DIALOGUE

HAZY REGULATIONS: CANNABIS AND THE ENVIRONMENT

SUMMARY

The U.S. legal cannabis market is an estimated $60 billion industry, with approximately 28,000 businesses operating and employing upwards of 300,000 people, and growing rapidly. Large-scale cultivation requires significant energy usage, nutrient and pesticide inputs, and water usage, resulting in cumulative environmental impacts. Addressing these concerns raises complex legal issues because of cannabis' federal classification as a Schedule 1 narcotic, which prevents federal agencies from collecting data on, providing guidance to, or regulating the industry. This has led to fragmented state regulations that differ widely in regulating its impacts. On July 7, 2022, the Environmental Law Institute hosted a panel of experts who explored these legal and technical challenges, the environmental impacts of cannabis production, and opportunities to improve sustainability. Below, we present a transcript of that discussion, which has been edited for style, clarity, and space considerations.

Chandler Randol (moderator) was the Manager of Educational Programs at the Environmental Law Institute.
John Kagia is the Chief Knowledge Officer at New Frontier Data.
Kaitlin Urso is a Cannabis Environmental Consultant with the Colorado Department of Public Health and Environment.
Robert L. (Buzz) Hines is a Partner with Farella Braun + Martel LLP.

Chandler Randol: I would like to introduce today's panel. First, we have John Kagia, the chief knowledge officer at New Frontier Data. He is a pioneer and thought leader in the cannabis industry, where he has developed market-leading forecasts for the growth of the industry, uncovered groundbreaking insights into the cannabis consumer, and led a first-of-its-kind analysis of global cannabis demand.

Next, Kaitlin Urso is an environmental consultant at the Colorado Department of Public Health and Environment, and chair of the Energy and Environmental Committee of the Cannabis Regulators Association. She works to advance environmental sustainability in the cannabis and craft brewing industries.

Last, we have Robert (Buzz) Hines, a partner at Farella Braun + Martell LLP. Buzz has a wide array of practice areas, including facility and project permitting, regulation of greenhouse gas emissions, and product stewardship. He also works with clients in the wine and cannabis industries, where he assists with facility expansions, acquisitions in the agricultural sector, and related product issues.

John Kagia: I'm delighted to be sitting on this panel with my two esteemed co-panelists to discuss some of the trends, trajectories, implications, and opportunities for more thoughtful environmental and sustainability considerations in the emerging global cannabis industry.

For those of you who might not know us, New Frontier Data is a market research, business intelligence, and data analytics company exclusively focused on the global cannabis economy. I'm going to share a few themes to contextualize why this conversation is so important right now, as well as some of the issues that we think are really salient to this market, as we talk about the impact of cannabis on the environment and issues related to the sustainable growth of this industry.

First, by way of context, while North America has led the emergence of legal cannabis as we know it, it's been incredible for us over the past eight years to watch this industry go from having barely a handful of countries in which cannabis is legal in any form, to having more than 70 countries that have legalized and begun to regulate cannabis in some form—whether that's low-tetrahydrocannabinol (THC) products, cannabidiol (CBD), hemp, or medical and adult use.

It's critically important to understand that the United States and Canada are going to play important roles in shaping the emergence of the global cannabis industry. The practices adopted in North America are going to be replicated globally. At the advent of the legal version of this industry, the decisions being made today around sustainability and around resource efficiency are going to have global consequences.

As an industry, cannabis is in a unique position to be able to build these regulations as the industry grows. There are a lot of other sectors where major changes are having to be applied retrospectively into well-established markets, so cannabis is in a unique position to be able to adopt these best practices early in the growth of the industry. It will be

truly unfortunate if we look back a decade from now and realize that we missed an opportunity to get it right out of the gate, particularly when there are so many markets that we can learn from.

There's also an issue of scale. Based on our modeling, in 2021, the global cannabis industry was set to be roughly $30 billion. By 2025, the legal market is going to be about $51 billion. But the total cannabis economy is already a half-trillion-dollar market. There's a tremendous amount of demand for cannabis in the world today. There are two important points there. If cannabis is already nearly a half-trillion-dollar industry, it means there's already a lot of cannabis being grown around the world. A lot of it is being grown without consideration for its impact on the environment in the places where it's being grown.

The goal of legalization is not to create a new market out of thin air, but to transition this very large existing market into a formal regulated structure. And therein lies the opportunity. We've seen it done in the United States. We've seen it done in Canada. But we barely scratched the tip of the iceberg when we think about this in the global context. That transition from a $50 billion legal market that will slowly cannibalize the existing half-trillion-dollar opportunity is why it's so important for us to be having a robust conversation about resource efficiency and sustainability right now.

In the United States alone, this year we're looking at an industry that will achieve about $32 billion in sales. But by 2030, the U.S. market alone could be driving more than $70 billion in revenue annually. Between 2020 and 2030, in total sales cumulatively, the United States will have generated nearly $0.5 trillion in revenue. So, there's a lot of money to be made in this space. Part of the reason why it's so important to make thoughtful decisions about the growth of this market is because of how much potential revenue is at stake.

We can talk about some of the resource constraints that operators in this market are facing, particularly given the sometimes crazy regulations that cannabis business operators have to face, but the bottom line is that there is a phenomenal amount of consumer demand for this product. However one might feel about it, that is the reality. And as the market grows, there is going to be increasing pressure for the industry to be a good steward of the resources that it is using.

Even the $70 billion market by 2030 will still not be close to a fully mature market. By 2030, our estimate for the total opportunity in the United States is well over $100 billion. Even beyond 2030, there will still be room for upside legal market growth in the United States and globally. It is clearly a big, fast-growing industry that is evolving quickly.

There are a few aspects related to the environmental issues this industry is facing that I'd like to mention. One is the urgency around issues like climate change and water use. We've been paying very close attention to the U.S. drought monitor over the past eight years, and it's been quite stunning to see how the western states—our country's most productive cannabis-producing regions—are being impacted by drought conditions and the impact that has on water access, the cost of water, and so on.

Our seven western states—our most productive states—have all experienced acute drought conditions in 2021. This includes Nevada at 70% of the state facing drought, California at 67%, and Arizona at 56%.[1] It isn't going to get better. One can bury one's head in the sand, but at some point, whether it's water bills going through the roof or wildfires, you cannot escape the realities that a drying western United States is going to have on the country's most productive regions. That alone should compel us to think about how to improve water efficiency.

With more than 60% of California facing drought, cannabis was being blamed for the water shortages in the state. We did an interesting collaboration with the Resource Innovation Institute, an organization out of Oregon that monitors resource use. We've completed two thought pieces with them: a report on water use in cannabis[2] and one on energy use in cannabis.[3] We knew that California's cannabis industry was under intense pressure, and being blamed for the water challenges that the rest of California's agricultural economy was facing.

We mapped how the average California grower was using water and we saw a cyclicality. There was a significant rise in water use going into the late summer months, and then it fell off going into the end of the year. That water use in late summer-early fall, at the time that drought tends to be at its peak, was why California cannabis producers were getting blamed for the water shortage. It was an easy finger to point because it had never been quantified.

We found that the average California grower uses about 180,000 gallons of water over the annual cycle of their production, with this seasonal pattern being reflected across most types of growers.[4] However, when we calculated how much water the state was using for cannabis versus other crops, it was actually quite stunning how little cannabis is using relative to the state's other major agricultural products.

Lands in orchards use nearly seven million acre-feet of applied water to their farms, which is a phenomenal amount of water. We have rice at nearly five million acre-feet, and land in vegetables at nearly three million acre-feet. In contrast, cannabis is at 0.003 million acre-feet.[5] It is minuscule compared to these other crops, which is not to say there aren't opportunities to increase the efficiency of water use. But to me, this was an excellent illustration of why it's so important to quantify the impact this industry

1. University of Nebraska-Lincoln National Drought Mitigation Center, *U.S. Drought Monitor*, droughtmonitor.unl.edu (last visited Sept. 22, 2022).
2. New Frontier Data, Resource Innovation Institute, and Berkeley Cannabis Research Center, Cannabis H_2O: Water Use and Sustainability in Cultivation, https://newfrontierdata.com/product/cannabis-h2o-water-use-and-sustainability-in-cultivation/.
3. New Frontier Data, Resource Innovation Institute, and Scale Microgrid Solutions, The 2018 Cannabis Energy Report (2018), https://newfrontierdata.com/product/2018-cannabis-energy-report/.
4. New Frontier Data, *supra* note 2.
5. *Id.*

is having because it's easy to assign blame when there aren't numbers to back it up.

Because cannabis is such a lucrative crop, you don't need to grow a lot of it for it to have a major economic impact. There was, I think, a gross misunderstanding of how much cannabis is actually being produced to yield the revenues that it has generated. As a result, it was being blamed for water use that was negligible relative to the state's overall water use.

That was an exciting moment. Again, we did not expect the difference to be so wide relative to the rest of water use in the state. It also underscored that cannabis is a major agricultural crop, but it may not actually be having some of the impacts that it is being blamed for.

Energy is another interesting aspect. This one is a little more problematic for the industry because so much cannabis is grown indoors. When you compare cannabis to some other major energy sinks in our economy, it may not be as high as data centers, which are using 70 billion kilowatt hours per year, or medical centers using 57 billion kilowatt hours per year. But at 4.2 billion kilowatt hours per year and growing,[6] particularly growing on the legal side, you can't ignore that cannabis is a major source of energy use in our broader economy.

It is worth noting, however, that when we did this analysis a couple of years back, these numbers reflected an industry that was still transitioning from the old way in which cannabis was being produced, with very little investment in research and development (R&D) or innovation. One of the things we have seen dramatically shift over the past five to 10 years in the cannabis industry is the massive investments being channeled to energy-saving innovations.

And this is happening in a few ways. First, there has been a significant transition from purely indoor to mixed-light environments. Second, there's been a rise of LEDs and a transition away from conventional, high-intensity discharge lighting. That alone is saving 30% to 40% of the energy cost in these operations. We've seen installation of things like solar energy. We've seen significant investment in data-monitoring systems in closed-environment cultivation facilities that allow the operator to both minimize their energy use and ensure that energy is being directed into the places where it is needed, and not being wasted on the places where it isn't.

So, even as we see the demand for energy continue to grow, the focus on energy efficiency means that, on average, newer facilities are using dramatically less energy than facilities were using five to 10 years ago. And that trend is only going to continue.

I'll make a few final points. One is around packaging, an important part of the environmental impact of this industry. If you've ever been to a cannabis dispensary, you've seen large packages on the shelves. If you've ever taken packages home from the cannabis dispensary, you'll see that there's actually not very large products in those packages.

As brands try to create packaging that is visually resonant for consumers, and as regulations require child-safety packaging or labels with a large amount of information on them, a lot of post-consumer waste is being created. Oftentimes, the only function of this packaging is to go between the dispensary and the consumer's waste bin when they get home.

There are a lot of companies that are now looking at using 100% post-consumer waste and using hemp-developed packaging to reduce the environmental impact. But even though folks in the industry are trying to think of ways to make the waste more recyclable, that doesn't address the issue of better managing packaging requirements. As we go from a $30 billion industry to a $70 billion or a $100 billion industry, the volume of packaging will grow dramatically, and the industry is going to bear the responsibility for accounting for that.

Similarly, we have been watching the market for vaporizers, and particularly the market for disposable vaporizers, very carefully. Vapes with components that are difficult to recycle could prove to be the cannabis industry's equivalent to the Keurig K-Cup problem—an efficient or elegant consumer solution that ends up driving massive amounts of waste. Consumers may not want to go through the burden of having to recycle these products. This is an evolving conversation. Vapes now account for about 20% of sales in the market.

The scale hasn't yet reached the point where it's become ever-present and constant in our disposal-and-trash recycling ecosystem. But if we don't figure out a way to mitigate the environmental impact of vapes in our trash waste streams, then in a decade or two, as this industry goes global, and as vapes grow in popularity, this could unfortunately end up being one of the areas where we wish we had done more sooner.

Finally, we can't talk about cannabis without talking about the industrial opportunities of the plant. Despite the big numbers I threw out at the beginning, we actually think that the industrial hemp sector could prove to be an even larger opportunity than the THC-based side of the economy.

When I first started doing this work, I used to hear from folks on the hemp side that hemp is the most versatile crop in our agricultural economy. And I thought they spent too much time in the hemp fields. But the more we've looked at this plant and its potential applications, the more we've seen opportunities to innovate some sticky parts of our existing industrial economy.

I have come to believe that this plant truly is one of the most versatile crops in our agricultural economy. Regulations and investment in innovation will be critical to determining how many of its applications—from textiles to plastics, biofuels, papers, and building materials—come to reach industrial scale. If we can achieve industrial and commercial viability for hemp in these sectors, then hemp poses real promise as a sustainable replacement for fossil fuel-based or other resource-intensive materials. We're excited to see what the global cannabis innovators will do with this plant over the next decade.

6. New Frontier Data, *supra* note 3.

If you're interested in the reports and work we're doing, visit https://newfrontierdata.com/cannabis-analyst-reports/. I hope these brief remarks have helped frame our conversation today.

Kaitlin Urso: I appreciate you laying out that data to help make sense of the industry's scale and impacts.

I work for the Colorado Department of Public Health and Environment. My role is to be a free environmental consultant for small businesses in Colorado. We define that as 100 or fewer employees, and a lot of cannabis businesses fall under that definition.

I rotate through industries to focus on providing proactive environmental assistance. In 2016-2017, I worked with the craft brewing industry. In 2018, I came to work with the cannabis industry, which I did through 2021. This year, I'm shifting my focus to data centers, which are pretty much the most energy-intensive type of industry, as John pointed out.

Having spent four years with the cannabis industry, I spent a lot of my time trying to document the environmental impacts and best management practices in an emerging industry. The goal of my work is to give businesses the tools to make improvements. A lot of my later work was focused on helping the government change its regulations to support environmentally friendly practices for cannabis businesses.

The Colorado Department of Public Health and Environment's website[7] offers many external links that provide a great starting point for cannabis sustainability. I was also the author of the National Cannabis Industry Association's environmental report published in 2020.[8] That document is a great starting point on the environmental impacts and best practices that can be applied, and there's content in there surrounding policy conversations as well.

As John pointed out, energy use is the main impact of cannabis, especially here in Colorado, where cannabis is primarily grown in an indoor environment. Our regulations dictate that setup.[9] It's very hard to do outdoor cultivation in Colorado, as we don't have many greenhouses. Hemp is typically grown outdoors, but marijuana is grown in indoor warehouses.

The energy load is mostly in the heating, ventilating, and air-conditioning (HVAC) system, and the lighting. The typical lighting that is used in a cannabis facility is about 1,000 watts per light fixture. And there are many light fixtures, so the electrical load is very high. Those lights also generate quite a bit of heat, which then needs to be overcome by the HVAC system. When you add plants to that equation, the light and heat produces transpiration, so you also have a large humidity load. Your HVAC system is then constantly fighting heat from your lights and humidity from your plants.

A one-size-fits-all solution—which John mentioned that I'll highlight even further—is to switch to LED lights. Not only do they bring down the energy load per light fixture, going from 1,000 watts to about 60 watts or even lower depending on the LED light, but they also produce much less heat. Your HVAC system then doesn't have to overcome that heat load and your plants don't transpire as much. There is also less lighting waste because you can position the LED lights much closer to the plants.

The other advantage with a lower heat profile is that you can go vertical with your farm. You can stack racks of plants. With traditional lighting, your heat load would amplify every layer because heat rises. If you don't have that amplified heat load, you can utilize your warehouse space more efficiently, which will also lead to more efficient HVAC systems. There's a lot that can be done to reduce energy use if you're willing to make the jump to LED lights. It's worth it.

As far as regulation, not a lot of energy regulation exists specific to the cannabis industry. A few states have tried it, and they've had varying degrees of success. But essentially there are two policy routes. You can either go the route of what I call "observe and report," where you have cannabis cultivators report their energy usage and then implement some metric of improvement to reduce that usage. Or you can build efficiency standards into equipment, which I believe is the easier policy route but may be a bit harder on industry. For example, you have to have the equivalent of LED lights within your facility or an HVAC system that's *x*-amount efficient. Essentially, green building codes that are industry-specific.

In Colorado, we have not yet broached the energy regulation side of the cannabis industry. We are more focused on encouraging energy efficiency and reduction. The number one business cost of cultivation is energy, so there are both economic and environmental drivers to reduce energy use.

For water use in an indoor cultivation environment, we are relying on the municipal drinking water supply to irrigate and grow the crops. We are also relying on the municipal wastewater treatment plants for the runoff, rather than dealing with erosion and runoff in an outdoor agricultural setup.

But the downside of that, again, is energy. It takes a lot of energy to treat water to municipal drinking water standards and move it through the pipes of the city, to then use it for agricultural crops. Same goes for the effluent; it's essentially agricultural runoff that's going to our wastewater treatment plants.

Our treatment plants are perfectly designed to handle these types of loads. It's not a matter of whether the wastewater treatment system can handle it. They're specifically designed to treat nutrients, such as magnesium, nitrogen, and phosphorous. These are all abundant in our traditional natural water supply. The issue is the energy being used to treat this agricultural runoff.

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7. Colorado Department of Public Health and Environment, *Greening the Cannabis Industry*, https://cdphe.colorado.gov/greening-the-cannabis-industry (last visited Sept. 22, 2022).
8. National Cannabis Industry Association, Environmental Sustainability in the Cannabis Industry (2020), https://thecannabisindustry.org/wp-content/uploads/2020/11/NCIA-Environmental-Policy-BMP-October-17-final.pdf.
9. Colorado Department of Revenue, *Marijuana Regulations*, https://sbg.colorado.gov/med/rules (last visited Oct. 6, 2022).

The quantity of water is not extremely high. We encourage businesses to use automated drip irrigation and to not overwater. Sometimes, businesses may overwater by more than 50%. But overwatering means you're also wasting nutrients that you just put into that water to feed your plants, which are also an expensive commodity. We are seeing more advanced systems using closed-loop water recycling, where they treat the water after feeding it to the plants and reuse the water to increase water efficiency.

The next category that I want to touch on is waste. The two main waste streams from cannabis are plant waste and packaging waste. For plant waste, especially marijuana waste, a common policy requirement is that all marijuana waste must be mixed with 50% non-marijuana waste before leaving a licensed facility. The intent of this regulation is ensuring safety and security—no illicit market diversions. Essentially, we don't want people diving into dumpsters to steal marijuana or have it reach the illicit market.

Therefore, the waste needs to be mixed 50/50 and ground up. But this essentially doubles our landfill footprint. It also essentially mandates landfilling, since it's hard to find a 50% organic mix to compost it. This was a big problem in Colorado.

I helped initiate some policy changes in Colorado, which took effect in 2020.[10] One exempts low-THC components of the plant from the 50/50 waste-mixing rule. The low-THC components of the plant—the stalks, the stems, the fan leaves, the root balls—compose about 90% of the plant waste stream. The buds and the sugar leaves are why we're growing the plants. That's the commodity—we don't throw it away.

Those low-THC components of the plant are now exempt because there's essentially no THC or cannabinoid value to them. We now allow that to go directly to composting without 50/50 mixing. This greatly reduces the plant waste footprint from facilities. We're actively encouraging other states to make similar considerations to allow for more direct composting of plant waste, or use other avenues like anaerobic digestion, which allows you to capture the commodity gasses produced from it—methane and carbon dioxide (CO_2).

The second waste stream is consumer packaging waste. The problem is that there's a lot of it, and it's hard to recycle. Even if it does make it into the recycling bin from a responsible consumer, often it cannot be sorted by the recycling facility because it's too small. The recycling facilities are not designed for this type of small plastic waste, like joint tubes and smaller drams that look like old film tubes, and medication bottles.

In Colorado, our policy solution was to legalize packaging take-back programs. Prior to this regulatory change, no outside product could enter the facility. The business would be in violation if there were trace amounts of product in vape cartridges or in packaging. We essentially removed that fear and said if the intent was recycling, you can do take-back programs and collection of waste.

We also made it so that traditional recyclers, like e-waste recyclers and plastic recyclers, do not have to have a special marijuana license to handle trace amounts of product if the intent is recycling. There was a lot of fear, especially from our e-waste recyclers, about taking cannabis vape cartridges without a handling license because there may be trace amounts of product.

The stores that do packaging take-back programs have two options to handle that waste. They can bulk recycle it—it's already collected, so it doesn't have to be sorted at the recycling facility. Or they can reuse it, which is exciting. I'm hoping to see more reusable packaging in the cannabis industry.

You might be familiar with growlers—those big glass or aluminum containers that you use to take beer home from the brewery. If you bring it back, you typically get a discount for getting it refilled. There's an opportunity for similar reusable, refillable packaging in the cannabis industry. I think it creates an opportunity for brand loyalty and differentiation in a very saturated market. Here in Colorado, where we have a dispensary on every corner, what's going to make me choose to shop at one versus another? What if I have a branded reusable package from one? You can create that consumer loyalty while reducing your packaging waste at the same time.

John hit the nail on the head in pointing out that there's a large untapped opportunity in the cannabis industry for industrial fiber use—not only from hemp, but from marijuana as well. Cannabis fibers are very long and strong. They can be used in building insulation, textiles, papers, oils, and plastics. But the problem I see right now is that we don't have industrial infrastructure for processing it. We have a ton of plant waste, and we don't have a lot of factories to turn it into usable goods. It's an untapped market. We need that industrial fiber market to come along and start utilizing all these waste fibers that we have from both hemp and marijuana.

Next, I'll cover air quality. Cannabis has a unique, distinct odor profile. Many consumer complaints and community complaints related to the industry are centered around the odor. Because this odor is so intense, there's a fear of the unknown. Is this odor harmful or is it just a nuisance?

I led an air research study[11] to quantify the air pollution from cannabis plants, and to determine how it interacts with our airshed, and whether it is harmful. As the plants grow, they emit terpenes, which are volatile organic compounds (VOCs). We care about VOCs because they contribute to a secondary reaction in our atmosphere when they come into contact with nitrogen oxide (NO_x) emissions. That's going to be anything from combustion, including cars, power plants, and wood burning. Anytime we're burning

10. Colorado Department of Revenue, *Marijuana Regulations*, https://sbg.colorado.gov/med/rules (last visited Oct. 6, 2022).

11. Kaitlin Urso et al., *Terpene Exhaust Emissions and Impact Ozone Modeling From Cannabis Plants at Commercial Indoor Cultivation Facilities in Colorado*, 72 J. Air & Waste Mgmt. Ass'n 828 (2022).

anything, we get NO_x. When NO_x and VOCs react in the atmosphere, they form ground-level ozone, which is toxic for us to breathe. In Colorado, that's our number one air pollutant of concern.

About 70% of Colorado's cannabis is grown in the urban Denver environment. That's a NO_x-rich environment, with many cars, power plants, and combustion activities. The question was: how much is the cannabis industry influencing ozone formation, if at all? I did a research study to quantify pounds of VOCs emitted per pound of marijuana grown, and then looked at the overall influence on ozone. That study was published in the *Journal of the Air & Waste Management Association*.[12] What I found is that marijuana is not producing pollution. The VOC emissions are extremely low. We found about 10 pounds of VOCs per ton—2,000 pounds—of marijuana grown. To give you a relative scale on VOCs, one gallon of paint is about eight pounds with two pounds of VOCs in it. The emissions from marijuana are very, very low.

Because the emission rate is low, and the type of terpene produced is very low on the reactivity scale for ozone formation, we found no influence from the cannabis industry on ozone. Our model had more noise in it than these VOC emissions.

What that tells us is that it is a nuisance odor that's coming off these facilities, rather than a public health threat. Odor control can be achieved through carbon filtration, but that takes a lot more energy than using an open HVAC duct. In controlling a nuisance odor, we need to weigh the benefits with the energy costs.

One last thing I'll touch on is a partnership I formed with the brewing industry. In an indoor cannabis-growing environment, often we have to feed supplemental CO_2 to the plants so they can perform photosynthesis at an accelerated rate. When we bring cannabis crops indoors, we condense their life-span from about five to nine months in an outdoor environment down to about two to three months indoors. Yet, the plants grow just as big, so they need more light, more nutrients, and more CO_2 in order to perform that photosynthesis.

Therefore, we feed in supplemental CO_2 to optimize the plants' light utilization and improve the overall energy use. Meanwhile, fermentation for brewing beer generates a lot of CO_2—way more than what you would expect. Breweries typically vent that to the atmosphere. Instead of venting it to the atmosphere, we partnered with a brewery to capture the CO_2 and use it for carbonating and packaging the beer. We then sold the excess to a local marijuana cultivation operation for their supplemental CO_2 needs, creating this closed-loop CO_2 economy. What would have been wasted from the brewery and emitted to the atmosphere is now being "fed to the plants."

Buzz Hines: From an environmental law perspective, and in terms of pragmatic steps that I and my colleagues at Farella Braun + Martel engage in, an important area is regulation. I was struck, John, by your information on the extent and the amount of money involved across the world on cannabis, in contrast to the degree to which the cannabis industry is legalized and regulated. There's a huge distinction there, and it relates to how California—and Colorado, too—has been focused on displacing the illegal market because of the harm to the environment that it has caused over time.

An element in California that complements the indoor grow industry is the outdoor grow industry. I had an opportunity to be on a panel several months ago with a southern California farmer who decided to convert some of their row crops to cannabis. The amount of acreage that they were converting was around 80 to 100 acres. It was a large-scale operation.

The county use permit process took about two years. That is not an insignificant effort. Some of the issues that Kaitlin mentioned, and that John touched on as well, were very prevalent in the permitting for use of that agricultural land. The issues included terpenes and a concern over the odors and potential taint on other nearby crops.

There were some mitigation measures put into place, like fast-growing trees and setbacks. Outdoor growing operations will continue to have to deal with these types of issues. In California, nuisance complaints associated with odor can be a problem—even though there may not be a scientific or credible basis associated with those terpenes or odors.

The other thing is some of these growing operations may be proximate to residential areas. Typically, they will be in areas that are zoned as agricultural. We have a large wine country practice in Napa and Sonoma that we do out of our offices in St. Helena and San Francisco. We're not seeing conversion of wine and vineyards to cannabis yet, but I think in other parts of the state, we are seeing that more and more.

In terms of best practices, I want to touch on a couple of issues. Obviously, a fair degree of cultivation using greenhouses still exists. And the wastewater associated with greenhouses, typically called irrigation tailwater, is rejection water, sometimes from reverse osmosis systems. It can be high in nitrates and total dissolved solids. The recovery associated with that tailwater can be challenging.

Discharges in the state of California require a waste discharge requirement permit. This permit is similar to a national pollutant discharge elimination system permit. But wastewater alternatives have been developed. Reuse is one example. Yet there are some liability concerns if the reuse of that water is as irrigation for edible crops. Reverse osmosis treatment systems, meanwhile, can be expensive and still have waste streams. Off-site disposal is also expensive and can generate traffic. Traffic can be a huge concern for use permits. You may have to go through the California Environmental Quality Act (CEQA)[13] process, or county use permit process. Other options are blending, evaporation ponds, and bioreactors.

12. *Id.*

13. Cal. Pub. Res. Code §21000 (West 2016).

One bioreactor that has started to come into favor is the woodchip bioreactor, for which a subsurface pit is dug. A lot of contractors are familiar with doing these types of bioreactor installations in other settings and contexts, not just in the state of California but across the United States. It offers a relatively low-cost linear design, and is a proven technology for nitrate reduction. And regulatory acceptance for a bioreactor is increasing. There's a Central Coast Regional Board order[14] that has recognized a waiver associated with these bioreactors. These could benefit the industry in terms of reducing waste streams.

John and Kaitlin mentioned surface water. Notwithstanding what I would call cannabis' minuscule use of water compared to other crops and other facility uses of water, water supply is still a key issue, whether you're growing inside or outside. Surface water is going to be seasonal. It can be a problem sometimes to draw from a nearby stream if it's not fully appropriated and you don't have riparian rights. It's not a drought-resilient system.

The state of California passed the Sustainable Groundwater Management Act[15] several years ago. Groundwater used to be largely unregulated in the state. But now, you have to assess sustainable yield, ensure beneficial use, and avoid adverse impacts. There's a planning process at both the local and state levels.

We're going to see more and more of these issues in the context of potential conversion of row crops to cannabis crops. Energy use in the indoor growing space will continue to be a huge issue and one that folks are going to have to think creatively about and look to alternative uses, such as battery power.

Chandler Randol: I see a couple of questions from our audience. The first is, to what extent is cannabis packaging more wasteful compared to similar products like vapes, cigarettes, or medicine?

Kaitlin Urso: The important thing to understand is that marijuana packaging is required to be child-resistant, which isn't the case for vapes and cigarettes traditionally. It's also a requirement for medicine, and marijuana is in both realms—recreational and medical. Some states have only legalized it for medical purposes.

The regulations are getting smarter in terms of the layers of packaging that's required. We can have a child-resistant container, yet keep it small and make sure the labeling requirements are reasonable. John mentioned before that, sometimes, the labeling requirements can get so enormous that you have to create a bigger package just to be able to put the label on. We need to make sure that these requirements are streamlined, so we can keep these containers small.

Like I mentioned before, there are opportunities to use a reuse model as well. Sterilization is absolutely a part of that reuse requirement. For packages to be reused, inspection for functionality of the child-resistant component of the package is also required.

There has been a trend where folks are just using a reusable package like a glass jar and getting a new child-resistant plastic top each time it goes to reuse. That way, you're only sanitizing the bottom and you get a new child-resistant top each time.

John Kagia: Operators themselves don't want to be the ones managing this process. And I think that's entirely fair. It's difficult enough to run a cannabis business operation without having to add on reuse, which has strict regulations around what allows a product to be reused in the sales stream.

To me, this is one of the myriad opportunities for an ancillary service for this market. But my expectation would not be that the retailers themselves are in the back scrubbing these jars clean. In terms of scale, it doesn't make sense. And from an efficiency standpoint, there's an opportunity for somebody to go through all the dispensaries in town, collecting their semi-standardized products, and getting them back into the appropriate retail channels.

One thing we have observed as this industry has matured is the idea of specialization. As you see in every other sector of the mature economy, companies take on very specialized roles in serving the supply chain and ensuring efficient operations. Recyclability is something that will likely end up being managed by third-party vendors who are serving multiple operators. Hopefully, that would lead to a couple of things. First, greater standardization. I think part of the reason why so much waste is being generated at a micro scale is because everybody is using their own sizes, their own dimensions, and their own types of packages. If we start converging toward standard sizes and standard models of operation, that will certainly help with recyclability.

But also, I don't see a lot of utility for each individual retailer to take this on. Maybe if the multistate operators grew to the scale of 7-Eleven, where they're driving such massive volumes that it makes sense to do this for themselves. But for most mom-and-pop shops, that's not the case.

Buzz Hines: I was just reflecting on the food industry. During the pandemic, we've all been going to our favorite restaurants and taking food out. Now, that's not analogous to the cannabis industry because of the need for child-proof packaging and other requirements.

But consumers can sometimes make a choice, which can be offered by the retailer, to either pay a bit more for a compostable disposable container, or use a container that can be returned to them, rinsed out, and sanitized by a third party that then brings it back to the restaurant. That's a nice reuse model.

I don't know if that can be applied in the cannabis industry because of the differences between serving food and selling cannabis. But it struck me that there are things

14. California Regional Water Quality Control Board, Central Coast Region, General Waiver for Specific Types of Discharges (Sept. 20, 2019) (Order No. R3-2019-0089), https://www.waterboards.ca.gov/rwqcb3/board_decisions/adopted_orders/2019/general_wdr_order_r3-2019-0089.pdf.
15. Cal. Water Code §10720 (2020).

that can be consumer-driven or retailer-driven to help with those kinds of recycling and reuse markets.

Kaitlin Urso: There are certain areas in New York that have a ban on single-use, to-go containers for food. Instead, there are third-party operators that have popped up that have reusable containers. You pay a deposit, and they sanitize, reuse, and then give containers back to all the restaurants. It's almost like a regional solution for multiple restaurants. There are multiple drop-off points, and points for sanitization and sterilization, and then redistribution.

John Kagia: A quick point around child-proof packaging: if you think about two sectors to which cannabis is most often analogized—tobacco and alcohol—we don't have child-proof packaging for either of those products. Maybe some neighborhoods have some theft-proof devices in the liquor store, but that's about it. As a society, we're still making this transition to accepting cannabis as another regulated intoxicant.

There's a lot of stigma that continues to influence and shape our public policymaking. But if we think about it, when was the last time we heard about a child's accidental ingestion of a pack of cigarettes? It doesn't happen because it doesn't have the same kind of appeal. Some products may be better suited for child-proof packaging. Edibles in particular are one area where maintaining that limited access is important. But most children are not going to look at a joint or a cannabis plant and think, I want to put that in my mouth because it looks delicious.

There's room for greater pragmatism about where the risk lies and creating regulations that are more targeted to the areas with real risk of exposure—instead of relying on rules that are so broad, they end up creating significant and intractable downstream waste.

Kaitlin Urso: I will add that the direct ingestion exposure to THC has to be heat-activated in order for it to become psychoactive. So, a child ingesting flower is not going to get high. It's not going to have that negative psychological effect. It's interesting that heat elements used to heat-activate marijuana are child-resistant up to age eight, while child-resistant packaging for marijuana is only restricted up to age five. That's interesting from a policy standpoint.

Chandler Randol: I want to ask you all a question about data. One of the things that we've talked about is how difficult it is to acquire data. How difficult is it, why is it difficult, and how accurate is the data that we do have?

John Kagia: I've been a market research analyst and consultant my entire career. It was interesting coming from other sectors of the economy—technology, government, healthcare, and financial services—where the problem was always too much data. We always had more data than we knew what to do with it, and then I came into the cannabis industry nearly eight years ago and found nothing.

The industry has evolved and there's a lot more data now than we have ever had. I'd like to commend Kaitlin and the entire team in Colorado, because Colorado has done a phenomenal job in creating reporting structures that give us insight into what's happening in the industry statewide. I encourage other states to follow that model.

One of the reasons why data has become more accessible is that many state regulations that require tracking—whether it's seed-to-sale tracking or a point-of-sale system data tracking—have enabled the ability to get better insights into this market. For example, at New Frontier Data, we now have point-of-sale data from about 25 legal, regulated markets in the United States, so we've finally broken through that big data threshold. We're finally starting to look like a real retail environment. At least on the retail side, the data collection component has gotten quite good.

But on the supply-chain operational side, challenges remain because historically, cannabis producers have been some of the cagiest people on the planet. Data collection protocols have not been the most robust, and getting them to share data has also been a major challenge.

For our two studies on water and energy, we had to beg, borrow, and do everything short of steal to get stakeholders to provide us with their data on what they were using in their operations. They may be thinking, if it's not required, why am I adding work to my plate? Another worry is, is this data going to be used against me?

But the industry is coming around. I've been heartened by some of the public-private partnerships that are being built. And I think Kaitlin has spoken beautifully to the type of research that the government is able to do in partnership with private-sector operators. The industry is realizing the utility in learning what's working well and what's not working.

This market is getting so competitive that some of this comparative data is used to help everyone elevate their performance. But the reality is that this industry still has a long way to go. I'm heartened by the role that technology is now playing in most of the supply chain, from cultivation to processing. And the more you integrate technological systems, the more data you have being generated. That data can then be made accessible more broadly.

But it remains a challenge outside of the retail sector. We're working furiously to gain access to as much of it as we can because it's easy to point a lot of fingers at this industry. But we find that having real data to inform some of these perspectives challenges many of the assumptions that drive the way this market is being regulated.

Chandler Randol: There's another question: Environmental groups need to put pressure on regulatory bodies to lower the barrier of entry. High taxes and fees are creating an illicit market that hurts the environment. But in the cannabis market, the bottom line is extraordinarily important for the consumer as well as the producer. What are your reactions to their points? What are you seeing in terms of barriers to entry? And what are some of the other issues that you're seeing in the market?

Buzz Hines: That's a very complicated issue in California and elsewhere. California has a long-standing history of illicit cannabis cultivation.

John, to your point about data collection, I think Kaitlin and I both smiled when you made that comment that folks within the industry can be reluctant to share information. Sometimes, that has nothing to do with being suspicious. It can be a business advantage too.

Kaitlin and I talked about Colorado trying to eliminate those licensing and permitting barriers as much as possible. I think that's key. The difficulty in any state, and perhaps California in particular, is that there can be contrary views about the appropriateness of a grow operation in your community. People can have strong views about a cannabis retailer locating in a spot where there used to be a restaurant or something. These are complicated and difficult issues.

In a litigious environment, you can have lawsuits on both ends, where project proponents who wish to proceed with a growing operation or a retail operation will check all the boxes. They'll go through CEQA. They'll comply with county use requirements. Those reports and that aspect of the project will be approved, and yet there may be a claim and litigation filed that challenges it. The same can be true on the other side of the equation, where those barriers can create a real disadvantage from a business perspective to cannabis operations that want to operate legally.

I don't have a solution, although I recognize the problem. I think the work that John and Kaitlin are doing, and the work that state regulators in California are doing, is going to help that process. But we're not there yet. We're always going to have that tension on both sides of the equation: project proponents and opponents.

Kaitlin Urso: In Colorado, as a more mature market especially on the recreational side, we've seen economic drivers tamping out the illicit market. We almost see it going the opposite direction, in that our legal market actors are getting very efficient.

There's so much competition that it's essentially a race to the bottom on price. It's typical here to find an ounce of marijuana at around $100. In many other markets, it's $400, $500. It's so price-competitive in Colorado that our illicit market actors are tamped out. They cannot grow an ounce and sell it for $100. They certainly can't do that in a clean, compliant store where a retail consumer would rather shop if it's priced competitively.

John Kagia: I'd love to riff on two points there. One, on Kaitlin's point about the efficiency of the legal market once it gains steam. First, most consumers do not want to go back to that illicit market once they have access to the legal market. They're not willing to pay 100% more than they were in the illicit market, but they would rather pay a little more for the advantages of being able to shop in the legal market, in daylight, and not having to deal with a guy on the corner or the back alleys pulling random stuff from underneath his bed. They want the quality, the testing, product selection, the value-added products. They're willing to pay premium for that, but it has to be within reason.

One of the challenges that we see in California is the tremendous taxation that the state has put on cannabis. Once you combine state, municipal, and excise taxes, in some counties in California, you're paying nearly 50% in taxes out the door. It doesn't make sense for most consumers to pay that much, particularly in a market like California where there's such widely abundant, high-quality cannabis available in the illicit market.

We tend to caution policymakers from viewing cannabis as a cash cow because the higher you place taxes on the product, the slower the transition will be for consumers to come from the illicit market into the legal market. It will ultimately happen because the market's efficiency will eventually offset that high taxation rate. But it will take much longer to get there.

Colorado is a great example of a market where they found the right balance in taxes. They had a pretty open licensing process, and the market got smart and competitive quickly. That is why the majority of the demand in Colorado is now being served by the legal market.

But a second point is the role that federal taxes are playing on impeding reinvestment and innovation in cannabis. Cannabis remains illegal under federal law, and cannabis businesses are not allowed to deduct their ordinary and necessary business expenses like you can in every other business. It's under Internal Revenue Code §280E.

I'm not going to go into the nitty-gritty, but the bottom line is that in most sectors of the economy, business taxes are coming in around 26%, maybe up to 30%. Cannabis businesses, because they can't make these deductions, are paying upwards of 75%, 80%, 85% in taxes. That has a huge impact on the ability to make reinvestments to focus on R&D and innovation, because Uncle Sam is getting that money.

Normalizing the taxation of cannabis businesses at the federal level will have a huge role in both cannabis business' profitability and their ability to invest in some of these innovations that we've been slow to reach because cannabis remains illegal under federal law.

Chandler Randol: I decided to throw out the biggest and maybe hardest question for all of you at the end. As you just mentioned, cannabis remains illegal at the federal level. But how might federal legalization affect environmental sustainability in the cannabis industry? Feel free to expand beyond environmental sustainability just to give us a sense of how legalization at the federal level would change the industry overall.

Buzz Hines: On an elemental basis, I know that it's incredibly challenging from a banking perspective. John raised the tax issues. But the fact that it's illegal as a federal matter, and yet many states are moving toward legalization, creates huge hurdles and challenges for the industry.

As John aptly pointed out, it's a huge industry, so the implications of federal laws are huge. I think about my corporate partners and colleagues in our cannabis prac-

tice group. Some of the stories about how acquisitions and mergers are done—to say that they're challenging, and frankly a little bit weird, is an understatement.

The Department of Justice has had a non-prosecutorial stance with respect to things. That doesn't mean that illegal operations are not subject to enforcement. They're certainly subject to enforcement on a statewide basis, and that's a tremendously important impediment to illegal growing—the risk of enforcement. We are seeing that more in California. But I think the federal government could see its way to pass some cannabis-friendly legislation. It would be very welcome.

John Kagia: I would add that we don't think that the federal government is going to legalize cannabis. We think it's going to deschedule it, which would make it a state issue and perpetuate some of this patchwork-nation issue that Buzz has been commenting on. So, yes, under a descheduled model and looking at the bills that have been proposed by Sen. Chuck Schumer (D-N.Y.) on the left and Rep. Nancy Mace (R-S.C.) on the right, there are going to be some stock elements that feature in what a national regulatory framework is going to look like.

There's going to be an excise tax. The amount of that tax is still being debated. There's going to be investment in medical cannabis. There will be standards required, likely under the Food and Drug Administration, which will introduce a new degree of complexity. We don't know what that will ultimately look like, but we assume that there will be some national standard for cannabis product quality control that may begin as advisory and transition to being mandated.

But we think it's unlikely that the federal government will legalize cannabis at the federal level. Given the national attitudes around cannabis, policymakers and lawmakers will want to perpetuate or at least maintain the ability of states to have some autonomy in the decisionmaking on how this plant is regulated.

Kaitlin Urso: I hope the federal government considers the environmental impacts in whatever framework it issues. But then again, states are always allowed to be more stringent than the federal government. For states like Colorado and California that already have legal structures for marijuana, their regulations will stand because they can always be more stringent than the federal regulations.

States that have previously legalized marijuana and have a regulatory structure in place are most likely better suited to face federal legalization than states that have not. If marijuana is suddenly decriminalized in states that do not already have a marijuana legal structure, it may create a gray area market that is legal but not really legal. If the state doesn't have a structure yet, then you have a market without testing the market, and without inspections or other policies.

Chandler Randol: I'd like to invite each of you to share any last remarks.

Kaitlin Urso: This is an emergent market that's constantly evolving. I think we should all keep an open mind to see if there's a different or better way to do things. Then, as we create these policy and regulatory structures, we need to have a pulse on whether things are working—New Frontier Data, for instance, providing data demonstrating that cannabis water use isn't as high as people expect. Those data checks can confirm if our regulatory structure is working, or if we are doubling our landfill footprint inadvertently by requiring cannabis waste to be mixed with 50% non-cannabis waste and creating an environmental disaster. We need to stay nimble, flexible, and willing to address these challenges of tomorrow.

And a final thought on federal legalization. That would create a market evolution of economies of scale that has happened in every other agricultural sector. There's a reason why Colorado does not grow oranges and almonds, and a reason why we grow them in California. These pockets of legalization that create evolving markets and a race to the bottom on prices will only be amplified on a macroeconomic scale when we get federal legalization and interstate commerce. Colorado may not be the hub of marijuana distribution in the future even if it keeps a hold in the craft cannabis area.

John Kagia: First, despite all of the growth excitement that we've seen around legal cannabis over the past few years, it is worth remembering that both on a national and global basis we have barely scratched the tip of this iceberg. I don't play baseball, but we're still in the very early innings of what is going to be a very, very long game. For those who observe this industry as a high-opportunity market but are wondering if you've missed the boat, you haven't. We think this will continue to be a very opportunity-rich market well into the next decade. Perhaps more competitive, more innovative, and more solutions-oriented than today, but certainly still very opportunity-rich.

Second, for anyone who is studying this space, we strongly urge you to look at where the market is going and not where it currently is. Kaitlin talked about the downward price pressure for flower. Colorado's wholesale flower prices have fallen, last I checked, 47% since the highest point in 2015. At one point, they were down 63% since the highest in 2015.

If you are building a cannabis facility assuming that you could get $2,000 per pound when your facility is active, by the time you're operational, cannabis may be selling at $800 per pound, and you'd be in deep trouble. There is a need to be very aggressive in operational efficiency. Every incremental gain does have an impact on the bottom line. Given how large this industry is growing and how competitive it's becoming, it is critically important to bear the imperative of resource efficiency as you think about these operations.

And then third, to Kaitlin's point, it is worth remembering that cannabis is a plant, and most plants do well outdoors. As we transition from a United States-centric conversation to a global conversation, at some point, we will start to see the locus of production move to places in

the world where there is plenty of sunlight, great outdoor growing conditions, and the ability to produce it at massive scale for a relatively low cost.

There will still be a demand for highly curated, indoor-produced, beautiful-in-the-jar flower products, and the connoisseurs are still going to want that. But as we start thinking about the value-added products, and we're looking for either just cannabinoids or for processed oils, there's not that same need for curation. Start looking at markets like Latin America, parts of Africa, and parts of Asia like Thailand, where they are planning mega facilities with the idea of becoming producers for the world.

Figure out where you want to sit in this continuum of highly specialized indoor, resource-intensive production versus outdoor, massive-agricultural-scale production for oils and cannabinoid extraction, and then plan accordingly for the evolution of this global market.

Buzz Hines: I think programs like this that the Environmental Law Institute and other providers can organize will be helpful to share knowledge. There's a degree of transparency associated with these kinds of discussions. And consistent with a lot of the points that have been raised today, there's a lot that technology can offer us in terms of improvements and scaling. It's a very interesting and evolving marketplace.

I think John's statement is one that we can probably all take home, which is that we're very early on in this. To use the baseball analogy, it has to be fluid. The rules may change, as we've seen with baseball—the baseball that was played several years ago is not exactly how it's being played right now just based on analytics, extra innings, a man on second base, and so on.