LED Grow Light Market Research

Prepared for:
Energy Trust of Oregon

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Executive Summary

Energy Trust contracted with ADM Associates to conduct market research that will help them update their LED grow light offerings to residential and business growers. Energy Trust supports grow lights via their Residential program and their Industry and Agriculture program. The Residential program works with 18 horticultural supplies retailers and offers instant discounts on LED grow light fixtures sold through these participating retailers. The Business Lighting program offers a downstream incentive to business growers who would like to purchase LED grow lights with Energy Trust incentives. They must work with an Energy Trust Trade Ally.

Energy Trust had the following objectives for this research.

1. Establish current baseline of efficiency, price, and market share for LED grow lights by sector including determining the market share of LEDs used in growing operations happening in residential buildings and determining the price difference between LED grow lights and other grow lighting types.
2. Understand the sales cycle of LED grow lights.
3. Understand what lighting efficiency and performance metrics are most important for cannabis growth.
4. Learn about dimming settings and installation information for LED grow lights among business cannabis growers participating in the Business Lighting program.
5. Understand current regulatory landscape for residential and business growers, and potential for change or stability in coming years.
6. Document current knowledge regarding the impact of LED grow lights on cannabis growth or plant quality.

Key findings included:

Establish Current Baseline of Efficiency, Price, and Market Share for LED Grow Lights by Sector

Grow light manufacturers, trade allies, participant retailers, and the Energy Trust participants make, recommend, sell, and use LEDs. Grow light manufacturer respondents reported making LEDs, almost exclusively. Trade allies reported recommending LEDs in most, if not all, circumstances. Business grower participants have most of their canopy under LED grow lights. And, on average participant retailers sell LED grow lights almost exclusively (88%) whereas nonparticipants sell few grow lights of any type. When nonparticipants do sell grow lights, they tend to be non-LED but their numbers are small. Furthermore, evidence from the research indicates that Energy Trust incentives are a key reason why consumers purchase LED grow lights with both participant and nonparticipant retailers reporting that growers located outside Energy Trust territory travel to purchase LED lights from participant retailers. Without incentives, participant retailers reported that LED grow lights are more than two times the cost of High Intensity Discharge (HID) lights at retail stores and can be up to four times more in the business market according to trade allies able to estimate the price difference. Several nonparticipant retailers reported explicitly that the incentives available to participants make it difficult for them to compete on grow light sales and participants noted that incentives encourage customers to replace old technology lighting sooner than they would otherwise.

Retailer and trade ally responses suggest that one four-foot LED or HID fixture supports similar amounts of canopy growth and three of those trade allies reported that a four-foot fixture supports about 25 square feet of canopy.

Responses from the business grower survey indicate that LEDs have just under two-thirds of the share of total canopy of cannabis under grow lights. The fact that LEDs make up nearly all reported trade ally grow light sales suggests that the non-LED canopy lighting is older lighting (mostly HID) that is yet to be upgraded. Given that nearly 90% of grow space is cooled and most of it cooled year-round, according to the survey results, the relatively high proportion of canopy area that currently is under HID suggests that achieving a large increase in LED share could reduce the heat generated from non-LED lighting and, therefore, reduce the cooling load. However, it is also the case that nearly 60% of grow space is heated, and so replacing HIDs with LEDs also could increase heating needs during heating season, which is about 6 to 8 months out of the year on average.[1]

Understand the Sales Cycle of LED Grow Lights

The LED grow lights business is a nascent industry. Many manufacturers entered the industry since states started legalizing and regulating cannabis around 2015. Manufacturers generally sell to business growers or retailers with none of the respondents reporting selling to distributors. Manufacturers reported paying close attention to incentive programs around the country, including Energy Trust programs, and targeting their marketing and advertisements around incentive programs. For example, if a jurisdiction is planning to lower a grow light incentive, manufacturers will target customers in that region with ads about purchasing new lights before the higher incentive sunsets.

Participant retailers and trade allies emphasize the value of Energy Trust incentives to their customers with both groups reporting they almost always inform their customers about the incentives.

Prior to 2024, the Energy Trust residential program placed a five-light limit on the number of grow lights a customer can purchase in a day from a retailer through the midstream program and subsequently lowered the limit to two lights per day for 2024. Energy Trust imposed the two-light per day rule to help them better manage the program budget. Based on feedback from retailers, customers are exceeding that limit with most customers, on average, purchasing closer to five incented lights.. These customers get around the limits by purchasing lights across multiple days or having colleagues purchase on their behalf.

Trade allies that are supporting the Business Lighting program are generally specialists in the cannabis or agriculture industry. They are not typically lighting or electrical contractors. These trade allies get their business mostly through long-term personal relationships with business growers and referrals. None indicated getting work through marketing efforts.

[1] Whether or not the increased heating load would offset reduced cooling load would depend on a variety of factors, including the type of heating and cooling employed, the overlap between hours of lighting use and heating/cooling, and local climate, among others

Understand What Lighting Efficiency and Performance Metrics Are Most Important for Cannabis Growth

Customers, retailers, and trade allies emphasize different aspects of cannabis growth and what is important to them. For example, retail customers often ask about cost and dimming characteristics of LEDs whereas retailers will tell customers about the efficiency and cost savings associated with LEDs. According to trade allies, business growers generally have specific interests in installing LEDs beyond just cost savings. For example, they are interested in using new LED lights to do things like increase performance by increasing yield or quality of product. They also ask about things like the durability of LEDs.

More than half of business growers reported having moderate or high levels of familiarity with spectral qualities of lighting (54%) and Photosynthetic Photon Flux density (PPFD) (64%) and these growers make lighting decisions based on their knowledge of these characteristics. For example, most business growers prefer using blue light for plants in the vegetative stage and a balanced spectrum for plants in the flowering stage.

Participant and nonparticipant retailers had limited insight into where customers install the light most purchased through the Residential program (700w 4’ x 4’). Less than half of phase two respondents could address the structure type customers installed lights in and of those that did answer, they reported, on average, that half their customers purchased for a commercial building and half purchased for a residential building.

Participant retailers reported that their grow light customers were using lights mostly for cannabis growing whereas nonparticipants reported a greater percentage of their customers were using grow-lights for non-cannabis growing like vegetables and house plants.

Under-canopy lighting and changes in environmental controls for growing spaces, like dehumidification, were the most reported emerging technological shifts in the industry reported by retailers.

Learn About Dimming Settings and Installation Information for LED Grow Lights Among Business Cannabis Growers Participating in the Business Lighting Incentive

Almost all business growers reported having at least some dimmable grow lights and almost three quarters reported all their grow lights were dimmable. On average, they tuned their lights to about half intensity during the vegetative stage and about three quarters during the flowering stage.

Understand Current Regulatory Landscape for Residential and Business Growers, and Potential for Change or Stability in Coming Years

Our team's review of secondary sources and knowledge of the cannabis industry led us to identify three potential changes to the regulatory landscape that could have notable impact on cannabis growers and Energy Trust's support for grow lights.

- Federal Rescheduling of Cannabis. As of August 2024, the US Drug Enforcement Agency (DEA) is in the process of rescheduling cannabis to a less restrictive status, Schedule III. By rescheduling cannabis as a Schedule III substance:
    - Banks and other lenders may be more likely to provide services to cannabis businesses.
    - Cannabis businesses would be able to deduct normal business expenses.
    - Businesses may become more confident in expanding to other states, knowing that federal interference is less likely.
    - Larger and better capitalized companies may enter the field, including publicly traded entities and those from other industries leading to mergers and acquisitions of smaller brands.
    - Stigma around cannabis use could decline, leading to higher consumer demand.
- Changes to the Farm Bill and Hemp Growing. Recent discussions about changing the Farm Bill could have significant impacts on businesses that cultivate hemp including:
    - Relaxing regulation on the amount of THC allowed in hemp products.
    - Improved insurance options for hemp farmers providing greater financial stability for these growers.
    - New hemp products and new markets to serve these products.
    - Uniform hemp standards that would ensure hemp products meet the same quality and safety standards.
    - Possible provisions in the bill for energy efficiency and renewable energy to support hemp growers.
- Oregon Liquor and Cannabis Commission (OLCC) Electricity Usage Reporting Requirements. It is plausible that in the future, electricity use could become a more prominent feature of license determinations, with license tiers, fees, or issuance being tied to electricity consumption.

Document Current Knowledge Regarding the Impact of LED Grow Lights on Cannabis Growth or Plant Quality

The results of the grower survey indicate that growers are tuning their lights in the flowering stage to increase yield, and their tuning practices align with best practices described in scientific literature. . Although increasing light intensity invariably leads to increased biomass yield, this practice will also require growers to increase energy consumption through more dehumidification and cooling. There are still many knowledge gaps regarding how different types and intensities of light can help optimize indoor cannabis cultivation. The existing literature about light intensity and spectral tuning impacts on cannabis growth and key outcomes has relied on studies with an extremely limited number of genetic varieties. It is highly likely that the generalizability of these findings is low, and on-site research and optimization will

continue in perpetuity, with each cannabis producer fine-tuning lighting features for their specific environmental conditions, cultivation practices, desired cannabinoid outcomes, and genetic varieties. Future research may yield higher-resolution evidence about the effects of light on various outcomes such as plant morphology, cannabinoid production, aromatic features, and biomass yield.

Conclusions and Recommendations

Our review of the data resulted in the following conclusions and recommendations.

Conclusion #1: LEDs are the dominant light source sold by trade allies and retailers and used by business and residential growers, however there is some evidence that larger commercial operations have a lesser percentage of their canopy under LEDs than smaller operations. Most retailers reported trying to reduce or remove any lingering non-LED inventory and trade allies almost never specify non-LEDs. Yet, due to the noticeable price difference between LEDs and HIDs, respondents indicate that the Energy Trust incentives are key to maintaining LED grow light purchases among both business and residential growers.

> **Recommendation #1.1**: Maintain business and residential incentives, with possible adjustments to amounts, for LED grow lights and consider marketing incentives with other equipment important to growers like dehumidifiers, water pumps, and HVAC incentives.
>
> **Recommendation #1.2**: Consider future research with larger business growers to verify their use of LEDs and, if they are using LEDs less than their smaller counterparts, identify larger growers' barriers to greater adoption of LED grow lights.

Conclusion #2: Among business grower respondents, almost all grow lights in use today, of which most are LED, have dimming capabilities and most growers are using those dimming capabilities in both the vegetative and flowering stages. Few growers reported operating their lights at 100% intensity all the time, however, more operate at high intensity during the flowering stage (around eight weeks) compared to the vegetative stage (four to 10 weeks). Our calculations revealed that growers operate their lights at close to half intensity during the vegetative stage and about three-quarters intensity during the flowering stage. Our research did not identify the best dimming practices for increasing yield or product quality.

> **Recommendation #2.1**: Consider monitoring relevant literature and industry best practices for lessons about effective dimming practices and how those practices may vary based on space and environmental conditions to learn if there are energy saving opportunities available. Perhaps by lowering the intensity of LED lights more than growers are currently doing and, via training trade allies about best practices, Energy Trust could influence the market to save more energy through better management of lighting intensity.

Conclusion #3: Participant retailers sell to residential growers and business operations and at least some customers are repeat customers of retailers, purchasing their allotment of two per day on multiple days. Participant retailers estimated that less than two-thirds of their customers, on average, are people growing for personal use and, on average, customers purchase almost five lights, three more than Energy Trust's two-per-day rule. These retailers reported that customers will purchase their maximum allotment on multiple days or recruit friends or colleagues to purchase lights on their behalf to acquire their desired number of lights. These respondents could not tell us which customer type – residential growers versus business growers – were most often purchasing more than two lights for their operation, but some evidence from the business grower survey suggests they are likely business growers with small indoor

operations and large outdoor operations. These growers only need a few lights for indoor plant starts that eventually are transplanted to larger outdoor grows.

The high percentage of participants that focus on indoor operations, combined with the indication that some business growers are purchasing lights from retailers suggests that the program may be serving business growers with small indoor operations. However, it may be hard to see that these small indoor business operators are participating because they are technically going through the residential midstream program pathway.

> **Recommendation #3.1**: Because retailers are selling to business and residential buyers, residential program dollars are currently supporting business activities. However, the residential program (through retailers) may be serving an important subset of the cannabis grower community – those with small indoor operations and larger outdoor operations. The current program design makes it hard to verify if the program is serving this subset of the community adequately so Energy Trust, to the extent possible, may want to consider reworking program rules to make these small indoor operators a more visible presence in the program. This could include asking retailers to ask their customers to identify if they are using the incented lights for personal or business applications and then periodically sharing that collected information with Energy Trust.

Conclusion #4: Trade allies of the grow lights program are often assisting business growers by working to improve yields, product quality, or to assist with incentive processing. Unlike other lighting programs where trade allies are often lighting designers and electricians, trade allies in this space are often specialists in the cannabis or agricultural market helping business growers solve problems. Additionally, about half of business growers reported at least moderate levels of familiarity with spectral qualities as it pertains to cannabis growth and about three-fifths reported at least moderate levels of familiarity with PPFD. This limited familiarity among business growers may be why they are leaning on agricultural and cannabis specialists to help with their operations.

> **Recommendation #4.1**: Trade allies' knowledge of evidence-based cultivation practices as they relate to energy efficiency could be critical to improving the efficiency of grow operations. Because they tend to be experts in growing, there is an opportunity for Energy Trust to use these handful of allies as conduits of information to business growers about ways to save energy. As noted above, for example, if Energy Trust learns of dimming best practices that could save energy, trade allies would be a good way to transfer that information to the grower market.

Conclusion #5: Rescheduling cannabis from Schedule I to Schedule III would have profound effects on the legal cannabis industry in the United States. It would reduce banking and tax challenges and likely increase nationwide consumer demand. Provided that interstate commerce will be permitted, businesses might expand or consolidate, leading to an expanded market, with Oregon businesses having a national presence. While interstate commerce of cannabis will not be immediately resolved, rescheduling could pave the way for future changes, further integrating cannabis into the national economy. Rescheduling may have short- and long-term impacts on the grow light economy as businesses become better capitalized and financially stable. With never-before seen access to lending and banking, new cannabis businesses may enter the market, requiring substantial investment in lighting and other controlled indoor agriculture equipment. Existing businesses may be better positioned to retrofit and upgrade existing cultivation environments. Other businesses may be restructured and their existing lighting assets may be liquidated as consolidation occurs through mergers and acquisitions. As consumer demand grows and the

national market expands, the market composition of grow light manufacturers may shift, with some previously successful brands losing market share to others.

> **Recommendation #5.1:** Consider conducting another market assessment if/after the DEA reschedules cannabis to a Schedule III drug. That regulatory change could have profound impacts on the cannabis market, many of which we discuss in Section 3.5.1, which could disrupt grower operations and how the market operates both in the state and nationally.

Conclusion #6: Changes to the United States Farm Bill could greatly impact hemp cultivation businesses. Hemp and cannabis are botanically indistinguishable. Hemp is simply a legal term for varieties of cannabis with little or no THC. Many cannabis businesses also cultivate hemp, and the ratio of hemp to cannabis production could be impacted by changes in federal policies. By clarifying or easing regulations, providing better financial support, and encouraging sustainable practices, the Farm Bill could make hemp farming more attractive and profitable. Businesses might expand their operations, invest in new technology, and adopt more sustainable cultivation practices. It is plausible that grow lights might be included in these technological investments, as many hemp businesses start hemp seedlings indoors before transplanting onto acreage. Furthermore, many hemp varieties are not adapted to rainy autumn weather in Oregon and are grown with supplemental lighting (greenhouse). Although it is possible that HID fixtures may be phased out in the US, it is unclear whether this change will come about because of the forthcoming revisions to the Farm Bill.

> **Recommendation #6.1**: Consider conducting another market assessment if the Farm Bill makes notable changes to the hemp cultivation business. That regulatory change could have profound impacts on the hemp market, many of which we discuss in Section 3.5.2, which could disrupt grower operations and how the market operates both in the state and nationally.

Conclusion #7: Responses from trade allies, manufacturers, and retailers suggest that Energy Trust is in some ways competing for the attention of grow light stakeholders with other grow light programs in the country. Trade allies, of which many were national incentive specialists, reported focusing their efforts on where the rebates were strongest. Manufacturers target their marketing resources to places where incentives are changing and or are robust. Retailers with shops in multiple states concluded that Energy Trust incentives draw growers to install LEDs because shops in states without incentives do not sell many LED grow lights.

> **Recommendation #7.1**: Continue monitoring residential and business grow light incentive rates and programs in other jurisdictions to stay competitive in the marketplace. Energy Trust staff should continue to stay aware of programs in other jurisdictions via their interactions with other professionals via trade association memberships, subscriptions to relevant newsletters, and conferences.

Conclusion #8: Energy Trust is defining the residential grow light market in Oregon. Grow light sales, mostly LED lights, are occurring at Energy Trust participant sites and growers across the state know to purchase lights from Energy Trust participant retailers to get discounted lights. Nonparticipant retailers are selling few grow lights in the state and when they do, they are generally selling non-LED lights or small LED grow lights, whereas program participants are mostly selling LEDs. A couple of participants noted that they get customers from outside their immediate region because they have discounted lights for sale and three nonparticipants reported losing grow light sales because they could not compete with participants, even if that participant site is not in the immediate vicinity of the grower. This trend towards LEDs is happening despite the expense of LEDs, about $800 without incentives, compared to non-LED

technologies. While HPS lights are cheaper than comparable LEDs, participant retailers reported they are not generally ordering new HPS (or any other technology) lights. Their sales of HPS, CMH, or fluorescents are mostly trying to get rid of old inventory. Additionally, nonparticipants rarely sell non-LED lights that compete with the program incented lights.

> **Recommendation #8.1**: Based on the effectiveness of the program in encouraging growers to use LED grow lights, determine whether the program should alter its incentive structure. These interviews suggest that ceasing to offer grow light incentives may limit growers' interest in replacing old lighting technology. But, as the program has done in the latter half of 2024 and in January 2025, program staff should continue to monitor incentive amounts and consider reducing or altering incentives that continue to support LED adoption while increasing the cost-effectiveness of the program.[2]

> **Recommendation #8.2**: Work with other non-investor-owned utilities with energy efficiency programs in the state to encourage them to support the adoption of grow lights. Retailers located outside Energy Trust territory reported losing business to those in Energy Trust territory. Getting programs to start supporting grow lights sales in these other areas may help utilities acquire energy savings, retailers gain business, and Energy Trust to reduce leakage of savings into neighboring areas. Most other utilities in Oregon are municipally owned entities that are customers of the Bonneville Power Administration, a federal entity. As such, these other utilities may be averse to supporting grow lights due to their association with cannabis growing, a federal crime. Where possible, Energy Trust could work with these other utilities to support grow light incentives.

Conclusion #9: Retailers have little insight into the type of structure customers are installing grow lights. More than half of respondents could not assess the number or percentage of customers that install 700w four feet by four feet fixtures in commercial properties (e.g. warehouses) and residential properties (e.g. houses). It is unclear how reliable the estimates the other half provided as they may have provided socially desirable answers to interviewers. The more than 90% decline in the number of Oregon Medical Marijuana Program OMMP registered growers in the state suggests that far fewer people are growing cannabis commercially in their homes than they were just a few years ago.

> **Recommendation #9.1**: Concentrate the grow light programs on those growing for personal use and those growing for commercial use and assume that personal use growers are growing in homes, and commercial growers are growing in warehouses, greenhouses, and outdoors. There is negligible overlap in people growing cannabis in their home, a residential structure, and selling it commercially.

Conclusion #10: There may be opportunities to acquire additional energy savings for the program. Retailers reported under canopy lighting and environmental controls (heating, cooling, and dehumidification) are the two energy related trends happening in the marketplace now. Through supporting the adoption of energy efficient under canopy lighting and ensuring grow sites are efficiently managing their environmental controls the program could acquire energy savings and ensure growers are operating as efficiently as possible.

[2] During this research project, the residential program reduced incentives from $350 to $250 in July 2024 and again reduced incentives from $250 to $150 Jan 2025.

Recommendation #10.1: Consider offering incentives or other support for growers to help them install efficient energy-using equipment beyond top-down grow lights. Energy Trust could investigate if there are any opportunities to support efficient under canopy lighting options and help growers install adequate and efficient environmental controls for their grow spaces.

MEMO

Date: April 10, 2025
To: Energy Trust Board of Directors
From: Ryan Crews, Program Manager – Residential
Kirstin Pinit, Senior Program Manager – Industry and Agriculture
Kenji Spielman, Engineer – Planning and Evaluation
Andi Nix, Engineer – Planning and Evaluation
Leila Shokat, Evaluation Project Manager

Subject: Staff Response to LED Grow Light Market Research Report

ADM conducted market research in 2024 and early 2025 to provide Energy Trust with information on the horticulture lighting market in Oregon. Energy Trust incentivizes customers to install efficient horticulture lighting through two programs. The Production Efficiency (PE) program offers rebates to indoor agricultural facilities that install LED grow lights; this offer is delivered through trade allies. Energy Trust's Residential program offers instant discounts on LED grow lights through participating brick-and-mortar retailers. This study had the goal of providing information to both the PE program and the Residential program to inform updates to their respective LED grow light measures.

For the PE program, the study sought to understand the qualities of LED lights that are most important to customers, as well as how the lights are installed and controlled in industrial growing settings. For the Residential program, the research gathered information on the market baseline for brick-and-mortar retailers that sell grow lights to update assumptions for the Residential program's midstream grow lighting offer.

To learn about the industrial grow light market, ADM surveyed 33 past participants in the PE program's grow light offer and interviewed eight trade allies who help deliver this offer. To gather information on grow light market share for the Residential program, ADM interviewed 12 brick-and-mortar retailers who offer instant discounts on LED grow lights through the program and six retailers who do not. All retailers sold equipment for indoor plant cultivation, and all were located in Oregon. ADM also interviewed three manufacturers of grow lights to understand larger trends in LED grow light sales over time.

Surveys of industrial participant growers found 64% of their total indoor canopy is under LED grow lights, and trade allies who work with these customers report recommending LED options in most circumstances. Trade allies also reported LED grow lighting options are significantly more expensive than other options; anywhere from two to four times as expensive. Because LEDs remain far more expensive than other grow lighting options, and with remaining opportunities to replace less efficient lighting with LED grow lights,

Energy Trust agrees with the recommendation to maintain incentives in this market to support LED grow light adoption.

The research also found 97% of PE program participants dim or tune their lights to promote desired crop outcomes. Quantifying these dimming practices could help the program better understand the energy savings in these facilities. Energy Trust is conducting additional site visits and metering through the PE 2023 program year Impact Evaluation to better quantify these dimming practices. This information will support the PE program in accounting for all energy savings impacts of LED grow lights and designing relevant and meaningful offers for these customers.

Interviews with retailers showed Energy Trust's Residential program instant discounts are a strong driver of LED grow light sales at participating retailers. While participating retailers on average reported 88% of their sold grow light units are LEDs, non-participating retailers reported that only 25% of their units sold are LEDs. Qualitative interview responses also indicate the level of discount offered at participating retailers may be making it difficult for non-participating retailers to compete with these discounted prices of LEDs. These findings indicate the Residential program's instant discount level was higher than needed, and the program reduced its instant discount amounts for these LED grow light units at the start of 2025.

Qualitative insights from retailer interviews also indicated some subset of customers at participating retailers are purchasing LED grow lights for use in non-residential structures or structures outside of Energy Trust service area, though retailers could not reliably estimate or report how prevalent these practices are. The Residential and PE programs avoid incentivizing the same units for residential and industrial applications by monitoring available grow light unit types that qualify for their respective offers. This ongoing review ensures savings are not double counted across programs. The Residential team also mitigates the risk of claiming savings on LED grow light units installed outside of Energy Trust service area by factoring in a leakage rate when savings are claimed, and findings from this study can help inform this methodology going forward.

Finally, the research team provided an overview of potential future legislative changes and possible impacts these could have on the cannabis industry in Oregon. These included possible changes to how cannabis is regulated, and impacts of the farm bill on hemp cultivation. It is not clear if or when these changes may occur, however it is valuable for the programs to be aware of how cannabis is regulated at the state and federal level and what legislative actions could change current market dynamics.

1 Introduction

Energy Trust contracted with ADM Associates to conduct market research that will help them update their LED grow light offerings to residential and business cannabis growers. Energy Trust supports grow lights via their Residential program and their Business Lighting program.

The Residential program offers a midstream incentive through 18 participating brick-and-mortar retailers. The program works with these horticultural supplies retailers and offers instant discounts on LED grow light fixtures sold through these retailers. LED grow light fixtures of various sizes received an instant discount of $50, $100, and $350 per fixture, respectively at the during the first phase of this research project[3]. Energy Trust incentives on residential LED grow lights are not available for online purchases.

The Business Lighting program offers a downstream incentive delivered through Energy Trust trade allies.[4] Business growers who would like to purchase LED grow lights with Energy Trust incentives must contact an Energy Trust Trade Ally, who will assist the grower in completing project documentation forms and applications. While any business grower can participate in the program, cannabis growers must have an active Oregon Liquor and Cannabis Commission (OLCC) license and hemp growers must have an active Oregon Department of Agriculture (ODA) registration. Unlike the Residential program incentive, the Business Lighting incentive is not limited to LED grow lights purchased at a particular set of retailers. However, customers of the Business Lighting program must apply for this incentive through an Energy Trust Business Lighting Trade Ally, and, like the Residential offering, the LED grow lights installed must be on the Design Light Consortium Horticultural Qualified Products List or have specifications that align with DLC's Horticultural Technical Requirements.

Using data from business growers, program participating grow light retailers, participating trade allies, manufacturers, and a literature review, this research aimed to address the objectives listed in Table 1-1.

[3] The extra-small, small, and extra-large category of lights are eligible for the program. Lights categorized as medium or large are not cost effective and therefore ineligible for incentives.

[4] The Business Lighting effort transitioned to Energy Trust's Industry and Agriculture Program in 2024. Throughout the report, the term business customers refer to customers who purchased grow lights for licensed grow operations through Energy Trust's Industry and Agriculture Downstream Program offering.

Table 1-1: Data Sources that Address Each Research Objective

Research Objective	Business Growers	Retailers	Trade Allies	Manuf.	Lit. Review
#1. Establish current baseline of efficiency, price, and market share for LED grow lights by sector.	✓	✓	✓		
#2. Understand the sales cycle of LED grow lights.		✓	✓		
#3. Understand what lighting efficiency and performance metrics are most important for cannabis growth.	✓	✓	✓	✓	
#4. Learn about dimming settings and installation information for LED grow lights among business cannabis growers participating in the Business Lighting incentive.	✓				
#5. Understand current regulatory landscape for residential and business growers, and potential for change or stability in coming years.	✓	✓	✓		✓
#6. Document current knowledge regarding the impact of LED grow lights on cannabis growth or plant quality.					✓

2 Methodology

This section reviews the methods used to conduct this research.

2.1 Manufacturer Interviews

We developed a sample of manufacturers of grow lights using insights from Energy Trust program staff, our team's experience in the industry, manufacturers mentioned by retailers and trade allies, and through online searches. This approach identified nine key manufacturers of grow lights.

We successfully collected information from three manufacturers of the initially identified nine (Table 2-1).

Table 2-1: Manufacturer Disposition Summary

	Count	Percent
Complete	3	33%
Refusal	1	11%
Attempted but no contact	5	56%
Total	9	100%

Additionally, one of the trade allies interviewed (Section 2.3) was also a manufacturer. While we did not complete the full manufacturer questionnaire with this respondent, where applicable, in our analysis, we included insights from this respondent related to manufacturers.

Interviews with manufacturers addressed their activity in Oregon, incentive support for grow lights, and their knowledge of the market for grow lights in Oregon and nationally. In collaboration with the Energy Trust team, we designed the manufacturer interview guide (Appendix D) to include open-ended questions and close-ended questions.

We conducted interviews with manufacturers in June 2024. With permission from the respondent, and to ensure accuracy of analysis, we recorded interviews using MS Teams and interviewers took notes during the call. We analyzed responses using MS Excel to identify themes and patterns across respondents. As a thank you for participating, we offered a $150 gift card to those that completed interviews.

2.2 Residential Program Retailer Interviews

Retailer interviews happened in two phases. The first phase was part of the original research plan and involved only retailers participating in the Energy Trust residential program. The second phase occurred as an outgrowth of the first draft of this report due to additional interest among Energy Trust staff about growing in residential structures and price differences between LEDs and other grow lights among both program participants and nonparticipants. We discuss the details of each phase of retailers interviews below.

2.2.1 Phase One Participant Retailer Interviews

We developed a sample of retailers participating in the instant discount program using the list of retailers available on the program website as of April 30, 2024. That list identified 21 sites representing 18 firms. After contacting these 18 sites, we learned that four were either out of business or had incorrect contact

information and one of the sites was a duplicate company. We successfully collected information from eight representatives from the remaining 13 firms (Table 2-2).

Table 2-2: Phase One Participant Retailer Disposition Summary

	Count	Percent
Complete	8	62%
Attempted but no contact	4	31%
Language barrier	1	8%
Subtotal	13	100%
Out of business/Bad contact information	5	-
Total	18	-

Our work plan indicated we would interview 10 of the estimated 20 retailers for a response rate of 50%. Our research identified seven fewer retailers than the workplan estimate and achieved a higher response rate (62%) than proposed.

Interviews with retailers addressed the pricing and sales cycle of LED and other grow light types and recent retailer sales data. In collaboration with the Energy Trust team, we designed the retailer interview guide (Appendix B) to include open-ended questions and close-ended questions. Topics covered:

- The type of growing focus (indoor or outdoor) of the retailer.
- Grow light customers and their interest in features and benefits of grow lights.
- The Energy Trust program and its support for grow lights.

We conducted interviews with retailers in May and June 2024 and attempted contact with retailers up to five times. With permission from the respondent, and to ensure accuracy of analysis, we recorded interviews using MS Teams and interviewers took notes during the call. Interviews lasted about 20 minutes and we analyzed responses using MS Excel to identify themes and patterns across respondents. As a thank you for participating, we offered a $150 gift card to those that completed interviews.

2.2.2 Phase Two Participant and Nonparticipant Retailer Interviews

In the process of reviewing the first draft of this report, submitted to Energy Trust in September 2024, Energy Trust staff determined they wanted a better understanding of two things:

1) What is the market share of LEDs used in growing operations happening inside residential buildings? Historically, cannabis cultivation inside residential structures was commonplace, largely in the form of registered grow sites within the Oregon Medical Marijuana Program (OMMP). Many OMMP grow sites are in homes, garages, and other residential structures. However, data from the Oregon Health Authority (OHA) suggests that the number of registered growers has declined considerably over the last ten years. OHA data shows that in 2015 there were 35,765 registered medical grow sites in the state.[5] By July 2024, the number of registrations

[5] *The Oregon Medical Marijuana Program, Statistical Snapshot*. January 2015. Oregon Health Authority, Accessed January 10, 2025.

decreased by over 90% to 3,190 sites.[6] The ADM Team hypothesizes that this decrease is due to the legalization of recreational cannabis in Oregon and the reduced price of cannabis over that time.

2) What is the price difference between LED grow lights and other grow lighting types?
3) What is the difference in LED sales between participants and nonparticipants to inform Energy Trust about the role of the program in supporting LED adoption

To address these additional interests, the teams decided to field a second survey of retailers – both those participating in the Energy Trust Residential program's grow light incentives and those that are not participating – about their sales of grow lights. In consultation with Energy Trust staff, we elected to conduct interviews with about 10 retailers, targeting about five participant and five nonparticipant retailers.

We developed a sample of retailers using the Energy Trust participant list and website, the Hawthorne Gardening Company's comprehensive list of hydroponic retailers available on their website[7], and web searches to identify other grow light suppliers in Oregon. This process identified 75 distinct firm names.

The ADM Team contacted firms in December 2024 and January 2025 and exceeded the initial goal of 10 by completing 13 interviews. Respondents were Energy Trust residential program participants (*n*=7) and nonparticipants (*n*=6). The Team's recruitment efforts revealed that 49% (37 of 75) of the stores the evaluators attempted to contact were out of business, were duplicate records, had incomplete or incorrect contact information, or did not pass screening because they were not retailers. This work suggests the population of stores in Oregon with some specialization in grow lights is less than 38 retailers. Additionally, through web searches and phone calls, the team was able to verify that eight participants were still in business selling grow lights without doing an interview. The team also determined that two program participants and five nonparticipants were likely not in the population but could not confirm that through phone calls or web searches. These seven records had broken websites, phone messages that did not identify a business, non-Oregon area codes, very old reviews on websites like Yelp, or, most commonly, a combination of all these factors. This suggests that the population of grow light retailers in the state is somewhere between 31 and 38 stores. (Table 2-2).

[6] *The Oregon Medical Marijuana Program, Statistical Snapshot*. July 2024. Oregon Health Authority, Accessed January 10, 2025.

[7] Energy Trust program staff recommended this site as a source. Additionally, ADM reviewed other growing supplies manufacturer sites for similar lists and found Hawthorne was one of the few that had a relevant list of retailers.

Table 2-3: Phase Two Retailer Disposition Summary

	Energy Trust Participant	Nonparticipant	Count
Total Records Used to Determine Population			
Total Records	32	43	75
Records Determined to be Ineligible			
Out of business	5	12	17
Bad/wrong contact number	2	5	7
Did not pass screening	3	4	7
Duplicate record	5	1	6
Total ineligible population	**14**	**22**	**37**
Eligible Population			
Complete	7	6*	13
Not reached for interview	8	10	18
Attempted but no contact	0	10	10
Verified in population, but no interview	8	0	8
Total likely eligible population (low estimate)	**15**	**16**	**31**
Likely not in population, but unverified	2	5	7
Total possible population (high estimate)	**17**	**21**	**38**

* One response was partial. This respondent did not provide details about price and initially refused to participate but did provide some information about stocking and selling grow lights before terminating call.

With permission from the respondent, and to ensure accuracy of analysis, we recorded interviews using MS Teams and interviewers took notes during the call. Interviews lasted about 20 minutes, and we content-coded responses using MS Excel to identify themes and patterns across respondents. As a thank you for participating, we offered a $100 gift card to those that completed interviews.

2.3 Business Program Trade Ally Interviews

We developed a sample of trade allies participating in the Business Lighting program using the list of trade allies, provided by Energy Trust, associated with business grower projects since 2019. We further refined our contact list to include only those trade allies (17) that completed grow light projects in 2022 or later. In consultation with Energy Trust staff, we deemed attempting interviews with trade allies active before that time frame as likely being unproductive because of the amount of time that had passed since project completion.

Our contact list identified 17 trade allies and after contacting these 17 allies, we learned that four were either out of business or had bad contact information and two were not actually trade allies but instead business growers that had completed their own installation. In these two cases, the interviewers completed a business grower survey with the respondents, and we included their responses in the business grower participant dataset (Section 2.4). We successfully collected information from eight trade allies from the remaining 11 firms (Table 2-4).

Table 2-4: Trade Ally Disposition Summary

	Count	Percent
Complete	8	73%
Attempted but no contact	3	27%
Subtotal	11	100%
Out of business/Bad contact information	4	-
Did not pass screening – redirected to grower survey	2	-
Total	17	-

Our work plan indicated we would interview 10 trade allies of the estimated 45 trade allies active in the program since 2019 for a response rate of 22%. However, as we decided to focus solely on more recently active trade allies, the population declined to 17 and the calling revealed the population of interest was 11. With eight completes, we achieved a 73% response rate.

Interviews with trade allies addressed the pricing and sales cycle of LEDs and other grow light types, how trade allies identify projects, and what features and benefits their customers look for in grow lights. In collaboration with the Energy Trust team, we designed the trade ally interview guide (Appendix C) to include open-ended questions and close-ended questions.

We conducted interviews with trade allies in May and June 2024 and attempted contact up to five times. With permission from the respondent, and to ensure accuracy of analysis, we recorded interviews using MS Teams and interviewers took notes during the call. Interviews lasted about 25 minutes and we analyzed responses using MS Excel to identify themes and patterns across respondents. As a thank you for participating, we offered a $150 gift card to those that completed interviews.

2.4 Business Program Grower Participant Survey

In consultation with Energy Trust staff, we designed and implemented a brief (around 15 minute) survey to address the research objectives. We implemented the survey with an email recruitment to take an online survey, with phone follow-up for nonrespondents to the email recruitment.

The instrument assessed business growers' use of grow lights, including installation and the dimming characteristics of the lighting types installed with Energy Trust incentives. We included some questions about the growers' characteristics, such as POC- or woman-owned business status and annual production. Appendix A displays the survey instrument.

2.4.1 Survey Implementation

The business grower data file Energy Trust shared with us on February 9, 2024, shows there were 183 projects (based on ProjectID) across 133 sites (based on et_siteId). Identifying duplicates on et_siteId, account operating name, phone numbers (business and mobile), or emails, we identified 113 unique program participants represented by those sites and projects. All projects occurred from March 28, 2019, to December 21, 2023.

We targeted 41 completions to provide 90/10 confidence/precision. Given the relatively small population of participants, we chose to recruit the entire population to maximize our chances of achieving the desired 41 responses and ensure inclusion of people of color (POC) and women-owned businesses.

Prior to fielding the survey, we coordinated with Energy Trust and the program implementer to make initial introductions with the participating business growers to alert them that a representative from ADM would be contacting them in the coming weeks. Some program participants refused to be contacted for the survey, leaving 106 in the sample frame. Email addresses were available for 86 of those 106 contacts and phone numbers were available for 92.

We sent an initial email to the 86 contacts for whom emails were available, inviting them to take the survey. The email referenced the initial outreach, explained the reason for the survey, provided a survey link, offered a $50 gift card for completing the survey, promised confidentiality of responses, and provided both Energy Trust and ADM contact information. About one week after the initial email, we sent a follow-up email to all those who did not complete the survey in response to the email. About one week after the follow-up email, we began making phone calls to 82 contacts for whom we had phone numbers and who did not complete the survey in response to the emails.

As a thank you for participating, we offered a $50 gift card to those that completed interviews.

2.4.2 Survey Response

Through the various recruitment approaches, a total of 33 program participants responded to the survey – 11 in response to email recruitments and 22 by phone. We removed two of the email respondents from the data set as they reported they do not grow cannabis or hemp, but instead grow only flowers, fruits, or vegetables. Table 2-5 shows the dispositions of all contact attempts.

Table 2-5: Business Grower Disposition Summary

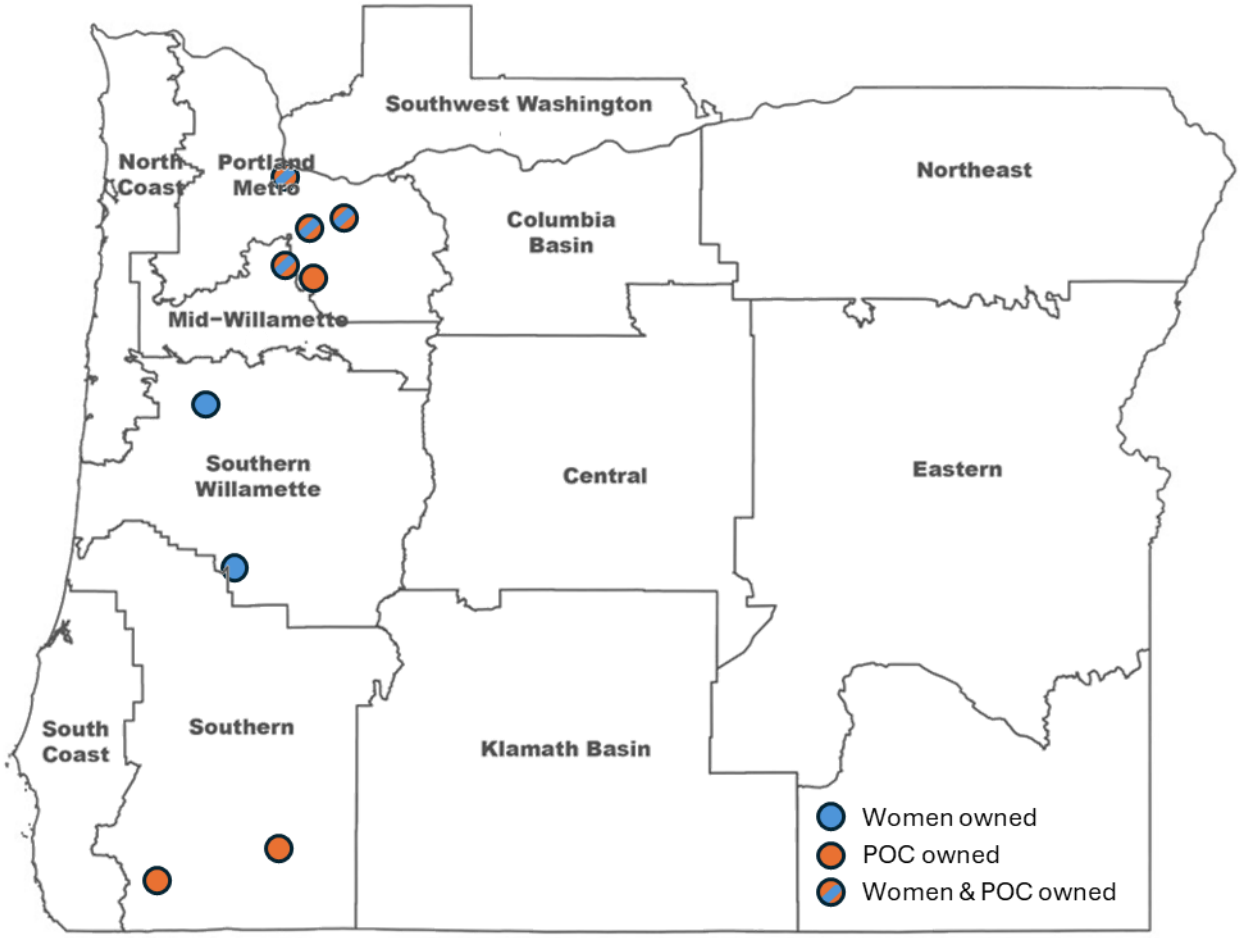
	Count	Percent of Applicable Recruitment Effort	Percent of Total (n = 106)
All attempted	106	n/a	100%
Attempted by email	86	100%	81%
Attempted by phone	83	100%	78%
Attempted by both email and phone	64	n/a	60%
Of All Attempted by Email (n = 86)			
Completed	12	14%	11%
Email sent, not completed	72	84%	68%
Email bounced	2	2%	2%
Of All Attempted by Phone (n = 82)			
Completed	21	26%	20%
Contacted but unable to complete	12	15%	11%
Unable to contact	40	49%	38%
Bad phone number	9	11%	8%
Of All Attempted by Email or Phone (n = 106)			
Total completed (email or phone)	33	n/a	31%
Do not grow cannabis or hemp	2	n/a	2%
Total retained in data	31	n/a	n/a

Nearly two-thirds (61%) of respondents were the owner, president, or CEO of their company, and another fifth were the facilities manager, with the remainder reporting a role related to operations, energy management, finance, or general management (Table 2-6). About one-third indicated their company is owned by a person of color and/or a woman. Figure 2-1 shows the geographic distribution of the respondents who reported their company is owned by a person of color and/or a woman.

Table 2-6: Respondent Firmographic Characteristics

	Count	Percent
Job or Title		
Proprietor/Owner	14	45%
President/CEO	5	16%
Facilities Manager	6	19%
COO/Director of Operations/Operations Manager	2	6%
Energy Manager	2	6%
Chief Financial Officer	1	3%
Manager	1	3%
Ownership (Multiselect)		
Owned by person of color	8	26%
Owned by woman	6	19%
Not owned by POC or woman	19	61%
Don't know if owned by POC or woman	1	3%

Figure 2-1: Distribution of Responding Women- and POC-Owned Business Growers



Survey respondents generally were representative of the program population in terms of recency of participation, number of projects completed, and location (Table 2-7). For example, 57% of program participants and 61% of survey respondents completed their most recent Energy Trust LED Grow Light project in 2022 or 2023 and about one-third of each group (37% and 32%, respectively) completed more than one project in the last five years. Similarly, survey respondents were distributed across the four Energy Trust regions similarly to all program participants.

Table 2-7: Program Population and Survey Respondents by Key Characteristics

	Participant Population (n=113)		Survey Respondents (n=31)	
	Count	Percent	Complete Count	Percent
Last project year				
2019	10	9%	3	10%
2020	19	17%	4	13%
2021	20	18%	5	16%
2022	25	22%	6	19%
2023	39	35%	13	42%
Number of projects completed				
One	71	63%	21	68%
Two	27	24%	8	26%
Three	8	7%	2	6%
More than three projects	7	6%	0	0%
Location[1]				
Portland Metro and Hood River	62	53%	19	61%
Willamette Valley	29	25%	6	19%
Southern Oregon	20	17%	4	13%
Central Oregon	5	4%	2	6%

[1] Some growers had sites in more than one region.

2.4.3 Data Weighting for Analysis

During initial analyses, we observed that responses to several variables (e.g., the various lighting types' share of total canopy area) were related to the total canopy area under grow lights. Therefore, we used data weighted by total canopy area under grow lights for analyses of survey items for which results based on total canopy area is likely to be more meaningful. These included variables relating to market share of lighting types, the share of grow light area or type by grow stage, dimmable grow lights share of total, and lighting intensity. In these cases, respondents who reported more total canopy area had greater weight in the analyses than those reporting less canopy area. We used unweighted data for analyses of items for which results based on total number of respondents might be more meaningful. These were items relating to level of familiarity with spectral lighting qualities and photosynthetic photon flux density (PPFD), PPFD preferences, and hours of grow light use per day.

2.5 Conduct Secondary Research and Literature Review

We conducted secondary research to identify regulatory factors that may impact home and business cannabis growers. Our technical expert, Dr. Adie Rae, combined her knowledge and experience in the field with reviews of OLCC, Oregon Health Authority, Oregon Department of Agriculture, and other relevant agency websites, newspaper articles, and other sources to identify current pertinent regulations and their impacts and as well as any changes under discussion and their likely impacts. We identified any areas

where changes in regulations at both the federal and state level, might increase or decrease participation in the Residential and Business Lighting programs in the future – for example, changes that would change the difficulty of obtaining grow licenses or that may affect growers' decisions concerning the selection of grow light equipment. This work addresses research objective number five and we present results of that work in Section 3.5.

We also conducted a literature review focused on how LED grow lights affect cannabis plant growth and the quality of the product grown (biomass yield and phytochemistry). There is an abundance of online information documenting various aspects of LED grow lights (light wavelength, temperature, harvest cycle) and how they might or might not affect growth and quality. This work addresses research objective number six and we present the results of that work Section 3.6.

3 Results

This section of the report discusses the results of the data collection efforts and organizes those results by the six research objectives Energy Trust presented in the RFP and presented in Section 1. While Energy Trust has a commercial facing program and a residential facing program that supports efficient grow lights purchases, our findings revealed that the grow light market does not always neatly fall under the commercial and residential headings. For example, manufacturers produce grow lights for both sectors and retailers sell to both home growers and commercial enterprises. Therefore, we present results from the data sources under the broad headings of the research objectives. We bolded the key takeaways from each finding and provide details in non-bolded text.

3.1 Establish Current Baseline of Efficiency, Price, and Market Share for LED Grow Lights by Sector

Findings in this section are informed by feedback from trade allies, retailers, manufacturers, and business growers as well as by an estimate of program penetration into the market. Information from all sources indicates that LEDs dominate the grow light market: they make up nearly all the interviewed manufacturers' product and the vast majority of retailer and trade ally grow light sales. Information from retailers and trade allies suggests this is in large part attributable to the Energy Trust incentives. Without incentives, LEDs are about twice the price of HIDs, according to retailers, or about four times the price, according to trade allies. The incentives bring the cost of LEDs down considerably, the importance of which is seen in the fact that Energy Trust incentives are included in the majority of trade allies' grow light projects. While LEDs make up 90% or more of current grow light sales, however, they appear to have just under two-thirds of the share of total canopy of cannabis under grow lights. The business grower survey data suggests that more than one-third of the canopy lighting is older HID lighting and the current dominance of LEDs in new purchases suggests that a large share of this HID lighting is old equipment yet to be upgraded.

3.1.1 Manufacturer Interviews

Manufacturer respondents were all focused on grow lights, which were almost exclusively LEDs. None of the four interviewed manufacturer contacts reported making products other than grow lighting. One of the four indicated that about five percent of their grow lights were something other than LED and the other three reported all their grow lights were LED.

3.1.2 Residential Program Phase One Retailer Interviews

Participant retailer respondents represented sites across Energy Trust service territory, with a mix of indoor and outdoor grow services, mostly, but not always, serving residential cannabis growers. Table 3-1 shows that four respondents represented sites in the Portland area and three were in Southern Oregon and one represented the Willamette Valley. Three mostly focused on indoor growing, three served a mix of indoor and outdoor growing operations, and two focused on outdoor growing operations. Six of the nine reported mostly serving cannabis growers with their grow light products, with two indicating high percentages (≥80%) of these cannabis growers were purchasing for personal use and two reporting half or less were for personal use.

Table 3-1: Retailer Characteristics

ID	Location	Indoor/Outdoor Focus	Percent of Customers That Are…	
			Cannabis Growers	Personal Use/Residential
Ret1	PDX	Entirely or nearly entirely indoor	80%	50%
Ret2	Southern OR	Mostly outdoor	90%	25%
Ret3	PDX	Mostly indoor	75%	80%
Ret4	Will. Valley	About equal indoor and outdoor	75%	90%
Ret5	Southern OR	Mostly outdoor	75%	Don't know
Ret6	Southern OR	About equal indoor and outdoor	33%	70%
Ret7	PDX	Mostly indoor	<50%	>90%
Ret8	PDX	Not reported	Not reported	<50%
Ret9	PDX	About equal indoor and outdoor	75%	50%
		Mean	**72%**	**63%**

LEDs are the dominant lighting types sold by participating retailers; most LEDs receive incentives from Energy Trust and, without incentives several participant retailers reported they would not sell many LEDs. LEDs are about twice the price of HIDs without incentives according to retailers. The addition of the incentives brings the cost of LEDs down considerably. As discussed in Section 3.3.1, according to several respondents, incentives are a key reason why LEDs are the dominant grow lighting type compared to HIDs and fluorescents in Oregon (Table 3-2). Furthermore, retailers did not report a difference in the number of HID compared to LED fixtures needed for a grow space.

Table 3-2: Grow Light Sales by Energy Trust Retailer Respondent

ID	Grow Light Sales by Lighting Type			Perc. of Grow Lights Incented by Energy Trust	Ratio of LED/HID Price (no Incentives)	Average Number of Fixtures Purchased by Retailer Customers
	LED	HID (HID, MH)	Fluorescent			
Ret1	90%	10%	0%	90%	2	9
Ret2	95%	4%	1%	75%	2	4
Ret3	90%	10%	0%	80%	2	9
Ret4	95%	5%	0%	95%	2.2	3
Ret5	95%	5%	0%	90%	2.9	6
Ret6	84%	1%	15%	70%	2.7	1.5
Ret7	45%	45%	10%	70%	1.75	2
Ret9	99%	<1%	<1%	98%	2.5	4.5
Mean	**87%**	**10%**	**3%**	**84%**	**2.2**	**4.9**

3.1.3 Residential Program Phase Two Retailer Interviews

The respondents represented residential program respondents and nonparticipants, sites across Energy Trust service territory, with a mix of indoor and outdoor grow services, mostly, but not always, serving cannabis growers. Table 3-1 shows that four respondents were participants that were interviewed in

phase one of this research, three were participants that were not interviewed in phase one, and six were nonparticipants, four of which were outside of Energy Trust territory.[8] Six represented sites in the Portland area, three were in Southern Oregon, two were in the Willamette Valley, one was in Eastern Oregon, and one was in Central Oregon. Most respondents represented stores that focused on indoor growing. Most respondents estimated that 80% or more of their customers were using their grow lights for growing cannabis, as opposed to house plants, vegetables, or flowers.

Table 3-3: Retailer Characteristics

ID	Respondent Type	Region	Store Located in Energy Trust Territory	Indoor/Outdoor Focus	Perc. of Customers that are Cannabis Growers
Participants					
Ret1	Follow-up, Phase1	Will. Valley	Yes	About equal in. & outdoor	80%
Ret4	Follow-up, Phase1	Portland Metro	Yes	All or nearly all indoor	DK
Ret9	Follow-up, Phase1	Southern Or.	Yes	Mostly outdoor	85%
Ret10	Follow-up, Phase1	Portland Metro	Yes	All or nearly all indoor	90%
Ret5	New interview	Southern Or.	Yes	Mostly outdoor	95%
Ret7	New interview	Portland Metro	Yes	Mostly indoor	90%
Ret8	New interview	Portland Metro	Yes	Mostly indoor	95%
				Mean	89%
Nonparticipants					
Ret2	Nonparticipant	Eastern Or.	No	About equal in. & outdoor	90%
Ret3	Nonparticipant	Will. Valley	No	Mostly indoor	80%
Ret6	Nonparticipant	Portland Metro	No	Mostly indoor	50%
Ret11	Nonparticipant	Central Or.	Yes	All or nearly all indoor	40%
Ret12	Nonparticipant	Portland Metro	No	Not answered	Not answered
Ret13	Nonparticipant	Southern Or.	Yes	About equal in. & outdoor	50%
				Mean	**62%**

Most respondents represented single store retailers. Of the 12 respondents that addressed the size of their business, nine represented a single store. Of the other three, one represented one store in Oregon and reported their firm had nine other stores, mostly in California. Another of the three represented two stores in Oregon, and the third represented a firm with two stores in Oregon and 28 stores located in twelve other states.

[8] The research team used the Oregon Department of Energy Find Your Utility tool to identify if the respondent site was in PGE or Pacific Power territory. If they were not in those territories, the team considered them outside Energy Trust territory.

Energy Trust residential program participants stock, sell, and generate most of their grow light revenue from LED grow lights whereas nonparticipants generally are stocking and selling other types of grow lights, if they sell grow lights at all. shows that LEDs represented a higher percentage of participant than nonparticipant respondents' lighting stocks (72% versus 33%), sales (88% versus 25%), and revenues (88% versus 26%). The colors in show how participants and nonparticipants differ in what they stock and sell with participants generally stocking and selling LEDs whereas nonparticipants stocking and sales practices varied. One nonparticipant respondent (Ret6) stocked only fluorescents and reported occasionally ordering other lighting types for customers. Another respondent (Ret11) reported equal amounts of stock by lighting type but in the last year, sold only HPS lights. One nonparticipant (Ret12), located close to but not in Energy Trust territory, reported that they had not stocked or sold any grow lights since 2020 because they were not generating enough sales to continue fstocking them.

Table 3-4: Reported Percentage of Grow Lights by Units in Stock, Units Sold, and Revenue

ID	Stock				Sold Units				Revenue			
	LED	CMH	HPS	Flu.	LED	CMH	HPS	Flu.	LED	CMH	HPS	Flu.
Participants												
Ret1	70%	10%	10%	10%	93%	3%	3%	3%	93%	3%	3%	3%
Ret4	80%	0%	20%	0%	80%	0%	20%	0%	80%	0%	20%	0%
Ret5	20%	30%	20%	30%	80%	10%	5%	5%	80%	10%	5%	5%
Ret7	65%	10%	25%	0%	85%	5%	10%	0%	85%	5%	10%	0%
Ret8	93%	1%	5%	1%	97%	1%	1%	1%	97%	1%	1%	1%
Ret9	75%	8%	15%	3%	85%	3%	10%	3%	85%	3%	10%	3%
Ret10	100%	0%	0%	0%	98%	1%	1%	0%	98%	1%	1%	0%
Mean	**72%**	**10%**	**16%**	**6%**	**88%**	**3%**	**7%**	**2%**	**88%**	**3%**	**7%**	**2%**
Nonparticipants												
Ret2	25%	10%	65%	0%	5%	5%	90%	0%	5%	5%	90%	0%
Ret3	35%	0%	10%	55%	66%	0%	0%	33%	66%	0%	0%	33%
Ret6	0%	0%	0%	100%	8%	13%	0%	80%	8%	13%	0%	80%
Ret11	25%	25%	25%	25%	0%	0%	100%	0%	0%	0%	100%	0%
Ret12	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Ret13	80%	0%	15%	5%	50%	15%	30%	5%	50%	15%	30%	5%
Mean	**33%**	**7%**	**23%**	**37%**	**25%**	**8%**	**44%**	**24%**	**26%**	**7%**	**44%**	**24%**

Participants reported that Gavita and Photobio LED lights were their most popular sale items, and nonparticipants, if they sold enough grow lights to be able to comment, reported a variety of lighting types as their best-selling fixture. On average, participants are mostly selling incented LED lights, and all other lights they sell are generally in small quantities and they are often just trying to sell off whatever non-LED lights they still have in inventory with no intention of restocking non-LEDs. Two of these participants elaborated that they sell to customers from outside their region because they are able to sell incented lights. Participants reported their most popular lights sold for $650 to $1,300 without rebates, averaging about $800 per unit. Nonparticipants, when they sell enough grow lights to be able to assess this, reported selling a variety of lighting types but they appear to be small starter lights like clone strips, not larger lights (Figure 3-1). Additionally, three nonparticipants noted they have limited or no sales of grow lights because of their inability to compete with stores that offer incented lighting.

Figure 3-1: Best Selling Fixture by Type, Non-incented Prices

ID	LED	CMH	HPS	Fluorescent
Participants				
Ret1	**Growers Choice 720w, 42in. x 42 in., $699 to $799**	Sunsystem, $100	Gavita sunsystem, Ballast $125-50	Sunsystem Sunblade, All sizes
Ret4	**Gavita RS 1900, 650w. 43 in. x 45 in., $650**	n/a	Efinity or Iluminar, $250	n/a
Ret5	**Photobio, 680w, MX 48 in.x 48in., $700-$800**	Growers Choice, 315, 48in. x 48 in. $379.	Gavita SL2, $400	Agrobrite FL248, T5 with 8 bulbs.
Ret7	**Ion 830, 48 in. x 48 in., $815**	Lux 315w, 36 in. x 36 in., $100	Ion 1000w 48in. x 48 in., $120	n/a
Ret8	**Gavita 1900, 650w. 43 in. x 45 in., $800 - $850**	Whatever is still in inventory.	Whatever is still in inventory.	Whatever is still in inventory.
Ret9	**Photobio MX 650w, 48 in. x 48 in., $1,100** **Photobio CX 850w, 12 in. x 24 in., $1,300**	Sunsystem, 315w, $275	Phantom 1000w 12 in. x 24 in., $400	Whatever is still in inventory.
Ret10	**Gavita 1900E, 680w. 45 in. x 45 in., $700-$900**	n/a	n/a	n/a
Nonparticipants				
Ret2	None.	Phantom Nanolux Summit or Gavita.	Summit series, $310.	None, bulbs only.
Ret3	**Gavita clone strip, 2 pack, $70**	n/a	n/a	Sunblaze 4, Single tube, $30
Ret6	Photon Tech, 700w, 48 in.* 48in., $700	Nanolux and Sunsystem w/ remote ballast, 315w & 630w.	n/a	**Sunblaster CFL kit, 125w, $60**
Ret11	None.	None.	None.	None.
Ret12	None.	None.	None.	None.
Ret13	**Gavita and Fluroflex clone strip, 18-32w, 2 pack, $70-$150**	No fixtures	Ushio and Sunsystem, 1000w, 24 in. x 6 in.	Sunblaze, 48in. x 20 in., $220-$260

Bold lettering indicates the most popular grow light sold.

Participants reported that, without incentives, their grow light business in general would decrease and that customers would be less inclined to switch to newer, more efficient lighting. Of the seven participants, one reported they were going out of business at the end of 2024 so incentive changes would have no bearing on their business. Of the remaining six participants, all reported that their business would decline without lighting incentives, but they differed in their comments about how much of an effect it would have. For example, one respondent claimed that the sales incentives "carried us through the winter," implying that without incentives, they may not have stayed in business. In contrast, another respondent reported that, without incentives, their business would decline but was not sure how much of an overall effect it would have on the business. A third respondent expects incentives to decrease which will in turn reduce the number of customers they currently receive from outside their area. This

respondent, located in the Portland area, reported that the incentives have increased their customer base by attracting customers from outside the Portland area.

Two respondents reported that, without grow lighting incentives, customers would keep existing technology longer. According to these two respondents, the incentives encourage customers to adopt more efficient LED lighting sooner than they would without incentives.

Most nonparticipants reported that incentives would help them sell grow lights. Four of the six nonparticipants reported that incentives would help them sell lights. One nonparticipant located in Eastern Oregon, noted that their store is located near a large commercial cannabis operation that purchases discounted lights in Portland instead of ordering from their store. This respondent further elaborated saying that incentives "made [their customers] leave their communities and go spend their dollars somewhere else." A nonparticipant located in the Eugene area reported that grow light incentives may help them sell more grow lights, but they expressed some hesitation in that prediction because "the damage" of the incentives on nonparticipants has been done. According to this respondent most growers in their area have upgraded to LEDs by purchasing incented grow lights from outside Eugene and the big transition from old inefficient lighting technology to new efficient lighting technology has mostly happened already.

3.1.4 Business Program Trade Ally Interviews

Trade allies represented a variety of business types and they varied in their program activity, the types of customers they serve, and the customer building types they worked in. Most trade ally respondents (5 of 8) described themselves as consultants. All respondents varied in their specialty area, with three focusing on incentives, two focusing on agriculture operations, two focusing on grow light use and operations and one being a general contractor. Some allies completed one project through the program and others have done more than 10 projects, resulting in millions of kWh savings. Almost all respondents reported their grow site customers were solely or primarily growing cannabis and the building types of their customers varied between warehouses and greenhouses (Table 3-5). Only two respondents reported selling equipment directly to customers for self-install.

Trade allies reported that almost all their grow light projects are LEDs despite the added cost of LEDs compared to HIDs. Of the eight respondents, seven reported that 100% of their grow light projects are LED and one electrician reported that more than 90% of their grow light projects are LEDs. Only four of the eight could estimate a price difference between HIDs and LEDs, in part because allies are almost exclusively completing LED projects. Those four respondents estimated that LEDs cost about four times as much as HIDs for a 100 square foot (10-foot by 10-foot) space. These respondents indicated that a grower would need about the same number of four-foot LEDs as HIDs for this 10x10 space. Three of the respondents reported needing four lights for this space, with each four-foot light supporting 25 square feet of canopy, and one reported needing five or six lights for the space.

Table 3-5: Trade Ally Characteristics

ID	Description		Program Activity				Customer Use of Grow Lights		Customer Site Types	
	Type	Specialty	# of Program Projects	2023 Savings	2019-2023 Savings (kWh)	2019-2023 Savings (kWh) per Project	% Cannabis	% Non-Cannabis	Greenhouse	Warehouse
TA1	Consultant/Distributor	Ag. ops.	1	-	125,550	125,550	0%	100%	100%	0%
TA2	General contractor	None	2	118,031	118,031	59,016	100%	0%	100%	0%
TA3	Consultant	Incentives	1	287,758	287,758	287,758	100%	0%	0%	100%
TA4	Electrician	Ag. ops.	1	144,336	144,336	144,336	50%	50%	25%	75%
TA5	Consultant	Incentives	17	113,337	1,692,904	99,583	100%	0%	20%	80%
TA6	Consultant/Distributor	Incentives	19	-	12,149,573	639,451	80%	20%	<50%	>50%
TA7	Consultant/Distributor	Grow lighting	13	831,620	912,742	70,211	90%	10%	30%	70%
TA8	Manuf./Distributor	Grow lighting	-	-	-	-	80%	20%	80%	20%
					Mean	**285,757**	**75%**	**25%**	**51%**	**49%**
					Weighted Mean		**88%**	**12%**	**37%**	**63%**

Energy Trust projects constitute a relatively small part of most allies' total revenue, but most allies indicated that the majority of grow light projects they work on receive Energy Trust incentives. The latter is in part because they tell customers about the incentive opportunities. Of the eight trade ally respondents, four reported that customers occasionally (3 respondents) or rarely (1 respondent) asked about Energy Trust incentives. One each reported customers frequently or very frequently asked about incentives and two could not address this topic. Almost all respondents reported they tell customers about Energy Trust incentives. The one exception was the electrician that specialized in agricultural operations (TA4). This respondent reported that the Energy Trust program paperwork and administrative requirements were too onerous for the potential benefit of participating (Table 3-6).

Table 3-6: Energy Trust Incentives

	Percent of revenue from Energy Trust projects in last year	Percent of grow light projects that received Energy Trust incentives	Frequency Customers Ask About Energy Trust Incentives	Frequency Allies Tell Customers About Energy Trust Incentives
TA1	<5%	100%	Occasionally	Very frequently
TA2	1%	100%	Rarely	Very frequently
TA3	5%	15%	Don't know	Very frequently
TA4	<5%	<5%	Frequently	Rarely
TA5	100%	100%	Don't know	Very frequently
TA6[1]	0%	0%	Occasionally	Very frequently
TA7	100%	100%	Occasionally	Very frequently
TA8	60%	60%	Very frequently	Very frequently
Mean	**35%**	**60%**	-	-

[1] Respondent reported not completing any Energy Trust projects in the last year.

3.1.5 Business Program Grower Survey

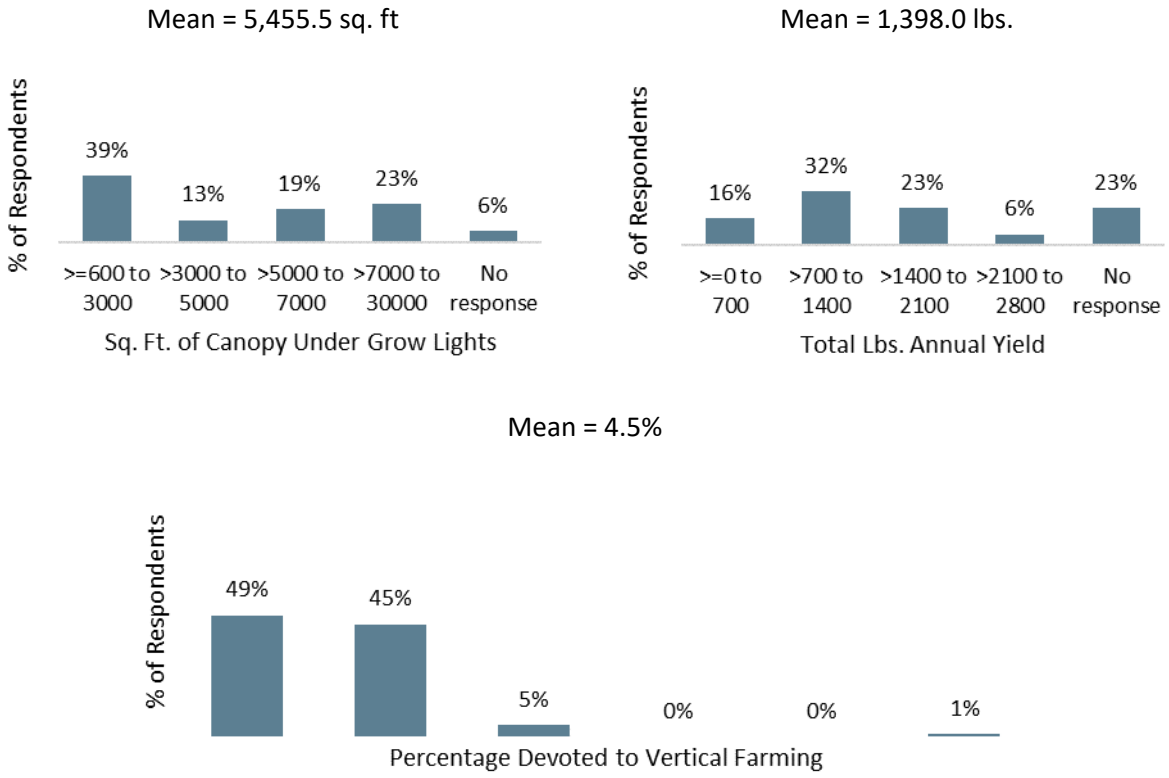
Responses from the business grower survey indicate that LEDs have just under two-thirds of the share of total canopy of cannabis under grow lights. The fact that LEDs make up nearly all reported trade ally grow light sales suggests that the non-LED canopy lighting is older lighting (mostly HID) that is yet to be upgraded. Given that nearly 90% of grow space is cooled, most of it cooled year-round, the relatively high proportion of canopy area that currently is under HID suggests that achieving a large increase in LED share could reduce the heat generated from non-LED lighting and, therefore, the cooling load.[9] However, it is

[9] It is likely that growers do year-round cooling to dehumidify their grow spaces. By using LEDs instead of HID, growers could potentially use less cooling load to dehumidify or they could use dedicated dehumidifiers instead of cooling systems that also dehumidify.

also the case that nearly 60% is heated, and so replacing HIDs with LEDs could increase heating needs during heating season, which is about 6 to 8 months out of the year on average.[10]

Business grower respondents varied in terms of the amount of canopy under grow lights they possessed and total annual cannabis yield that came from that canopy, with a mean of 5,455.5 square feet under grow lights and 1,398.0 pounds of annual yield (Figure 3-2). Note, however, that nearly one-quarter of respondents did not report total annual cannabis yield.[11] About half use vertical farming methods: of those, most devote 20% or less of their grow space to that method.

Figure 3-2: Business Grower Characteristics (n = 31; unweighted data)[1,2]



[1] Note the relatively large percentage of nonresponse for total annual yield.

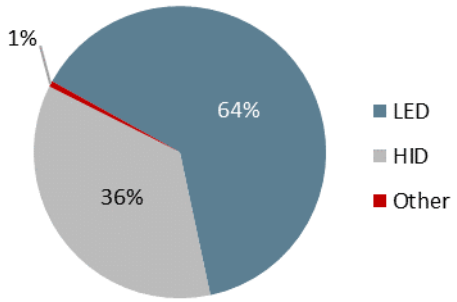
[2] For the mean of area of canopy and total annual yield, we replaced missing data with a value estimated with linear regression based on the relationship between the two variables.

[10] Whether or not the increased heating load would offset reduced cooling load would depend on a variety of factors, including the type of heating and cooling employed, the overlap between hours of lighting use and heating/cooling, and local climate, among others.

[11] There does not appear to be a strong relationship between the area under grow lights and total yield. Among those who reported both, the ratio of the two varied widely, from 0.67 to 60 square feet of lighting per pound of cannabis produced. Moreover, on average, those who reported yield reported more area under canopy (8,500 sq. ft.) than those who did not report yield (4,760 sq. ft.), further weakening any conclusions about the relationship.

Business growers reported that LEDs represent the lion's share of both canopy and fixtures. LEDs represent about two-thirds of canopy area (Figure 3-3), and the distribution is essentially identical for fixtures. The LED share was inversely related to total area of canopy under grow lights, and the HID share was positively related to the total area. Specifically, when we split respondents into those at or below the median canopy area under grow lights and those above the median, we found that on average, LEDs made up 88% of the first group (less area under grow lights) and 70% of second group (more area under grow lights), and HIDs made up 11% for the first group and 29% of the second group. Although this difference did not quite attain statistical significance,[12] it nevertheless supports the decision to weight response data by canopy area so that the results reflect the total area represented by survey respondents.

Figure 3-3: Lighting Types Share of Canopy Under Grow Lights (n = 31; data weighted by canopy sq. ft.)[1]

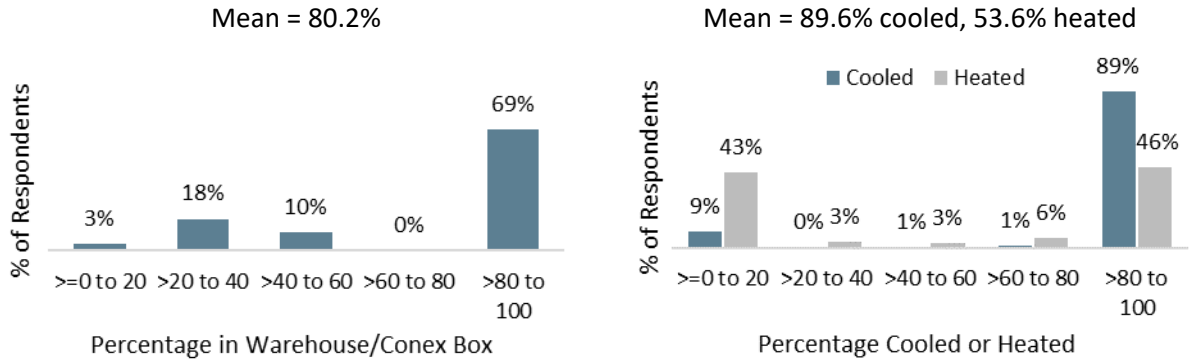


[1]The break-down by number of fixtures is nearly identical to that by canopy.

According to business growers, a very large share of grow space is fully indoors, most of which is cooled and somewhat less than half of which is heated. Across all respondents, an average of 80.2% of grow space is fully indoors, requiring grow lights (Figure 3-4). That percentage is inversely correlated (r = -0.51) with the area of canopy under grow lights: That is, the greater the area of canopy under grow lights, the lower the percentage of that canopy that is fully indoors. On average, 89.6% of the fully indoors space is cooled. Heating varies much more than cooling, with 53.6% of indoor space heated, on average.

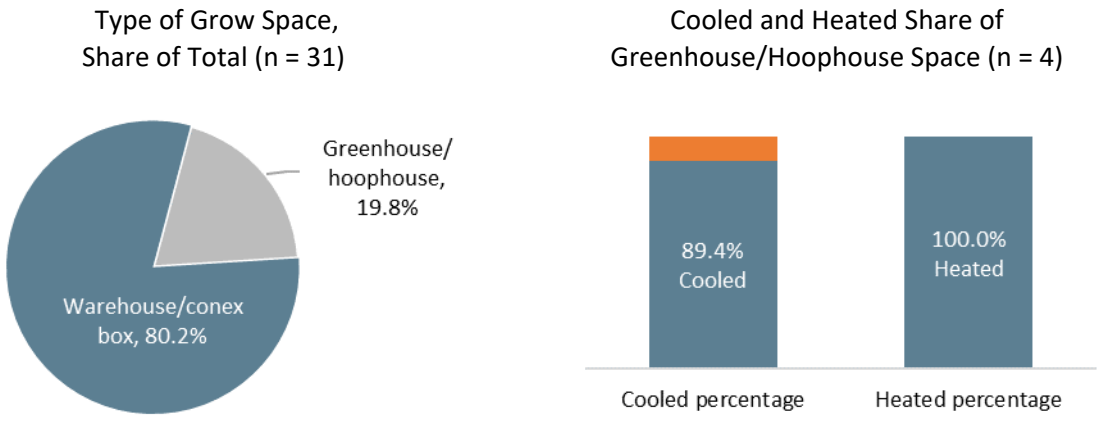
[12] For this comparison, t = 0.62, p = .09. The relatively small sample size offers relatively low power for detecting moderate differences.

Figure 3-4: Warehouse Type Grow Space Heating and Cooling (n = 31; data weighted by canopy sq. ft.)



Four business grower respondents reported any grow space in greenhouses or hoophouses, which may use grow lights as a supplement to natural light. Averaging across all respondents (and weighting by total canopy area), those types of space make up 19.8% of grow space. Across the four respondents who reported grow space in greenhouses or hoophouses, 89.4% of that space is cooled and 100% is heated (Figure 3-5). Taking all the above factors into account, **89.6**% of grow space is cooled and **62.8% is heated.**

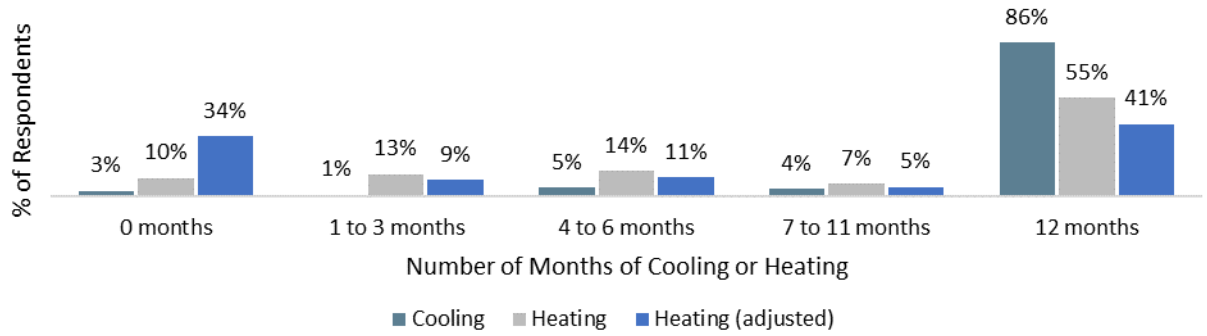
Figure 3-5: Distribution of Grow Space by Type, and Cooled/Heated Share of Greenhouse/Hoophouse Space (data weighted by canopy sq. ft.)



A large majority of respondents reported cooling their grow space year-round, with a mean of 11.1 months across all respondents (Figure 3-6). The reported number of months of heating grow space varied much more, with a mean of about 8.2 months. However, about one-quarter of respondents did not report the number of months of heating. All but one of those respondents reported 12 months of cooling. One possible interpretation of this pattern is that those respondents assumed it would be understood that they did not heat their grow space at all if they cooled it year-round. When we assume zero months of heating for respondents who did not report heating but reported 12 months of cooling, the mean number of months of heating drops to 6.1.

Figure 3-6: Months of Heating and Cooling (n = 31; data weighted by canopy sq. ft.)

Mean = 11.1 months cooling, 6.1 to 8.2 months heating[1]



[1] About one-quarter of respondents (data weighted by canopy sq. ft.) did not report months of heating, all but one whom reported 12 months of cooling. This figure shows the reported months of heating, including all nonresponse, as well as the adjusted months of heating, which assumes zero months of heating for nonrespondents who did not report heating but reported 12 months of cooling.

3.1.6 Estimate of Program Penetration

Any market baselines must apply to the market as a whole. The feedback from manufacturers, retailers, and trade allies all confirmed that LEDs dominate grow light sales. The business grower survey indicated that LEDs have just under two-thirds of the share of total canopy of cannabis under grow lights. The fact that retailers and trade allies generally said that most grow light sales receive Energy Trust incentives suggests that most of the non-LED grow lights may be lights that have not recently been replaced. An estimate of the program's penetration of cannabis growers would provide some information on the potential for additional sales of LED grow lights.

We carried out two estimates of program penetration: 1) the program share of all licensees within Energy Trust territory; and 2) the program share of total OLCC licensed indoor cannabis production within Energy Trust territory. In both cases, we defined "Energy Trust territory" as the electric service territory of Energy Trust's funding utilities.

3.1.6.1 Program Share of Licensees within Energy Trust Territory

As noted above, we identified 113 unique program participants that received support for custom projects. Dividing this count by the total number of unique licensees within Energy Trust territory provides the first estimate of program penetration.

During the preparation of this report, ADM downloaded the OLCC list of approved marijuana licensees,[13] which identified 1,385 current licensees across the state. Excluding those with zero indoor canopy, those

[13] https://www.oregon.gov/olcc/marijuana/Pages/Recreational-Marijuana-Licensee-Reports.aspx. Accessed September 3, 2024.

with expired licenses, and those duplicating other records with indoor canopy[14], we identified 741 unique, current licensees with nonzero indoor canopy. However, the addresses of cannabis licensees is exempt from public disclosure under ORS 475B.541(1)(a), and so those addresses were not included on the OLCC list and, thus, could not be used to determine which of the 741 licensees were within the service territory. The list *did* show the county each licensee was located in, so we excluded 116 licensees in counties that were entirely, or nearly entirely, outside of Energy Trust territory: Baker, Columbia, Grant, Harney, Lane, and Malheur. This left 625 licensees in counties *partly or completely* within the Energy Trust service area. To estimate how many of those 625 licensees were within the service territory, we: 1) estimated the proportion of each county's sites that were likely within the service territory; 2) calculated the proportion of all 625 licensees located in each of those counties; and 3) computed the sum of the products of those two proportions for each county. The result, 0.75, gave us the estimated proportion of the 625 licensees within the service territory, which equated to 469 unique, current licensees with nonzero indoor canopy.

If there are 469 licensees within the service territory, the count of 113 unique program participants represents a penetration rate of about 24% (Table 3-7). If the concentration of licensees within the service territory is greater than we estimated – if, say, there is a greater concentration of licensees near population centers, which were often located within the service territory, than we assumed – then there may be more than 469 licensees within the service territory, which would reduce the penetration estimate. As a lower bound, program penetration would be 18% if all 625 licensees in the counties partly or completely within the service territory are themselves within the service territory. However, if licensees within a county are disproportionately located outside of the service territory, then the penetration rate within the service territory would be greater.

Table 3-7: Estimated Program Share of Unique Cannabis Licensee in Energy Trust Service Territory

Parameter	Quantity
Number of unique, current licensees with nonzero indoor canopy	741
Number of counties entirely, or nearly entirely, outside of Energy Trust territory	6
Number of licensees in those 6 counties	116
Number of counties at least partly inside Energy Trust territory	30
Licensees in those 30 counties	625
Mean proportion grower sites inside Energy Trust territory, in those 30 counties	0.75
Estimated number of licensees inside Energy Trust territory	469
Number of unique program participants	113
Program participants' percentage of licensees inside Energy Trust territory	24.1%

3.1.6.2 Program Share of Indoor Cannabis Production within Energy Trust Territory

We also attempted to estimate the program share of total OLCC licensed indoor cannabis production. The survey asked respondents to report total annual yield of dry/cured cannabis but did not ask them to report

[14] We checked for duplication on license number, licensee name, trade name, licensee contact phone number, or licensee contact email address.

yield specifically from indoor production. We therefore estimated each respondent's total indoor production using the reported total annual yield and the reported percentage of total canopy space that is fully indoors.[15] Eight respondents did not report total annual yield. The mean indoor canopy area for those eight respondents (7,571 square feet) was greater than that for the other respondents (4,885 square feet). Therefore, failing to account for those eight respondents likely would underestimate the mean total indoor yield across all 31 respondents. We estimated the indoor yield for each of those eight respondents by multiplying their reported indoor canopy area by the mean ratio of indoor yield to indoor canopy area across the other 23 respondents.[16]

The above produced a mean indoor production of 1,409 pounds per respondent. Survey respondents are representative of the program population on location and program participation indices (Table 2-7 in Section 2.4.2). Assuming they also are representative of production levels produces an estimated a total of 159,188 pounds of total annual dry yield for the Business Lighting program participants. (We discuss this initial assumption further below.)

Calculating the denominator for this estimate of penetration presented two challenges: 1) the OLCC reports wet production,[17] not dry yield; and 2) the OLCC data are not broken out by county.

We addressed the first challenge with information from a variety of sources that indicate that the weight loss from drying ranges from 75% to 80%.[18] The OLCC reported a total of 2,634,862 (wet) pounds of indoor cannabis production for 2023, covering both recreational and medical cannabis sales. Taking the midpoint of 75% and 80% weight loss, this corresponds to 592,844 pounds of dry production.

The second challenge meant that we could not perform the same type of county-by-county analysis described above for the estimate of program share of licensees. In particular, we could not begin by excluding all the cannabis production from those counties that are entirely, or nearly entirely, outside of the service territory. Instead, we divided the estimated count of unique, current licensees with nonzero indoor canopy within the service territory (469) by the statewide count of unique, current licensees (741) to estimate the proportion of statewide production that is within the service territory (0.63). Applying these to the statewide estimate of 592,844 pounds of dry production yields an estimated 375,228 pounds within the service territory.

[15] This was not calculated as a straightforward percentage of total annual yield multiplied by the indoors share of canopy space, as indoor canopy generally yields higher production than outdoor space. One source (https://crophouse-seedbank.com/indoor-vs-outdoor-cannabis-growing/) puts the ratio at about 1.25 : 0.75. We therefore adjusted the indoor share using that ratio. Specifically, where x = the reported percentage of grow space that is indoors and y = the percentage of yield from indoor grow space, $y = 1.25x / (1.25x + (1-x)0.75)$.

[16] We examined the possibility of using linear regression. However, the regression of indoor yield on indoor canopy area was nonsignificant ($F[1,20] = 0.43$, $p = .52$). As there was no apparent relationship between indoor yield and indoor canopy area, we deemed the mean ratio between the two to be the most reasonable approach to estimating one from the other.

[17] https://www.oregon.gov/olcc/marijuana/Pages/Marijuana-Market-Data.aspx.

[18] For example, https://www.icmag.com/threads/wet-weight-v-dry-weight-with-w-o-stems.160771/.

If the above estimate of 159,188 pounds of total annual dry yield for program participants is accurate, it represents about 42% of total OLCC-licensed facility indoor dry yield within Energy Trust's service territory (Table 3-8). That estimate is 1.76 times the estimated program share of licensees (24%).

Table 3-8: Estimated Program Share of Total Indoor Cannabis Production in Energy Trust Territory, Assuming Production Levels Reported in Survey Are Representative of all Participants

Parameter	Quantity
Number of unique participants	113
Mean indoor dry/cured production for survey respondents (pounds)	1,409
Program total indoor dry/cured production (pounds)	159,188
Total OLCC-reported wet indoor cannabis production for 2023 (pounds)	2,634,862
Estimated weight loss from drying (midpoint of range)	77.5%
Estimated total dry statewide indoor cannabis production for 2023 (pounds)	592,844
Estimated prop. of statewide cannabis production within Energy Trust service territory	0.63
Estimated total dry cannabis production within Energy Trust service territory (pounds)	375,228
Program share of total dry cannabis production within Energy Trust service territory	42.4%

Two factors could contribute to why the program share of production is so much greater than the program share of licensees. First, program participants may, on average, produce more cannabis than do nonparticipants. Second, it is possible survey respondents, on average, produce more cannabis than do participants who did not respond to our survey. If this were the case, then the mean indoor production from our sample may overestimate that for participants as a whole, which would mean the above estimate of program share of production is inflated.

The licensee dataset obtained from OLCC does not include annual cannabis production data – that was provided in aggregate only. We examined whether data on indoor canopy space from the OLCC list of approved licensees could be used as a proxy for indoor cannabis to address these possibilities.

We attempted to match the businesses on the OLCC list to the list of program participants on business name (either the Licensee or Trade Name in the OLCC list), contact name, contact phone, or contact email address. As noted in the introduction to this section, the addresses of cannabis licensees is exempt from public disclosure under ORS 475B.541(1)(a), and so those addresses were not included on the OLCC list and we could not be used to match the OLCC to the participant list. We started by assessing exact matches, and then followed up with visual examination of the businesses in the participant data that did not match any record in the OLCC data. We were able to match 89 of the 113 uniquely identifiable participants, including 30 of the 31 survey respondents, to the 741 unique licensee in the OLCC list.

Several considerations argue for caution in interpreting the results of the analyses of the OLCC data, discussed below. First, the fact that we were unable to match 24 participants, including three survey respondents, to the OLCC list means that 24 of the 652 unmatched licensees (3.7%) apparently are participants. Therefore, the 89 known participants must be compared to 652 licensees, most of whom are nonparticipants but 24 of whom are participants. This would dilute any difference by a small amount. Second, the 652 unidentified licensees are not limited to Energy Trust territory, as the OLCC list did not provide sufficient data to limit this analysis to Energy Trust territory. Third, the comparison of survey respondents and nonrespondent participants excludes three licensees, with an unknown impact on the

results. Fourth, indoor canopy area is not necessarily a very good predictor of indoor yield: among the 30 survey respondents identified in the OLCC list, the correlation between the OLCC-identified indoor canopy area and the survey-reported cannabis yield was modest (r = 0.25). Finally, the OLCC figures do not correlate well with what survey respondents reported (r = 0.23). On average, survey respondents reported about 30% more indoor canopy than what was identified for them in the OLCC data, but the difference between the survey-reported and OLCC-identified numbers varied widely. In aggregate, the difference between two groups in yield should be reflected at least to some degree by a difference in canopy space, but the magnitude of the difference in canopy space may not accurately reflect the magnitude of the difference in yield.

The mean reported indoor canopy area of the 89 identified participants (7,730 square feet) was about 1.6 times that of the 652 remaining uniquely identified licensees (4,864 square feet).[19] If the 24 unidentified participants are more similar to the identified participants than to the nonparticipants, then this analysis slightly underestimates the indoor canopy area difference between participants and nonparticipants, but the amount of overestimation has very little impact on results.[20]

Can the difference between participants and nonparticipants in indoor canopy space (a ratio of about 1.6) explain the difference between the program share of production and the program share of licensees (a ratio of about 1.5)? Possibly not. Given the much larger number of program nonparticipants than participants, we estimate that participants would need to have more than three times the mean level of indoor cannabis production as nonparticipants to account for the difference between the program share of production and the program share of licensees. This is shown in Table 3-9.

Table 3-9: Estimated Ratio of Participant and Nonparticipant Mean Indoor Cannabis Production

Parameter	Quantity
Estimated number of unique licensees in Energy Trust territory (see Section 3.1.6.1)	625
Number of unique participants	113
Mean indoor dry production for survey respondents (pounds)	1,409
Program total indoor dry production (pounds)	159,188
Estimated total dry cannabis production within Energy Trust service territory (pounds)	375,228
Estimated nonparticipant total dry cannabis prod., Energy Trust service territory (pounds)	216,039
Number of unique nonparticipant licensees in Energy Trust service territory	512
Mean indoor dry production for nonparticipant (pounds)	422
Ratio of participant to nonparticipant mean indoor dry cannabis production	3.34

[19] Note that the 652 unidentified licensees is statewide, not limited to Energy Trust territory. The information in the OLCC list was not sufficient to reliably conduct this analysis only for sites within Energy Trust territory.

[20] Where x is the mean indoor canopy for nonparticipants, 96.3% of unmatched businesses are nonrespondents, and 3.7% of unmatched businesses are respondents, 0.963x + (0.037 * 7,730) = 4,864.2. Therefore, 0.963x = 4,864 – (.037 * 7,730) = 4,864.2 – 284.5 = 4,579.7, and so x = 4,579.7 / 0.973 = 4,754.7. This increases the ratio between participants and nonparticipants from 1.58 to 1.63.

Again, indoor canopy area is not a perfect predictor of total yield. It is possible that, for some reason, program participants, on average, generate greater yield per square foot of indoor canopy than do nonparticipants. However, the currently available data do no allow an assessment of that possibility.

As noted above, an alternative hypothesis is that our survey respondents, on average, had higher-than-average indoor cannabis production than nonresponding participants, inflating the estimate of program share of production. Analysis of the OLCC indoor canopy data do not support this hypothesis. The 30 licensees identified as survey respondents in the OLCC list had *less* indoor canopy space, on average (6,482.4 square feet), than the 59 participants not identified as survey respondents (8,364.4 square feet).

Notwithstanding the above, the modest correlation between canopy area and yield means that it is still possible that survey respondents *do* produce more cannabis, on average, than do nonrespondents. However, the mean annual indoor production by survey respondents would have to be more than twice that of nonrespondents to account for the difference between the program share of licensees and the program share of indoor production. This is illustrated by Table 3-10. The middle column shows the current estimate of program share of production (42%), which does not assume any difference between respondents' and nonrespondents' mean production levels. The right column shows how the estimate would be affected by using the same survey data but assuming that survey respondents, on average, produce twice as much cannabis as do nonrespondents. This scenario is needed to produce an estimate of program share of production that approximates the program share of licensees.

Table 3-10: Estimated Program Share of Total Indoor Cannabis Production in Energy Trust Territory, Under Different Assumptions of Respondents' and Nonrespondents' Mean Production

Parameter	Assumed Difference Between Survey Respondents and Nonrespondents	
	No Assumed Difference in Production	Respondents, On Average, Have Twice as Much Production as Nonrespondents
Respondents' mean yield	1,409	1,409
Number of respondents	31	31
Respondents' total yield	43,671	43,671
Nonrespondents' mean yield	1,409	704
Number of Nonrespondents	82	82
Nonrespondents' total yield	115,517	57,759
Total yield, all participants	159,188	101,430
Share of service territory (375,228 lbs.)	42.4%	27.0%

It may be that the best explanation of the difference between program share of production and program share of licensees is that program participants produce more cannabis than nonparticipants *but also* that the survey respondents produce more cannabis than nonrespondents, and so the estimated participant total was inflated. For example, if we assume that survey respondents' mean indoor cannabis yield is 50% higher than nonparticipants' mean yield, rather than twice as great, that generates a total participant yield of 120,683 pounds. Inserting that into the analysis shown in Table 3-9, reduces the ratio of participant to nonparticipant mean indoor dry cannabis production from 3.34 to 2.15. While still high, this begins to approach a believable difference.

Based on the above, it seems most reasonable to suggest the program accounts for **more than 24% and, at most, about 42% of total OLCC-licensed facility indoor dry yield.**

Given the limitations identified above concerning the use of OLCC data on indoor canopy space, however, the above analysis probably is not sufficient to draw a firm conclusion. Additional research that includes data collection from program nonparticipants may be needed.

3.2 Understand the Sales Cycle of LED Grow Lights

To understand the sales cycle of LED grow lights, we asked manufacturers, retailers, and trade allies to reflect on the sales process, their customers, and trends they see in the market for LED grow lights.

3.2.1 Manufacturer Interviews

The manufacturer respondents had been in business for no more than 14 years with two of the three reporting they began business soon after states began legalizing cannabis, with one started manufacturing in 2016 and the other in 2019. One of the respondent companies was spun off from an existing automotive lighting company.

Respondents generally sold to business growers with smaller percentages of their sales going to retailers or home growers. One respondent estimated that 93% of their sales were to business growers, another estimated 80% went to business growers, and the third could not provide a percentage but reported that all their sales went to either business growers or retailers. No respondent reported sales to distributors.

Manufacturers varied in their perceptions of sales trends.

- **Most manufacturers' products are eligible for Energy Trust incentives, and they all reported paying attention to national trends in available rebates**. Manufacturers reported they regularly review what rebates are available in the country and they target their marketing efforts based on incentive availability. For example, one respondent noted that a utility in Colorado announced they were lowering incentives for grow lights so the manufacturer launched a campaign to alert their Colorado customers and stakeholders of the incentive change and to encourage growers to purchase lights before the incentives decreased.
- **Perceptions about the popularity of vertical farming vary.** Two respondents reported an increase in sales of grow lights suitable for vertical or multilevel operations and one reported seeing a decrease in this product because, according to this respondent, vertical farming is too difficult to manage the grow environment including air flow and humidity.
- **Customers are reluctant to add controls to projects:** One manufacturer reported that growers used to be interested in controls but recently there has been less interest in controls. They did not elaborate as to why this change was occurring.
- **There are more lights per order**. One respondent reported seeing an uptick in the number of lights a customer purchased per order compared to a year or two ago.
- **Retrofit dominates the cannabis growing market, currently.** One respondent reported there is little new construction happening for cannabis growers. Currently, sales are mostly going to the retrofit market.

- **Digital marketing dominates the marketing approach of manufacturer respondents**. All manufacturers noted a heavy reliance on social media for their marketing approach. Other marketing approaches included attending trade shows (2 mentions), email blasts (2 mentions), and reaching out to past customers (1 mention). Additionally, one manufacturer, that also happened to be a trade ally, reported more personalized and targeted marketing to agriculture and incentive specialists to tell them about their lights.

3.2.2 Residential Program Retailer Interviews

Some customers work to get around the two lights per day limit at retail stores. Program rules in 2024 limit each customer to two incented lights per day yet, according to respondents (Table 3-2), most customers, on average, are purchasing closer to five incented lights. According to retailers, customers get around the limitations by purchasing two lights per day till they reach their desired amount or by partnering with a friend that purchases lights on their behalf.

Retailers varied in their estimates of how often customers ask about incentives and they did not vary in how often they inform customers about incentives. All retailer respondents reported telling customers about incentives "very frequently" (Table 3-11).

Table 3-11: Frequency Customers Ask About Incentives and Retailers Inform Customers of Incentives

	How frequently customers ask about incentives?	How often retailers inform customers about incentives?
Never	0	0
Rarely	1	0
Occasionally	3	0
Frequently	1	0
Very frequently	2	7

3.2.3 Business Program Trade Ally Interviews

All trade allies reported they largely acquire grow light customer projects via personal relationships in the industry, not via advertisements or marketing. Of the eight respondents, seven reported they got grow light projects because of their relationships with other trade allies, electricians, or others in the industry and one reported acquiring grow light projects because he had worked with a business grower site on other agriculture, non-lighting, projects. Five of the eight respondents reported their firms use general marketing tactics like social media and advertisements to announce their services. However, in all cases, respondents reported relying more on referrals than marketing to identify grow light projects.

The type of trade ally and their specialty corresponds with why their customers hired them. The four trade allies that specialized in agriculture operations or grow lighting specifically reported being hired to help business growers with production problems such as a need to increase yield or reduce heat in a facility. Similarly, business growers hired incentive specialists to help identify the best incentives available for a potential project and to assist with the administrative aspects of applying for incentives.

Five allies reported challenges working with the Energy Trust program.

- An incentive consultant and a grow light specialist mentioned that the preapproval process can be onerous to explain to customers that want to start a project immediately.

- One agriculture operations specialist reported difficulties using the lighting tool and specified that if it was not for the assistance offered by program implementers, he would likely not bother offering the program to customers.
- An electrician reported the program is not suitable for licensed electricians because they cannot compete with non-electricians when it comes to labor rates for projects. According to this respondent, cannabis grow light specialists can do these projects for less than licensed electricians.
- Another incentive consultant indicated that the incentive amounts and the requirement to pay up front and then get reimbursed with the incentive can be problematic for some customers because they are unable to wait for reimbursement.

3.3 Understand What Lighting Efficiency and Performance Metrics Are Most Important for Cannabis Growth

We asked retailers, trade allies and business growers to reflect on the features and benefits they see in using LED grow lights, including characteristics such as efficiency and spectral performance.

3.3.1 Residential Program Phase One Participant Retailer Interviews

According to retailers, customers ask about a variety of characteristics about grow lights and retailers, similarly, emphasize a variety of characteristics. Cost and dimming were what customers most commonly asked about and efficiency and cost were what retailers emphasized (Table 3-12).

Table 3-12: Grow Light Characteristics that Customers Ask About and Retailers Emphasize (n=9)

Grow Light Characteristics	What do customers ask about?	What do retailers emphasize?
Cost	6	3
Dimming	4	0
Efficacy	2	0
Spectral Quality	2	2
Efficiency	2	4
Heat (HID v LED)	2	2
Ease of use	1	0
Compatibility with controls	1	1
Quality/Warranties	0	2
Ask about what they are growing	0	1

Retailer respondents identified these key trends related to the sales of grow lights.

- **Energy Trust incentives are important to LED adoption**. Three retailers reported that Energy Trust incentives were a key reason why LEDs are so prevalent among growers in Oregon. One retailer that has sites in other states noted that their LED sales in those other states is negligible compared to LEDs sales in Oregon and he attributed that difference to incentives. Another respondent estimated that his store "would sell 10% of the lights we do now without the program."
- **Increased interest in smaller growers**. Three retailers indicated there has been an increase in interest in indoor growing. One of these retailers reported regularly serving customers wanting

30-40 items in the past whereas now there are more folks purchasing from him that want two to four lights for a home. Another respondent stated that "a lot of new people are getting into growing."

- **LEDs have become standard**. Commensurate with the sales data in Table 3-2 that shows most participant retailers mostly sell LEDs, two respondents specified that LED grow lights have recently become the standard lighting choice in the state.
- **Under canopy lights**. Two respondents noted that some growers have begun to ask about or adopt under canopy lighting. This strategy, where lighting is directed at plants from above and below the canopy, can increase cannabis yields by ensuring light hits most of the plant, not just the top.
- **Controls**. One respondent reported seeing an increase in interest in controls, specifically sunrise and sunset controls that adjust lighting based on sunlight.

3.3.2 Residential Program Phase Two Participant and Nonparticipant Retailer Interviews

Purchase price is the most important factor to customers when considering grow lights, according to most retailers. Of the 11 retailers that reported what customers considered when purchasing grow lights, 10 ranked purchase prices as the most important factor and one respondent reported the durability of the equipment was most important. The second and third most important factors varied by respondent with no factor receiving more than three respondent choices (Table 3-13).

Table 3-13: Most Important Factors Customer Consider When Purchasing Grow Lights

Factors	Most important	Second Most Important	Third Most Important
Purchase price	10	0	0
Durability	1	3	2
Wattage	0	3	2
Color spectrum	0	1	3
Warranty	0	2	1
Operating costs	0	1	2
Heat output	0	1	0
Dimming	0	0	1

Retailer respondents reported that their customers purchasing lights for a residential building generally purchase about two lights per transaction and they almost always purchase the same kinds of lights. Participant and nonparticipant respondents did not differ much in their responses. No respondent reported a customer purchasing more than five lights and the most common responses were a range from one to three lights. All respondents reported that they never or very rarely would sell two different types of lights to a customer.

Most retailers struggled to answer how many of their customers purchase lights that are about 700w and four feet by four feet in size for use in commercial versus residential-type spaces. The team asked about this size light because it is the most common light size incentivized by the Energy Trust program. Of the seven participants, three could provide an answer and of the six nonparticipants, three provided an

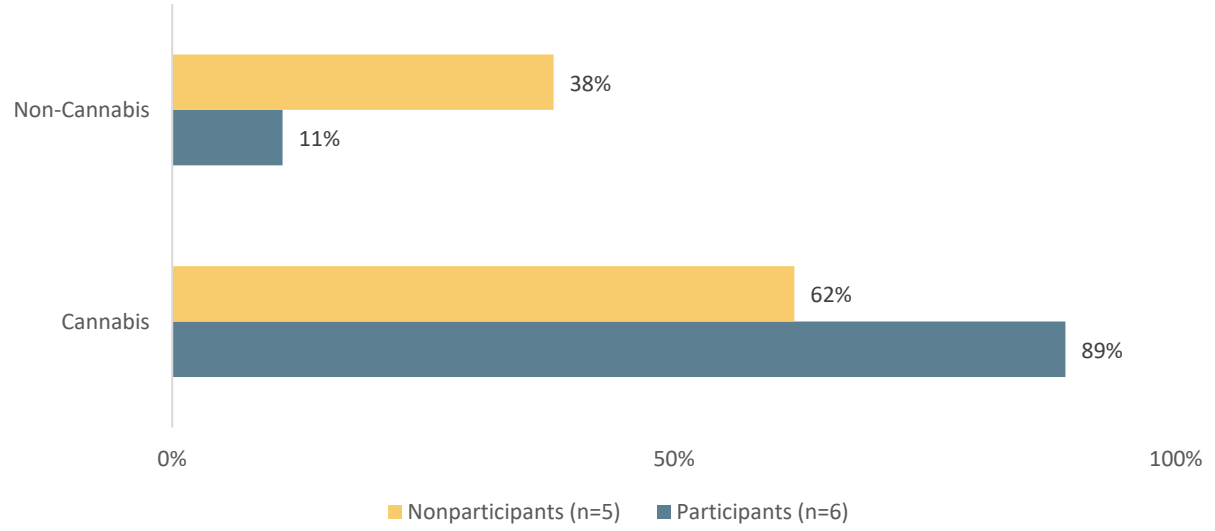
answer. The seven respondents that could not assess their customer's facility type stated things like "I have no idea. I don't really ever go out to anybody's facility" and another respondent reported there was "no commercial [operation] running out of a residential [structure]." Those six that did answer the question generally reported that about half their customers were purchasing lights for a commercial structure (e.g. warehouse) and about half were purchasing for a residential structure (e.g. house, Table 3-14). These respondents reported a high degree of confidence in their estimates with five of the six reporting a "10" on a scale where one is not confident and ten is very confident in their estimate. These results should be interpreted with caution as interview respondents can fall prey to social desirability bias – that is, they answer questions in a way that they presume will gain approval from others, including the interviewer.

Table 3-14: Percentage of Customers Using Lights in Commercial vs. Residential Structures

	Commercial Structures	Residential Structures
Participants		
Ret7	50%	50%
Ret9	50%	50%
Ret10	0%	100%
Nonparticipants		
Ret6	50%	50%
Ret11	0%	100%
Ret13	40%	60%

On average, all retailer respondents estimated that about three-quarters of their customers were using their grow lights for cannabis and about one-quarter for houseplants, fruits, or vegetables. These percentages vary by participation status with nonparticipants reporting fewer customers growing cannabis (62%) than participants (89%) (Figure 3-7).

Figure 3-7: Percent of Customers Growing Cannabis vs. Non-Cannabis



Under-canopy lighting and changes in environmental controls for growing spaces, like dehumidification, were the most reported emerging technological shifts in the industry reported retailers. Four retailers reported that under canopy lighting, light directed from below the plant canopy, is an emerging trend among some cannabis growers. One retailer described under canopy lighting as a method to "put more weight" on plants and another noted that manufacturers are starting to promote under canopy lighting as a method to increase plant yield and quality.

Four retailers mentioned that recent changes in controlling the indoor environment through efficient dehumidification and reducing cooling needs is another emerging trend in the industry. One of these retailers mentioned that there have been dehumidification options for commercial growers but there are far fewer options for small-scale residential growers.

Other emerging trends noted by respondents were a general shift towards efficiency, increased adoption of LEDs, and a move by manufacturers towards more disposable growing equipment. Regarding this last point, this respondent reported that grow lighting has become all-in-one fixtures that when the lamp burns out, the entire fixture needs to be replaced instead of just a bulb or ballast.

3.3.3 Business Program Trade Ally Interviews

Trade allies reported that most grow business growers ask specific and informed questions about the technical potential of grow lights. They ask about performance (5 mentions), durability/warranty (3 mentions), controls (1 mention) and one electrician that specializes in the agriculture industry mentioned that customers "know what they want to install." One mentioned that customers ask about cost and another respondent, one that specializes in incentive processing, reported not knowing enough about horticulture to address this topic.

Six of the eight allies reported being involved in the initial lighting assessment of a project and four of the six provided specifics about their lighting assessments.

- Two grow lighting specialists focus their assessment on the potential improvements in yield that could result from an LED upgrade by examining things like how changes in PPFD will improve crop yields.
- An agriculture consultant focuses his assessment on the overall design of the existing lighting to see if is supports new LEDs, or if they need to re-design the layout to support new LEDs.
- An incentive consultant focuses their assessment on the return on investment and how much energy the customer can save with new LEDs.

Trade allies reported that customers are looking for a variety of features and benefits by installing LED grow lights, however allies suggested that customers are more interested in the benefits than features. An agriculture operations specialist even specified that customers are not interested in lighting features like dimming but are only focused on what benefits, like improved production yields, that new lighting can provide. Table 3-15 displays the features and benefits trade allies reported that customers want from new grow lights. Two respondents, an incentive specialist and an electrician, reported they did not know enough about customer expectations to address this topic.

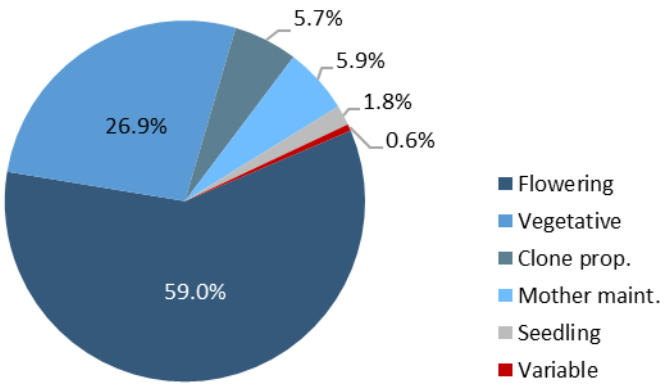
Table 3-15: Features and Benefits Customers Expect from New Grow Lights as Reported by Trade Allies

Characteristics	Count
Features	
Dimming	2
Spectrum	2
Integrate with Controls	1
Reliable	1
Benefits	
Production efficiencies	4
Lower bills	2
Uniform yield	1
Better site aesthetics	1
Lower cooling needs	1

3.3.4 Business Program Grower Survey

The flowering and vegetative stages together make up 86% of the area under grow lights (Figure 3-8). Upwards of two-thirds of the area is devoted to flowering plants and just over one-quarter is plants in the vegetative stage. Most of the remainder is clone propagation, mother maintenance, and seedling. Two respondents reported 9% to 10% of area has varied use (the mean, across all respondents, is less than 1%).

Figure 3-8: Share of Area Under Grow Lights, by Stage (n = 31; data weighted by canopy sq. ft.)

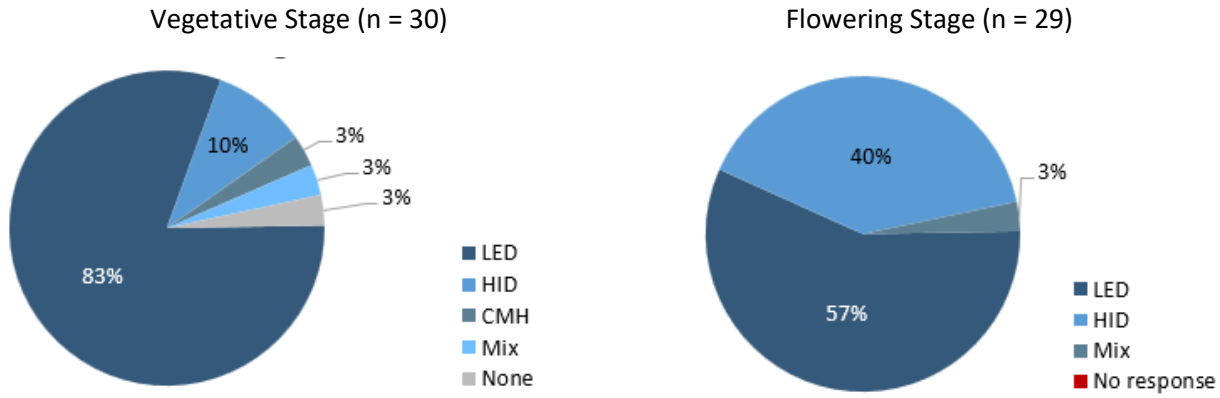


Respondents were asked about the primary lighting type, preferred spectral qualities, and typical PPFD for the vegetative and flowering stages. Questions about the vegetative stage were displayed only to those who reported that any of the area under grow lights was devoted to either vegetative or clone propagation, and those about the flowering stage were displayed only to respondents who reported some area under grow lights devoted to the flowering stage.

LED is the most common lighting type in both vegetative and flowering stages, although it is less common, and HID is more common, in the flowering than vegetative stage (Figure 3-9). The two respondents who reported 0% of their grow space was devoted to the flowering stage, and so were not

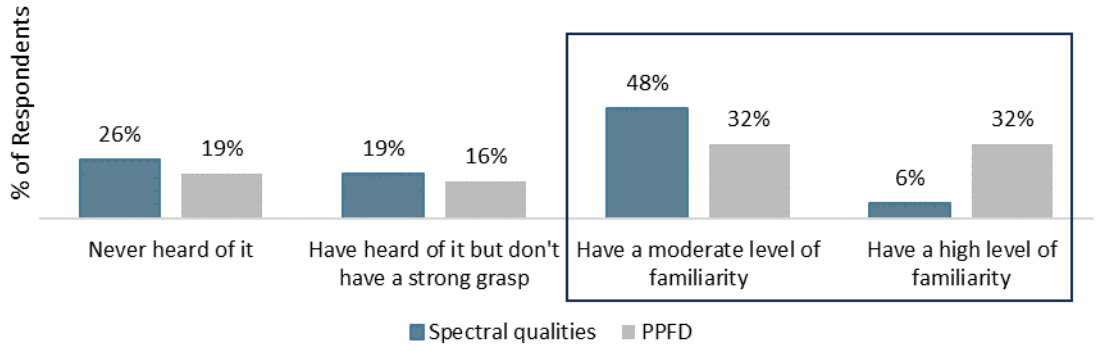
asked about the lighting type for that stage, identified LED for the vegetative stage. A total of eight respondents identified a different type of lighting for vegetative and flowering. There was no clearly consistent pattern across those eight respondents. Four identified LED for vegetative and HID for flowering. Three identified LED for flowering but all identified a different lighting type for vegetative (one each identifying HID, CMH, or a mix of types).

Figure 3-9: Primary Lighting Type for Vegetative and Flowering Stages[1] (data weighted by canopy sq. ft.)



The level of familiarity with the spectral qualities of lighting and photosynthetic photon flux density (PPFD) varies across respondents (Figure 3-10). Familiarity is somewhat higher, in general, for PPFD than for spectral qualities.

Figure 3-10: Familiarity with Lighting Spectral Qualities and Photosynthetic Photon Flux Density (PPFD (n = 31; unweighted data)

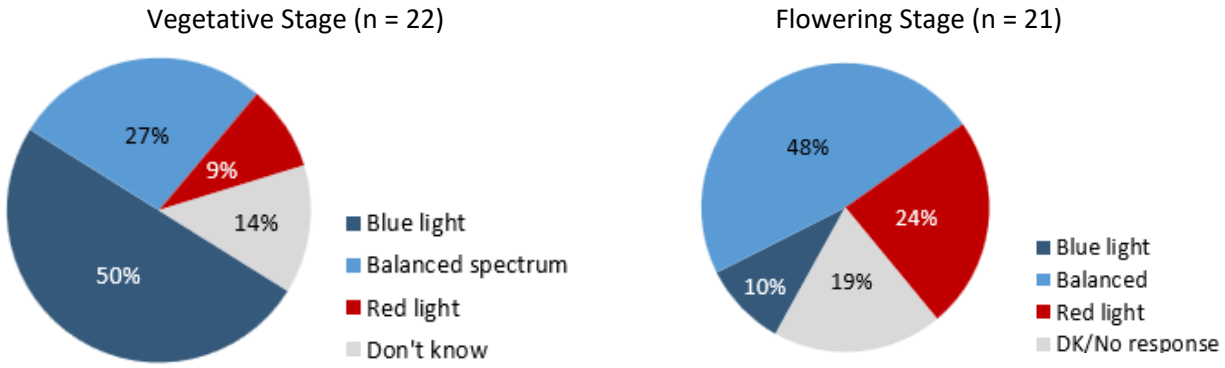


Respondents who reported no familiarity at all ("never heard of it") with the concept of lighting spectral qualities were excluded from further questioning on that topic. Similarly, those reporting no familiarity with PPFD were excluded from further questioning on that.

Among those familiar with spectral qualities, the reported preferences varied for both the vegetative and flowering stages, but the way in which the reported preferences varied was not the same for the two stages (Figure 3-11). Blue light was the most preferred spectrum for vegetative, followed by balanced

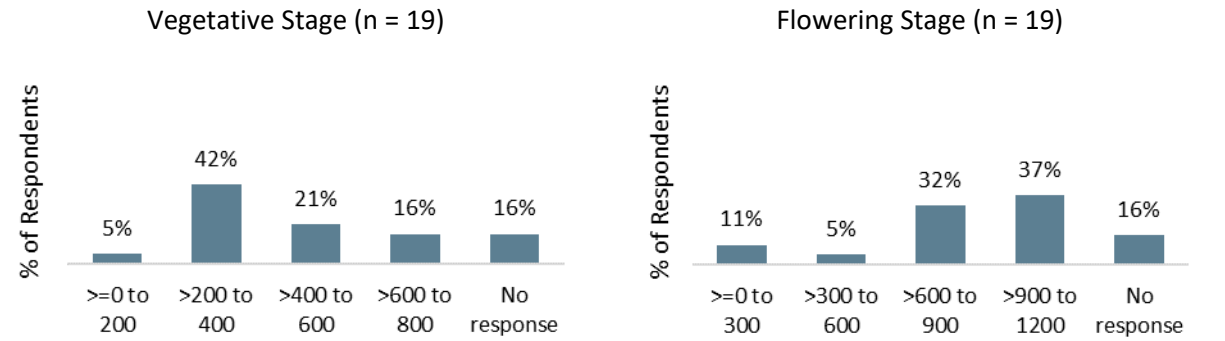
spectrum, while a balanced spectrum was the most preferred for the flowering stage, followed by red light.[21].

Figure 3-11: Preferred Spectral Qualities for Vegetative and Flowering Stage (unweighted data)



The typical PPFD also varied for both stages, among those familiar with PPFD, with the distribution also differing between the two stages (Figure 3-12). In general, lower PPFD was preferred in the vegetative than flowering stage.

Figure 3-12: Typical PPFD in Vegetative and Flowering Stage (unweighted data)



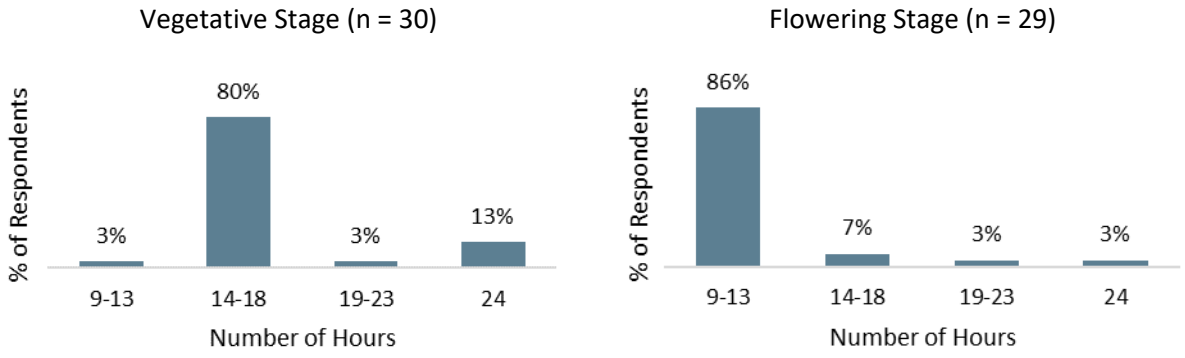
3.4 Learn About Dimming Settings and Installation Information for LED Grow Lights Among Business Cannabis Growers Participating in the Business Lighting Incentive

Grower respondents tended to be very consistent in the reported duration of grow light use in both the vegetative and flowering stage, consistently reporting less use of grow lights in the flowering than

[21] The survey defined blue light as "5500k or higher," balanced spectrum as "around 3500k," and red light as "around 2800k."

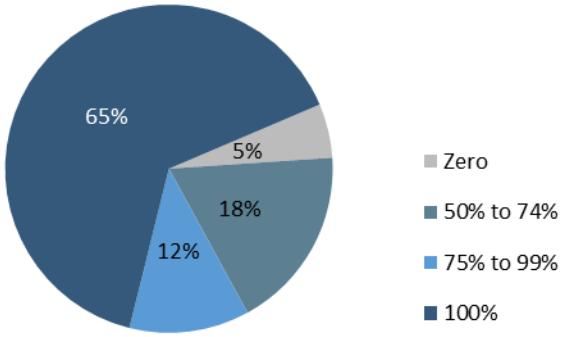
vegetative stage (Figure 3-13). Specifically, a large majority reported using grow lights 14 to 18 hours per day during the vegetative stage and 9 to 13 hours during the flowering stage.[22]

Figure 3-13: Hours of Grow Light Use per Day (unweighted data)



The survey asked respondents what percentage of their grow lights have dimming capabilities. Nearly all (97%) respondents reported having at least some dimmable grow lights, with two-thirds (65%) reporting that all of their grow lights were dimmable (Figure 3-15). Across all respondents, the mean, weighted by canopy area, was about 86%.[23]

Figure 3-14: Percentage of Grow Lights that are Dimmable (n = 31; data weighted by canopy sq. ft.)



Close inspection of the responses suggests that respondents may have varied in whether they interpreted this question as asking what percentage of *all* grow lights or what percentage *just of LEDs* have dimming capabilities. This is revealed by the fact that, for 11 respondents, the low end of the range for the reported dimmable lighting percentage was *higher* than the reported LED percentage.[24] It seems likely that these

[22] Only one respondent reported more grow light use in the flowering stage (19-23 hours) than in the vegetative stage (9-13 hours).

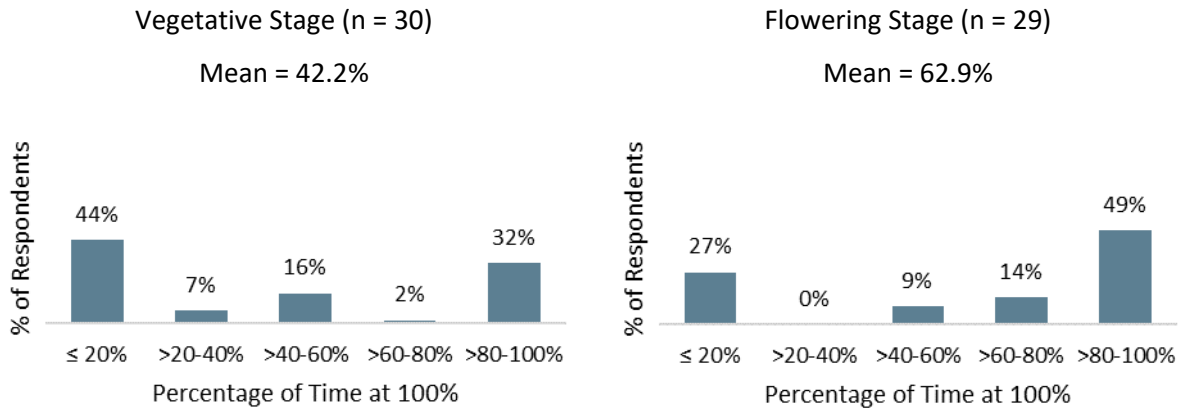
[23] While most questions asking for a percentage were open-ended, this question offered multiple ranges to select from. We took the midpoint of each option to calculate the mean percentage.

[24] Although it appears that there are technologies for dimming HID lamps, this seems to be a specialized application and, therefore, one that likely is not widely used for cannabis cultivation. See: https://www.ecmweb.com/content/article/20886252/hid-lamp-dimming.

respondents interpreted the question as asking about the percentage of LEDs that are dimmable. In the end, it may not matter how the other 20 respondents interpreted the question. Sixteen of those respondents reported that 100% of their lights are LEDs and one reported that 99% are LEDs, and so the question for those respondents is *ipso facto* about the percentage of LEDs that are dimmable. The remaining three respondents reported from 70% to 90% of grow lights are LEDs; all of them reported the dimmable percentage was in the 75%-to-99% range. For these three respondents, then, the dimmable percentage of LEDs may be in that range but it is possible that 100% of their LEDs are dimmable.

Grower respondents reported the amount of time lights were at 100% intensity in the vegetative and flowering stages. Responses varied widely for both the vegetative and flowering stages (Figure 3-15). On average, across all respondents, lights were at 100% intensity about 42% of the time during the vegetative stage and about 63% of the time during the flowering stage.

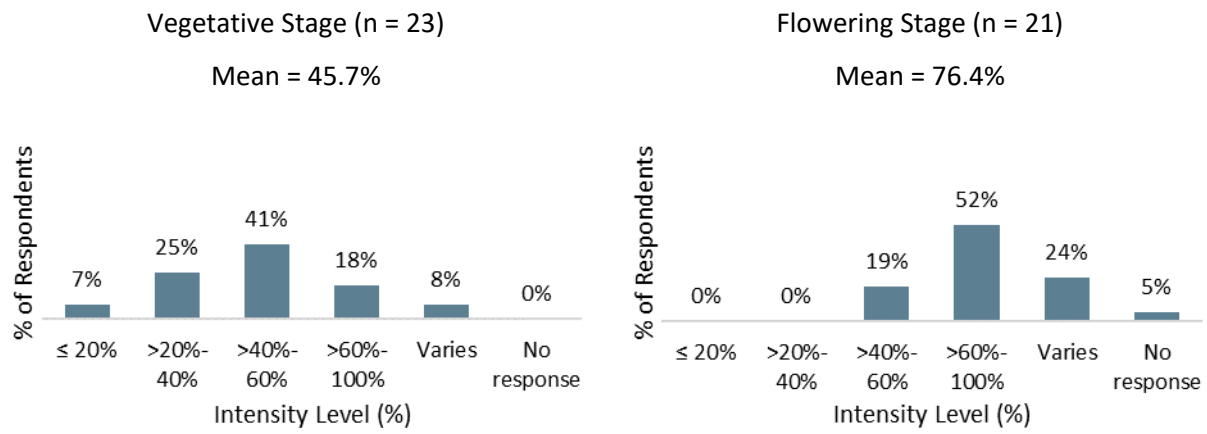
Figure 3-15: Percentage of Time Lights at 100% (data weighted by canopy sq. ft.)[1]



[1] Includes non-dimmable lights.

Similarly, the reported intensity level of dimmable lights for the two stages varied across respondents (Figure 3-16), with an **average intensity of 45.7% during the vegetative stage and 76.4% during the flowering stage.**

Figure 3-16: Intensity Level of Lights (data weighted by canopy sq. ft.)



We calculated the average intensity of all grow lights (dimmable and non-dimmable) during the vegetative and flowering stages. To do this, we summed each respondent's reported percentage of dimmable lights, multiplied by the percentage of time those lights are at 100%, with the percentage of non-dimmable lights. The latter must be at 100% whenever they are in use. Doing this indicates that, using weighted data, **the average intensity of all grow lights is about 66% intensity during the vegetative stage and 71% during the flowering stage.**

3.5 Understand Current Regulatory Landscape for Residential and Business Growers, and Potential for Change or Stability in Coming Years

Our team's experience, connections, and expertise in the cannabis industry identified three potential regulatory changes that would impact the cannabis market in coming years. Each of those regulatory changes, the possibility of a federal rescheduling of cannabis, changes to the Farm Bill, and the Oregon Liquor and Cannabis Commission (OLCC) electricity usage reporting requirements, all can affect growers in Oregon. The sections below describe our team's knowledge and expertise in the cannabis industry and the possible regulatory changes and likely effects of those changes. This section was not informed by interviews with growers, retailers, or manufacturers, but one respondent did mention the possibility of OLCC regulatory changes.

3.5.1 Federal Rescheduling of Cannabis

The federal government currently classifies cannabis as a Schedule I drug under the Controlled Substances Act, which means it has a high potential for abuse and no accepted medical use. However, **the US Drug Enforcement Agency (DEA) is currently in the process of rescheduling cannabis to a less restrictive status, Schedule III**. Rescheduling cannabis to Schedule III would mean it is recognized to have medical use and a lower potential for abuse. This change could significantly impact legal cannabis businesses in Oregon and across the United States. The paragraphs below describe likely effects on the cannabis market in Oregon, should the DEA downgrade cannabis from Schedule I to Schedule III.

Currently, cannabis businesses face difficulties with banking because most banks are federally regulated and do not want to risk dealing with customers who are involved in illegal activities based on federal law. **By the DEA rescheduling cannabis as a Schedule III substance, banks may be more likely to provide**

services to cannabis businesses. This would allow businesses to have better access to loans and other financial services, making it easier to operate and expand. Businesses may use this enhanced financial freedom to retrofit cultivation environments, upgrade lighting equipment, and make other investments related to increasing production efficiencies or expanding production capacity.

Currently, cannabis businesses cannot deduct many business expenses due to IRS Code 280E, which applies to Schedule I and II substances. With 280E liability, many cannabis businesses are taxed up to an 80% effective rate. **By rescheduling, cannabis businesses would be able to deduct normal business expenses, reducing their tax burden and potentially increasing profitability**. Businesses may use this enhanced financial freedom to retrofit cultivation environments, upgrade lighting equipment, and make other investments related to increasing production efficiencies or expanding production capacity.

Interstate commerce of cannabis is illegal due to its Schedule I status, creating isolated state markets. The inability to transfer cannabis products across state lines induces a heavy capital burden of setting up parallel businesses in multiple states. **Should federal authorities reschedule cannabis, businesses may become more confident in expanding their businesses to meet out- of- state demand, knowing that federal interference is less likely (Wilson and Rhee 2022, Clobes and Gagnon, 2023)**.. Although this could lead to a more national presence for many companies, even if cannabis is rescheduled to Schedule III, interstate commerce may remain complicated unless specific federal regulations are addressed. However, the rescheduling could be a step toward future legalization of interstate commerce.

Many cannabis businesses are small and localized due to capital and lending constraints, and the illegality of interstate commerce. **Rescheduling has the potential to attract larger and more thoroughly capitalized companies to the field, including publicly traded entities and those from other industries may enter the cannabis market, leading to mergers and acquisitions of smaller brands.** This could result in a few large companies dominating the market, potentially increasing efficiency but reducing competition. Large, well-capitalized entities may be able to retrofit existing cannabis cultivation facilities with more energy-efficient and feature-rich lighting fixtures than smaller operations.

Overall, in the US, consumer demand for cannabis is growing. Previous studies suggest that social stigma around cannabis use is consistently declining, and that recreational cannabis laws are associated with the increased use of cannabis. **Federal rescheduling could further reduce stigma and increase acceptance of cannabis, leading to higher consumer demand across the US.** Oregon businesses would likely respond by expanding product lines and improving availability across the US. In some cases, business expansion could require changes in cultivation activities (e.g. more harvest cycles per calendar year) or operations efficiency (e.g. optimization of lighting and controlled cultivation environments for maximum yield). Increased consumer demand could directly impact cannabis brands' decisions to retrofit existing cannabis cultivation facilities with more energy-efficient and feature-rich lighting fixtures.

3.5.2 Changes to the Farm Bill and Hemp Growing

The United States Farm Bill is a large piece of legislation that affects many aspects of agriculture. **Recent discussions about changing the Farm Bill could have significant impacts on businesses that cultivate hemp.** Importantly, many businesses in Oregon cultivate both hemp and cannabis, including some of the respondents to the Business Grower Survey. Hemp and cannabis are botanically identical (the same plant species), their only difference is the amount of THC found in the plant. Because of their botanical similarities, indoor hemp and cannabis cultivation practices are identical. Many Oregon hemp and cannabis cultivators begin seedlings indoors (i.e. "under protection" USDA 2024) before transplanting

outside. Likewise, “mother” hemp and cannabis plants are often maintained indoors, and clones of the mother are maintained indoors before distribution or transplanting. Furthermore, many cannabis and hemp varieties are poorly adapted to rainy Pacific Northwest autumns, and they are cultivated in greenhouses with supplemental lighting. One meaningful difference between hemp and cannabis cultivation is scale. The national hemp market is larger than the US market, which means that despite identical cultivation techniques, cannabis cultivation happens at a smaller scale. Understanding how changes to the Farm Bill might affect these businesses is important for predicting the future of the hemp industry (USDA, 2024).

Currently, hemp farmers must follow strict regulations, including pre-harvest testing for THC levels to ensure they stay below 0.3%. **The Farm Bill might relax these regulations, making it easier for farmers to comply with the pre-harvest testing.** This could reduce costs and make operations smoother, allowing businesses to focus more on growing and less on regulatory paperwork. More streamlined operations could incentivize businesses to change their cultivation strategies, producing more hemp and less high-THC cannabis. However, these decisions will likely be balanced by market conditions, as relaxed federal regulations could lead to an increase in the national supply of hemp and more competition.

Hemp farmers have limited access to crop insurance and federal support programs compared to other crops. **If the Farm Bill includes better insurance options and support programs for hemp, farmers would have more security**. This could encourage more investment in hemp cultivation and reduce the financial risks associated with crop failures or market fluctuations.

Many hemp businesses are cautious about expanding due to market instability and regulatory uncertainty. With clearer and more supportive regulations provided by a new Farm Bill, businesses might feel more confident in expanding their operations. This could lead to more investments in new farms, equipment, and technology, including more energy-efficient and feature-rich lighting fixtures.

Hemp businesses often focus on niche markets due to limited product approval and consumer awareness. If the Farm Bill allows for a broader range of hemp products, businesses might adjust their market strategy and target larger markets. This could include more mainstream health and wellness products, textiles, and biofuels.

Hemp is primarily used for CBD products, but also for food, clothing, and building materials. However, the current version of the Farm Bill (which defines hemp products as those with 0.3% delta-9 THC by weight) creates loopholes exploited by the hemp industry. This has led to the emergence of unregulated, potentially harmful cannabinoids like delta-8 THC, HHC, THC-O, and other impairing compounds with effects similar to delta-9 THC. These products lack safety standards and pose health risks, particularly to children.

Changes to the Farm Bill might allow growers to produce new types of hemp products. This could include pharmaceuticals, biodegradable plastics, and even more diverse food products. Greater freedom in product development could lead to a boom in innovation and new uses for hemp. Conversely, experts anticipate that forthcoming changes in the farm bill will close the loopholes which currently permit the production of impairing cannabinoids like delta-8 THC. Advocates suggest regulating all intoxicating hemp products like cannabis, with age restrictions, labeling, and safety measures. Regulatory clarity about which products are permitted and which products are prohibited may lead to greater market stability. Hemp businesses might feel more confident in expanding their operations. This could lead to more investments in new farms, equipment, and technology, including more energy-efficient and feature-rich lighting fixtures.

There is great inconsistency in quality and safety standards for hemp products across different states. Current federal regulations do not require products to be tested by third-party laboratories for impurities or cannabinoid potency. **The Farm Bill could establish uniform national standards, ensuring all hemp products meet the same quality and safety requirements.** This would build consumer trust and help businesses market their products nationwide.

Energy use in hemp farming includes powering cultivation lighting and equipment, harvesting machinery, and processing facilities, which can be costly and resource intensive. **If the Farm Bill includes provisions for energy-efficient grow lights or renewable energy use in agriculture, hemp businesses might invest in energy-efficient lighting fixtures and adopt solar or wind power.** It is also possible that the US will phase out high-pressure sodium (HPS) lighting fixtures, in the same way that Oregon is phasing out fluorescent lighting. One respondent on the Growers' Survey mentioned this possibility. This would reduce energy costs and the environmental footprint of hemp farming, and it could impact hemp cultivators' decisions to invest in more energy-efficient and feature-rich lighting fixtures.

3.5.3 Oregon Liquor and Cannabis Commission's (OLCC) Electricity Usage Reporting Requirements

Section 845-025-1030 of the Oregon Liquor and Cannabis Commission's regulations on Recreational Cannabis require that businesses applying for or renewing an OLCC cultivation license submit a report describing their electricity and water usage. Although OLCC regulations do not specify how this information is used in a licensing determination, presumably electricity use is accounted for in the OLCC's licensing process. Alternatively, the OLCC may use this information to develop a baseline for future energy use.

OLCC regulations are consistently changing and evolving. It is possible that in the future, electricity use could become a more prominent feature of license determinations, with license tiers, fees, or issuance being tied to electricity consumption. Although there has been no formal indication from the OLCC that these changes are on the horizon, there is the potential that applicants with lower electricity consumption could receive preferential treatment (lower license fees, larger allowable canopies, etc.). OLCC licensees are typically well-attuned to the agency's plans, and one respondent on the Business Growers' Survey mentioned this possibility.

3.6 Document Current Knowledge Regarding the Impact of LED Grow Lights on Cannabis Growth or Plant Quality

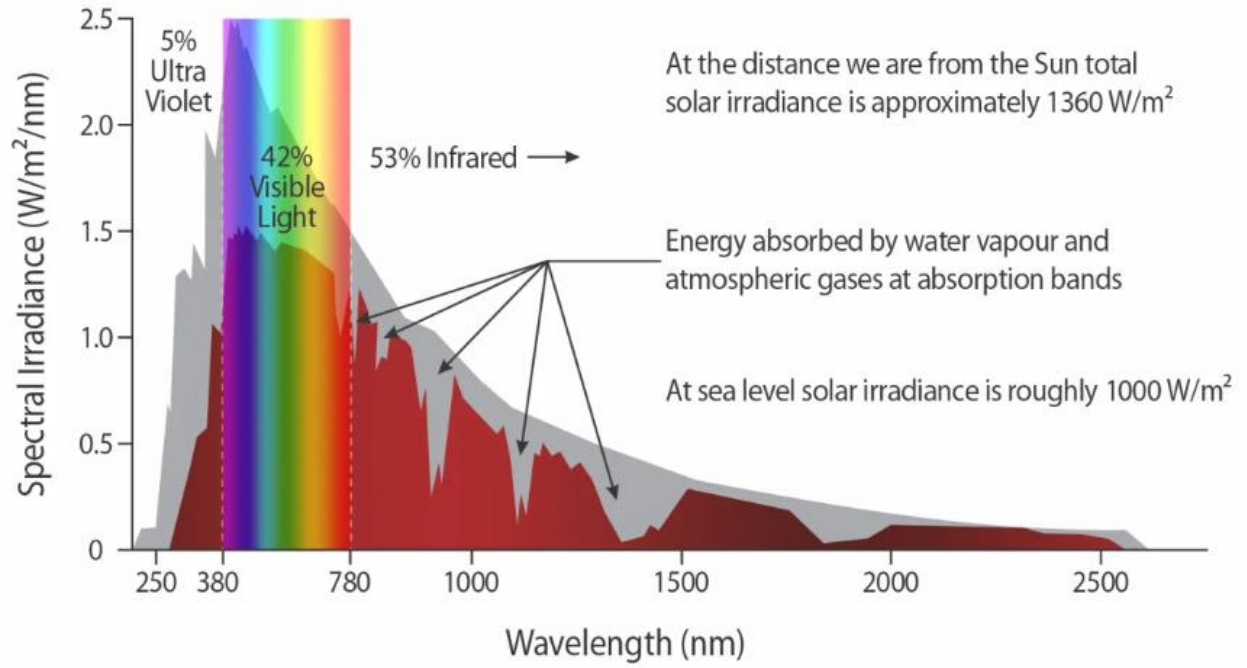
A key task of this evaluation was to conduct a literature review focused on how LED grow lights affect cannabis plant growth and product quality. This section of the report summarizes the results of that literature review with references included in Appendix E.

3.6.1 Background: The Importance of Light for Plant Growth

There are four main stages for growing cannabis from seed to flower. 1) Germination (three to 10 days), 2) Seedling (two to three weeks), 3) Vegetative (two to eight weeks), and 4) Flowering (around eight weeks). Light is crucial for plants in all stages because it affects their growth and development. Light influences photosynthesis, where plants convert light into energy, and other processes throughout a plant's life. About half of the sun's radiation that reaches Earth is visible light, which ranges from 400 to

740 nanometers (nm). This light is essential for plants, along with ultraviolet (UV) light (10-400 nm) and infrared (IR) light (700 nm to 1 mm), which make up the other half of solar radiation.

Figure 3-17: Solar Radiation Spectrum[25]



3.6.1.1 Photosynthesis

Photosynthesis is vital for plant growth. It involves complex reactions where plants use light energy to create carbohydrates, storing it as chemical energy. This process happens in the chloroplasts, which are found in the cells of leaves. Chloroplasts contain structures called thylakoids, where light reactions occur. These reactions involve protein complexes that help produce energy carrier molecules (NADPH and ATP) needed for making carbohydrates.

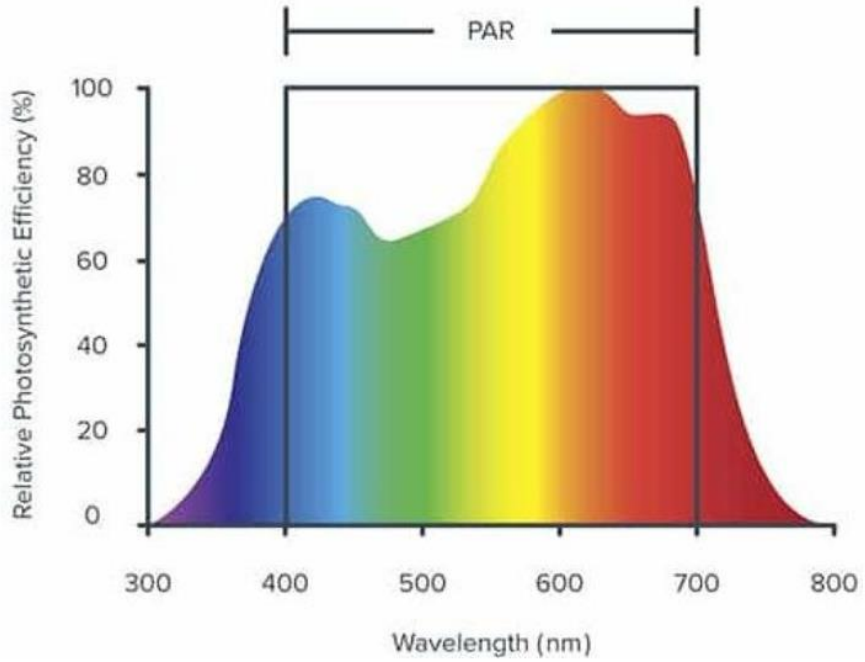
Plants have pigments like chlorophyll that absorb light. Chlorophyll a and b absorb mostly red and blue light. For example, chlorophyll a absorbs light at 430 and 663 nm, and chlorophyll b absorbs light at 453 and 642 nm. Other pigments like carotenoids absorb primarily blue light. For example, carotenoids like β-carotene and lutein absorb light at around 454 and 448 nm. These pigments' absorbance is crucial for photosynthesis, as it allows plants to capture and use light energy.

[25] Solar Radiation Spectrum • SunWind Solar. Accessed September 3, 2024

3.6.1.2 Photosynthetically Active Radiation (PAR)

Understanding the quality of light that plants use is important for indoor cultivation. The range of light that plants use for photosynthesis is called Photosynthetically Active Radiation (PAR). Studies by McCree in the 1970s showed that plants absorb and use light most effectively within the range of 400-700 nm (McCree, 1981). Since then, the scientific community's consensus definition of PAR has been 400-700 nm. Light outside of this spectrum can still impact the way some plants grow, but anything below 400 or above 700 is considered extended PAR or ePAR (Pazuki et al., 2017).

Figure 3-18: Photosynthetically Active Radiation[26]



Although PAR describes the *range* of wavelengths of light that plants need for photosynthesis, there is still the question of *how much* of that light is actually hitting the plant and being absorbed for the purpose of photosynthesis. This is called photosynthetic photon flux density (PPFD). McCree also described the process of quantifying this light intensity, which involves measuring the number of light particles (photons, in micromoles) per square meter, per second (µmol/m^2/s, McCree, 1981). So, PPFD measures the amount of PAR hitting the plant at a specific location and time. In summary, PAR is the type of light, measured in nanometers, and PPFD is how much of that light there is, measured in µmol/m^2/s.

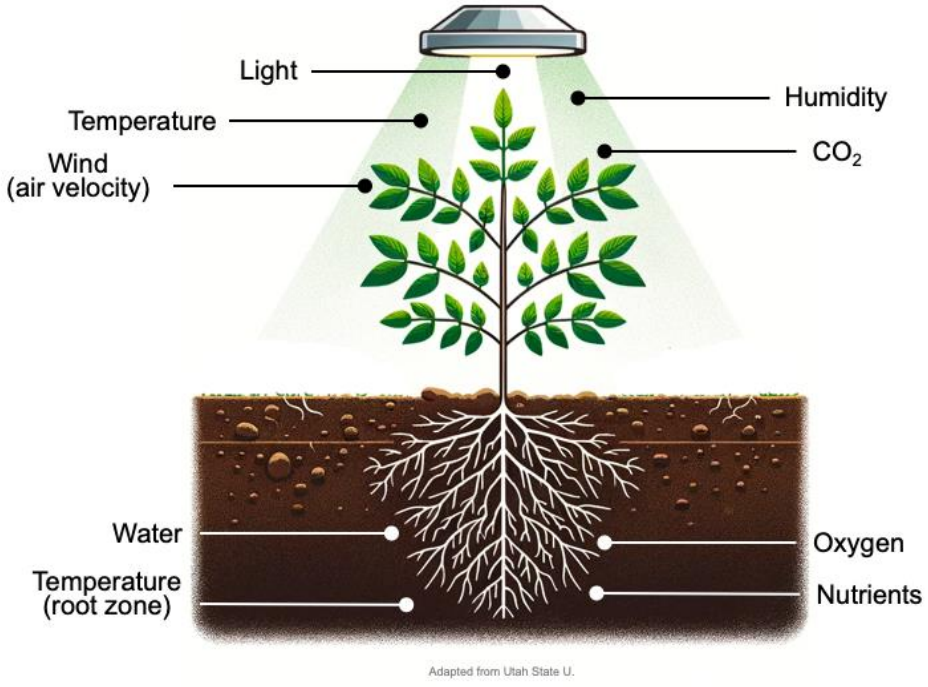
[26] Photosynthetically Active Radiation. Accessed on September 5, 2024. https://www.researchgate.net/figure/The-wavelength-range-of-the-photosynthetically-active-radiation-PAR-Nelson-and-Bugbee_fig5_364386462

3.6.2 Optimizing Growth Starts with Optimizing Light

In general, greater light intensity (or PPFD in µmol/m^2/s) results in faster plant growth, provided that the other eight cardinal parameters of controlled indoor agriculture are in balance. The nine cardinal parameters are:

- Light
- Humidity
- Air temperature
- CO2 in the ambient air
- Air flow velocity
- Root zone water
- Root zone temperature
- Root zone oxygen
- Root zone nutrients

Figure 3-19: Nine Cardinal Parameters of Indoor Plant Growth



When light interception (LI) is increased, plants draw more water from the growing media, they transpire more water through the leaves into the atmosphere, and they require more CO2. Greater LI also generally increases the ambient air temperature due to light fixture operating temperatures. The thermal load of light fixtures is much lower for LED fixtures than HID or metal halide. Nonetheless, even under LED lighting

conditions, increasing LI increases the rate of plant growth, requiring more water input, more cooling, and more dehumidification, as well as more plant nutrition and air movement.

However, **each cannabis cultivation environment is unique, as is each genetic cannabis variety.** Although peer reviewed literature supports the inter-relatedness of the nine cardinal parameters, each cannabis cultivation environment must be tailored after careful observation and optimization with the specific genetic varieties being grown within the environment.

3.6.2.1 Light Compensation and Saturation Points

Plants grow better with increased light up to a certain point. The light compensation point is where the amount of light is just enough for photosynthesis to match the plant's respiration, meaning the plant neither gains nor loses energy. Respiration is defined as a series of enzyme-driven reactions that allow plants to turn the stored energy of carbohydrates made via photosynthesis into a form of energy they can use to grow and produce metabolites such as cannabidiol (CBD) and tetrahydrocannabinol (THC).

Understanding these points helps in providing the right light intensity for plants. If light intensity is below the light compensation point, plants lose energy. If it's above the light saturation point, additional light doesn't increase photosynthesis and may even harm the plant (Rodriguez-Morrison, V. et. al., 2021).

Rodriguez-Morrison found that for at least one genetic variety of cannabis, the typical photosynthetic saturation observed in food commodities or ornamental flowers is somewhat different than results found in cannabis. As measured in the *leaves* during both the vegetative and flowering states, cannabis behaves like other plants in that it can reach photosynthetic saturation in response to increasing light intensity. However, saturation does not occur within the *flowers/buds*: During the flowering stage, cannabis continues to produce flower biomass proportionally (linearly, without a plateau) to light intensity. This is an important consideration because the flowers/buds are the final product which is harvested from the plant. For commercial grows, the cost of increased lighting intensity (electricity) is far outweighed by the increased profit from higher yields (Eaves 2020).

3.6.2.2 Lighting Spectra, Intensity, and Fixture Impacts on Key Cannabis Outcomes

Light directly influences plant development, known as photomorphogenesis. Different wavelengths of light can affect plant height and color, leaf size, flowering, and secondary metabolite production. Few facets of indoor photobiology from other plant species can be generalized to cannabis. Cannabis is one of only six other species which is commercially grown specifically for its glandular trichomes – the other five being tomato (*Solanum lycopersicum*), cucumber (*C. sativus*), sweet wormwood (*A. annua*), tobacco (*Nicotiana tabacum*), and cotton (*Gossypium hirsutum,* Feng, et al. 2021). Thus, specialized research focused exclusively on cannabis is required to fully understand how light and other parameters impact indoor production.

For cannabis producers, there are four key outcomes of interest:

- How quickly the plants can grow (harvest cycle duration)
- The physical appearance of the plant and flower (morphology)
- How much flower/bud biomass they can produce (yield)
- The phytochemical features of the biomass (secondary metabolites such as CBD, THC, and aromatic molecules like terpenes)

The literature review finds that some indoor cannabis lighting practices are supported by peer-reviewed literature, while others remain unstudied and/or unsubstantiated by evidence. Because cannabis has been a Schedule I substance for decades, research barriers have impaired scientists' ability to thoroughly characterize these outcomes. As with any field in its infancy, there are currently conflicting results and major research gaps. Nonetheless, the existing literature supports the following:

3.6.3 Harvest Cycle Duration

Although the growth rate of cannabis is indeed impacted by light intensity (Morello 2022), fast-maturing plants with short harvest cycles are generally optimized through phenotype hunting. That is, rather than increasing light intensity for shorter harvest cycles, growers and breeders seek out seeds and clones from genetic lineages with shorter harvest cycles. Once genetic selections have been made, light and other parameters can be optimized for each genetic variety.

Most varieties of cannabis are photoperiod-dependent, which means that they are sensitive to the duration of the day. When outdoor plants sense that days are becoming shorter (autumn is approaching), they naturally transition from the vegetative state to the flowering state. **In order to shorten overall harvest cycle duration, many indoor cultivators choose vegetative conditions in which plants are exposed to light 24 hours per day.** The current survey results indicate that 13% of respondents engage in this practice. **When the plants are of an optimal size and maturity, shortening the "day" length (reducing the duration of light exposure) forces plants into the flowering stage manually.** Under "24-hour day" conditions (constant light), cultivators must closely monitor plants for nutritional deficiencies and light damage, such as photobleaching or burns.

In addition to day length, harvest cycle duration may be impacted by light spectra. One study has shown that ePAR in the far-red spectra (greater than 700 nm) can delay flowering in cannabis by 12 days, which is an unwanted outcome for most cannabis producers (Kasuma et al., 2021). Although it is unlikely that indoor cultivators would intentionally expose plants to near-infrared light, accidental exposure could occur through night-vision security cameras, which are common in commercial cannabis cultivation facilities (Kusuma et al., 2021).

3.6.4 Morphology

Indoor cultivation of cannabis is often space limited. To maximize LI while balancing energy use, plants are often grown close to the light source: Lights are often height-adjusted or growing platforms are lowered as plants grow taller. Thus, a desirable factor for indoor cannabis cultivation in the vegetative stage is short plants with a high number of lateral branches. Well-respected cannabis cultivators such as Anthony Domangue anecdotally claim that blue-shifted light during the vegetative stage encourages low canopy height (Waggoner 2023), and this commonly held belief is reflected in the grower survey results. **Survey results indicate that Energy Trust incentive recipients do indeed tend to shift their lighting spectrum into the blue range during the vegetative stage**.

Reichel et al. (2021) demonstrated that canopy height can indeed be manipulated by lighting conditions, however the genetic variety of the plants plays an equally important role in the overall height. Thus, similar to phenotype-hunting for fast-maturing plants, growers and breeders may seek out seeds and clones from genetic lineages with shorter canopies and more lateral branching.

For some commercial cannabis growers, the color of the plant is also of market relevance. Specifically, there is high consumer demand for cannabis flower with purple hues, as opposed to green hues (Figure 3-20).

Figure 3-20: Desired Color of Cannabis

The purple hue in many plants such as cannabis and lettuce is produced by anthocyanin, a flavonoid with antioxidative properties that protects the plant against UV damage. Recent research has shown that cannabis plant anthocyanin content varies across genetic varieties, (Bassolino et al., 2023), and can be manipulated by temperature (Kim, 2024). Although other plants such as lettuce can be manipulated by blue+red LED spectra (450 and 660 nm) to produce significantly more anthocyanins and purple coloration (Hooks et al., 2021), this finding has yet to be replicated in cannabis. Nonetheless, grow light manufacturers specifically market certain fixtures with spectral peaks at 450 and 660 nm (blue and red) to enhance anthocyanin content and purple coloration (e.g. Fluence LED AnthoSpec).

3.6.5 Biomass Yield

For virtually all cannabis cultivators including medical patients, home growers, and commercial growers, increasing the total yield of consumable flower is the primary cultivation objective. Floral hemp (from which cannabidiol – CBD – and other cannabinoids are derived) represents a significant portion of the hemp industry, and thus floral biomass is also the primary endpoint for many hemp cultivators. Many peer-reviewed studies suggest that inflorescence (flower/bud) yield can indeed be impacted by different lighting conditions, including fixture type, lighting spectrum, and light intensity.

There is a positive correlation between light intensity and flower biomass (Rodriguez-Morrison et al., 2021, Westmoreland et al., 2021). For commercial growers, the estimated increased electricity cost of turning up their LED lighting intensity (for example, from 700 to 1000 µmol/m^2/s), is far outweighed by the potential profit gained from greater biomass yield produced by higher-intensity LED lighting (Eaves et al. 2020). That is, the same LED fixture will produce more biomass if the intensity is increased, and it is financially worth it to do so. The incentive recipients in the current grower's survey are likely aware of this phenomenon, given that more respondents operate their LEDs at high intensity during the flowering stage compared to the vegetative stage.

Furthermore, the fixture efficiency of LED lights vs. HID lights strongly supports that the initial higher cost of LEDs is far more economical (as measured by yield) than the long-term electricity costs of growing cannabis under HID lighting (Westmoreland et al., 2021).

3.6.6 Secondary Plant Metabolites

Light also affects the production of secondary metabolites in plants, like carotenoids, flavonoids, and terpenes. Carotenoids, which absorb light in the 400-550 nm range, protect plants from photo-oxidative damage. Flavonoids, sensitive to light quality, are higher under UV, blue, and far-red light treatments and help with stress resistance and attraction of pollinators. Terpenes, found in small quantities (up to 11% by dry weight) in cannabis, contribute to the plant's aroma and help defend against biotic stresses. They also help manage light and drought stress (Eichhorn Bilodeau et al., 2019).

Cannabinoids such as CBD, THC, and CBG are another type of secondary metabolite, and are produced in the glandular trichomes of cannabis plants. Cannabinoid potency, and particularly THC potency, is of extreme importance to commercial cannabis cultivators in both medical and recreational markets (Stith et al., 2020, Weizman et al., 2018, Dobbins et al., 2022) . Peer-reviewed studies strongly suggest that cannabinoid potency can increased by broad-spectrum lighting which includes UV-B exposure (Fluence, Jenkins 2021). Spectral tuning does not appear to impact cannabinoid potency, however these effects may be cultivar-specific and cannabinoid-specific, and more research is needed to confirm this definitively (Rodriguez-Morrison et al., 2021, Westmoreland et al., 2021).

Studies also show that light intensity can impact cannabinoid potency (Rodriguez-Morrison et al., 2021, Eaves et al., 2020). However, experiments published in the literature use lighting intensities which are significantly higher than the PPFD used in typical controlled indoor agriculture environments from the growers' survey (1800-3000+ PPFD vs 200 - 1200 PPFD, respectively).

Terpenes, which are a major component contributing to the aroma of cannabis, are also impacted by light spectra (Reichel et al., 2022, Babaei et al., 2022). However, more than 20 terpenes are commonly detected by analytical laboratories in regulated commercial markets, and much more research is needed to determine the specific lighting parameters which impact individual terpenes or classes of terpenes which share common metabolic production pathways.

4 Conclusions and Recommendations

Our review of the data resulted in the following conclusions and recommendations.

Conclusion #1: LEDs are the dominant light source sold by trade allies and retailers and used by business and residential growers, however there is some evidence that larger commercial operations have a lesser percentage of their canopy under LEDs than smaller operations. Most retailers reported trying to reduce or remove any lingering non-LED inventory and trade allies almost never specify non-LEDs. Yet, due to the noticeable price difference between LEDs and HIDs, respondents indicate that the Energy Trust incentives are key to maintaining LED grow light purchases among both business and residential growers.

> **Recommendation #1.1**: Maintain business and residential incentives, with possible adjustments to amounts, for LED grow lights and consider marketing incentives with other equipment important to growers like dehumidifiers, water pumps, and HVAC incentives.
>
> **Recommendation #1.2**: Consider future research with larger business growers to verify their use of LEDs and, if they are using LEDs less than their smaller counterparts, identify larger growers' barriers to greater adoption of LED grow lights.

Conclusion #2: Among business grower respondents, almost all grow lights in use today, of which most are LED, have dimming capabilities and most growers are using those dimming capabilities in both the vegetative and flowering stages. Few growers reported operating their lights at 100% intensity all the time, however, more operate at high intensity during the flowering stage compared to the vegetative stage. Our calculations revealed that growers operate their lights at close to half intensity during the vegetative stage and about three-quarters intensity during the flowering stage. Our research did not identify the best dimming practices for increasing yield or product quality.

> **Recommendation #2.1**: Consider monitoring relevant literature and industry best practices for lessons about effective dimming practices and how those practices may vary based on space and environmental conditions to learn if there are energy saving opportunities available. Perhaps by lowering the intensity of LED lights more than growers are currently doing and, via training trade allies about best practices, Energy Trust could influence the market to save more energy through better management of lighting intensity.

Conclusion #3: Participant retailers sell to residential growers and business operations and at least some customers are repeat customers of retailers, purchasing their allotment of two per day on multiple days. Participant retailers estimated that less than two-thirds of their' customers, on average, are people growing for personal use and, on average, customers purchase almost five lights, three more than Energy Trust's two per day rule. These retailers reported that customers will purchase their maximum allotment on multiple days or recruit friends or colleagues purchase lights on their behalf to acquire their desired number of lights. These respondents could not tell us which customer type – residential growers versus business growers – were most often purchasing more than two lights for their operation, but some evidence from the business grower survey suggests they are likely business growers with small indoor operations and large outdoor operations. These growers only need a few lights for indoor grow starts that eventually are used for larger outdoor grows.

The high percentage of participants that focus on indoor operations, combined with the indication that some business growers are purchasing lights from retailers suggests that the program may be serving business growers with small indoor operations. However, it may be hard to see that these small indoor business operators are participating because they are technically going through the residential midstream program pathway.

> **Recommendation #3.1**: Because retailers are selling to business and residential buyers, residential program dollars are currently supporting business activities. However, the residential program (through retailers) may be serving an important subset of the cannabis grower community – those with small indoor operations and larger outdoor operations. The current program design makes it hard to verify if the program is serving this subset of the community adequately so Energy Trust, to the extent possible, may want to consider reworking program rules to make these small indoor operators a more visible presence in the program. This could include asking retailers to ask their customers to identify if they are using the incented lights for personal or business applications and then periodically sharing that collected information with Energy Trust.

Conclusion #4: Trade allies of the grow lights program are often assisting business growers by working to improve yields, product quality, or to assist with incentive processing. Unlike other lighting programs where trade allies are often lighting designers and electricians, trade allies in this space are often specialists in the cannabis or agricultural market helping business growers solve problems. Additionally,

about half of business growers reported at least moderate levels of familiarity with spectral qualities as it pertains to cannabis growth and about three-fifths reported at least moderate levels of familiarity with PPFD. This limited familiarity among business growers may be why they are leaning on agricultural and cannabis specialists to help with their operations.

> **Recommendation #4.1**: Trade allies' knowledge of evidence-based cultivation practices as they relate to energy efficiency could be critical to improving the efficiency of grow operations. Because they tend to be experts in growing, there is an opportunity for Energy Trust to use these handful of allies as conduits of information to business growers about ways to save energy. As noted above, for example, if Energy Trust learns of dimming best practices that could save energy, trade allies would be a good way to transfer that information to the grower market.

Conclusion #5: Rescheduling cannabis from Schedule I to Schedule III would have profound effects on the legal cannabis industry in the United States. It would reduce banking and tax challenges and likely increase nationwide consumer demand. Provided that interstate commerce will be permitted, businesses might expand or consolidate, leading to an expanded market, with Oregon businesses having a national presence. While interstate commerce of cannabis will not be immediately resolved, rescheduling could pave the way for future changes, further integrating cannabis into the national economy. Rescheduling may have short- and long-term impacts on the grow light economy as businesses become better capitalized and financially stable. With never-before seen access to lending and banking, new cannabis businesses may enter the market, requiring substantial investment in lighting and other controlled indoor agriculture equipment. Existing businesses may be better positioned to retrofit and upgrade existing cultivation environments. Other businesses may be restructured and their existing lighting assets may be liquidated as consolidation occurs through mergers and acquisitions. As consumer demand grows and the national market expands, the market composition of grow light manufacturers may shift, with some previously successful brands losing market share to others.

> **Recommendation #5.1:** Consider conducting another market assessment after the DEA reschedules cannabis to a Schedule III drug. That regulatory change could have profound impacts on the cannabis market, many of which we discuss in Section 3.5.1, which could disrupt grower operations and how the market operates both in the state and nationally.

Conclusion #6: Changes to the United States Farm Bill could greatly impact hemp cultivation businesses. Hemp and cannabis are botanically indistinguishable. Hemp is simply a legal term for varieties of cannabis with little or no THC. Many cannabis businesses also cultivate hemp, and the ratio of hemp to cannabis production could be impacted by changes in federal policies. By clarifying or easing regulations, providing better financial support, and encouraging sustainable practices, the Farm Bill could make hemp farming more attractive and profitable. Businesses might expand their operations, invest in new technology, and adopt more sustainable cultivation practices. It is plausible that grow lights might be included in these technological investments, as many hemp businesses start hemp seedlings indoors before transplanting onto acreage. Furthermore, many hemp varieties are not adapted to rainy autumn weather in Oregon and are grown with supplemental lighting (greenhouse). Although it is possible that HID fixtures may be phased out in the US, it is unclear whether this change will come about because of the forthcoming revisions to the Farm Bill.

> **Recommendation #6.1**: Consider conducting another market assessment if the Farm Bill makes notable changes to the hemp cultivation business. That regulatory change could have profound

impacts on the hemp market, many of which we discuss in Section 3.5.2, which could disrupt grower operations and how the market operates both in the state and nationally.

Conclusion #7: Responses from trade allies, manufacturers, and retailers suggest that Energy Trust is in some ways competing for the attention of grow light stakeholders with other grow light programs in the country. Trade allies, of which many were national incentive specialists, reported focusing their efforts on where the rebates were strongest. Manufacturers target their marketing resources to places where incentives are changing and or are robust. Retailers with shops in multiple states concluded that Energy Trust incentives draw growers to install LEDs because shops in states without incentives, they do not sell many LED grow lights.

> **Recommendation #7.1**: Continue monitoring residential and business grow light incentive rates and programs in other jurisdictions to stay competitive in the marketplace. Energy Trust staff should continue to stay aware of programs in other jurisdictions via their interactions with other professionals via trade association memberships, subscriptions to relevant newsletters, and conferences.

Conclusion #8: Energy Trust is defining the residential grow light market in Oregon. Grow light sales, mostly LED lights, are occurring at Energy Trust participant sites and growers across the state know to purchase lights from Energy Trust participant retailers to get discounted lights. Nonparticipant retailers are selling few grow lights in the state and when they do, they are generally selling non-LED lights or small LED grow lights, whereas program participants are mostly selling LEDs. A couple of participants noted that they get customers from outside their immediate region because they have discounted lights for sale and three nonparticipants reported losing grow light sales because they could not compete with participants, even if that participant site is not in the immediate vicinity of the grower. This trend towards LEDs is happening despite the expense of LEDs, about $800 without incentives, compared to non-LED technologies. While HPS lights are cheaper than comparable LEDs, participant retailers reported they are not generally ordering new HPS (or any other technology) lights. Their sales of HPS, CMH, or fluorescents are mostly trying to get rid of old inventory. Additionally, nonparticipants rarely sell non-LED lights that compete with the program incented lights.

> **Recommendation #8.1**: Based on the effectiveness of the program in encouraging growers to use LED grow lights, determine whether the program should alter its incentive structure. These interviews suggest that ceasing to offer grow light incentives may limit growers' interest in replacing old lighting technology. But, as the program has done in the latter half of 2024 and in January 2025, program staff should continue to monitor incentive amounts and consider reducing or altering incentives that continue to support LED adoption while increasing the cost-effectiveness of the program.[27]

> **Recommendation #8.2**: Work with other non-investor-owned utilities with energy efficiency programs in the state to encourage them to support the adoption of grow lights. Retailers located outside Energy Trust territory reported losing business to those in Energy Trust territory. Getting programs to start supporting grow lights sales in these other areas may help utilities acquire

[27] During this research project, the residential program reduced incentives from $350 to $250 in July 2024 and again reduced incentives from $250 to $150 Jan 2025.

energy savings, retailers gain business, and reduce leakage of Energy Trust's savings into neighboring areas. Most other utilities in Oregon are municipally owned entities that are customers of the Bonneville Power Administration, a federal entity. As such, these other utilities may be averse to supporting grow lights due to their association with cannabis growing, a federal crime. Where possible, Energy Trust could work with these other utilities to support grow light incentives.

Conclusion #9: Retailers have little insight into the type of structure customers are installing grow lights. More than half of respondents could not assess the number or percentage of customers that install 700w four feet by four feet fixtures in commercial properties (e.g. warehouses) and residential properties (e.g. houses). It is unclear how reliable the estimates the other half provided as they may have provided socially desirable answers to interviewers. The more than 90% decline in the number of OMMP registered growers in the state suggests that far fewer people are growing cannabis commercially in their homes than they were just a few years ago.

Recommendation #9.1: Concentrate the grow light programs on those growing for personal use and those growing for commercial use and assume that personal use growers are growing in homes, and commercial growers are growing in warehouses, greenhouses, and outdoors. There is negligible overlap in people growing cannabis in their home, a residential structure, and selling it commercially.

Conclusion #10: There may be opportunities to acquire additional energy savings for the program. Retailers reported under canopy lighting and environmental controls (heating, cooling, and dehumidification) are the two energy related trends happening in the marketplace now. Through supporting the adoption of energy efficient under canopy lighting and ensuring grow sites are efficiently managing their environmental controls the program could acquire energy savings and ensure growers are operating as efficiently as possible.

Recommendation #10.1: Consider offering incentives or other support for growers to help them install efficient energy-using equipment beyond top-down grow lights. Energy Trust could investigate if there are any opportunities to support efficient under canopy lighting options and help growers install adequate and efficient environmental controls for their grow spaces.

Appendix A – Grower Survey

Thank you for taking the time to provide your feedback about grow lights and how you use them. This information will help Energy Trust design their programs to best serve businesses such as yours. Throughout this questionnaire, we are interested in plants under lights designed to generate growth, not office lights, security lights, or other lights.

Screening

[ASK ALL]
Q1. First, we understand that your business name is [BUSINESS NAME]? Is that correct??

1. Yes
2. No
3. Not sure

[ASK IF Q1= 2 or 3]
Q2. What is the name of your business and what type of business is it?

1. _____

[ASK IF Q1 = 1]
Q3. Is your address [ADDRESS]?

1. Yes
2. No
3. Not sure

[ASK IF Q3 = 2 or 3]
Q4. At what address is [BUSINESS NAME] is your ?

1. _____

Facility Information

[ASK ALL]
Q5. What is the primary plant you are using lighting to grow at your facility at [ADDRESS]?

[SELECT ONE]

1. Cannabis for medical purposes
2. Cannabis for recreational purposes
3. Hemp
4. Flowers
5. Fruits or Vegetables
6. Other (please specify):

[ASK ALL]
Q6. What is the approximate square feet of your canopy – the total area of plants under grow lights at [ADDRESS]?

1. _____ square feet

[ASK ALL]
Q7. Do you use vertical farming methods where you have two or more stacked growing levels?

1. Yes
2. No
3. Don't know

[ASK IF Q7 =1]
Q8. What percentage of your grow floor space is devoted to vertical farming?

1. _____ %

[ASK ALL]
Q9. Of all the grow light fixtures currently in use at your facility at [ADDRESS] approximately what percentage are…? Your best guess is ok and please fill in a "0" for any item you do not have at your facility.

1. High-Intensity Discharge (HID) (e.g., HID, MH)		
2. Light Emitting Diodes (LED)		
3. Light Emitting Ceramic (LEC)		
4. Fluorescent		
5. Other (please specify):		
TOTAL [SHOULD SUM TO 100%]	100%	100%

[ASK ALL]
Q10. Of all the grow space in use at your facility at [ADDRESS] approximately what percentage …? Your best guess is ok and please fill in a "0" for any building type you do not have.

1. Is fully indoor requiring grow lights (e.g. warehouse or conex box)	
2. Uses grow lights as a supplement to natural light (e.g. greenhouse or hoophouse)	
TOTAL [SHOULD SUM TO 100%]	100%

[ASK IF Q10_2>0]

Q11. What percent of the lighting in the grow space that requires supplemental grow lights uses automatic daylighting controls?

[ASK ALL]

Q12. How many months per year do you....

1. Cool your growing space_____
2. Heat your growing space_____

[ASK IF Q12 = 2]

Q13. For each type of growing space you have at your facility, what percentage is cooled and what percentage is heated? Your best guess is ok and please fill in a "0" for any space that is not cooled.

1. [ASK IF Q10_1 >0 AND Q12] A warehouse type facility		
2. [ASK IF Q10_2 >0 AND Q12 = 2] A greenhouse or hoophouse		
3. [ASK IF Q10_3 >0 AND Q12 = 2] Conex box		
4. [ASK IF Q10_4 >0 AND Q12 = 2] Other (please specify):		

[ASK ALL]

Q14. Of all the growing space in use at your facility at [ADDRESS] what percentage of the space – the grow area under lights - do you devote to…? Please fill in a "0" for any stage that you do not grow at your facility.

1. The seedling stage	
2. The vegetative stage	
3. The flowering stage	
4. Mother maintenance	
5. Clone propagation (if different from seedling or veg)	
6. Other (please specify):	
TOTAL [SHOULD SUM TO 100%]	100%

[ASK ALL]

Q15. What percentage of your grow lights have dimming capabilities?

1. Zero
2. 1% to 25%
3. 25% to 49%

4. 50% to 74%
5. 75% to 100%

Familiarity with Lighting

[ASK ALL]
Q16. How familiar are you with the concept of spectral qualities in lighting?

1. Never heard of it
2. Have heard of it but don't feel I have a strong grasp
3. Have a moderate level of familiarity
4. Have a high level of familiarity

[ASK ALL]
Q17. Are you familiar with the term Photosynthetic Photon Flux Density or PPFD and how it relates to plant growth?

1. Never heard of it
2. Have heard of it but don't feel I have a strong grasp
3. Have a moderate level of familiarity
4. Have a high level of familiarity

Use of Lights by Growth Stage

The next several questions are about your use of grow lights in the vegetative and flowering states.

[ASK ALL]
Q18. What is the primary lighting type you use for your plants in their vegetative stage?

[SELECT ONE]

1. High-Intensity Discharge (HID) (e.g., HID, MH)	☐
2. Light Emitting Diodes (LED)	☐
3. Light Emitting Ceramic (LEC)	☐
4. Fluorescent	☐
5. Other (please specify):	☐

[ASK IF Q5=1 OR Q5=2 AND ASK IF Q16 = 1]
Q19. Which spectral qualities do you prefer for your cannabis plants in the vegetative stage?

[SELECT ONE]

1. Blue light (5500K or higher)
2. Red light (around 2800K)
3. Balanced spectrum (around 3500K)
4. Other, please specify:)_____

5. Don't know

[ASK IF Q5=1]
Q20. How many hours a day do you use grow lights during the vegetative stage for your cannabis plants?

[SELECT ONE]

1. Less than 8 hours
2. 9 to 13 hours
3. 14 to 18 hours
4. 19 to 23 hours
5. 24 hours

[ASK IF Q5=1]
Q21. What percent of the time are the lights at 100%?

1. _____

[ASK IF Q21= 1]
Q22. What intensity do you dim your lights to during the vegetative stage with 0% being no light and 100% being full capacity of the fixture?

1. _____%

[ASK IF Q17 = 3 OR 4]
Q23. What's the typical PPFD you use in the vegetative stage?

1. _____µmol/m²/s

Flowering

[ASK ALL]
Q24. What is the primary lighting type you use for your plants in the flowering stage?

[SELECT ONE]

[SELECT ONE]

1. Intensity Discharge (HID) (e.g., HID, MH)
2. Light Emitting Diode (LED)
3. Light Emitting Ceramic (LEC)
4. Fluorescent
5. Other, please specify:)_____

[ASK IF Q5=1 OR Q5=2 AND ASK IF Q16 = 1]
Q25. Which spectral qualities do you prefer for your cannabis plants in the flowering stage?

[SELECT ONE]

1. Blue light (5500K or higher)
2. Red light (around 2800K)
3. Balanced spectrum (around 3500K)
4. Other, please specify:)_____
5. Don't know

[ASK IF Q5=1]

Q26. How many hours a day do you use grow lights during the flowering stage for your cannabis plants?

[SELECT ONE]

1. Less than 8 hours
2. 9 to 13 hours
3. 14 to 18 hours
4. 19 to 23 hours
5. 24 hours

[ASK IF Q5=1]

Q27. What percent of the time are the lights at 100%?

1. _____

[ASK IF Q27 = 1]

Q28. What intensity do you dim your lights to during the flowering stage with 0% being no light and 100% being full capacity of the fixture?

[ASK IF Q17 = 3 OR 4]

Q29. What's the typical PPFD you use in the flowering stage?

1. _____µmol/m²/s

[ASK ALL]

Q30. How, if at all, has product yield changed since installing the LED grow lights?

1. _____
2. Not applicable – We have always used LED lights.

[ASK IF Q5=1 OR Q5=2]

Q31. What, if any, regulatory changes do you see impacting your energy use in the next one to three years?

1. _____

Demographics

[ASK ALL]

Q32. COBID is an Oregon certification that helps businesses owned by minorities, women, or service-disabled veterans participate in government contracts. Is your business COBID certified?

1. Yes
2. No
3. Don't know

[ASK IF Q32 = 2 or 3]

Q33. Is your company owned by a person of color or a woman?

[SELECT ALL THAT APPLY]

1. Yes – Person of Color
2. Yes - Woman
3. No [MAKE EXCLUSIVE]
4. Don't know [MAKE EXCLUSIVE]

[ASK ALL]

Q34. What is your total annual yield of dried/cured flower?

1. _____[WHOLE NUMBER UP TO 5,000 POUNDS]

[ASK ALL]

Q35. What is your job title or role for your company?

[SELECT ONE]

1. Facilities Manager
2. Energy Manager
3. Other facilities management/maintenance position
4. Chief Financial Officer
5. Other financial/administrative position
6. Proprietor/Owner
7. President/CEO
8. Manager
9. Other (Please specify) _____

Closing

Q36. Thank you for providing your feedback. As thanks for completing this survey, we are offering a $50 electronic gift card. Please let us know what email address you would like us to send this gift card to.

_____email

Appendix B - Instant Discount Retailer Interview Guide

Background

[ASK ALL]

Q1. What share of your store is devoted to indoor growing versus outdoor growing?

1. Entirely or nearly entirely outdoor
2. Mostly outdoor
3. About equal indoor and outdoor
4. Mostly indoor
5. Entirely or nearly entirely indoor

Grow Light Customers

The next few questions are about your customers that purchase grow lights.

[ASK ALL]

Q2. What percentage of customers use their grow lights for…? [INTERVIEWER: Please fill in a "0" for any item customers are not using their grow lights for.]

Item	Percent	Don't know
1. Flowers		☐
2. House plants		☐
3. Fruits and vegetables		☐
4. Cannabis		☐
5. Hemp		☐
6. Other, please specify: _____		☐

[ASK ALL]

Q3. About what percentage of all your grow light sales go to businesses versus those sold to individuals for personal use?

Item	Percent	Don't know
1. Businesses		
2. Individuals growing for personal use		

[ASK ALL]

Q4. What percentage of all your grow light sales are…? [Please mark "0" for any light type you do not sell.]

Item	Percent
1. Fluorescent	
2. High-Intensity Discharge (HID) like Metal Halide (MH) or High-Pressure Sodium (HID)	

3. Light Emitting Diode (LED)	
4. Light Emitting Ceramic (LEC)	
5. Other, please specify:_____	
TOTAL (Sum Should equal 100%)	

[ASK ALL]
Q5. Suppose someone needed lighting for 100 square feet (10x10) of growing space – plants under grow lights. How much more, if any, would LED grow lights cost than HIDs?

[ASK ALL]
Q6. What, if anything, do customers ask you about when they are interested in purchasing grow lights? [PROBES: Do they ask about cost, dimming settings, efficiency, spectral quality, durability, yield increase, something else?]

[ASK ALL]
Q7. What is the average number of fixtures an individual customer buys for an indoor home grow?

[ASK ALL]
Q8. What features, if any, do you emphasize to customers when telling them about grow lights? [PROBE: Do you focus on cost, spectral quality, durability, efficiency, something else?]

[ASK ALL]
Q9. In the last year, what trends, if any, have you noticed in the sales of grow lights? [PROBES: For example, are you seeing greater adoption of a specific lighting type, notable change in price of equipment, lighting controls, size, dimming, daylight sensing technology, or something else?]

Energy Trust Supported Lights

[ASK ALL]
Q10. Of all the grow light equipment you sell, what percentage receives incentives from Energy Trust?

[ASK ALL]
Q11. How frequently do customers inquire about Energy Trust supported grow lights for their projects?

1. Not at all
2. Rarely
3. Occasionally
4. Frequently
5. Very frequently

[ASK ALL]
Q12. How often do you tell customers about Energy Trust incentives?

1. Not at all
2. Rarely

3. Occasionally
4. Frequently
5. Very frequently

[ASK IF Q12 = 4 or 5]
Q13. What do you tell customers about the Energy Trust incented lights?

[ASK ALL]
Q14. Why, if at all, would a customer choose a non-Energy Trust supported grow light?

[ASK ALL]
Q15. What benefits do you highlight when recommending Energy Trust supported grow lights for indoor plant cultivation? [PROBES: Do you focus on energy efficiency, durability, manufacturer's warranty, quality, or some other characteristic of the light?]

[ASK ALL]
Q16. Energy Trust has flyers that help promote efficient LED grow lights. Are you using these flyers? If so, how could those materials be improved, if at all? Do those flyers seem effective?

[ASK ALL]
Q17. What challenges, if any, do you face in promoting Energy Trust supported grow lights to customers?

Conclusion

[ASK ALL]
Q18. What trends in the grow light market, if any, should Energy Trust be aware of when they are thinking about their program over the next few years?

[ASK ALL]
Q19. Is there anything else you'd like to share about the sales of grow lights or your experience with them and the Energy Trust program?

[ASK ALL]
Q20. Those are all the questions I have. As I noted earlier, we would like to give you a $150 gift card as a thank you for your time. What email address can I send that gift card to?

_____

Appendix C – Trade Ally Interview Guide

Background

[ASK ALL]

Q1. Which of the following best describes your company?

1. Electrical contractor
2. Lighting installer
3. Lighting designer
4. General contractor
5. Distributor
6. Consultant
7. Other:_____

[ASK ALL]

Q2. Please tell me what percentage of your overall revenues are grow light projects? (Compared to all your other sources of revenue)?

1. _____%

Grow Light Customers

The next couple of questions are about your customers that use your services to install grow lights at their facilities.

[ASK ALL]

Q3. What percentage of customers use their grow lights for…? [INTERVIEWER: Please fill in a "0" for any item customers are not using their grow lights for.]

Item	Percent	Don't know
7. Flowers		☐
8. Vegetables		☐
9. Medical Cannabis		☐
10. Adult-Use Cannabis		☐
11. Hemp		☐
12. Other, please specify: _____		☐
13.		

[ASK ALL]

Q4. What types of buildings do you complete grow light projects in? [PROBES: Are you mostly doing projects in warehouses, greenhouse/hoophouse, Conex box, a mix] Please elaborate.

[ASK IF Q4 IF GREENHOUSE]

Q5. For your supplemental light projects (like greenhouses), what percentage of your customers use daylight-sensing or automatic daylight-controlled lighting?

1. _____%

[ASK ALL]

Q6. What percentage of the time, if ever, do you sell lighting equipment to customers that complete their own installation?

1. _____%

Sales Process

The next few questions are about the sales process for your customers that install grow lights in their facilities, beginning with how you identify projects or customers.

Project Identification

[ASK ALL]

Q7. How do you get your grow light customers? [PROBE: Do customers come to you? Are they referred from other customers?]

[ASK ALL]

Q8. Why do indoor grow operators typically hire you for a project? [PROBES: Are they interested in repairing old lights, expanding or altering operations, improving efficiency, improving spectral quality, something else?]

[ASK ALL]

Q9. How, if at all, do you market your services to growers? [PROBE: What methods are most effective for your marketing - advertisements, door-to-door, something else?]

[ASK IF Q9 INDICATES RESPONDENT DOES MARKETING]

Q10. What, if anything, has been the most effective way you have marketed your services?]

[ASK ALL]

Q11. When it comes to the lighting fixtures themselves, what, if anything, do customers typically ask you about? [PROBES: Do they ask about dimming settings, efficiency, spectral quality, durability, something else?]

[ASK ALL]

Q12. How do you assess the need for lighting upgrades for retrofit projects? [PROBE: Are you looking for upgrades to efficiency, spectral qualities, durability, something else?]

[ASK ALL]
Q13. How do you assess the need for lighting upgrades in new construction grow facilities? [PROBE: Do you focus on cost, efficiency, spectral qualities, durability, something else?]

Project Sales and Proposals

[ASK ALL]
Q14. What percentage of your grow light customers request guidance from you or your staff when purchasing grow lights versus knowing what they want before installation?

[ASK ALL]
Q15. What features, if any, are customers looking for when choosing grow lights for indoor plants? [PROBE: Are they looking for energy efficiency, dimming abilities, certain spectral features, or something else?]

[ASK ALL]
Q16. What benefits, if any, are customers looking for when choosing grow lights for indoor plants? [PROBE: Are they looking for high yield, high cannabinoid content, or something else?]

[ASK ALL]
Q17. What strategies, if any, do you use to demonstrate the benefits of energy-efficient lighting? [PROBE: How do you educate customers about the benefits of newer, more efficient lighting?]

Types of Lights Used

[ASK ALL]
Q18. What percentage of all your grow light project sales are…? [INTERVIEWER: Please mark "0" for any light type you do not sell.]

Item	Percent
1. Fluorescent	
2. High-Intensity Discharge (HID) like Metal Halide (MH) or High-Pressure Sodium (HID)	
3. Light Emitting Diode (LED)	
4. Light Emitting Ceramic (LEC)	
5. Other, please specify:_____	
TOTAL (Sum Should equal 100%)	100%

[ASK ALL]
Q19. What percentage of your industrial projects use vertical farming methods, with two or more stacked growing levels?

1. _____%

[ASK ALL]
Q20. What, if any, specific lighting types do you recommend to your grow facility customers? Why?

[ASK ALL]
Q21. What features of grow lights do you most commonly recommend to your customers? (PROBES: Easy to install, high PPFD, most efficient, easy maintenance, low cost)

[ASK ALL]
Q22. Suppose someone needed lighting for 100 square feet (10 x 10) of growing space that is,– one level of plants under one level of grow lights. What would the differences be between LEDs and HIDs, in terms of total cost and number of fixtures??? [PROBE: Would you recommend the same number of LED lights as HID? Does it depend? How so?]

[ASK ALL]
Q23. In the last year, what trends, if any, have you noticed in the sales of grow lights? [PROBES: For example, are you seeing greater adoption of a specific lighting type, size, dimming or other lighting technology, use of controls, change in equipment price, or something else? Are MSRPs changing?]

Energy Trust Supported Lights

[ASK ALL]
Q24. What percentage of your total revenue was from projects that received incentives from Energy Trust?

1. _____%

[ASK ALL]
Q25. Of all the grow light projects you completed in the last year, what percentage received incentives from Energy Trust?

1. _____%

[ASK ALL]
Q26. Are your grow light projects that received incentives from Energy Trust larger, smaller, or about the same as your other grow light projects?

1. Larger
2. Smaller
3. About the same

[ASK ALL]
Q27. How frequently do customers inquire about Energy Trust supported grow lights for their projects?

1. Not at all
2. Rarely
3. Occasionally
4. Frequently
5. Very frequently

[ASK ALL]
Q28. How often do you tell customers about Energy Trust incentives?

1. Not at all
2. Rarely
3. Occasionally
4. Frequently
5. Very frequently

[ASK ALL]
Q29. What challenges, if any, do you face in promoting Energy Trust supported grow lights to customers?

[ASK ALL]
Q30. How, if at all, can Energy Trust help support your work with customers interested in grow light upgrades or installation?

Conclusion

[ASK ALL]
Q31. Is there anything else you'd like to share about the installation of grow lights at commercial facilities or your experience with them and the Energy Trust program?

[ASK ALL]
Q32. Those are all the questions I have. As I noted earlier, we would like to give you a $150 gift card as a thank you for your time. What email address can I send that gift card to?

1. _____

Thank you for taking the time! Your feedback is valuable in shaping energy-efficient lighting practices for indoor plant growers.

Appendix D - Manufacturer Interview Guide

Background

[ASK ALL]

Q1. What percentage of your total revenue is grow lights?

1. _____

[ASK ALL]

Q2. Approximately how many years has your company manufactured grow lights?

1. _____

[ASK ALL]

Q3. Of all your grow light revenue in the last year nationally, what percentage are…? [INTERVIEWER: *Please mark "0" for any light type you do not sell.]*

Item	Percent
1. Fluorescent	
2. High-Intensity Discharge (HID) like Metal Halide (MH) or High-Pressure Sodium (HID)	
3. Light Emitting Diode (LED)	
4. Light Emitting Ceramic (LEC)	
5. Other, please specify:_____	
TOTAL (Sum Should equal 100%)	100%

[ASK ALL]

Q4. How, if at all, does this percentage differ in Oregon compared to the rest of the country?

Grow Lights in Oregon

[ASK ALL]

Q5. This may be a hard question to answer, so your best guess is fine: What share of the Oregon grow light market belongs to your company?

1. _____

[ASK ALL]

Q6. Of all the grow lights you sell in Oregon, what percentage are direct sales to… ?

Item	Percent
1. Commercial growers	
2. Home growers	

3. Retailers (e.g. Nursery, garden center, etc.)	
4. Wholesalers or distributors	
TOTAL	100%

[ASK ALL]
Q7. In the last year, what trends, if any, have you noticed in the sales of grow lights? [PROBES: For example, are you seeing greater adoption of a specific lighting type, size, dimming, daylight sensing technology, controls, or something else?]

[ASK ALL]
Q8. How, if at all, do you market your products to industrial growers?

[ASK ALL]
Q9. How, if at all, do you market your products to retailers like garden centers?

[ASK ALL]
Q10. How, if at all, do you market your products to lighting contractors?

[ASK ALL]
Q11. How, if at all, do you market your products to home growers?

Support for Efficient Grow Lights

[ASK ALL]
Q12. Of all the grow light equipment you sell, what percentage is eligible for incentives from a utility program such as Energy Trust of Oregon? For example, utility programs often use the Design Lights Consortium (DLC) Horticultural Lighting requirements to determine eligibility for their programs.

1. _____%

[ASK ALL]
Q13. Programs like the Energy Trust of Oregon offer incentives for energy-efficient fixtures. What, if anything, do you do to promote grow lights that qualify for these incentives?

[ASK ALL]
Q14. What benefits do you highlight when promoting efficient grow lights?

[ASK ALL]
Q15. What challenges, if any, do you face in promoting efficient grow lights to customers?

Market Knowledge

[ASK ALL]

Q16. How, if at all, do you learn about the grow light market nationally? And in Oregon? [PROBES: Do you conduct your own market research, work with distributors and trade allies, use other methods?]

[ASK ALL]

Q17. What trends in the grow light market, if any, should Energy Trust be aware of when they are thinking about their program over the next few years? [PROBES: New or emerging technology, regulatory changes, market conditions, products that have recently fallen off DLC list]

[ASK ALL]

Q18. How, if at all, do you learn about the grow light market nationally? And in Oregon? [PROBES: Do you conduct your own market research, work with distributors and trade allies, use other methods?]

Conclusion

[ASK ALL]

Q19. Is there anything else you'd like to share about your manufacturing experience and the Energy Trust program?

[ASK ALL]

Q20. Those are all the questions I have. As I noted earlier, we would like to give you a $150 gift card as a thank you for your time. What email address can I send that gift card to?

1. _____

Thank you for taking the time to complete this survey! Your feedback is valuable in shaping energy-efficient lighting practices for indoor plant growers.

Appendix E - References

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