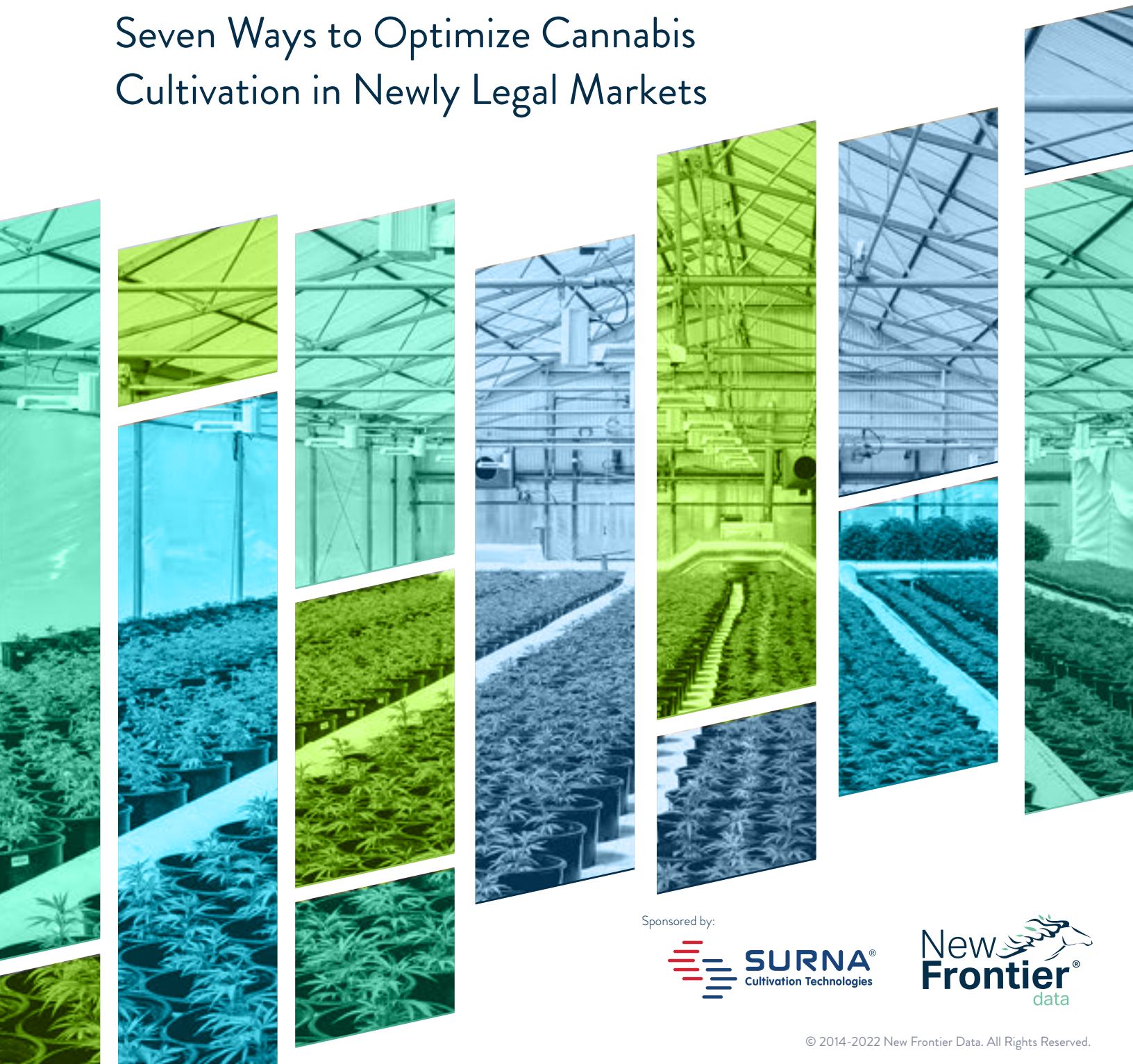


Growing Excellence

Seven Ways to Optimize Cannabis Cultivation in Newly Legal Markets



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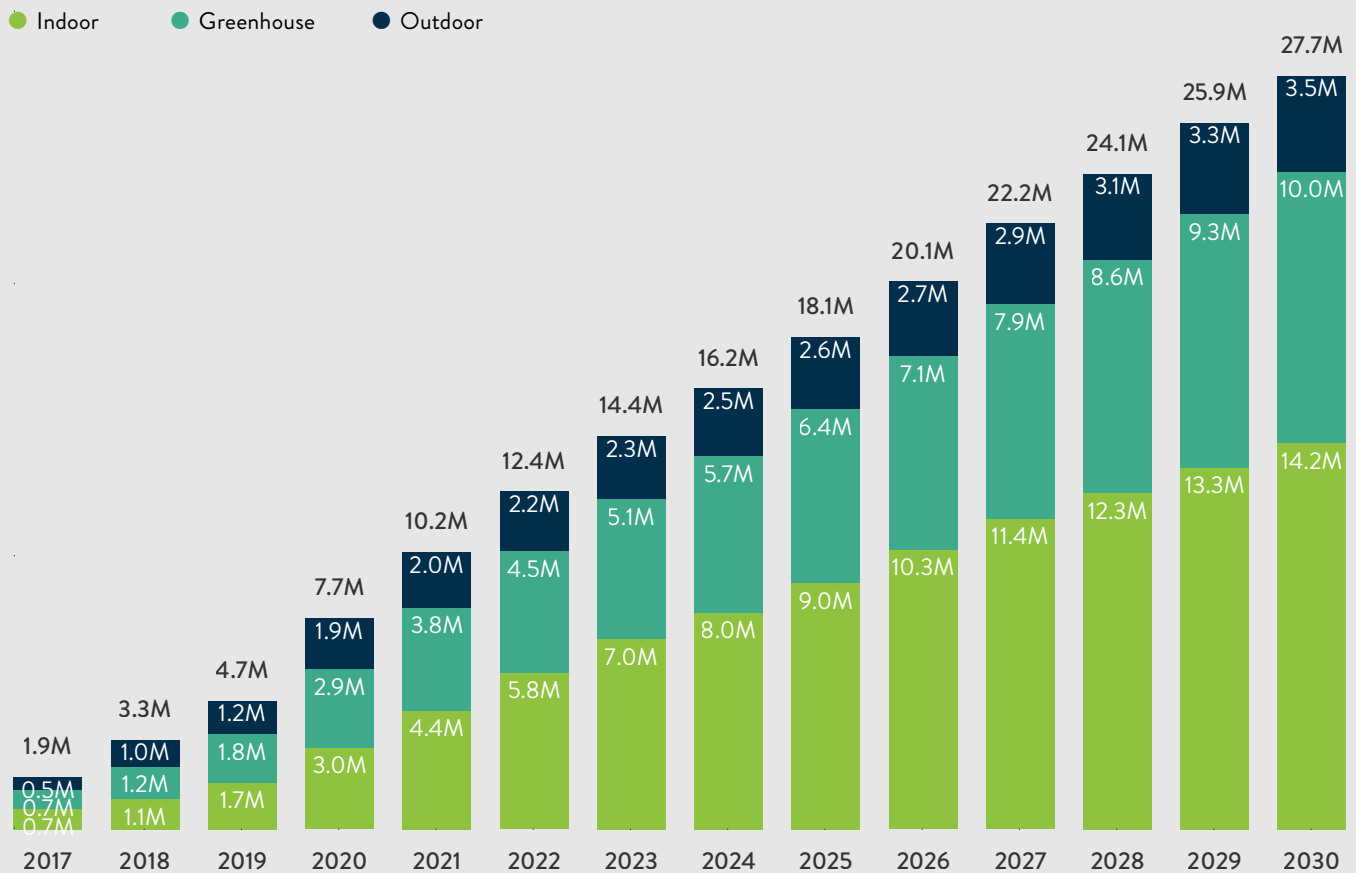


Growing Excellence

Seven Ways to Optimize Cannabis Cultivation in Newly Legal Markets

LEGAL CANNABIS PRODUCTION IN THE UNITED STATES is poised to grow dramatically with the launch of newly legal markets in the East Coast and Midwest. Between 2022 and 2030, Florida, New York, New Jersey, and Virginia will collectively account for one-quarter of the legal cannabis produced in the country, underscoring the scale of opportunity emerging in those states.

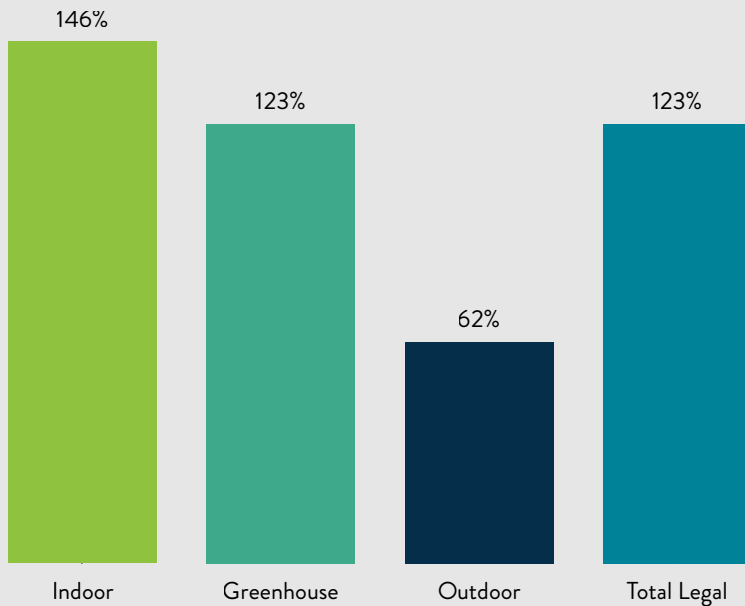
U.S. Legal Cannabis Cultivation by Facility Type: 2017-2030 by Pounds in Millions



Source: New Frontier Data

Introduction

Change in Legal Pounds Produced by Facility Type: 2022-2030



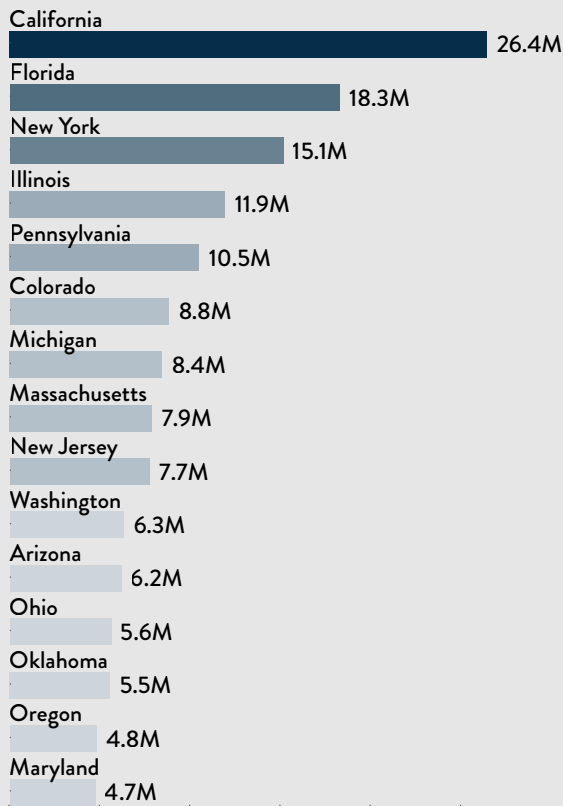
Source: New Frontier Data

As the legal cannabis industry transitions eastward from West Coast markets, several factors will impact how cannabis is grown in the new markets. Different climatic conditions will favor controlled environments over outdoor cultivation, given either the length and depth of winters in the North, or summer humidity in the South. Strained, aging electrical systems will make energy efficiency an even greater priority for growers reliant on the grid. Odor control will be imperative for producers in the country's most densely populated regions. And cost competitiveness will be critical for legal markets competing against those states' sophisticated and highly efficient illicit markets.

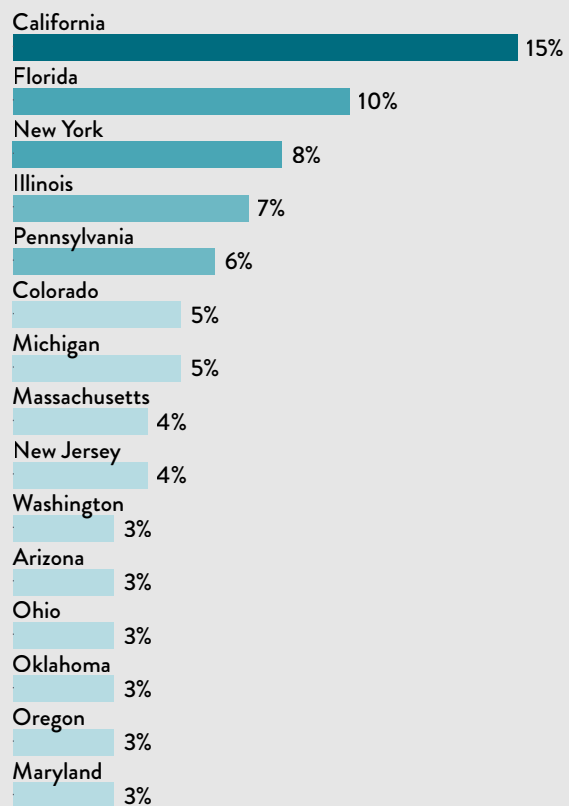


TOP 15 LEGAL CANNABIS PRODUCTION MARKETS

Total Legal Lbs Produced: (2022 - 2030)



Share of Total Legal Production: (2022 - 2030)

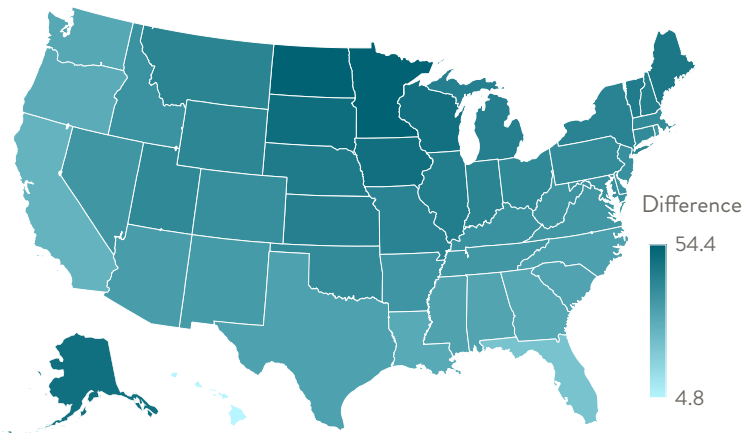


Source: New Frontier Data

This report explores seven issues which producers must consider as they build or upgrade facilities to serve newly expanding markets.

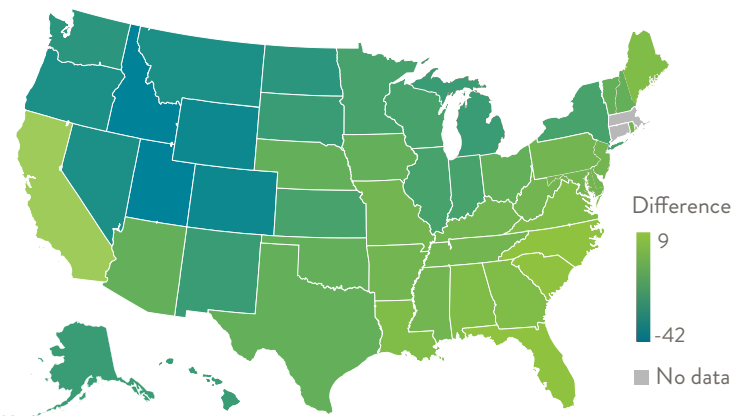
1. Location significantly influences tradeoffs between indoor and greenhouse facilities.

Differences in Average Summer and Winter Temperatures by State: Fahrenheit



While mixed-light production generally offers the best balance of reduced energy costs with control of the cultivation environment, associated priorities including ambient conditions (such as temperature and weather extremes), the cost of a new build or retrofitting, and security requirements can significantly influence the overall operating costs and productivity of a facility.

Difference in Relative Humidity Between Summer & Winter



Cooling/heating costs and humidity management requirements amid environments featuring extreme heat or cold can be higher for mixed-light facilities than fully indoor spaces. States including the Dakotas, Maine, New Hampshire, and New York typically experience the country's widest variance in temperatures during the summer and winter months, which will impact insulation, heating, and cooling requirements, especially in greenhouses where the structures have more direct exposure to ambient conditions.

Note: Negative values indicate higher humidity in winter compared to summer

Source: New Frontier Data

Odor control will also be an important consideration for mixed-light facilities, especially in densely populated municipalities or in areas with strong political opposition to cannabis. The Northeast is the country's most densely populated corridor (accounting for nearly one-fifth of the country's population), which increases the likelihood for odor complaints against any facilities in urban centers or tightly packed suburbs.

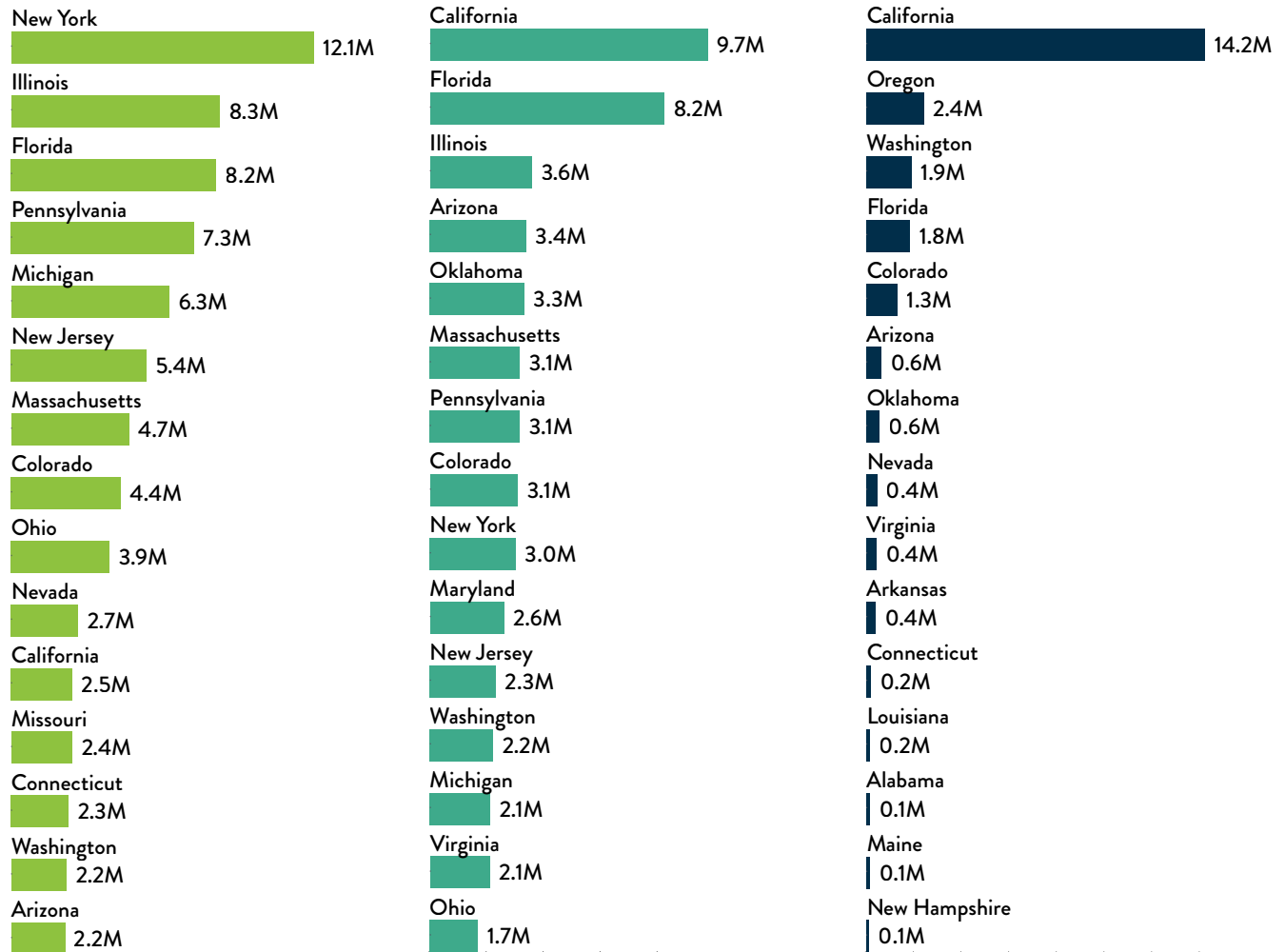
Depending on the design of a greenhouse, integrated pest management (IPM) can also be more challenging than in a fully enclosed environment, because insects, rodents, and other biological contaminants may offer more risks to enter a facility. While pest control is not an insurmountable challenge, it's important for growers to understand their facilities' potential vulnerabilities based on design choices.

Design tolerances for facilities being built in environments which experience extreme conditions must be more stringent, as miscalculations on the system's tolerances can be extremely costly. For example, one greenhouse facility located where summer temperatures regularly exceed 100 degrees Fahrenheit miscalculated its cooling requirements: Since construction began in the fall and was completed in the spring, the builders had not experienced peak summer conditions before operations were launched. On the first day that temperatures exceeded 90 degrees, the HVAC system was overwhelmed, with interior temperatures quickly exceeding 130 degrees, killing all the plants. Consequently, the unbudgeted retrofit for a new, higher-capacity HVAC system cost the operation more than six months' production time, and doubled the investment in HVAC and control systems, both a costly and preventable mistake.



Top 15 Legal Cannabis Production Markets by Facility Type: Total Lbs. Produced 2022 - 2030

● Indoor ● Greenhouse ● Outdoor



Source: New Frontier Data

2. Automation is changing the game, but also increases the imperative for having the right people managing the system.

Automation has become an increasingly integral part of cannabis cultivation, including:

- Automated irrigation and fertigation systems that detect moisture content of the grow media and apply only the water needed to maintain optimal conditions;
- Photosensors at the canopy level that measure the light hitting the canopy in mixed-light environments, and automatically turn on the lights and adjust their height to ensure that the plants receive optimal exposure as the quality of sunlight fluctuates;
- Centralized systems that monitor and automatically adjust each temperature, humidity, and carbon dioxide levels for optimal plant health; and
- Motion sensors linked to central security systems which turn off lights and reduce heating and cooling in unoccupied areas of the facility outside of cultivation areas.

Optimized integration of technology into the cultivation environment offers several benefits for cultivators:

- Smart scheduling for lighting, fertigation, CO₂ and exhaust, and fresh air purges;
- Optimizing grow conditions by ensuring that the facility's ambient conditions do not deviate from pre-set conditions;
- Ensuring that the plants receive proper water and nutrients as needed in real time throughout the day;
- Reducing waste by eliminating the risk of overwatering or over-fertilizing the plants;
- Reducing power requirements by only applying lighting and HVAC output to occupied areas of the facility;
- Enabling remote-controlled corrective actions through the use of notifications via phone alerts and integrated remote-management systems;
- Lowering labor costs by reducing manual oversight (e.g., irrigation/fertigation, monitoring temperatures, recalibrating HVAC systems to address changing conditions); and
- Enhancing security to ensure only authorized access to sensitive areas of the facility.

One additional benefit of well-designed, remote-management systems is by enabling off-site support of the facility. For example, a grower in Northern California contracted a Midwestern greenhouse technology company to build his facility's systems. The tech company designed a solution that could be completely managed remotely, enabling its Ohio-based support team to monitor the system around the clock.

While automated systems may reduce labor requirements for tasks that were previously performed manually, they must be managed by technically qualified staff capable of ensuring correct operation of the automated systems, troubleshooting them if anything goes wrong,

and implementing redundancies and back-up processes in response to any system failure. In short, automation is only as good as the people managing those systems.



Furthermore, while automated systems support the work of a cultivation team, there remains no substitute for a team that intimately understands the crop, who can detect issues with plant health or conditions in the grow room without needing either to consult a dashboard or rely on computer-generated readings. Even as technology can aid cultivation of high-quality plants, no substitute exists for a highly skilled and experienced master grower.





3. Build vs. buy? It depends.

In newly legal medical markets, buying an existing cannabis cultivation facility is rarely an option. However, purchasing an existing, closed-environment farming operation (e.g., a tomato greenhouse) might offer an option should such a facility exist.

In established legal markets, purchasing a distressed existing producer is increasingly an available alternative to constructing a new facility.

	 Build	 Buy
Equipment	New equipment might be: <ul style="list-style-type: none"> Protected under warranty; More efficient than older systems; Unused, so still at optimal settings; or Offering more available options for which type of system to use. Note: New equipment is also more expensive.	Existing equipment may be: <ul style="list-style-type: none"> Out of warranty; Presenting unknown/unreported issues; Less efficient, with providing degraded performance; Dependent on components unavailable for replacement. Note: Older equipment is less expensive, often cheaper to maintain, and (if well-maintained) perhaps adaptable to optimal settings for a facility.
Location	Provides for the physical requirements of a facility along with potential for expansion.	<ul style="list-style-type: none"> An established footprint may constrain options for production. Future expansion might also be limited.
Cost	Buildout for a new facility with new equipment is expensive.	An existing owner may charge premium to recoup their investment.
Facility Performance	The facility can be designed and built with tolerances to specification.	Issues to address before taking occupancy include electrical performance, insulation, airflow, etc.

	 Build	 Buy
Cleanliness & hygiene	Careful environmental monitoring during buildout can reduce risks of contamination in the finished grow space.	Mold, mildew, bacterial contaminants, etc., may be present in hard-to-inspect places.
Integrations	Building from the ground up can help ensure that all systems are compatible, and to address any issues with integration before the facility becomes operational.	A well-built facility should allow for systems to work well together, and provide an established performance record.
Future Expansion	Future expansion may be accounted for while building a new facility, to ensure sufficiently increased capacity, that any integration of additional systems can provide efficiency through modular design, and locate readily accessible connection points.	Modular expansion can be constrained in any facility not designed for expansion. The location and capacity of key systems (e.g., electrical load capacity and wiring points, water availability and feeder pipe locations, aisle width for moving large equipment) can all impact or dictate how readily a facility can be expanded. As adding capacity can be both costly and highly disruptive to existing operations, ease of expandability should be a key consideration when evaluating facility purchase options.

Generally, buying a well-designed facility reduces the time to operationalization relative to building a new one from the ground up. However, if the existing facility needs retrofitting of major systems, the time advantage of buying can be reduced significantly.

Bottom line: There is no simple answer on whether is better to build versus buy. However, when evaluating your options, consulting with advisors with extensive knowledge of how to evaluate relative merits of each, and who can perform all the needed assessments on a facility's performance is key to reducing risk.

Setting Up a Commercial Cultivation Facility

Pre-planning

- Goal- and budget-setting
- Consulting an attorney
- Developing the team
- Obtaining a license
- Securing funding
- Identifying real estate
- Assessing utilities

Planning and Design

- Coordination and design project management
- Architecture and floor plans
- Materials Electrical & Plumbing (MEP) engineering
- Structural engineering
- Civil engineering
- Life safety design
- Lighting
- Water purification
- Irrigation
- Fertigation
- Water reclamation
- Benching and racking
- Controls, data collection, and automation
- Security
- Equipment commissioning
- Miscellaneous (e.g., grow media, seeds, fertilizer, nutrients, etc.)

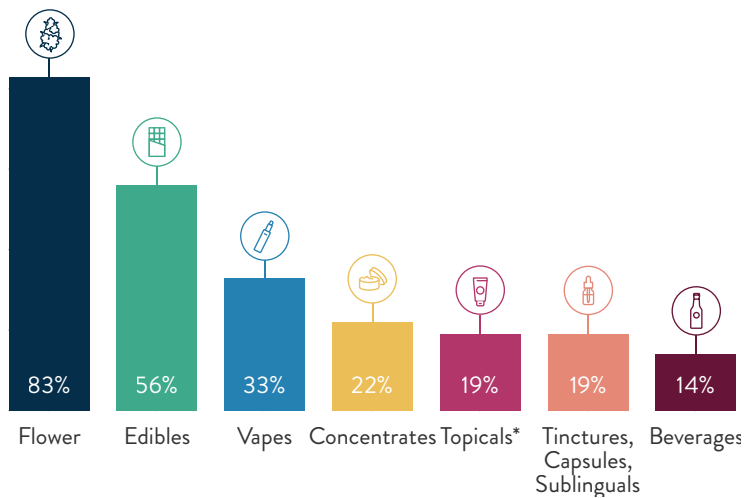


Source: *How to Set Up a Commercial Grow Operation: Road-mapping your commercial-scale indoor farm planning & buildout*, Surna, March 2022

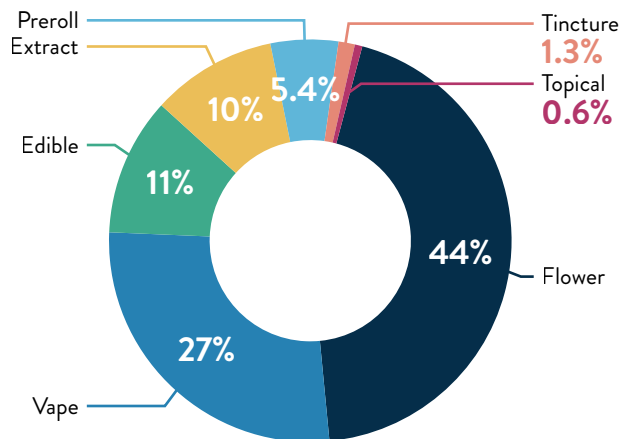
4. As demand for value-added products surges, cultivation will be increasingly split between smokable flower and extraction.

Top Forms

What % of current consumers use each form



Product Share of Sales: 2021 Average



Source (bottom): SAMHSA

Note: *Topicals includes transdermal patches. Among current (annual+) consumers.

Value-added products (vapes, edibles, topicals, etc.) now account for half of all legal product sales, and consumer interest in these new products is poised for sustained growth as innovation drives increased product quality and diversity, enabling consumers to integrate cannabis into their lives in increasingly novel ways. While demand for flower is also growing, especially for pre-rolls, it is growing more slowly than demand for non-flower products.

With extract-targeted plants requiring less manicuring than plants for smokable flower, growers are increasingly cultivating plants for extraction outdoors or in less resource-intensive production environments and reserving the premium cultivation spaces for smokable products.

The split in cultivation approach based on end use will widen the difference in pricing of flower for extract relative to flower for smoking. This trend will put growers producing flower for extract in high cost, indoor production environments at an increasing disadvantage against those moving to mixed-light or outdoor production for extraction.

5. Resource efficiency is an increasingly important competitive differentiator.

Wholesale prices will continue to fall as markets become more competitive. In markets like California, the number of cultivation licenses issued has risen dramatically faster than the number of retail licenses, resulting in a production glut that is acutely depressing prices. However, the downward pressure in prices is also happening in mature markets like Colorado, where the average price per pound has fallen by two-thirds, from just over \$2,000 in 2015 to \$700 today.

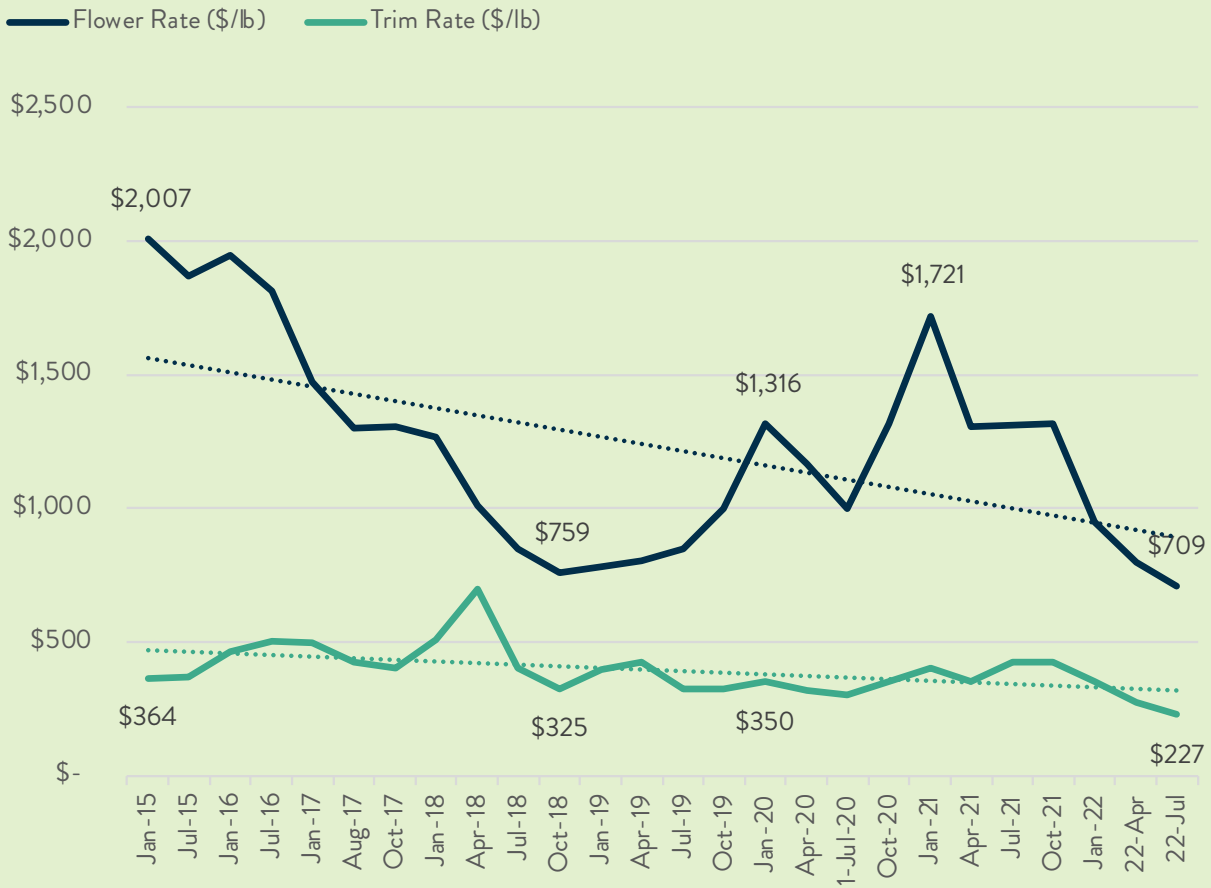
Increasing resource efficiency is one of the easiest ways to lower production costs. Energy costs in controlled environment cultivation are typically the second-highest production-cost line item outside of labor. As such, innovation in energy efficiency, particularly recent advancements in LED technologies, have helped dramatically lower total electricity use compared to historically used high intensity discharge (HID) and metal halide (MH) lighting. Notably, the use of LED's has compounding effect on lowering energy use across the facility. HID and MH lighting not only use more electricity to produce the same amount of light as an LED fixture, but they also generate a lot of heat, which stimulates transpiration, creating humidity that needs to be managed by the HVAC and humidification systems. Energy efficient LEDs eliminate most of the heat-related downstream effects of traditionally used fixtures.

Similarly, water presents an opportunity for significant cost savings. The transition from hand watering to automated, sensor-based irrigation systems that directs water to each individual plant rather than across the entire grow area can halve runoff of unused water. Integrating water reclamation systems, that processes runoff, or condensate captured by dehumidification systems creates a closed loop for water, reducing the amount of new water being sourced externally.

While water recapture and reclamation systems can yield significant savings, especially in drought-prone areas (and in areas with water that is not suitable for agriculture due to high salinity or mineral content) it is critical to ensure that such systems are carefully monitored and kept highly sterile as poorly processed reclaimed water can quickly propagate contaminant throughout the grow

Cost savings from operational efficiency will be a significant advantage in the face of sustained downward price pressure and new growers should focus on how to optimize their facility from the outset, then regularly review processes and procedures to identify if there are ways to drive even greater efficiency.

Average Market Rate for Cannabis Flower & Trim in Colorado: Jan 2015 - July 2022



Change in \$/lb Value: Jan 2015 - July 2022



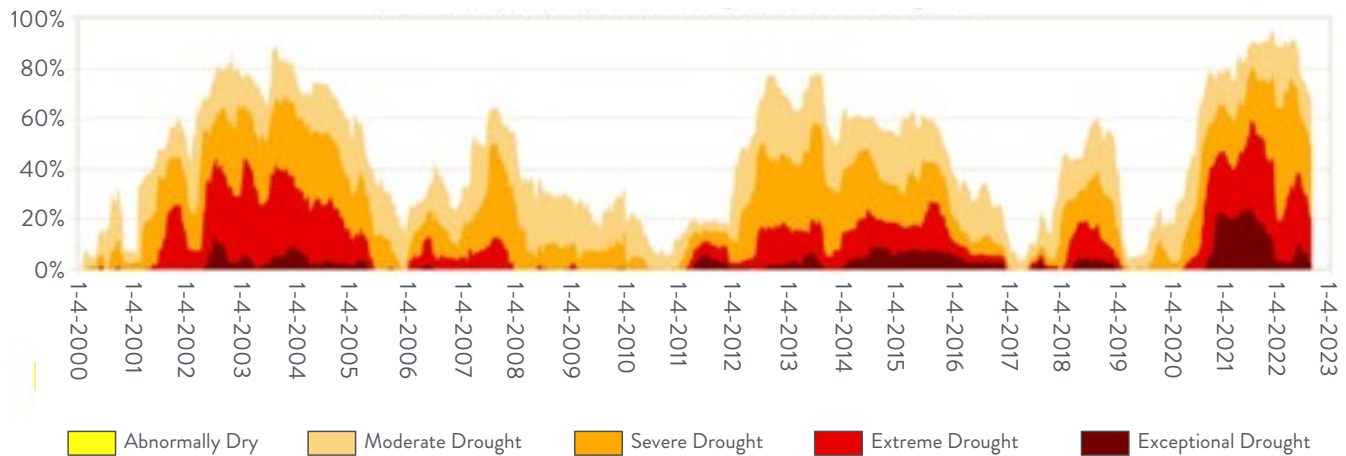
Source: New Frontier Data

6. Climate change will have increasingly consequential impacts on cultivation environments.

Cannabis producers must consider the looming implications of a changing climate on their operations. Longer, hotter summers will add premiums on increased cooling requirements and higher energy demand to operate HVAC systems at higher levels for longer periods. Acute droughts — such as those currently being

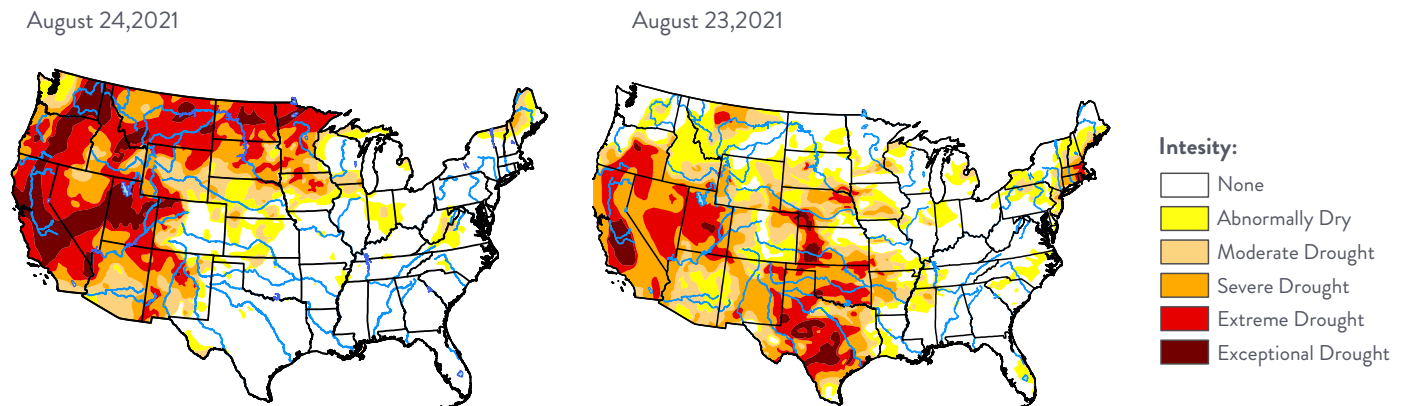
experienced in the Western U.S. states — will drive water shortages, increased water losses from evaporation, and higher costs of water from municipal or community sources. Boreholes or seasonal water sources (e.g., private streams) will become less reliable as competition intensifies for dwindling sources.

Percentage of Western States Experiencing at Least Some Drought



Source: U.S. Drought Monitor

Comparing US Drought Conditions: 8/2021 vs 8/2022



Source: U.S. Drought Monitor

Smoke contamination is also an issue, with growers needing to consider the quality and efficiency of their HVAC system air filtration; the last few summers have seen tons of cannabis plants rendered unsellable due to their exposure to wildfire smoke, just before the plants were due to be harvested.

Facility location and structural design in fire-prone regions will need to account for wildfires that occur more frequently, cover larger territories, and burn hotter than ever.

In the Eastern and Southern states, the increasingly common risk of generational-scale flooding should inform where and how facilities are built, to minimize the risk of water ingress. Indoor facilities may be better protected than greenhouses from such environmental vulnerabilities. Regardless of the facility type, however, new growers should carefully examine points of exposure and understand how best to mitigate risks.

7. Plan for where the market is going, not where it currently is.

Legal cannabis demand is poised to explode, growing from \$31 billion in 2022 to \$73 billion in 2030.

However, opportunities which market growth presents will not be uniformly distributed, as the most efficient and differentiated producers will be positioned to lead the space.

Costs will be a key determinant of future success, and increasingly crowded markets will compress wholesale prices and drive competition for shelf space in a fragmenting product landscape. Still, such changes represent immense opportunity

for those growers who are able to minimize their production costs (especially for labor, energy, and water) while differentiating themselves whether based on cost, quality, or the novelty of their genetics.

While producers in new markets may enjoy a period of high margins and low competition, the most successful operators will be those who plan for where the market is going, not where it currently is.



About

New Frontier Data

NEW FRONTIER DATA is the premier data, analytics, and technology firm specializing in the global cannabis industry, delivering solutions that enable investors, operators, advertisers, brands, researchers, and policymakers to assess, understand, engage, and transact with the cannabis industry and its consumers. New Frontier Data's global reach and reputation is evidenced by research and analysis citations in more than 85 countries. Founded in 2014, New Frontier Data is headquartered in Washington, D.C., with presence in Europe, Latin America, and Africa.

Mission

New Frontier Data's mission is to inform policy and commercial activity for the global legal cannabis industry. We maintain a neutral position on the merits of cannabis legalization through comprehensive and transparent data analysis and projections that shape industry trends, dynamics, demand and opportunity drivers.

Core Values

- Honesty
- Respect
- Understanding

Vision

To be the nexus of data for the global cannabis industry.

Commitment to Our Clients

The trusted one-stop shop for cannabis business intelligence, New Frontier Data provides individuals and organizations operating, researching, or investing in the cannabis industry with unparalleled access to actionable industry intelligence and insight, helping them leverage the power of big data to succeed in a fast-paced and dynamic market. We are committed to the highest standards and most rigorous protocols in data collection, analysis, and reporting, protecting all IP and sources, as we continue to improve transparency into the global cannabis industry.

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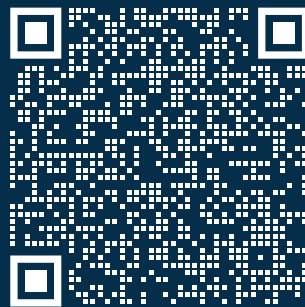


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