

10/21/2022

Clad Flake, Executive Officer / Clerk of the Court

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ENVIRONMENTAL DEMOCRACY PROJECT

8 **SUPERIOR COURT OF THE STATE OF CALIFORNIA**
9 **COUNTY OF ALAMEDA**

10 ENVIRONMENTAL DEMOCRACY
11 PROJECT, a non-profit corporation,

12 Petitioner and Plaintiff,

13 v.

14 CITY OF OAKLAND; CITY OF OAKLAND
15 PLANNING AND BUILDING
16 DEPARTMENT; CITY OF OAKLAND
17 OFFICE OF THE CITY ADMINISTRATOR;
and DOES 1 THROUGH 20,

18 Respondents and Defendants.

19 I METALS, INC, a California corporation; and
20 DSF MANAGEMENT, INC., a California
corporation,

21 Real Parties In Interest.
22

Case No. **22CV020520**

**VERIFIED PETITION FOR WRIT OF
MANDATE AND COMPLAINT FOR
DECLARATORY AND INJUNCTIVE
RELIEF**

CEQA CASE

C.C.P. §§ 1085 and 1094.5; Pub. Res. Code §§
21000 et seq.

INTRODUCTION

1. This action challenges Respondents City of Oakland, City of Oakland Planning and Building Department, and City of Oakland Office of the City Administrator's (each a Respondent and collectively Respondents) unlawful approval of major indoor cannabis cultivation projects in East Oakland—an overburdened community of color—without any analysis of their environmental impacts under the California Environmental Quality Act (CEQA), Pub. Res. Code, §§ 21000 *et seq.* The first of these projects, proposed by I Metal Inc. (I Metal), is a 2,400 square foot indoor cannabis cultivation facility located at 60 Hegenberger Place, Oakland, CA 94621. The second project, proposed by DSF Management Inc. (DSF Management), is a 7,280 square foot indoor cannabis cultivation facility located at 740 Kevin Court, Oakland, CA 94621. A true and correct copy of each project's "Preliminary Checklist for Cannabis Operators Pursuant to the California Environmental Quality Act (CEQA)" (CEQA Checklist) and each project's corresponding Notice of Exemption is attached as **Exhibit A**.

2. In addition, Petitioner Environmental Democracy Project (EDP or Petitioner) brings this action for declaratory and injunctive relief to put an end to Respondents' pattern and practice of exempting all cannabis cultivation projects from CEQA—projects that have significant environmental impacts including toxic emissions from diesel generators and diesel trucks, significant energy and water use, traffic, odors, and hazardous waste. Respondents routinely grant permits for cannabis cultivation projects in East Oakland without conducting any analysis of their environmental impacts on the neighborhoods and residents of East Oakland under CEQA. For example, Respondents have, on hundreds of occasions, failed to ensure that proposed indoor cannabis cultivation facilities have access to the power grid, that the grid has sufficient power to fuel the facilities' energy intensive operations, and that the facilities will not resort to using massive diesel-generators in lieu of grid power.

3. Residents of East Oakland living near the proposed project sites are concerned about, among other things, indoor cannabis cultivation operations' potential to cause significant environmental impacts, and the unfairness of siting more cannabis cultivation projects in a community that already hosts numerous cultivation projects. Nevertheless, Respondents regularly approve cannabis cultivation projects without conducting any environmental review under CEQA.

4. East Oakland is a community of color adversely impacted by a long history of government-sponsored racially discriminatory practices such as redlining. Today, as a result of these practices, East Oakland is overburdened by pollution, poverty, and a lack of resources such as access to greenspace and grocery stores. Approving hundreds of cannabis cultivation facilities without any environmental review is yet another example of the City's practice of targeting East Oakland for projects that wealthier Oakland neighborhoods do not want.

5. In sum, Respondents' project approvals are unlawful because: (1) Respondents did not conduct environmental review under CEQA for cannabis cultivation projects; and (2) Respondents' pattern and practice of approving cannabis cultivation projects without conducting environmental review under CEQA violates the statute. Petitioner seeks a declaratory judgment that Respondents' pattern and practice of circumventing CEQA is unlawful. Petitioner seeks an injunction restraining Respondents' approval of indoor cannabis cultivation facilities without conducting CEQA review.

PARTIES

6. Petitioner and Plaintiff Environmental Democracy Project is a 501(c)(3) nonprofit corporation dedicated to representing communities of color exposed to disproportionate amounts of pollution. EDP is based in East Oakland where several of its officers live.

7. EDP members live in and around areas directly affected by the hundreds of indoor cannabis cultivation projects permitted in East Oakland without CEQA compliance. They are exposed, on a daily basis, to the pollution, odor, noise, and traffic caused by these sites.

8. EDP and its members are directly, adversely, and irreparably affected, and will continue to be prejudiced by these indoor cannabis cultivation sites, unless and until this Court provides the relief prayed for in this Petition and Complaint. Respondents' pattern and practice of approving cannabis cultivation projects without CEQA review results in significant adverse environmental impacts to members of EDP.

9. The maintenance and prosecution of this action will confer a substantial benefit on the public by protecting the public from harms to the environment and other harms alleged herein. This action will also ensure that Respondents abide by procedures required by law.

1 10. Respondent City of Oakland (the City) is a municipal corporation and a chartered city,
2 organized and existing under the laws of the State of California. The City and its officials, boards,
3 commissions, departments, bureaus, and offices constitute a single “local agency,” “public agency” or
4 “lead agency” as those terms are used under the California Environmental Quality Act. *See* Pub. Res.
5 Code §§ 21062, 21063, 21067; Oak. Muni. Code § 17.158.090. Thus, the City has the principal
6 responsibility for conducting environmental review of its actions. The City has a duty to comply with
7 state law, including CEQA.

8 11. Respondent City of Oakland Planning and Building Department (Planning and Building)
9 is a subdivision of the City of Oakland that is responsible for CEQA compliance in Oakland. Planning
10 and Building is a responsible agency under CEQA. *See* Pub. Res. Code § 21069.

11 12. Respondent City of Oakland Office of the City Administrator (City Administrator) is
12 “responsible for implementing a process for selection of qualified cannabis operators and may set forth
13 criteria to determine an operator’s qualifications to meet the requirements of the applicable City’s
14 ordinances, regulations and state law.” 2021-2022 Administrative Regulations and Performance
15 Standards for City of Oakland Cannabis Operators § III.A. The City Administrator’s Office has
16 authorized hundreds of exemptions from CEQA for cannabis cultivation facilities. The City
17 Administrator’s Office is a responsible agency under CEQA. *See* Pub. Res. Code, § 21069.

18 13. I Metal, Inc. is named as Real Party in Interest because it is a “person” under Public
19 Resources Code section 21065, subdivisions (b) and (c). *See* Pub. Res. Code § 21167.6.5.

20 14. DSF Management, Inc. is named as Real Party in Interest because it is a “person” under
21 Public Resources Code section 21065, subdivisions (b) and (c). *See* Pub. Res. Code, § 21167.6.5.

22 15. EDP is unaware of the true names and capacities of Respondents or Real Parties in
23 Interest fictitiously named Does 1 through 20 and sues such Respondents or Real Parties in Interest by
24 fictitious names. EDP is informed and believes, and on that basis alleges, that the fictitiously named
25 Respondents or Real Parties in Interest are also responsible for the actions described in this Petition.
26 When the true identities and capacities of these Respondents or Real Parties in interest have been
27 determined, Petitioner will amend this petition, with leave of the Court if necessary, to insert such
28 identities and capacities.

JURISDICTION AND VENUE

16. EDP realleges and incorporates by reference the preceding paragraphs in their entirety.

17. This Court has jurisdiction over the matters alleged herein pursuant to Code of Civil Procedure sections 526, 527, 1060, 1085, 1087, and 1094.5, and Public Resources Code sections 21168, 21168.5, and 21168.9.

18. Venue for this action properly lies in the Superior Court for the State of California in and for the County of Alameda pursuant to Code of Civil Procedure section 394. The activities authorized by Respondents have occurred, will occur, and are occurring in and around the City of Oakland, located in Alameda County.

19. Respondents have taken final agency actions with respect to approving the projects at issue without complying with CEQA.

20. Respondents have a duty to comply with CEQA. EDP possesses no effective remedy to challenge the approvals at issue in this action other than by means of this lawsuit.

21. On October 21, 2022, EDP complied with Public Resources Code section 21167.5 by serving a written notice on Respondents regarding EDP's commencement of this action. Attached hereto as **Exhibit B** is the true and correct copy of this written notice.

22. EDP is filing and serving its Notice to Attorney General concurrently with this filing, thereby complying with the requirements of Public Resources Code section 21167.7 and Code of Civil Procedure section 388.

23. EDP performed all conditions precedent to filing the instant action and exhausted any and all available administrative remedies to the extent possible and required by law. EDP and its members made numerous objections highlighting Respondents' failure to comply with CEQA. In response, the City Attorney's office told EDP's counsel that the City's CEQA exemption determinations were "made pursuant to, and consistent with, City Code and State law requirements. Further, the determination does not contain an appeal process. Thus, the City's decision is final."

24. Accordingly, EDP has no plain, speedy, or adequate remedy in the course of ordinary law unless this Court grants the requested writ of mandate to require Respondents to set aside their project approvals. In the absence of such remedies, Respondents' approvals will remain in effect in violation of

of CEQA. EDP's members and residents in East Oakland and nearby communities will be irreparably harmed. No money damages or legal remedy could adequately compensate for that harm.

CEQA'S REQUIREMENTS

25. CEQA requires an agency to analyze the potential environmental impacts of its proposed actions in an Environmental Impact Report (EIR) except in certain limited circumstances. *See, e.g.*, Pub. Res. Code § 21100. The EIR is the very heart of CEQA. *Dunn-Edwards v. BAAQMD* (1992) 9 Cal.App.4th 644, 652. "The foremost principle in interpreting CEQA is that the Legislature intended the act to be read so as to afford the fullest possible protection to the environment within the reasonable scope of the statutory language." *Communities. for a Better Env. v. Cal. Res. Agency* (2002) 103 Cal. App.4th 98, 109.

26. CEQA's primary purposes are as follows. CEQA informs decision makers and the public about the potential, significant environmental effects of a project. 14 Cal. Code Regs. § 15002(a)(1). "Its purpose is to inform the public and its responsible officials of the environmental consequences of their decisions before they are made. Thus, the EIR 'protects not only the environment but also informed self-government.'" *Citizens of Goleta Valley v. Board of Supervisors* (1990) 52 Cal. 3d 553, 564. The EIR has been described as "an environmental 'alarm bell' whose purpose it is to alert the public and its responsible officials to environmental changes before they have reached ecological points of no return." *Berkeley Keep Jets Over the Bay v. Bd. of Port Comm'rs.* (2001) 91 Cal. App. 4th 1344, 1354; *County of Inyo v. Yorty* (1973) 32 Cal.App.3d 795, 810.

27. CEQA requires public agencies to avoid or reduce environmental damage when "feasible" by requiring "environmentally superior" alternatives and all feasible mitigation measures. 14 Cal. Code Regs. § 15002(a)(2) and (3); *see also Berkeley Jets*, 91 Cal.App.4th at 1354; *Citizens of Goleta Valley*, 52 Cal.3d at p. 564. The EIR serves to provide agencies and the public with information about the environmental impacts of a proposed project and to "identify ways that environmental damage can be avoided or significantly reduced." 14 Cal. Code. Regs. §15002(a)(2). If the project will have a significant effect on the environment, the agency may approve the project only if it finds that it has "eliminated or substantially lessened all significant effects on the environment where feasible" and that

any unavoidable significant effects on the environment are “acceptable due to overriding concerns.”
Pub. Res. Code § 21081; 14 Cal. Code Regs. § 15092(b)(2)(A) & (B).

28. A lead agency must make a good-faith effort, based to the extent possible on scientific and factual data, to describe, calculate or estimate the amount of greenhouse gas emissions resulting from a project. A lead agency shall have discretion to determine, in the context of a particular project, whether to: (1) Quantify greenhouse gas emissions resulting from a project; and/or (2) Rely on a qualitative analysis or performance based standards. 14 Cal. Code Regs. § 15064.4.

29. CEQA requires evaluation, disclosure, mitigation, and consideration of alternatives for significant impacts caused by air pollution, water use, traffic, hazardous waste, noise, and other impacts. *Azusa Land Reclamation Co. v. Main San Gabriel Basin Watermaster* (1997) 52 Cal.App.4th 1165, 1206 (hazardous waste impacts required environmental review under CEQA); *King & Gardiner Farms, LLC v. County of Kern* (2020) 45 Cal.App.5th 814, 895 (air pollution, noise impacts, and water supply impacts required adequate environmental review under CEQA).

STATEMENT OF FACTS

The Significant Environmental Impacts from Indoor Cannabis Cultivation Facilities

30. The electricity consumption of indoor cannabis cultivation facilities is staggering. Indoor cannabis cultivation is one of the most energy-intensive industries in the nation. “Indoor marijuana cultivation has an energy demand that rivals data centers. With energy intensities around 2,000 watts per minute, it consumes between 50 and 200 times more than an average office building and 66 times more than an average home.” Gina S. Warren, *Hotboxing the Polar Bear: The Energy and Climate Impacts of Indoor Marijuana Cultivation* BOSTON UNIVERSITY LAW REVIEW (2015). Attached hereto as **Exhibit C** is a true and correct copy of this scientific study.

31. Indoor cannabis cultivation results in approximately \$6 billion in energy costs annually, accounting for at least 1% of the nation’s electricity. Evan Mills, *The carbon footprint of indoor Cannabis production*, ENERGY POLICY (Volume 46, 2012). Attached hereto as **Exhibit D** is a true and correct copy of this scientific study.

32. In California, the nation’s largest marijuana producer, indoor cannabis production *consumes three percent of state’s total electricity*, and eight percent of household electricity. Warren

2015 [Exhibit C]. In 2010, these figures corresponded to 17 million metric tons of greenhouse gas (CO₂) emissions for the United States, and 4 million metric tons of CO₂ emissions for California; these emissions were estimated to have been released from electricity generated from fossil fuel sources being used to grow cannabis. Mills 2012 [Exhibit D].

33. One average kilogram of final cannabis product is associated with 4,600 kilograms of carbon dioxide emissions into the atmosphere, or that of 3 million average U.S. cars when aggregated across all national production. Mills 2012 [Exhibit D].

34. Typical indoor cannabis cultivation facilities cost millions of dollars and are state-of-the-art “grow rooms” constructed as isolated ecosystems in locations such as warehouses. Electricity is used to power high-intensity discharge lights that take the place of the sun in driving photosynthesis and secondary plant metabolite production. A primary goal of indoor growers is to create an environment that maximizes the quantity and quality of marijuana flower buds produced. Indoor growing operations rely on tightly regulated light, temperature, humidity, and air quality, which come at a large cost in the form of electricity. Mills, *Energy Use by the Indoor Cannabis Industry: Inconvenient Truths for Producers, Consumers, and Policymakers* THE ROUTLEDGE HANDBOOK OF POST-PROHIBITION CANNABIS RESEARCH (2021). Attached hereto as **Exhibit E** is a true and correct copy of this scientific study.

35. Cannabis cultivation and processing operations emit a variety of air contaminants including volatile organic compounds and combustion by-products. Vera Samburova, *Dominant volatile organic compounds (VOCs) measured at four Cannabis growing facilities: Pilot study results* J AIR WASTE MANAG ASSOC. (2019; 69:11) 1267-1276. Attached hereto as **Exhibit F** is a true and correct copy of this scientific study. Volatile organic compounds are air contaminants regulated under the federal Clean Air Act and California’s State Implementation Plan.

36. Cannabis operations also generate hazardous waste. Examples of hazardous waste generated by cannabis operations include pesticides or other chemicals used in the cultivation process, solvents or other chemicals used in the production of cannabis concentrate, and cannabis soaked in a flammable solvent for purposes of producing a cannabis concentrate. Indoor practices involving hydroponics yield contaminated wastewater that may be introduced into or circumvent wastewater

streams. Mills 2021 [Exhibit E]. Moreover, cultivators commonly use non-degrading growing media, such as mineral wool that is saturated with nutrient-laden water, that is typically sent to landfill after each harvest. *Id.* An operation with 100,000 square feet of canopy requires 14,000 to 34,000 cubic feet of mineral wool per cycle, which results in the generation of approximately to 85,000 to 200,000 cubic feet of solid waste to landfill over a year with six growing cycles. *Id.*

37. The City requires indoor cannabis cultivation facilities to complete a cursory “CEQA Checklist” prior to approval. The CEQA Checklist requires, among other things, project proponents to enroll in the City’s “renewable 100 option” program. This “program” is nothing more than meaningless greenwashing. Indoor cannabis cultivation requires far more energy than the state’s current renewable energy sources could ever supply. Evan Mills, *California: a cannabis-climate train wreck in progress* (2021). A true and correct copy of this study is attached hereto as **Exhibit G**. The energy for indoor cannabis cultivation operations comes almost entirely from climate-killing fossil-fuel sources—which is anathema to Oakland’s clean energy goals. *Id.* For example, Oakland’s Equitable Climate Action Plan enacted in 2020 requires significant greenhouse gas reductions through, among other things, “aligning permit and project approvals” with the City’s greenhouse gas reduction priorities. Inexplicably, the City has not applied this policy to indoor cannabis cultivation facilities.

38. Yet, despite the significant environmental impacts from indoor cannabis cultivation facilities, the City has exempted hundreds of cannabis cultivation facilities from CEQA—facilities that are concentrated in overburdened communities of color such as East Oakland.

Respondents Improper Approval of the I Metal, Inc. and DSF Management, Inc. Projects

39. Respondents recently approved two large indoor cannabis cultivation operations in East Oakland—a community of color that is overburdened by industrial pollution. The City exempted each of these energy-intensive projects from CEQA review based on a one-page boilerplate Notice of Exemption.

40. The I Metal facility is in East Oakland. I Metal proposes to construct an indoor cannabis cultivation facility that will occupy approximately 2,400 square feet of a 8,712 square foot facility. I Metal completed the City’s CEQA Checklist on or around April 20, 2022, indicating that the project will

1 require “New Construction.” The City Clerk issued I Metal a Notice of Exemption from CEQA on
2 September 16, 2020. *See* CEQA Checklist and Notice of Exemption [Exhibit A].

3 41. The DSF Management facility is also located in East Oakland. DSF Management
4 proposes to construct an indoor cannabis cultivation facility that will occupy approximately 7,280 square
5 feet of a facility of unknown size (though the Notice of Exemption lists the facility size at 18,000 square
6 feet.) DSF Management completed the City’s CEQA Checklist on or around July 11, 2022. The City
7 issued DSF Management an undated and unsigned Notice of Exemption from CEQA. *See* CEQA
8 Checklist and Notice of Exemption [Exhibit A].

9 42. The City’s I Metal and DSF Management Notices of Exemption from CEQA are
10 identical. Both Notices of Exemption state that the project is categorically exempt from CEQA under
11 the “Existing Facilities” exemption, 14 Cal. Code Regs. § 15301 (despite I Metal indicating “New
12 Construction”). Both Notices of Exemption further state that the project is exempt under the “Other”
13 exemption for “projects consistent with a community plan, general plan, or zoning,” citing 14 Cal. Code
14 Regs. § 15183(f). Both Notices of Exemption state as the “[r]eason why project is exempt” that “[t]he
15 Applicant is proposing to operate as a[n] indoor cannabis cultivator in an existing commercial facility
16 and will use non-fossil fuel services to power the operation. Further, the use of indoor cannabis
17 cultivation is permitted at the discretion of the City Administrator under Chapter 5.81 of the Oakland
18 Municipal Code. Thus, the proposed use will not have a significant effect on the environment.” *See*
19 Exhibit A.

20 43. The City’s determination as to the projects’ exemption from CEQA precluded any public
21 CEQA process, restricting opportunities for meaningful public participation and public comments
22 concerning the location and potential impacts of the proposed projects.

23 **The City’s Pattern and Practice of Exempting All Indoor**
24 **Cannabis Cultivation Operations from CEQA**

25 44. The City has approved hundreds of indoor cannabis facilities without ensuring that there
26 is sufficient electricity from the grid for the facilities to operate. As a result of the City’s failure to
27 conduct CEQA review, numerous facilities have been using massive diesel generators to supply power
28 to their energy-intensive facilities. One such facility, Green Sage Management, LLC, operated nine

1 semi-truck size diesel generators twenty-four hours a day, seven days a week, for over two years. The
2 City did nothing to stop them. It was not until EDP obtained a federal injunction that the generators at
3 the Green Sage facility were shut down. *See Environmental Democracy Project v. Green Sage*
4 *Management, LLC* (N.D. Cal., July 13, 2022, No. 22-CV-03970-JST) 2022 WL 4596612, at *1.

5 45. The City has also exempted hundreds of indoor cannabis cultivation facilities from
6 CEQA review without considering their impacts on water during a time of severe drought in California.
7 Cannabis is a water- and nutrient-intensive crop. Indoor cannabis cultivation consumes approximately
8 2.5 and 2.8 gallons of water per day per plant in August and September. Zhonghua Zheng, *A narrative*
9 *review on environmental impacts of cannabis cultivation* Journal of Cannabis Research (2021). A true
10 and correct copy of this scientific study is attached hereto as **Exhibit H**. The water demand for cannabis
11 growing far exceeds the water needs of many commodity crops. *Id.* For example, in a growing season
12 cannabis plants need twice as much water as that required by maize, soybean, and wheat plants. *Id.*

13 46. The City has never conducted CEQA review for any of the hundreds of indoor cannabis
14 cultivation facilities it has approved. The only effort the City makes regarding CEQA is to require the
15 project proponent to fill out a “Preliminary Checklist for Cannabis Operators Pursuant to California
16 Environmental Quality Act.” The CEQA Checklist does not require the applicant to identify any
17 potentially significant environmental impacts from the proposed project such as energy consumption,
18 access to the grid, air pollution, water use, traffic, noise, odors, or hazardous waste. Once the checklist
19 is complete, the City automatically grants a Notice of Exemption or otherwise exempts the facility from
20 CEQA review.

21 47. Indeed, the City candidly represents that Notices of Exemption are automatically granted
22 for all indoor cannabis cultivation facilities: “Completed CEQA questionnaires will be reviewed by the
23 Planning Department *and a Notice of Exemption (NOE) will be issued*. Applicants will be notified to
24 pick up the NOE and an Inspection Card will then be issued. Applicants will then file the NOE
25 document with the County Recorder’s Office and supply our office with the stamped copy” (emphasis
26 added.) A true and correct copy of the City’s webpage entitled “Apply for a Cannabis Permit” if
27 attached hereto as **Exhibit I**.

48. EDP requested public documents regarding all cannabis facilities approved by the City. To date, the City has produced 2,298 “CEQA Checklists” along with a smaller number of Notices of Exemption for cannabis projects the City has approved. All of the 2,298 applications for cannabis facilities were exempted from CEQA by the City.

49. For example, one project proponent identified the following major additions necessary to turn its facility into a state-of-the-art indoor cannabis cultivation operation:

- “Renovation of partial existing warehouse (6500SF out of 7600SF) for the use of cannabis cultivation, distribution, and delivery to include approximately:
- 3 Cultivation Rooms
- 130 LED Cultivation Lights, Tables, and Irrigation System
- 60 Tons of AC
- CO2 (Delivered Liquid) Supply System
- Supply and Exhaust Fans for Each Room
- Dry/Storage Rooms, Office
- Add Fire Sprinkler System and Fire/CO2 Alarm”

A true and correct copy of the “CEQA Checklist” and Notice of Exemption for Emerald Wizards, Inc. is attached hereto as **Exhibit J**. Despite these significant additions to transform the facility into a major cannabis cultivation operation, the City exempted the project from CEQA as an “Existing Facility.”

50. In another instance, the City exempted a cannabis cultivation facility from CEQA review based on its representation that the project would use “high energy efficiency bulbs, low flow toilets and water systems, and a strict recycling program . . . to mitigate our environmental impacts.” A true and correct copy of the CEQA Checklist for DC Capital Holdings LLC is attached hereto as **Exhibit K**. However, following approval, this facility operated massive diesel-fired generators twenty-four hours a day for two years because the facility lacked power supply from the grid—yet another example of the City’s pattern and practice of violating CEQA at the expense of the overburdened communities of color in which these facilities are located.

The City’s Improper Use of Categorical Exemptions to Evade CEQA Review

1 51. In issuing boilerplate Notices of Exemption to cannabis cultivation applicants, the City
2 overwhelmingly relies on (1) the categorical exemption for “existing facilities” under 14 Cal. Code
3 Regs. § 15301; (2) an exemption for “[p]rojects consistent with a community plan, general plan or
4 zoning” citing 14 Cal. Code Regs. § 15183(f); (3) an assertion that the facilities “will use non-fossil fuel
5 services to power the operation,” and (4) the City Administrator’s discretion to permit indoor cannabis
6 cultivation under Oakland Municipal Code § 5.81. Each of these reasons for exempting cannabis
7 cultivation operations from CEQA fails.

8 **A. The Existing Facilities Exemption.**

9 52. The City incorrectly, and uniformly, relies on the categorical exemption for “existing
10 facilities” under 14 Cal. Code Regs. § 15301 (the Existing Facilities Exemption) to exempt indoor
11 cannabis cultivation projects. The Existing Facilities Exemption only applies to activities involving
12 “negligible” or “no expansion of [an] existing or former use.” 14 Cal. Code Regs. § 15301. This class
13 of exemption “consists of the operation, repair, maintenance, permitting, leasing, licensing, or minor
14 alteration of existing . . . facilities.” *Id.* In determining whether a project falls into this exempt class, the
15 “key consideration is whether the project involves negligible or no expansion of use.” *Id.* Accordingly,
16 “[t]he relevant issue in determining whether the existing facilities exemption applies is whether the
17 project involves ‘expansion of a use beyond that *existing or former use.*’” *San Diegans for Open*
18 *Government v. City of San Diego* (2018) 31 Cal.App.5th 349, 371 (emphasis in original).

19 53. The conversion of storage warehouses, factories, auto shops, and other existing structures
20 into state-of-the-art “grow rooms” constructed as isolated ecosystems for the cultivation of cannabis are
21 not “negligible” modifications or “no expansion of [an] existing or former use.” These indoor cannabis
22 cultivation projects are in fact wholly new uses—not minor modifications to an existing use. The
23 projects require the addition of equipment capable of providing high-intensity lighting, CO2 generation,
24 ventilation, irrigation, climate control, diesel-truck trips, generators, and security, requiring massive
25 amounts of electricity, water, and alterations to the site. In fact, cannabis cultivation was not a legally
26 permitted use of any facility in Oakland prior to 2016, well after the erection of the vast majority of the
27 structures now being converted to this purpose. These major transformations to indoor cannabis
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1 cultivation facilities are not minor alterations to an existing use. Thus, the Existing Facilities exemption
2 does not apply.

3 **B. Exemption for Projects Consistent with a Community Plan, General Plan, or**
4 **Zoning.**

5 54. The exemption for “Projects Consistent with a Community Plan, General Plan, or
6 Zoning” does not justify the City’s uniform exemption of all indoor cannabis cultivation operations from
7 CEQA. *See* 14 Cal. Code Regs. § 15183. That exemption provides that: “CEQA mandates that projects
8 which are consistent with the development density established by existing zoning, community plan, or
9 general plan policies for which an EIR was certified shall not require additional environmental review,
10 except as might be necessary to examine whether there are project-specific significant effects which are
11 peculiar to the project or its site.” Here, the City does not identify any EIR that was certified that
12 governs indoor cannabis cultivation facilities. Even if there were such an EIR, indoor cannabis
13 cultivation facilities have “project-specific significant effects which are peculiar to the project”
14 including stunning energy-use requirements, diesel particulate matter pollution, odors, noise, traffic, and
hazardous waste.

15 **C. The Projects Require an Enormous Amounts of Fossil Fuels.**

16 55. It is patently false that the projects will “use non-fossil fuel services to power the
17 operation.” *See* Notice of Exemption [Exhibit A]. Because of the staggering amount of power needed
18 for indoor cultivation facilities, massive amounts of fossil-fuel sources are required. Indoor cannabis
19 cultivation operations require twenty-four hour continuous energy to ensure their product meets control
20 standards. Warren 2015 [Exhibit C]. There is not enough renewable energy resources in the entire state
21 to supply the energy demand of indoor cultivation. Mills 2021 [Exhibit E].

22 **D. The City’s Discretion to Permit Indoor Cannabis Operations.**

23 56. The City mistakenly supports issuing boilerplate Notices of Exemption to proposed
24 indoor cannabis cultivation projects with the statement: “the use of indoor cannabis cultivation is
25 permitted at the discretion of the City Administrator under Chapter 5.81 of the Oakland Municipal Code.
26 Thus, the proposed use will not have a significant effect on the environment.” *See* Notice of Exemption
27 [Exhibit A]. CEQA, however, expressly applies to discretionary projects. Moreover, the City has
28

utterly failed to exercise its discretion to ensure that cannabis operations will have a negligible environmental impact as the City contends.

57. Discretionary projects (as opposed to ministerial projects) are subject to CEQA review. Pub. Res. Code § 21080(a); *see also Protecting Our Water & Env't'l Resources v. County of Stanislaus* (2020) 10 Cal.5th 479, 488. “CEQA applies in situations where a governmental agency can use its judgment in deciding whether and how to carry out or approve a project. A project subject to such judgmental controls is called a ‘discretionary project.’” 14 Cal. Code Regs. § 15002(i); *see also id.* § 15357. The City’s Notices of Exemption correctly state that these projects are approved at the City’s discretion. Thus, CEQA applies.

58. Oakland Municipal Code section 5.81 provides in pertinent part that “[t]he City Administrator shall establish criteria for minimizing the carbon footprint, environmental impact and resource needs of permitted facilities. Applicants that demonstrate they can satisfy these environmental criteria, such as cultivators seeking to operate greenhouse facilities, ***will be given preference in the processing of their application.***” Oak. Muni. Code § 5.81.050(C) (emphasis added). The City’s Administrative Regulations for Cannabis Operators further clarify “[t]he City, in its discretion . . . may determine that either: (1) a CEQA exemption applies and a Notice of Exemption is appropriate, or (2) further environmental study . . . may be needed.” 2021-2022 Administrative Regulations and Performance Standards for City of Oakland Cannabis Operators ¶ 42.

59. The Municipal Code and Administrative Regulations do not support the City’s conclusory assertion that its discretion in permitting cannabis operations exempts them from CEQA while ensuring that they “will not have a significant effect on the environment.” *See* Notice of Exemption [Exhibit A]. Rather, the City’s discretion triggers CEQA, and most certainly does not ensure that these facilities will have a negligible environmental impact.

E. The Exceptions to Any Categorical Exemptions Apply Here.

60. Even where categorical exemptions apply, they are not absolute. CEQA provides several exceptions when exemptions must be denied. *See* 14 Cal. Code. Regs. § 15300.2. Relevant here are the “cumulative impact” and “unusual circumstances” exceptions under section 15300.2 (b) and (c). Each exception is applicable to the City’s permitting of cannabis cultivation operations.

61. The “cumulative impact” exception applies where the cumulative impact of successive projects of the same type in the same place is significant. 14 Cal. Code Regs. § 15300.2(b). CEQA provides that the “cumulative impacts from several projects is the change in the environment which results from the incremental impact of the project when added to other closely related past, present, and reasonably foreseeable probable future projects. Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time.” *Id.* § 15355(b); *See* Pub. Res. Code § 21083(b)(2).

62. Here, the City has approved hundreds of indoor cannabis cultivation operations. A great many of them are in East Oakland. Applications for and approvals of these projects have steadily and exponentially increased in the years since the City began permitting indoor cannabis cultivation. *See* City of Oakland Cannabis Regulatory Commission 2019-2020 Annual Reports, Attachment D: 2017-2020 City of Oakland Cannabis Application and Permit Trends. A true and correct copy of this Attachment D is Attached hereto as **Exhibit L**. East Oakland has a significant amount of closely related past and present cannabis cultivation projects. And future projects of the same type and in the same place are reasonably foreseeable. The cumulative impact of these operations on East Oakland— each demanding unavailable quantities of electricity, each emitting carbon dioxide, increasing traffic, and producing hazardous waste—are significant. Therefore, the “cumulative impact” exception applies.

63. CEQA’s “unusual circumstances” exception negates the finding of an exemption “where there is a reasonable possibility that the project will have a significant effect on the environment due to unusual circumstances.” 14 Cal. Code Regs. § 15300.2(c). “Unusual circumstances” are those that “differ from the general circumstances of the projects covered by the particular categorical exemption” and which “create an environmental risk that does not exist for the general class of exempt projects.” *Azusa*, 52 Cal.App.4th at 1207.

64. Despite the City’s formulaic reliance on the Existing Facility Exemption for indoor cannabis cultivation projects, the conversion of storage warehouses, factories, auto shops, and other existing structures into state-of-the-art “grow rooms” constructed as isolated ecosystems, differs greatly from the general circumstances (i.e. “negligible” modifications or “no expansion of [an] existing or former use.”) that fall within that exemption. Adding equipment capable of providing high-intensity

1 lighting, CO2 generation, ventilation, irrigation, climate control, and security, requiring massive
2 amounts of electricity, water, and alterations to the site, are indeed unusual circumstances—
3 circumstances that have only legally existed in Oakland since 2016. Thus, CEQA’s “unusual
4 circumstances” exception applies to indoor cannabis cultivation projects in East Oakland.

5 **FIRST CAUSE OF ACTION**

6 **Violations of the California Environmental Quality Act** 7 **Injunctive and Declaratory Relief** 8 **(Against City of Oakland, Planning Department, City Administrator, and Real Parties in Interest)**

9 65. EDP realleges and incorporates by reference the preceding paragraphs in their entirety.

10 66. CEQA is designed to ensure that government agencies incorporate the goal of long-term
11 protection of the environment into their decisions that may affect the environment. CEQA applies to
12 any discretionary action taken by an agency that may cause a reasonably foreseeable change in the
13 environment.

14 67. In furtherance of its goal of environmental protection, CEQA requires that the lead
15 agency prepare an Environmental Impact Report (EIR) for a project whenever substantial evidence in
16 the record supports a fair argument that the project may have a significant impact on the environment.
17 As the cornerstone of the CEQA process, the EIR must disclose and analyze a project’s potentially
18 significant environmental impacts. In addition, the EIR also must inform decision-makers and the
19 public of feasible mitigation measures and alternative project designs or elements that would lessen or
20 avoid the project’s significant adverse environmental impacts.

21 68. CEQA also mandates that the lead agency adopt all feasible mitigation measures that
22 would reduce or avoid any of the project’s significant environmental impacts. If any of the project’s
23 significant impacts cannot be mitigated to a less-than-significant level, the project can be approved only
24 if the agency finds that the project’s benefits would outweigh its unavoidable impacts.

25 69. Under CEQA, all findings required for any agency’s approval of a project must be legally
26 adequate and supported by substantial evidence in the administrative record. CEQA further requires that
27 an agency provide an explanation of how the evidence in the record supports the conclusions that the
28 agency has reached.

70. The City found the Real Parties' proposed projects are exempt from CEQA under the "Existing Facilities" exemption, 14 C.C.R. § 15301. The projects do not meet the requirement for the Existing Facilities exemption because they are new uses—not modifications to an existing use. The projects require the addition of new infrastructure state-of-the-art "grow rooms" constructed as isolated ecosystems. Moreover, the projects will use massive amounts of electricity to power high-intensity discharge lights including intensive lighting. The projects will also likely use CO2 generators, requiring even more electricity. These major indoor cannabis cultivation facilities are not minor alterations to the existing use. Thus, the "Existing Facilities" exemption does not apply.

71. The findings made by the City and Cannabis Regulatory Commission asserting that the project is exempt from CEQA constitute an abuse of discretion and failure to proceed in a manner required by law. This abuse of discretion and failure to proceed in a manner required by law is prejudicial. Thus, Respondents' decisions to approve the project must be set aside.

SECOND CAUSE OF ACTION

**Illegal Pattern and Practice of Exempting Indoor Cannabis Cultivation
Facilities from CEQA Review
Injunctive and Declaratory Relief
(Against City of Oakland and Cannabis Regulatory Commission)**

72. EDP hereby realleges and incorporates by reference the preceding paragraphs in their entirety.

73. The City has an ongoing pattern and practice of approving hundreds of indoor cannabis cultivation operations without CEQA review. The City has effectively determined that the indoor cannabis cultivation industry is uniformly exempt from CEQA. The City made this determination without public notice or an opportunity for public participation.

74. CEQA requires each public agency to conduct an Initial Study and prepare an EIR when the agency proposes to approve or carry out a discretionary project that may have a significant impact on the environment. These projects include the issuance of permits. Respondents' issuance of building and other permits to indoor cannabis cultivation operations is a discretionary act subject to CEQA. CEQA requires that Respondents evaluate and disclose significant environmental impacts

1 from indoor cannabis cultivation facilities, and impose all feasible mitigation measures and consider
2 alternatives that will reduce the impact to a level of insignificance. 14 Cal. Code Regs. § 15092(b).

3 75. Respondents have exempted hundreds of indoor cannabis cultivation facilities from
4 CEQA—facilities that have the potential to cause significant impacts on the environment. EDP has
5 reviewed thousands of pages of public records regarding indoor cannabis operations in the City.
6 EDP is not aware of the City ever requiring CEQA review for an indoor cannabis cultivation
7 facility. Thus, the City has a pattern and practice of evading CEQA review for all indoor cannabis
8 cultivation facilities.

9 76. Respondents abused their discretion and failed to proceed in the manner required by
10 CEQA by approving hundreds of cannabis cultivation projects that have the potential to cause
11 significant environmental impacts including energy use, greenhouse gas emissions, diesel particulate
12 matter emissions, traffic, odor, noise, and hazardous waste. The City’s abuse of discretion and failure to
13 proceed in the manner required by law is prejudicial. Thus, the City’s pattern and practice of evading
14 CEQA must be declared unlawful and enjoined.

15 77. There is a present and actual existing controversy between EDP and Respondents as
16 to the legality of Respondents’ ongoing pattern and practice of evading CEQA review of cannabis
17 cultivation projects. Petitioner contends that Respondents are in violation CEQA in each of the
18 respects alleged above. Respondents have not agreed to remedy the violations despite Petitioner’s
19 attempt to resolve this matter outside of the judicial context. Instead, Respondents believe that
20 their conduct and repeated pattern of conduct is in accord with the law. As Supervising Deputy
21 City Attorney Brian Mulry said in an email to counsel for EDP: Respondents’ actions were “made
22 pursuant to, and consistent with, City Code and State law requirements.”

23 78. Petitioner is entitled to a judicial determination of the rights and obligations of
24 Respondents with respect to their pattern and practice of exempting cannabis cultivation
25 projects from CEQA.

26 **PRAYER FOR RELIEF**

27 WHEREFORE, Environmental Democracy Project prays for judgment as follows:
28

1 1. For alternative and peremptory writs of mandate directing Respondents to vacate and set
2 aside their decisions to approve I Metals, Inc and DSF Management, Inc. without complying with
3 CEQA;

4 2. For alternative and peremptory writs of mandate directing Respondents to comply with
5 the requirements of CEQA and the CEQA Guidelines and take any other action as required by Public
6 Resources Code section 21168.9;

7 3. For a temporary stay, temporary restraining order, and preliminary and permanent
8 injunctions restraining Respondents and their representative agents, servants, and employees, and all
9 others acting in concert with Respondents on their behalf, from taking any action to authorize cannabis
10 cultivation facilities pending full compliance with the requirements of CEQA, the CEQA Guidelines,
11 and State law;

12 4. For declaratory relief stating that Respondents' pattern and practice of exempting all
13 indoor cannabis cultivation facilities from CEQA is unlawful;

14 5. For costs of the suit;

15 6. For an order awarding Environmental Democracy Project its attorneys' fees under Code
16 of Civil Procedure section 1021.5 and other applicable authority; and

17 7. For such other and further relief as the Court deems just and proper.
18

19 DATED: October 21, 2022

WILLIAMS ENVIRONMENTAL

20
21 By: /s/ Lucas Williams

22 LUCAS WILLIAMS

23 Attorneys for Petitioner and Plaintiff
24 ENVIRONMENTAL DEMOCRACY PROJECT
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Executed at Oakland, California on October 21, 2022.

21

EXHIBIT A



CITY OF OAKLAND
Office of the City Administrator

SPECIAL ACTIVITY PERMITS • 1 Frank H. Ogawa Plaza, 1st Floor • Oakland, CA 94612

**PRELIMINARY CHECKLIST FOR CANNABIS OPERATORS PURSUANT TO THE
CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA)**

APPLICANT NAME: YONG GUANG YE

DBA: I Metal inc

APPLICANT CONTACT INFORMATION:



PROPERTY OWNER AND APPLICANT INFORMATION
(Only complete if different from Applicant)
Original signatures or clear & legible copies are required.

Property Owner: YONG GUANG YE

Property Owner Mailing Address: 60 Hegenberger Pl

City/State: OAKland CA Zip: 94621

I authorize the applicant indicated above to submit the application on my behalf.

Signature of Property Owner: Yong Guang Ye

I. SITE INFORMATION

Project Address: 60 Hegenberger Pl Oakland CA 94621

Project APN: 44-5020-5-16

Project Overview and Description:

Indoor Cultivation

What is the approximate square footage for **each** cannabis activity at your proposed site?

Delivery _____

Distribution _____

Indoor Cultivation 2400 SQF

Outdoor Cultivation _____

Volatile Manufacturing _____

Non-Volatile Manufacturing _____

Transporter _____

Lab Testing _____

What is the approximate square footage of the lot on which the cannabis activity will take place?

8712 SQF

Is the project new construction or rehabilitation of an existing facility?

☒ New Construction

☐ Rehabilitation of an existing facility

If rehabilitation, is the number of units or square footage being changed? ☐ Yes ☐ No (Explain if yes)

What was the prior use of the property/premises?

Farm agriculture Food product

If your application is approved, will there be multiple cannabis operators located at the property?

☐ Yes ☒ No

If yes, how many and what is the approximate total square-footage for all cannabis operators?

Have you incorporated any measures into your project to mitigate or reduce potential environmental impacts? ☒ Yes ☐ No ☐ Unknown

If so, list them here. (Examples include enrollment in clean energy programs, tree preservation plans, creek restoration plans, and open space easements.)

Will enroll in "renewable 100 option" program.

+

Air filter for any odors.

Will the Project utilize a carbon dioxide generator as part of your cannabis facility? ☐ Yes ☒ No

If yes, will the carbon dioxide generator emit carbon dioxide into the air and at what levels? Please explain and provide consultant report if necessary.

II. HISTORIC RESOURCES

Is the project site located within a historic district, or contain a historic building? ☐ Yes ☒ No
(Historic information can be obtained from the Planning & Zoning Division at (510) 238-6879)

a) What is the OCHS (Oakland Cultural Heritage Survey) rating of the building?

F3

b) If so, is the building proposed for demolition or alteration?

no

c) Is there a California Office of Historic Preservation DPR Form 523 with rating of 1 to 5?

no

Note: Any modification to a historic building will require additional CEQA analysis and may not be eligible for a CEQA exemption.

III. HAZARDOUS MATERIALS

Is the subject property located on a State List of sites containing hazardous materials compiled pursuant to Section 65962.5 of the Government Code? ☐ Yes ☒ No
(Cortese list, among others; more information can be obtained from California EPA at https://www.dlsc.ca.gov/SiteCleanup/Cortese_List.cfm)

a) If so, has the site been remediated? _____

- b) Is there a "Closure Letter" from the appropriate regulatory Agency? _____
- c) If not remediated, is there an approved Remedial Action Plan (RAP)? _____
- d) If not, has a RAP been submitted? _____

IV. OTHER

Is the applicant aware of any other environmental conditions/impacts likely to require further CEQA or National Environmental Policy Act (NEPA) review, such as:

- i. Sensitive environments, e.g., creeks-wetlands, seismically active areas ☐ Yes ☒ No
- ii. Peculiar or unique characteristics of the site, the project, or adjacent uses ☐ Yes ☒ No

Please explain:

I understand that review and approval of this preliminary CEQA checklist does not constitute approval for any administrative review, conditional use permit, variance, or exception from any other City regulations which are not specifically the subject of this application. I understand further that I remain responsible for satisfying requirements of any private restrictions or covenants appurtenant to the property. I understand that the Applicant and/or Owner phone number listed above will be included on any public notice, if any, for the project.

I certify that I am the applicant and that the information submitted with this preliminary CEQA checklist is true and accurate to the best of my knowledge and belief. I understand that the City is not responsible for inaccuracies in information presented, and that inaccuracies may result in the revocation of any permits as determined by the City. I further certify that I am the owner or purchaser (or option holder) of the property involved in this application, or the lessee or agent fully authorized by the owner to make this submission, as indicated by the owner's signature above.

I certify that statements, if any, made to me about the time it takes to review and process this application are general. I am aware that the City has attempted to request everything necessary for an accurate and complete CEQA review of my proposal; however, that after this preliminary CEQA checklist and/or application has been submitted and reviewed by the City Administrator's Office, it may be necessary for the City to request additional information and/or materials. I understand that any failure to submit the additional information and/or materials in

a timely manner may render the application inactive and that periods of inactivity do not count towards statutory time limits applicable to the processing of this application.

I HEREBY CERTIFY, UNDER PENALTY OF PERJURY, THAT ALL THE INFORMATION PROVIDED ON THIS APPLICATION IS TRUE AND CORRECT.

Signature of Applicant: Yong Guang Ye

Date: April-20-2022

**FOR
OFFICE
USE
ONLY**

CEQA Review done by: _____ Date: _____

Findings: ☐ Exempt ☐ Needs Additional Information

Notice of Exemption completed by: _____ Date: _____

CITY OF OAKLAND



DALZIEL BUILDING • 250 FRANK H. OGAWA PLAZA • SUITE 3315 • OAKLAND, CALIFORNIA 94612

Planning and Building Department
Bureau of Planning

(510) 238-3941
FAX (510) 238-6538
TDD (510) 238-3254

NOTICE OF EXEMPTION

TO: Alameda County Clerk
1106 Madison Street
Oakland, CA 94612

Project Title: Cannabis Cultivation @ 60 Hegenberger Pl.

Project Applicant: Yong Guang Ye dba iMetals

Project Location: 60 Hegenberger Pl. (APN: 44-5020-5-16)

Project Description: Applicant has proposed approximately 2,400-sq. ft. of a 8,712 sq. ft.-facility for indoor cannabis cultivation.

Exempt Status:

Statutory Exemptions

☐ Ministerial {Sec.15268}

Categorical Exemptions

☒ Existing Facilities {Sec.15301}

☐ Small Structures {Sec.15303}

Other

☒ Projects consistent with a community plan, general plan or zoning {Sec. 15183(f)}

☐ _____ (Sec. _____)

Reason why project is exempt:

The Applicant is proposing to operate as a indoor cannabis cultivator in an existing commercial facility and will use non-fossil fuel services to power the operation. Further, the use of indoor cannabis cultivation is permitted at the discretion of the City Administrator under Chapter 5.81 of the Oakland Municipal Code. Thus, the proposed use will not have a significant effect on the environment. **Lead Agency:** City of Oakland, Planning and Building Department, 250 Frank H. Ogawa Plaza, Suite 2114, Oakland, CA 94612 **Division/Contact Person:** Bureau of Planning / Zoning / Sandra Smith, Bureau of Operations **Phone:** 510-238-3239.



Signature (Ed Manasse, Environmental Review Officer)

9/16/2022

Date

Pursuant to Section 711.4(d)(1) of the Fish and Game Code, statutory and categorical exemptions are also exempt from Department of Fish and Game filing fees.

***ENVIRONMENTAL DECLARATION
(CALIFORNIA FISH AND GAME CODE SECTION 711.4)**

: FOR COUNTY CLERK USE ONLY

LEAD AGENCY NAME AND ADDRESS:

CITY OF OAKLAND
Bureau of Planning
250 Frank H. Ogawa Plaza, Suite 2114
Oakland, CA 94612

APPLICANT: Yong Guang Ye
60 Hegenberger Pl.
Oakland, CA 94621

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**CLASSIFICATION OF ENVIRONMENTAL DOCUMENT:
(PLEASE MARK ONLY ONE CLASSIFICATION)**

1. NOTICE OF EXEMPTION / STATEMENT OF EXEMPTION

☒ A – STATUTORILY OR CATEGORICALLY EXEMPT

\$50.00 – COUNTY CLERK HANDLING FEE

1. NOTICE OF DETERMINATION (NOD)

☐ A – NEGATIVE DECLARATION (OR MITIGATED NEG. DEC.)

\$2,406.75 - STATE FILING FEE

\$50.00 (Fifty Dollars) – COUNTY CLERK FILING FEE

☐ B – ENVIRONMENTAL IMPACT REPORT

\$3,343.25 – STATE FILING FEE

\$50.00 (Fifty Dollars) – CLERK'S FEE

3. ☐ **OTHER:** _____

****A COPY OF THIS FORM MUST BE COMPLETED AND SUBMITTED WITH EACH COPY OF AN ENVIRONMENTAL DECLARATION BEING FILED WITH THE ALAMEDA COUNTY CLERK.*****

BY MAIL FILINGS:

PLEASE INCLUDE FIVE (5) COPIES OF ALL NECESSARY DOCUMENTS AND TWO (2) SELF-ADDRESSED ENVELOPES.

IN PERSON FILINGS:

PLEASE INCLUDE FIVE (5) COPIES OF ALL NECESSARY DOCUMENTS AND ONE (1) SELF-ADDRESSED ENVELOPE.

ALL APPLICABLE FEES MUST BE PAID AT THE TIME OF FILING.

FEES ARE EFFECTIVE JANUARY 1, 2020

MAKE CHECKS PAYABLE TO: ALAMEDA COUNTY CLERK



CITY OF OAKLAND
Office of the City Administrator

SPECIAL ACTIVITY PERMITS • 1 Frank H. Ogawa Plaza, 1st Floor • Oakland, CA 94612

**PRELIMINARY CHECKLIST FOR CANNABIS OPERATORS PURSUANT TO THE
CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA)**

APPLICANT NAME: Richard Lei

DBA: DSF Management Inc

APPLICANT CONTACT INFORMATION:



PROPERTY OWNER AND APPLICANT INFORMATION
(Only complete if different from Applicant)
Original signatures or clear & legible copies are required.


Property Owner: Magic CUP LLC

Property Owner Mailing Address: 740 Kevin Court

City/State: Oakland, California Zip: 94621



I authorize the applicant indicated above to submit the application on my behalf.

Signature of Property Owner: 

I. SITE INFORMATION

Project Address: 740 Kevin Court, Oakland, California 94621

Project APN: 041-391000400

Project Overview and Description:

Indoor Cannabis Cultivation Facility

What is the approximate square footage for **each** cannabis activity at your proposed site?

| | |
|---|----------------------------------|
| Delivery _____ | Distribution _____ |
| Indoor Cultivation 7280 SF _____ | Outdoor Cultivation _____ |
| Volatile Manufacturing _____ | Non-Volatile Manufacturing _____ |
| Transporter _____ | Lab Testing _____ |

What is the approximate square footage of the lot on which the cannabis activity will take place?

Is the project new construction or rehabilitation of an existing facility?

☐ New Construction ☒ Rehabilitation of an existing facility

If rehabilitation, is the number of units or square footage being changed? ☐ Yes ☒ No (Explain if yes)

What was the prior use of the property/premises?

Warehouse

If your application is approved, will there be multiple cannabis operators located at the property?

☐ Yes ☒ No

If yes, how many and what is the approximate total square-footage for all cannabis operators?

Have you incorporated any measures into your project to mitigate or reduce potential environmental impacts? ☐ Yes ☒ No ☐ Unknown

If so, list them here. (Examples include enrollment in clean energy programs, tree preservation plans, creek restoration plans, and open space easements.)

Will the Project utilize a carbon dioxide generator as part of your cannabis facility? ☐ Yes ☐ No

If yes, will the carbon dioxide generator emit carbon dioxide into the air and at what levels? Please explain and provide consultant report if necessary.

There will be Recepture system and monitors
Also, Bay Alarms has security measures and alarms.

II. HISTORIC RESOURCES

Is the project site located within a historic district, or contain a historic building? ☐ Yes ☒ No
(Historic information can be obtained from the Planning & Zoning Division at (510) 238-6879)

a) What is the OCHS (Oakland Cultural Heritage Survey) rating of the building?

b) If so, is the building proposed for demolition or alteration?

c) Is there a California Office of Historic Preservation DPR Form 523 with rating of 1 to 5?

Note: Any modification to a historic building will require additional CEQA analysis and may not be eligible for a CEQA exemption.

III. HAZARDOUS MATERIALS

Is the subject property located on a State List of sites containing hazardous materials compiled pursuant to Section 65962.5 of the Government Code? ☐ Yes ☒ No
(Cortese list, among others; more information can be obtained from California EPA at https://www.dtsc.ca.gov/SiteCleanup/Cortese_List.cfm)

a) If so, has the site been remediated? _____

- b) Is there a "Closure Letter" from the appropriate regulatory Agency? _____
- c) If not remediated, is there an approved Remedial Action Plan (RAP)? _____
- d) If not, has a RAP been submitted? _____

IV. OTHER

Is the applicant aware of any other environmental conditions/impacts likely to require further CEQA or National Environmental Policy Act (NEPA) review, such as:

- i. Sensitive environments, e.g., creeks-wetlands, seismically active areas ☐ Yes ☐ No
- ii. Peculiar or unique characteristics of the site, the project, or adjacent uses ☐ Yes ☐ No

Please explain:

Not Applicable

I understand that review and approval of this preliminary CEQA checklist does not constitute approval for any administrative review, conditional use permit, variance, or exception from any other City regulations which are not specifically the subject of this application. I understand further that I remain responsible for satisfying requirements of any private restrictions or covenants appurtenant to the property. I understand that the Applicant and/or Owner phone number listed above will be included on any public notice, if any, for the project.

I certify that I am the applicant and that the information submitted with this preliminary CEQA checklist is true and accurate to the best of my knowledge and belief. I understand that the City is not responsible for inaccuracies in information presented, and that inaccuracies may result in the revocation of any permits as determined by the City. I further certify that I am the owner or purchaser (or option holder) of the property involved in this application, or the lessee or agent fully authorized by the owner to make this submission, as indicated by the owner's signature above.

I certify that statements, if any, made to me about the time it takes to review and process this application are general. I am aware that the City has attempted to request everything necessary for an accurate and complete CEQA review of my proposal; however, that after this preliminary CEQA checklist and/or application has been submitted and reviewed by the City Administrator's Office, it may be necessary for the City to request additional information and/or materials. I understand that any failure to submit the additional information and/or materials in

a timely manner may render the application inactive and that periods of inactivity do not count towards statutory time limits applicable to the processing of this application.

I HEREBY CERTIFY, UNDER PENALTY OF PERJURY, THAT ALL THE INFORMATION PROVIDED ON THIS APPLICATION IS TRUE AND CORRECT.

Signature of Applicant: 

Date: 7/11/2022

**FOR
OFFICE
USE
ONLY**

CEQA Review done by: _____ Date: _____

Findings: ☐ Exempt ☐ Needs Additional Information

Notice of Exemption completed by: _____ Date: _____

CITY OF OAKLAND



DALZIEL BUILDING • 250 FRANK H. OGAWA PLAZA • SUITE 3315 • OAKLAND, CALIFORNIA 94612

Planning and Building Department
Bureau of Planning

(510) 238-3941
FAX (510) 238-6538
TDD (510) 238-3254

NOTICE OF EXEMPTION

TO: Alameda County Clerk
1106 Madison Street
Oakland, CA 94612

Project Title: Cannabis Cultivation @ 740 Kevin Ct.

Project Applicant: Richard Lei dba DSF Management Inc.

Project Location: 740 Kevin Ct. (APN: 041-391000400)

Project Description: Applicant has proposed approximately 7,280-sq. ft. of a 18,000 sq. ft. facility for indoor cannabis cultivation.

Exempt Status:

Statutory Exemptions

☐ Ministerial {Sec.15268}

Categorical Exemptions

☒ Existing Facilities {Sec.15301}

☐ Small Structures {Sec.15303}

Other

☒ Projects consistent with a community plan, general plan or zoning {Sec. 15183(f)}

☐ _____ (Sec. _____)

Reason why project is exempt:

The Applicant is proposing to operate as a indoor cannabis cultivator in an existing commercial facility and will use non-fossil fuel services to power the operation. Further, the use of indoor cannabis cultivation is permitted at the discretion of the City Administrator under Chapter 5.81 of the Oakland Municipal Code. Thus, the proposed use will not have a significant effect on the environment. **Lead Agency:** City of Oakland, Planning and Building Department, 250 Frank H. Ogawa Plaza, Suite 2114, Oakland, CA 94612 **Division/Contact Person:** Bureau of Planning / Zoning / Sandra Smith, Bureau of Operations **Phone:** 510-238-3239.

Signature (Ed Manasse, Environmental Review Officer)

Date

Pursuant to Section 711.4(d)(1) of the Fish and Game Code, statutory and categorical exemptions are also exempt from Department of Fish and Game filing fees.

***ENVIRONMENTAL DECLARATION
(CALIFORNIA FISH AND GAME CODE SECTION 711.4)**

: FOR COUNTY CLERK USE ONLY

LEAD AGENCY NAME AND ADDRESS:

CITY OF OAKLAND
Bureau of Planning
250 Frank H. Ogawa Plaza, Suite 2114
Oakland, CA 94612

APPLICANT: Richard Lei dba DSF Management Inc.
740 Kevin Ct.
Oakland, CA 94621

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**CLASSIFICATION OF ENVIRONMENTAL DOCUMENT:
(PLEASE MARK ONLY ONE CLASSIFICATION)**

1. NOTICE OF EXEMPTION / STATEMENT OF EXEMPTION

☒ A – STATUTORILY OR CATEGORICALLY EXEMPT

\$50.00 – COUNTY CLERK HANDLING FEE

1. NOTICE OF DETERMINATION (NOD)

☐ A – NEGATIVE DECLARATION (OR MITIGATED NEG. DEC.)

\$2,406.75 - STATE FILING FEE

\$50.00 (Fifty Dollars) – COUNTY CLERK FILING FEE

☐ B – ENVIRONMENTAL IMPACT REPORT

\$3,343.25 – STATE FILING FEE

\$50.00 (Fifty Dollars) – CLERK'S FEE

3. ☐ **OTHER:** _____

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IN PERSON FILINGS:

PLEASE INCLUDE FIVE (5) COPIES OF ALL NECESSARY DOCUMENTS AND ONE (1) SELF-ADDRESSED ENVELOPE.

ALL APPLICABLE FEES MUST BE PAID AT THE TIME OF FILING.

FEES ARE EFFECTIVE JANUARY 1, 2020

MAKE CHECKS PAYABLE TO: ALAMEDA COUNTY CLERK

EXHIBIT B

October 21, 2022

By Email and U.S. Priority Mail

City of Oakland Office of the City Administrator
ED Reiskin, City Administrator
1 Frank H. Ogawa Plaza
Oakland, CA 94612
cityadministratorsoffice@oaklandca.gov

**Re: Notice of Commencement of CEQA Litigation Challenging the City's
Approval of Indoor Cannabis Cultivation Facilities**

Dear Mr. Reiskin:

This letter is to notify you that the Environmental Democracy Project will file suit against the City of Oakland Office of the City Administrator for failure to observe the requirements of the California Environmental Quality Act ("CEQA"), Public Resources Code section 21000 et seq., the CEQA Guidelines, California Code of Regulations section 15000 et seq., and state law in approving indoor cannabis cultivation operations in East Oakland without conducting environmental review and in making associated approvals. This notice is given pursuant to Public Resources Code section 21167.5.

Please note that, under Public Resources Code section 21167.6, the record of proceedings for the Office of the City Administrator's actions includes, among other items, all "internal agency communications, including staff notes and memoranda related to the project or to compliance with [CEQA]." Because these materials related to the indoor cannabis cultivation operations in East Oakland and associated approvals are part of the administrative record for the lawsuit to be filed by the Environmental Democracy Project, the Office of the City Administrator may not destroy or delete such documents prior to preparation of the record in this case.

Respectfully,



Lucas Williams
Attorney for Environmental Democracy
Project

October 21, 2022

By Email and U.S. Priority Mail

City of Oakland Office of the Mayor
Mayor Libby Schaaf
1 Frank H. Ogawa Plaza #3
Oakland, CA 94612
officeofthemayor@oaklandca.gov

**Re: Notice of Commencement of CEQA Litigation Challenging the City's
Approval of Indoor Cannabis Cultivation Facilities**

Dear Mayor Schaaf:

This letter is to notify you that the Environmental Democracy Project will file suit against the City of Oakland for failure to observe the requirements of the California Environmental Quality Act ("CEQA"), Public Resources Code section 21000 et seq., the CEQA Guidelines, California Code of Regulations section 15000 et seq., and state law in approving indoor cannabis cultivation operations in East Oakland without conducting environmental review and in making associated approvals. This notice is given pursuant to Public Resources Code section 21167.5.

Please note that, under Public Resources Code section 21167.6, the record of proceedings for the City of Oakland's actions includes, among other items, all "internal agency communications, including staff notes and memoranda related to the project or to compliance with [CEQA]." Because these materials related to the indoor cannabis cultivation operations in East Oakland and associated approvals are part of the administrative record for the lawsuit to be filed by the Environmental Democracy Project, the City of Oakland may not destroy or delete such documents prior to preparation of the record in this case.

Respectfully,



Lucas Williams
Attorney for Environmental Democracy
Project

cc: BJParker@oaklandcityattorney.org
BMulry@oaklandcityattorney.org
claims@oaklandcityattorney.org

October 21, 2022

By Email and U.S. Priority Mail

City of Oakland Planning & Building Department
Director William Gilchrist
250 Frank H. Ogawa Plaza, Ste. 2114
Oakland, CA 94612
wgilchrist@oaklandca.gov

**Re: Notice of Commencement of CEQA Litigation Challenging the City's
Approval of Indoor Cannabis Cultivation Facilities**

Dear Director Gilchrist:

This letter is to notify you that the Environmental Democracy Project will file suit against the City of Oakland Planning & Building Department for failure to observe the requirements of the California Environmental Quality Act ("CEQA"), Public Resources Code section 21000 et seq., the CEQA Guidelines, California Code of Regulations section 15000 et seq., and state law in approving indoor cannabis cultivation operations in East Oakland without conducting environmental review and in making associated approvals. This notice is given pursuant to Public Resources Code section 21167.5.

Please note that, under Public Resources Code section 21167.6, the record of proceedings for the City of Oakland Planning & Building Department's actions includes, among other items, all "internal agency communications, including staff notes and memoranda related to the project or to compliance with [CEQA]." Because these materials related to the indoor cannabis cultivation operations in East Oakland and associated approvals are part of the administrative record for the lawsuit to be filed by the Environmental Democracy Project, the City of Oakland Planning & Building Department may not destroy or delete such documents prior to preparation of the record in this case.

Respectfully,



Lucas Williams
Attorney for Environmental Democracy
Project

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ENVIRONMENTAL DEMOCRACY PROJECT

8 **SUPERIOR COURT OF THE STATE OF CALIFORNIA**
9 **COUNTY OF ALAMEDA**

10 ENVIRONMENTAL DEMOCRACY
11 PROJECT, a non-profit corporation,

12 Petitioner and Plaintiff,

13 v.

14 CITY OF OAKLAND; CITY OF OAKLAND
15 PLANNING AND BUILDING
16 DEPARTMENT; CITY OF OAKLAND
17 OFFICE OF THE CITY ADMINISTRATOR;
and DOES 1 THROUGH 20,

18 Respondents and Defendants.

19 I METALS, INC, a California corporation; and
20 DSF MANAGEMENT, INC., a California
corporation,

21 Real Parties In Interest.
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Case No.

PROOF OF SERVICE

CEQA CASE

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I am a citizen of the United States and employed in the County of Alameda, State of California. I am over the age of eighteen (18) years and not a party to this action. My business address is 490 43rd Street, #23, Oakland, CA 94609 and my email address is jake@williams-envirolaw.com.

NOTICE OF CEQA LITIGATION

City of Oakland Office of the City Administrator
ED Reiskin, City Administrator
1 Frank H. Ogawa Plaza
Oakland, CA 94612
cityadministratorsoffice@oaklandca.gov

City of Oakland Planning & Building Department
Director William Gilchrist
250 Frank H. Ogawa Plaza, Ste. 2114
Oakland, CA 94612
wgilchrist@oaklandca.gov
emanasse@oaklandca.gov

1 I declare under penalty of perjury under the laws of the State of California that the
2 foregoing is true and correct.

3 Executed on October 21, 2022 at Oakland, California.
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5

6 /s/ Jacob Janzen
7 Jacob Janzen
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EXHIBIT C

HOTBOXING THE POLAR BEAR: THE ENERGY AND CLIMATE IMPACTS OF INDOOR MARIJUANA CULTIVATION[†]

GINA S. WARREN*

ABSTRACT

Indoor marijuana cultivation is currently legal—at least at some level—in all but eight states in the United States. This Article explores the energy and climate harms caused by the budding industry and recommends that state regulators and public utility companies work together to ensure that those harms are mitigated. Indoor marijuana cultivation has an energy demand that rivals data centers. With energy intensities around 2,000 watts per minute, it consumes between 50 and 200 times more than an average office building and 66 times more than an average home. And, given the lucrative nature of the industry and the movement toward legalization, its energy demand is projected to grow exponentially over the next several years. The problem is that this growth is exacerbating an already strained energy delivery system and increasing greenhouse gas emissions due to a fossil-fuel reliant grid. While moving cultivation outdoors would be the most effective way of reducing these harms, outdoor grows are prohibited, or limited, in many states and by the federal government. A small number of states and localities, however, have recognized the energy-related harms and are working to mitigate them through their licensing frameworks. This Article discusses California’s new requirement to limit energy intensity or to require carbon offset purchases, Massachusetts’s and Illinois’s mandates for lighting efficiency, and Boulder, Colorado’s renewable energy requirements and carbon offset funds. While these regulatory requirements can result in significant out-of-pocket costs for indoor growers, this Article recommends all states that legalize indoor cultivation implement policies to address harms caused by overconsumption of fossil-fuel-based energy. Furthermore, public utility companies can play a role in helping offset compliance costs and incentivizing best practices through push and pull policies that can provide incentives for energy-efficient technology, grants for studies to fully understand

[†] 2020 © Gina S. Warren.

* George Butler Research Professor, Professor of Law, and Codirector of the Environment, Energy, and Natural Resources Center, University of Houston Law Center. Special thanks to Jay Wexler for inviting me to present this Article at the *Boston University Law Review*’s Symposium, “Marijuana Law 2020: Lessons from the Past, Ideas for the Future.” Thank you to my copanelists Jessica Owley and Ryan Stoa for their lively discussion and feedback.

the industry's energy demand and for individualized funding of energy-efficient technology, and taxes or fees for overconsumption beyond a set baseline.

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INTRODUCTION

This Article discusses the energy intensity of indoor marijuana cultivation and its harms. It looks at some of the lessons learned (or perhaps not learned) over the last five years of marijuana legalization and offers some ideas for moving forward. While more studies are needed, it appears that commercial indoor marijuana cultivation has an energy intensity level that rivals Internet data centers.¹ It requires twenty-four-hour climate control and, even at a residential level, is a significant consumer of electricity due to lighting requirements and temperature and climate control.² As more states legalize marijuana cultivation, there is a concern that, if left unbridled, this electricity demand will not only result in grid vulnerabilities and blackouts but also exacerbate climate change and contribute to global warming.

Part I discusses the energy demand of indoor cultivation and the prediction for future growth. Only eight states completely prohibit marijuana within their borders.³ The remaining states have either fully or partially legalized the once illicit plant.⁴ Furthermore, the industry has proven to be quite lucrative, and it is predicted to become fully legal in the entire United States in the future.⁵ As more states legalize marijuana cultivation and as states continue to require indoor cultivation and limit outdoor grows, energy demand will continue to rise.

Part II outlines two immediate concerns with the current and projected electricity demand: (1) electric grid vulnerability and (2) greenhouse gas (“GHG”) emissions. The U.S. electric grid is already overloaded and running on an antiquated delivery system established several decades ago.⁶ Utilities have disclosed that areas with high indoor marijuana cultivation have experienced blackouts and premature equipment replacement due to the stress on the system.⁷

¹ KELLY CRANDALL, EQ RSCH., LLC, A CHRONIC PROBLEM: TAMING ENERGY COSTS AND IMPACTS FROM MARIJUANA CULTIVATION 5 (2016), <https://eq-research.com/wp-content/uploads/2016/09/A-Chronic-Problem.pdf> [<https://perma.cc/DY5M-EGYS>].

² GRID20/20, INC., IS THE POWER GRID GOING TO POT? 5-6 (2018), https://www.grid2020.com/site/download?filename=GRID2020_WP_Is_The_Power_Grid_Going_To_Pot.pdf [<https://perma.cc/R3GW-2XA7>].

³ Eli McVey, *US Cannabis Industry's Economic Impact Could Hit \$130 Billion by 2024*, MARIJUANA BUS. DAILY (July 21, 2020), <https://mjbizdaily.com/chart-us-cannabis-industrys-economic-impact-could-hit-130-billion-by-2024/> [<https://perma.cc/464U-9U9N>].

⁴ *Map of Marijuana Legality by State*, DISA, <https://disa.com/map-of-marijuana-legality-by-state> [<https://perma.cc/G5ER-V3SG>] (last updated Apr. 2021).

⁵ McVey, *supra* note 3.

⁶ GRID20/20, INC., *supra* note 2, at 3-4.

⁷ Gordon Friedman, *Pot Grows Strain the Electrical Grid*, STATESMAN J. (Salem, Or.), Nov. 5, 2015, at A1; Martha Davis, *Pot Is Not Green*, T&D WORLD (Feb. 13, 2020), <https://www.tdworld.com/utility-business/article/21122891/pot-is-not-green>; *see also* GRID20/20, INC., *supra* note 2, at 8-9 (discussing need to replace transformers, sensors, and other electricity delivery infrastructure to accommodate the unforeseeable energy demands such as marijuana legalization).

In addition to local grid concerns, the marijuana industry also contributes to global GHG emissions due to the United States's reliance on fossil fuels for the majority of its electricity generation.⁸ This is especially problematic during a time when the world needs to decarbonize its electricity delivery and reduce overall energy consumption.

Part III looks at some of the lessons from the past five years and discusses state and local licensing schemes that attempt to mitigate some of the energy intensity of the indoor marijuana industry. Massachusetts and Illinois have licensing schemes that focus on energy-efficient lighting and HVAC systems.⁹ California's framework seeks to limit overall energy emissions,¹⁰ and both the City of Boulder and Boulder County in Colorado tend to focus on renewable energy mandates and payment of offsets.¹¹ While moving cultivation outdoors would no doubt be the best option from an energy and climate perspective, until that occurs, Part IV recommends that states continue (or begin) to look at state licensing schemes as a means to control the amount and type of energy consumed by indoor cultivators. In addition, Part IV recommends that state-regulated utilities work with indoor cultivators to help offset increased compliance costs, better understand their energy use, incentivize clean energy and energy-efficient technology, and penalize cultivators who consume above a set baseline.

The Article concludes that it is time for states and state utilities to protect the energy delivery system and to mitigate unfettered GHG emissions. First, states should consider moving cultivation outdoors. While outdoor cultivation has its own set of environmental concerns that would need to be addressed, it would go a long way toward alleviating its energy demands. Second, states that do require or allow indoor cultivation need to enact a stringent framework that requires

⁸ *What Is U.S. Electricity Generation by Energy Source?*, U.S. ENERGY INFO. ADMIN., <https://www.eia.gov/tools/faqs/faq.php?id=427&t=3> [https://perma.cc/U44Z-EPWV] (last updated Mar. 5, 2021).

⁹ MASS. CANNABIS CONTROL COMM'N, ENERGY AND ENVIRONMENT COMPILED GUIDANCE 4 (2020), https://mass-cannabis-control.com/wp-content/uploads/200825_Energy_and_Environment_Compiled_Guidance.pdf [https://perma.cc/Y42S-RV59]; *Illinois Has the Greenest Cannabis Bill in the Country*, ILL. ENV'T COUNCIL (May 31, 2019), <https://ilenviro.org/illinois-just-passed-the-greenest-cannabis-law-in-the-country/> [https://perma.cc/2BQ9-CB7X].

¹⁰ See Nate Seltenrich, *Most States Legalizing Marijuana Have Yet to Grapple with Energy Demand*, ENERGY NEWS NETWORK (June 27, 2019), <https://energynews.us/2019/06/27/west/most-states-legalizing-marijuana-have-yet-to-grapple-with-energy-demand/> [https://perma.cc/2U9T-X38C].

¹¹ BOULDER, COLO., MUNICIPAL CODE § 6-14-8(i), -9(g) (2021) (requiring all commercially licensed marijuana cultivators to report their energy usage and to comply with renewable energy targets); *Cannabis Energy Impact Offset Fund*, BOULDER CNTY., <https://www.bouldercounty.org/environment/sustainability/marijuana-offset-fund/> [https://perma.cc/5SAE-WUVH] (last visited Apr. 13, 2021) (requiring commercial cultivators to utilize renewable energy or pay surcharge per kilowatt-hour of consumption).

utilization of clean energy or the payment of an offset fee substantial enough to motivate reliance on clean energy. Third, state utilities should educate indoor cultivators about their energy intensity. Electricity bills are some of the most expensive costs for cultivators. Utilities can use push and pull policies to educate and incentivize their customers to convert to more energy-efficient technology and processes.

I. ENERGY DEMAND OF INDOOR CULTIVATION

Indoor marijuana cultivation has many benefits, including growers' abilities to carefully control and monitor the growing conditions.¹² However, it has one major drawback: it is extremely energy intensive, requiring twenty-four-hour climate control. Exactly how much electricity does the indoor marijuana cultivation industry require? We know it is significant, but we do not know exactly how much. The reason we do not have this information is twofold: First, given the historical illegality of indoor cultivation, growers have not necessarily been forthcoming with their energy use. Second, as indoor cultivation has been legalized, states have mostly ignored the energy issues that go along with indoor cultivation, and they have failed to mandate or even incentivize studies that would provide a more thorough understanding of the industry's energy intensity.¹³

What we do know with certainty is that it takes a lot of electricity to run the equipment needed to sustain an around-the-clock cultivation cycle.¹⁴ "[I]ndoor grows can have energy intensities of 2,000 [watts per minute]," which is similar to the energy intensity of data centers or somewhere between 50 and 200 times more than the average office building.¹⁵ A 5,000 square-foot facility uses 66 times more energy than a house from the same area.¹⁶ Even growing four plants indoors is equivalent to powering twenty-nine refrigerators.¹⁷

¹² Christopher D. Strunk & Mackenzie S. Schoonmaker, *How Green Is the "Green Rush"?* *Recognizing the Environmental Concerns Facing the Cannabis Industry*, 21 VT. J. ENV'T L. 506, 512 (2020) (discussing litigation risks of contaminated cannabis, in part due to patchwork of state and local environmental laws).

¹³ CRANDALL, *supra* note 1, at 5.

¹⁴ Kahn R. Wiedis, Comment, *High Time to Go Green: Environmental Impact of Marijuana Legalization*, 31 VILL. ENV'T L.J. 193, 203-04 (2019) (discussing energy intensity of indoor growing and desire of cultivators to "recreate outdoor conditions").

¹⁵ CRANDALL, *supra* note 1, at 5.

¹⁶ Davis, *supra* note 7 ("In 2015, the average electric consumption of a 5,000 sq. ft. facility in Boulder County, Colorado, was 41,808 kWh per month, while the average household in the same area was 630 kWh.").

¹⁷ GRID20/20, INC., *supra* note 2, at 5. Residential growing is increasingly becoming a concern for utilities. Even on a small scale, if everyone in the neighborhood is growing their own plants, it can make a significant impact on the energy delivery system. *Id.* at 5-6.

The three main areas of energy intensity for indoor cultivation include lighting, moisture control, and temperature control.¹⁸ Lighting tends to be the largest source of energy consumption at between 38-86%, depending on the types of lights used.¹⁹ LED lightbulbs, for example, are less energy intensive than incandescent bulbs, and a simple switch from conventional lights to LEDs is an easy way to reduce overall energy consumption.²⁰ Significant electricity is also required for moisture control and temperature control—for cooling and heating—of the facility.²¹

In 2012, it was estimated that the industry consumed some 20 billion kilowatt-hours of electricity every year and generated some \$6 billion per year in energy costs.²² We also know that “electricity use increased by 36% annually between 2012 and 2016” in Colorado, and approximately 4% of Denver’s electricity is consumed by indoor growers.²³ Comparatively, by sector, indoor cultivation is one of the most energy-intensive industries in the United States and is on par with data centers.²⁴ As states have continued to legalize marijuana, there is no doubt that this number has grown—and will continue to grow—exponentially higher with consumption for legal marijuana cultivation projected to increase by 162% between 2017 and 2022.²⁵

¹⁸ Evan Mills & Scott Zeramby, *Energy Use by the Indoor Cannabis Industry: Inconvenient Truths for Producers, Consumers, and Policymakers*, in THE ROUTLEDGE HANDBOOK OF POST-PROHIBITION CANNABIS RESEARCH (Dominic Corva & Joshua Meisel eds., forthcoming 2021) (manuscript at 5 n.2), https://www.researchgate.net/profile/Evan_Mills/publication/342364745_Energy_Use_by_the_Indoor_Cannabis_Industry_Inconvenient_Truths_for_Producers_Consumers_and_Policymakers/links/5fddd2cc299bf14088237514/Energy-Use-by-the-Indoor-Cannabis-Industry-Inconvenient-Truths-for-Producers-Consumers-and-Policymakers.pdf [<https://perma.cc/6Q3K-GYTY>].

¹⁹ Jason Reott, *Legal Cannabis Presents Challenges for Utilities, Opportunities for Energy Efficiency*, ALL TO SAVE ENERGY (Sept. 8, 2020), <https://www.ase.org/blog/legal-cannabis-presents-challenges-utilities-opportunities-energy-efficiency> [<https://perma.cc/9GT9-69JY>].

²⁰ Omar Sacirbey, *Electric Utilities Work with Cannabis Growers to Save on Power Costs*, MARIJUANA BUS. DAILY (July 17, 2018), <https://mjbizdaily.com/electric-utilities-work-with-cannabis-growers-to-save-on-power-costs/> [<https://perma.cc/6K26-MKWC>].

²¹ Mills & Zeramby, *supra* note 18 (manuscript at 4-5).

²² *Id.* (manuscript at 6).

²³ *Id.* (manuscript at 6, 12).

²⁴ *Id.* (manuscript at 5) (“Operating the equipment needed to create and maintain these artificial environments can require as much energy as a similarly sized data center.” (footnote omitted)).

²⁵ SCALE MICROGRID SOLUTIONS & RES. INNOVATION INST., THE 2018 CANNABIS ENERGY REPORT 5 (2018). It is important to note that utilities also struggle with energy theft due to illegal marijuana grows for both private use and commercial use. GRID20/20, INC., *supra* note 2, at 6-7 (discussing problems associated with power theft and the cost of installing “smart transformers” to detect them).

II. GRID VULNERABILITY AND GHG EMISSIONS

Two immediate concerns arise with this level of increased electricity demand: (1) electric grid vulnerability and (2) GHG emissions. The United States grid has long been vulnerable to blackouts caused by climate events and antiquated infrastructure. In recent years, utilities have struggled to keep up with the demand for renewable energy and smart grid technology. This already strained, fossil-fuel-dependent energy delivery system is now being challenged with an increase in demand from data centers, electric vehicles, and the marijuana industry. Further, GHG emissions contribute significantly to climate change and global warming due to fossil fuel electricity generation. The majority of the electricity in the United States still comes from fossil fuels, and until renewable energy is the dominant energy source, the energy delivery system will continue to emit large amounts of GHG.

Electric grid vulnerability. Indoor marijuana cultivators require twenty-four-hour firm (continuous) energy demand to ensure their product meets the highest control standards.²⁶ As a result, several utilities in the Pacific Northwest have reported problems with higher incidents of blackouts and equipment failure and replacement in areas with known indoor marijuana cultivation. For example, Pacific Power in Portland, Oregon, reported seven blackouts attributable to the marijuana industry,²⁷ and Portland General Electric reported that 10% of its transformers needed replacement due to overheating caused by indoor cultivation.²⁸ And, risks of power outages are exponentially increasing as “growing weed creates substantial unplanned power demands upon our already aged distribution grid infrastructure.”²⁹ When the United States power grid was constructed decades ago, no one could predict that it would need to accommodate multiple events such as net metering, data center electricity demand, electric vehicles, and marijuana legalization.³⁰

GHG emissions. As energy consumption increases, so do harmful GHG emissions. Any time we increase electricity consumption through a mostly fossil-fuel-driven system, GHG emissions increase and climate change concerns become even more perilous.³¹ As of 2017, the United States was one of the biggest GHG emitters in the world.³² Per capita, the United States is only behind

²⁶ GRID20/20, INC., *supra* note 2, at 5-6 (reporting that growers need power “for lights, fans, humidity and air conditioning, water pumps, etc.” in order to maintain “controlled indoor conditions”).

²⁷ Davis, *supra* at 7.

²⁸ Friedman, *supra* note 7, at A1; *see also* GRID20/20, INC., *supra* note 2, at 8-9 (discussing need to replace transformers, sensors, and other electricity delivery infrastructure to accommodate unforeseeable energy demands such as marijuana legalization).

²⁹ GRID20/20, INC., *supra* note 2, at 3.

³⁰ *See id.* at 3-4.

³¹ Spencer Gill, *Budding Marijuana Industry Meets Climate & Environmental Crisis: A Call to Legislative Action*, 5 OIL & GAS NAT. RES. & ENERGY J. 661, 674-80 (2020).

³² Thomas C. Frohlich & Liz Blossom, *These Countries Produce the Most CO2 Emissions*,

Saudi Arabia and Canada.³³ About 31% of United States GHG emissions come from the electricity sector.³⁴ In 2019, the electricity sector generated some 1,618 million metric tons (“MMmt”) of the United States’s total emissions of 5,146 MMmt.³⁵ That is because the U.S. electric grid is still over 60% fossil-fuel based.³⁶

While the United States has made a lot of progress toward decarbonizing its electric grid, it still has a long way to go. As of 2019, U.S. electricity consumption by energy source was 17.6% renewables, 19.6% nuclear, 38.4% natural gas, 23.4% coal, and 1.2% other fossil fuels—or about 62.6% fossil-fuel based.³⁷ The United States has increased renewables and clean energy sources over the years and reduced reliance on coal, but it has increased reliance on natural gas.³⁸ Furthermore, it should be noted that the 62.6% share by fossil fuels is a nationwide statistic. To more accurately predict the amount of GHG emissions coming from indoor cultivation, the key is to look at the electricity portfolio in states where marijuana is legal to determine their dependence on fossil fuels. For example, in 2020, Colorado, one of the largest producers of marijuana in the country, relied on coal-fired power plants for 36% of its electricity generation, and according to 2021 numbers, fossil fuels currently generate 67% of the state’s electricity with renewables making up the remaining 32%.³⁹

Compounding the reliance on fossil fuels to supply the United States electric grid is the global need to keep the impacts of global warming to at most 1.5 degrees Celsius above preindustrial levels to avoid the harshest of climate

USA TODAY: MONEY (July 14, 2019, 1:59 PM), <https://www.usatoday.com/story/money/2019/07/14/china-us-countries-that-produce-the-most-co-2-emissions/39548763/> [<https://perma.cc/7KEG-374G>].

³³ *Id.*

³⁴ *How Much of U.S. Carbon Dioxide Emissions Are Associated with Electricity Generation?*, U.S. ENERGY INFO. ADMIN., <https://www.eia.gov/tools/faqs/faq.php?id=77&t=11> [<https://perma.cc/42MJ-K6GM>] (last updated Dec. 1, 2020) (providing breakdown of carbon dioxide (“CO₂”) generated by U.S. electricity production by source).

³⁵ *Id.*

³⁶ *What Is U.S. Electricity Generation by Energy Source?*, *supra* note 8.

³⁷ *Id.*

³⁸ Rob Jackson, Robbie Andrew, Pep Canadell, Pierre Friedlingstein & Glen Peters, Opinion, *Natural Gas Use Is Rising: Is that Good News or Bad News for the Climate?*, SCI. AM. (Jan. 9, 2020), <https://blogs.scientificamerican.com/observations/natural-gas-use-is-rising-is-that-good-news-or-bad-news-for-the-climate/> (“In the United States and Europe, natural gas is replacing coal in electricity generation. Coal consumption in both regions dropped at least 10 percent in 2019. . . . Most of the lost U.S. coal capacity was replaced by natural gas, with additional contributions from renewables and energy efficiency.”).

³⁹ *Colorado State Profile and Energy Estimates*, U.S. ENERGY INFO. ADMIN., <https://www.eia.gov/state/?sid=CO#tabs-4> [<https://perma.cc/HXF3-A793>] (last visited May 19, 2021).

change predictions.⁴⁰ According to the Intergovernmental Panel on Climate Change, pathways to achieving this goal include decreasing energy demand and intensity, “deeply” lowering emissions from energy sources, actively engaging in carbon capture and decarbonization efforts, and increasing renewables to 70-85% of the energy supply by 2050.⁴¹

These pathways encompass decarbonizing electricity and reducing demand, which is opposite of what is occurring in the United States generally and with the cannabis industry more specifically. According to some projections, this general energy demand will continue to increase over the coming years.⁴² The United States’s general electricity demand growth is expected to continue to grow over the next ten years with some analysts predicting that three industries—electric vehicles, data centers, and cannabis cultivation—will significantly increase electricity consumption.⁴³ Data centers are projected to see

⁴⁰ INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, GLOBAL WARMING OF 1.5°C, at 7-8 (Valérie Masson-Delmotte et al. eds., 2019), https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_High_Res.pdf [<https://perma.cc/XKY3-K87G>] (“Climate models project robust differences in regional climate characteristics between present-day and global warming of 1.5°C, and between 1.5°C and 2°C. These differences include increases in: mean temperature in most land and ocean regions (*high confidence*), hot extremes in most inhabited regions (*high confidence*), heavy precipitation in several regions (*medium confidence*), and the probability of drought and precipitation deficits in some regions (*medium confidence*).” (footnotes omitted)).

⁴¹ Casey Ivanovich & Ilissa Ocko, *Six Takeaways from the New Climate Report*, ENV’T DEF. FUND (Oct. 8, 2018), <http://blogs.edf.org/climate411/2018/10/08/six-takeaways-from-the-new-climate-report/> [<https://perma.cc/TH8N-V3GG>].

⁴² U.S. ENERGY INFO. ADMIN., OFF. OF ENERGY ANALYSIS, U.S. DEP’T OF ENERGY, ANNUAL ENERGY OUTLOOK 2020 WITH PROJECTIONS TO 2050, at 64 (2020), <https://www.eia.gov/outlooks/aeo/pdf/AEO2020%20Full%20Report.pdf> [<https://perma.cc/GY29-J97A>] (predicting average 1% growth in electricity demand from 2019 to 2020). The U.S. Energy Information Administration predicts that electricity demand will grow slowly through 2050. *Id.* Morningstar is among analysts predicting an increase in electricity demand through 2030 due in part to marijuana, electric vehicles, and data servers. Andrew Bischof, *Why Electricity Demand Is About to Get a Jolt*, MORNINGSTAR (Dec. 14, 2018), <https://www.morningstar.com/articles/904313/why-electricity-demand-is-about-to-get-a-jolt> (“We think three emerging electricity demand sources--electric vehicle charging, data centers, and cannabis cultivation--will approach 6% of total U.S. electricity demand by 2030, offsetting energy efficiency and supporting our 1.25% annual electricity demand growth forecast through this time period.”); Ben Geman, *The Energy Thirst of Pot, Electric Vehicles, and Servers*, AXIOS (Dec. 4, 2018), <https://www.axios.com/energy-thirst-pot-marijuana-electric-vehicles-power-8a66bd21-46a7-450d-b737-921565833d26.html> [<https://perma.cc/5HMT-ST4LJ>].

⁴³ Reott, *supra* note 19 (depicting graphs of total electricity demand growth by sector).

the greatest growth, but not far behind are the electric vehicle⁴⁴ and cannabis industries.⁴⁵

Another concern is that the indoor marijuana industry could undo state and local comprehensive climate plans to reduce carbon emissions within their jurisdictions.⁴⁶ Multiple states have legislative mandates, goals, and policies in place to reduce statewide GHG emissions.⁴⁷ For example, Colorado's target is to reduce emissions by 90% by 2050 (using a 2005 baseline), Massachusetts's goal is 80% by 2050 (using a 1990 baseline), and California's goal is 40% by 2030 (using a 1990 baseline).⁴⁸ Without restrictions in place, the marijuana industry could single-handedly negate any previous progress.

Interestingly, Colorado has gotten creative with its attempt to capture GHG emissions and boost marijuana growth at the same time. In 2020, it initiated a

⁴⁴ In December 2020, Elon Musk predicted that all of the world's cars will be electric within twenty years and that the shift will result in doubling our electricity consumption. *Tesla CEO Says Electric Cars Will Double Global Electricity Demand*, REUTERS (Dec. 1, 2020, 11:50 AM), <https://www.reuters.com/article/us-tesla-electric-germany/tesla-ceo-says-electric-cars-will-double-global-electricity-demand-idUSKBN28B5Q8> [<https://perma.cc/25G4-U4EA>] (reporting Musk's projections that 5% of cars would be made electric per year, requiring expansion of solar and wind power and larger battery capacity).

⁴⁵ Peter Maloney, *Data Centers, EVs and Cannabis Poised to Boost Demand*, AM. PUB. POWER ASS'N (Dec. 10, 2018), <https://www.publicpower.org/periodical/article/data-centers-evs-and-cannabis-poised-boost-demand> [<https://perma.cc/J7EQ-J72U>] (reporting that analysts expect demand growth from data centers, electric vehicle charging stations, and cannabis cultivation to account for 3.2%, 1.7%, and 1.5%, respectively, of total U.S. electricity demand by 2030); Robert Walton, *Pot, EVs, Data to Lead Electricity Demand Growth*, MORNINGSTAR, UTIL. DIVE (Dec. 5, 2018), <https://www.utilitydive.com/news/pot-evs-data-to-lead-electricity-demand-growth-morningstar/543613/> [<https://perma.cc/P2G5-6KDR>]. New Frontier predicts energy use for marijuana cultivation will increase 162% by 2022. Chris Hudock, *162% Increase in U.S. Legal Cannabis Cultivation Electricity Consumption by 2022*, NEW FRONTIER DATA (Oct. 25, 2018), <https://newfrontierdata.com/cannabis-insights/162-increase-in-u-s-legal-cannabis-cultivation-electricity-consumption-by-2022/> [<https://perma.cc/M9M8-N7VN>].

⁴⁶ Gina S. Warren, *Regulating Pot to Save the Polar Bear: Energy and Climate Impacts of the Marijuana Industry*, 40 COLUM. J. ENV'T L. 385, 416 (2015) (detailing derailment of a municipal project to reduce electricity consumption in Arcata, California, most likely due to 600 residents that were cultivating marijuana).

⁴⁷ Laura Shields, *Greenhouse Gas Emissions Reduction Targets and Market-Based Policies*, NAT'L CONF. OF STATE LEGISLATURES, <https://www.ncsl.org/research/energy/greenhouse-gas-emissions-reduction-targets-and-market-based-policies.aspx> [<https://perma.cc/UXC9-HRXM>] (last updated Mar. 11, 2021) ("At least 16 states and Puerto Rico have enacted legislation establishing GHG emissions reduction requirements, with more requiring state agencies to report or inventory GHG emissions. Other states, such as New Mexico, North Carolina and Pennsylvania, have recently committed to statewide GHG reduction goals through executive action, but do not currently have binding statutory targets." (citations omitted)).

⁴⁸ *Id.*

pilot program to capture the carbon dioxide emitted during the fermentation process at local beer brewing facilities and transport it to marijuana facilities, where it is pumped into the air to speed photosynthesis.⁴⁹ While this is an innovative idea on a small scale, until states can move to a zero-carbon-emissions grid,⁵⁰ the majority of electricity consumption will result in increased GHG emissions in contravention of these comprehensive plans.

III. LESSONS FROM THE PAST

When I first published on this topic in 2015,⁵¹ the legalized cannabis industry was in its infancy. As states decided how to regulate the industry, I saw an opportunity to integrate sustainable energy practices into state licensing schemes. At the time, only four states had fully legalized marijuana—Alaska, Colorado, Oregon, and Washington.

I envisioned that states could mandate, as part of their licensing schemes, that marijuana growers use 100% clean energy or pay a carbon fee on a sliding scale. One big concern at the time, and still today, however, is that there simply is not enough clean energy available on the grid⁵² and not enough space on the rooftops for indoor cultivators to utilize 100% clean energy.⁵³ In fact, by some estimates, the most rooftop solar energy can supply is “about 5% of a facility’s electricity needs” due to marijuana’s high energy intensity.⁵⁴ As a result, I recommended the following:

One option for policymakers faced with this dilemma is to take a two-pronged approach by requiring indoor growers to pay an ever-increasing carbon fee, which would go into a fund for the development of more efficient technology and climate-friendly electricity facilities, *in conjunction with* requiring growers to meet an incrementally increasing requirement to incorporate carbon-free electricity sources. Combining these requirements would ensure growers do not become complacent just

⁴⁹ Jennifer Oldham, *Recycled Carbon Dioxide Feeds Pot*, WASH. POST, Feb. 12, 2020, at A3.

⁵⁰ Thirty states plus the District of Columbia have renewable and/or clean energy standards, with many seeking to reach 100% by 2050. See DSIRE & NC CLEAN ENERGY TECH. CTR., RENEWABLE & CLEAN ENERGY STANDARDS (2020), <http://ncsolarcenterprod.s3.amazonaws.com/wp-content/uploads/2020/09/RPS-CES-Sept2020.pdf> [<https://perma.cc/48XS-G5UV>].

⁵¹ Warren, *supra* note 46, at 385 (addressing negative climate and energy impacts of marijuana cultivation).

⁵² Gina S. Warren, *1-Click Energy: Managing Corporate Demand for Clean Power*, 78 MD. L. REV. 73, 81 (2018).

⁵³ Mills & Zeramby, *supra* note 18 (manuscript at 12) (“The feasibility of [going solar] has not been demonstrated at scale, probably because the required solar array would need to be many times larger than the roof of the facility, and of course could not be on the roof at all if a traditional greenhouse design is used.”).

⁵⁴ *Id.*

to pay the fee. Instead, it would encourage a shift in behavior to implement more efficient technology to keep the cost down and at the same time encourage indoor growers and policymakers to find a solution to ending fossil-fuel consumption.⁵⁵

After making this recommendation, various state regulatory entities that were interested in the concept contacted me, but none of the original states implemented clean energy standards. At the time, and still today, the City of Boulder and Boulder County in Colorado (collectively, “Boulder”) were the only locality doing something similar.

The City of Boulder requires all commercially licensed marijuana cultivators to report their energy usage⁵⁶ and to comply with 100% renewable energy targets.⁵⁷ Cultivators can meet this requirement by (1) installing on-site renewable energy, (2) participating in a verified solar program, or (3) purchasing offsets through the city’s Energy Impact Offset Fund.⁵⁸

Likewise, Boulder County requires commercial cultivators to utilize 100% renewable energy or pay a 2.16 cent surcharge per kilowatt-hour of consumption.⁵⁹ Fees from this surcharge go into the county’s Energy Impact Offset Fund.⁶⁰ Boulder County’s program also has an Energy Impact Offset Fund Credit Program, which allows cultivators to receive a credit against their usage fees for out-of-pocket costs used to install energy-efficient equipment and technology.⁶¹ This is helpful because start-up costs for the marijuana industry are already expensive and many new growers “have limited access to capital due

⁵⁵ Warren, *supra* note 46, at 428.

⁵⁶ BOULDER, COLO., MUNICIPAL CODE § 6-14-9(g) (“The records to be maintained by each medical marijuana cultivation facility and submitted to the city shall include, without limitation, records showing on a monthly basis the use and source of energy and any renewable energy generated onsite or through a Community Solar Garden subscription. Such records shall include all statements, reports, or receipts to verify the items included in the report of the business. By application for a medical marijuana business license from the city for a cultivation facility, the medical marijuana cultivation facility grants permission to providers of the energy or other renewable energy acquisition program to disclose the records of the business to the city. Medical marijuana businesses shall maintain records showing compliance with the renewable energy requirements in this chapter.”).

⁵⁷ *Id.* § 6-14-8(i) (“A medical marijuana cultivation facility shall directly offset one hundred percent of its electricity consumption through a verified subscription in a Community Solar Garden, or renewable energy generated onsite, or an equivalent that is subject to approval by the city. For medical marijuana businesses licensed by the city on October 22, 2013, this requirement shall apply at the time of renewal of the medical marijuana business license following October 22, 2013.”).

⁵⁸ *Boulder Marijuana Cultivation Facilities Energy Requirements*, CITY OF BOULDER COLO., <https://bouldercolorado.gov/planning/boulder-marijuana-facility-energy-requirements> [<https://perma.cc/EU6W-Z92U>] (last visited Apr. 13, 2021).

⁵⁹ *Cannabis Energy Impact Offset Fund*, *supra* note 11.

⁶⁰ *Id.*

⁶¹ *Id.*

to Federal Deposit Insurance Corporation . . . restrictions and limitations on federal tax deductions.”⁶²

In any event, the goal of both the City and the County’s Energy Impact Offset Funds is to educate the industry and create best practices for reducing energy use and increasing reliance on clean-energy and energy-efficient technologies. Interestingly, both funds have a secondary mission to facilitate the supply of affordable renewable energy to low-income families.⁶³

Through these programs, Boulder has continued to collect high-quality energy usage data and provide individualized reports to licensed indoor cultivators so that they can understand how best to lower their electricity bills and deliver a “cleaner” product. Unfortunately, Boulder is one of the only jurisdictions in the United States that has undertaken this level of energy efficiency management.

As of January 2021, marijuana is fully legal in fifteen states—Alaska, Arizona, California, Colorado, Illinois, Maine, Massachusetts, Michigan, Montana, Nevada, New Jersey, Oregon, South Dakota, Vermont, Washington—plus the District of Columbia.⁶⁴ It is decriminalized in thirty-two states and legal for medicinal purposes in more than two dozen states.⁶⁵ At this point, it is probably easier to list the remaining eight states where it is still fully *illegal*—Alabama, Idaho, Kansas, Nebraska, North Carolina, South Carolina, Tennessee, and Wyoming.⁶⁶ And, many predict that marijuana will receive federal legal status in the coming years.⁶⁷ The industry is a very lucrative one, generating a lot of money and raising a lot of taxes in legalized states. According to one report, “[T]he total economic impact of legal cannabis sales [is projected to] increase[] from \$38 billion-\$46 billion in 2019 to \$106 billion-\$130 billion by 2024 - a 181% increase.”⁶⁸

Given this exponential growth of legal marijuana growing in the United States,⁶⁹ it follows that electricity consumption will exponentially grow as well.

⁶² CRANDALL, *supra* note 1, at 9.

⁶³ *Cannabis Energy Impact Offset Fund*, *supra* note 11 (“This fund in turn, can be used to educate and support best in industry practices with regards to energy usage as well as for funding other carbon pollution reducing projects such as low income renewable energy.”).

⁶⁴ *Map of Marijuana Legality by State*, *supra* note 4.

⁶⁵ *Id.*

⁶⁶ *Id.*

⁶⁷ See Marijuana Opportunity Reinvestment and Expungement Act of 2020, H.R. 3884, 116th Cong. (2020) (proposing decriminalization and removal of cannabis from schedule of Controlled Substances Act, 21 U.S.C. § 812).

⁶⁸ McVey, *supra* note 3.

⁶⁹ One study suggests that marijuana agro-tourism could be an opportunity to “enhance the overall GDP of the country.” Sophia Rolle, *Marijuana Agro-Tourism Habitat*, in *TOURISM DEVELOPMENT, GOVERNANCE AND SUSTAINABILITY IN THE BAHAMAS* 177, 182 (Sophia Rolle, Jessica Minnis & Ian Bethell-Bennett eds., 2020) (evaluating viability of sustainable marijuana agro-tourism in The Bahamas).

This is further exacerbated by the fact that the majority of states prohibit outdoor growing and require commercial growers to maintain secure indoor growing facilities.⁷⁰

Most states have done little to nothing to limit the negative externalities of indoor cultivation, and they are seeing skyrocketing electricity demands, failed comprehensive climate plans, and increased occurrences of blackouts and grid vulnerability.⁷¹ No jurisdiction has been hit harder than California,⁷² the largest producer of cannabis in the nation, which has begun to rethink unbridled marijuana electricity consumption with new limits on energy GHG emissions and requirements to purchase carbon offsets for excess emissions.⁷³ Two additional states—Massachusetts and Illinois—have utilized their licensing authority to encourage, or in some instances mandate, energy efficiency. While neither mandate use of renewable/clean energy, they do put some additional limitations on lighting.

California. California fully legalized marijuana in 2016. Its initial licensing scheme contained no clean energy requirements or electricity monitoring provisions. Due to concerns with unfettered electricity use, however, the framework was amended to incorporate emission intensity mandates. Beginning in 2022, indoor cultivators will be required to report their energy usage.⁷⁴ And, beginning in 2023, growers will be required to “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”⁷⁵ If it exceeds the emissions intensity, the cultivator will be required to purchase carbon offsets to cover the excess.⁷⁶ By some estimates, the main avenue for cultivators to comply with this limitation will be to convert existing lighting to LEDs or to pay the

⁷⁰ Mills & Zeramby, *supra* note 18 (manuscript at 16-18).

⁷¹ CRANDALL, *supra* note 1, at 2 (“Utilities and local and state regulators have yet to consider the energy impacts of marijuana cultivation comprehensively.”).

⁷² See generally Genevieve Yip, Sustainable Cannabis Policy in California: Addressing the Legal Cannabis Industry’s Carbon Footprint (May 2020) (M.P.A. thesis, San Jose State University) (on file with Boston University Law Review) (discussing energy and climate externalities of marijuana cultivation in California).

⁷³ See Seltnerich, *supra* note 10 (“[California’s] Bureau of Cannabis Control won’t begin asking cultivators for data on energy use until 2022, and hold them to statewide standards for renewable energy starting in 2023.” (citation omitted)).

⁷⁴ *Id.*

⁷⁵ CAL. CODE REGS. tit. 3, § 8305 (2021).

⁷⁶ *Id.* § 8305(b) (“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”).

offset costs.⁷⁷ And, according to the California Department of Energy, as of 2017 only about 4% of indoor cultivators relied on LED lighting.⁷⁸

Massachusetts. Massachusetts fully legalized marijuana in 2016. Massachusetts's statutory framework for marijuana cultivators is quite extensive,⁷⁹ but it became more so in July 2020, when it required applicants to comply with energy efficiency and reporting standards.⁸⁰ All medical and adult-use growers of marijuana must comply with the new provisions.⁸¹ To assist in understanding Massachusetts law, the Cannabis Control Commission issued a fifty-seven-page "Energy and Environment Compiled Guidance" document for growers.⁸²

To apply for a license to operate, applicants must show that they have created and maintained "written operating procedures that demonstrate compliance with the energy efficiency standards in the regulations."⁸³ This operating plan must describe how the cultivator will achieve a reduction of energy and increased efficiency, its efforts to utilize utility efficiency programs, and its efforts to incorporate renewable energy.⁸⁴ Annually, the successful candidate must show its energy usage and water consumption as part of the license renewal process.⁸⁵

As noted above, one of the largest areas of energy intensity for indoor cultivation is the lighting system that is required to keep the plants warm and growing twenty-four hours per day. Massachusetts's Department of Energy Resources noted that a failure to address the lighting situation could negate the benefits of all LED bulbs installed in Massachusetts's streetlight replacement

⁷⁷ Bob Gunn, *California Cannabis Energy Mandates Add Undue Cost Burden to Growers*, MARIJUANA BUS. DAILY (July 22, 2020), <https://mjbizdaily.com/california-cannabis-energy-mandates-add-undue-cost-burden-to-growers/> [<https://perma.cc/CM7B-AYWN>].

⁷⁸ KELSEY STOVER, KYUNG LEE, MARY YAMADA & MORGAN PATTISON, OFF. OF ENERGY EFFICIENCY & RENEWABLE ENERGY, U.S. DEP'T OF ENERGY, ENERGY SAVINGS POTENTIAL OF SSL IN HORTICULTURAL APPLICATIONS, at iii (2017), https://www.energy.gov/sites/prod/files/2017/12/f46/ssl_horticulture_dec2017.pdf [<https://perma.cc/ET4M-NCVU>] ("In 2017, . . . LED products [made] up only 2% of lighting supplemented greenhouses and 4% of lighting in non-stacked indoor farms.").

⁷⁹ 935 MASS. CODE REGS. 500.120(11) (2021) ("A Marijuana Cultivator shall satisfy minimum energy efficiency and equipment standards established by the Commission and meet all applicable environmental laws, regulations, permits and other applicable approvals including, but not limited to, those related to water quality and quantity, wastewater, solid and hazardous waste management, and air pollution control, including prevention of odor and noise . . . as a condition of obtaining a final license . . . and as a condition of renewal . . .").

⁸⁰ MASS. CANNABIS CONTROL COMM'N, *supra* note 9, at 9-10.

⁸¹ *Id.* at 11.

⁸² See generally *id.* (assisting licensed Marijuana Establishments with developing best practices for energy efficiency and environmental concerns to comply with state regulations).

⁸³ *Id.*

⁸⁴ *Id.* at 12.

⁸⁵ *Id.* at 11.

program—a total of 130,000 bulbs that cost the state \$11 million.⁸⁶ In an attempt to address this concern, Massachusetts enacted a technology pushing standard that requires facility light intensity to stay at or below thirty-six to fifty watts per square foot, depending on the total square footage of the facility.⁸⁷ To put this in context, a typical office building utilizes two to five watts per square foot and computer system facilities around five to ten watts per square foot.⁸⁸ Of note, cultivators who generate their electricity with 80% clean energy are exempt from these lighting density requirements.⁸⁹

Illinois. Illinois fully legalized marijuana in 2020 through its Illinois Cannabis Regulation and Tax Act (“Act”),⁹⁰ which has been touted as the “Greenest Cannabis Bill in the Country.”⁹¹ The Act limits the number of licenses the state will issue and requires all grows to be indoors.⁹² Applicants must provide an environmental plan, which must include a “plan of action to minimize the carbon footprint, environmental impact, and resource needs for the dispensary, which may include, without limitation, recycling cannabis product packaging.”⁹³ After the plans are filed, they become a binding legal obligation.⁹⁴ In addition, like Massachusetts’s statute, the Act limits lighting intensity and provides that it must not exceed thirty-six watts per square foot.⁹⁵

⁸⁶ MASS. DEP’T OF ENERGY RES., CANNABIS AND ENERGY 10 (2018), https://aeenewengland.starchapter.com/images/Cannabis_Energy_DOER_to_AEENE_Dec_2018_Web.pdf [<https://perma.cc/EXF4-C4QU>].

⁸⁷ MASS. CANNABIS CONTROL COMM’N, *supra* note 9, at 15.

⁸⁸ *Commercial Library*, UNION POWER COOP., <https://c03.apogee.net/mvc/home/hes/land/el?utilityname=union-power&spc=cel&id=960> [<https://perma.cc/9X4N-CA4A>] (last visited Apr. 13, 2021) (“In an office building the lighting and normal ‘floor’ (equipment) electrical loads typically average from two (2) to five (5) watts per square foot. However, architectural or other considerations may make them considerably higher. Buildings with computer systems and other electronic equipment can have electrical loads as high as 5 to 10 watts per square foot.”).

⁸⁹ MASS. CANNABIS CONTROL COMM’N, *supra* note 9, at 18.

⁹⁰ 410 ILL. COMP. STAT. 705/1-5(a) (2020) (“In the interest of allowing law enforcement to focus on violent and property crimes, generating revenue for education, substance abuse prevention and treatment, freeing public resources to invest in communities and other public purposes, and individual freedom, the General Assembly finds and declares that the use of cannabis should be legal for persons 21 years of age or older and should be taxed in a manner similar to alcohol.”).

⁹¹ *Illinois Has the Greenest Cannabis Bill in the Country*, *supra* note 9 (“This bill is a great example of prioritizing environmental protection and it would put Illinois at the forefront of national cannabis policy.”).

⁹² 410 ILL. COMP. STAT. 705/15-25(c), 20-30(c).

⁹³ *Id.* at 15-30(c)(7).

⁹⁴ *Id.* at 30-15(c).

⁹⁵ *Id.* at 20-15(a)(23)(B).

The industry has expressed concern that these restrictions will be too burdensome and have a discriminatory impact on smaller cultivators.⁹⁶ No doubt replacing conventional lights with LEDs and incorporating more energy-efficient technologies will be expensive without proper state and utility incentives, discussed in Part IV. According to one estimate, it could cost as much as “\$62,000 for each 1,000 square feet of growing canopy.”⁹⁷ Greater restrictions also have the potential to cause some cultivators to go underground,⁹⁸ some cultivators to use deceptive reporting practices,⁹⁹ or corporate growers to run out the moms-and-pops.¹⁰⁰ While this is not a new argument against greater regulatory restrictions, it is a concern that should be closely monitored as states proceed with clean energy directives.

IV. IDEAS FOR THE FUTURE

Two immediate energy needs arise with indoor cultivation. First is the need to reduce grower’s overall energy consumption and alleviate some of the stress on the electric grid. Second is the need to fuel switch from fossil fuels to renewable clean energy and reduce GHG emissions.

Evan Mills and Scott Zeramby, who have been researching this topic for about a decade, argue that the only way to meet these needs is to move marijuana grows outdoors because clean energy and energy-efficient technology will not be enough to actually mitigate the climate damage caused by indoor

⁹⁶ Gunn, *supra* note 77.

⁹⁷ *Id.*

⁹⁸ *Id.*

⁹⁹ See Mills & Zeramby, *supra* note 18 (manuscript at 17) (“[Massachusetts’s] efforts at setting energy standards have been clumsy, e.g., seeking to specify wattage limits on individual light fixtures, which could easily result in operators installing more fixtures than would otherwise be the case.”); Gretchen Schimelpfenig & Leora Radetsky, *Which Cannabis Cultivation Lighting Is Right for You?*, CANNABIS BUS. TIMES (Jan. 14, 2021), <https://www.cannabisbusinesstimes.com/article/the-right-light-cannabis-cultivation-resource-innovation-institute-designlights-consortium/> [https://perma.cc/TNK4-78T9] (noting that Massachusetts and Illinois offer use of horticultural lighting as route for compliance with energy efficiency regulations). While it is commendable that California acknowledges and is attempting to rectify the situation, the problem with a wattage-per-square-foot requirement is that growers could simply install more fixtures to meet the limitations.

¹⁰⁰ Ryan Stoa and others have raised concerns that the regulation of marijuana and some of the controls exerted can result in socioeconomic disparities and create discriminatory practices in marijuana licensing and regulation. See, e.g., Ryan B. Stoa, *Equity in Cannabis Agriculture*, 101 B.U. L. REV. 1135, 108-11 (2021); Michael Polson, *Making Marijuana an Environmental Issue: Prohibition, Pollution, and Policy*, 2 ENE 229, 247 (2018) (“Regulatory attempts are shadowed by prohibition’s legacy and this can affect the socioeconomic differentiation of producers.”).

cultivators.¹⁰¹ They argue, “[T]here is a degree of naïve optimism and hubris that cultivators need only ‘go solar’ to solve the problem of any remaining energy requirements after efficiencies have been captured.”¹⁰² To them, the only viable solution is to move the cultivation back outdoors, where it belongs.¹⁰³

I do not disagree with this premise.¹⁰⁴ Outdoor cultivation would certainly alleviate the majority of the industry’s energy demand, as indoor cultivation requires over thirteen times more power to grow one gram of marijuana as compared to outdoor cultivation.¹⁰⁵ One main problem is that the federal government and most states prohibit (or at least significantly limit) outdoor marijuana cultivation.

The Agriculture Improvement Act of 2018 (“2018 Farm Bill”) provided a level of hope when it legalized some outdoor cannabis grows, but it also created some confusion along the way.¹⁰⁶ The 2018 Farm Bill reclassifies marijuana with low tetrahydrocannabinol (“THC”) levels as “hemp” and defines hemp as cannabis leaves, buds, and germinating seeds with a THC concentration of 0.3% or less.¹⁰⁷ The 2018 Farm Bill places regulatory authority on the states for

¹⁰¹ Mills & Zeramby, *supra* note 18 (manuscript at 11) (noting that grow facilities tend to use high amounts of energy due to “counterproductive design and operational features”).

¹⁰² *Id.* (manuscript at 12).

¹⁰³ *Id.* (manuscript at 24).

¹⁰⁴ Outdoor cultivation has its own set of environmental concerns, including but not limited to water waste, land sprawl and use, and pesticide use. Jessica Owley and Ryan Stoa have written about some of the concerns. See Jessica Owley, *Unforeseen Land Uses: The Effect of Marijuana Legalization on Land Conservation Programs*, 51 U.C. DAVIS L. REV. 1673, 1675-76 (2018) (discussing need for environmental and land use regulations for outdoor marijuana growers); Ryan B. Stoa, *Marijuana Agriculture Law: Regulation at the Root of an Industry*, 69 FLA. L. REV. 297, 303-04 (2017) (outlining environmental harms caused by failed or nonexistent regulatory regime); Ryan B. Stoa, *Weed and Water Law: Regulating Legal Marijuana*, 67 HASTINGS L.J. 565, 569-70 (2016) (discussing potential harms to water usage caused by lack of proper regulatory action to accommodate marijuana cultivation); see also Asha Wiegand-Shahani, *Illegal Water Use, Marijuana, and California’s Environment*, 48 ENV’T L. REP. 10,625, 10,629-30 (2018) (discussing environmental damage caused by illegal water use by outdoor growers). But see Flavio Scrucca, Carlo Ingraio, Chadi Maalouf, Tala Moussa, Guillaume Polidori, Antonio Messineo, Claudia Arcidiacono & Francesco Asdrubali, *Energy and Carbon Footprint Assessment of Production of Hemp Hurds for Application in Buildings*, ENV’T IMPACT ASSESS. REV., no. 106,417, 2020, at 1, 7 (discussing climate benefits of outdoor hemp cultivated for purposes of processing it into fibers and building materials).

¹⁰⁵ SCALE MICROGRID SOLUTIONS & RES. INNOVATION INST., *supra* note 25, at 41.

¹⁰⁶ *Marijuana or Hemp? Manufacturers Snagged by Farm Bill Confusion*, MARIJUANA BUS. DAILY (Feb. 6, 2019) [hereinafter *Marijuana or Hemp?*], <https://mjbizdaily.com/marijuana-or-hemp-manufacturers-snagged-by-farm-bill-confusion/> [<https://perma.cc/Q4WG-JQKA>] (highlighting law enforcement confusion in distinguishing between hemp and marijuana).

¹⁰⁷ Agriculture Improvement Act of 2018, Pub. L. No. 115-334, §§ 10113, 12619, 132

outdoor cultivation of “hemp” and requires states that choose to regulate it to establish a plan for tracking, testing, inspecting, and disposing of the product.¹⁰⁸ If the state does not establish a plan, the federal government will regulate it through the Department of Agriculture.¹⁰⁹ The 2018 Farm Bill also allows for the transportation in interstate commerce¹¹⁰ of hemp and lessens penalties for violations of state and federal plans.¹¹¹

The confusion lies with the 2018 Farm Bill’s definition of hemp, “the plant’s complicated biology,” and an inability of law enforcement to determine the difference between hemp and marijuana.¹¹² Local law enforcement made two high-profile arrests in 2019 when truck drivers attempted to transport what they believed was legally certified hemp across state lines.¹¹³ As noted by one commentator, “The newly enacted legislation does not mean that hemp will immediately become a cash crop or that farmers can grow it as freely as they do corn, soybeans, wheat or tobacco.”¹¹⁴ While it appears to be a step toward the federal legalization of cannabis and an opportunity to grow at least some types of cannabis outdoors,¹¹⁵ the 2018 Farm Bill is not consistently applied and gives states the authority to prohibit any hemp harvests within their borders as well as the authority to require cannabis be grown indoors.¹¹⁶

Stat. 4490, 4908, 5018 (removing hemp from definition of marijuana in the Controlled Substances Act, thereby rendering it no longer a controlled substance).

¹⁰⁸ *Id.* § 10113, 132 Stat. at 4909-10 (noting that states must certify that they have the resources and personnel to enforce such plans).

¹⁰⁹ *Id.* § 10113, 132 Stat. at 4912-13 (mandating that the Department of Agriculture establish a plan with tracking, testing, inspecting, and disposing requirements).

¹¹⁰ *Id.* § 10114, 132 Stat. at 4914 (stating that “[n]othing in this title . . . prohibits the interstate commerce of hemp . . . or hemp products” and that “[n]o State . . . shall prohibit the transportation or shipment of hemp or hemp products produced in accordance with” a state or federal plan through the state).

¹¹¹ *Id.* § 10113, 132 Stat. at 4911 (“A hemp producer that negligently violates a State . . . plan . . . shall not as a result of that violation be subject to any criminal enforcement action by the Federal Government or any State government . . .”).

¹¹² *Marijuana or Hemp?*, *supra* note 106.

¹¹³ *Id.*

¹¹⁴ Harold B. Hilborn, *2018 Farm Bill Legalizes Hemp, but Obstacles to Sale of CBD Products Remain*, NAT’L L. REV. (Mar. 5, 2019), <https://www.natlawreview.com/article/2018-farm-bill-legalizes-hemp-obstacles-to-sale-cbd-products-remain> [https://perma.cc/9SWD-PLLL].

¹¹⁵ Jordan Waldrep, *How Cannabis Just Took a Step Towards Legalization in the U.S. Farm Bill*, FORBES (Jan. 3, 2019, 9:04 AM), <https://www.forbes.com/sites/jordanwaldrep/2019/01/03/how-cannabis-just-took-a-step-towards-legalization-in-the-us-farm-bill/> [https://perma.cc/FMB8-2N5J] (characterizing 2018 Farm Bill as “the first real step the federal government has taken towards legalization [in] almost 50 years”).

¹¹⁶ Agriculture Improvement Act § 10113, 132 Stat. at 4910 (noting that states may include other mandated procedures in their regulatory plan).

This leads us back to the problem at hand—most marijuana is currently cultivated indoors due to federal legal hurdles and state mandates (or due to poor growing climates). Until this indoor cultivation mindset changes, state regulators and public utility companies should work together to mitigate the immediate harms caused by unfettered energy consumption.

State licensing schemes. State regulators are in a good position to control the amount and type of electricity consumed through their state licensing schemes. They can mandate growers utilize only clean energy, limit energy intensity, and require energy-efficient technologies as a condition of licensing. As more states create licensing schemes that require indoor cultivation, they should look to Boulder’s clean energy requirements and offset fund management as well as California’s emissions restrictions as baseline models. Massachusetts and Illinois each require environmental plans and limit lighting intensity, but again, neither requires clean energy nor limits the overall energy intensity of the facility. As a result, energy consumption will continue to increase, which will strain the energy delivery system, and GHG emissions will continue to increase, which will contribute to overall global warming.

Utility incentives. In addition, state-regulated utilities are well situated to educate indoor cultivators and to incentivize clean and efficient energy consumption through push-and-pull policies including energy audits, rebates and incentives, grants, and surcharges.

When marijuana emerged as a legal state industry, many utilities were very concerned about even supplying electricity to marijuana cultivators, let alone creating incentive programs for them.¹¹⁷ With marijuana federally illegal, banks, utilities, and other similar service suppliers were concerned that they could be subjected to fines or criminal charges if they assisted those involved in the marijuana industry.¹¹⁸ Even though banking can still be a gray area, state-regulated utilities are more confident in their ability—and their obligation—to meet the energy needs of their marijuana customers.

That is because, in the United States, electricity is regulated through a cooperative federalism model. Pursuant to the Federal Power Act, the federal government, through the Federal Energy Regulatory Commission (“FERC”), regulates wholesale sales of electricity in interstate commerce, and states, through state public utility commissions, regulate the retail distribution of electricity. In fact, the FERC is prohibited from regulating or interfering with the retail distribution of electricity.¹¹⁹ State public utility commission regulations mandate that utilities serve their retail customers in a

¹¹⁷ Ryan Dadgari, *Powering Mary Jane: Marijuana and Electric Public Utilities*, 10 GOLDEN GATE U. ENV’T L.J. 55, 56 (2018) (discussing role of state utility companies in supplying electricity to federally illegal marijuana growers).

¹¹⁸ See, e.g., *id.* at 77 (“While unlikely, public utilities could face criminal prosecution for providing service to marijuana grows.”).

¹¹⁹ 16 U.S.C. § 824(a)-(b).

nondiscriminatory manner.¹²⁰ This means that utilities must supply electricity to anyone seeking the service at the same rate and on the same basis as others within the same customer category. It is possible that a utility receiving federal funding or receiving power from a federally owned energy source could still run up against concerns;¹²¹ however, most utilities are fully funded through their intrastate retail consumer base and regulated by their state public utility commission.¹²²

Some areas in which utilities can make a big difference in offsetting compliance costs, reducing consumption, and increasing efficiencies include energy audits, incentives, grants, and surcharges.¹²³

Energy audits. As noted at the beginning of this Article, one of the biggest problems with addressing the energy consumption issue is actually knowing exactly how much energy is being consumed and what aspects of the indoor cultivation process have the highest energy intensity.¹²⁴ Lighting is an obvious area of energy intensity, but studies and on-site audits would provide additional information for growers and utilities alike. To incentivize growers to evaluate their electricity usage, some utilities are offering energy audits at discounted prices. For example, National Grid's program in Massachusetts will defray 75% of the cost to study the heating, ventilation, and air conditioning and lighting systems.¹²⁵

Utility incentives and grants. Reducing emissions intensity will no doubt increase out-of-pocket costs for growers, but it will also reduce monthly electricity costs, which should offset the costs over time. The indoor cultivator's electricity bill is one of the biggest expenses incurred during the cultivation process with monthly bills ranging between \$3,000 and \$100,000.¹²⁶ Utilities can provide incentives by reducing the costs of electricity in exchange for greater

¹²⁰ 18 C.F.R. § 35.27 (2021).

¹²¹ See CRANDALL, *supra* note 1, at 9 (discussing how marijuana customers who receive power from Bonneville Power Administration, which is a federal agency, are not provided any rebates or incentives because marijuana is still federally illegal); see also Sacirbey, *supra* note 20 (explaining that utilities that receive power from particular federal entities "generally balk at providing cannabis businesses [power] because they fear federal interference").

¹²² CRANDALL, *supra* note 1, at 2 (describing how public utility commissions regulate costs that investor-owned utilities can recover from customers).

¹²³ *Id.* at 11-14 (recommending that utilities: (1) educate marijuana growers about how much electricity they are using, (2) tailor incentives for the marijuana industry, (3) design rates to promote efficiency, and (4) create fair policies for new customers).

¹²⁴ *Id.* at 8 ("There is an information vacuum both about, and within, the marijuana industry.").

¹²⁵ *Energy Companies Incentivize Growers*, ANDEN (July 23, 2020), <https://www.anden.com/energy-companies-incentivize-growers/> [https://perma.cc/VR4M-8AN2].

¹²⁶ See CRANDALL, *supra* note 1, at 7 (explaining that monthly energy bills for cannabis growers in Denver, Colorado typically range from \$20,000 to \$50,000).

energy efficiency and utilization of more energy-efficient technology. Puget Sound Energy in Washington, for example, offers an incentive of \$0.20 per kilowatt-hour of first-year savings, up to 100% of the incremental cost of more efficient equipment.¹²⁷ Likewise, some utilities are offering grants, which are nonrepayable funds given in exchange for energy efficiency, to growers who install energy-efficient technology. For example, Efficiency Maine may pay up to 50% of a project's cost (up to \$1 million) for LED lights and energy-efficient HVAC systems.¹²⁸ Interestingly, Efficiency Maine had originally banned offering incentives to marijuana growers due to concerns that the federal government would crack down on the marijuana industry.¹²⁹ It was only in October 2020 that it voted to lift the ban.¹³⁰ In any event, providing these types of incentives that lower the grower's electricity bill can be appealing to a grower and beneficial for an overloaded utility.¹³¹

Surcharges and taxes. The above types of incentives use the proverbial carrot to encourage growers to become more energy conscious. Another option is using the stick—a surcharge or tax for electricity consumed above a certain baseline. It has always baffled me that some utilities will provide discounts for higher energy usage. It is not uncommon for the first 500 kilowatts of electricity to be \$0.10 per kilowatt, but after that, it goes down to \$0.095 per kilowatt.¹³² Given the climate damage caused by energy consumption, this seems extremely counterintuitive and harmful. Some jurisdictions are catching on, however, and reversing course. For example, Arcata, California is leveraging a 45% surcharge or tax on customers who use more than 600% of an energy consumption

¹²⁷ MARK CROWDIS, ENERGY EFFICIENCY REBATES AND THIRD-PARTY FINANCE (2018) (PowerPoint) (on file with Boston University Law Review).

¹²⁸ Penelope Overton, *Once Shut Out, Maine Cannabis Industry Now Eligible for Sustainable Energy Grants*, PORTLAND PRESS HERALD (Oct. 7, 2020), <https://www.pressherald.com/2020/10/07/once-shut-out-maine-cannabis-industry-now-eligible-for-sustainable-energy-grants/> [<https://perma.cc/SDG2-N63X>] (noting that Energy Maine trustees' choice to reverse ban reflected confidence that marijuana businesses were "just as likely to last long enough to produce the energy savings needed to justify the grant as any other kind of business").

¹²⁹ *Id.*

¹³⁰ *Maine Cannabis Companies Now Qualify for Energy-Efficiency Grants*, MARIJUANA BUS. DAILY (Oct. 8, 2020), <https://mjbizdaily.com/maine-cannabis-companies-now-qualify-for-energy-efficiency-grants/> [<https://perma.cc/DM64-L8FG>].

¹³¹ Investor-owned utilities, however, can run into a conflict with helping customers decrease their electricity bills as their sole source of income comes from their customer base. See CRANDALL, *supra* note 1, at 2 ("Because the majority of U.S. electric customers are served by investor-owned utilities . . . , the public utility commissions that regulate them may soon be faced with balancing utilities' incentives to increase their sales of electricity versus other societal goals for efficient, affordable, and clean energy." (footnote omitted)).

¹³² *Id.* at 11 (discussing rate design measures that can encourage efficiency).

baseline.¹³³ This type of surcharge could be effective in incentivizing consumers to reduce their overall energy consumption.

CONCLUSION

Indoor cultivation of marijuana is not green. With a U.S. grid that is still primarily fossil-fuel based, it is more a smoky brown than green, placing the polar bear¹³⁴ in the notorious hotbox.¹³⁵ Moving cultivation outdoors would be the best option, but until that happens (1) states that legalize marijuana should establish responsible licensing frameworks that mitigate the industry's energy consumption; and (2) state-regulated utilities should work with cultivators to provide energy audits, offer incentives and grants for clean energy alternatives, and penalize costumers whose energy intensity is over an established baseline.

¹³³ *Excessive Electricity Use Tax*, CITY OF ARCATA, CAL., <https://www.cityofarcata.org/733/Excessive-Electricity-Use-Tax> [<https://perma.cc/XSV3-ZE3J>] (last visited Apr. 13, 2021) (noting that Arcata citizens passed the surcharge tax measure by a vote of 68% to 32%).

¹³⁴ Of course, I refer to the polar bear as a euphemism for our climate. Warren, *supra* note 46, at 388 n.5 (“Ezra Rosser notes that the majority of the population will never have an occasion to see a polar bear, but polar bears are the representative for the anti-global warming movement.” (citing Ezra Rosser, *Offsetting and the Consumption of Social Responsibility*, 89 WASH. U. L. REV. 27, 70-71 (2011))).

¹³⁵ A “hotbox” is a hot, confined space. It is slang for a place where pot smokers get together to smoke marijuana so that the exhaled smoke fills the space and intensifies the experience for everyone. See *Hotbox*, URB. DICTIONARY (Aug. 24, 2004), <https://www.urbandictionary.com/define.php?term=hotbox> [<https://perma.cc/H8V2-XAGF>].

EXHIBIT D



The carbon footprint of indoor *Cannabis* production

Evan Mills 

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Abstract

The emergent industry of indoor *Cannabis* production – legal in some jurisdictions and illicit in others – utilizes highly energy intensive processes to control environmental conditions during cultivation. This article estimates the energy consumption for this practice in the United States at 1% of national electricity use, or \$6 billion each year. One average kilogram of final product is associated with 4600 kg of carbon dioxide emissions to the atmosphere, or that of 3 million average U.S. cars when aggregated across all national production. The practice of indoor cultivation is driven by criminalization, pursuit of security, pest and disease management, and the desire for greater process control and yields. Energy analysts and policymakers have not previously addressed this use of energy. The unchecked growth of electricity demand in this sector confounds energy forecasts and obscures savings from energy efficiency programs and policies. While criminalization has contributed to the substantial energy intensity, legalization would not change the situation materially without ancillary efforts to manage energy use, provide consumer information via labeling, and other measures. Were product prices to fall as a result of legalization, indoor production using current practices could rapidly become non-viable.

Highlights

► The emergent industry of indoor *Cannabis* production utilizes highly energy intensive processes and is highly inefficient. ► In the United States, this represents an annual energy expenditure of \$6 billion. ► One kg of final product is associated with emissions of 4600 kg of CO₂ emissions to the

atmosphere. ► Aggregate U.S. emissions are equivalent those of 3 million cars. ► Energy analysts and policymakers have not previously addressed this use of energy.

 Previous

Next 

Keywords

Energy; Buildings; Horticulture

1. Introduction

On occasion, previously unrecognized spheres of energy use come to light. Important historical examples include the pervasive air leakage from ductwork in homes, the burgeoning energy intensity of computer datacenters, and the electricity “leaking” from billions of small power supplies and other equipment. Intensive periods of investigation, technology R&D, and policy development gradually ensue in the wake of these discoveries. The emergent industry of indoor *Cannabis* production appears to have joined this list.¹

This article presents a model of the modern-day production process – based on public-domain sources – and provides first-order national scoping estimates of the energy use, costs, and greenhouse-gas emissions associated with this activity in the United States. The practice is common in other countries but a global assessment is beyond the scope of this report.

2. Scale of activity

The large-scale industrialized and highly energy-intensive indoor cultivation of *Cannabis* is a relatively new phenomenon, driven by criminalization, pursuit of security, pest and disease management, and the desire for greater process control and yields ([U.S. Department of Justice, 2011a](#); World Drug Report, 2009). The practice occurs across the United States ([Hudson, 2003](#), [Gettman, 2006](#)). The 415,000 indoor plants eradicated by authorities in 2009 (and 10.3 million including outdoor plantations) ([U.S. Department of Justice, 2011a, b](#)) presumably represent only a small fraction of total production.

Cannabis cultivation is today legal in 15 states plus the District of Columbia, although it is not federally sanctioned ([Peplow, 2005](#)). It is estimated that 24.8 million Americans are eligible to receive a doctor's recommendation to purchase or cultivate *Cannabis* under existing state laws, and approximately 730,000 currently do so ([See Change Strategy, 2011](#)). In California alone, 400,000 individuals are currently authorized to cultivate *Cannabis* for personal medical use, or sale for the

same purpose to 2100 dispensaries ([Harvey, 2009](#)). Approximately 28.5 million people in the United States are repeat consumers, representing 11% of the population over the age of 12 ([U.S. Office of National Drug Control Policy, 2011](#)).

Cultivation is also substantial in Canada. An estimated 17,500 “grow” operations in British Columbia (typically located in residential buildings) are equivalent to 1% of all dwelling units Province-wide, with an annual market value of \$7 billion ([Easton, 2004](#)).

Official estimates of total U.S. *Cannabis* production varied from 10,000 to 24,000 metric ton per year as of 2001, making it the nation's largest crop by value at that time ([Hudson, 2003](#), [Gettman, 2006](#)). A recent study estimated national production at far higher levels (69,000 metric ton) ([HIDTA, 2010](#)). Even at the lower end of this range (chosen as the basis of this analysis), the level of activity is formidable and increasing with the demand for *Cannabis*.

No systematic efforts have previously been made to estimate the aggregate energy use of these activities.

3. Methods and uncertainties

This analysis is based on a model of typical *Cannabis* production, and the associated energy use for cultivation and transportation based on market data and first-principals buildings energy end-use modeling techniques. Data sources include equipment manufacturer data, trade media, the open literature, and interviews with horticultural equipment vendors. All assumptions used in the analysis are presented in [Appendix A](#). The resulting normalized (per-kilogram) energy intensity is driven by the effects of indoor-environmental conditions, production processes, and equipment efficiencies.

Considerable energy use is also associated with transportation, both for workers and for large numbers of small-quantities transported and then redistributed over long distances before final sale.

This analysis reflects typical practices, and is thus intended as a “central estimate”. While processes that use less energy on a per-unit-yield basis are possible, much more energy-intensive scenarios also occur. Certain strategies for lowering energy inputs (e.g., reduced illumination levels) can result in lower yields, and thus not necessarily reduce the ultimate energy-intensity per unit weight. Only those strategies that improve equipment and process energy efficiency, while not correspondingly attenuating yields would reduce energy intensity.

Due to the proprietary and often illicit nature of *Cannabis* cultivation, data are intrinsically uncertain. Key uncertainties are total production and the indoor fraction thereof, and the corresponding scaling up of relatively well-understood intensities of energy use per unit of production to state or national levels could result in 50% higher or lower aggregate results.

Greenhouse-gas emissions estimates are in turn sensitive to the assumed mix of on- and off-grid power production technologies and fuels, as off-grid production (almost universally done with diesel generators) can – depending on the prevailing fuel mix in the grid – have substantially higher emissions per kilowatt-hour than grid power. Final energy costs are a direct function of the aforementioned factors, combined with electricity tariffs, which vary widely geographically and among customer classes. The assumptions about vehicle energy use are likely conservative, given the longer-range transportation associated with interstate distribution.

Some localities (very cold and very hot climates) will see much larger shares of production indoors, and have higher space-conditioning energy demands than the typical conditions assumed here. More in-depth analyses could explore the variations introduced by geography and climate, alternate technology configurations, and production techniques.

4. Energy implications

Accelerated electricity demand growth has been observed in areas reputed to have extensive indoor *Cannabis* cultivation. For example, following the legalization of cultivation for medical purposes ([Phillips, 1998](#), [Roth, 2005](#), [Clapper et al., 2010](#)) in California in 1996, Humboldt County experienced a 50% rise in per-capita residential electricity use compared to other parts of the state ([Lehman and Johnstone, 2010](#)).

Aside from sporadic news reports ([Anderson, 2010](#), [Quinones, 2010](#)), policymakers and consumers possess little information on the energy implications of this practice. A few prior studies tangentially mentioning energy use associated with *Cannabis* production used cursory methods and under-estimate energy use significantly ([Plecas et al., 2010](#) and [Caulkins, 2010](#)).

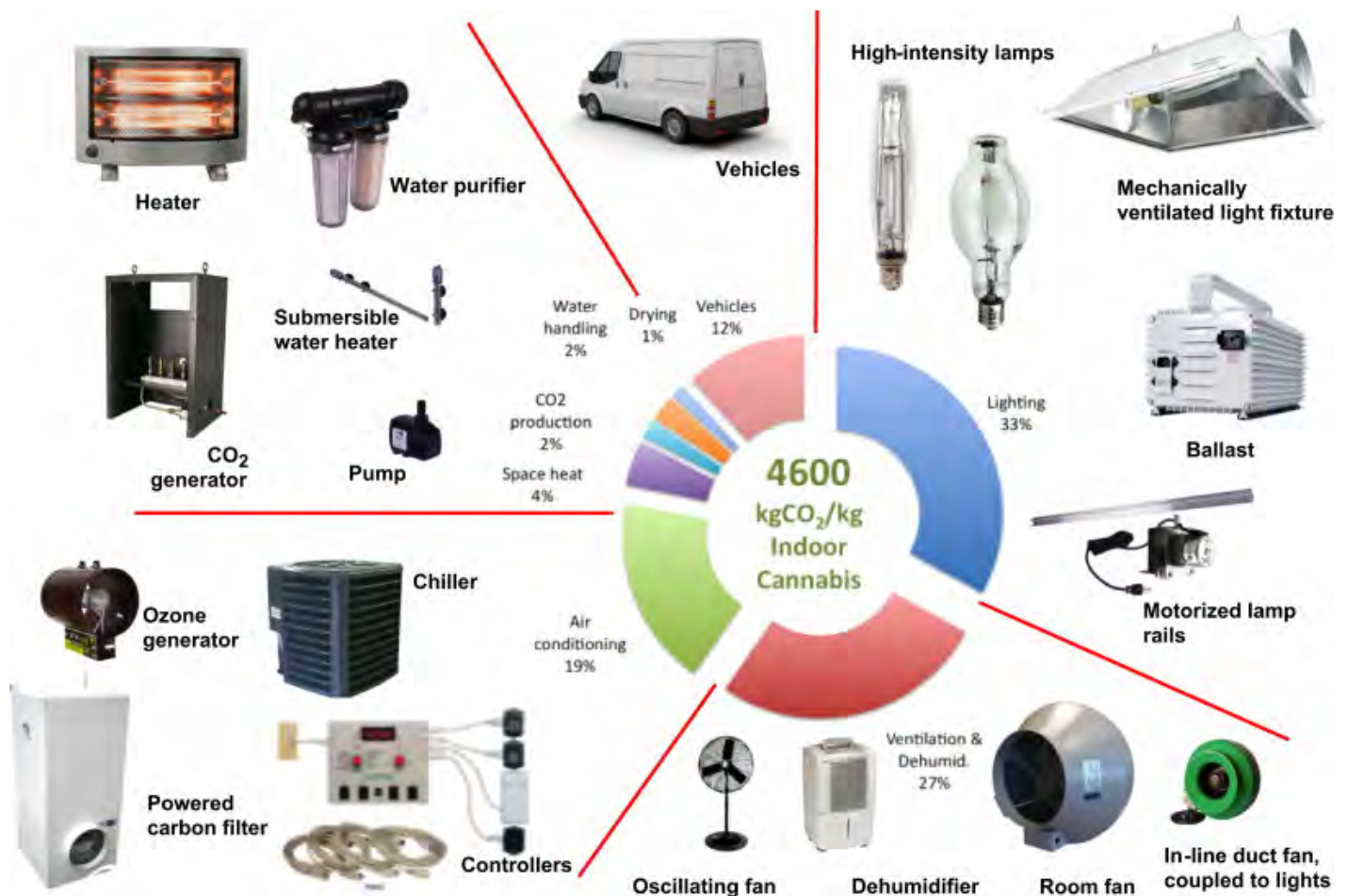
Driving the large energy requirements of indoor production facilities are lighting levels matching those found in hospital operating rooms (500-times greater than recommended for reading) and 30 hourly air changes (6-times the rate in high-tech laboratories, and 60-times the rate in a modern home). Resulting power densities are on the order of 2000 W/m², which is on a par with that of modern datacenters. Indoor carbon dioxide (CO₂) levels are often raised to 4-times natural levels in order to boost plant growth. However, by shortening the growth cycle, this practice may reduce final energy intensity.

Specific energy uses include high-intensity lighting, dehumidification to remove water vapor and avoid mold formation, space heating or cooling during non-illuminated periods and drying, pre-heating of irrigation water, generation of carbon dioxide by burning fossil fuel, and ventilation and air-conditioning to remove waste heat. Substantial energy inefficiencies arise from air cleaning, noise and odor suppression, and inefficient electric generators used to avoid conspicuous utility bills. So-called “grow houses” – residential buildings converted for *Cannabis* production – can contain 50,000 to 100,000 W of installed lighting power ([Brady, 2004](#)). Much larger facilities are also

used.

Based on the model developed in this article, approximately 13,000 kW/h/year of electricity is required to operate a standard production module (a 1.2×1.2×2.4 m (4×4×8 ft) chamber). Each module yields approximately 0.5 kg (1 pound) of final product per cycle, with four or five production cycles conducted per year. A single grow house can contain 10 to 100 such modules.

To estimate national electricity use, these normalized values are applied to the lower end of the range of the aforementioned estimated production (10,000 t per year), with one-third of the activity takes place under indoor conditions. This indicates electricity use of about 20 TW/h/year nationally (including off-grid production). This is equivalent to that of 2 million average U.S. homes, corresponding to approximately 1% of national electricity consumption — or the output of 7 large electric power plants (Koomey et al., 2010). This energy, plus associated fuel uses (discussed below), is valued at \$6 billion annually, with associated emissions of 15 million metric ton of CO₂ — equivalent to that of 3 million average American cars (Fig. 1 and Table 1, Table 2, Table 3.)



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Fig. 1. Carbon footprint of indoor Cannabis production.

Table 1. Carbon footprint of indoor *Cannabis* production, by end use (average U.S conditions).

| | Energy intensity (kW/h/kg yield) | Emissions factor (kgCO ₂ emissions/kg yield) | |
|--|----------------------------------|---|------|
| Lighting | 2283 | 1520 | 33% |
| Ventilation & dehumid. | 1848 | 1231 | 27% |
| Air conditioning | 1284 | 855 | 19% |
| Space heat | 304 | 202 | 4% |
| CO ₂ injected to increase foliage | 93 | 82 | 2% |
| Water handling | 173 | 115 | 2% |
| Drying | 90 | 60 | 1% |
| Vehicles | | 546 | 12% |
| Total | 6074 | 4612 | 100% |

Note: The calculations are based on U.S.-average carbon burdens of 0.666 kg/kW/h. “CO₂ injected to increase foliage” represents combustion fuel to make on-site CO₂. Assumes 15% of electricity is produced in off-grid generators.

Table 2. Equivalencies.

| | | | | | | | |
|--|----|--|----|---------------------------------------|----|--------------------------------|----------------------------------|
| Indoor Cannabis production consumes... | 3% | of California's total electricity, and | 9% | of California's household electricity | 1% | of total U.S. electricity, and | 2% of U.S. household electricity |
|--|----|--|----|---------------------------------------|----|--------------------------------|----------------------------------|

| | | | | | | | |
|---|-------------|--|---------------|--|---|-----------|---------------------------|
| U.S. Cannabis production & distribution energy costs... | \$ 6 | Billion, and results in the emissions of | 15 | Million tonnes per year of greenhouse gas emissions (CO ₂) | Equal to the emissions of | 3 | million average cars |
| U.S. electricity use for Cannabis production is equivalent to that of... | 1.7 | Million average U.S. homes | or | 7 | Average U.S. power plants | | |
| California Cannabis production and distribution energy costs... | \$ 3 | Billion, and results in the emissions of | 4 | Million tonnes per year of greenhouse gas emissions (CO ₂) | Equal to the emissions of | 1 | Million average cars |
| California electricity use for Cannabis production is equivalent to that of... | 1 | Million average California homes | | | | | |
| A typical 4x4x8-ft production module, accomodating four plants at a time, consumes as much electricity as... | 1 | Average U.S. homes, or | 2 | Average California homes | or | 29 | Average new refrigerators |
| Every 1 kilogram of Cannabis produced using national-average grid power results in the emissions of... | 4.3 | Tonnes of CO ₂ | Equivalent to | 7 | Cross-country trips in a 5.3 l/100 km (44 mp g) car | | |
| Every 1 kg of Cannabis produced using a prorated mix of grid and off-grid generators results in the emissions of... | 4.6 | Tonnes of CO ₂ | Equivalent to | 8 | Cross-country trips in a 5.3 l/100 km (44 mp g) car | | |
| Every 1 kg of Cannabis | 6.6 | Tonnes of | Equivalent | 11 | Cross- | | |

| | | | | | | | |
|---|------------|--|----------------|-------------|--|------------|--|
| produced using off-grid generators results in the emissions of... | | CO ₂ | to | | country trips in a 5.3 l/100 km (44 mp g) car | | |
| Transportation (wholesale+retail) consumes... | 226 | Liters of gasoline per kg | or | \$ 1 | Billion dollars annually, and | 546 | Kilograms of CO ₂ per kilogram of final product |
| One Cannabis cigarette is like driving... | 37 | km in a 5.3 l/100 km (44 mpg) car | Emitting about | 2 | kg of CO ₂ , which is equivalent to operating a 100-watt light bulb for | 25 | Hours |
| Of the total wholesale price... | 49% | Is for energy (at average U.S. prices) | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

Table 3. Energy indicators (average U.S. conditions).

| | per cycle, per production module | per year, per production module | |
|------------------------------|----------------------------------|---------------------------------|-------------------------|
| Energy use | | | |
| Connected load | | 3,225 | (watts/module) |
| Power density | | 2,169 | (watts/m ²) |
| Elect | 2756 | 12,898 | (kW/h/module) |
| Fuel to make CO ₂ | 0.3 | 1.6 | (GJ) |
| Transportation fuel | 27 | 127 | (Gallons |

| | | | |
|---|------|--------|-----------------------|
| On-grid results | | | |
| Energy cost | 846 | 3,961 | \$/module |
| Energy cost | | 1,866 | \$/kg |
| Fraction of wholesale price | | 47% | |
| CO ₂ emissions | 1936 | 9,058 | kg |
| CO ₂ emissions | | 4,267 | kg/kg |
| Off-grid results (diesel) | | | |
| Energy cost | 1183 | 5,536 | \$/module |
| Energy cost | | 2,608 | \$/kg |
| Fraction of wholesale price | | 65% | |
| CO ₂ emissions | 2982 | 13,953 | kg |
| CO ₂ emissions | | 6,574 | kgCO ₂ /kg |
| Blended on/off grid results | | | |
| Energy cost | 897 | 4,197 | \$/module |
| Energy cost | | 1,977 | \$/kg |
| Fraction of wholesale price | | 49% | |
| CO ₂ emissions | 2093 | 9,792 | kg |
| CO ₂ emissions | | 4,613 | kgCO ₂ /kg |
| Of which, indoor CO ₂ production | 9 | 42 | kgCO ₂ |
| Of which, vehicle use | | | |
| Fuel use | | | |
| During production | | 79 | Liters/kg |
| Distribution | | 147 | Liters/kg |

| | | |
|-------------------|-----|-----------------------|
| Cost | | |
| During production | 77 | \$/kg |
| Distribution | 143 | \$/kg |
| Emissions | | |
| During production | 191 | kgCO ₂ /kg |
| Distribution | 355 | kgCO ₂ /kg |

Fuel is used for several purposes, in addition to electricity. The carbon dioxide injected into grow rooms to increase yields is produced industrially ([Overcash et al., 2007](#)) or by burning propane or natural gas within the grow room contributes about 1–2% to the carbon footprint and represents a yearly U.S. expenditure of \$0.1 billion. Vehicle use associated with production and distribution contributes about 15% of total emissions, and represents a yearly expenditure of \$1 billion. Off-grid diesel- and gasoline-fueled electric generators have per-kilowatt-hour emissions burdens that are 3- and 4-times those of average grid electricity in California. It requires 70 gallon of diesel fuel to produce one indoor *Cannabis* plant (or the equivalent yield per unit area), or 140 gallon with smaller, less-efficient gasoline generators.

In California, the top-producing state, indoor cultivation is responsible for about 3% of all electricity use, or 9% of household use.² This corresponds 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. Due to higher electricity prices and cleaner fuels used to make electricity, California incurs 50% of national energy costs but contributes only 25% of national CO₂ emissions from indoor *Cannabis* cultivation.

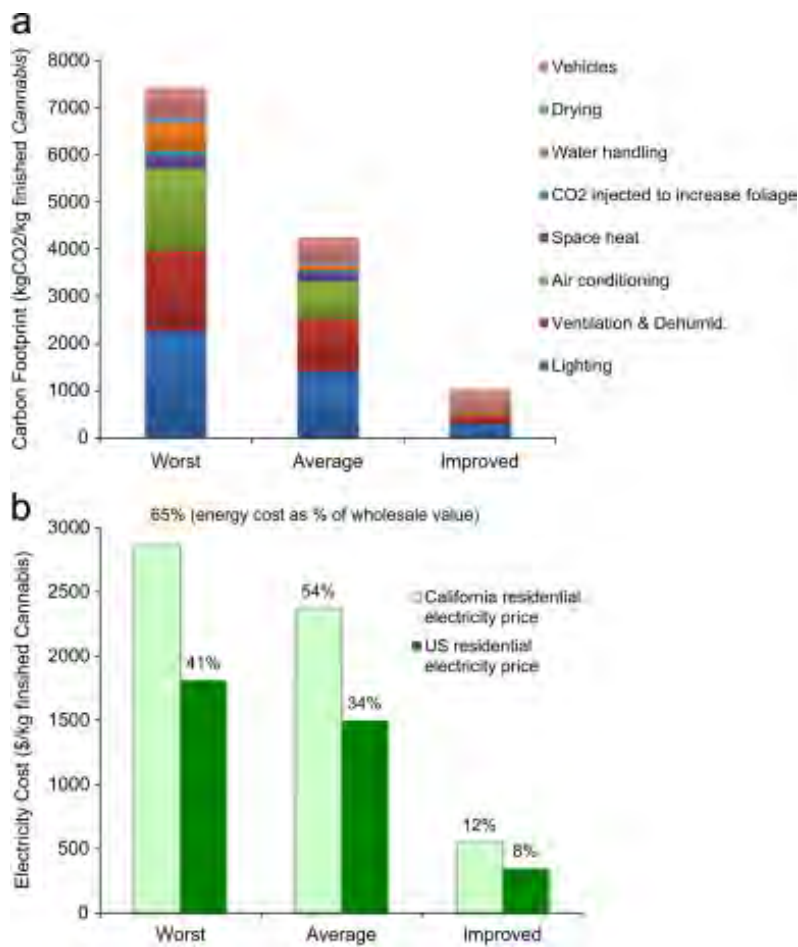
From the perspective of individual consumers, a single *Cannabis* cigarette represents 1.5 kg (3 pounds) of CO₂ emissions, an amount equal to driving a 44 mpg hybrid car 22 mile or running a 100-watt light bulb for 25 h, assuming average U.S. electricity emissions. The electricity requirement for one single production module equals that of an average U.S. home and twice that of an average California home. The added electricity use is equivalent to running about 30 refrigerators.

From the perspective of a producer, the national-average annual energy costs are approximately \$5500 per module or \$2500 per kilogram of finished product. This can represent half the wholesale value of the finished product (and a substantially lower portion at retail), depending on local conditions. For average U.S. conditions, producing one kilogram of processed *Cannabis* results in 4600 kg of CO₂ emissions to the atmosphere (and 50% more when off-grid diesel power generation is used), a very significant carbon footprint. The emissions associated with one kilogram of processed *Cannabis* are equivalent to those of driving across country 11 times in a 44-mpg car.

These results reflect typical production methods. Much more energy-intensive methods occur, e.g., rooms using 100% recirculated air with simultaneous heating and cooling, hydroponics, or energy end uses not counted here such as well-water pumps and water purification systems. Minimal information and consideration of energy use, coupled with adaptations for security and privacy (off-grid generation, no daylighting, odor and noise control) lead to particularly inefficient configurations and correspondingly elevated energy use and greenhouse-gas emissions.

The embodied energy of inputs such as soil, fertilizer, water, equipment, building materials, refinement, and retailing is not estimated here and should be considered in future assessments. The energy use for producing outdoor-grown *Cannabis* (approximately two-thirds of all production) is also not estimated here.

If improved practices applicable to commercial agricultural greenhouses are any indication, such large amounts of energy are not required for indoor *Cannabis* production.³ The application of cost-effective, commercially-available efficiency improvements to the prototypical facility modeled in this article could reduce energy intensities by at least 75% compared to the typical-efficiency baseline. Such savings would be valued at approximately \$40,000/year for a generic 10-module operation (at California energy prices and \$10,000/year at U.S. average prices) (Fig. 2(a)–(b)). These estimated energy use reductions reflect practices that are commonplace in other contexts such as more efficient components and controls (lights, fans, space-conditioning), use of daylight, optimized air-handling systems, and relocation of heat-producing equipment out of the cultivation room. Moreover, strain choice alone results in a factor-of-two difference in yields per unit of energy input (Arnold, 2011).



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Fig. 2. Carbon footprint and energy cost for three levels of efficiency. (a) Indoor cannabis: carbon footprint. (b) Indoor cannabis: electricity cost. Assumes a wholesale price of \$4400/kg. Wholesale prices are highly variable and poorly documented.

5. Energy intensities in context

Policymakers and other interested parties will rightfully seek to put these energy indicators in context with other activities in the economy.

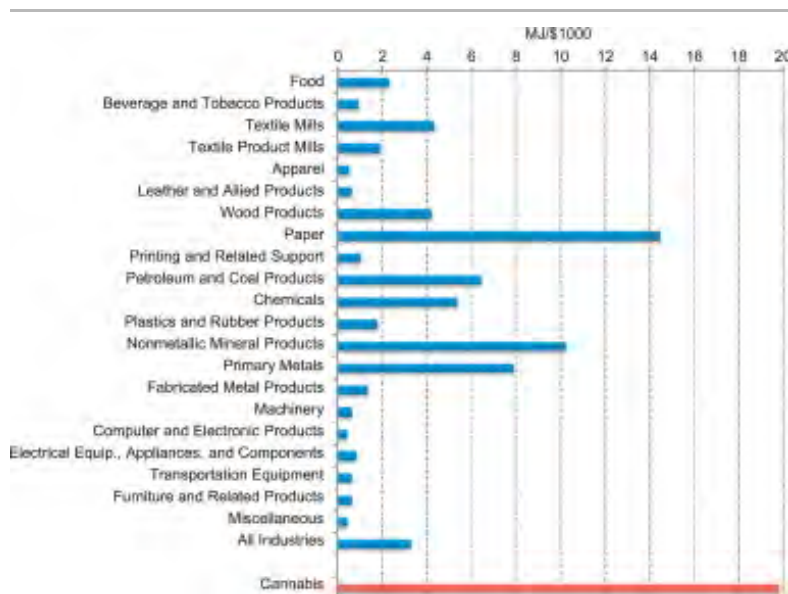
One can readily identify other energy end-use activities with far greater impacts than that of *Cannabis* production. For example, automobiles are responsible for about 33% of U.S. greenhouse-gas emissions (USDOE, 2009), which is 100-times as much as those produced by indoor *Cannabis* production (0.3%). The approximately 20 TW/h/year estimated for indoor *Cannabis* production is about one-third that of U.S. data centers (US EPA, 2007a, 2007b), or one-seventh that of U.S. household refrigerators (USDOE, 2008). These shares would be much higher in states where *Cannabis* cultivation is concentrated (e.g., one half that of refrigerators in California (Brown and

[Koomey, 2002](#))).

On the other hand, this level of energy use is high in comparison to that used for other indoor cultivation practices, primarily owing to the lack of daylighting. For comparison, the energy intensity of Belgian greenhouses is estimated at approximately 1000 MJ/m² ([De Cock and Van Lierde, No date](#)), or about 1% that estimated here for indoor *Cannabis* production.

Energy intensities can also be compared to those of other sectors and activities.

- Pharmaceuticals — Energy represents 1% of the value of U.S. pharmaceutical shipments ([Galitsky et al., 2008](#)) versus 50% of the value of Cannabis wholesale prices. The U.S. “Pharma” sector uses \$1 billion/year of energy; Indoor Cannabis uses \$6 billion.
- Other industries — Defining “efficiency” as how much energy is required to generate economic value, Cannabis comes out the highest of all 21 industries (measured at the three-digit SIC level). At ~20 MJ per thousand dollars of shipment value (wholesale price), Cannabis is followed next by paper (~14), nonmetallic mineral products (~10), primary metals (~8), petroleum and coal products (~6), and then chemicals (~5) ([Fig. 3](#)). However, energy intensities are on a par with *Cannabis* in various subsectors (e.g., grain milling, wood products, rubber) and exceed those of *Cannabis* in others (e.g., pulp mills).

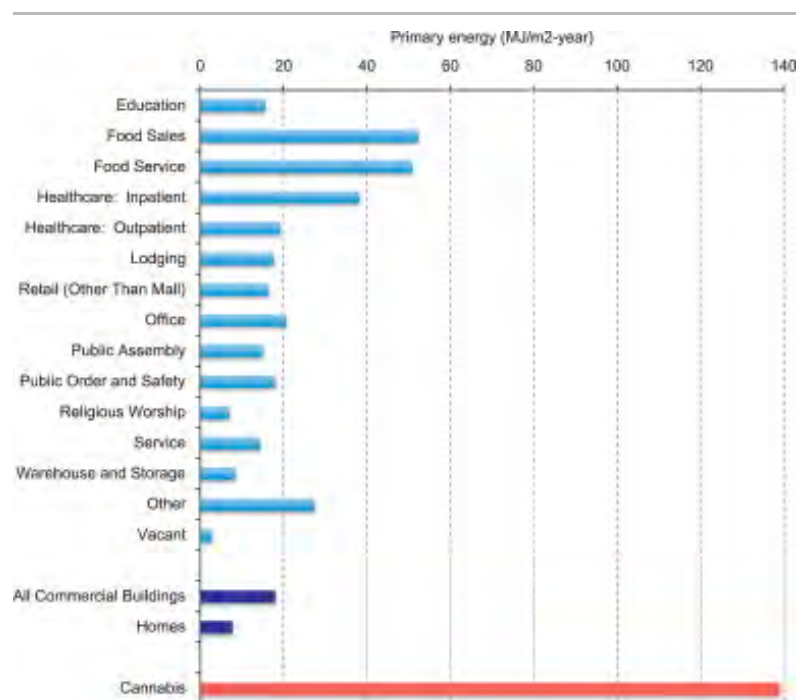


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Fig. 3. Comparative energy intensities, by sector (2006).

- Alcohol — The energy used to produce one marijuana cigarette would also produce 18 pints of beer ([Galitsky et al., 2003](#)).

- Other building types — Cannabis production requires 8-times as much energy per square foot as a typical U.S. commercial building (4x that of a hospital and 20x that of a building for religious worship), and 18-times that of an average U.S. home ([Fig. 4](#)).



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Fig. 4. Comparative energy intensities, by U.S. building type (2003).

6. Outdoor cultivation

Shifting cultivation outdoors can nearly eliminate energy use for the cultivation process. Many such operations, however, require water pumping as well as energy-assisted drying techniques. Moreover, vehicle transport during production and distribution remains part of the process, more so than for indoor operations.

A common perception is that the potency of *Cannabis* produced indoors exceeds that of that produced outdoors, leading consumers to demand *Cannabis* produced indoors. Federal sources ([National Drug Intelligence Center, 2005](#)) as well as independent testing laboratories ([Kovner, 2011](#)) actually find similar potencies when best practices are used.

Illegal clearing of land is common for multi-acre plantations, and, depending on the vegetation type, can accordingly mobilize greenhouse-gas emissions. Standing forests (a worst-case scenario) hold from 125 to 1500 t of CO₂ per hectare, depending on tree species, age, and location ([National Council for Air and Soil Improvement, 2010](#)). For biomass carbon inventories of 750 t/ha and

typical yields (5000 kg/ha) ([UNODC, 2009](#)), associated biomass-related CO₂ emissions would be on the order of 150 kg CO₂/kg *Cannabis* (for only one harvest per location), or 3% of that associated with indoor production. These sites typically host on the order of 10,000 plants, although the number can go much higher ([Mallery, 2011](#)). When mismanaged, the practice of outdoor cultivation imposes multiple environmental impacts aside from energy use. These include deforestation; destruction of wetlands, runoff of soil, pesticides, insecticides, rodenticides, and human waste; abandoned solid waste; and unpermitted impounding and withdrawals of surface water ([Mallery, 2011](#), [Revelle, 2009](#)). These practices can compromise water quality, fisheries, and other ecosystem services.

7. Policy considerations

Current indoor *Cannabis* production and distribution practices result in prodigious energy use, costs, and unchecked greenhouse-gas pollution. While various uncertainties exist in the analysis, the overarching qualitative conclusions are robust. More in-depth analysis and greater transparency of the energy impacts of this practice could improve decision-making by policymakers and consumers alike.

There is little, if any, indication that public policymakers have incorporated energy and environmental considerations into their deliberations on *Cannabis* production and use. There are additional adverse impacts of the practice that merit attention, including elevated moisture levels associated with indoor cultivation that can cause extensive damage to buildings,⁴ as well as electrical fires caused by wiring out of compliance with safety codes ([Garis, 2008](#)). Power theft is common, transferring those energy costs to the general public ([Plecas et al., 2010](#)). As noted above, simply shifting production outdoors can invoke new environmental impacts if not done properly.

Energy analysts have also not previously addressed the issue. Aside from the attention that any energy use of this magnitude normally receives, the hidden growth of electricity demand in this sector confounds energy forecasts and obscures savings from energy efficiency programs and policies. For example, [Auffhammer and Aroonruengsawat \(2010\)](#) identified a statistically significant, but unexplained, increase in the growth rate for residential electricity in California during the years when indoor *Cannabis* production grew as an industry (since the mid-1990s).

For *Cannabis* producers, energy-related production costs have historically been acceptable given low energy prices and high product value. As energy prices have risen and wholesale commodity prices fallen, high energy costs (now 50% on average of wholesale value) are becoming untenable. Were product prices to fall as a result of legalization, indoor production could rapidly become unviable.

For legally sanctioned operations, the application of energy performance standards, efficiency incentives and education, coupled with the enforcement of appropriate construction codes could lay a foundation for public-private partnerships to reduce undesirable impacts of indoor *Cannabis*

cultivation.⁵ There are early indications of efforts to address this.⁶ Were such operations to receive some form of independent certification and product labeling, environmental impacts could be made visible to otherwise unaware consumers.

Acknowledgment

Two anonymous reviewers provided useful comments that improved the paper. Scott Zeramby offered particularly valuable insights into technology characteristics, equipment configurations, and market factors that influence energy utilization in this context and reviewed earlier drafts of the report.

Appendix A

See [Table A1](#), [Table A2](#), [Table A3](#).

Table A1. Configuration, environmental conditions, set-points.

| Production parameters | | |
|--|--------------|-------------------------------------|
| Growing module | 1.5 | m ² (excl. walking area) |
| Number of modules in a room | 10 | |
| Area of room | 22 | m ² |
| Cycle duration | 78 | days |
| Production continuous throughout the year | 4.7 | cycles |
| Illumination | | |
| | Leaf phase | Flowering phase |
| Illuminance | 25 klux | 100 klux |
| Lamp type | Metal halide | High-pressure sodium |
| Watts/lamp | 600 | 1000 |
| Ballast losses (mix of magnetic & digital) | 13% | 0.13 |
| Lamps per growing module | 1 | 1 |
| Hours/day | 18 | 12 |

| | | |
|--|---|---------------------------------|
| Days/cycle | 18 | 60 |
| Daylighting | None | none |
| Ventilation | | |
| Ducted luminaires with “sealed” lighting compartment | 150 | CFM/1000 W of light (free flow) |
| Room ventilation (supply and exhaust fans) | 30 | ACH |
| Filtration | Charcoal filters on exhaust; HEPA on supply | |
| Oscilating fans: per module, while lights on | 1 | |
| Water | | |
| Application | 151 | liters/room-day |
| Heating | Electric submersible heaters | |
| Space conditioning | | |
| Indoor setpoint — day | 28 | C |
| Indoor setpoint — night | 20 | C |
| AC efficiency | 10 | SEER |
| Dehumidification | 7x24 | hours |
| CO ₂ production — target concentration (mostly natural gas combustion in space) | 1500 | ppm |
| Electric space heating | When lights off to maintain indoor setpoint | |
| Target indoor humidity conditions | 40–50% | |
| Fraction of lighting system heat production removed by luminaire ventilation | 30% | |
| Ballast location | Inside conditioned space | |
| Drying | | |
| Space conditioning, oscillating fans, maintaining 50% RH, 70–80F | 7 | Days |

Electricity supply

| | |
|--|-----|
| grid | 85% |
| grid-independent generation (mix of diesel, propane, and gasoline) | 15% |

Table A2. Assumptions and conversion factors.

| | | |
|------------------------------|--------|-----------------------------------|
| Service levels | | |
| Illuminance* | 25–100 | 1000 lux |
| Airchange rates* | 30 | Changes per hour |
| Operations | | |
| Cycle duration** | 78 | Days |
| Cycles/year** | 4.7 | Continuous production |
| Airflow** | 96 | Cubic feet per minute, per module |
| Lighting | | |
| Leafing phase | | |
| Lighting on-time* | 18 | hrs/day |
| Duration* | 18 | days/cycle |
| Flowering phase | | |
| Lighting on-time* | 12 | hrs/day |
| Duration* | 60 | days/cycle |
| Drying | | |
| Hours/day* | 24 | hrs |
| Duration* | 7 | days/cycle |
| Equipment | | |
| Average air-conditioning age | 5 | Years |

| | | |
|--|-------|--------------------------------------|
| Air conditioner efficiency [Standards increased to SEER 13 on 1/23/2006] | 10 | SEER |
| Fraction of lighting system heat production removed by luminaire ventilation | 0.3 | |
| Diesel generator efficiency* | 27% | 55 kW |
| Propane generator efficiency* | 25% | 27 kW |
| Gasoline generator efficiency* | 15% | 5.5 kW |
| Fraction of total prod'n with generators* | 15% | |
| Transportation: Production phase (10 modules) | 25 | Miles roundtrip |
| Daily service (1 vehicle) | 78 | Trips/cycle. Assume 20% live on site |
| Biweekly service (2 vehicles) | 11.1 | Trips/cycle |
| Harvest (2 vehicles) | 10 | Trips/cycle |
| Total vehicle miles** | 2089 | Vehicle miles/cycle |
| Transportation: Distribution | | |
| Amount transported wholesale | 5 | kg per trip |
| Mileage (roundtrip) | 1208 | km/cycle |
| Retail (0.25ozx5 miles roundtrip) | 5668 | Vehicle-km/cycle |
| Total** | 6876 | Vehicle-km/cycle |
| Fuel economy, typical car [a] | 10.7 | l/100 km |
| Annual emissions, typical car [a] | 5195 | kgCO ₂ |
| | 0 | kgCO ₂ /mile |
| Annual emissions, 44-mpg car** | 2,598 | kgCO ₂ |
| | 0.208 | kgCO ₂ /mile |
| Cross-country U.S. mileage | 4493 | km |
| Fuels | | |
| Propane [b] | 25 | MJ/liter |
| Diesel [b] | 38 | MJ/liter |

| | | |
|--|-------|-------------------------|
| Gasoline [b] | 34 | MJ/liter |
| Electric generation mix* | | |
| Grid | 85% | share |
| Diesel generators | 8% | share |
| Propane generators | 5% | share |
| Gasoline generators | 2% | share |
| Emissions factors | | |
| Grid electricity — U.S. [c] | 0.609 | kgCO ₂ /kW/h |
| Grid electricity — CA [c] | 0.384 | kgCO ₂ /kW/h |
| Grid electricity — non-CA U.S. [c] | 0.648 | kgCO ₂ /kW/h |
| Diesel generator** | 0.922 | kgCO ₂ /kW/h |
| Propane generator** | 0.877 | kgCO ₂ /kW/h |
| Gasoline generator** | 1.533 | kgCO ₂ /kW/h |
| Blended generator mix** | 0.989 | kgCO ₂ /kW/h |
| Blended on/off-grid generation — CA** | 0.475 | kgCO ₂ /kW/h |
| Blended on/off-grid generation — U.S.** | 0.666 | kgCO ₂ /kW/h |
| Propane combustion | 63.1 | kgCO ₂ /MBTU |
| Prices | | |
| Electricity price — grid (California — PG&E) [d] | 0.390 | per kW/h (Tier 5) |
| Electricity price — grid (U.S.) [e] | 0.247 | per kW/h |
| Electricity price — off-grid** | 0.390 | per kW/h |
| Electricity price — blended on/off — CA** | 0.390 | per kW/h |
| Electricity price — blended on/off — U.S.** | 0.268 | per kW/h |
| Propane price [f] | 0.58 | \$/liter |
| Gasoline price — U.S. average [f] | 0.97 | \$/liter |
| Diesel price — U.S. average [f] | 1.05 | \$/liter |
| Wholesale price of Cannabis [g] | 4,000 | \$/kg |
| Production | | |

| | | |
|---|-----------|--|
| Plants per production module* | 4 | |
| Net production per production module [h] | 0.5 | kg/cycle |
| U.S. production (2011) [i] | 10,000 | metric tonnes/y |
| California production (2011) [i] | 3,902 | metric tonnes/y |
| Fraction produced indoors [i] | 33% | |
| U.S. indoor production modules** | 1,570,399 | |
| Calif indoor production modules** | 612,741 | |
| Cigarettes per kg** | 3,000 | |
| Other | | |
| Average new U.S. refrigerator | 450 | kW/h/year |
| | 173 | kgCO ₂ /year (U.S. average) |
| Electricity use of a typical U.S. home — 2009 [j] | 11,646 | kW/h/year |
| Electricity use of a typical California home — 2009 [k] | 6,961 | kW/h/year |

Notes:

* Trade and product literature; interviews with equipment vendors.

** Calculated from other values.

Notes for Table A2.

[a]. [U.S. Environmental Protection Agency., 2011.](#)

[b]. *Energy conversion factors*, U.S. Department of Energy, http://www.eia.doe.gov/energyexplained/index.cfm?page=about_energy_units, [Accessed February 5, 2011].

[c]. United States: ([USDOE 2011](#)); California ([Marnay et al., 2002](#)).

[d]. Average prices paid in California and other states with inverted-block tariffs are very high because virtually all consumption is in the most expensive tiers. Here the PG&E residential tariff as of 1/1/11, Tier 5 is used as a proxy for California <http://www.pge.com/tariffs/ResElecCurrent.xls>, (Accessed February 5, 2011). In practice a wide mix of tariffs apply, and in some states no tier structure is in place, or the proportionality of price to volume is nominal.

[e]. State-level residential prices, weighted by *Cannabis* production (from [Gettman. 2006](#)) with actual tariffs and

U.S. Energy Information Administration, “Average Retail Price of Electricity to Ultimate Customers by End-Use Sector, by State”, http://www.eia.doe.gov/electricity/epm/table5_6_a.html, (Accessed February 7, 2011)

[f]. U.S. Energy Information Administration, Gasoline and Diesel Fuel Update (as of 2/14/2011) – see <http://www.eia.gov/oog/info/gdu/gasdiesel.asp> Propane prices – http://www.eia.gov/dnav/pet/pet_pri_prop_a_EPLLPA_PTA_dpgal_m.htm, (Accessed April 3, 2011).

[g]. [Montgomery, 2010](#).

[h]. [Toonen et al., 2006](#)); [Plecas et al., 2010](#).

[i]. *Total Production*: The lower value of 10,000 t per year is conservatively retained. Were this base adjusted to 2011 values using 10.9%/year net increase in number of consumers between 2007 and 2009 per [U.S. Department of Health and Human Services \(2010\)](#), the result would be approximately 17 million tonnes of total production annually (indoor and outdoor). *Indoor Share of Total Production*: The three-fold changes in potency over the past two decades, reported by federal sources, are attributed at least in part to the shift towards indoor cultivation See <http://www.justice.gov/ndic/pubs37/37035/national.htm> and ([Hudson, 2003](#)). A weighted-average potency of 10% THC (U.S. Office of Drug Control Policy, 2010) reconciled with assumed 7.5% potency for outdoor production and 15% for indoor production implies 33.3%::67.7% indoor::outdoor production shares. For reference, as of 2008, 6% of eradicated plants were from indoor operations, which are more difficult to detect than outdoor operations. A 33% indoor share, combined with per-plant yields from [Table 2](#), would correspond to a 4% eradication success rate for the levels reported (415,000 indoor plants eradicated in 2009) by the U.S. Drug Enforcement Agency (<http://www.justice.gov/dea/programs/marijuana.htm>). Assuming 400,000 members of medical Cannabis dispensaries in California (each of which is permitted to cultivate), and 50% of these producing in the generic 10-module room assumed in this analysis, output would slightly exceed this study's estimate of total statewide production. In practice, the vast majority of indoor production is no doubt conducted outside of the medical marijuana system.

[j]. Total U.S. electricity sales: U.S. energy information administration, “retail sales of electricity to ultimate customers: Total by end-use sector” http://www.eia.gov/cneaf/electricity/epm/table5_1.html, (Accessed March 5, 2011)

[k]. [California Energy Commission, 2009](#), [California Energy Commission, 2011](#).

Table A3. Energy model.

| Number of | |
|-----------|-------|
| 4x4x8-ft | Input |

| ELECTRICITY | Energy | Penetration | Rating | production | energy | Units | Hours/day | Hours/day | Days |
|---|--------|-------------|--------------|----------------|------------|-------|--------------|----------------|--------------|
| | type | | (Watts or %) | modules served | per module | | (leaf phase) | (flower phase) | (leaf phase) |
| Light | | | | | | | | | |
| Lamps (HPS) | elect | 100% | 1,000 | 1 | 1,000 | W | | 12 | |
| Ballasts (losses) | elect | 100% | 13% | 1 | 130 | W | | 12 | |
| Lamps (MH) | elect | 100% | 600 | 1 | 600 | W | 18 | | 18 |
| Ballast (losses) | elect | 100% | 0 | 1 | 78 | W | 18 | | 18 |
| Motorized rail motion | elect | 5% | 6 | 1 | 0.3 | W | 18 | 12 | 18 |
| Controllers | elect | 50% | 10 | 10 | 1 | W | 24 | 24 | 18 |
| Ventilation and moisture control | | | | | | | | | |
| Luminare fans (sealed from conditioned space) | elect | 100% | 454 | 10 | 45 | W | 18 | 12 | 18 |
| Main room fans — supply | elect | 100% | 242 | 8 | 30 | W | 18 | 12 | 18 |
| Main room fans — exhaust | elect | 100% | 242 | 8 | 30 | W | 18 | 12 | 18 |
| Circulating fans (18") | elect | 100% | 130 | 1 | 130 | W | 24 | 24 | 18 |
| Dehumidification | elect | 100% | 1,035 | 4 | 259 | W | 24 | 24 | 18 |
| Controllers | elect | 50% | 10 | 10 | 1 | W | 24 | 24 | 18 |
| Spaceheat or cooling | | | | | | | | | |
| Resistance heat or AC [when lights off] | | 90% | 1,850 | 10 | 167 | W | 6 | 12 | 18 |
| Carbon dioxide Injected to | | | | | | | | | |

Increase foliage

| | | | | | | | | | |
|---|-------|------|-------|----|-----|---|----|----|----|
| Parasitic electricity | elect | 50% | 100 | 10 | 5 | W | 18 | 12 | 18 |
| AC (see below) | elect | 100% | | | | | | | |
| In-line heater | elect | 5% | 115 | 10 | 0.6 | W | 18 | 12 | 18 |
| Dehumidification (10% adder) | elect | 100% | 104 | 0 | 26 | W | 18 | 12 | 18 |
| Monitor/control | elect | 100% | 50 | 10 | 5 | W | 24 | 24 | 18 |
| Other | | | | | | | | | |
| Irrigation water temperature control | elect | 50% | 300 | 10 | 15 | W | 18 | 12 | 18 |
| Recirculating carbon filter [sealed room] | elect | 20% | 1,438 | 10 | 29 | W | 24 | 24 | 18 |
| UV sterilization | Elect | 90% | 23 | 10 | 2.1 | W | 24 | 24 | 18 |
| Irrigation pumping | elect | 100% | 100 | 10 | 10 | W | 2 | 2 | 18 |
| Fumigation | elect | 25% | 20 | 10 | 1 | W | 24 | 24 | 18 |
| Drying | | | | | | | | | |
| Dehumidification | elect | 75% | 1,035 | 10 | 78 | W | | 24 | |
| Circulating fans | elect | 100% | 130 | 5 | 26 | W | | 24 | |
| Heating | elect | 75% | 1,850 | 10 | 139 | W | | 24 | |
| Electricity subtotal | elect | | | | | | | | |
| Air-conditioning | | | | 10 | 420 | W | | | |
| Lighting loads | | | | 10 | | W | | | |
| Loads that can be remotd | elect | 100% | 1,277 | 10 | | W | | | |
| Loads that can't be remotd | elect | 100% | 452 | 10 | | W | | | |

| | | | | | | | | | |
|--|--------------------|-------------------|-------------------|--|----------------------------------|-------------------------------|------------------------------|--------------------------------|--------------------------|
| CO2-production heat removal | elect | 45% | 1,118 | 17 | | W | 18 | 12 | 18 |
| Electricity Total | elect | | | | 3,225 | W | | | |
| FUEL | Units | Technology Mix | Rating (BTU/h) | Number of 4x4x8-ft production modules served | Input energy per module | | Hours/day (leaf phase) | Hours/day (flower phase) | Days, (leaf phase) |
| On-site CO ₂ production | | | | | | | | | |
| Energy use | propane | 45% | 11,176 | 17 | 707 | kJ/h | 18 | 12 | 18 |
| CO ₂ production → emissions | kg/CO ₂ | | | | | | | | |
| Externally produced Industrial CO ₂ | | 5% | | 1 | 0.003 | liters CO ₂ /hr | 18 | 12 | 18 |
| Weighted-average on- site/purchased | kgCO ₂ | | | | | | | | |
| Weighted average on- site/purchased | kg CO ₂ | | | | | | | | |

[Recommended articles](#)

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- ¹ This article substantively updates and extends the analysis described in [Mills \(2011\)](#).
- ² This is somewhat higher than estimates previously made for British Columbia, specifically, 2% of total Provincial electricity use or 6% of residential use ([Garis, 2008](#), [Bellett, 2010](#)).
- ³ See, e.g., this University of Michigan resource: <http://www.hrt.msu.edu/energy/Default.htm>
- ⁴ For observations from the building inspectors community, see <http://www.nachi.org/marijuana-grow-operations.htm>
- ⁵ The City of Fort Bragg, CA, has implemented elements of this in *TITLE 9 – Public Peace, Safety, & Morals*, Chapter 9.34. <http://city.fortbragg.com/pages/searchResults.lasso?-token.editChoice=9.0.0&SearchType=MCsuperSearch&CurrentAction=viewResult#9.32.0>
- ⁶ For example, the City of Boulder, Colorado, requires medical *Cannabis* producers to offset their greenhouse-gas emissions ([Barnes, 2010](#)).

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EXHIBIT E

Energy Use by the Indoor Cannabis Industry:

Inconvenient Truths for Producers, Consumers, and Policymakers

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and
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Forthcoming in *The Routledge Handbook of Post-Prohibition Cannabis Research*
Dominic Corva and Joshua Meisel (eds.), 2021¹

(Final Version May 28, 2021)

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¹ This chapter expands on a presentation entitled “*Policymakers’ Primer on Addressing the Carbon Footprint of Cannabis Production*,” delivered by E. Mills at the Council of State Governments annual meeting in December 2017 (Mills 2017).

Executive Summary

Decades spent in the shadows of the black market precluded opportunities to understand the energy use of indoor cannabis cultivation and compel the industry to keep its environmental consequences in check. Although the impacts of outdoor cultivation on ecosystems have received considerable attention, those associated with vastly more energy-intensive indoor cultivation have rarely been evaluated and integrated into policy-making, even in the post-prohibition era. Indeed, indoor cannabis cultivators continue to be passed over by most energy policy instruments developed since the energy crises of the 1970s. Moreover, some cannabis regulations are inadvertently driving energy use upwards, while “financial incentives” for energy efficiency offered to indoor growers by utility companies subsidize and legitimize polluting activities that could be performed outdoors with virtually no energy use. These anti-competitive, ill-conceived, and poorly evaluated policy efforts demonstrate that cannabis legalization is necessary but not sufficient to address environmental issues.

Even at ostensibly high energy efficiencies and use of renewable energy, indoor cultivation “optimizes the suboptimal” and cannibalizes renewable energy infrastructure developed for other purposes, which is untenable in a carbon-constrained world. Outdoor cultivation—which has sufficed for millennia and could meet all U.S. demand with only 0.01% of current farmland—is the most technologically elegant, sustainable, ethical, and economically viable approach for minimizing the rising energy and environmental burden of cannabis production.

This chapter pinpoints blind spots in regulation, outlines research and analysis needs, argues for consumer information and protections against greenwashing and industry capture of regulatory and green-certification processes, and offers recommendations for incorporating energy considerations into the broader tapestry of cannabis policy.

Following are some key needs and opportunities in the policy sphere.

- Improve transparency and require energy-use disclosure that informs environmental policymakers and other stakeholders.
- Create an improved consumer-information environment, including embodied-carbon product labeling, and raise the environmental literacy of retailers.
- Eliminate outdoor-cultivation bans, subsidies, loopholes and other anti-competitive market distortions such as prohibitions on interstate transportation that favor indoor cultivation.
- Design licensing fees with to encourage best practices.
- Develop equitable and science-based product-testing standards to avoid unnecessary crop destruction.
- Conduct market-relevant, non-proprietary research to fill information gaps.
- Ban indoor cultivation, or, where deemed politically expedient, mandate exceptionally high efficiencies and maximal use of on-site solar.

Cannabis legalization is necessary but not sufficient for addressing energy waste

Decades spent in the shadows of the black market created few opportunities to understand the patterns of energy use associated with indoor cannabis cultivation, let alone compel the industry to manage consumption and thus keep its environmental consequences in check. Cannabis production, distribution, and sale involve a myriad of energy uses, some of which are direct and others indirect (Figure 1). Drivers of energy demand and the associated greenhouse-gas emissions include creating the inputs and energy used during production, processing, managing waste, downstream retail activities, and transportation. Key decision-makers and stakeholders include policymakers, planners, producers, investors, industry analysts, and consumers.

Although the impacts of outdoor cultivation on ecosystems have received considerable attention (and do not primarily involve energy), those associated with far more energy-intensive indoor cultivation have only rarely been evaluated and integrated into policy-making, even in the post-prohibition era. Indeed, cannabis cultivators continue to be passed over by almost every energy policy instrument developed since the first modern energy crisis of half a century ago. Moreover, there are many instances of post-prohibition cannabis policies that are inadvertently driving energy use upwards, while the “financial incentives” for energy efficiency being offered to indoor cultivators by electric utility companies represent a counter-productive subsidy and legitimization of a polluting activity that could be done much more sustainably outdoors, which could meet all U.S. demand with only 0.01% of current farmland.²

The anti-competitive repercussions of ill-conceived policy and scant evaluation of policy adequacy demonstrate that legalization is necessary but not sufficient to address the associated environmental issues. These considerations intersect with more prominent cannabis policy issues such as taxation, public health and safety, interstate commerce, testing and product labeling, broader agricultural policy, water resources, and solid waste management. Particularly vexing is that even the most basic analyses are impeded by lack of rigor and lingering uncertainties about the structure and drivers of energy use and how far energy-efficiency and renewable energy can realistically go towards mitigating the associated undesirable impacts. Stemming from fundamental data gaps, even baseline studies often omit key considerations, and unwittingly suffer from unquantified biases due to problems with data collection and verification.

This chapter pinpoints blind spots in regulation, outlines research and analysis needs, argues for consumer information and protections against greenwashing and industry capture of regulatory and green-certification processes, and offers recommendations for incorporating energy considerations into the broader tapestry of cannabis policy. The balance of evidence suggests that even at ostensibly high energy efficiencies and intensive use of renewable energy, indoor cultivation “optimizes the suboptimal” and cannibalizes renewable resources previously developed for other purposes, which is untenable in a carbon-constrained world. Outdoor cultivation—which has sufficed for millennia—is the most technologically elegant, sustainable, ethical, and economically viable approach for minimizing the rising energy and environmental burden of cannabis production.

² Based on NFD’s estimate of 34.4 million pounds/year consumption, 1300 pounds/acre-year yield, and agricultural land area in the US of 312 million acres.

Direct and indirect drivers of energy use and greenhouse-gas emissions from the cannabis industry

| | |
|---|--|
| Inputs <ul style="list-style-type: none"> • Energy (embodied) • Industrial CO₂* • Water production and supply • Soil, amendments, fertilizers • Artificial growing media • Pesticides, herbicides, fungicides, rodenticides • Plastics (bagging, mulch, greenhouse sheeting, containers, irrigation, etc.) |  |
| Cultivation <ul style="list-style-type: none"> • Outdoor • Small structure (windowless)* • Large structure (windowless) • Greenhouse • Energy: lighting, cooling, heating, ventilation, odor control, CO₂ generator, dehumidification, water heat, pumping, IT, plug loads* |  |
| Processing <ul style="list-style-type: none"> • Flower drying* / freezing • Energy for producing extracts; solvents (butane, propane, ethanol, isopropyl alcohol) • Cooking/baking • Packaging • Testing labs |  |
| Waste <ul style="list-style-type: none"> • Failed/interdicted crops • Material not passing inspection • Single-use soil or artificial growing media • Plastics • Hydroponic water effluent to waste-treatment plant • Biomass residues • Transpiration water recovery |  |
| Retail <ul style="list-style-type: none"> • Facility construction • Lighting • Heating • Cooling • Ventilation • Refrigeration |  |
| Transport <ul style="list-style-type: none"> • Materials to jobsite • Workers to jobsite* • Product to intermediaries • Product to retail* • Consumer to retail* • Delivery services • Waste disposal |  |

* Items accounted for in energy-use estimates by Mills (2012).

Figure 1. Modes of energy use associated with cannabis production, distribution, and sale.

The cannabis conundrum: Drug policy is decoupled from environmental policy

Few public policy issues are as multifaceted as that of cannabis production and consumption. Quantifying the energy use and carbon footprint associated with producing cannabis and its derivative products is one of the primary and least explored policy-relevant questions. When confined to the black market, this sector could not readily access relevant expertise and information-sharing networks. However, little progress has been made in the wake of legalization efforts. To our knowledge, no state has initiated a comprehensive approach to the problem, and federal engagement is non-existent.

Windowless cannabis factory farms constantly battle local weather conditions to maintain stable round-the-clock temperatures and pump out acres of electric light brighter than the summer sun, day or night. Such industrialized cannabis cultivation facilities—whether in Fairbanks or Phoenix—must simulate and maintain artificially cloudless tropical environments while suppressing disease-causing humidity year-round. Industrially manufactured carbon dioxide (an added energy-intensive input and greenhouse gas in its own right, increasing carbon footprint on the order of 5% -- more if and as energy efficiency improves), is often injected to artificially boost plant growth. Operating the equipment³ needed to create and maintain these artificial environments can require as much energy as a similarly sized data center. Indoor cultivators cite debatable reasons for this practice: security, a more predictable product, buffering from weather and other crop hazards, maximized cash flow due to year-round production, the need for fewer employees, legislative restrictions, and the ability to achieve multiple harvests per year.⁴

As with most other environmental issues, those associated with cannabis get “shaded out” by other seemingly more pressing concerns faced by policymakers (in this case taxation, zoning, child safety, etc.). Together with the highly technical and complicated nature of how energy is used in the industry and how to quantify energy efficiency, few policymakers are even equipped to engage effectively. As a case-in-point, the IRS has been thwarted in pursuing tax-fraud cases since it cannot readily correlate reported sales volumes with utility bills.

The environmental footprint of cannabis production: Demonization or double standard?

Energy-intensive indoor cultivation has been conducted within the black market for decades. The original shift to the practice was, in part, a product of prohibition enforcement efforts that pushed growers indoors to avoid detection (Silvaggio in this volume). As will be outlined below, legalization does not intrinsically address the energy issues, and can even compound them by

³ The primary energy users are heating and cooling, dehumidification, and lighting. With conventional lighting, most of the input energy results in heat generation which needs to be immediately removed by air conditioning. Other miscellaneous energy loads can include irrigation pumps, water pre-heaters or coolers, air disinfection systems, motors to operate light-deprivation curtains, and crop dryers. Transportation (during and after production) and post-cultivation product manufacturing further contributes to energy use and carbon footprint.

⁴ This latter argument is not material, as outdoor growers using light-deprivation methods also achieve multiple harvests per year. Moreover, reducing labor intensity is contrary to the job-creation objectives of most policy makers.

encouraging the rapid scale-up of indoor facilities and otherwise altering patterns of energy use in unexpected ways.

Some industry advocates have complained that cannabis is singled out for scrutiny, while other sectors are left to their devices or otherwise pollute more. This argument is spurious (Mills 2016), as cannabis is in actuality one of the vanishingly few segments of the economy that has been largely overlooked in energy and environmental policy. Moreover, as is well established in the climate change mitigation field, there is no “silver-bullet” solution and a multitude of energy uses must be simultaneously addressed in order to meet society’s important emissions-reduction targets. It is a false choice to argue that one energy use should be addressed in lieu of another. There is no single cause of climate change, and thus no single solution. Meanwhile, the cannabis sector is arguably decades behind the rest of the economy when it comes to energy efficiency. In any case, adequate technical fixes are unlikely to be available if the demand for extraordinary levels of artificial illumination persists.

A key starting point for establishing a context for good decision-making is quantifying the level of energy use and associated greenhouse-gas emissions, and how that compares to other activities. Until less than a decade ago, no peer-reviewed public-domain assessment of cannabis energy use had been published. Early work on this question included a national scoping estimate of the issue based on the largely pre-recreational-legalization policy environment, where virtually all large-scale cultivation was conducted outdoors and indoor cultivation was predominantly windowless (Mills 2012). That said, small indoor operations were (and still are) numerous and generally not designed with energy efficiency considerations in mind.

Based on best-available information at the time, a “bottom-up” model was created based on interviews with practitioners, equipment retailers, and published guidelines for growers (e.g., Rosenthal 2010) (Mills 2012). The boundary conditions (inputs and activities resulting in energy use and greenhouse-gas emissions) represented only a subset of those depicted in Figure 1. The per-facility results compared favorably to measured data available for indoor growing operations and the aggregate energy demand estimates compared well with those subsequently made by others, including the long-range planning authorities for the Northwest power system (Northwest Power and Conservation Council 2016).

From a national vantage point, Mills (2012) found that indoor cannabis consumed 20 billion kilowatt-hours of electricity annually as of a decade ago, with additional amounts from direct fuel use, together corresponding to 15 million metric tonnes of CO₂ released into the atmosphere each year.⁵ This in turn corresponded to an expenditure of \$6 billion per year on energy, nationally, which amounted to 9% of California household electricity use, 3% of total statewide electricity use (all sectors), and 1% of electricity use nationally. Other independent estimates have found similar economy-level results. For example, indoor cultivation is estimated to require 0.6% of statewide electricity use (all sectors) in Colorado and 4% in the city of Denver (Hood 2018).⁶ Washington State also reports that indoor cultivation is responsible for one percent of the state’s overall electricity consumption (Jourabchi 2014), a number that has probably risen in the intervening years. As early as 2004, it was reported that indoor cannabis cultivation was

⁵ This analysis represented the typical small- to mid-scale indoor cultivation practices of the time and associated energy tariffs.

⁶ The City of Denver reports that 45% of its total growth in electricity demand stems from cannabis (Walton 2015).

responsible for 1% of electricity use in British Columbia (Easton 2004) which was long before the recreational legalization decision in Canada. Others have estimated cannabis energy use constitutes 3% of electricity demand in parts of Washington and 0.5 to 1% in Colorado (Remillard and Collins 2017).

For context, the aforementioned national estimate was equivalent to the emissions of 1.7 million average U.S. homes or three million cars, and was more than four-times the aggregate U.S. pharmaceutical industry energy expenditure.⁷ While part of this difference arises from the lower energy prices paid by industrial users compared to residentially-based cannabis producers of the time, it is noteworthy that the average primary energy intensity of pharmaceutical facilities (approximately 3,600 kBTU/sf-y) (Capparella 2013) is well below that of indoor cannabis cultivation facilities at around 5,500 kBTU/sf-y.⁸

An additional key finding was that the “energy intensity” (energy use per unit of floor area) in indoor cultivation facilities was vastly higher than in other common building types (Figure 2).

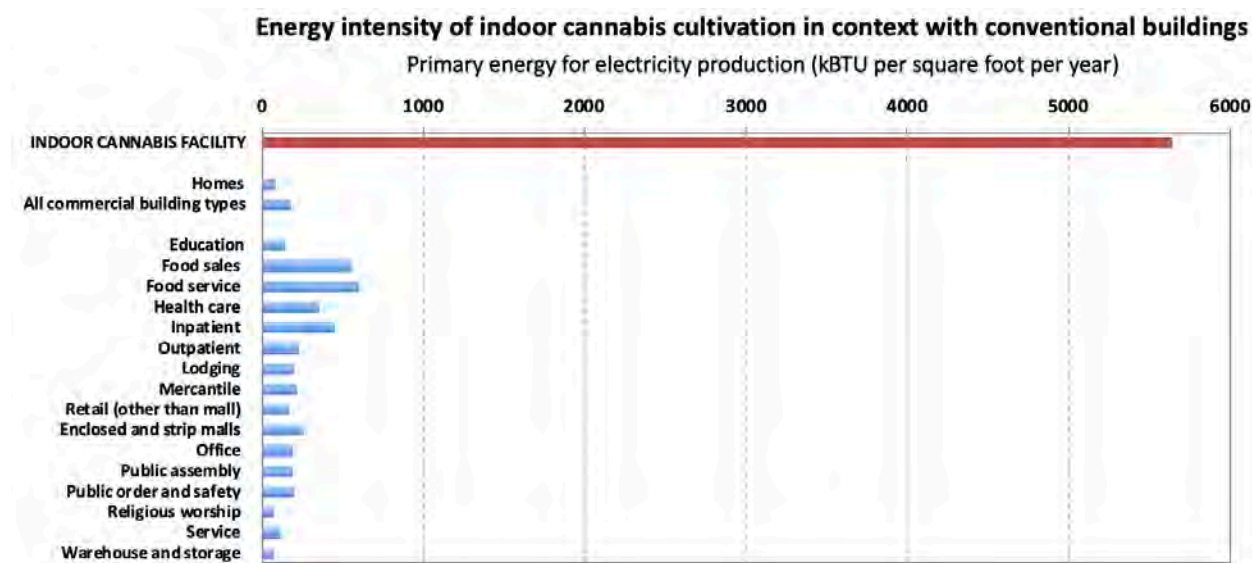


Figure 2. Cannabis energy intensity from Mills (2012). Reference data from U.S. Energy Information Administration. Homes (<https://www.eia.gov/consumption/residential/>). Commercial Buildings (<https://www.eia.gov/consumption/commercial/>)

From a regional vantage point, energy use can also be put in context by estimating how it contributes to per-person carbon emissions in economies where cannabis production is significant. While cannabis has been referred to as the largest cash crop in the U.S. in dollars (Gettman 2006), it is particularly significant in California. The implied per-person carbon footprint for the small populations in many of the cannabis-producing areas is far above the

⁷ Note that the original study (Mills 2012) put this at six-times, but the value noted here is adjusted for approximately 25% of pharmaceuticals being consumed by Americans that are produced off-shore (Altstedter 2017).

⁸ This cautiously assumes that the source of pharmaceutical industry energy is reporting in “site” energy units, i.e., not including the losses due to the inefficiencies of electricity production in power plants. The source’s estimate of 1,210 kBTU/sf-year translates to approximately 3,600 kBTU/sf-year when adjusting for this conversion factor.

averages in a state otherwise known for its energy efficiency—closer to that of the most carbon-intensive “coal” states.

From a consumer vantage point, the energy use for growing one 1-gram “joint” creates 10 pounds of carbon dioxide pollution, equivalent to running ten 10-watt LED light bulbs (or one 100-watt incandescent bulb) for 76 hours (Mills 2012). That’s as much as driving 22 miles in a 44-mpg Prius. Embedded in each average indoor-grown plant is the energy equivalent of 70 gallons of oil. A small “grow house” with ten grow lights consumes approximately as much electricity as ten average U.S. homes.

All told, the CO₂ emissions of the *average* cannabis user ranges from 16% of their total household carbon footprint in Rhode Island (the state with the nation’s lowest consumption rate) where cannabis availability is highly limited to 59% in Colorado (the nation’s highest consumption rate) where it is pervasive. Put differently, the per-capita emissions are equivalent to that from powering two high-efficiency refrigerators in Rhode Island and nine in Colorado.⁹

From a producer’s vantage point, the cost of energy use varies widely depending on energy prices, efficiency, growing techniques, and strain choice (Arnold 2011), while the business significance of the cost depends on the prevailing wholesale price of the finished product. Circa 2012, the average energy expenditure for indoor cultivation equated to approximately one-quarter to one-half of the wholesale price. As energy prices rise and wholesale prices drop (post-legalization) this ratio will become increasingly unfavorable and could even become a factor in the solvency of some producers. Indoor producers have a far more energy-sensitive business model than outdoor producers or those in other industries, and may find themselves in a boom-and-bust scenario given the magnitude of energy expenses.

Widespread cultivation in large-scale greenhouses is a relatively recent development. An analysis of industrial-scale greenhouses found that they, too, are highly energy intensive (Mills 2018), especially if poorly designed and operated. While these “hyper greenhouses” use less energy than windowless facilities per unit floor area, they still require prodigious amounts of lighting, cooling, heating, and dehumidification in most climates. As evidence of the issue, cannabis greenhouses are one reason cited for the need to update high-voltage electricity transmission lines in Canada (CBC 2019a). Data published by NFD (2018) found greenhouses in the U.S. to use half the electricity of windowless facilities on a per-square-foot basis, yet, due to their lower yields, they actually required only 25% less energy per unit weight of the finished product.¹⁰ An important caveat is that the values reported in that study do not include natural gas, which is a common heating fuel for greenhouses while heating in windowless facilities is often provided with electricity. An assessment in Canada found that greenhouses used only about one-third less energy than windowless facilities (Posterity Group 2019). The data thus suggest that these greenhouses are anything but “green”, as their energy use per unit floor area still tends to be greater than that of virtually any other commercial building type.

⁹ Per-capita cannabis consumption from *MJ Business Daily* (<https://mjbizdaily.com/chart-of-the-week-average-annual-mmj-purchases-by-state-vary-widely/>). State-specific household emissions from U.S. Department of Energy, Energy Information Administration. Assuming cultivation carbon footprint per Mills (2012).

¹⁰ Average reported values were 0.79 grams of dried flower yield per kWh for indoor facilities and 1.07 grams/kWh for greenhouses. Values elsewhere in the NFD report suggest the greenhouses were even less favorable.

A more recent attempt to estimate national energy consumption demonstrated many of the challenges of such analysis (NFD 2018). Of note, the energy used for outdoor as well as greenhouse operations was usefully contrasted with that of windowless indoor facilities, and that of legal and black-market production estimated separately. The report admirably brought forward more measured data on specific facilities than previously available in the public domain, although the sample was small (only two dozen sites with energy and yield data), self-selected, and self-reported. Almost one third of the sites used LED lights for energy savings, likely far higher than the proportion of sites adopting this technology in the overall marketplace. The analytical scope had narrower boundary conditions (excluding energy sources other than electricity within the facility as well as transportation energy, and cultivation in perhaps more energy-intensive non-industrial settings such as homes and other informal “small-scale” facilities), did not include off-grid operations often reliant on diesel generators, and was based on a non-randomized sample weighted towards milder climates in the United States. The energy intensity of black-market operations was presumably equated with that of legal operations, embodying an assumption of equivalent efficiencies not verified with actual data. Meaningful direct comparisons to the Mills (2012) study are thus not possible given the narrower boundary conditions and non-representativeness of the sample. The study indicated that some energy-intensity metrics may be improving with the passage of time, as would be expected, although more definitive surveys are sorely needed. Of particular note, the NFD study found roughly a factor of ten variation in key energy intensity metrics (electricity per square foot and per unit of flower yield), indicating enormous non-standardization of existing practices and a correspondingly large potential for energy savings irrespective of historical trends. It is not yet known whether the carbon intensity of today’s legal production facilities is lower or higher than that of earlier operations, but the recent work of Summers et al., (2021) suggests not.

* * *

There is increasing recognition of the need to manage energy use in cannabis cultivation. While it is encouraging to observe a variety of organizations developing environmental product labeling for cannabis, the methodologies often lack transparency and there is little or no direct recognition of excellence or penalties for underachievement. Organizational factors create real or perceived conflicts of interest (financial dependence on the industry and users of the product being evaluated, lack of an independent watchdog, and a chronic tension between profit or market share and rigor among certifiers which can result in the dilution of standards). It has been reported that growers will “shop” for certifications that put their product in the best light (Bennett 2019).

Despite nascent certification and labeling systems, consumers are largely unaware of the energy and environmental impacts of indoor cultivation. It is notable that the “ethical purchasing” movement (consumers seeking to vote with their dollar, e.g., to promote sustainable products) has barely appeared in the cannabis marketplace and, perhaps fearing stigmatization, environmental organizations have conspicuously sidestepped the issue (Bennett 2019). Moreover, cannabis dispensaries have been found to be unreliable sources of information on environmental issues associated with the products they sell and existing sustainability certifications for cannabis are underdeveloped, vulnerable, and lack credibility (Bennett 2017; Bennett 2020, in this volume). Consumers thus operate in an information environment that impedes good purchase decisions.

Externalities compound the social and environmental costs of indoor cultivation

In addition to the policy community's need to better understand facility-scale energy use, cannabis operations have various externalities (side effects not reflected in the prices of goods sold) that are not often considered or quantified.

These include moisture damage to buildings, nighttime light pollution, power plant emissions and other environmental impacts, power theft, and power outages and other constraints on the broader grid caused by unchecked electrical load growth. As an example of this latter issue, the city of Portland Oregon associated seven power outages over a period of five months with indoor cannabis operations (Pacific Power 2015) and Portland General Electric traced 85% of its residential transformer problems to indoor cannabis growing (Borrud 2015).

In 2010, British Columbia reported that power theft by two thirds of cannabis producers was costing the utility \$100 million per year (BC Hydro 2016). At that time cannabis was legal only for medical purposes, and most offending facilities were serving the black market.

Unpermitted or uninspected electrical wiring has been the source of a disproportionate number of fires in some localities, and the building stock has been damaged by mold and other consequences of raising humidity in buildings not intended for agricultural operations (Fire Chiefs Association of British Columbia 2008; Mills 2012). Massive fires have occurred even in legal facilities (*Reuters* 2015).

Cultivating cannabis in areas based on hydro power is often touted as an environmentally benign alternative to carbon-based power. However, attention has recently been given to the likely linkages between hydroelectric power production, reduced salmon populations, and starvation issues facing salmon-eating killer whales (*orcas*) in the Pacific Northwest (Mapes 2018; University of Massachusetts 2017). Hydroelectric power also results in substantially more water evaporation than other forms of electricity production.

Adverse public-health considerations and waste generation merit more analysis

Another form of externality—public health impacts related to energy-intensive cultivation practices—also merits close analysis. Cannabis has been widely demonstrated to offer medical benefits under the appropriate circumstances. However, the countervailing health-related dimensions of indoor cultivation—for workers and the general public—have not received much attention, although it is treated elsewhere (Schenker and Langer in this volume).

Indoor environmental conditions can be an issue for workers and consumers. For example, while mold is a common risk to product viability for indoor and outdoor cultivators alike, indoor environments can be particularly prone to mold growth that can destroy an entire crop. The risk is especially high during power outages or equipment failures when ventilation and

dehumidification processes are interrupted. Researchers have noted the potential health risks to workers of the high levels of VOCs (terpenes) emitted from cannabis plants (Plautz 2019). In another example, doubling or quadrupling of current background carbon-dioxide levels (up to 1500 ppm, to force growth) was once believed to be safe for humans but has subsequently been found to result in CO₂ levels found to significantly reduce nine distinct measures of cognitive and decision-making functioning (Fisk *et al.*, 2013; Allen *et al.*, 2015). Combustion products, such as carbon monoxide, from unvented on-site CO₂ production can also pose health hazards.

Concerns have been raised about the effect of large concentrations of plants in urban areas adversely impacting air quality through their emissions of volatile organic compounds (VOCs), which catalyze other air pollutants. A recent investigation determined that 600 cultivation facilities within the city of Denver Colorado could double the prevailing levels of VOCs, while air pollution in that city already periodically violates federal limits (Wang *et al.*, 2019).

More broadly, energy production itself has well-known health consequences, and of course is the primary source of human-generated greenhouse gases which bring their own health impacts. Mills (2012) estimated national greenhouse-gas emissions of 15 metric tons of CO₂ each year from indoor cannabis cultivation across the United States. Outdoor practices can also result in greenhouse-gas emissions from land-use change and chemical fertilizers.

Hazardous wastes associated with indoor cultivation are also understudied. The “high-intensity discharge” lamps used for most cultivation contain significant amounts of mercury (~40 mg/lamp). The extent of recycling/recovery of this mercury is unknown, and broken lamps introduce mercury into the growing facility in an uncontrolled fashion. More costly LED lights do not contain mercury. However, recycling programs for LED fixtures are not yet in place.

Indoor practices involving hydroponics (or even traditional irrigation) yield contaminated wastewater that may be introduced into or circumvent wastewater systems. Moreover, non-degrading growing media, such as mineral wool that is saturated with nutrient-laden water, is typically sent to landfill after each harvest. We estimate that an operation with 100,000 square feet of canopy requires 14,000 to 34,000 cubic feet of mineral wool per cycle, which would result in the generation of approximately to 85,000 to 200,000 cubic feet of solid waste to landfill over a year with six growing cycles. For perspective, this results in waste generation of 5- to 11-times the weight of the processed flowers.¹¹ Recycling of agricultural mineral wool is not currently available in the U.S. Indoor operations also tend not to re-use soils after each growth cycle, which is yet another large source of solid waste.

Energy efficiency and renewable energy are not enough to mitigate the problem

A key challenge intrinsic to the indoor cultivation process, and compounded by seemingly unrelated local ordinances or needs, is that these facilities tend to embody a number of counterproductive design and operational features that make energy use even higher than need

¹¹ See assumptions below in the discussion of mineral wool embodied energy.

be. For example, CO₂ injection requires facilities to be sealed and all air recirculated, which, in turn, boosts energy use significantly. Another example is the sometimes-mandated use of tall opaque walls in front of greenhouses in the name of security which can also block useful sunlight and thus require added electric lighting energy input. Location of these facilities in or near population centers requires high-resistance air filtration to control odor, which, in-turn requires increased ventilation energy to counteract the backpressure caused by the dense filter media. Heat is often run at the same time as air conditioning in an effort to control humidity that can otherwise lead to mold growth. Lastly, local light-pollution ordinances may require that light-deprivation covers be drawn over greenhouses at night (light may be on during that time, e.g., when the days are short or to capitalize on cheaper power rates), which can trap heat and thus require additional cooling energy. Lastly are a host of energy-using technologies to remove mold with UV, treat polluted water, recapture and purify waste water, etc., that are ironically used to improve the “sustainability” of indoor cultivation.

Despite these challenges, the industry has begun to look for efficiencies, likely driven more by the squeeze between falling wholesale prices and rising energy costs than by environmental concerns (Pols 2017). Aside from efficiencies (e.g., energy used per given weight of finished product), it is critical to maintain focus on trends in *aggregate* demand, especially for a growing industry. For example, Colorado reports a startling year-over-year increase of 23% in overall production (Hood 2018) and that electricity use increased by 36% annually between 2012 and 2016 (Denver Public Health and Environment 2018). Energy efficiencies cannot improve rapidly enough to offset such growth, and the preceding numbers suggest that energy intensity has actually been increasing. The energy forecasting authority in the Pacific Northwest projects an 82% increase in energy demand despite improving energy efficiency (Jourabchi 2014). A large-scale energy savings study for the province of Ontario, Canada, found a *maximum technical* potential of only 16% energy savings for indoor facilities and 21% for greenhouses (*without* accounting for limited uptake rates or cost-effectiveness) (Posterity Group 2019).

Sleek images of energy-saving LED lights and greenhouses look “green” on the surface, but the devil is in the details. These lighting systems are still quite energy intensive.¹² One experiment found that 780 Watts of LED were needed to replace 1000-1100 watts of traditional lighting (Massoud 2014) in order to maintain yields. Peer-reviewed research dating from the time these alternative lighting sources began being manufactured suggested that cannabis grown under LEDs may actually take longer to mature and have lower yield and/or potency (Pocock 2015), thus saving little if any energy on a per-weight basis (Nelson and Bugbee 2014). LED performance in these applications appears to be improving, although even more recent studies obtained mixed results (Leichliter *et al.*, 2018). However, product attributes (flower appearance) may be adversely affected by LEDs, which is a palpable market risk for producers. The up-front cost of LED lighting is also vastly higher than conventional lighting, the recovery of which requires a long time-horizon for the facility developer. Although the vast majority of indoor cultivation facility space has been constructed since LED fixtures have been available in the market, adoption rates are probably in the low single-digit percentage range. The aforementioned in-depth analysis for Canada found that the technical potential energy savings for LED lighting (without regard for cost-effectiveness or limited adoption rates) was only 7% of entire facility-

¹² One advantage of less-efficient high-intensity discharge lamps is that the heat-producing ballasts can be placed outside the conditioned space, reducing air-conditioning needs. LED ballasts are integral to the fixture and cannot be remotely located.

level energy use (Posterity Group 2019). These barriers notwithstanding, it is certainly possible to construct cultivation facilities with far higher energy efficiencies than is done at present. Indications of these opportunities as applied to the facility envelope and daylighting are provided a decade ago by Kinney *et al.* (2012).

That said, there is naïve optimism and hubris that cultivators need only “go solar” meet remaining energy needs after efficiencies have been captured. The feasibility of this has not been demonstrated at scale, probably because the required solar array would need to be many times larger than the roof of the facility, and of course could not be on the roof at all if a traditional greenhouse design is used. Even in areas with excellent solar availability, only about 5% of a facility’s electricity needs could be generated on the roof (Mills 2018). One noted large-scale facility aiming to be as sustainable as possible achieved a solar contribution of about 30% (Daniels 2019), which presumably required using a very large area of land beyond the building footprint. A ‘state-of-the-art’ facility in Canada is projecting to offset only 8% to 10% of its electricity use by covering its entire roof (CBC 2019b), emitting approximately 9,000 tons of CO₂ per year instead of 10,000 tons without the solar. Among the nation’s largest proposed facilities, with 2.4 million square feet of enclosed “cannabis industrial park”, would only provide 4% of the needed electricity from its rooftops, despite being in an optimal solar resource area on the California-Arizona border. Meeting the full electricity demand would require approximately 1,400 acres of photovoltaic panel area.¹³ An 80-megawatt dedicated natural-gas powerplant is instead proposed to provide energy (Kidder Mathews 2019). Such a generator would need to produce 1.23 TWh-y, enough to power 90,000 average U.S. all-electric homes (Figure 3).

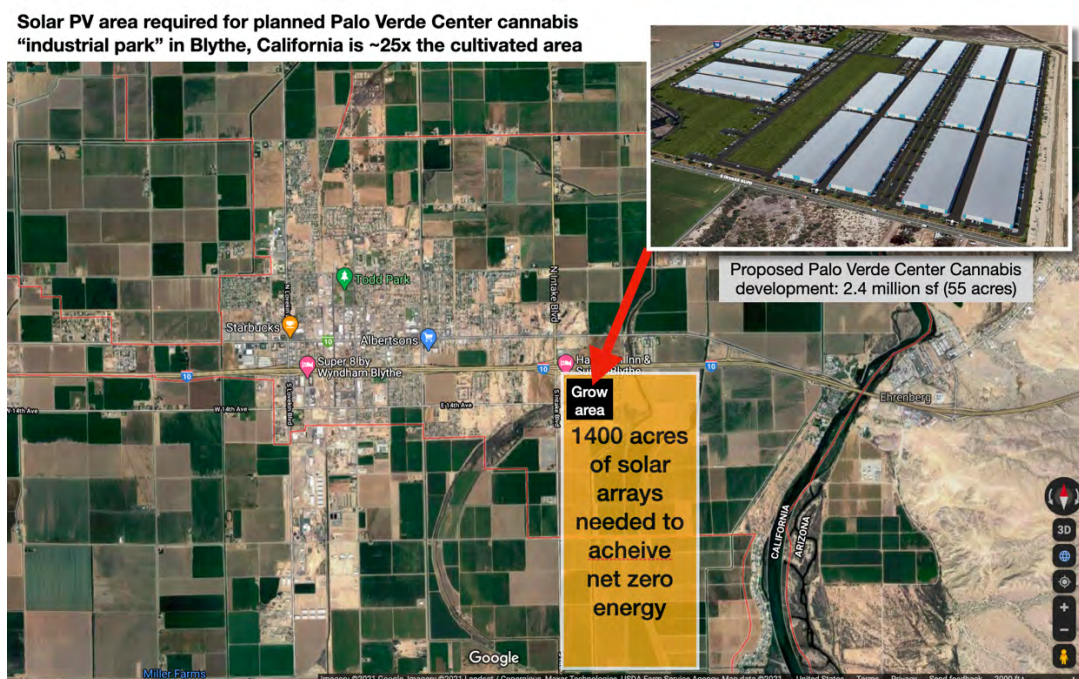


Figure 3. Hypothetical solar PV area requirements for proposed cannabis industrial park.

¹³ Array area range represents the annual electricity intensity (kWh/square foot) estimated by Mills (2012), similar to that measured in nearby Nevada (NFD 2018). Solar output per unit area estimated by Sage Energy using Helioscope software.

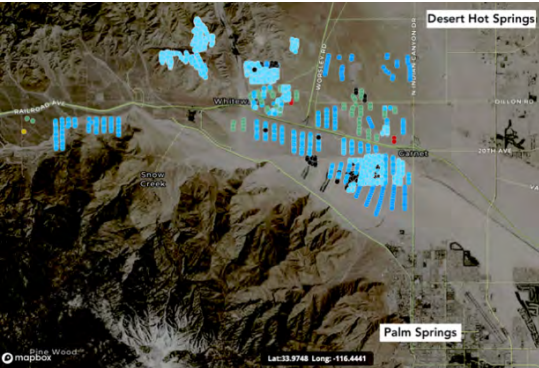
While it can be argued that cannabis industry could be powered with centralized renewable energy, the amounts required are prodigious and for practical purposes (e.g., land-use constraints) rarely achievable.

As a case in point, although California's Coachella Valley is one of the largest wind-energy production areas in that state, cannabis production there (assuming business-as-usual energy efficiencies) will soon eclipse the entire output of all 40 wind-power projects located in the area (Figure 4).

Our "bottom-up" estimate is that projects already in operation in the Coachella Valley region consume 13% as much as wind energy in the region produces, although other estimates (Daniels 2019) suggest cannabis facilities in the "west side" of Coachella Valley consume 235 megawatts, which is fully 35% the rated capacity of all wind projects in the area, and far more on an energy basis. Full build-out of existing cannabis facility entitlements would consume far more: 11-times as much electricity as can be produced by all existing wind systems in the area, and more than all the wind power generated across California. It has taken decades and the dedication of vast land areas to build up this level of wind-generation capacity. From a broader public-policy vantage point, there is an acute shortage of investment in renewable energy infrastructure to offset even existing carbon emissions, let alone emissions growth from new energy-intensive development. This comparison is a poignant illustration of the broader problematic tension between advances in renewable energy supply and unbridled growth in energy demand.



a. 2,229 wind turbines in Coachella Valley, CA



b. 663 megawatts of wind power across 40 projects



c. Large-scale indoor cannabis cultivation



d. Indoor cannabis facility, Cathedral City, CA

**Coachella cannabis energy:
build-out with entitlements (16.1 TWh/y)**

**California wind energy in 2018
(14.2 TWh/y)**

**Coachella cannabis energy:
in development or proposed (10.4 TWh/y)**

**Coachella wind energy in 2019:
(1.5 TWh/y)**

**Coachella
cannabis
energy: 2019
(0.2 TWh/y)**

e. Relative scale of electricity supply and demand

Figure 4. California's Coachella Valley is the site of 10% of the State's wind energy production. Cannabis cultivation facilities already in operation in five cities within the Coachella Valley require the equivalent of 13% of the entire electricity production of the 40 wind energy projects (2,229 turbines) located throughout the valley. This will grow to more than 70% of the area's total wind energy output upon completion of projects proposed or under development. Full build-out per existing entitlements will consume eleven-times as much power, significantly exceeding the 14 TWh/year generated by wind power in all of California. Photos: (a). Wind turbines from ecoflight.com, with permission. (b). Satellite view from Hoen et al. (2018), public domain. (c). Cultivation facility photo by the authors. (d). Rendering of Venlo-type glasshouse by Sunniva (under construction), with permission.¹⁴

¹⁴ Calculation notes: Estimated cultivated area development status in five Coachella Valley cities based on Simmons (2019), with 350,000 square feet of "canopy" as of April 2019, 19.4 million square feet proposed or under development, and 30 million square

Myths and market distortions bolster environmentally detrimental production practices

Among the fundamental preconditions for “perfect functioning” of markets is a vibrant information environment for all actors. Unfortunately, energy-relevant information in the cannabis industry is incomplete and often incorrect. One long-standing “myth” is that indoor-cultivated cannabis is superior to its outdoor counterpart. This is a commonly held view in the popular culture, and dispensaries are notorious for “bottom-shelfing” outdoor-grown products as inferior and otherwise favoring and steering customers towards indoor-grown products. Industry experts have argued to the contrary (*San Francisco Bay Guardian* 2011) and medical cannabis produced by the U.S. government is cultivated almost exclusively outdoors.¹⁵

Economic signals can also distort markets. Energy utilities earn billions of dollars per year from cannabis cultivators. While utilities play a key role in improving energy efficiency in the economy at large (assuming that policymakers ensure that investing in new energy supply is not more profitable than investing in efficient use), utilities benefit far less from outdoor cannabis cultivation and have not been observed to encourage it.

In some areas, indoor cultivators receive the historically low, subsidized electricity prices enjoyed by traditional outdoor farmers (PG&E 2017). Many agricultural customers also receive industrial rates,¹⁶ which are lower than those paid by occupants of other types of buildings (warehouses, data centers, offices, etc.). Subsidies of this sort to indoor growers make them more competitive against outdoor growers while artificially suppressing the profitability of making energy efficiency improvements or investment in renewable energy supply.

Conversely, in order to discourage indoor cultivation, some well-intended policymakers have sought to impose extreme electricity surcharges (*The Arcata Eye* 2012). In practice, however, the expected effect could be to merely trigger relocation. This may “solve” the locality’s problem, but does not address global energy concerns and can even push cultivators off-grid and onto even more polluting diesel generators for power.

In other contexts, good public policy has often included financial incentives for energy efficiency (rebates, tax credits, etc.). However, in this context, far greater energy savings can be obtained by shifting to outdoor cultivation. A perspective must be maintained that even super-efficient indoor facilities are highly energy intensive when compared to other building types (imagine the values in Figure 2 being reduced by, say, 75%). Outdoor producers are disadvantaged when their well-funded indoor competitors are subsidized with efficiency incentives such as rebates that are, in turn, paid by consumers through utility tariff “adders” (the traditional way of financing utility

feet entitled. Energy intensity is that calculated by Mills (2012). Note that while NFD (2018) cites lower average electricity intensity for some states, their value for the adjacent desert state (Nevada) in their sample is virtually identical to that used here for a California desert location. Wind energy generating capacity values are from Hoen et al (2018) and associated energy production from California Energy Commission (2019a): average wind energy production rates for 26 projects (475 MW) in the area (2.23 GWh/MW) are applied to the total installed 663 MW for the area to estimate total electricity production.

¹⁵ See <https://pharmacy.olemiss.edu/marijuana/>

¹⁶ See <https://www.eia.gov/todayinenergy/detail.php?id=16231>

rebate programs). Such incentives arguably disrupt market forces that could otherwise lead to optimally reduced energy use.

Investor roles in indoor operations also have an impact. Enormous cash infusions following initial public offerings of stock can disincentivize efficiency, particularly if investors are unaware of best practices or unequipped to evaluate the adequacy of cultivation practices. Losses arising from inefficiency of energy use (or other inputs) can be camouflaged by lack of transparency, investor ignorance of energy engineering, and the readiness of investors to compensate for shortfalls. An example of this is Canopy Growth Corporation, who, despite shrinking gross margins and being unable to post a profit from their primarily indoor-cultivation-based business was still able to attract a \$4 billion investment from Constellation Brands (Alpert 2019). Compounding these problems, cultivation-facility investors tend not to have the time horizons needed to amortize energy efficiency or renewable energy investments. More broadly, “green investment” funds must think twice before including carbon-intensive cannabis stocks.

The current policy environment increases the energy use of cannabis cultivation

Prohibition was previously blamed for the environmental impacts of cannabis cultivation, but the reality is far more complicated (Vitiello 2016). Indeed, owing to the lack of coordination between cannabis policy and environmental policy, decisions are inadvertently being made in the post-prohibition era that are compounding the energy problem.

That said, there are ample reasons to pursue regulation. For example, historically, some black-market growers have been rumored to leverage the fact of their undocumented income to take advantage of low-income electricity tariffs. This not only created an unintended cross-subsidy from other ratepayers, but the low rates also reduced their incentive to invest in energy efficiency or shift cultivation outdoors.

Local control of cannabis market regulation (e.g., at the city or county level) can lead to perverse outcomes that distort broader market conditions. For example, as noted above, the Coachella Valley in southern California has become a major hub of production due to the absence of caps on facility size, local efforts to promote the industry, and a generally permissive regulatory environment. Conversely, local ordinances set a very large minimum size for facilities at five acres (over 200,000 square feet) (Maschke 2018). As a result, very large-scale indoor cultivation is taking place in this extremely hot region, requiring far more air conditioning than in climates more naturally suited for cultivation. An engineer working in the area is quoted as estimating that cannabis cultivation facilities use about 25-times as much energy as a “standard industrial” development (Daniels 2019).

Perversely, there are many reports of localities banning outdoor cultivation as part of their legalization process, examples of which include Nevada County, California (Riquelmy 2016) and the entire state of Illinois (Thill 2019). Regulations also require all production to occur indoors in Canada (CBC 2019b). These measures are presumably taken with security in mind.

Yet, if giant internationally sanctioned opium poppy plantations for pain-management drugs can be secured outdoors (Bradsher 2014), surely cannabis farms can do so as well.

License fees are typically assessed on a per-square-foot basis and some localities stipulate equal limits to the allowable cultivation area for indoor and outdoor cultivation, thus strongly biasing choices towards high-density, energy intensive indoor operations where more crops can be produced each year.

Local officials and others have cited the odors arising from outdoor cultivation as a significant problem, and suggest the activity be restricted to indoor facilities (Johnson 2019). This of course also entails the implementation of high-resistance air filters for odor control which, as noted above, increase ventilation energy needs. This concern may be unfounded, as massive VOCs measured in the Denver regional air basin have been traced to indoor grow operations (Wang *et al.*, 2019).

Providing an example of the aggregate effect of these market distortions, an estimated 80% of licensed cannabis production in California is conducted indoors (McVey and Cowee 2018). Once indoor cultivation is endorsed (or mandated), it becomes incumbent on policymakers to ensure that the resultant energy use is not excessive. Virtually all building types and the equipment in them are subject to energy codes and standards in the United States, yet comprehensive ones appropriate for cannabis cultivation facilities have not been promulgated and the supporting research essential for standards analysis has not been conducted. Massachusetts is among the early states to grapple with this. The state has determined that a single (massive) indoor cultivation facility could result in an increase in lighting demand equal to the energy saved over many years by the state's effort to convert over 130,000 streetlights from conventional high-intensity lamps to LEDs.¹⁷ However, the state's efforts at setting energy standards have been clumsy, e.g., seeking to specify wattage limits on individual light fixtures, which could easily result in operators installing more fixtures than would otherwise be the case (Davis 2019a).

In another example of unintended energy consequences, mandatory product testing--which is certainly a potentially appropriate policy intervention--can uncover long-standing practices that yield unacceptable contamination levels in the final product. Tainted cannabis products must be destroyed, thus entailing all associated energy to be reallocated to materials that pass testing. The safety thresholds stipulated by the regulations are not necessarily based on scientific study, and nor are they consistent with standards for other consumer products. For example, there are no standards or testing for heavy metals in tobacco, despite it being known to contain them, yet testing is done at the parts-per-billion level for cannabis. Researchers have described the lack of studies on the health risks of heavy metals in tobacco (Caruso *et al.*, 2014).

Some previously black-market cultivators have found the new permitting processes under legalization to be onerous and so time-consuming that they cannot transition their businesses to the regulated market. This already appears to be having the effect of driving some legal producers back to the black market, and thus away from access to policy inducements for environmentally improved practices. As of April 16, 2019, roughly 3,000 temporary cultivation

¹⁷ Cannabis Energy Overview and Recommendations, MA Department of Energy Resources Energy and Environmental Affairs, 2/23/18, slide 6.

permits had expired and the California Department of Food and Agriculture (CDFA) had issued only 62 annual licenses and 564 provisional permits. Reports indicated that less cannabis was sold (legally) in the year after recreational laws went into effect than before. As an indicator of the size of the black market, the most recent official estimates of California's cannabis production, a report published in 2018 by the California Department of Food and Agriculture, showed the state producing as much as 15.5 million pounds of cannabis and consuming just 2.5 million pounds (ERA Economics 2017). The balance is presumably illegal export to areas where prevailing retail prices are higher.

Even where states legalize cannabis cultivation, localities that thwart implementation further reinforce black-market activity. For example, there are many counties in California where a public majority voted to legalize cannabis yet local government has banned most if not all cannabis-related business activities. According to Schroyer and McVey (2019) only 161 of California's 482 municipalities and 24 of the 58 counties allow commercial cannabis businesses. Illinois—the most carbon-intensive cannabis producer in the U.S. (Summers et al., 2021) has banned outdoor cultivation statewide.

A key example of the consequences of a resurgent black market are that off-grid cultivation using diesel generators results in an even higher “carbon footprint” (carbon per unit of electricity produced and consumed) than the electric grids in many areas -- e.g. 2.5-times higher in the case of California (Mills 2012).

Relevant to indoor and outdoor cultivation alike, cannabis regulatory practices also counterproductively influence transportation energy use. In the California regime, for example the product is typically transported at least four times between the point of cultivation and the point of consumption. Regulations require farmers to transport their product to processors, who then transport to distributors, who then transport to dispensaries. Retail consumers then transport the final product from the dispensary. Shipments of only 25 to 40 pounds between farmer and processor are not atypical. The amounts transported become progressively smaller along the supply chain, which multiplies the amount of embodied transport energy per unit weight.

Transport energy notwithstanding, one fundamental policy barrier to reducing energy use is restrictions on interstate commerce. A comparison of electricity use per unit yield in seven states found a variation of 3.4-fold and that for greenhouse-gas emissions of 26-fold, and this did not include the full range of climate severity or power plant emissions factors seen across the whole country (NFD 2018). Were the nation's supply of cannabis grown in climatically benign locations, energy use would be vastly reduced as would pressures to grow indoors.

The case of California: A cannabis-climate train wreck driven by ill-informed policymaking

California is a beacon of progressive environmental thought and has long been an engine for innovative environmental technologies and policies. State legislators have passed some of the most far-reaching climate change policies and targets in the world, notably the California Global

Warming Solutions Act of 2006 (SB-32), designed to reduce statewide greenhouse-gas emissions to a level 40% below 1990 levels by the year 2030.¹⁸

Yet, the regulatory structure established for the cannabis industry now works at cross-purposes to these overriding goals (Mills 2019). Seemingly prior to any rigorous analysis of energy impacts, the state inexplicably dictated that indoor cultivation was integral to the broader goal of legalization, creating a preordained legal “purpose” that seemingly cannot be questioned by subsequent environmental considerations. This binding purpose led to the explicit rejection of “environmentally superior” outdoor cultivation alternatives identified in the official Environmental Impact Report (EIR), despite a recognized lack of data that precluded more than cursory quantitative environmental impact analysis (California Department of Food and Agriculture 2017) and conclusions in other official reports that environmental impacts would be “negligible” (Bureau of Cannabis Control 2017).

The EIR takes several leaps of faith to conclude that the legalization program will be “beneficial” towards attaining the State’s greenhouse-gas emission reduction goals. They achieve this feat by assuming, remarkably, that overall cannabis production levels would not rise materially following legalization, while the legal fraction of production will increase from approximately 5% to 10% of statewide totals (the rest remaining in the black market) and that this increment will automatically conform with the state’s SB-32 emissions-reduction target thus rendering aggregate emissions slightly lower than without legalization.

The net effect of these analytical contortions—juxtaposed with the market and policy failures outlined earlier in this chapter, particularly the forcing of indoor cultivation in many local jurisdictions—is that California has thus far failed to grasp a rapidly closing window of opportunity to manage energy use and greenhouse-gas emissions from the cannabis industry. Few localities have made efforts to manage energy use and emissions (California Department of Food and Agriculture 2017). A highly limited building energy standards-setting process is slowly being explored, but the earliest date for possible implementation will be 2022 – a full 25 years after the state’s initial legalization of cannabis for medical use (California Energy Commission 2019b).

A large research vacuum remains

Although it has been many years since the energy issues of cannabis cultivation were first identified (Mills 2012), very little subsequent research has been conducted and thus policymaking proceeds in an information vacuum. Contributing to this problem, the cannabis industry and energy suppliers are not always forthcoming with information about current practices, and are selective about what they do release. Early work pointed out the need for open-source energy benchmarking using measured data (Mills 2012). Some studies have come forward with information of this sort, often with small samples limited to a certain region or type of cultivation (e.g., County of Boulder 2018) while other efforts are pooling and standardize the information, although based on self-selected participants and limited public access to the

¹⁸ https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB32

proprietary data.¹⁹ Also needed are improved estimates of market-scale drivers (numbers and types of cultivation facilities, consumption trends, etc.) Much more data (and modeling) are needed to get a strong handle on trends in national energy use associated with indoor cannabis production, and to understand the potential for improved energy efficiency and greenhouse-gas reductions. More broadly, measured data alone does not help improve efficiency unless it compels the adoption of improved practices and technologies.

Among the critical policy-relevant questions remaining unanswered:

Are newer large industrial-scale facilities more or less energy efficient than traditionally smaller indoor cultivation practices?

No definitive data have been presented in answer to this question. On the one hand, more efficient heating and cooling systems can be expected, but on the other hand higher ceilings and wider lanes for vehicles and equipment result in far greater volumes of air being space-conditioned. Pressure for maximum yields, which includes six or more crops per year, may also entail greater aggregate energy inputs but less per final unit weight.

How much energy is used in manufacturing extracts and other derivative products?

These processes can be energy intensive, involving equipment that creates high pressures and temperatures, post-processing, etc. In some cases, raw materials are frozen and stored prior to extraction, using added energy. Post-harvest freezing becomes more likely when there is oversupply or inertia in bringing fresh product to market due to over-production or policy obstacles.

What is the added water burden of indoor cultivation with respect to electricity production and wastewater treatment?

Conventional wisdom is that less direct irrigation water is needed for indoor cultivation, thanks to reduced evaporation, and irrigation efficiencies may be improving with industrialized processes. However—and of particular relevance to the many drought-stricken parts of the country—the massive amounts of water steadily evaporated from dams and cooling towers while producing the electricity destined for indoor cultivation facilities vastly exceeds the direct irrigation water needed to grow outdoors. Based on a rule-of-thumb of one gallon of water per plant per day and the water intensity of average U.S. electricity production at the electricity intensities of Mills (2012) and seven liters of cooling water per kilowatt-hour (per Torcellini *et al.*, 2003), indoor cultivation indirectly consumes about 18-times as much water (~1300 gallons per plant) as the amount used for direct irrigation. Amounts will vary locally depending on practices and electric generation mix in the grid. Ironically, the most water-intensive mode of electricity production is otherwise environmentally lower-impact hydroelectric power. Meanwhile, the greenhouse-gas emissions associated with the electricity used to power indoor grows are fueling future droughts. The demands on wastewater treatment plants (and their energy use) must also be considered.

¹⁹ See <https://powerscore.resourceinnovation.org>

How much energy and emissions are embodied in inputs, equipment, and facilities used for cultivation?

The energy use in making soils (or single-use growing media), soil amendments, and pesticides for cannabis production has not been quantified. Nor has that for constructing facilities and the mechanical equipment that goes into them. Soils or other growing media are typically discarded after each indoor growing cycle, making this an ongoing stream of solid waste and embodied energy. As an illustration, we estimate that the mineral wool often used as a growing media in hydroponic indoor cannabis-cultivation operations increases the overall carbon footprint of the final cannabis product by approximately 5% to 11%, depending on cultivation practices (and likely more given that it is manufactured in areas with substantially higher electricity-related greenhouse-gas emissions than those assumed here).²⁰ In another example, peat that is mined as a soil amendment destroys an important stable carbon sink in the environment. Meanwhile, agricultural activities of all kinds consume about a billion pounds of plastic, a petrochemical product, annually in the United States alone (Grossman 2015).

How much energy is embodied in producing cannabis products that never reach market?

The cannabis industry has been engaging in overproduction. Recent reports from Canada indicate extraordinary levels of overproduction, with only 4% of cannabis produced there reaching the market (McBride 2019). Technical problems during cultivation cycles (temperature excursions and mold outbreaks) can result in total crop losses, and, for black market actors, interdiction also results in product not reaching the market. Product failing quality testing must be destroyed. The additional energy consumption associated with these factors has yet to be estimated but could be very significant.

How much transportation energy is involved, and how can that be minimized?

The smaller the quantity of cannabis transported the greater the per-unit transportation emissions. In the original 2012 study (Mills 2012), transportation energy amounted to about 15% of the total carbon footprint. Vertically integrated operations (with co-located production, processing, and retail) may well reduce transportation energy requirements.

What is the ongoing role of black-market cultivation, which escapes measurement?

There is a tendency to assume that with legalization “all” production shifts to a new footing. In practice black-market cultivation has remained dominant, and may well have a distinctly different energy and carbon profile than industrialized operations. Misdirected policy measures appear to be *enlarging* the black-market share of total production, which escapes regulation altogether. In California, for example, permitting has resulted in large amounts of paperwork and long periods of suspended operations. Fees in that state for a

²⁰ Per Mills (2012), the grid-based electricity related emissions of CO₂ are 8.1 kg CO₂ per square foot for each indoor cannabis growth cycle. Per Bribian *et al.*, (2010), the lifecycle emissions of mineral wool are 1.511 kg CO₂ per kilogram for average European conditions. This emissions factor depends heavily on electricity generation mix. A value of 2.736 was determined by Aivazidou (2013) for conditions in Greece (where the electric system is heavily dependent on lignite coal). Much U.S. manufacturing occurs in Mississippi and West Virginia, where electricity-related CO₂ emissions are much higher than U.S. averages, which, in turn, are substantially higher than European-average emissions upon which Bribian *et al.*'s analysis is based. Mineral wool usage calculations are based on specific weight of 1.8 kg per cubic foot of mineral wool (per Grodan manufacturer's specs) and a range of material use in cultivation of 0.14 to 0.34 cubic feet (0.26 to 0.61kg) per square foot of growing area per growing cycle. This yields 0.38 to 0.92 kgCO₂/sf-cycle, or 5 to 11% of the energy-related emissions. This analysis generously assumes that yields are two pounds per light per cycle in industrial grow operations.

“medium” indoor facility (10,001-22,000 square feet) can be \$80,000 per year, which can discourage participation in the regulated market (Bodwitch et al., 2019). NFD (2018) estimates that black-market operations are still responsible for three-quarters of the energy used to produce cannabis nationally. Non-uniform policy among the states is a significant driver of the black market, and also fosters illegal transportation to states without legalization.

Policy solutions

Previously, policymakers’ focus on the environmental impact of cannabis has been centered on outdoor cultivation, and even those efforts have been deemed highly inadequate by some observers (Carah *et al.*, 2015). The past California Lieutenant Governor’s 2015 report on the topic doesn’t once mention energy considerations (Blue Ribbon Commission on Marijuana Policy 2015).

Solutions to the problems of indoor cultivation must begin with earnest policymaker engagement. Sadly, as leading promulgators of energy R&D and policy at the national level, the U.S. Department of Energy and the U.S. Environmental Protection Agency, federal entities with decades of jurisdiction and impactful work on energy efficiency through all segments of the economy, remain silent on the topic. Due to absence of legalization at the federal level, these agencies even back away from research on issues that could have significant public health and welfare implications (Plautz 2019). Moreover, vanishingly few policymakers at the state level, even in states with varying degrees of legalization, have embraced the issue. Notable exceptions are Massachusetts and Illinois, which have taken initial steps in the form of energy-related building codes, although the quality of the outcomes is uncertain.

Following are some key needs and opportunities in the policy sphere.

Gather and publish more representative and useful energy data. A start has been made on collecting measured data for actual facilities, but it is far from being representative of the market or having the resolution necessary to evaluate specific regions, cultivation practices, or facility types. It is essential to have third-party quality control and to ensure that these data are unbiased. An acute challenge here is that energy data in this industry—as for any energy-intensive industry—is regarded as highly proprietary. Producers as well as utilities are reluctant to disclose information. Lessons may be taken from the IT sector, in which there is now ample transparency of energy use in data centers and other high-tech facilities, despite prior concerns about the sensitivity of this information. In any case, raw data on energy use doesn’t in and of itself identify rates of adoption of efficient technologies, best practices, or help facilities know how to improve. Action-oriented benchmarking can achieve these latter objectives (Mills 2015).

Improve transparency and require energy-use disclosure. Mandatory public disclosure of total energy use as well as efficiency metrics for many types of non-residential buildings is becoming widespread nationally,²¹ but the cannabis industry has thus far been passed over by these initiatives. Disclosure of this information could fill information voids that currently impede

²¹ See <https://database.aceee.org/state/building-energy-disclosure>

sound decision-making on the part of investors, energy companies, local authorities, cultivators, and consumers. More transparency regarding the role of energy expenses in business cost structures can help identify inefficiencies that create energy waste, as well as help to develop best practices. Permitted cultivators are typically required to report plant counts, the number of cropping cycles and the total amount harvested from each crop. Requiring cultivators to report the facility type and equipment deployed during each cropping cycle along with the aggregate energy used as well as energy per unit crop finished weight could provide additional valuable data for policy analysts.

Create an improved consumer information environment, including product labeling. Policy attention should be focused on consumer education and credible product labeling to enable more informed consumer choice and guard against the greenwashing that is today prevalent. Prior to distribution, producers are generally required to submit their products for testing and to make some of that information available to consumers through product labels. It would be a benefit to consumers to also have information regarding the methods used to produce the products and the associated carbon footprint. Dispensaries have a key role to play in this process and budtenders can help encourage decarbonization by educating customers and promoting products that are produced using the most environmentally benign methods.

Eliminate anti-competitive market distortions favoring indoor cultivation. Subsidies to indoor cultivators (grants, tax credits, energy rebates, etc.) mask price signals that would otherwise help markets function correctly. Awarding preferential electricity tariffs or cash incentives for new equipment disadvantages outdoor growers who have a vastly lower carbon footprint. Subsidies of all forms should be eliminated when they result in added energy use. Alternatively, it has been proposed that instead of utilities providing financial incentives to “efficient” indoor growers, that they incentivize outdoor cultivators, which achieves the greatest energy savings (Davis 2019b).

Allocate a portion of licensing fees to help address externalities. Licensing fees for indoor operations are often higher than those for outdoor operations. This “signal” could be further improved by incorporating some fee-proportionality to energy intensity, with an appropriate portion of resulting fees reinvested in improving energy efficiency. Note that there is a tremendous loophole in the current California license fee structure: greenhouses regardless of how many supplemental lights they incorporate, are virtually exempt from indoor cultivation fees, yet, as noted above, their energy use is substantial.

Develop science-based product-testing standards to avoid unnecessary crop destruction. To minimize unnecessary destruction of energy-intensive finished products, more effort is needed to ensure that required residue levels are realistic and in line with other consumer products such as tobacco and alcohol. Rather than requiring immediate destruction of products, quarantined products should be remediated where possible. Methods such as advanced distillation and micro-filtration have been used to remove pesticides, heavy metals, mold, and other contaminants.

Conduct market-relevant open-source research and development. Public-sector R&D has a long and successful track record of compensating for market failures where private industry does not independently pursue technological pathways that are in the broader public interest (Mills

1995). Where there is lack of political will to mandate that all production be conducted outdoors, R&D can inform strenuous interventions to address the damage of any compromise position. These include better engineering and design tools for designers, labeling of energy using componentry, and mandatory efficiency standards. Other promising avenues include plant genetics to minimize energy (and water) requirements, development of large-scale energy benchmarking and disclosure initiatives, impartial technology assessments, and peer-reviewed best-practice guidelines.

* * *

Where policymakers insist on subsidizing indoor growers – to the anticompetitive disadvantage of outdoor growers – the thresholds for eligibility should be uncompromising. Arguably, only “Net Zero” facilities, i.e., those that generate all their energy on-site with zero-carbon methods (typically solar photovoltaic cells) should be allowed. Hundreds of net-zero non-residential buildings have been constructed around the country (NBI 2018), but there is no evidence that this has yet been accomplished for cannabis production.

Conclusions

Cannabis policy and environmental policy must be harmonized. Until then, some of the nation’s hardest-earned progress towards climate change solutions is at risk as regulators continue to ignore this industry’s mushrooming carbon footprint. Thanks to this inattention, producers have enjoyed a climate-change double standard (and lack of support) while being passed over by a host of policies and programs successfully improving energy efficiency and deploying renewable energy into virtually every other segment of the economy.

Those citing climate pollution as a reason not to legalize cannabis are missing the point: legalization is necessary—but not sufficient—for addressing the problem. Yet, if done poorly, legalization can make the problem far worse. Indeed, history may judge today’s cannabis policymakers as betraying the public trust by enabling an industry with such a large carbon footprint.

Many are eager to see an industry more forthcoming about its carbon footprint and one that signals more hands-on interest in managing it and raising consumer awareness. A key factor in this process is individual consumer choice and expectations, which sends signals back to the market that ultimately help shape production choices and processes.

The continuation of indoor cultivation does not appear to be defensible on energy and environmental grounds. It may be argued that energy use can be reduced with large investments in energy efficiency or offset with renewable energy generation. However, this is an optimization of a suboptimal activity. These resources could be used more productively in other arenas where essentially zero-energy methods (i.e., outdoor cultivation, which has met humankind’s needs for five millennia) are not available. Meanwhile, zero-net-energy indoor cannabis production facilities have not been demonstrated, presumably because of the enormous area (and cost) of the required solar arrays. Even with zero-net-energy indoor practices, other issues such as mercury in lighting, embodied energy in buildings and equipment, water use, and solid waste production remain concerns.

Proficiency in accomplishing the unnecessary will not yield true sustainability. Myopic optimization of an activity that does not have to be conducted in the first place is not a legitimate response to the very real risks society faces from climate change. The ethical integrity of indoor cultivation—even at the greatest imaginable "stretch" levels of energy efficiency and renewable propulsion—is in question. This is a pressing issue for producers, policymakers, and consumers alike.

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EXHIBIT F



Dominant volatile organic compounds (VOCs) measured at four *Cannabis* growing facilities: Pilot study results

Vera Samburova, Mark McDaniel, Dave Campbell, Michael Wolf, William R. Stockwell & Andrey Khlystov

To cite this article: Vera Samburova, Mark McDaniel, Dave Campbell, Michael Wolf, William R. Stockwell & Andrey Khlystov (2019) Dominant volatile organic compounds (VOCs) measured at four *Cannabis* growing facilities: Pilot study results, Journal of the Air & Waste Management Association, 69:11, 1267-1276, DOI: [10.1080/10962247.2019.1654038](https://doi.org/10.1080/10962247.2019.1654038)

To link to this article: <https://doi.org/10.1080/10962247.2019.1654038>



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Dominant volatile organic compounds (VOCs) measured at four *Cannabis* growing facilities: Pilot study results

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ABSTRACT

In recent years, sale of recreational marijuana products has been permitted in several states and countries resulting in rapid growth of the commercial cannabis cultivation and processing industry. As previous research has shown, biogenic volatile organic compounds (BVOCs) emitted from plants can react with other urban air constituents (e.g., NO_x, HO radical) and thus negatively affect regional air quality. In this pilot study, BVOC emissions from *Cannabis* plants were analyzed at four grow facilities. The concentrations of measured BVOCs inside the facilities were between 110 and 5,500 µg m⁻³. One adult *Cannabis* plant emits hundreds of micrograms of BVOCs per day and thus can trigger the formation of tropospheric ozone (approximately 2.6 g day⁻¹ plant⁻¹) and other toxic air pollutants. In addition, high concentrations of butane (1,080–43,000 µg m⁻³), another reactive VOC, were observed at the facilities equipped with *Cannabis* oil extraction stations.

Implications: High concentrations of VOCs emitted from *Cannabis* grow facilities can lead to the formation of ozone, secondary VOCs (e.g., formaldehyde and acrolein), and particulate matter. Our results highlight that further assessment of VOC emissions from *Cannabis* facilities is needed, and this assessment is one of the key factors for developing policies for optimal air pollution control.

PAPER HISTORY

Received April 23, 2019

Revised July 21, 2019

Accepted August 01, 2019


Introduction

It is well-known that vegetation is the largest source of atmospheric biogenic volatile organic compounds (BVOCs) (Atkinson and Arey 2003), contributing a significant fraction (approximately 89%) of the total atmospheric VOCs (Goldstein and Galbally 2007). Trees and other types of vegetation emit BVOCs, such as isoprene, pinenes, and terpenoid compounds (Fuentes et al. 2000). Sindelarova et al. (2014) reported that the mean total global emission of BVOCs is 760 Tg (C) year⁻¹, with main constituents such as isoprene (70%), monoterpenes (11%), and sesquiterpenes (2.5%). The average global isoprene emission was found to be 594 Tg year⁻¹, while for North America, it was 34.5 Tg year⁻¹. The principle reactions of BVOCs are with the hydroxyl radical (HO), ozone (O₃) and the nitrate radical (NO₃) (Fuentes et al. 2000). Since the lifetimes of major BVOCs ranges from minutes to a few hours (Atkinson and Arey 2003), they play a major role in the chemistry of the lower troposphere. For example, the lifetime of the most abundant BVOC, isoprene, is 1.4 hours with respect to its reaction with HO radical

(Atkinson and Arey 2003), assuming that HO radical concentration is 2×10^6 cm⁻³. Emitted in the air BVOCs react with HO, NO₃ and O₃ to yield products that react with nitrogen oxides and form pollutants such as ozone, formaldehyde, acetaldehyde, and acrolein (Li et al. 2016; Papiez et al. 2009; Seinfeld and Pandis 2016). Some of these pollutants are potentially hazardous compounds. Tropospheric ozone, for example, is one of the criteria air pollutants (Atkinson 2000; Logan 1985), which, in high concentrations, has harmful effects on human health (Brunekreef and Holgate 2002; Gryparis et al. 2004; Yang et al. 2003) and the environment (Chuwah et al. 2015; Dickson et al. 2001; Mills et al. 2011). Papiez et al. (2009) found that BVOCs emitted by landscaped vegetation contribute significantly to ozone growth rates in the Las Vegas region and should be considered as one of the sources of ozone air pollution. The oxidation of higher molecular weight VOCs and BVOCs produces secondary organic aerosol particles (SOA) that may be even more harmful than ozone (Claeys et al. 2004; Hoffmann et al. 1997; Katsouyanni et al. 2001).

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Because of the importance of atmospheric photochemical reactions, the estimation of atmospheric VOC emissions, including BVOCs, is needed where NO_x emissions are high. *Cannabis* facilities are typically built in urbanized areas near automobile roads, which are known areas of high NO_x concentration. These facilities can be a source of large amounts of BVOC and VOC generated during the production of *Cannabis* products. The oxidation of highly reactive BVOCs from *Cannabis* plants can lead to the formation of ozone and secondary VOCs (e.g., formaldehyde and acrolein). In recent years, the *Cannabis* market has increased drastically since the sale of recreational marijuana has been permitted in several states. At the same time, not much information on BVOC emissions from *Cannabis* is currently available. Therefore, identification of the speciated VOCs at commercial *Cannabis* facilities is needed. The goal of this pilot study is to characterize and quantitatively analyze VOC emissions at commercial *Cannabis* grow facilities and identify what future steps should be taken to evaluate their contribution to photochemical processes and production of potentially harmful compounds. In this project, 80 individual VOCs, both biogenic and anthropogenic, were measured at four different *Cannabis* producers located in California and Nevada. To our knowledge, this study is the first attempt to obtain a detailed profile and concentrations of VOCs at commercial *Cannabis* grow facilities.

Experimental

Materials and methods

To accurately identify and quantify BVOCs, a standard mixture of VOCs (Table S1) was purchased from Apel-Reimer Environmental Inc. (Broomfield, CO, USA) and a standard mixture of *Cannabis* VOCs (Table S2) was obtained from Restek (Restek Corporation, Bellefonte, PA, USA).

VOC sampling and analysis

VOC sampling canisters were cleaned prior to sampling by repeated evacuation and pressurization with humidified zero air (Airgas, Inc., Radnor, PA, USA), as described in the EPA document “Technical Assistance Document for Sampling and Analysis of Ozone Precursors” (U.S.EPA 1998, 2009) (Supplementary Material).

Canister samples were analyzed for BVOC and non-BVOC species using gas chromatography instrument coupled with mass spectrometry and flame ionization

detectors (GC-MS/FID) according to EPA Method TO-15 (U.S.EPA 1999). The GC-MS/FID system includes a Lotus Consulting Ultra-Trace Toxics sample pre-concentration system built into a Varian 3800 GC with FID coupled to a Varian Saturn 2000 ion trap MS. The detailed description is presented in the Supplementary Material.

Calibration of the GC-MS/FID system was conducted with a mixture that contained hydrocarbons commonly found in the air (Table S1) in the range of 0.2 to 10 ppbv. Calibration of *Cannabis* VOCs was performed using a standard mixture of terpenes (Table S2). Five point external calibrations were run prior to analysis, and one calibration check was run every 24 hours. If the response of an individual compound was more than 10% off, the system was recalibrated. Replicate analysis was conducted at least 24 hours after the initial analysis to allow re-equilibration of the compounds within the canister.

Sampling and calculation of emission rates

All the facilities where the VOC samples were collected are commercial indoor-growing *Cannabis* facilities. One facility was located in California, and another three were in the state of Nevada. Measurements in Nevada were conducted at three locations within an urban area of Reno and Sparks, while the area around the facility in California can be characterized as suburban/rural. At all facilities, the rooms had no access to natural light, and they were equipped with high-pressure sodium (HPS) lamps. The relative humidity inside the grow rooms was 50%–60%, and the temperature was 24–28°C. The air in the grow rooms was well mixed with fans during the sampling (Figure S1, Supplementary Material). At all tested facilities, the sampling was conducted when the plants were at their flowering grow stage and their buds had reached full maturation. The plants cultivated were a mixture of *Cannabis Sativa*, *Cannabis Indica*, and hybrid strains. To sample the VOCs, a Teflon sampling tube was positioned 30 cm above the *Cannabis* canopy and the other end attached to the canister medium-volume sampler. The samples were collected in different rooms: the grow room, where plants are grown under controlled conditions; the curing room, where drying and aging of the harvested buds is performed; and the purging room, where removal of any residual solvents (e.g., liquid butane) is performed from the *Cannabis* concentrate using a vacuum oven or hot water bath. The data on plant strains and other growing conditions (fertilization, soil type, etc.) were not released to us.

Table 1. Concentrations of BVOCs and non-BVOCs at four different *Cannabis* grow facilities; *facilities with extraction stations; the standard deviations were calculated based three (in some cases two) replicate canister samples collected simultaneously; grow room is a room where plants are grown under controlled conditions; curing room: where drying and aging of the harvested buds is performed in a controlled environment; purging room: where removal of any residual solvents (e.g., liquid butane) is performed from the *Cannabis* concentrate using a vacuum oven or hot water bath.

| Facility name | Total BVOCs, $\mu\text{g m}^{-3}$ | % of the total VOCs | Total non-BVOCs, $\mu\text{g m}^{-3}$ | % of the total VOCs | Ratio: non-BVOCs/ BVOCs |
|----------------------------|--------------------------------------|---------------------|--|------------------------|-------------------------------|
| *Facility 1. | | | | | |
| Outside | 0.12 \pm 0.01 | 1 | 15 \pm 1 | 99 | 125 |
| Curing room | 863 \pm 95 | 19 | 3764 \pm 226 | 81 | 4.4 |
| Grow room | 1563 \pm 172 | 53 | 1374 \pm 82 | 47 | 0.9 |
| Facility 2. | | | | | |
| After C-scrubber | 25 \pm 1 | 30 | 59 \pm 7 | 70 | 2.4 |
| Grow room (light/fan: off) | 5502 \pm 55 | 99 | 51 \pm 6 | 1 | 0.01 |
| Grow room (light/fan: on) | 634 \pm 4 | 90 | 71 \pm 9 | 10 | 0.11 |
| *Facility 3. | | | | | |
| Outside | N/A | - | N/A | - | - |
| Grow room | 196 \pm 4 | 3 | 6686 \pm 152 | 97 | 34 |
| Purge room | 1005 \pm 90 | 2 | 49431 \pm 2482 | 98 | 49 |
| Facility 4. | | | | | |
| Outside | N/A | - | N/A | - | - |
| Grow room | 112 \pm 55 | 72 | 44 \pm 3 | 28 | 0.4 |
| Cure room | 1055 \pm 517 | 96 | 42 \pm 3 | 4 | 0.04 |

The emission rates (ERs) of target compounds produced by *Cannabis* plants were measured only at Facility 2 that had one grow room (Table 1). The ERs derived assuming the growing room has well mixed air and losses of compounds due to depositions on walls and other surfaces were not considered. In order to obtain the ERs, BVOC concentrations were measured during steady state, when exhaust fan was on, and 10 min after the exhaust fan was turned off. The increase in concentrations was used to calculate the ERs (in $\text{mg min}^{-1} \text{plant}^{-1}$) of each individual VOC per time unit per plant:

$$ER_i = \frac{(C_{fan \text{ off}} - C_{fan \text{ on}}) \times V_{room}}{t \times N_{plants}} \quad (1)$$

where: $C_{fan \text{ off}}$ – concentration of individual BVOC (mg m^{-3}) after the exhaust fan was turned off, $C_{fan \text{ on}}$ – concentration of individual BVOC (mg m^{-3}) before the exhaust fan was turned off, t – time while the fan was off (10 min); V_{room} – volume of the room (m^3); N_{plants} – number of plants in the room.

Calculation of relative ozone formation potential of emitted BVOCs

Ozone formation potentials (OFP) are widely used to estimate the potential of individual VOC to form ozone in the air. While there are different possible methods of estimating OFP, here we use the concept of maximum incremental reactivity (MIR) that is based on incremental reactivity (Carter 1994). Carter defines

incremental reactivity (IR) as the change in the O_3 mass concentration ($\Delta[\text{O}_3]$) due to an incremental change in the mass concentration of a VOC ($\Delta[\text{VOC}]$) for standard conditions, Equation (2).

$$IR = \frac{\Delta[\text{O}_3]}{\Delta[\text{VOC}]} \quad (2)$$

To estimate maximum incremental reactivity, a standard VOC mixture is chosen and a series of simulations are made for varying concentrations of NO_x . There will be a NO_x level where the IR values reach a maximum, the MIR point (Carter 1994; Stockwell, Geiger, and Becker 2001). At the MIR point more simulations are made with incremental variations of individual VOCs to calculate MIR values from Equation (2). Note that the MIR point is at a NO_x level where O_3 production is very limited by the available VOC. Carter with the California Air Resources board performed these calculations (Carter 1994, 2009) and they provide tables of standard MIR values for individual VOC on the California Air Resources Board website (ARB 2012).

Here, the OFP of each measured emitted BVOC was estimated by multiplying its mass emission rate by its MIR value using the following equation:

$$OFP_i = ER_i \times MIR_i \quad (3)$$

where: ER_i – mass emission rate for individual VOC ($\text{mg plant}^{-1} \text{day}^{-1}$);

MIR – maximum incremental reactivity in $\text{mg-O}_3 \text{mg-VOC}^{-1}$.

The relative OFP of the measured BVOC mixture was calculated by summing the OFPs for the mixture and dividing each OFP_i to determine the percent relative OFP (%OFP).

$$\%OFP = \frac{OFP_i \times 100\%}{\sum OFP_i} \quad (4)$$

Results and discussion

Concentrations of BVOCs and nonbiogenic VOCs measured at four *Cannabis* facilities are presented in Table 1. The variation of VOC levels between facilities and rooms depends on several factors, such as the number of plants and their growing stage, the performance of ventilation systems, the size of facility rooms, and the presence of other VOC sources. Overall, VOC levels are specific for each individual facility. The highest concentration of the total BVOCs was observed at Facility 2 ($5502 \pm 55 \mu\text{g m}^{-3}$), when the fan was off and BVOCs accumulation was the largest. The lowest

BVOC concentration was in the grow room of Facility 4 ($112 \pm 55 \mu\text{g m}^{-3}$), even though in this room the number of plants per volume of the room was the highest among grow rooms at other facilities (Table S3). The total BVOCs were also measured outside the facilities (Facilities 1 and 2). In the case of Facility 1, the concentration of the total analyzed BVOCs was thousands of times lower outside than inside (Figure 1a). Facility 2 was equipped with C-scrubbers, and the samples were collected outside of the grow room as the area was not climate controlled. Even though Facility 2 was located in a forest area, the total concentration of BVOCs was significantly higher inside the facility than outside, being 220 times higher in the grow room with fan off and 25 times higher in the same room (with fan on) than outside (Figure 1b). Analysis of individual BVOCs showed that the most abundant compounds at all four facilities are β -myrcene, D-limonene, terpinolene, α -pinene, and β -pinene. For example, in the curing room at Facility 1 (Figure 1a), the top analyzed BVOCs were β -myrcene (54% of the BVOCs, $840 \pm 96 \mu\text{g m}^{-3}$), terpinolene (20%, $312 \pm 23 \mu\text{g m}^{-3}$), and

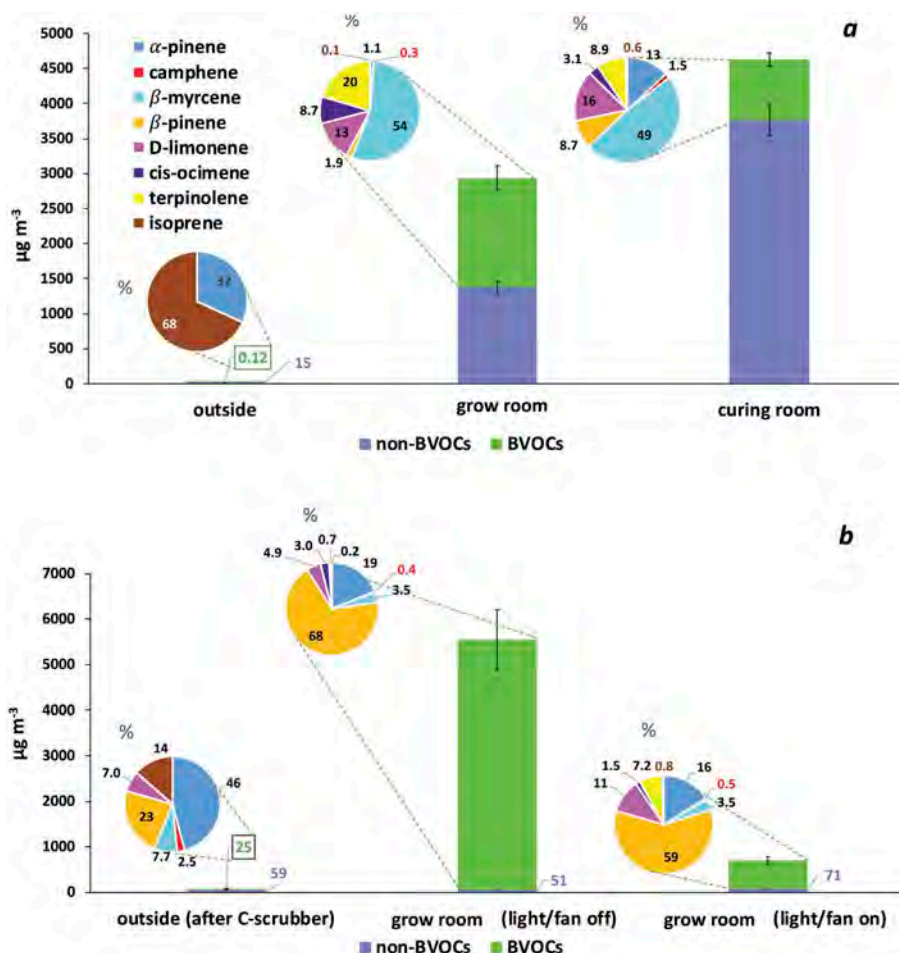


Figure 1. Biogenic (in $\mu\text{g m}^{-3}$) and non biogenic (in %) VOCs at four *Cannabis* facilities: (a) Facility 1, (b) Facility 2, (c) Facility 3, and (d) Facility 4. The standard deviations were calculated based on three (in some cases two) replicate canister samples collected simultaneously.

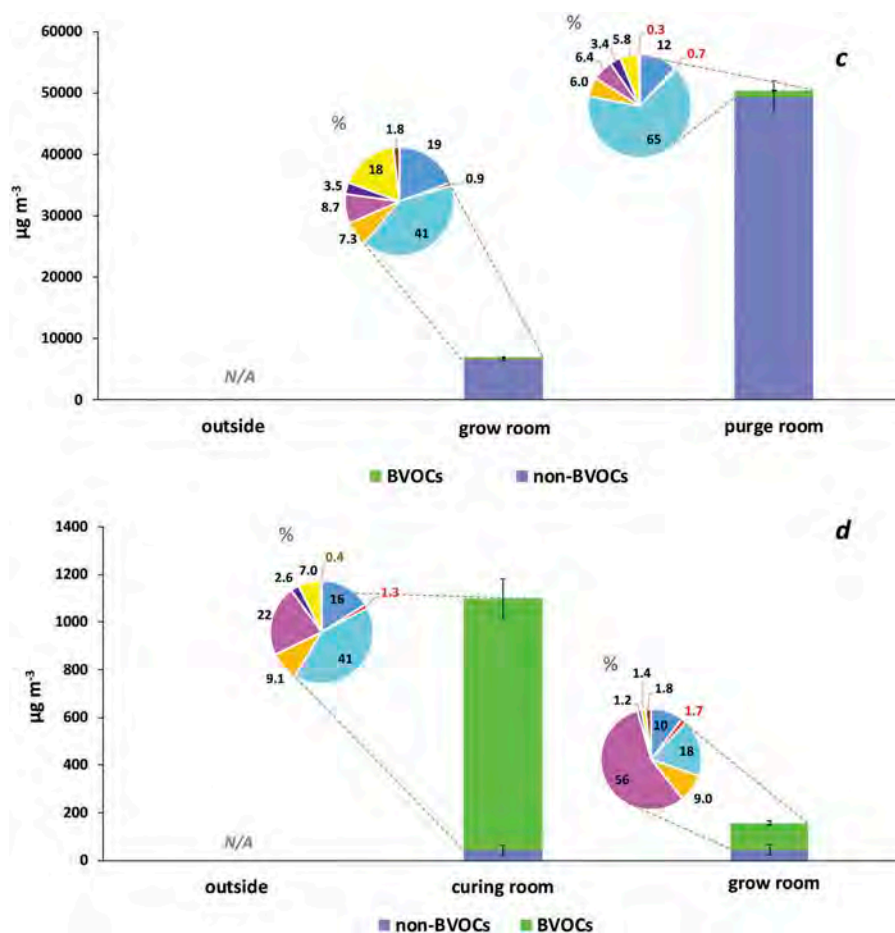


Figure 1. (Continued).

D-limonene (13% , $202 \pm 12 \mu\text{g m}^{-3}$). At the same time, the most abundant BVOCs outside of Facility 1 were isoprene ($0.084 \pm 0.009 \mu\text{g m}^{-3}$) and α -pinene ($0.039 \pm 0.004 \mu\text{g m}^{-3}$), being 68% and 32% of the total analyzed outside BVOCs, respectively. In comparison, the most abundant BVOCs at Facility 2 were β -pinene and α -pinene. When the fan and lights were off, the β -pinene and α -pinene concentrations were $3766 \pm 452 \mu\text{g m}^{-3}$ and $1036 \pm 124 \mu\text{g m}^{-3}$, which are 68% and 19% of the total BVOCs, respectively (Figure 1b). Predictably, the BVOC levels were lower when the fan and lights were on, and the concentrations of β -pinene and α -pinene, the most abundant at Facility 2, were $377 \pm 45 \mu\text{g m}^{-3}$ (59% of the total BVOCs) and $102 \pm 12 \mu\text{g m}^{-3}$ (16% of the total BVOCs), respectively. For Facility 3 (Figure 1c), the most abundant BVOCs were β -myrcene ($78\text{--}650 \mu\text{g m}^{-3}$) and α -pinene ($35\text{--}140 \mu\text{g m}^{-3}$), while at Facility 4, the highest levels were observed for D-limonene ($44\text{--}232 \mu\text{g m}^{-3}$) and β -myrcene ($10\text{--}432 \mu\text{g m}^{-3}$). Isoprene is the major biogenic compound, being two-thirds of the total global BVOCs (Guenther et al. 1995; Sindelarova et al. 2014), and it is widely used as a tracer compound of biogenic emissions (Carlton, Wiedinmyer, and Kroll 2009; Kleindienst et al. 2007;

Wang et al. 2013), while for *Cannabis* emissions, it is not in the top five of the analyzed BVOCs (Figure 1). Similar to our results, Wang et al. (2019) found that β -myrcene is one of the most abundant BVOCs emitted from four strains of *Cannabis* plants. However, in contrast to Wang's study, in our results, eucalyptol was not a dominating terpene at any of the tested commercial facilities.

The total concentrations of the non-BVOCs (Table 1) widely varied between the facilities with and without additional plant-processing stations. Facilities 1 and 3 were equipped with extraction stations, where low molecular weight alkanes, such as liquid butane, are used as an extraction solvent of the oil from the *Cannabis* plants. At these facilities, the total concentration of non-BVOCs in different rooms ranged from $1,290$ to $52,000 \mu\text{g m}^{-3}$. These levels of non-BVOCs were $0.9\text{--}49$ times higher than BVOCs concentrations for the same rooms (Table 1). At Facilities 2 and 4, the non-BVOC concentrations ranged from 30 to $80 \mu\text{g m}^{-3}$. BVOCs were $2.5\text{--}107$ times higher than the non-BVOCs inside these facilities. Therefore, to control VOC emissions from *Cannabis* facilities, non-BVOCs must also be monitored, especially at the

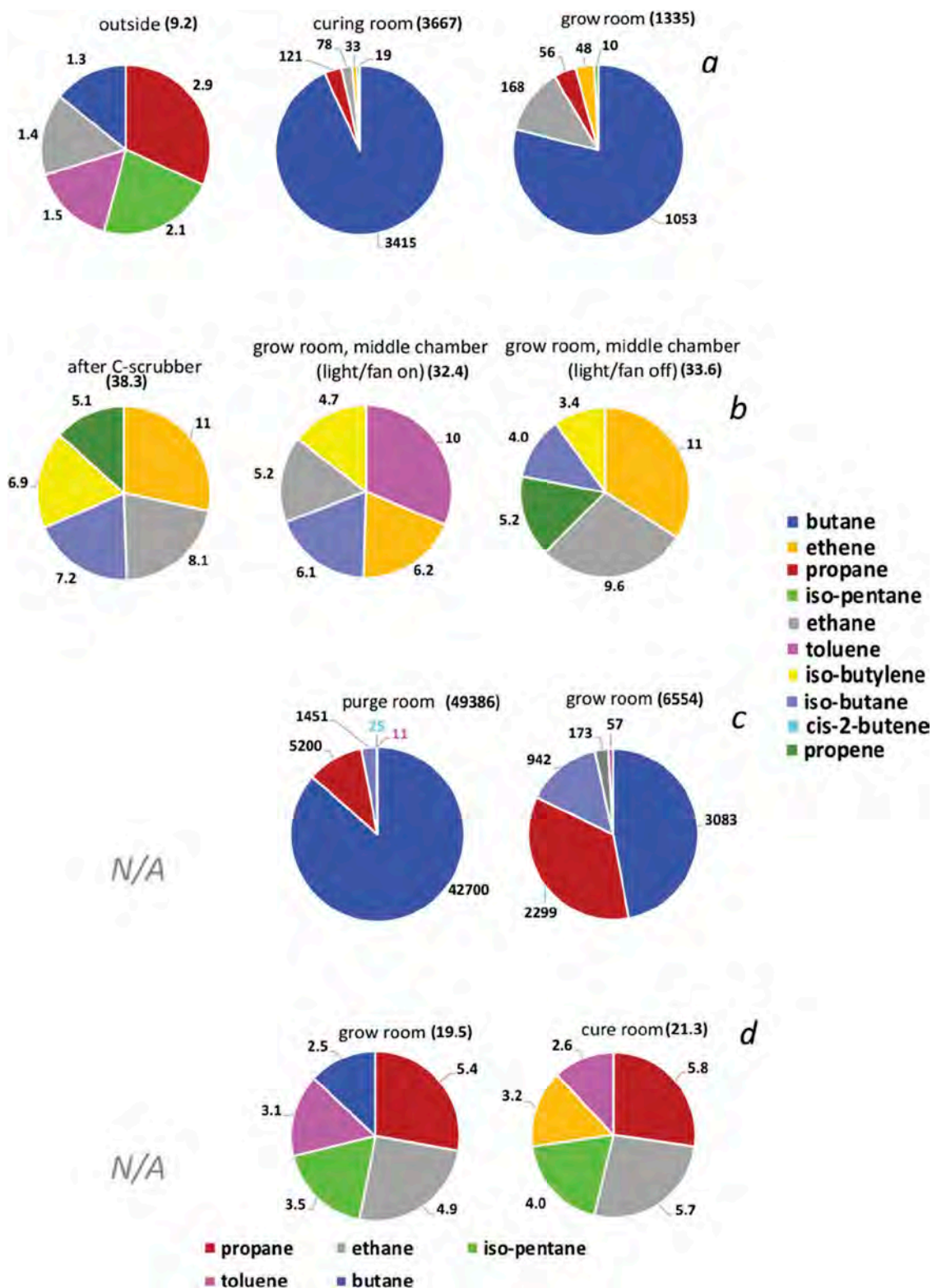


Figure 2. Top five non-BVOCs at four commercial *Cannabis* facilities: (a) Facility 1, (b) Facility 2, (c) Facility 3, (d) Facility 4; (in $\mu\text{g m}^{-3}$); total of the top five non-BVOCs are presented in brackets in bold font (units: $\mu\text{g m}^{-3}$).

facilities with additional processing of the *Cannabis* product.

Figure 2 presents the top five individual non-BVOCs that were detected at facilities with (Facility 1 and 3) and

without (Facility 2 and 4) extraction stations. As was expected, butane was the dominant non-BVOC at the facilities where butane extraction was performed. For Facility 1, butane concentrations inside the curing and

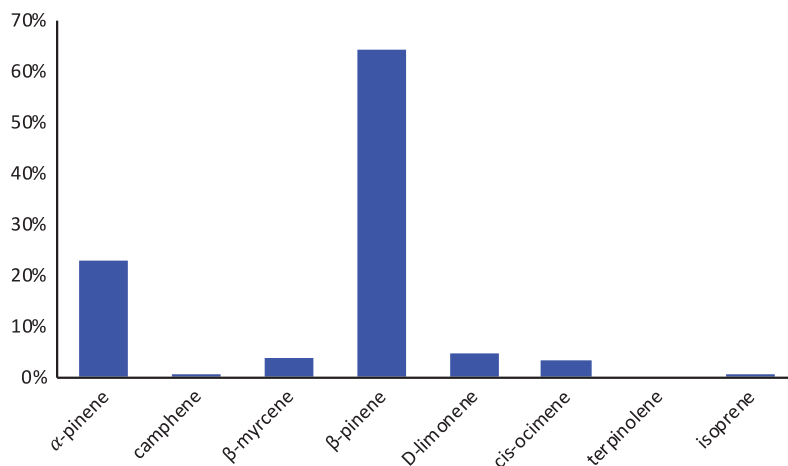


Figure 3. Relative contribution to ozone forming potential of the most abundant BVOCs at Facility 2.

grow rooms were $3,415 \pm 205$ (90.7% of total non-BVOCs) and $1,083 \pm 43 \mu\text{g m}^{-3}$ (75.8% of total non-BVOCs), respectively, which are approximately 2,600 and 800 times more than the butane level measured outside of this facility ($1.3 \pm 0.4 \mu\text{g m}^{-3}$). In the case of Facility 3, which was also equipped with an extraction station, the butane levels in its grow ($3,083 \pm 302 \mu\text{g m}^{-3}$) and purge ($42,723 \pm 4,300 \mu\text{g m}^{-3}$) rooms were 1.7–36 times higher than in the rooms of Facility 1, and butane was responsible for 46% and 86% of the total non-BVOCs, respectively (Figure 2). In Facilities 2 and 4, butane concentrations were low ($2.5\text{--}4.3 \mu\text{g m}^{-3}$) compared with Facilities 1 and 3, since there were no butane extraction stations there. Butane is one of the most reactive VOCs with a lifetime of 2.5 days under typical HO level atmospheric conditions (2×10^6 of HO radicals per m^{-3}) (Finlayson-Pitts and Pitts 2000). It is well-known that ozone is produced via photochemical reactions of n-butane with oxidants in the atmosphere (Andersson-Sköld, Grennfelt, and Pleijel 1992; Bowman, Pilinis, and Seinfeld 1995; Finlayson-Pitts and Pitts 1997). High concentrations of n-butane in the air can lead to high levels of harmful tropospheric ozone (Bell, Peng, and Dominici 2006; Fann et al. 2012; Kampa and Castanas 2008). Therefore, n-butane emissions from the facilities with butane extraction stations should not be ignored.

Emission rates and ozone-forming potential

To predict the potential of analyzed BVOCs for ozone formation, the ERs of target BVOCs were measured. We were able to obtain the ERs only for the BVOCs at Facility 2, and they are summarized in Table S4 (Supplementary Material). The highest ERs were observed for β-pinene ($518 \text{ mg day}^{-1} \text{ plant}^{-1}$), α-pinene ($143 \text{ mg day}^{-1} \text{ plant}^{-1}$), and D-limonene

($31 \text{ mg day}^{-1} \text{ plant}^{-1}$), which are 70%, 19%, and 4% of the total measured BVOCs ($744 \text{ mg day}^{-1} \text{ plant}^{-1}$), respectively.

Figure 3 shows the relative OFP contributions of the most abundant BVOCs collected at Facility 2. It is clear that α- and β-pinenes contributed the most to the OFP, being 87% of the total OFP for all analyzed *Cannabis* BVOCs. The OFP can significantly vary (more than two orders of magnitude) for the species with the same ER (Benjamin and Winer 1998). For example, MIR for isoprene (10.61, Supplementary Material) is three times higher than for β-pinene (3.52), but because ER for isoprene is more than 400 times lower than for β-pinene, β-pinene's contribution to ozone formation is significantly higher (146 times) than for isoprene's. However, as our results showed, BVOCs can vary among the facilities; therefore, different terpenes can be responsible for the formation of harmful compounds. Assuming that terpenes are released from Facility 2 into typical ambient conditions, α- and β-pinenes will be responsible for the formation of a maximum of approximately $2.6 \text{ g day}^{-1} \text{ plant}^{-1}$ of ozone (Table S3), and plants that produce $1\text{--}10 \text{ g day}^{-1} \text{ plant}^{-1}$ of ozone are considered as “medium” OFP species (Benjamin and Winer 1998).

Conclusion

The analysis of volatile terpenes at four commercial *Cannabis* facilities showed that the most abundant BVOCs at all facilities are β-myrcene, D-limonene, terpinolene, α-pinene, and β-pinene. The calculated terpenes' OFP at one of the facilities where ERs were measured demonstrated a significant contribution of α- and β-pinenes to the total OFP. These

results suggest that isoprene, which is a widely used tracer for studying chemistry and modeling of biogenic emissions, is not suitable for estimating BVOC emissions from *Cannabis* facilities and for understanding the chemical processes of *Cannabis* BVOCs in the lower troposphere. We also found that butane concentration at the facilities with cannabis oil extraction stations can be very high; thus, butane emissions from these facilities may significantly contribute to the chemistry of emitted-in-the-air VOCs, and it may lead to the formation of harmful compounds.

Since this research is a pilot study, there are several questions that need to be addressed in the future. Measuring at what rate BVOCs and other VOCs are emitted outside by *Cannabis* facilities and estimating the effect of these emissions on air quality will be important. The ERs should be measured for more than one *Cannabis* facility, and significantly more data points should be collected during these experiments. In this study, we have focused on volatile BVOCs collected with canisters, but our preliminary research showed that semivolatile biogenic organic compounds (e.g., linalool, β -caryophyllene, and α -bisabolol) that can be sampled with Tenax sorbent tubes are also emitted by *Cannabis* plants in high quantities. The effects of these species on the formation of ozone, formaldehyde, and other harmful compounds have to be evaluated. Moreover, different types of plants (mainly *Cannabis sativa* and *Cannabis indica*) at different growing stages and conditions (soil type, light, fertilization, watering, ventilation, size of pots, concentration of CO₂ in grow rooms, relative humidity, temperature, etc.) may release BVOCs in various ratios (Niinemets, Loreto, and Reichstein 2004; Riedlmeier et al. 2017; Wiß et al. 2017). Knowing the ERs of BVOCs per plant, the non-BVOC concentrations in the facilities, the release of these emissions into the air, and the concentrations of NO_x around the facilities can help estimate the impact of *Cannabis* grow facilities on air quality and develop optimal air pollution control strategies in the future.

Funding

This work was supported by the Desert Research Institute; Washoe County, NV.

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EXHIBIT G

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Evan Mills

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California: A cannabis-climate train wreck in progress

An [analysis](#) I performed ten long years ago found that the carbon footprint of electricity use in cannabis production in California (for legal and illegal activities combined), amounted to that of 1 million average homes or 1 million cars. With the rapid industrialization of cannabis cultivation over the intervening years (facilities well over 100,000 square feet are now being constructed — and sometimes grouped together in compounds with millions of square feet), energy use may be higher ... or lower ... no one knows. California policymakers are flying blind regarding the current carbon footprint of this burgeoning industry. Surely, they would not want this fledgling industry to negate the hard-won greenhouse-gas reductions earned through decades of effort. Alas, read on.

California is not only a symbol of progressive environmental thought, it has long been an engine for innovative environmental technologies and policies. Many of the nation's leading energy research and policy centers are located in the state, the utilities have been in the vanguard as developers of energy efficiency programs and policies for many decades, and California is one of the top states in the nation in terms of renewable energy production. State legislators have passed some of the most far-reaching climate change policies and targets in the world, notably State Bill 32 (SB 32), the [California Global Warming Solutions Act of 2006](#) which aims to reduce statewide greenhouse-gas emissions to a level 40% below 1990 levels by the year 2030.

Yet, a quiet but potent countervailing challenge to the attainment of these goals is



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dictated that indoor cultivation was integral to the broader goal of legalization, creating a preordained “purpose” that cannot be trumped by subsequent environmental considerations.

At a higher level, the state’s flagship California Environmental Quality Act (CEQA) guidelines for development set a high bar for industries such as cannabis by stipulating that “[i]f analysis of the project’s energy use reveals that the project may result in significant environmental effects due to inefficient, or unnecessary use of energy, or wasteful use of energy resources, the EIR [Environmental Impact Report] shall mitigate that energy use. This analysis should include the project’s energy use for all project phases and components, including transportation-related energy, during construction and operation.” Project owners are also required to make good-faith estimates of long-term greenhouse-gas impacts and give more consideration to water issues [CEQA Guideline §§15064.4, 15155].

These safeguards are well-founded in the case of cannabis. I recently completed a couple of calculations that are truly shocking.

The first one involves a thought experiment to see how much “rooftop solar” it would take to “zero-out” all the energy needed by indoor grow facility. Even in areas with excellent solar availability, less than 5% of a facility’s electricity needs could be generated on the roof (and none in the case of greenhouses). One noted large-scale facility aiming to be as sustainable as possible achieved a solar contribution of about 30% (Daniels 2019), which presumably required using a very large area of land beyond the building footprint. A ‘state-of-the-art’ facility in Canada is projecting to offset only 8% to 10% of its electricity use by covering its entire roof (CBC 2019b), emitting approximately 9,000 tons of CO₂ per year instead of 10,000 tons without the solar. Among the nation’s largest proposed facilities, with 2.4 million square feet of enclosed “cannabis industrial park”, would only provide 4% of the needed electricity from its rooftops, despite being in an optimal solar resource area on the California-Arizona border. Meeting the full electricity demand would require approximately 1,400 acres of photovoltaic panel area. An 80-megawatt dedicated natural-gas power plant is instead





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Offsetting on-site energy with solar isn't feasible

~25x roof area in PV panels => won't pencil



Hypothetical solar PV area requirements for proposed cannabis industrial park in Blythe, California. Array area range represents the annual electricity intensity (kWh/square foot) estimated by Mills (2012), similar to that measured in nearby Nevada (NFD 2018). Solar output per unit area estimated by Sage Energy using Helioscope software.

Alternatively, it might be argued that cannabis industry could be powered with centralized renewable energy, the amounts required are prodigious and for practical purposes (e.g., land-use constraints) rarely achievable. Although California's Coachella Valley is one of the largest wind-energy production areas in that state, cannabis production there (assuming business-as-usual energy efficiencies) will soon eclipse the entire output of all 40 wind-power projects located in the area (Figure). Full build-out of existing cannabis facility entitlements in the Coachella Valley would consume for more 11 times as much power as can be produced by all existing wind systems in



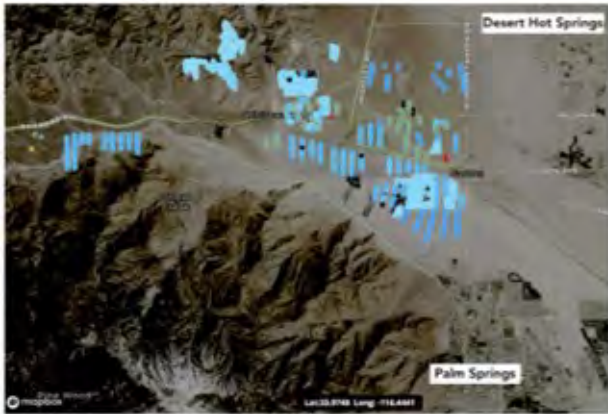
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shortage of investment in renewable energy infrastructure to offset even existing carbon emissions, let alone emissions growth from new energy-intensive development. This comparison serves as a poignant illustration of the broader problematic tension between advances in renewable energy supply and unbridled growth in energy demand.




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a. 2,229 wind turbines in Coachella Valley, CA



b. 663 megawatts of wind power across 40



c. Large-scale indoor cannabis cultivation



d. Indoor cannabis facility, Cathedral City, CA

California wind energy in 2018
(14.2 TWh/y)

Coachella cannabis energy:
in development or proposed (10.4 TWh/y)

Coachella wind energy in 2019:
(1.5 TWh/y)

Coachella cannabis energy: 2019
(0.2 TWh/y)

California's Coachella Valley is the site of 10% of the State's wind energy production. Cannabis cultivation facilities already in operation in five cities within the Coachella Valley require 13% of the entire electricity production of the 40 wind energy projects (2,229 turbines) located throughout the valley. This will grow to more than 70% as the area's total wind energy output upon completion of cannabis-facility projects proposed



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permission; satellite view from USGS (2019); interior of cultivation facility from systemsn.space.com, with permission; Rendering of Venlo type glasshouse by Sunniva (under construction), with permission.

Estimated cultivated area development status in five Coachella Valley cities, based on data gathered by [Simmons](#) in 2019, with 350,000 square feet of “canopy” as of April 2019, 19.4 million square feet proposed or under development, and 30 million square feet entitled. Energy intensity is that calculated by Mills (2012). Note that while NFD (2018) cites lower average electricity intensity for some states, their value for the one desert state (Nevada) in their sample is virtually identical to that used here for a California desert location. Wind energy generating capacity values are from USGS (2019) and associated energy production from CEC (2019). Average production rates for 26 projects (475 MW) in the area (2.23 GWh/MW) are applied to the total installed 663 MW for the area to estimate total electricity production.

Here’s another illustration of the emerging madness. Even in areas with excellent solar availability, only about 5% of a facility’s electricity needs could be generated on the roof (Mills 2018). One noted large-scale facility aiming to be as sustainable as possible achieved a solar contribution of about 30% (Daniels 2019), which presumably required using a very large area of land beyond the building footprint. A ‘state-of-the-art’ facility in Canada is projecting to offset only 8% to 10% of its electricity use by covering its entire roof (CBC 2019b), emitting approximately 9,000 tons of CO₂ per year instead of 10,000 tons without the solar. Among the nation’s largest proposed facilities, with 2.4 million square feet of enclosed “cannabis industrial park”, would only provide 4% of the needed electricity from its rooftops, despite being in an optimal solar resource area on the California-Arizona border. Meeting the full electricity demand would require approximately 1,400 acres of photovoltaic panel area.^[1] An 80-megawatt dedicated natural-gas powerplant is instead proposed to provide energy (Kidder Mathews 2019). Such a generator would need to produce 1.23 TWh-y, enough to power 90,000 average U.S. all-electric homes (Figure 3).

[1] Array area range represents the annual electricity intensity (kWh/square foot)



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Remarkably, despite available evidence, the state's Department of Consumer Affairs initial CEQA analysis of proposed regulations for licensing of cannabis businesses (applicable to cultivation operations up to 10,000 square feet) in California arrived at a "Negative Declaration", indicating a perception of negligible environmental impacts (Bureau of Cannabis Control 2017). The report deemed the energy-related impacts as "Less Than Significant". A parallel Environmental Impact Report (EIR), prepared by the California Department of Food and Agriculture (CDFA), examined the larger-scale cultivation and "track-and-trace" system for product distribution. The CDFA report concedes that "[d]ue to the proprietary and often illicit nature of past and current cannabis cultivation activities, limited accurate and reliable data are available ... sufficient detail is not available to determine whether this [legalization] could result in a meaningful change in energy use and GHG emissions compared to baseline conditions" (California Department of Food and Agriculture 2017). They thus undertake a "qualitative" rather than "quantitative" analysis.

Despite their enormous caveat, the EIR takes several leaps of faith to conclude that the legalization program will be "beneficial" to attaining the State's greenhouse-gas emission reduction goals. They achieve this feat by assuming that overall cannabis production levels will not rise materially following legalization, while the legal fraction of total statewide production will increase from approximately 5% to 10% of the state totals (the rest being black market) and that this increment will automagically conform with the state's SB emissions-reduction target. Thus, thanks to quick arithmetic, the overall average emissions would be (slightly) lower than without legalization.

Additional (seemingly irrelevant) benefits are claimed via improvements in *non*-greenhouse-gas emissions by diesel generators (with perhaps some assumed efficiency gains therein). Moreover, in practice, diesel generators are rarely if ever used by legal operators, so this is a largely irrelevant claim of benefits. The document predicts a "small increase" in indoor cultivation, but does not document or quantify this heroic assumption or anticipate the fact that localities are forcing large numbers of legal projects indoors. In an additional oversight, no serious consideration seems to be given to potential increases (due to regulatory requirements) in transportation energy use and thus emissions given the large number of times that the product must be



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focus cultivation activities on outdoor and mixed-light techniques using natural lighting and would prohibit indoor cultivation and some mixed-light cultivation techniques that rely solely or partially on high-intensity grow lights.” However, this option is ultimately rejected because of the requirement under MAUCRSA that indoor cultivation be allowed. The even more environmentally superior alternative of restricting cultivation to outdoor farming (as is most of the other agriculture in the state), was dismissed as well.

The net effect of these machinations is that California has thus far failed to grasp a rapidly-closing window of opportunity to manage energy use and greenhouse-gas emissions from the cannabis industry. California is:

- Allowing a degree of statewide development that cannot be met by renewable energy
- Establishing an onerous post-prohibition regulatory regime that is compelling producers to return to the black market and its covert, energy-intensive practices
- Fostering cannabis development in some of the harshest climates in the state, leading to higher energy use
- Forcing cannabis cultivation to be done only indoors in many localities, per decisions made at the city/county level
- Providing financial incentives to indoor producers (via utility rebates), without corresponding incentives to outdoor producers who save even more energy
- Not investing in R&D on how to manage energy and greenhouse-gas emissions in this sector

To their credit, a few localities have made preliminary efforts to manage energy use and emissions. Yet, only 3 of 58 counties have implemented regulations calling for renewable energy and/or limits on energy use (California Department of Food and Agriculture 2017). Unfortunately, the very low stipulated energy budgets (e.g., 6 to 10



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EXHIBIT H

REVIEW

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A narrative review on environmental impacts of cannabis cultivation

Zhonghua Zheng¹, Kelsey Fiddes² and Liangcheng Yang^{2*} 

Abstract

Interest in growing cannabis for medical and recreational purposes is increasing worldwide. This study reviews the environmental impacts of cannabis cultivation. Results show that both indoor and outdoor cannabis growing is water-intensive. The high water demand leads to water pollution and diversion, which could negatively affect the ecosystem. Studies found out that cannabis plants emit a significant amount of biogenic volatile organic compounds, which could cause indoor air quality issues. Indoor cannabis cultivation is energy-consuming, mainly due to heating, ventilation, air conditioning, and lighting. Energy consumption leads to greenhouse gas emissions. Cannabis cultivation could directly contribute to soil erosion. Meanwhile, cannabis plants have the ability to absorb and store heavy metals. It is envisioned that technologies such as precision irrigation could reduce water use, and application of tools such as life cycle analysis would advance understanding of the environmental impacts of cannabis cultivation.

Keywords: Cannabis cultivation, Water demand, BVOCs emission, Carbon footprint, Soil erosion

Background

The *Cannabis* plant has been cultivated throughout the world since ancient civilizations and used for thousands of years for both medicinal and recreational applications. Cannabis contains a psychoactive compound called tetrahydrocannabinols (THC) that creates a psychogenic effect. It can be consumed through the respiratory tract and digestive tract through smoking and oral ingesting, respectively. In contrast, cannabidiol (CBD), another component derived from cannabis, is a non-psychoactive cannabinoid that has gained popularity for its medicinal values and as a supplement. In the USA, an estimated “30 million Americans use marijuana (cannabis) at least occasionally, and 20 million use it at least once per month” (Osbeck and Bromberg 2017). Despite being used widely, the lack of science-based information due to the legal status of cannabis in the last centuries worldwide (e.g., in the USA) has prevented research.

Cultivation methods have an unavoidable influence on the environment in different degrees. Outdoor cultivation is the traditional and original method of cannabis cultivation. Although with low costs, it is subject to weather and natural resources. Improper soil and water resources management and pest control may induce critical environmental issues. On the contrary, indoor cultivation (including greenhouse cultivation) enables full control over all aspects of the plants, such as light and temperature, but is constrained by higher costs, energy demand, and associated environmental implications. Reducing the global environmental impact of agriculture is vital to maintain environmental sustainability. However, there is a lack of systemic principles towards the sustainable farming of cannabis because its environmental impacts remain unclear. In the wake of the unprecedented legalization of cannabis, there is a pressing need for a complete review of its environmental assessment.

In this paper, we conduct a narrative review of the available literature. We strive to build a better understanding of the environmental impacts induced by cannabis cultivation. This improved understanding can benefit communities, including policymakers, cannabis industry

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stakeholders, agricultural engineers, ecologists, and environmental scientists. This review covers the environmental effects on water, air, and soil. Energy consumption and carbon footprint are included as well. Possible research directions are also put forward.

Methods and materials

The literature search for this narrative review paper was conducted several times in 2020 and 2021. We searched combinations of keywords such as “cannabis cultivation,” “marijuana cultivation,” “cannabis water demand,” “cannabis emissions,” “cannabis energy demand,” and “environmental impacts.” Papers, reports, and government documents from 1973 to 2021 from Science Direct and Google Scholar databases have been searched in English. We screened over 250 literatures and discarded irrelevant literature for further analysis. A total of 63 literatures were cited in the review.

Water demand analysis

To unify the water demand calculations from different data sources, we conducted the following unit conversions:

$$1 \text{ inch of water} = 27,154 \text{ gallons of water per acre} \quad (1)$$

$$1 \text{ acre} = 43,560 \text{ ft}^2 \quad (2)$$

Similarly, units reported for water demand such as “mm/total growing period” were converted to “gallon/

ft²/day”. For example, the water need of cotton is 700 mm per total growing period. The water demand was calculated to:

$$700 \text{ mm} = 27.56 \text{ inches} = 748,346 \text{ gallon per acre} \quad (3)$$

Finally, the minimal daily water demand for cotton (shown in Table 1) was calculated using the maximal growing days (195 days):

$$\frac{748,346 \text{ gallon per acre}}{195 \text{ days}} \times \frac{\text{acre}}{43,560 \text{ ft}^2} = 0.09 \frac{\text{gallons}}{\text{ft}^2 \times \text{days}} \quad (4)$$

Water demand and pollution

Water demand

Cannabis is a water- and nutrient-intensive crop (Carah et al. 2015). Table 1 shows that the water demand for cannabis growing far exceeds the water needs of many commodity crops. For example, cannabis in a growing season needs twice as much as the water required by maize, soybean, and wheat. On average, a cannabis plant is estimated to consume 22.7 l (6 gallons) of water per day during the growing season, which typically ranges from June to October for an approximate total of 150 days (Butsic and Brenner 2016). As a comparison, the mean water usage for the wine grapes, the other major irrigated crop in the same region, was estimated as 12.64 l of water per day (Bauer et al. 2015). Although the average daily water use varies from site

Table 1 Water demand comparison between Cannabis and commodity crops

| Plants | Total growing period (days) | Water demand per season (million gallons acre ⁻¹) | Daily water demand (gallon ft ⁻² day ⁻¹) | Ref |
|-------------------|-----------------------------|---|---|------------------------------|
| Cannabis: outdoor | 150 | 1.57 ^a | 0.24 | (HGA, 2010) |
| Cannabis: outdoor | August | n.a | 0.22 | (Wilson et al., 2019) |
| Cannabis: outdoor | September | n.a | 0.17 | (Wilson et al., 2019) |
| Cannabis: indoor | August | n.a | 0.18 | (Wilson et al., 2019) |
| Cannabis: indoor | September | n.a | 0.22 | (Wilson et al., 2019) |
| Cotton | 180–195 | 0.75–1.39 ^b | 0.09–0.15 | (Brouwer and Heibloem, 1986) |
| Cotton | / | / | 0.14–0.17 | (Hussain et al., 2020) |
| Maize | 130–150 | 0.53–0.86 ^b | 0.07–0.13 | (Brouwer and Heibloem, 1986) |
| Corn | / | / | 0.22 (peak) | (Rogers et al. 2017) |
| Soybean | 135–150 | 0.48–0.75 ^b | 0.07–0.13 | (Brouwer and Heibloem, 1986) |
| Soybean | / | / | 0.22 (peak) | (Rogers et al. 2017) |
| Wheat | 120–150 | 0.48–0.69 ^b | 0.07–0.19 | (Brouwer and Heibloem, 1986) |
| Wheat | / | / | 0.19 (peak) | (Rogers et al. 2017) |
| Rice | 90–150 | 0.48–0.75 ^b | 0.09–0.18 | (Brouwer and Heibloem, 1986) |
| Rice | / | / | 0.11–0.15 | (Intaboot, 2017) |

Note^a: The water demand of cannabis is calculated based on 22.7 l (6 gallons) of water per day during the growing season and 200 plants per 5,000 sq. ft (HGA, 2010)

Note^b: The water demand of crops is based on crop water need from Table 14 in Brouwer Heibloem (Brouwer and Heibloem, 1986). We convert the unit from mm to million gallon acre⁻¹ according to the rule of unit conversion where 1 acre inch is equivalent to 27,154.29 gallon

to site, depending on many factors such as the geographic characters, soil properties, weather, and cultivation types, it is an agreed-upon truth that cannabis is a high-use water plant. A survey conducted by Wilson et al. (2019) reports the water usage of outdoor cannabis cultivation in California is 5.5 gallons per day per plant (equivalent to $0.22 \text{ gallon ft}^{-2} \text{ day}^{-1}$) in August and 5.1 gallons per day per plant (equivalent to $0.17 \text{ gallon ft}^{-2} \text{ day}^{-1}$) in September (Wilson et al. 2019). The indoor cultivation water consumptions are 2.5 and 2.8 gallons per day per plant in August and September. However, the application rates ($0.18 \text{ gallon ft}^{-2} \text{ day}^{-1}$ in August and $0.22 \text{ gallon ft}^{-2} \text{ day}^{-1}$ in September) are very close to outdoor cultivation (Wilson et al. 2019). In California, irrigated agriculture is regarded as the single largest water consumer, accounting for 70–80% of stored surface water and pumping vast volumes of groundwater (Moyle 2002; Bauer et al. 2015). The great water demand induced by agriculture, amid population growth and climate change, is most likely to exacerbate water scarcity in the foreseeable future (Bauer et al. 2015). Notably, the predicted decrease in water availability downscales in California may adversely affect the value of farmland (Schlenker et al. 2007) and pose a severe challenge to the cannabis industry. As a result, the immense amount of water necessary to keep cannabis plants alive and healthy will continue to burden our environment.

The high water demand presses the need for water sources. Water diversion is a common practice, which removes or transfers the water from one watershed to another to meet irrigation requirements. While the water diversion alleviates the water shortage problem for cannabis cultivation, it also presents new challenges. A study conducted by Bauer et al. quantitatively revealed that surface water diversions for irrigation led to reduced flows and dewatered streams (Bauer et al. 2015). Four northwestern California watersheds were investigated in this study since they are remote, primarily forested, sparsely populated. The results show that the annual seven-day low flow was reduced by up to 23% in the least impacted watersheds of this study, and water demands for cannabis cultivation in three watersheds exceed streamflow during the low-flow period. More recently, Dillis et al. identified well water (58.2%), surface water diversions (21.6%), and spring diversions (16.2%), are the most commonly extracted water source for cannabis cultivation in the North Coast region of California (Dillis et al. 2019). The distributing percentages, however, vary among the counties. For example, the growers in Humboldt County relied more on surface water and spring diversions (57%) than the wells (40.9%), while another study conducted by Wilson et al. showed that groundwater (wells or springs)

was the primary water source for irrigation, followed by municipal water, rainwater, and surface water (Wilson et al. 2019).

Water pollution

Cannabis cultivation, especially illegal cultivation, may deteriorate water quality. Recent studies have suggested the considerable demands of nutrition such as nitrogen (Saloner and Bernstein 2020, 2021), phosphorous (Shiponi and Bernstein 2021), and potassium (Saloner et al. 2019) for cannabis growth. However, there is limited data on the impact of cannabis cultivation on water quality worldwide or even nationwide. Here we focus on a survey conducted by Wilson et al. (2019) for CA, USA. Based on the survey, more than 30 different soil amendments and foliar nutrient sprays were used to maintain nutrition and fertility (Wilson et al. 2019). The applied pesticides (including herbicides, insecticides, fungicides, nematodes, and rodenticides), due to routine pest and disease controls, make their way into the water without restriction and therefore posing significant risks to the water environment (Gabriel et al. 2013). The transport and fate of the applied fertilizers and pesticides vary. For example, nitrogen and pesticides can get into runoff or leach into groundwater due to rainfall or excessive irrigation (Trautmann et al. 2012). If the polluted water continues to be used, it would add contaminants into soil, surface water, and groundwater. These chemicals may threaten humans and crops through the food chain (Pimentel and Edwards 1982). The other major irrigated crops can also be significantly impacted since the placement of crops is subject to the environmental safety of runoff, groundwater contamination, and the poisoning of nearby bodies of water. However, without the ability to sample water quality and assess the extent to which chemical inputs are entering adjacent water bodies, the ability to link cultivation practices to water pollution is greatly limited (Gianotti et al. 2017). Besides, few environmental clean-up and remediation efforts in the polluted watersheds are accessible due to a lack of resources and staff in state or federal agencies.

Water ecosystem

Water diversion and water pollution affect the water ecosystem. The high demand for water due to cannabis cultivation in watersheds affects wildlife such as fish and amphibians in a significant way since cannabis cultivation is widespread within the boundaries of the watersheds, where the downstream water houses populations of sensitive aquatic species. The diminished flows may be notably detrimental to salmonid fishes since they need clean, cold water and suitable flow regimes (Bauer et al. 2015). As the reduced streamflow has a strong positive

correlation with increased water temperature, indirectly resulting in reduced growth rates in salmonids, lowered dissolved oxygen, increased predation risk, and increased susceptibility to disease (Marine and Cech 2004). It has been reported that there are 80%–116% increases in cannabis cultivation sites near high-quality habitats for threatened and endangered salmonid fish species (Butsic et al. 2018). Besides, the threat of water diversions and altered stream flows to amphibians cannot be neglected. The desiccation-intolerant species, such as southern torrent salamander (*Rhyacotriton variegatus*) and coastal tailed frog (*Ascaphus truei*), are vulnerable to headwater stream diversions or dewatering (Bauer et al. 2015). The headwater stream-dwelling amphibians also exhibit high sensitivity to water temperature changes (Bury 2008). It is vital to get all the growers on the same page regarding water resources because flow modification is one of the greatest threats to aquatic biodiversity. The cannabis industry is becoming a major abuser concerning water diversions. Studies show that the second-generation anticoagulant rodenticides (ARs) affect many predators in both rural and urban settings (Gabriel et al. 2013, 2012; Elliott et al. 2014). Necropsy revealed that a male fisher had died of acute AR poisoning in April 2009, most likely due to the source of numerous illegal cannabis cultivation sites currently found on public lands throughout the western USA (Thompson et al. 2014). A study examining the effects of ARs on the Pacific fisher reports that four out of fifty-eight deceased fishers examined were killed by “lethal toxicosis, indicated by AR exposure.”

Outdoor and indoor air quality

Outdoor air quality

Little attention has been devoted so far to study the impact of cannabis cultivation on outdoor air quality. The emission of volatile organic compounds (VOCs) attracts special attention because of the vital role played by VOCs in ozone and particulate matter formation, as well as VOC's health impact (D.R. et al. 2001; Jacob 1999). Amongst the VOCs, the biogenic volatile organic compounds (BVOCs) (Atkinson and Arey 2003), mainly emitted from vegetation, account for approximately 89% of the total atmospheric VOCs (Goldstein and Galbally 2007). Previous studies have identified cannabis plant tissues contain high concentrations of many BVOCs such as monoterpenes (C_6H_{16}), terpenoid compounds (e.g., eucalyptol; $C_{10}H_{18}O$), sesquiterpenes ($C_{15}H_{24}$), and methanol. Hood et al. investigated that the monoterpenes α -pinene, β -pinene, β -myrcene, and d-limonene accounted for over 85% of the detected VOCs emitted, with acetone and methanol contributing a further 10% (Hood et al. 1973; Rice and Koziel 2015; Ross and ElSohly 1996). However, limited systematic studies characterized and accurately

quantified volatile emissions during the growing and budding process (Wang et al. 2019b).

To determine the BVOCs emission rates, Wang et al. employed an enclosure chamber and live Cannabis spp. plants during a 90-day growing period considering four different strains of Cannabis spp. including Critical Mass, Lemon Wheel, Elephant Purple, and Rockstar Kush (Wang et al. 2019b). They found the percentages of individual BVOCs emissions were dominated by β -myrcene (18–60%), eucalyptol (17–38%), and d-limonene (3–10%) for all strains during peak growth (Table 2). The terpene emission capacity was determined, ranging from 4.9 to 8.7 $\mu\text{g-C}$ per g dry biomass per hour. The estimation with $\mu\text{g-C}$ per g dry biomass per hour for Denver would result in more than double the existing rate of BVOCs emissions to 520 metric ton year⁻¹, leading to 2100 metric ton year⁻¹ of ozone, and 131 metric ton year⁻¹ of PM (particulate matter). However, a high emission can be expected since the better growing conditions contribute to rapid growth and higher biomass yields.

A recent study conducted by Wang et al. was the first attempt at developing an emission inventory for cannabis (Wang et al., 2019a). This study compiled a bottom-up emission inventory of BVOCs from cannabis cultivation facilities (CCFs) in Colorado using the best available information. Scenarios analysis shows that the highest emissions of terpenes occur in Denver County, with rates ranging from 36 to 362 t year⁻¹, contributing to more than half of the emissions across Colorado. With the emission inventory, the air quality simulations using the Comprehensive Air Quality Model with extensions (CAMx) show that increments in terpene concentrations could result in an increase of up to 0.34 ppb in hourly

Table 2 Composition of BVOCs

| BVOCs | 30-day (%) | 46-day (%) |
|-----------------------|------------|------------|
| β -myrcene | 26.6–42.6 | 18.3–59.4 |
| Eucalyptol | 18.5–32.8 | 16.8–37.6 |
| d-limonene | 4.4–17.2 | 3.0–10.0 |
| p-cymene | 2.3–12.8 | 0.6–4.6 |
| γ -terpinene | 2.0–9.7 | 2.8–14.0 |
| β -pinene | 0.4–6.9 | 1.3–3.5 |
| (Z)- β -ocimene | 1.3–5.9 | 0.0 |
| Sabinene | 0.0–5.0 | 0.2–10.9 |
| Camphene | 0.0–4.4 | 0.0–1.0 |
| α -pinene | 0.8–4.3 | 2.7–3.6 |
| Thujene | 0.9–3.1 | 1.2–3.4 |
| α -terpinene | 0.0–2.0 | 0.5–5.4 |

Note: BVOCs biogenic volatile organic compounds

Data adapted from Wang, C. T., Wiedinmyer, C., Ashworth, K., Harley, P. C., Ortega, J., Vizuete, W. (2019b). Leaf enclosure measurements for determining volatile organic compound emission capacity from Cannabis spp. Atmos. Environ., 199, 80–87. (Wang et al., 2019b)

ozone concentrations during the morning and 0.67 ppb at night. Given that Denver county is currently classified as “moderate” non-attainment of the ozone standard (USEPA 2020), the air quality control of the CCF operation is essential.

In addition to BVOC emissions, like every crop cultivation in water-sensitive zones, the fertilization of cannabis causes deterioration in air quality. As fertilization is one of the most critical factors for cannabis cultivation, the introduction of excessive nitrogen into the environment without regulation can lead to adverse multi-scale impacts (Balasubramanian et al. 2017; Galloway et al. 2003). Ammonia in the chemical nitrogen fertilizer volatilized from cropland to the atmosphere forms PM via the reaction with acidic compounds in the atmosphere. Besides, the wet and dry deposition of reactive nitrogen consisting of ammonia continuously deteriorates the ecological environment. Both soil acidification and water eutrophication risks could significantly increase because of the nitrogen cascade (Galloway et al. 2003; Galloway et al. 2008).

Indoor air quality

Although cannabis can be grown outdoors in many regions of the world, sizeable commercial cultivation can also occur indoors or in greenhouses. Ambient measurements collected inside growing operations pre-legalization have found concentrations as high as 50–100 ppbv of terpenes including α -pinene, β -pinene, β -myrcene, and d-limonene for fewer than 100 plants in the cannabis cultivation facility (Martyny et al. 2013; Atkinson and Arey 2003; Wang et al. 2019a). The study conducted by Spokane Regional Clean Air Agency (SRCAA) measured indoor VOCs in seven flowering rooms and two dry bud rooms across four different CCFs, reporting the average terpene concentration was 361 ppb (27–1676 ppb) (Southwellb et al. 2017).

Samburova et al. analyzed the BVOCs emissions from four indoor-growing Cannabis facilities in California and Nevada (Samburova et al. 2019). They reported the indoor concentrations of measured BVOCs could

vary among the facilities, ranging from 112 $\mu\text{g m}^{-3}$ to 5502 $\mu\text{g m}^{-3}$ (Table 3), for a total measured BVOCs of 744 $\text{mg day}^{-1} \text{ plant}^{-1}$. The BVOCs characterization partially agrees with the measurements shown by Wang et al. where β -myrcene is one of the dominated BVOCs emitted by Cannabis, but eucalyptol was not a dominating terpene in this study (Wang et al. 2019b). The obtained emission rates ranged between 0 to 518.25 $\text{mg day}^{-1} \text{ plant}^{-1}$. The largest emission contributors were β -pinene (518.25 $\text{mg day}^{-1} \text{ plant}^{-1}$, 70% of the total BVOCs) α -pinene (142.92 $\text{mg day}^{-1} \text{ plant}^{-1}$, 19% of the total BVOCs), and D-limonene (30.86 $\text{mg day}^{-1} \text{ plant}^{-1}$, 4% of the total BVOCs). Silvey (2019) characterized the overall VOC total terpene mass concentration using sorbent tube sampling and found a higher range between 1.5 mg m^{-3} (office) to 34 mg m^{-3} (trimming room) (Silvey 2019).

The indoor cannabis (marijuana) grows operations (known as “IMGO”) also pose a risk of potential health hazards such as mold exposure, pesticide, and chemical exposure (Martyny et al. 2013). For example, cannabis cultivations typically require a temperature between 21 and 32 °C, with a relative humidity between 50 and 70% (Koch et al. 2010), while the ventilation rate is often suppressed to limit odor emanating, especially for the illegal cultivation. John and Miller suggested that the houses built after 1980 in Canada are at high risk of moisture-related damage if used as IMGO, and increased moisture levels of the IMGO are associated with elevated mold spore levels (Johnson and Miller 2012). The reports by IOM (IOM 2004) and WHO (World Health Organization) showed that the presence of mold in damp indoor environments is correlated with upper respiratory tract symptoms, respiratory infections, wheeze, cough, current asthma, asthma symptoms in sensitized individuals, hypersensitivity pneumonitis, and dyspnea (WHO 2009). Cuyppers et al. conducted a study in Europe, showing that pesticide use in Belgian indoor cannabis cultivation is a common practice, putting both the growers and intervention staff at considerable risk (Cuyppers et al. 2017). They

Table 3 Indoor BVOCs concentrations

| BVOCs | Sites | Unit in ppbv | Unit in $\mu\text{g m}^{-3}$ | Ref |
|---|----------------|--------------|------------------------------|---|
| α -pinene, β -myrcene, β -pinene, and limonene | Growing room | 50–100 | n.a | (Martyny et al., 2013; Wang et al., 2019a) |
| Terpenes | Flowering room | 30–1600 | n.a | (Southwellb et al., 2017; Wang et al., 2019a) |
| Total BVOCs | Growing room | n.a | 112–5502 | (Samburova et al., 2019) |
| Total BVOCs | Curing room | n.a | 863–1055 | (Cuyppers et al., 2017) |
| Total BVOCs | Purging room | n.a | 1005 | (Trautmann et al., 2012) |

BVOCs Biogenic volatile organic compounds

found 19 pesticides in 64.3% of 72 cannabis plant samples and 65.2% of 46 carbon filter cloth samples, including o-phenylphenol, bifentazate, and cypermethrin.

Energy demands and carbon footprint

Indoor cultivation energy demands and impacts

As one of the most energy-intensive industries in the USA (Warren 2015), cannabis cultivation results in up to \$6B in energy costs annually, accounting for at least 1% of the nation's electricity (Mills 2012). The cannabis electricity consumption increases to 3% in California (Warren 2015). In Denver, the average electricity use from cannabis cultivation and associated infused product manufacturing increased by 36% annually between 2012 and 2016 (DPHE 2018). As cannabis becomes legalized throughout the country, energy consumption will continue to grow in the foreseeable future.

The energy use of indoor cannabis cultivation arises from a range of equipment, falling into two major categories: lighting and precise microclimate control. For the cannabis plants to thrive and therefore make the growers a profit, several energy-intensive tools are regularly utilized. The energy demand for indoor cannabis cultivation was reported to be 6074 kWh kg-yield⁻¹ (Mills 2012). Figure 1 shows the end-use electricity consumption according to a study performed by the Northwest Power and Conservation Council (NPCC 2014). Amongst them, lighting, HVAC (heating, ventilation, and air conditioning), and dehumidification account for 89% of the total end-use electricity consumption.

High-intensity lighting is the main contributor to electricity for indoor production facilities. Sweet pointed out that lighting alone can account for up to 86% of the total electricity usage (Sweet 2016). It has been reported that the intensity of the indoor cannabis lamps (25 klux for leaf phase, and 100 klux for flowering (Mills 2012)) approximates that of hospital operating room lamps, which is up to 500 times greater than a standard reading

light (Warren 2015). Indoor cultivation facilities typically utilize a combination of high-pressure sodium (HPS), ceramic metal halide (CMH), fluorescent, and/or light-emitting diode (LED) lamps. In addition to the lamp type, lighting system design is also critical to maximizing energy efficiency in the cultivation facilities, and time of use also plays a crucial role.

HVAC Dehumidification system ensures frequent air exchanges, ventilation, temperature, and humidity control day and night. This system can account for more than half of the total energy consumption in an indoor cultivation facility (Mills 2012). Besides, water and energy are inextricably linked, given water and wastewater utilities contribute to 5% of overall USA electricity consumption (Pimentel and Edwards 1982). The grow systems (including automation and sensors), irrigation (including fertigation and pumps), and CO₂ injection also consume an amount of electricity.

Energy production, especially fossil fuel use, is accountable for the environmental impact. Table 4 shows that coal and natural gas make up almost three-quarters of the power supply for Colorado customers in the USA. Considering the environmental impacts of different energy sources, the extensive usages of fossil fuels (coal, natural gas, and oil) causes serious environmental damage and

Table 4 Power supply mix for Colorado customers

| Energy sources | Total generation mix (%) |
|--|--------------------------|
| Coal | 44 |
| Natural gas | 28 |
| Wind | 23 |
| Solar | 3 |
| Hydroelectric | 2 |
| Others (including biomass, oil and nuclear generation) | 0 |

Data adapted from Dever Public Health Environment. 2018. Cannabis Environmental Best Management Practices Guide. (DPHE, 2018)

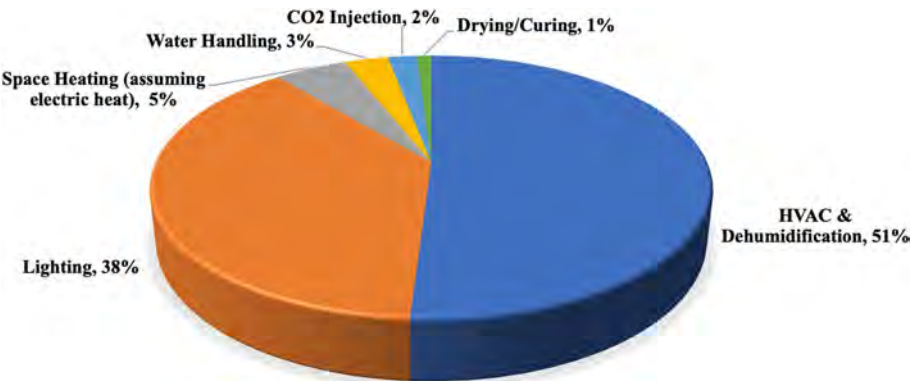


Fig. 1 End-use electricity consumption

pose effects on (1) humans, (2) animals, (3) farm produce, plants, and forests, (4) aquatic ecosystems, and (5) buildings and structures (Barbir et al. 1990).

Carbon footprint

The term *carbon footprint* refers to “a measure of the exclusive total amount of carbon dioxide emissions that is directly and indirectly caused by an activity or is accumulated over the life stages of a product” (Wiedmann and Minx 2008). In the context of cannabis cultivation, a carbon footprint can be defined as the total amount of greenhouse gases (GHGs) emitted during the production of cannabis. Denver Department of Public Health Environment broke the GHG inventory down into the three primary scopes: (1) an organization’s direct GHG emissions produced on-site; (2) an organization’s off-site carbon emissions, or indirect emissions; (3) all other indirect carbon emissions associated with the operation of a business (DPHE 2018). However, a relatively small body of literature pays particular attention to the carbon footprint calculation. Mills estimates that producing one kilogram of processed cannabis indoors leads to 4600 kg of CO₂ emissions to the atmosphere, equivalent to one passenger vehicle driven for one year or 11,414 miles driven by an average passenger vehicle (Mills 2012). Amongst them, the emissions factor (kg CO₂ emissions per kg yield) of lighting is 1520 (33%), followed by ventilation and dehumidify (1231, 27%), and air conditioning (855, 19%). On the other hand, outdoor cultivation can alleviate the energy use for lighting and precise microclimate control but requires other facilities and techniques such as water pumping. Carbon footprint analysis is the first step towards the carbon reduction strategies, which contributes to the reduction of the environmental impacts of the cannabis industry. Future studies are foreseen to improve the understanding of the carbon footprint of cannabis cultivation both indoors and outdoors.

Soil erosion and pollution

Soil erosion

Soil erosion is a natural process that occurs when there is a loss or removal of the top layer of soil due to rain, wind, deforestation, or any other human activities. It increases fine-sediment loading into streams and threatens rare and endangered species (Carah et al. 2015). Soil erosion can happen slowly due to wind or quickly due to the heavy rainfall event. Land terracing, road construction, and forest clearing make their ways to remove native vegetation and to induce soil erosion (Carah et al. 2015). Barringer (Barringer 2013) and O’Hare et al. suggested that cannabis cultivation directly contributes to soil erosion (O’Hare et al. 2013). The slope is a useful proxy for erosion potential since soil on steep slopes tends to erosion

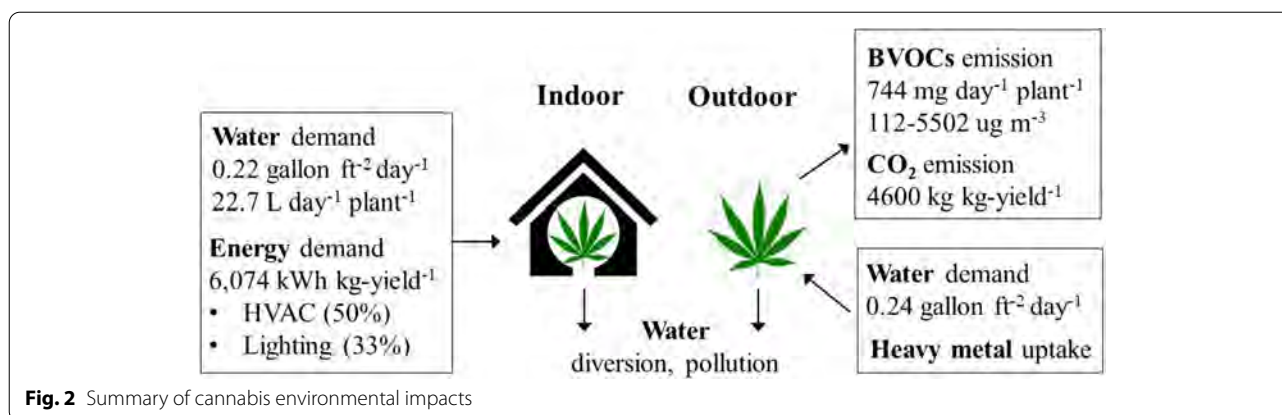
when cleared or cultivated (Butsic et al. 2018). Butsic and Brenner conducted a systematic, spatially explicit survey for the Humboldt County, California, involving digitizing 4,428 grow sites in 60 watersheds (Butsic and Brenner 2016). About 22% of the clustered cannabis on steep slopes indicates a risk of erosion. Many studies also suggest that cannabis cultivation can result in deforestation and forest fragmentation (Wang et al. 2017), which exacerbate soil erosion. Though greenhouse prevents soil erosion, they are surrounded by large clearings accumulated during construction with exposed soils subject to erosion (Bauer et al. 2015).

Phytoremediation potential

Cannabis has gradually garnered attention as a “bioremediation crop” because of its strong ability to absorbing and storing heavy metals (McPartland and McKernan 2017). It can remove heavy metal substances from substrate soils and keep these in its tissues by means of its bio-accumulative capacity (Dryburgh et al. 2018). Usually, it takes up high levels of heavy metals from the soil or growing medium via its roots and potentially deposits into its flowers (Seldenrich 2019). Tainted fertilizer uptake from the soil is often a source of heavy metals contamination such as arsenic, cadmium, lead, and mercury. Singani and Ahmadi reported that *Cannabis sativa* could absorb lead and cadmium from soils amended with contaminated cow and poultry manures (Singani and Ahmadi 2012). Though limited studies discussed the effectiveness of cannabis for heavy metals removal, many studies have addressed the uptake of heavy metals by industrial hemp (Campbell et al. 2002; Linger et al. 2002). It indicates that the cannabis plant is qualified as a phytoremediation of contaminated soils.

Conclusions and envisions

A summary of the environmental impacts of cannabis cultivation is shown in Fig. 2. Water demand and usage will continue to be a major concern. Illegal cannabis cultivation and improper operation may raise water pollution issues. Studies on cannabis’ physiological properties will guide to determine water demand. Besides, identifying and applying best management practices, such as precision irrigation and enhanced climate control, will be critical to minimize the environmental impacts on water. Energy consumptions mainly come from the equipment operation of the indoor cultivations such as lighting, HVAC, and dehumidification. Carbon footprint can be calculated both indoors and outdoors based on energy consumption. Quantitatively accounting for the energy assumption across operations at scales is the key to better estimating the carbon footprint. Techniques such as life cycle energy



assessment and life cycle carbon emissions assessment would offer informative guidance to reduce the environmental impacts. Few studies have focused on the impacts of cannabis cultivation on air quality. Evidence has emerged that BVOCs and fertilization may contribute to outdoor air quality issues. Indoor air pollutants, i.e., BVOCs emission, mold, pesticide, and chemicals pose a risk of health hazards. Field or chamber studies on determining the species and emission rate of BVOCs, trace gases, and particles from the plant, plant detritus, and soils are important. Much work will be needed to include this information in the emission inventory for air quality modeling. Investigation concerning the contribution of those species to regional, even global air quality, is useful for policymakers and the public. Besides, a better understanding of indoor pollutant concentration and emission ensures the safety of indoor operation. The environmental impact of cannabis cultivation on soil quality has two sides, and it needs to be treated dialectically. On one side, cannabis cultivation directly contributes to soil erosion. On the other side, cannabis has a strong ability to absorb and store heavy metals in the soil. Further studies on the soil mechanics and dynamics of heavy metals in plant-soil interactions are needed.

Abbreviations

ARs: Anticoagulant rodenticides; BVOCs: Biogenic volatile organic compounds; CAMx: Comprehensive Air Quality Model with extensions; CBD: Cannabidiol; CCFs: Cannabis cultivation facility; CMH: Ceramic metal halide; CSA: Controlled Substances Act; GHGs: Greenhouse gases; HPS: High-pressure sodium; HVAC: Heating, ventilation, and air conditioning; IMGO: Indoor Marijuana Grows Operations; LED: Light-emitting diode; NIH: National Institutes of Health; OSHA: Occupational Safety and Health Administration; PM: Particulate matter; SRCAA: Spokane Regional Clean Air Agency; THC: Tetrahydrocannabinols; USDA: Department of Agriculture; VOCs: Volatile organic compounds; WHO: World Health Organization.

Acknowledgements

The authors would like to thank Illinois State University for supporting this project.

Authors' contributions

Dr. Zheng worked on sections including outdoor and indoor air quality, energy demand and carbon footprint, and soil erosion. Miss Fiddes worked on water demand and pollution. Dr. Yang supervised Dr. Zheng and Miss Fiddes in completing this project. The author(s) read and approved the final manuscript.

Funding

Not applicable.

Availability of data and materials

All data generated or analyzed during this study are included in this published article.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

Not applicable.

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Received: 16 April 2021 Accepted: 9 July 2021

Published online: 06 August 2021

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EXHIBIT I



Apply for a Cannabis Permit

Contact Us

Permit Process Step-by-Step

1. Complete the [LiveScan](#) form and retain copy of results for application submission

All applicant board members, partners and managers must complete a LiveScan background check with a licensed LiveScan service provider. Complete the LiveScan form and bring in your stamped form(s) to the Special Activity Department Office after you have submitted your Cannabis Permit Application online.

2. Complete the [Updated Cannabis Application](#). If you are identifying a site, be sure to complete the CEQA questionnaire (pages 10-15). The CEQA questionnaire **requires the signature of the property owner**. If you have not yet identified a site, you will skip these pages, and provide them at the time a site is identified. Completed CEQA questionnaires will be reviewed by the Planning Department and a Notice of Exemption (NOE) will be issued. Applicants will be notified to pick up the NOE and an Inspection Card will then be issued. Applicants will then file the NOE document with the County Recorder's Office and supply our office with the stamped copy.

Equity applicant eligibility is based on:

- a) Proof of current Oakland residency,
- b) Income, and
- c) Either past residency or a cannabis-related arrest. (See pages 4-5 of the Cannabis Permit Application Form for more details)

Equity applicants can find the police beat they reside in on the [Police Beat Locator](#) . They can also determine if their annual income is at or less than the required 80 percent of the 2021 Oakland Average Medium Income (AMI) thresholds:

- \$76,720 for a one-person household
- \$87,680 for a two-person household
- \$98,640 for a three-person household
- \$109,600 for a four-person household
- \$118,400 for a five-person household
- \$127,200 for a six-person household
- \$135,920 for a seven-person household
- \$144,720 for an eight-person household

3. Submit completed permit application and LiveScan form and pay City processing fees

Please scan completed application and all supporting documents in PDF format to cannabisapp@oaklandca.gov After you have submitted your application, come in to the Special Activity Permits Office with your live scan form(s) and the \$32 DOJ processing fee per form, your non-refundable application fee of \$3010.69 for the first application submitted. For each additional permit type for the same operator at the same location, the non-refundable application fee is \$887.86. **ONLY CHECKS, CASHIER'S CHECKS OR MONEY ORDERS ARE ACCEPTED FORMS OF PAYMENT.** **PLEASE NOTE:** *Equity applicants are only required to submit the \$32 DOJ processing fee per LiveScan Form they submit.*

Updates and changes to your application will require a **Change of Application Fee: \$103.00**

4. Applicant follows instructions on inspection card to obtain approvals from City departments and other entities for a facility located in [a permitted zone](#).

5. The applicant submits completed Inspection Card in person to the City Administrator's Office. Our office will then schedule your final site visit and security inspection.

Regulatory Reminder

Cannabis business applicants are subject to all local, state, and federal laws and regulations. Accordingly, cannabis permit applicants are not entitled to operate simply because they have submitted a cannabis permit application, particularly in situations that the City of Oakland Fire Department (OFD) or the Planning & Building Department (PBD) deem unsafe. Please see these [updated procedures](#) about how to obtain approval from OFD and PBD. Also, please note the Permit Counter recently re-opened for in-person services. Please visit our [Permit Center Reopening webpage](#) for full details on hours of operation, scheduling your appointments, and services offered.

About

Contact Us

Phone Numbers

Phone Number: [\(510\) 238-3294](#) or [\(510\) 238-3671](#)

Email Address

cannabisapp@oaklandca.gov

Your Government

- [Departments](#)
- [City Officials](#)
- [City Council](#)
- [Boards & Commissions](#)
- [Public Meetings](#)
- [Community Events](#)

- [News](#)
- [City Jobs](#)
- [Contracting Opportunities](#)
- [Open Data](#)
- [Oakland Maps](#)
- [Oakland Municipal Code](#)

How can we help?

- [Report a Problem to Oak311](#)
- [Report a Crime](#)
- [Staff Directory](#)
- [City Services](#)
- [OakApps](#)

Sign up for updates

Your Email Address

Sign Up

EXHIBIT J



CITY OF OAKLAND
Office of the City Administrator

SPECIAL ACTIVITY PERMITS • 1 Frank H. Ogawa Plaza, 1st Floor • Oakland, CA 94612

**PRELIMINARY CHECKLIST FOR CANNABIS OPERATORS PURSUANT TO THE
CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA)**

APPLICANT NAME: Emerald Wizards, Inc.

DBA: _____

APPLICANT CONTACT INFORMATION:



PROPERTY OWNER AND APPLICANT INFORMATION
(Only complete if different from Applicant)
Original signatures or clear & legible copies are required.

Property Owner: 944 85th Ave Associates, LLC. / Jeffrey Haw

Property Owner Mailing Address: 1153 Mckinley Ave Apt #4 Oakland, CA 94610

City/State: Oakland **Zip:** 94610

I authorize the applicant indicated above to submit the application on my behalf.

Signature of Property Owner: 

I. SITE INFORMATION

Project Address: 944 85th Ave Unit A Oakland, CA 94621

Project APN: 42-4282-26-1

Project Overview and Description:

Renovation of partial existing warehouse (6500SF out of 7600SF) for the use of cannabis cultivation, distribution, and delivery to include approximately:

- ~3 Cultivation Rooms
- ~130 LED Cultivation Lights, Tables, and Irrigation System
- ~60 Tons of AC
- ~CO2 (Delivered Liquid) Supply System
- ~Supply and Exhaust Fans for Each Room
- ~Dry/Storage Rooms, Office
- ~Add Fire Sprinkler System and Fire/CO2 Alarm

No needed changes to structural components and no changes to wall partitions.
No needed upgrade to existing Electrical, Water, or Sewer as existing is sufficient.
No needed increased occupancy rate of building or parking capacity.

~6500SF for Main Micro Cannabis Business and ~1100SF for Incubator Business

What is the approximate square footage for each cannabis activity at your proposed site?

Delivery 800 SF

Distribution 800 SF

Indoor Cultivation 4900 SF

Outdoor Cultivation _____

Volatile Manufacturing _____

Non-Volatile Manufacturing _____

Transporter _____

Lab Testing _____

What is the approximate square footage of the lot on which the cannabis activity will take place?

9750 SF

Is the project new construction or rehabilitation of an existing facility?

☐ New Construction ☒ Rehabilitation of an existing facility

If rehabilitation, is the number of units or square footage being changed? ☐ Yes ☒ No (Explain if yes)

No changes to square footage.

What was the prior use of the property/premises?

Prior owner purchased from stated it was used for woodwork and cabinet manufacturing. Building was completely empty and appeared to be undeveloped for any use inside prior to renovation.

If your application is approved, will there be multiple cannabis operators located at the property?

☒ Yes ☐ No

If yes, how many and what is the approximate total square-footage for all cannabis operators?

~6500SF for Micro Business - Emerald Wizards, Inc.
~1100SF for Micro Business - Emerald Connector, Inc. (Incubator)

Have you incorporated any measures into your project to mitigate or reduce potential environmental impacts? ☒ Yes ☐ No ☐ Unknown

If so, list them here. (Examples include enrollment in clean energy programs, tree preservation plans, creek restoration plans, and open space easements.)

- All Power supplied by East Bay Community Energy program / PG&E
- Installation of energy efficient equipment and LED lights throughout building
- Employee Carpooling Program Incentives to reduce carbon footprint
- Excess irrigation water diverted from sewer system and used for in front planters for employee grown vegetables
- Recycled use of growing media (coco and organic soil) to reduce disposal of grow media
- Community Street sweeping (weekly) in front of property and ~100ft proximity of front entrance to reduce trash flowing into storm drains.

Will the Project utilize a carbon dioxide generator as part of your cannabis facility? ☐ Yes ☒ No

If yes, will the carbon dioxide generator emit carbon dioxide into the air and at what levels? Please explain and provide consultant report if necessary.

No carbon dioxide generators of any kind.

II. HISTORIC RESOURCES

Is the project site located within a historic district, or contain a historic building? ☐ Yes ☒ No
(Historic information can be obtained from the Planning & Zoning Division at (510) 238-6879)

a) What is the OCHS (Oakland Cultural Heritage Survey) rating of the building?

NA

b) If so, is the building proposed for demolition or alteration?

No

c) Is there a California Office of Historic Preservation DPR Form 523 with rating of 1 to 5?

No

Note: Any modification to a historic building will require additional CEQA analysis and may not be eligible for a CEQA exemption.

III. HAZARDOUS MATERIALS

Is the subject property located on a State List of sites containing hazardous materials compiled pursuant to Section 65962.5 of the Government Code? ☐ Yes ☒ No
(Cortese list, among others; more information can be obtained from California EPA at https://www.dtsc.ca.gov/SiteCleanup/Cortese_List.cfm)

a) If so, has the site been remediated? _____

- b) Is there a "Closure Letter" from the appropriate regulatory Agency? _____
- c) If not remediated, is there an approved Remedial Action Plan (RAP)? _____
- d) If not, has a RAP been submitted? _____

IV. OTHER

Is the applicant aware of any other environmental conditions/impacts likely to require further CEQA or National Environmental Policy Act (NEPA) review, such as:

- i. Sensitive environments, e.g., creeks-wetlands, seismically active areas ☐ Yes ☒ No
- ii. Peculiar or unique characteristics of the site, the project, or adjacent uses ☐ Yes ☒ No

Please explain:

I understand that review and approval of this preliminary CEQA checklist does not constitute approval for any administrative review, conditional use permit, variance, or exception from any other City regulations which are not specifically the subject of this application. I understand further that I remain responsible for satisfying requirements of any private restrictions or covenants appurtenant to the property. I understand that the Applicant and/or Owner phone number listed above will be included on any public notice, if any, for the project.

I certify that I am the applicant and that the information submitted with this preliminary CEQA checklist is true and accurate to the best of my knowledge and belief. I understand that the City is not responsible for inaccuracies in information presented, and that inaccuracies may result in the revocation of any permits as determined by the City. I further certify that I am the owner or purchaser (or option holder) of the property involved in this application, or the lessee or agent fully authorized by the owner to make this submission, as indicated by the owner's signature above.

I certify that statements, if any, made to me about the time it takes to review and process this application are general. I am aware that the City has attempted to request everything necessary for an accurate and complete CEQA review of my proposal; however, that after this preliminary CEQA checklist and/or application has been submitted and reviewed by the City Administrator's Office, it may be necessary for the City to request additional information and/or materials. I understand that any failure to submit the additional information and/or materials in

a timely manner may render the application inactive and that periods of inactivity do not count towards statutory time limits applicable to the processing of this application.

I HEREBY CERTIFY, UNDER PENALTY OF PERJURY, THAT ALL THE INFORMATION PROVIDED ON THIS APPLICATION IS TRUE AND CORRECT.

Signature of Applicant: 

Date: 12/15/2021

FOR
OFFICE
USE
ONLY

CEQA Review done by: _____ Date: _____

Findings: ☐ Exempt ☐ Needs Additional Information

Notice of Exemption completed by: _____ Date: _____

CITY OF OAKLAND



DALZIEL BUILDING • 250 FRANK H. OGAWA PLAZA • SUITE 3315 • OAKLAND, CALIFORNIA 94612

Planning and Building Department
Bureau of Planning

(510) 238-3941
FAX (510) 238-6538
TDD (510) 238-3254

NOTICE OF EXEMPTION

TO: Alameda County Clerk
1106 Madison Street
Oakland, CA 94612

Project Title: Cannabis Distribution @ 944 85th Ave. Unit A

Project Applicant: Emerald Wizards, Inc.

Project Location: 944 85th Ave. #A (APN: 42-4282-26-1)

Project Description: Applicant has proposed a cannabis distribution operation of which 800-sq ft. of 9,750-sq. ft facility that will store cannabis products.

Exempt Status:

Statutory Exemptions

☐ Ministerial {Sec.15268}

Categorical Exemptions

☒ Existing Facilities {Sec.15301}

☐ Small Structures {Sec.15303}

Other

☒ Projects consistent with a community plan, general plan or zoning {Sec. 15183(f)}

☐ _____ (Sec. _____)

Reason why project is exempt:

The Applicant is proposing to operate as a cannabis distributor in an existing commercial facility. Further, the use of cannabis distribution is permitted at the discretion of the City Administrator under Chapter 5.80 of the Oakland Municipal Code, and a delivery operation of this size does not generate a significant number of vehicle trips. Thus, the proposed use will not have a significant effect on the environment. **Lead Agency:** City of Oakland, Planning and Building Department, 250 Frank H. Ogawa Plaza, Suite 2114, Oakland, CA 94612 **Division/Contact Person:** Bureau of Planning / Zoning / Aubrey Rose AICP, Planner III **Phone:** 510-238-2071

Signature (Ed Manasse, Environmental Review Officer)

Date:

Pursuant to Section 711.4(d)(1) of the Fish and Game Code, statutory and categorical exemptions are also exempt from Department of Fish and Game filing fees.

***ENVIRONMENTAL DECLARATION**
(CALIFORNIA FISH AND GAME CODE SECTION 711.4)

: FOR COUNTY CLERK USE
ONLY

LEAD AGENCY NAME AND ADDRESS:

CITY OF OAKLAND
Bureau of Planning
250 Frank H. Ogawa Plaza, Suite 2114
Oakland, CA 94612

APPLICANT: Emerald Wizards Inc.
944 85th Ave.
Oakland, CA 94621

: FILE NOS. n / a

CLASSIFICATION OF ENVIRONMENTAL DOCUMENT:
(PLEASE MARK ONLY ONE CLASSIFICATION)

1. NOTICE OF EXEMPTION / STATEMENT OF EXEMPTION

☒ A – STATUTORILY OR CATEGORICALLY EXEMPT

\$50.00 – COUNTY CLERK HANDLING FEE

1. NOTICE OF DETERMINATION (NOD)

☐ A – NEGATIVE DECLARATION (OR MITIGATED NEG. DEC.)

\$2,480.25 - STATE FILING FEE

\$50.00 (Fifty Dollars) – COUNTY CLERK FILING FEE

☐ B – ENVIRONMENTAL IMPACT REPORT

\$3,445.25 – STATE FILING FEE

\$50.00 (Fifty Dollars) – CLERK’S FEE

3. ☐ **OTHER:** _____

****A COPY OF THIS FORM MUST BE COMPLETED AND SUBMITTED WITH EACH COPY OF AN ENVIRONMENTAL DECLARATION BEING FILED WITH THE ALAMEDA COUNTY CLERK.****

BY MAIL FILINGS:

PLEASE INCLUDE FIVE (5) COPIES OF ALL NECESSARY DOCUMENTS AND TWO (2) SELF-ADDRESSED ENVELOPES.

IN PERSON FILINGS:

PLEASE INCLUDE FIVE (5) COPIES OF ALL NECESSARY DOCUMENTS AND ONE (1) SELF-ADDRESSED ENVELOPE.

ALL APPLICABLE FEES MUST BE PAID AT THE TIME OF FILING.

FEES ARE EFFECTIVE JANUARY 1, 2021
MAKE CHECKS PAYABLE TO: ALAMEDA COUNTY CLERK

CITY OF OAKLAND



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Planning and Building Department
Bureau of Planning

(510) 238-3941
FAX (510) 238-6538
TDD (510) 238-3254

NOTICE OF EXEMPTION

TO: Alameda County Clerk
1106 Madison Street
Oakland, CA 94612

Project Title: Cannabis Retailer Non-Storefront @ 944 85th Ave. #A

Project Applicant: Emerald Wizards Inc.

Project Location: 944 8th Ave. #A (APN: 42-4282-26-1)

Project Description: Applicant has proposed a cannabis delivery operation of which 800-sq ft. of 9,7500-sq. ft facility that will store cannabis products for delivery.

Exempt Status:

Statutory Exemptions

☐ Ministerial {Sec.15268}

Other

☒ Projects consistent with a community plan, general plan or zoning {Sec. 15183(f)}

☐ _____ (Sec. _____)

Categorical Exemptions

☒ Existing Facilities {Sec.15301}

☐ Small Structures {Sec.15303}

Reason why project is exempt:

The Applicant is proposing to operate as a cannabis retailer-non-storefront in an existing commercial facility. Further, the use of cannabis delivery is permitted at the discretion of the City Administrator under Chapter 5.80 of the Oakland Municipal Code, and a delivery operation of this size does not generate a significant number of vehicle trips. Thus, the proposed use will not have a significant effect on the environment. **Lead Agency:** City of Oakland, Planning and Building Department, 250 Frank H. Ogawa Plaza, Suite 2114, Oakland, CA 94612 **Division/Contact Person:** Bureau of Planning / Zoning / Aubrey Rose AICP, Planner III **Phone:** 510-238-2071

Signature (Ed Manasse, Environmental Review Officer)

Date:

Pursuant to Section 711.4(d)(1) of the Fish and Game Code, statutory and categorical exemptions are also exempt from Department of Fish and Game filing fees.

***ENVIRONMENTAL DECLARATION**
(CALIFORNIA FISH AND GAME CODE SECTION 711.4)

: FOR COUNTY CLERK USE
ONLY

:

LEAD AGENCY NAME AND ADDRESS:

:

CITY OF OAKLAND
Bureau of Planning
250 Frank H. Ogawa Plaza, Suite 2114
Oakland, CA 94612

:

:

:

:

:

APPLICANT: Emerald Wizards Inc.
944 85th Ave. #A
Oakland, CA 94621

: FILE NOS. n / a

CLASSIFICATION OF ENVIRONMENTAL DOCUMENT:
(PLEASE MARK ONLY ONE CLASSIFICATION)

1. NOTICE OF EXEMPTION / STATEMENT OF EXEMPTION

☒ A – STATUTORILY OR CATEGORICALLY EXEMPT

\$50.00 – COUNTY CLERK HANDLING FEE

1. NOTICE OF DETERMINATION (NOD)

☐ A – NEGATIVE DECLARATION (OR MITIGATED NEG. DEC.)

\$2,480.25 - STATE FILING FEE

\$50.00 (Fifty Dollars) – COUNTY CLERK FILING FEE

☐ B – ENVIRONMENTAL IMPACT REPORT

\$3,445.25 – STATE FILING FEE

\$50.00 (Fifty Dollars) – CLERK'S FEE

3. ☐ **OTHER:** _____

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CITY OF OAKLAND



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Planning and Building Department
Bureau of Planning

(510) 238-3941
FAX (510) 238-6538
TDD (510) 238-3254

NOTICE OF EXEMPTION

TO: Alameda County Clerk
1106 Madison Street
Oakland, CA 94612

Project Title: Cannabis Cultivation @ 944 85th Ave. A

Project Applicant: Emerald Wizards Inc.

Project Location: 944 8th Ave. #A (APN: 42-4282-26-1)

Project Description: Applicant has proposed a cannabis operation of which 4,900-sq.ft. of a 9,750-sq. ft facility that will cultivate cannabis.

Exempt Status:

Statutory Exemptions

☐ Ministerial {Sec.15268}

Categorical Exemptions

☒ Existing Facilities {Sec.15301}

☐ Small Structures {Sec.15303}

Other

☒ Projects consistent with a community plan, general plan or zoning {Sec. 15183(f)}

☐ _____ (Sec. _____)

Reason why project is exempt:

The Applicant is proposing to operate as a cannabis cultivation in an existing commercial facility. Further, the use of cannabis cultivation is permitted at the discretion of the City Administrator under Chapter 5.80 of the Oakland Municipal Code, and a delivery operation of this size does not generate a significant number of vehicle trips. Thus, the proposed use will not have a significant effect on the environment. **Lead Agency:** City of Oakland, Planning and Building Department, 250 Frank H. Ogawa Plaza, Suite 2114, Oakland, CA 94612 **Division/Contact Person:** Bureau of Planning / Zoning / Aubrey Rose AICP, Planner III **Phone:** 510-238-2071

Signature (Ed Manasse, Environmental Review Officer)

Date:

Pursuant to Section 711.4(d)(1) of the Fish and Game Code, statutory and categorical exemptions are also exempt from Department of Fish and Game filing fees.

***ENVIRONMENTAL DECLARATION**
(CALIFORNIA FISH AND GAME CODE SECTION 711.4)

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LEAD AGENCY NAME AND ADDRESS:

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Bureau of Planning
250 Frank H. Ogawa Plaza, Suite 2114
Oakland, CA 94612

APPLICANT: Emerald Wizards Inc.
944 8th Ave. #A.
Oakland, CA 94621

: FILE NOS. n / a

CLASSIFICATION OF ENVIRONMENTAL DOCUMENT:
(PLEASE MARK ONLY ONE CLASSIFICATION)

1. NOTICE OF EXEMPTION / STATEMENT OF EXEMPTION

☒ A – STATUTORILY OR CATEGORICALLY EXEMPT

\$50.00 – COUNTY CLERK HANDLING FEE

1. NOTICE OF DETERMINATION (NOD)

☐ A – NEGATIVE DECLARATION (OR MITIGATED NEG. DEC.)

\$2,480.25 - STATE FILING FEE

\$50.00 (Fifty Dollars) – COUNTY CLERK FILING FEE

☐ B – ENVIRONMENTAL IMPACT REPORT

\$3,445.25 – STATE FILING FEE

\$50.00 (Fifty Dollars) – CLERK’S FEE

3. ☐ **OTHER:** _____

****A COPY OF THIS FORM MUST BE COMPLETED AND SUBMITTED WITH EACH COPY OF AN ENVIRONMENTAL DECLARATION BEING FILED WITH THE ALAMEDA COUNTY CLERK.****

BY MAIL FILINGS:

PLEASE INCLUDE FIVE (5) COPIES OF ALL NECESSARY DOCUMENTS AND TWO (2) SELF-ADDRESSED ENVELOPES.

IN PERSON FILINGS:

PLEASE INCLUDE FIVE (5) COPIES OF ALL NECESSARY DOCUMENTS AND ONE (1) SELF-ADDRESSED ENVELOPE.

ALL APPLICABLE FEES MUST BE PAID AT THE TIME OF FILING.

FEES ARE EFFECTIVE JANUARY 1, 2021
MAKE CHECKS PAYABLE TO: ALAMEDA COUNTY CLERK

EXHIBIT K



CITY OF OAKLAND
Office of the City Administrator

SPECIAL ACTIVITY PERMITS

• 1 Frank H. Ogawa Plaza, 1st Floor

• Oakland, CA 94612

PRELIMINARY CHECKLIST FOR CANNABIS OPERATORS PURSUANT TO THE
CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA)

APPLICANT NAME: DC Capital Holdings LLC

DBA: _____

APPLICANT CONTACT INFORMATION:



PROPERTY OWNER AND APPLICANT INFORMATION
(Only complete if different from Applicant)
Original signatures or clear & legible copies are required.

Property Owner: Greensage -- Patrick KoentgesProperty Owner Mailing Address: 1137 Bannock StCity/State: Denver, COZip: 80204*I authorize the applicant indicated above to submit the application on my behalf.*

Signature of Property Owner: _____

I. SITE INFORMATION

Project Address: 5733 San Leandro StreetProject APN: 41-3848-13-3

Project Overview and Description:

Cannabis Cultivation. We will be growing plants in a warehouse space in East Oakland. There are multiple other tenants in the building.

What is the approximate square footage of the building? 62,000

What is the total square footage of the entire project site? 30,000

Is the project new construction or rehabilitation of an existing facility?

☐ New Construction ☒ Rehabilitation of an existing facility

If rehabilitation, is the number of units or square footage being changed? ☐ Yes ☒ No (Explain if yes)

What was the prior use of the property/premises?

Cannabis cultivation/Vacant/Food Cannery

If your application is approved, will there be multiple cannabis operators located at the property?

☒ Yes ☐ No

If yes, how many and what is the approximate total square-footage for all cannabis operators?

one other operator in our building: 60,000.

Have you incorporated any measures into your project to mitigate or reduce potential environmental impacts? ☒ Yes ☐ No ☐ Unknown

If so, list them here. (Examples include enrollment in clean energy programs, tree preservation plans, creek restoration plans, and open space easements.)

Use of high energy efficiency bulbs, low flow toilets and water systems, and a strict recycling program are the methods we intend to use to mitigate our environmental impacts. We also intend to install some solar, but are still currently putting that process into plans.

Will the Project utilize a carbon dioxide generator as part of your cannabis facility? ☐ Yes ☒ No

If yes, will the carbon dioxide generator emit carbon dioxide into the air and at what levels? Please explain and provide consultant report if necessary.

The CO2 used in the grow rooms should not leak any CO2. We understand that CO2 is a harmful greenhouse gas and as such are only releasing it when the rooms are airtight. We want our plants to have the benefit of a CO2 enriched environment but do not want to affect any harm upon our world or community. Once CO2 levels are normal will we break the seal on the room and allow for inter-room air exchange. No CO2 should escape our facility.

II. HISTORIC RESOURCES

Is the project site located within a historic district, or contain a historic building? ☐ Yes ☒ No
(Historic information can be obtained from the Planning & Zoning Division at (510) 238-6879)

a) If so, what is the OCHS (Oakland Cultural Heritage Survey) rating of the building?

b) If so, is the building proposed for demolition or alteration?

c) Is there a California Office of Historic Preservation DPR Form 523 with rating of 1 to 5?

Note: Any modification to a historic building will require additional CEQA analysis and may not be eligible for a CEQA exemption.

III. HAZARDOUS MATERIALS

Is the subject property located on a State List of sites containing hazardous materials compiled pursuant to Section 65962.5 of the Government Code? ☐ Yes ☒ No
(Cortese list, among others; more information can be obtained from California EPA at https://www.dtsc.ca.gov/SiteCleanup/Cortese_List.cfm)

a) If so, has the site been remediated? _____

b) Is there a "Closure Letter" from the appropriate regulatory Agency? _____

c) If not remediated, is there an approved Remedial Action Plan (RAP)? _____

d) If not, has a RAP been submitted? _____

IV. OTHER

Is the applicant aware of any other environmental conditions/impacts likely to require further CEQA or National Environmental Policy Act (NEPA) review, such as:

- i. Sensitive environments, e.g., creeks-wetlands, seismically active areas ☐ Yes ☐ No
- ii. Peculiar or unique characteristics of the site, the project, or adjacent uses ☐ Yes ☐ No

Please explain:

I understand that review and approval of this preliminary CEQA checklist does not constitute approval for any administrative review, conditional use permit, variance, or exception from any other City regulations which are not specifically the subject of this application. I understand further that I remain responsible for satisfying requirements of any private restrictions or covenants appurtenant to the property. I understand that the Applicant and/or Owner phone number listed above will be included on any public notice, if any, for the project.

I certify that I am the applicant and that the information submitted with this preliminary CEQA checklist is true and accurate to the best of my knowledge and belief. I understand that the City is not responsible for inaccuracies in information presented, and that inaccuracies may result in the revocation of any permits as determined by the City. I further certify that I am the owner or purchaser (or option holder) of the property involved in this application, or the lessee or agent fully authorized by the owner to make this submission, as indicated by the owner's signature above.

I certify that statements, if any, made to me about the time it takes to review and process this application are general. I am aware that the City has attempted to request everything necessary for an accurate and complete CEQA review of my proposal; however, that after this preliminary CEQA checklist and/or application has been submitted and reviewed by the City Administrator's Office, it may be necessary for the City to request additional information and/or materials. I understand that any failure to submit the additional information and/or materials in a timely manner may render the application inactive and that periods of inactivity do not count towards statutory time limits applicable to the processing of this application.

I HEREBY CERTIFY, UNDER PENALTY OF PERJURY, THAT ALL THE INFORMATION PROVIDED ON THIS APPLICATION IS TRUE AND CORRECT.

Signature of Applicant: 

Date: 9/19/2019

FOR
OFFICE
USE
ONLY

CEQA Review done by: _____ Date: _____

Findings: ☐ Exempt ☐ Needs Additional Information

Notice of Exemption completed by: _____ Date: _____

EXHIBIT L

ATTACHMENT D:

2017-2020 City of Oakland Cannabis Application and Permit Trends

Figure 1: Graph of Cannabis Permit Applications Received Since 2017

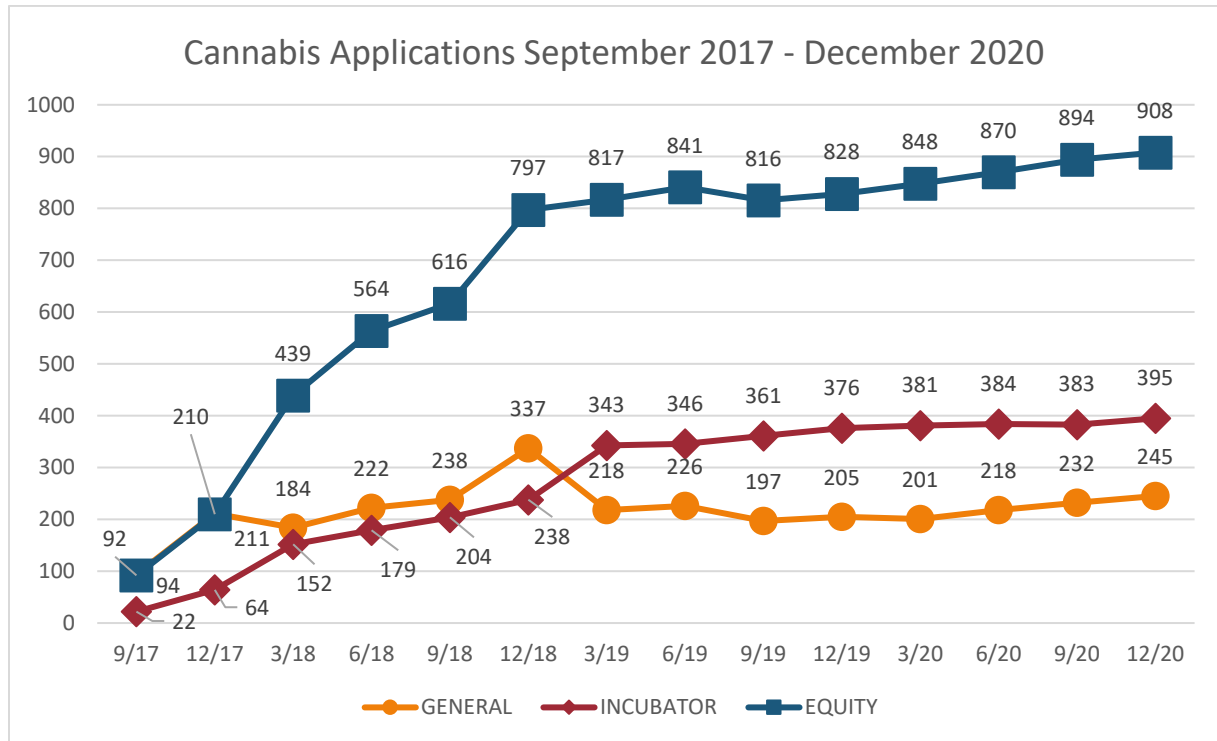


Figure 2: Graph of New Cannabis Permits Issued Since 2017

