne, 2018, p. 46). As an example, in California, cities could "offer cannabis cultivators incentives for corresponding their peak load with the middle of the day, when solar generation is so high that the state's energy production exceeds its net load" (Browne, 2018, p. 46).

# METHODOLOGY

To determine how California cities have developed regulations to address the carbon footprint associated with indoor cannabis cultivation, a four-phase process evaluation was used in this descriptive study. The four-phase process evaluation approach was used to identify the problem, develop solutions, study implementation of the solutions, and evaluate the subsequent feedback to understand how the 50 most populous California cities (excluding Los Angeles) have implemented local policies or regulations to address the high energy demand of indoor cannabis cultivation, and minimize the industry's climate impact (Sylvia & Sylvia, 2012).

Qualitative data was used in this study to analyze how California cities have developed and implemented local policies or regulations to reduce the energy consumption of indoor cannabis cultivation and reduce its overall carbon footprint (Sylvia & Sylvia, 2012). The data collecting methods used in this research include administering a questionnaire to the 50 most populous California cities (excluding Los Angeles), collecting information from municipal codes, and cataloging information available on individual cities' respective webpages, to yield relevant data to answer the research question of this study. The City of Los Angeles was excluded from this study due to its population size (4 million) relative to next 50 California cities following Los Angeles in population size. San Diego, the second largest city, has a population of 1.46 million, for example (US Census Bureau, 2018t). Relevant data on the cities that did not respond to the questionnaire was collected from individual city webpages and municipal codes, and is public information. The questionnaire was administered between February 18, 2020, and March 19, 2020[1], via Qualtrics, an online survey platform. The cities investigated for this

[1] As a result of the COVID-19 pandemic, California was on mandatory shelter-in-place during most of this period, and public agency workers may have been working from home with limited access to e-mails and with overwhelming demands on their time due to community needs.

research are shown in Table 2, with an asterisk symbol indicating the cities that did not respond to the questionnaire.

**Table 2: 50 Most Populous California Cities by Population Size**

| Rank | City | Population |
|---|---|---|
| 1 | San Diego | 1,425,976 |
| 2 | San Jose* | 1,030,119 |
| 3 | San Francisco* | 883,305 |
| 4 | Fresno | 530,093 |
| 5 | Sacramento | 508,529 |
| 6 | Long Beach* | 467,354 |
| 7 | Oakland* | 429,082 |
| 8 | Bakersfield | 383,579 |
| 9 | Anaheim* | 352,005 |
| 10 | Santa Ana* | 332,725 |
| 11 | Riverside* | 330,063 |
| 12 | Stockton* | 311,178 |
| 13 | Irvine* | 282,572 |
| 14 | Chula Vista | 271,651 |
| 15 | Fremont* | 237,807 |
| 16 | San Bernardino* | 215,941 |
| 17 | Modesto* | 215,030 |
| 18 | Fontana* | 213,739 |
| 19 | Santa Clarita | 210,089 |
| 20 | Oxnard* | 209,877 |
| 21 | Moreno Valley | 209,050 |
| 22 | Glendale* | 201,361 |
| 23 | Huntington Beach* | 200,641 |
| 24 | Ontario* | 181,107 |
| 25 | Rancho Cucamonga* | 177,751 |
| 26 | Santa Rosa | 177,586 |
| 27 | Oceanside* | 176,080 |
| 28 | Elk Grove | 172,886 |
| 29 | Garden Grove | 172,646 |
| 30 | Corona* | 168,819 |
| 31 | Hayward | 159,620 |
| 32 | Lancaster* | 159,053 |

**Table 2: 50 Most Populous California Cities by Population Size (Cont'd)**

| | | |
|---|---|---|
| 33 | Palmdale | 156,667 |
| 34 | Salinas | 156,259 |
| 35 | Sunnyvale | 153,185 |
| 36 | Pomona | 152,361 |
| 37 | Escondido* | 152,213 |
| 38 | Torrance | 145,182 |
| 39 | Pasadena* | 141,371 |
| 40 | Fullerton* | 139,640 |
| 41 | Orange* | 139,484 |
| 42 | Roseville* | 139,117 |
| 43 | Visalia | 133,800 |
| 44 | Concord* | 129,688 |
| 45 | Santa Clara | 129,488 |
| 46 | Thousand Oaks | 127,690 |
| 47 | Simi Valley* | 125,851 |
| 48 | Victorville | 122,312 |
| 49 | Vallejo | 121,913 |
| 50 | Berkeley | 121,643 |
| *Cities did not participate in questionnaire. | | |

The table above displays data from the U.S. Census Bureau. Please see U.S. Census Bureau 2018a through 2018xx.

The questionnaire was emailed to the City Manager's Office of each municipality, and was comprised of six questions, inquiring if their municipality (1) permitted commercial cannabis activity (e.g., cultivation, manufacturing, distribution/retail) within their boundaries; (2) established local policies or regulations to address indoor cannabis cultivation's high electricity-based energy use and its associated carbon impacts; (3) addressed the high-energy usage of indoor cannabis cultivation in their climate action plan or goals; (4) offered workshops to educate indoor cultivation licensees on energy efficiency and/or reducing overall energy consumption; (5) offered incentives for indoor cannabis cultivation licensees that participate in voluntary certification standards programs that support energy and/or carbon reductions; and (6) recommended any best practices for energy efficiency for indoor cannabis cultivation. The

questionnaire had a 44% response rate. The questionnaire is included in Appendix A of this report. The outreach email is included in Appendix B of this report.

The four-phase process evaluation described by Sylvia & Sylvia (2012) was used and adapted as shown in Table 3: below:

**Table 3: Methodology**

| **Phase 1: Problem Identification** | **Phase 2: Solution Development** | **Phase 3: Solution Implementation** | **Phase 4: Feedback Evaluation** |
|---|---|---|---|
| Indoor cannabis cultivation is highly energy-intensive and produces greenhouse gas emissions which will significantly contribute to climate change, offset climate change mitigation efforts made by California municipalities, and negatively impact California's electrical grid as the industry continues to grow. | As California cities are developing local policies and regulations in accordance with new state regulations, they can support regulatory activity that limits the amount of fossil-fuel-generated-energy used for indoor cannabis cultivation, thereby reducing its overall carbon footprint and climate impact. | California cities have established (or are in the process of establishing) local policies and/or regulations to address the energy intensity and climate impacts of indoor cannabis cultivation. | Evaluate the feedback and information obtained to understand how California cities have developed policies and/or regulations to address indoor cannabis cultivation's high demand for fossil-fuel-generated-energy and reduce its overall carbon footprint. |

This research collected information on how cities have addressed the emergent industry of commercialized indoor cannabis cultivation when developing local cannabis policy, thereby enhancing the understanding of how local governments in California can develop policies that reduce the industry's carbon footprint and maintain climate impact limitation goals.

This project qualified for exclusion from Institutional Research Board (IRB) review, as it was a qualitative research study consisting of a questionnaire that was administered to 50 California cities regarding municipal strategies to address the carbon footprint of indoor cannabis

cultivation, and did not involve human subjects. The participants responding to the questionnaire are not considered human subjects, as they were only asked questions about their municipality's regulations or pertaining to his/her expertise or institutional knowledge (i.e., work-related questions) as opposed to personal information or views.

# FINDINGS

This section will address the results of the research discussed in the Methodology and will include a breakdown of responses for all six questions of the questionnaire. Data was collected from the questionnaire and from public information obtained from each city's webpage in March of 2020. The questionnaire results include data collected from the 22 cities that responded and was supplemented by public information available on the individual webpages of the 28 cities that did not respond. In each table, responses are displayed in order of city size, with the largest first.

## Current Status of Commercial Cannabis Activity by City

Table 4 below shows the 50 California cities investigated and the current status of commercial cannabis activity in their respective jurisdictions. The information was gathered from the questionnaire results and from publicly available information on city webpages.

**Table 4: Current Status of Commercial Cannabis Activity by City**

| Current Status of Commercial Cannabis Activity by City | |
|---|---|
| **City** | **Response** |
| San Diego | Yes - Cultivation; Manufacturing; Distribution; Retail Sales |
| San Jose* | Yes - Cultivation; Manufacturing; Distribution; Retail Sales |
| San Francisco* | Yes - Cultivation; Manufacturing; Distribution; Retail Sales |
| Fresno | In Progress - Developing local regulations to permit activity. |
| Sacramento | Yes - Cultivation; Manufacturing; Distribution; Retail Sales |
| Long Beach* | Yes - Cultivation; Manufacturing; Distribution; Retail Sales |
| Oakland* | Yes - Cultivation; Manufacturing; Distribution; Retail Sales |
| Bakersfield | No - All commercial cannabis activity has been banned. |
| Anaheim* | No - All commercial cannabis activity has been banned. |
| Santa Ana* | Yes - Cultivation; Manufacturing; Distribution; Retail Sales |
| Riverside* | No - All commercial cannabis activity has been banned. |
| Stockton* | Yes - Cultivation; Manufacturing; Distribution; Retail Sales |
| Irvine* | No - All commercial cannabis activity has been banned. |
| Chula Vista | Yes - Cultivation; Manufacturing; Distribution; Retail Sales |
| Fremont* | No - All commercial cannabis activity has been banned. |

**Table 4: Current Status of Commercial Cannabis Activity by City (Cont'd)**

| | |
|---|---|
| San Bernardino* | Yes - Cultivation; Manufacturing; Distribution; Retail Sales |
| Modesto* | Yes - Cultivation; Manufacturing; Distribution; Retail Sales |
| Fontana* | No - All commercial cannabis activity has been banned. |
| Santa Clarita | No - All commercial cannabis activity has been banned. |
| Oxnard* | Yes - Cultivation; Manufacturing; Distribution; Retail Sales |
| Moreno Valley | Yes - Cultivation; Manufacturing; Distribution; Retail Sales |
| Glendale* | No - All commercial cannabis activity has been banned. |
| Huntington Beach* | No - All commercial cannabis activity has been banned. |
| Ontario* | No - All commercial cannabis activity has been banned. |
| Rancho Cucamonga* | No - All commercial cannabis activity has been banned. |
| Santa Rosa | Yes - Cultivation; Manufacturing; Distribution; Retail Sales |
| Oceanside* | Limited - Activities limited to only medicinal cannabis. |
| Elk Grove | No - All commercial cannabis activity has been banned. |
| Garden Grove | No - All commercial cannabis activity has been banned. |
| Corona* | No - All commercial cannabis activity has been banned. |
| Hayward | Yes - Cultivation; Manufacturing; Distribution; Retail Sales |
| Lancaster* | Limited - Activities limited to only medicinal cannabis. |
| Palmdale | No - All commercial cannabis activity has been banned. |
| Salinas | Yes - Cultivation; Manufacturing; Distribution; Retail Sales |
| Sunnyvale | No - All commercial cannabis activity has been banned. |
| Pomona | In Progress - Developing local regulations to permit activity. |
| Escondido* | No - All commercial cannabis activity has been banned. |
| Torrance | No - All commercial cannabis activity has been banned. |
| Pasadena* | Yes - Cultivation; Manufacturing; Distribution; Retail Sales |
| Fullerton* | No - All commercial cannabis activity has been banned. |
| Orange* | No - All commercial cannabis activity has been banned. |
| Roseville* | Limited - Activities limited to only medicinal cannabis. |
| Visalia | No - All commercial cannabis activity has been banned. |
| Concord* | Limited - Activities limited to only medicinal cannabis. |
| Santa Clara | In Progress - Developing local regulations to ban activity. |
| Thousand Oaks | Limited - Activities limited to only medicinal cannabis. |
| Simi Valley* | No - All commercial cannabis activity has been banned. |
| Victorville | No - All commercial cannabis activity has been banned. |
| Vallejo | Yes - Cultivation; Manufacturing; Distribution; Retail Sales |
| Berkeley | Yes - Cultivation; Manufacturing; Distribution; Retail Sales |

*Cities did not participate in questionnaire; information was obtained through individual city webpages and/or municipal codes.

### Cities and Types of Requirements

The 11 cities identified as having developed local policies or regulations to address the cannabis industry's energy demand were categorized by the type of requirements established and broken down into four categories. The four categories are: (1) energy efficiency requirement; (2) renewable energy requirement; (3) annual reporting requirement; and (4) minor requirement, which includes cities that have minimal requirements for energy efficiencies. The 11 cities and their type(s) of requirement are shown in Table 5 below.

**Table 5: Cities and Types(s) of Requirement**

| City | | Energy Efficiency Requirement | Renewable Energy Requirement | Annual Reporting Requirement | Minimal/Other Requirement |
|---|---|---|---|---|---|
| 1 | San Francisco* | | X | X | |
| 2 | Sacramento | X | | | |
| 3 | Long Beach* | X | | X | |
| 4 | Oakland* | X | X | X | |
| 5 | Chula Vista | | | X | |
| 6 | San Bernardino* | | | | X |
| 7 | Modesto* | | | | X |
| 8 | Moreno Valley | | X | | |
| 9 | Hayward | X | | | |
| 10 | Salinas | | | | X |
| 11 | Berkeley | X | X | X | |

*Cities did not participate in questionnaire; information was obtained through individual city webpages and/or municipal codes.

### Cities with Established Policies, Regulations, or Minimum Requirement

The 11 cities and information on their respective type(s) of requirement are described in Table 6 below.

**Table 6: Cities with Established Policies, Regulations, or Minimum Requirement**

| City | Requirement(s) |
|---|---|
| San Francisco* | Commercial cannabis businesses are required to ensure that electrical power is procured from sources that meet the city's minimum requirements for renewable energy. The minimum renewable energy requirements are set by the Director of the Department of the Environment, and are consistent with the amount of renewable energy contained in CleanPowerSF's Green Service.<br><br>Commercial cannabis businesses are also required to provide to the Director and the Department of the Environment an annual report documenting the amount and source of energy consumed by the business in the prior 12 months (SFPC Section 6-1618-8(c)). |
| Sacramento | Applicants are required contact Sacramento Municipal Utility District for their estimated power usage and find energy efficient options for their business. Applicants are required to submit an energy efficiency plan with their business operating permit application (City of Sacramento, 2019). |
| Long Beach* | Heating, ventilating, and air-conditioning systems of all structures shall be designed and installed for efficient utilization of energy. Commercial cannabis businesses are required to collect energy usage data and submit annual reports of energy usage. Cultivation shall always be conducted in accordance with state and local laws and regulations related to cultivation, zoning, grading, electricity, water usage, water quality, fish and wildlife habitat protection, wastewater discharges, pesticides, and fertilizers, handling and storage of gases, and employee safety (LBMC, Section 5.92.1010). |
| Oakland* | Indoor cultivators are required to demonstrate that 100% of their electricity is derived from renewable or carbon free sources. This can be done by enrolling in East Bay Community Energy's Brilliant 100 program's renewable content option for electricity or equivalent.<br><br>Applicants are required to submit Statement of Energy Performance (SEP) and Emissions Performance Reports to the City Administrator's Office (OMC, 5.81.050). The City of Oakland's Green Building compliance standards requires that new residential, commercial, including commercial cannabis businesses, and retrofitted buildings are designed to achieve high levels of energy efficiency and green performance (City of Oakland, 2019). |

**Table 6: Cities with Established Policies, Regulations, or Minimum Requirement (Cont'd)**

| | |
|---|---|
| Chula Vista | Commercial cannabis businesses are required to collect energy usage data and submit annual reports of energy usage. |
| San Bernardino* | Commercial cannabis business applicants are required to submit sustainable businesses practices as part of their supplemental evaluation criteria in their application (City of San Bernardino, 2019). |
| Modesto* | Use of renewable resources for indoor cultivation and mixed-light operations is encouraged. The City of Modesto's Commercial Cannabis permit application procedures may award credit for use of renewable resources (MMC§10-3.707(g)). |
| Moreno Valley | Commercial cannabis businesses are required to use electrical power from municipality's minimum requirements for renewable energy. |
| Hayward | Applicants are required to submit a Sustainability Plan that mitigates electric and water use. Plans are required to be prepared by an environmental engineer and reviewed by the Environmental Services Department. |
| Salinas | Applicants are required to describe how their business would practice energy efficiency in their application. |
| Berkeley | Commercial cannabis businesses are required to collect energy usage data and submit annual reports of energy usage. Indoor cultivators are required to demonstrate that 100% of their electricity is derived from renewable or carbon free sources.<br><br>Cultivators must mitigate the carbon dioxide emissions caused by the generation of electrical energy delivered to its Facility by participating in East Bay Community Energy's 100% renewable content option for electricity or equivalent. Alternatively, the offset can be achieved through purchase of renewable energy certificates certified by the Center for Resource Solutions. |

*Cities did not participate in questionnaire; information was obtained through individual city webpages and/or municipal codes.

## Energy Policies and Programs Implemented in Other States

"The last two decades have brought waves of significant change to state laws regarding medical and recreational cannabis, which in turn have implications for local governments" (ICMA, 2018, p.1). Recreational or "adult use" of cannabis is legal in the U.S. states of Alaska, California, Colorado, Illinois, Maine, Massachusetts, Michigan, Nevada, Oregon, Washington, and Vermont, as well as in Washington, D.C. (NCSL, 2019).

### *Boulder, Colorado*

The City of Boulder, Colorado has taken steps to address the energy consumption of indoor cannabis cultivation. Boulder County is a leading innovator in promoting sustainable energy use practices through the Boulder County Energy Impact Offset Fund, which promotes cannabis industry use of renewable energy, educates cultivators on efficient cultivation practices, and funds carbon offset and renewable energy projects (Browne, 2018).

The Board of County Commissioners of Boulder County adopted Resolution No. 2014-41, entitled "A Resolution Creating the Boulder County Energy Impact Offset Fund," on August 5, 2014 (Boulder County, 2014). The Boulder County Energy Impact Offset Fund was established with the intent to reduce greenhouse gas emissions of the local cannabis industry. The offset fees collected through the BCEIOF have been used to establish the technical infrastructure of the program, such as eGauge electricity monitors and the software code to aggregate and analyze the electricity-usage data that they produce (Boulder County Sustainability Office, 2018).

This data is intended to identify the best lighting and growing methods for energy efficiency to be considered by indoor cannabis cultivators' energy management. In an effort to support the cannabis industry in learning more about their energy impact and to spur innovation

around best energy practices that will help reduce energy usage and greenhouse gas emissions, Boulder County is collecting energy consumption data through eGauge electricity monitors. The eGauge electricity monitors collect electrical energy use data, anonymizes the data, and makes the anonymized data available to the general public. To anonymize the electrical energy use data collected from Boulder County cultivators, the data is stripped down to only include time stamps and average power across 15-minute intervals, thereby allowing the identity of Boulder County cultivators to be protected (Boulder County Sustainability Office, 2018).

Boulder County uses the data collected to analyze energy intensity and energy productivity to discern best practices in the indoor cannabis cultivation industry (Boulder County Sustainability Office, 2018). The Boulder County Sustainability Office released Phase 1 of its Energy Impact Offset Fund's Demand Side Management Study to inform county policymakers and for the intended use of "similar research efforts by other government entities and cannabis industry professionals interested in energy and emissions reductions"; Phase II of the study will refine efficiency and distributed energy strategies, tactics, and draft program designs (Boulder County Sustainability Office, 2018, p. 2).

Consistent with its Sustainability and Climate Action Plan goals, the City of Boulder requires renewable energy sources for energy used to grow indoor cannabis. Boulder Municipal Code §§6-14-8(i) and 6-16-8(i) requires licensed medical cannabis and recreational cannabis cultivation facilities to offset 100% of their electricity consumption and to keep monthly records of their energy use and compliance with renewable energy requirements. Cultivators are required to offset 100% of their electricity use with installation of on-site renewables, purchases of renewable energy or carbon offsets, or participation in a community solar garden (Crandall, 2016). These regulations and programs in Boulder, Colorado, were established in an effort to

address cannabis industry's impact on their carbon reduction goals and reduce the carbon emissions produced by indoor cannabis cultivation facilities.

***Denver, Colorado***

In Denver, Colorado, indoor cannabis cultivation facilities account for nearly 4% of the city's total electricity use (DDPHE, 2019). The City and County of Denver has made cannabis sustainability one of the city's initiatives, and has established working groups and programs to share best practices in the cannabis industry that will reduce the industry's climate and environmental impact (DDPHE, 2018).

The City and County of Denver's Cannabis Sustainability Work Group was formed to promote sustainability in the cannabis industry through education, and has published cannabis environmental best management practices guides to share relevant sustainable practices and optimization techniques that facilitates continual improvement (DDPHE, 2019). The Cannabis Sustainability Work Group's best management practices guide for energy covers best practices for measurement and verification, scheduling, lighting, greenhouses, on-site and off-site power generation, and heating, ventilation, and air conditioning (HVAC) and dehumidification, (DDPHE, 2019).

***Oregon***

As a result of the legalization of commercial cannabis production in Oregon, "indoor agriculture is anticipated to contribute to between 100 and 200 average megawatts of increased electricity demand over the next twenty years" (Northwest Power and Conservation Council, 2016, p. 2-6). In Oregon, the Energy Trust of Oregon offers licensed cannabis growers free technical services and cash incentives for the installation of energy-efficient equipment at new and existing grow operations. Incentives are available for indoor, outdoor, and greenhouse grow operations. In an

effort to encourage businesses to invest in energy-saving equipment and systems, the Energy Trust of Oregon offers free technical services and cash incentives of $0.25 USD per kWh saved and $2.00 USD per therm of natural gas saved for new and existing grow facilities. Incentives are calculated based on operating hours and usage (Energy Trust of Oregon, 2019).

## Questionnaire Results

The breakdown of responses for the questionnaire is shown in Tables 7 through 12.

**Table 7: Question 1 Response Breakdown**

| **Q1: Does your municipality permit commercial cannabis activity (e.g., cultivation, manufacturing, distribution/retail) within your boundaries?** | | |
|---|---|---|
| **Response** | **Total Number** | **Percentage** |
| Yes - Cultivation; Manufacturing; Distribution; Retail Sales | 19 | 38.0% |
| No - All commercial cannabis activity has been banned. | 23 | 46.0% |
| Limited - Activities limited to only medicinal cannabis. | 5 | 10.0% |
| In Progress - Developing local regulations to permit activity. | 2 | 4.0% |
| In Progress - Developing local regulations to ban activity. | 1 | 2.0% |
| **Totals** | **50** | **100.0%** |

**Table 8: Question 2 Response Breakdown**

| **Q2: Has your municipality established local policies or regulations to address indoor cannabis cultivation's high electricity-based energy use and its associated carbon impacts?** | | |
|---|---|---|
| **Response** | **Total Number** | **Percentage** |
| Yes | 11 | 22.0% |
| No | 38 | 76.0% |
| In progress | 1 | 2.0% |
| **Totals** | **50** | **100.0%** |

**Table 9: Question 3 Response Breakdown**

| **Q3: Is the high-energy usage of indoor cannabis cultivation addressed in your municipality's climate action plan (or climate action goals)?** | | |
|---|---|---|
| **Response** | **Total Number** | **Percentage** |
| Yes | 0 | 0.0% |
| No | 48 | 96.0% |
| In progress | 2 | 4.0% |
| **Totals** | **50** | **100.0%** |

**Table 10: Question 4 Response Breakdown**

| **Q4: Does your municipality offer workshops to educate indoor cultivation licensees on energy efficiency and/or reducing overall energy consumption?** | | |
|---|---|---|
| **Response** | **Total Number** | **Percentage** |
| Yes | 2 | 4.0% |
| No | 48 | 96.0% |
| In progress | 0 | 0.0% |
| **Totals** | **50** | **100.0%** |

**Table 11: Question 5 Response Breakdown**

| **Q5: Does your municipality offer incentives for indoor cannabis cultivation licensees that participate in voluntary certification standards programs that support energy and/or carbon reductions?** | | |
|---|---|---|
| **Response** | **Total Number** | **Percentage** |
| Yes | 2 | 4.0% |
| No | 48 | 96.0% |
| In progress | 0 | 0.0% |
| **Totals** | **50** | **100.0%** |

**Table 12: Question 6 Response Breakdown**

| **Q6: Does your municipality recommend any best practices for energy efficiency for indoor cannabis cultivation?** | | |
|---|---|---|
| **Response** | **Total Number** | **Percentage** |
| Yes | 0 | 0.0% |
| No | 48 | 96.0% |
| In progress | 2 | 4.0% |
| **Totals** | **50** | **100.0%** |

# ANALYSIS

As California state law allows local governments to regulate commercial cannabis activities in their respective jurisdictions, this study sought to learn how California cities have developed local regulations to mitigate the negative externalities associated with cannabis cultivation. The passage of the MAUCRSA provided municipalities with a unique opportunity to address the emergent legal cannabis industry, and establish regulations that achieve their regulatory priorities on energy use, and thereby minimize the negative externalities of the industry.

The research shows that of the 50 most populous California cities (excluding Los Angeles), 19 (or 38%) of the cities permit commercial cannabis activity within their boundaries, and two cities are currently in the process of developing local regulations to permit activity. The findings also show that 46% of the cities have banned all commercial cannabis activity, with an additional city currently in the process of bringing an ordinance to ban all commercial cannabis activity for city council consideration. Five of the municipalities only permit limited medicinal cannabis activity.

Of the 19 cities that permit commercial cannabis activity, only 11 cities (or 57%) have established some type of requirement to address indoor cannabis cultivation's high electricity-based energy use and its associated carbon impacts. The cities of Sacramento, Long Beach, Oakland, Hayward, and Berkeley have an energy efficiency requirement. The City and County of San Francisco and the cities of Oakland, Moreno Valley, and Berkeley have renewable energy requirements. The City and County of San Francisco and the cities of Long Beach, Oakland, Chula Vista, and Berkeley have annual reporting requirement. Lastly, the cities of San Bernardino, Modesto, and Salinas have minimal requirements.

The cities of Berkeley and Oakland were among the 11 cities that had the most progressive programs, as both municipalities had multiple types of requirements. Both municipalities have established local requirements for energy efficiency, renewable energy usage, mandatory reporting, as well as offer options to purchase carbon offsets. In both cities, commercial cannabis businesses are required to demonstrate that 100% of their electricity is derived from renewable or carbon-free sources. As both cities are in Alameda County, businesses in both cities can mitigate the carbon dioxide emissions caused by the generation of electrical energy delivered to its facility by participating in East Bay Community Energy's 100% renewable content option for electricity or equivalent. Consistent with the City of Oakland's Energy and Climate Action Plan to reduce energy consumption and greenhouse gas emissions, applicants are required to submit Statement of Energy Performance (SEP) and Emissions Performance Reports to the City Administrator's Office. The SEP is a one-page report, summarizing the energy consumption for a property (City of Oakland, 2019). The City of Berkeley also requires businesses to collect energy use data and submit annual reports of energy usage. As energy efficiency standards and the employment of renewable energy can reduce the carbon footprint of indoor cultivation operations (Browne, 2018), the cities of Berkeley and Oakland could be used as models for cities that would like to expand on their current regulations, or for cities that are still considering permitting commercial cannabis activities in their boundaries. Cities may also consider modeling their programs after the City of Boulder's program.

In regard to the minimal requirements established, the City of Salinas only requires applicants to describe how their business would practice energy efficiency in their applications, but does not require the actual implementation of energy efficiency measures. The City of

Modesto encourages the use of renewable resources for indoor cultivation, but does not require it.

The findings show that 48 cities do not currently address the high energy usage of indoor cannabis cultivation in their municipality's climate action plan or goals, but that two cities are currently in the process of updating their climate action plan to address the high energy usage of indoor cannabis cultivation. The findings also show that, of the 19 cities that permit commercial cannabis activity, only two cities offer workshops to educate indoor cultivation licensees on energy efficiency and/or reducing overall energy consumption. None of the cities investigated have incentives for indoor cannabis cultivation licensees that participate in voluntary certification standards programs that support energy and/or carbon reductions.

While none of the cities investigated currently offer published best practice recommendations for energy efficiency for indoor cannabis cultivation, the City of Chula Vista responded that they are currently in the process of doing so; commercial cannabis activity is currently permitted within its boundaries. The City of Fresno also responded that they are currently in the process of developing best practice recommendations for energy efficiency for indoor cannabis cultivation, as they are currently working to develop local regulations. Of the remaining cities that permit activity, there were no cities that provided any recommendations for best practices in regard to energy efficiency for indoor cannabis cultivation.

As discussed in the Literature Review, policymakers may consider establishing incentive programs to encourage commercial cultivators to adopt energy efficiency methods and designs. While cities can ban commercial cannabis cultivation in their jurisdictions, California state law permits adults to grow up to six plants for personal cultivation on their private property. In regard to the cities that have banned commercial cannabis activity, policymakers may consider

establishing similar incentive programs for individuals who grow plants for personal use in their private homes.

**Evaluation of the Currently Implemented Solutions**

This research study sought to explore how local governments in California have developed regulations to reduce the carbon footprint of energy consumption from indoor cannabis cultivation, and to provide insight on potential carbon emission reduction policies to address climate change. As municipalities create the policy framework necessary to support the emergent industry of legalized cannabis, it is "critical that policymakers account for the industry's propensity to cultivate indoors and require that cultivators prioritize energy efficiency and the use of renewable energy plus storage" (Brown, 2018, p. 43). As municipalities in California are working toward regulating commercial cannabis activities in accordance with new state regulations, this is an opportunity for policymakers to address the externalities associated with energy use for cannabis cultivation and identify energy efficiency strategies as the industry continues to grow.

While there is not sufficient data available to support specific policy recommendations, the California Public Utilities Commission recommended that local policymakers engage with the legal cannabis industry, utility companies, local jurisdictions, and other stakeholders, to explore options for ensuring that the legal cannabis cultivation industry is energy efficient (Mulqueen et al., 2017). Since the Bureau of Cannabis Control will not require cultivators to report data on energy use until 2022, nor require statewide standards for renewable energy until 2023, California cities may consider enacting local laws to support regulatory activity that will either prohibit or limit the use of fossil-fuel-generated-energy as they develop local regulations and their local cannabis programs.

# CONCLUSION

Given the relatively recent passage of the MAUCRSA in 2017, cities are still either developing or amending their cannabis policies and programs. As such, it is recommended that further studies be conducted to better understand the industry of commercial cannabis cultivation and how to mitigate its carbon footprint. Further studies should review changes in regulations and consider any new developments concerning the impact on energy use in California cities. As the legal cannabis industry is relatively nascent, further research should be conducted on energy efficiency methods, energy consumption reduction, and methods to minimize the industry's carbon footprint.

As the cannabis industry continues to grow, its negative externalities will continue to grow as well, unless local governments develop regulatory policies that drive energy efficiencies and sustainability; as such, further research on the industry's energy use and best practices to reduce its carbon footprint, can assist policymakers with developing and establishing regulations to mitigate the negative externalities of indoor cannabis cultivation.

## REFERENCES

Barajas, J. (2018, November 5). Judge: California city that banned home growing has gone too far. *CannabisWire.* Retrieved from https://cannabiswire.com/2018/11/05/judge-california-city-that-banned-home-growing-has-gone-too-far/

Board of County Commissioners of Boulder County Resolution No. 2014-41: A Resolution Creating the Boulder County Energy Impact Offset Fund. (2014, August 5). Retrieved October 28, 2019, from https://assets.bouldercounty.org/wp-content/uploads/2017/03/energy-impact-offset-fund-res-2014-41.pdf

Boulder County Sustainability Office. (2018). Energy impact offset fund's demand side management study – phase 1. Retrieved August 2, 2019 from https://assets.bouldercounty.org/wp-content/uploads/2018/04/BCEIOF-DSM-Study-Phase-1.pdf

Boulder County Sustainability Office. (n.d.). *Cannabis energy impact offset fund.* Retrieved October 27, 2019, from https://www.bouldercounty.org/environment/sustainability/marijuana-offset-fund/

Browne, A. (2018). Power Hungry: The energy demands of the growing cannabis industry. *Journal of Renewable Energy Law and Policy, 8*(4), 7-11. Retrieved from https://sjsu-primo.hosted.exlibrisgroup.com/permalink/f/1o6n68g/TN_proquest2088828794

Bureau of Cannabis Control. (2020). *About us*. Retrieved January 12, 2020, from https://bcc.ca.gov/about_us/

Burlington Electric Department. (2019). Energy efficiency guide for residential indoor growing. Retrieved October 5, 2019, from https://resourceinnovation.org/wp-content/uploads/2019/06/EVT-Res-Growers-Guide-FINAL.pdf

Butsic, V., & Brenner, J. C. (2017). Cannabis (Cannabis sativa or C. indica) agriculture and the environment: a systematic, spatially-explicit survey and potential impacts. *Gen. Tech. Rep. PSW-GTR-258. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 383-393*. Retrieved from https://www.fs.fed.us/psw/publications/documents/psw_gtr258/psw_gtr258_383.pdf

Butsic, V., Baumann, M., Brenner, J. C. , & Schwab, B. (2017). Inside the emerald triangle: Modeling the placement and size of cannabis production in Humboldt County, CA, USA. *Environmental Research Letters*, *13*(12), 124017. Retrieved from https://doi.org/10.1016/j.ecolecon.2017.06.013

Butsic, V., Schwab, B., Baumann, M., & Brenner, J. C. (2017). Inside the emerald triangle: modeling the placement and size of cannabis production in Humboldt County, CA USA. *Ecological Economics, 142*, 70-80. Retrieved from https://doi.org/10.1016/j.ecolecon.2017.06.013

CalCannabis. (2019a). *A reference guide for creating a cultivation plan.* Retrieved December 18, 2019, from https://www.cdfa.ca.gov/calcannabis/documents/CultivationPlanGuide.pdf

CalCannabis. (2019b). *Highlights of the new California cannabis cultivation regulations.* Retrieved from https://static.cdfa.ca.gov/MCCP/document/Fact%20Sheet--Highlights%20of%20New%20Regulations_2.8.19.pdf

California Cannabis Portal. (2020). *Cannabis legislation.* Retrieved January 16, 2020, from https://cannabis.ca.gov/cannabis-legislation/

California Code, Business and Professions Code (BPC). Division 10: Cannabis. (2017). Retrieved January 8, 2020, from https://leginfo.legislature.ca.gov/faces/codes_displayexpandedbranch.xhtml?tocCode=BPC&division=10

California Code of Regulations (CCR). Title 3: Food and Agriculture. Division 8: Cannabis Cultivation. (2019). Retrieved December 16, 2019, from https://bcc.ca.gov/law_regs/cannabis_cdfa_text.pdf

California Energy Commission. (2018a). California energy efficiency action plan. Retrieved February 14, 2020, https://ww2.energy.ca.gov/business_meetings/2019_packets/2019-12-11/Item_06_2019%20California%20Energy%20Efficiency%20Action%20Plan%20(19-IEPR-06).pdf

California Energy Commission. (2018b, April 19). California energy demand 2018-2030 revised forecast. Retrieved January 8, 2020, from https://efiling.energy.ca.gov/getdocument.aspx?tn=223244

City and County of San Francisco Police Code. §§1612-1618-8(cc). Retrieved March 20, 2020, from https://codelibrary.amlegal.com/codes/san_francisco/latest/sf_police/

City of Anaheim, California, Municipal Code. §§4.100.010-4.100.050. Retrieved March 26, 2020, from www.anaheim.net/2904/Municipal-Code

City of Boulder, Colorado, Municipal Code. §6-14-8. Retrieved November 2, 2019, from https://library.municode.com/co/boulder/codes/municipal_code

City of Chula Vista, California, Municipal Code. Chapter 5.19. Retrieved March 11, 2020, from https://chulavista.municipal.codes/CVMC/5.19

City of Concord, California, Municipal Code. §§5.80.010-5.80.140, Retrieved March 28, 2020, from https://www.codepublishing.com/CA/Concord/#!/html/Concord05/Concord0580.html

City of Corona, California. (n.d.) *Frequently asked questions - commercial cannabis businesses.* Retrieved March 24, 2020, from https://www.coronaca.gov/businesses/commercial cannabis-portal/faq

City of Escondido, California, Municipal Code. §33-1117. Retrieved March 28, 2020, from www.qcode.us/codes/escondido/?view=desktop&topic=33-57-33_1117

City of Fontana, California, Zoning and Development Code. Section 30-7(e). Retrieved March 24, 2020, from https://library.municode.com/ca/fontana/codes/zoning_and_development_code

City of Fremont, California, Municipal Code. §§15.05.40-15.04. Retrieved March 27, 2020, from https://www.codepublishing.com/CA/Fremont

City of Fullerton California, Municipal Code. §18.25.1815 and 18.190.307. Retrieved March 27, 2020, from https://codelibrary.amlegal.com/codes/fullerton/latest/fullerton_ca/0-0-0-8473t

City of Glendale, California, Municipal Code. §9.10.020. Retrieved March 27, 2020, from http://www.qcode.us/codes/glendale/view.php?topic=9-9_10-9_10_020

City of Huntington Beach, California, Zoning Code. §§204.20-204.22. Retrieved March 26, 2020, from https://www.qcode.us/codes/huntingtonbeach/view.php?topic=zoning_code-20-204-204_20

City of Irvine, California, Municipal Code. §3-39-2. Retrieved March 26, 2020, from https://library.municode.com/ca/irvine/codes/zoning?nodeId=ZOOR_DIV3GEDESTLA USRE_CH3-39CAREUSCOCAACDECUPR

City of Lancaster, California, Municipal Code. §§5.56.010-5.56.070. Retrieved March 26, 2020, from https://library.municode.com/ca/lancaster/codes/code_of_ordinances

City of Oakland, California. (2020, February, 4). *Green building ordinance mandatory requirements and compliance standards.* Retrieved March 24, 2020, http://www2.oaklandnet.com/oakca1/groups/pwa/documents/report/oak039056.pdf

City of Oakland, California, Municipal Code. §§5.80.040-5.81.070. Retrieved March 24, 2020, from https://library.municode.com/ca/oakland/codes/code_of_ordinances?nodeId=TIT5BUTAPERE_CH5.81MEADECACUMAOTFAPE

City of Oakland, California. (2012, December 4). Oakland energy and climate action plan. Retrieved March 24, 2020, http://www2.oaklandnet.com/oakca1/groups/pwa/documents/report/oak039056.pdf

City of Ontario, California, Municipal Code. §16.18.05. Retrieved March 26, 2020, from https://codelibrary.amlegal.com/codes/ontarioca/

City of Oxnard, California, Municipal Code. §§11.410-11.450. Retrieved March 27, 2020, from https://codelibrary.amlegal.com/codes/oxnard

City of Orange, California, Municipal Code. §5.89.020. Retrieved March 27, 2020, from https://library.municode.com/ca/orange/codes/code_of_ordinances?nodeId=TIT5BUTARE_IIIADRE_CH5.89MECABU

City of Pasadena, California, Zoning Code. §17.50.066. Retrieved March 28, 2020, from https://library.municode.com/ca/pasadena/codes/code_of_ordinances?nodeId=TIT17_ZONING_CODE_ART5STSPLAUS_CH17.50STSPLAUS_17.50.066CABU

City of Rancho Cucamonga, California, Municipal Code. §8.52.020. Retrieved March 26, 2020, from http://qcode.us/codes/ranchocucamonga/?view=desktop&topic=8-8_52

City of Riverside, California, Municipal Code. §§19.342.010-19.342.080. Retrieved March 24, 2020, from https://library.municode.com/ca/riverside/codes/code_of_ordinances?nodeId=PTIICOOR_TIT19ZO_ARTVIISPLAUSPR_CH19.342MAUSAC

City of Roseville, California, Municipal Code. §19.62.030 and §19.63.040. Retrieved March 26, 2020, from http://qcode.us/codes/roseville/?view=desktop&topic=19-iv-19_6319_63_040

City Santa Ana, California, Municipal Code. §40-9-1. Retrieved March 20, 2020, from https://library.municode.com/ca/santa_ana/codes/code_of_ordinances?nodeId=14452

City of San Bernardino, Community Development Department. (2019). *Application procedure guidelines for a commercial cannabis business.* Retrieved March 27, 2020, from https://www.sbcity.org/civicax/filebank/blobdload.aspx?blobid=25694

City of San Bernardino, Community Development Department. (2018). Commercial cannabis business permit application. Retrieved March 27, 2020, from https://sbcity.org/civicax/filebank/blobdload.aspx?BlobID=25691

City of San Bernardino, California, Municipal Code. §§5.10.010-5.10.420. Retrieved March 27, 2020, from https://www.ci.san-bernardino.ca.us/civicax/filebank/blobdload.aspx?blobid=19233

City of San Jose. (2016). Third addendum to the medical marijuana land use regulations ordinance initial study/negative declaration: San José Medical Marijuana Municipal Code and City Manager's Office regulation amendments. Retrieved March 31, 2020, from https://www.sanjoseca.gov/home/showdocument?id=26349

City of Santa Clara. (2013). City of Santa Clara Climate Action Plan. Retrieved July 16, 2019, from http://santaclaraca.gov/home/showdocument?id=10170

City of Simi Valley, California, Municipal Code. §§5-41.01-5-41.05. Retrieved March 28, 2020 from https://library.municode.com/ca/simi_valley/codes/code_of_ordinances?nodeId=TIT5PUWE_CH41NOMECAST_5-41.04CADIDIMECADIPRUS

City of Los Angeles, Department of Cannabis Regulation. (2019). Rules and regulations for cannabis procedures. Retrieved March 24, 2020, from https://cannabis.lacity.org/sites/g/files/wph1171/f/Rules%20and%20Regulations%20for%20Cannabis%20Procedures.pdf

City of Long Beach. (2019). Cannabis facilities permit requirements. Retrieved March 25, 2020, from http://www.longbeach.gov/globalassets/lbds/media-library/documents/building--safety/inspections/information-bulletins/bu-051-cannabis-facility-permit-requirements_4-29-19_adopted

City of Modesto, California, Municipal Code. §§10-3.701-10-3.7012. Retrieved March 26, 2020, from https://library.municode.com/ca/modesto/codes/code_of_ordinances

City of Oceanside, California. (2018). Medical cannabis facilities ordinance and adult-use of cannabis FAQs. Retrieved March 27, 2020, from https://www.ci.oceanside.ca.us/civicax/filebank/blobdload.aspx?blobid=47449

City of Oceanside, California, Municipal Code. §§7.115-7.132. Retrieved March 27, 2020, from https://library.municode.com/ca/oceanside/codes/code_of_ordinances

City of Stockton, California, Municipal Code, Charter, and Civil Service Rules. § 16.80.195. Retrieved March 26, 2020, from https://qcode.us/codes/stockton/

Crandall, K. (2016). A Chronic Problem: Taming energy costs and impacts from marijuana cultivation. *EQ Research.* Retrieved from https://eq-research.com/wp-content/uploads/2016/09/A-Chronic-Problem.pdf

Crowder L. (2019a). “Like every other industry” - An on-the-ground perspective on Proposition 64. *California Agriculture, 73*(3), 117-118. Retrieved from https://doi.org/10.3733/ca.2019a0012

Crowder L. (2019b). Restrictions and opportunities for UC cannabis research. *California Agriculture, 73*(3), 104-105. https://doi.org/10.3733/ca.2019a0023.

Denver Department of Public Health & Environment (DDPHE). (2019, October). Cannabis environmental best practice guide: Energy. Retrieved October 30, 2019, from https://www.denvergov.org/content/dam/denvergov/Portals/771/documents/EQ/MJ%20Sustainability/2_Cannabis_BestPracticesManagementGuide_Energy.pdf

Denver Department of Public Health & Environment (DDPHE). (2018). Cannabis environmental best management practices guide. Retrieved August 1, 2019, from https://www.denvergov.org/content/dam/denvergov/Portals/771/documents/EQ/MJ%20Sustainability/Cannabis_BestManagementPracticesGuide_FINAL.pdf

Goldstein, R. & Sumner, D. (2019). California cannabis regulation: An overview. *California Agriculture*, *73*(3), 101-102. Retrieved from https://doi.org/10.3733/ca.2019a0021

Grachev, V. A. (2019). Environmental effectiveness of energy technologies. *International Journal of Geomate,16*(55), 228-237. Retrieved from https://doi.org/10.21660/2019.55.271117

International City/County Management Association (ICMA). (2018, September). Local impacts of commercial cannabis: final report. Retrieved January 5, 2020, from https://icma.org/documents/commercial-cannabis-report

Jin, D., Jin, S., & Chen, J. (2019). Cannabis indoor growing conditions, management practices, and post-harvest treatment: A review. *American Journal of Plant Sciences*, *10*(6), 925-946. Retrieved from https://doi.org/10.4236/ajps.2019.106067

Jourabchi, M. (2018, June 5). Northwest Power and Conservation Council memorandum: Cannabis production impact on load (results of survey). Retrieved March 3, 2020, from https://www.nwcouncil.org/sites/default/files/2018_0612_p4.pdf

Martyny, J. W., Serrano, K. A., Schaeffer, J. W., & Van Dyke, M. V. (2013). Potential exposures associated with indoor marijuana growing operations. *Journal of occupational and environmental hygiene*, *10*(11), 622-639. Retrieved August 7, 2019, from https://doi.org/10.1080/15459624.2013.831986

Medicinal and Adult Use Cannabis Regulation and Safety Act (MAUCRSA), Cal. S.B. 94. Chapter 27. (Cal. Stat. 2017).

Mills, E. (2012). The carbon footprint of indoor cannabis production. *Energy Policy*, *46*, 58-67. Retrieved from https://doi.org/10.1016/j.enpol.2012.03.023

Mulqueen, A., Lee, R., & Zafar, M. (2017). California Public Utilities Commission: Energy impacts of cannabis cultivation workshop report and staff recommendations. Retrieved November 22, 2019, from http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/About_Us/Organization/Divisions/Policy_and_Planning/PPD_Work/PPD_Work_Products_(2014_forward)/PPD%20-%20Prop%2064%20Workshop%20Report%20FINAL.pdf

National Conference of State Legislatures (NCSL). (2019, October 17). *Marijuana overview.* Retrieved January 10, 2020, from https://www.ncsl.org/research/civil-and-criminal-justice/marijuana-overview.aspx

Northwest Power and Conservation Council. (2019, February 26). Seventh power plan midterm assessment. Retrieved January 8, 2020, from https://www.nwcouncil.org/reports/midterm-assessment-seventh-power-plan

Resource Innovation Institute. (2019). Cultivating cannabis with LED lighting: A primer: what you need to know. Retrieved October 5, 2019, from https://resourceinnovation.org/wp-content/uploads/2019/05/RII-LEDBrochure-1.pdf

Ruby-Cisneros, K. (2018). Promoting the Sustainable Growth of Cannabis. *Journal of Environmental Health, 80*(7), 56. Retrieved from https://sjsu-primo.hosted.exlibrisgroup.com/permalink/f/1o6n68g/TN_gale_ofa531711285

Sacramento Municipal Utility District. (2018a, March 14). SevenLeaves 2017: Indoor horticulture lighting study. Retrieved October 11, 2019, from https://www.smud.org/-/media/Documents/Business-Solutions-and-Rebates/Advanced-Tech-Solutions/LED-Reports/Seven-Leaves-Indoor-Horticulture-LED-Study-Final

Sacramento Municipal Utility District. (2018b, March 14). Amplified Farms 2017: Indoor horticulture lighting study. Retrieved October 11, 2019, from https://www.smud.org/-/media/Documents/Business-Solutions-and-Rebates/Advanced-Tech-Solutions/LED-Reports/Amplified-Farms-Indoor-Horticulture-LED-Study-Final

Seltenrich, N. (2019, June 27). Most states legalizing marijuana have yet to grapple with energy demand. *Energy News Network.* Retrieved from https://energynews.us/2019/06/27/west/most-states-legalizing-marijuana-have-yet-to-grapple-with-energy-demand/

Short-Giannotti, A., Harrower, J., Baird, G., & Sepaniak, S. (2017). The quasi-legal challenge: Assessing and governing the environmental impacts of cannabis cultivation in the north coastal basin of California. *Land Use Policy*, 61, 126-134. Retrieved from https://doi.org/10.1016/j.landusepol.2016.11.016

Sylvia, Sylvia, R. D., & Sylvia, K. M. (2012). *Program planning and evaluation for the public manager.* Long Grove, IL: Waveland Press Inc.

Warren, G. S. (2015). Regulating pot to save the polar bear: Energy and climate impacts of the marijuana industry. *Columbia Journal of Environmental Law, 40*, 385-433. Retrieved from https://scholarship.law.tamu.edu/facscholar/647

USA Facts. (2020, April 15). State of the earth report: A data-driven portrait of America's energy, climate, and environment. Retrieved April 19, 2020, from https://usafacts.org/earth-day-facts/energy-emissions/

U.S. Census Bureau. (2018a). *QuickFacts: Anaheim city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/anaheimcitycalifornia

U.S. Census Bureau. (2018b). *QuickFacts: Bakersfield city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/bakersfieldcitycalifornia

U.S. Census Bureau. (2018c). *QuickFacts: Berkeley city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/berkeleycitycalifornia

U.S. Census Bureau. (2018d). *QuickFacts: Chula Vista city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/chulavistacitycalifornia

U.S. Census Bureau. (2018e). *QuickFacts: Concord city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/concordcitycalifornia

U.S. Census Bureau. (2018f). *QuickFacts: Corona city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/coronacitycalifornia

U.S. Census Bureau. (2018g). *QuickFacts: Elk Grove city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/elkgrovecitycalifornia

U.S. Census Bureau. (2018h). *QuickFacts: Escondido city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/escondidocitycalifornia

U.S. Census Bureau. (2018i). *QuickFacts: Fontana city, California*. Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/fontanacitycalifornia

U.S. Census Bureau. (2018j). *QuickFacts: Fremont city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/fremontcitycalifornia

U.S. Census Bureau. (2018k). *QuickFacts: Fresno city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/fresnocitycalifornia

U.S. Census Bureau. (2018l). *QuickFacts: Fullerton city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/fullertoncitycalifornia

U.S. Census Bureau. (2018m). *QuickFacts: Garden Grove city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/gardengrovecitycalifornia

U.S. Census Bureau. (2018n). *QuickFacts: Glendale city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/glendalecitycalifornia

U.S. Census Bureau. (2018o). *QuickFacts: Hayward city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/haywardcitycalifornia

U.S. Census Bureau. (2018p). *QuickFacts: Huntington Beach city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/huntingtonbeachcitycalifornia

U.S. Census Bureau. (2018q). *QuickFacts: Irvine city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/irvinecitycalifornia

U.S. Census Bureau. (2018r). *QuickFacts: Lancaster city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/lancastercitycalifornia

U.S. Census Bureau. (2018s). *QuickFacts: Long Beach city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/longbeachcitycalifornia

U.S. Census Bureau. (2018t). *QuickFacts: Los Angeles city, California/San Diego city, California.* Retrieved February 1, 2020, from https://www.census.gov/quickfacts/fact/table/losangelescitycalifornia,sandiegocitycalifornia

U.S. Census Bureau. (2018u). *QuickFacts: Modesto city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/modestocitycalifornia

U.S. Census Bureau. (2018av). *QuickFacts: Moreno Valley city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/morenovalleycitycalifornia

U.S. Census Bureau. (2018w). *QuickFacts: Oakland city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/oaklandcitycalifornia

U.S. Census Bureau. (2018x). *QuickFacts: Oceanside city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/oceansidecitycalifornia

U.S. Census Bureau. (2018y). *QuickFacts: Ontario city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/ontariocitycalifornia

U.S. Census Bureau. (2018z). *QuickFacts: Orange city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/orangecitycalifornia

U.S. Census Bureau. (2018aa). *QuickFacts: Oxnard city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/oxnardcitycalifornia

U.S. Census Bureau. (2018bb). *QuickFacts: Palmdale city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/palmdalecitycalifornia

U.S. Census Bureau. (2018cc). *QuickFacts: Pasadena city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/pasadenacitycalifornia

U.S. Census Bureau. (2018dd). *QuickFacts: Pomona city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/pomonacitycalifornia

U.S. Census Bureau. (2018ee). *QuickFacts: Rancho Cucamonga city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/ranchocucamongacitycalifornia

U.S. Census Bureau. (2018ff). *QuickFacts: Riverside city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/riversidecitycalifornia

U.S. Census Bureau. (2018gg). *QuickFacts: Roseville city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/rosevillecitycalifornia

U.S. Census Bureau. (2018hh). *QuickFacts: Sacramento city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/sacramentocitycalifornia

U.S. Census Bureau. (2018ii). *QuickFacts: Salinas city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/salinascitycalifornia

U.S. Census Bureau. (2018jj). *QuickFacts: San Bernardino city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/sanbernardinocitycalifornia

U.S. Census Bureau. (2018kk). *QuickFacts: San Diego city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/sandiegocitycalifornia

U.S. Census Bureau. (2018kk). *QuickFacts: San Francisco city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/sanfranciscocitycalifornia

U.S. Census Bureau. (2018ll). *QuickFacts: San Jose city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/sanjosecitycalifornia

U.S. Census Bureau. (2018mm). *QuickFacts: Santa Ana city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/santaanacitycalifornia

U.S. Census Bureau. (2018nn). *QuickFacts: Santa Clara city, California.* Retrieved October 19, 2019, from https://www.census.gov/quickfacts/fact/table/santaclaracitycalifornia

U.S. Census Bureau. (2018oo). *QuickFacts: Santa Clarita city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/santaclaritacitycalifornia

U.S. Census Bureau. (2018pp). *QuickFacts: Santa Rosa city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/santarosacitycalifornia

U.S. Census Bureau. (2018qq). *QuickFacts: Simi Valley city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/simivalleycitycalifornia

U.S. Census Bureau. (2018rr). *QuickFacts: Stockton city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/stocktoncitycalifornia

U.S. Census Bureau. (2018ss). *QuickFacts: Sunnyvale city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/sunnyvalecitycalifornia

U.S. Census Bureau. (2018tt). *QuickFacts: Thousand Oaks city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/thousandoakscitycalifornia

U.S. Census Bureau. (2018uu). *QuickFacts: Torrance city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/torrancecitycalifornia

U.S. Census Bureau. (2018vv). *QuickFacts: Vallejo city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/vallejocitycalifornia

U.S. Census Bureau. (2018ww). *QuickFacts: Victorville city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/victorvillecitycalifornia

U.S. Census Bureau. (2018xx). *QuickFacts: Visalia city, California.* Retrieved January 8, 2020, from https://www.census.gov/quickfacts/fact/table/visaliacitycalifornia

U.S. Department of Energy. (2017, December). Energy savings potential of SSL in horticultural applications. Retrieved August 3, 2019, from https://www.energy.gov/sites/prod/files/2017/12/f46/ssl_horticulture_dec2017.pdf

U.S. Drug Enforcement Administration. (n.d.). *Drug Scheduling.* Retrieved February 2, 2020, from https://www.dea.gov/drug-scheduling

U.S. Environmental Protection Agency. (2019). Greenhouse gases equivalencies calculator – calculations and references. Retrieved November 1, 2019, from https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references

U.S. Environmental Protection Agency. (2016, August). What climate change means for California. Retrieved February 2, 2020, from https://www.epa.gov/sites/production/files/2016-09/documents/climate-change-ca.pdf

# APPENDIX A

## Questionnaire: Municipal Strategies to Address Energy Use of Indoor Cannabis Cultivation

What is your email address?

_____

What department do you work for?

_____

What is the title of your position?

_____

1. Does your municipality permit commercial cannabis activity (e.g., cultivation, manufacturing, distribution/retail) within your boundaries?
   - □ Yes
     If yes, please check all that apply:
     - □ Cultivation
     - □ Manufacturing
     - □ Distribution
     - □ Retail Sales
   - □ No – All commercial cannabis activity has been banned in my municipality.
   - □ No – No local regulations or ordinances permitting commercial cannabis activity are currently in place.
   - □ In Progress - My municipality is in progress of developing local regulations or ordinances to permit commercial cannabis activity.
   - □ In Progress - My municipality is in progress of developing local regulations or ordinances to ban commercial cannabis activity.

2. Has your municipality established local policies or regulations to address indoor cannabis cultivation's high electricity-based energy use and its associated carbon impacts?
   - □ Yes
     If yes, please check all that apply:
     - □ Requiring commercial cannabis businesses to use electrical power from your municipality's minimum requirements for renewable energy
     - □ Requiring commercial cannabis businesses to use electrical power from your municipality's minimum requirements for renewable energy or purchase carbon offsets
     - □ Requiring commercial cannabis businesses to collect energy usage data and submit annual reports of energy usage
     - □ Other – Please describe below.

       _____

- □ No
- □ In Progress - My municipality is in progress of developing local policies or regulations to address the high electricity-based energy use and associated carbon impacts of indoor cannabis cultivation.

3. Is the high-energy usage of indoor cannabis cultivation addressed in your municipality's climate action plan (or climate action goals)?
   - □ Yes
   - □ No
   - □ In Progress - My municipality is in progress of updating our climate action plan or climate action goals to address the high-energy usage of indoor cannabis cultivation.

4. Does your municipality offer workshops to educate indoor cultivation licensees on energy efficiency and/or reducing overall energy consumption?
   - □ Yes
   - □ No
   - □ In Progress - My municipality is in progress of developing workshops to educate indoor cultivation licensees on energy efficiency and/or reducing overall energy consumption.

5. Does your municipality offer incentives for indoor cannabis cultivation licensees that participate in voluntary certification standards programs that support energy and/or carbon reductions?
   - □ Yes
   - □ No
   - □ In Progress - My municipality is in progress of developing an incentive program for indoor cannabis cultivation licensees that participate in voluntary certification standards programs that support energy and/or carbon reductions.

6. Does your municipality recommend any best practices for energy efficiency for indoor cannabis cultivation?
   - □ Yes
     If yes, please describe below.
     _____
   - □ No
   - □ In Progress - My municipality is in progress of developing best practice recommendations for energy efficiency for indoor cannabis cultivation.

# APPENDIX B

## Questionnaire Email

Dear Recipient,

My name is Genevieve Yip, and I am a graduate student at San Jose State University in the Master of Public Administration program. I am in the process of completing my final research project to fulfill the requirements for my master's degree. This research project will explore how California municipalities have developed local cannabis regulations in accordance with new state regulations and if/how municipalities have developed local regulations or programs to address the high electricity-based energy use for indoor cannabis cultivation and its associated carbon impacts.

I am reaching out to you in hopes that you will participate in a short questionnaire. Your identity will remain anonymous. Upon completion of this research project, the data and findings will be shared with all participants via email.

Please access the questionnaire by clicking here or by copying and pasting the website address below:
https://sjsu.qualtrics.com/jfe/form/SV_3QcblwaBPnmOVV3

It would greatly be appreciated if you could kindly respond to this questionnaire by Thursday, March 19, 2020.

Thank you for your time, and I look forward to your feedback.

Cordially,

Genevieve Yip