Green Energy Horticulture: Efficiency and Sustainability for Indoor Cannabis Cultivation

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Abstract

Cultivating cannabis requires an enormous amount of energy. Lighting and HVAC systems make up a majority of the monthly and annual energy consumption, around 38% and 51% respectively. More efficient methods for growing have been discovered through recent technological advancements. Replacing high pressure sodium or metal halide lighting fixtures with light emitting diodes (LEDs) has shown to be more efficient in terms of energy consumption and thermal output. In addition to growing with LEDs, switching from standard alternating current LED drivers to direct current powered LEDs has shown ideal results. Using VDC LED drivers may be the largest shift in vertical farming that growers have ever seen. VDC is nearly 30% more efficient when compared to VAC. It can also remove 40% of the heat from a grow room. Direct current power drivers can extend up to 350 feet away from the light source, while alternating current can only extend about 15 feet away. The need for HVAC systems will decrease as growers integrate VDC LEDs as their primary light and power sources. In addition to lighting and ventilation, transitioning to mobile, vertical racks has been proven to maximize canopy per square foot. Growing vertical has the ability to produce up to 50% more canopy within the same square footage (depending on how many levels are used). This is especially true when growing sea of green. Sea of green is the concept of growing a large quantity of small plants, compared to a small number of large plants. By switching to more energy and space efficient options, growers will save substantially on operating costs. The future of cannabis is growing green.

Keywords
Sea of green, vertical horticulture, vertical farming, direct current, alternating current, LEDs, HVAC, high pressure sodium, metal halide, photosynthetic active radiation, photosynthetic photonic flux density, quantum response, hydroponics, aeroponics.

Introduction

The cannabis industry is booming and isn’t expected to slow down anytime soon. Indoor cultivation facilities are becoming the common practice as the industry evolves. With this, comes massive energy consumption and environmental implications. Compared to outdoor or greenhouse cultivation, indoor cannabis production requires an enormous amount of energy. This is mainly due to HVAC and lighting, around 51% and 38%, respectively.

Cannabis was responsible for 1% of the nation’s energy usage in 2011, which amounts to nearly $6 billion annually. In Denver alone, cannabis production has been responsible for up to 4% of Colorado’s total energy usage (2018). From 2012 to 2016, energy production from cannabis has grown an average of 35% annually (2018). The carbon footprint of a typical indoor cannabis facility is anywhere from eight to ten times more than a similar sized office space (Gellerman 2018). It is in grower’s best interest to incorporate energy and space efficient practices in order to drive down operating costs and maintain a baseline level of sustainability.

The sea of green growing method in combination with vertical racks, and highly engineered LEDs, can significantly cut down energy usage and total operating costs. Sea of green focuses on cultivating a large quantity of smaller plants versus a smaller number of large plants. This technique allows growers to maximize square footage of canopy and even overall biomass yield per grow cycle. This concept can be expanded even further when integrating mobile, vertical racking systems.

Growing with LEDs has a myriad of benefits. One advantage that LEDs have over traditional HPS or metal halide lighting, is that plants can be grown closer to the light source since they radiate less heat. In addition, LED
shave the ability to design customizable spectrums, tailored to specific phases of the grow cycle. LEDs are evolving quickly. However, it’s important to understand that they are not all created equally. The way in which LEDs are powered makes a significant difference in heat production and energy consumption. Most LED drivers use alternating current (AC) power. Instead, using LEDs with direct current (DC) power drivers is far more energy efficient. DC drivers can be placed up to 350 feet away from the light source, removing excess heat from the grow room. This can be compared to alternating current drivers, which can extend only about 15 feet away from the light. DC power highly reduces and potentially removes the need for HVAC systems. In addition, DC drivers have the ability to be powered fully by solar energy. A conversion of this magnitude will drive down energy consumption and production costs, despite the initial investment.

Smart Grow Systems (SGS) has designed one of the most energy efficient systems in the world of cannabis cultivation today: growing sea of green in mobile, vertical racks with direct current powered LEDs. This method is paving the way for a more sustainable future in cannabis production.

**Energy Usage Breakdown for Indoor Cannabis Cultivation**

![Energy Usage Breakdown](image)

Figure 1: A breakdown of energy usage in a standard indoor grow facility (Kolwey 2017). HVAC and lighting contribute to the majority of a grow facility’s energy consumption. Energy consumption from lighting and HVAC can be significantly reduced when converting to VDC powered LED lights.

**Lighting**

Growing cannabis requires high quality light sources and tailored spectrums for various phases in the grow cycle. Traditionally, growers have used high pressure sodium (HPS), metal halide (MH) and fluorescent lights to cultivate cannabis. HPS lights have an emphasis on blue and high red light, which are necessary in the vegetative and flowering phases. HPS, metal halide and fluorescent lights contain full spectrums. However, they have large gaps in many necessary wavelengths that contribute to photosynthesis. Lighting fixtures should closely mimic the sun’s spectrum, which has little to no drop off in energy. Within the visible light spectrum is the quantum response...
area (400 - 700 nm), which provides active photonic energy. This is also known as PAR light, photosynthetic active radiation. Traditional lighting sources and many LEDs lack necessary PAR wavelengths, while Smart Grow System’s LEDs do not.

Through recent technological advancements, the use of light emitting diodes (LEDs) has become increasingly popular. LEDs have the ability to create a customized, full spectrum with little to no drop off in PAR light. SGS LEDs closely mimic the sun’s spectrum. This design delivers precise photonic energy to plants, which drives photosynthesis. In addition, LEDs require much less energy to operate, have a longer lifespan and produce much less heat when compared to their HPS or other traditional lighting counterpart.

Figure 2: The McCree Curve shows the Quantum Response area (400 - 700 nm), which provides active photonic energy to drive photosynthesis. This full spectrum figure shows no drop off in wavelengths. SGS LEDs closely mimic this graph, while emphasizing blue and red wavelengths for the propagation and flowering phases of growing cannabis.

The cloning and vegetative stage (propagation) of growing cannabis requires 18 hours of light a day, with an emphasis on blue wavelengths. As plants transition from propagation to flower, lighting intensity increases. During flower, lights remain on for 12 hours each day. Red and orange wavelengths are necessary for this phase in the grow cycle. HPS, metal halide and fluorescent lights have limitations when it comes to providing a quality, full spectrum light for each phase of the grow cycle.
Figure 3: A comparison between HPS, metal halide and two Smart Grow System’s LED lights. The SGS Golden Glow and Baby Blue spectrums closely mimic the quantum response area, while emphasizing specific wavelengths. HPS and metal halide lights have a less consistent spectrum, with many drop offs in various wavelengths needed to drive photosynthesis. The SGS Golden Glow spectrum is used for flower and the Baby Blue is used for propagation.

Many growers are pleased when making the transition from traditional lights to LEDs, despite their high price tag. When converting to the most efficient LEDs, growers are able to cut their energy consumption down by an average of 50%. This is usually made possible by replacing a 600 watt HPS light for a 300 watt LED light during vegetation. For flower, a 500 or 600 watt light can easily take the place of a 1,000 watt HPS light (Kolwey 2017).

Not only do LEDs reduce energy consumption, but they have a very low thermal output. LEDs have the ability to use a remote power and driver system, automatically redirecting heat away from the plants. With a smaller thermal output, plants are also able to be grown closer to lights. This allows growers to integrate sophisticated vertical racking systems to maximize canopy per square foot (Kolwey 2017). Traditional lighting options lack this capability due to their excess heat production. HPS, metal halide and fluorescent lights require a much larger space between the top of the canopy and the light, so plants don’t get burned or destroyed (Kolwey 2017). Using LEDs in vertical racking systems allows growers to maximize square footage, improve overall cannabis yield and even increase THC percentage in some circumstances (Kolwey 2017). When utilized correctly, LEDs have also shown to expedite the growing process by up to two weeks (2018). Operating costs will also be significantly reduced, considering that using LEDs can cut energy consumption in half. LEDs quickly pay themselves off with monthly and annual energy savings. LEDs have been continually identified as the primary energy efficient opportunity for indoor grow operations moving forward (Remillard & Collins 2017).

<table>
<thead>
<tr>
<th>Amps</th>
<th>The number of electrons flowing through a specific point per second</th>
<th>Volts x Amps = Watts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watts</td>
<td>How much energy is consumed per unit of time</td>
<td>Ex. Watts and kilowatts per hour</td>
</tr>
<tr>
<td>Volts</td>
<td>Measures how strongly electricity is pushed through a circuit (electrical pressure)</td>
<td>Provided by a + and - charge through a circuit</td>
</tr>
</tbody>
</table>
Direct Current vs. Alternating Current

Alternating current (AC) refers to a back and forth flow of electrons. Direct current (DC) refers to a constant flow of electrons in one direction. DC does not have any drop off in energy, while AC has constant ebbs and flows. Most current LED drivers use VAC (volts alternating current) or a combination of VAC and VDC. Both of these options are much less efficient than using only VDC (volts direct current) power, alone.

One major benefit of choosing VDC power over VAC is heat removal from the grow room. VDC drivers can be placed up to 250 - 350 feet away from the light source, without degradation in the PAR map. Contrarily, AC drivers can only extend about 12 - 15 feet away, which generates enormous amounts of heat. When comparing AC to DC power, the most important thing to consider is how far away the drivers are able to be placed. Using VDC drivers removes roughly 40% of the heat from a grow room, reducing the need for HVAC systems. More lights can be added to the room if less heat is being produced. Using this system also allows for advanced vertical growing. This is because the racks above and below the plants are not getting overheated. Overall, DC rectifiers have shown to be, on average, 30% more efficient than 24VAC LED drivers. Though many factors contribute to efficiency of a grow, direct current power is arguably the biggest technological shift in vertical farming.

<table>
<thead>
<tr>
<th>Lights</th>
<th>Input Power</th>
<th>Voltage</th>
<th>120 V</th>
<th>208V</th>
<th>240V</th>
<th>277V</th>
<th>480V</th>
<th>600V</th>
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<tr>
<td>Gavita HPS 1000W</td>
<td>1000W</td>
<td>Amperage</td>
<td>9A</td>
<td>5.2A</td>
<td>4.5A</td>
<td>3.8A</td>
<td>NA</td>
<td>NA</td>
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<tr>
<td>GAVITA HPS 1200W</td>
<td>1200W</td>
<td>Amperage</td>
<td>10.6A</td>
<td>6.2A</td>
<td>5.3A</td>
<td>4.6A</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Fluence Spyder 2P LED</td>
<td>645W</td>
<td>Amperage</td>
<td>5.38A</td>
<td>3.10A</td>
<td>2.69A</td>
<td>2.33A</td>
<td>1.91A</td>
<td>NA</td>
</tr>
<tr>
<td>SGS GOLDENi 500 USA</td>
<td>500W</td>
<td>Amperage</td>
<td>NA</td>
<td>1.7A</td>
<td>1.3A</td>
<td>1.1A</td>
<td>0.83A</td>
<td>NA</td>
</tr>
<tr>
<td>SGS GOLDENi 500 Canada</td>
<td>500W</td>
<td>Amperage</td>
<td>NA</td>
<td>1.7A</td>
<td>1.3A</td>
<td>1.1A</td>
<td>0.85A</td>
<td>0.6A</td>
</tr>
</tbody>
</table>

Figure #5: Amperage comparisons between Gravita HPS, Fluence LED and SGS LED.
Figure 6: Alternating current vs. Direct current. AC power is a back and forth flow in electrons, where power is lost during low points in the wavelength. DC power is a constant flow of electrons, with no drop off in energy. Direct current powered drivers can extend up to 250 - 350 feet away from the light source. Alternating current drivers can only extend about 12 - 15 feet away. Using DC drivers removes a majority of the heat from the room since they have the ability to be located in a different room.

Heating, Ventilation and Air Conditioning

HVAC stands for heating, ventilation and air conditioning. For standard office buildings and cannabis operations, HVAC typically contributes to around half of the total energy usage. HVAC is the largest energy consumer in both residential and non-residential settings. In total, HVAC contributes to nearly 20% of the United State’s annual energy consumption (Perez-Lombard, Ortiz, & Pout 2007).

When using traditional growing methods, HVAC plays an important role in the production of cannabis. These systems reduce outdoor air contamination, help maintain ideal humidity and CO2 levels (Perez-Lombard, Ortiz, & Pout 2007). Controlling for humidity is necessary for ensuring crops don’t grow mold or mildew (Remillard & Collins 2017). It is important to note that temperature and humidity regulation for an indoor grow will vary based on geographic location. For example, Washington state tends to be more humid than Central Oregon. Temperature, humidity and CO2 levels will differ for both of these locations and need to be tightly controlled (Mulqueen, Lee, & Zafar 2017).

Humidity determines how much water plants will consume. Relative humidity is a measure of moisture in the air, compared to what the air can sustain at a given temperature (2005). Most vegetation rooms run roughly 70% relative humidity and flower rooms run around 50% (Kolwey 2017). Typically, growers install one or many rooftop HVAC units, in addition to portable dehumidifiers inside the flower rooms (Kolwey 2017). Designing the room around Vapor Pressure Deficit (VDP) rather than relative humidity can save money and energy consumption long term. VDP is the difference between the leave’s internal vapor pressure and that of the air surrounding the leaves. Ultimately, VDP will determine the rate of transpiration. It will increase with higher room temperatures and lower relative humidity. If VDP is too low, leaves can accumulate condensation. If VDP is too high, plants are easily heat stressed and can dry out (Kolwey 2017).

Growers can save energy and money by choosing a “premium efficiency” dehumidifier. There are a few systems that are recommended for energy savings: plate air to air heat exchange, hybrid desiccant/evaporative systems and chilled water systems. Plate air to air heat exchange dehumidifiers can save up to 30-65% of energy consumed by normal, commercial dehumidifiers. Hybrid desiccant and evaporative systems can save 30-50% of energy. Chilled water systems are effective for grow operations that have larger than a 4,000-6,000 square foot
canopy (Kolwey 2017). There are many energy efficient alternatives for HVAC units. However, the need for HVAC is significantly reduced when growing with VDC LEDs. This is due to the reduced thermal output and locating power drivers far outside of the room. Cultivators have also completely removed the use of HVAC systems when growing with a VDC Smart Grow LED system.

**Height & Space**

One of the best ways to utilize indoor spaces is by installing vertical racking systems. Vertical farming has shown, time and time again, to be a viable solution for increasing crop yield within a given area. Currently, vertical racks are primarily being used for plants in vegetation. At this stage, plants are smaller and require a lower light intensity. This makes using vertical racks a practical option (2018). However, with the right technology, vertical racking systems can be used for both propagation and flower. Vertical systems have been compared with traditional, single level methods and vertical farming has continually produced more crop per unit area.

Vertical farming becomes the most effective when growing sea of green, using specialized VDC powered LEDs. Sea of green naturally has shorter grow cycles since plants are smaller in size (Two weeks clone, two weeks veg, eight weeks flower). This can increase the number of harvests and annual yield. When using VDC LEDs in rack systems, plants can be grown very close to the light. Growing plants closer to the light source maximizes space and increases PPFD, photosynthetic photonic flux density (Kolwey 2017). PPFD is the number of photosynthetic active photons (400 - 700 nm) that fall within a square meter in a given second. It’s important to dose cannabis plants with the proper amount of micromoles during each phase of the grow cycle in order to optimize rate of photosynthesis and plant development.

Vertical farming can be taken to the next level by incorporating a mobile system. Mobile racks can increase cubic space by up to three to four times (depending on how many racks and levels are used). Mobile racks have the ability to be pushed together, creating one giant PAR map. This will ensure an even distribution of light over the grid space, leading to maximum and consistent yields (2018).
Figure 7: A standard 31’ x 31’ flower module room diagram showing 8’ x 3’ decks with GOLDENi 500 lights and the mobile aisle dimensions.
<table>
<thead>
<tr>
<th>Room/POD</th>
<th>Footprint Sqft</th>
<th>Racks</th>
<th>Levels per Rack</th>
<th>Total Count of Decks</th>
<th>GOLDE Ni Framez Per Deck</th>
<th>Canopy Per Deck</th>
<th>Watts used</th>
<th>Perpetual flower rooms</th>
<th>Total Watts (20% head room)</th>
<th>GOLDE Ni Framez all decks</th>
<th>Total Flower Canopy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3, 24, 72</td>
<td>8</td>
<td>3</td>
<td>24</td>
<td>6</td>
<td>216</td>
<td>500</td>
<td>Yes</td>
<td>86,400</td>
<td>144</td>
<td>1728</td>
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</tbody>
</table>

Figure 8: Three level high vertical rack specs.

<table>
<thead>
<tr>
<th>Room/POD</th>
<th>Footprint Sqft</th>
<th>Racks</th>
<th>Levels per Rack</th>
<th>Total Count of Decks</th>
<th>GOLDE Ni Framez Per Deck</th>
<th>Canopy Per Deck</th>
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<th>Total Watts (20% head room)</th>
<th>GOLDE Ni Framez all decks</th>
<th>Total Flower Canopy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3, 24, 72</td>
<td>8</td>
<td>4</td>
<td>32</td>
<td>6</td>
<td>288</td>
<td>500</td>
<td>Yes</td>
<td>115,200</td>
<td>192</td>
<td>2304</td>
</tr>
</tbody>
</table>

Figure 9: Four level high vertical rack specs.

Figure 10: Mobile racks can increase canopy capacity up to 50% (Pipp Horticulture).
Water

Indoor cannabis cultivation is the most water efficient when compared to growing outdoors and in greenhouses. These environments allow for water loss via evaporation. Humidity and total water levels are tightly controlled indoors in a closed system (Mulqueen, Lee, & Zafar 2017). Cannabis plants have a threshold at which they can absorb water. This can lead to serious over watering problems, which is wasteful and detrimental to plant health. Though there are many methods for watering, it has been suggested to hydrate plants in smaller quantities more frequently, versus dumping gallons into the soil every now and again. Automated drip systems are also ideal solutions for precise watering dosages (Fred 2014).

One of the most effective ways to save water is by growing sea of green with a zero drain to waste system. Smaller sized plants require a shallower soil depth and less water. Sea of green plants are typically grown to be about 18 inches tall versus traditional plants, which are nearly 6 feet tall. The smaller the plant, the less water it requires to stimulate growth. On average, sea of green soil beds are 7 inches deep. Compare this to a traditional growing pot with soil double the depth. Sea of green soil beds will need a smaller quantity of water to reach the root system (Dreier 2014). Growing sea of green has shown to reduce water consumption by up to 60%.

Grow Mediums & Environmental Impact

It is key to find growing mediums that reduce nutrient runoff and water waste. Crops require controlled environments to thrive. Quality, purity, consistency, bioactivity and biomass production can be measured to determine how controlled the environment is. Keeping track of these factors also reduces the risk for pathogens and pests (Hayden 2006).

The living soil, sea of green growing method is a zero drain to waste system. Essentially, this means there are no excess nutrients or water that will leach from the soil into waterways. A living soil refers to a healthy, aerobic environment in which the soil microbiology is feeding the plants. In this type of environment, nutrients are readily available for the plant to undergo exchange and uptake. A well-balanced soil has a broad range of macro and micronutrients. The living soil medium consists of The Original CHO feeding regimen in a light NPK soil mixture. This system provides plants with the correct ratio of nutrients they need, taking out guesswork and need for constant balancing. Ultimately, this makes the growing process much simpler (2017). In addition to simplicity, zero drain to waste systems are much more environmentally friendly. When excess salts get leached into waterways, eutrophication and water contamination can occur.

There are other methods of growing instead of a traditional soil medium. Hydroponic growing has a system that delivers nutrients in a liquid form, excluding aggregate mediums that would normally anchor the plant. Hydroponics are fairly efficient in terms of water and fertilizer usage (Hayden 2006). They can also be more environmentally friendly, considering they reduce waste from soil run off (2018). Typically, hydroponic systems use mediums such as perlite, rockwool or peat moss. Plants don’t have to work quite as hard in a hydroponic system to obtain nutrients. Therefore, plants will grow easier and develop quickly.

Aeroponic grown crops are suspended in a spray chamber. These systems recirculate nutrient solutions underneath plants and are fairly simple to use. Using aeroponic a-frame structures can allow for up to 1.7 times the amount of growing area that the square footage in the greenhouse would normally allow (372 sq ft of crops in a 216 sq ft space) (Hayden 2006). Both hydroponic and aeroponic systems are becoming more popular grow mediums for cannabis cultivation.

Flood tables are another common grow method. Rockwool cubes are typically used as the medium to anchor the plant’s root system. A flood table has a tray that gets flooded with a water and nutrient solution on a consistent schedule. The rockwool cubes absorb this solution, delivering it to the plant’s roots. Flood tables are said to help speed the rate of growth in plants and overall size as watering intervals increase. Though flood tables are fairly efficient, large amounts of water can potentially be wasted by using this type of system (2018).
Grow Cycles: Perpetual vs. Reset

When designing a flower room, one of the first steps is to decide if you want to grow perpetual or on a reset schedule. Perpetual growing allows for more yields and number of harvests per year. Growing in vertical racks with the SGS DLI dimming controls enables growers have plants in various stages of the grow cycle in different racks. For example, in an flower room with eight racks, one rack could be dedicated to plants in each week of flower (one rack has week 1, the second rack has week 2 plants, and so on). A major downfall of perpetual growing is that it requires intensive labor due to frequent transplanting and harvesting. For this reason, growing on a reset schedule is more common. A reset grow is when all veg plants are transplanted to flower at once and then harvested at the same time.

The sea of green Smart Grow System consists of two weeks clone, two weeks veg and eight weeks flower. Growing throughout the entire year gives growers 4 to 4.5 annual harvests. A perpetual grow done correctly could result in a minimum of one additional harvest per year. And of course, more harvests results in more income.

Cost Analysis

High pressure sodium and metal halide lights have a fairly cheap initial cost when compared to LEDs. As stated earlier, HPS and MH consume an enormous amount of energy and produce excessive amounts of heat. LEDs have an higher initial cost but quickly pay themselves off with monthly and annual savings. Standard LEDs are rated for 50,000 hours, which typically last up to 10 years on a 12:12 flower schedule (2018). In most cases, HPS bulbs need to be replaced once or multiple times a year (2018). Considering up to 50% of total costs in a grow operation come from energy, it is worth investing in more expensive alternatives that will pay themselves off quicker (Kolwey 2017).

For example, Yerba Buena in Hillsboro, Oregon converted their veg room to 1,270 tubular LEDs from standard HPS lights. They run nearly 6,570 hours a year. The conversion from HPS to LEDs cost just under $30,000. However, it will be paid back within just 9 months due to energy savings and reduced operating costs. Yerba Buena is saving 258,600 kWh/year just by switching to LEDs and reducing their annual operating costs by $22,000.
Calculating LED Grow Light Energy Savings:

\[
\text{kWh Savings} = \text{lighting kWh savings} + \text{HVAC interactive}
\]

\[
\text{Lighting kWh savings} = (\text{HID wattage} - \text{LED wattage}) \times \text{Annual Operating Hours}
\]

\[
\text{HVAC interactive} = \text{lighting kWh savings} \times 3,412 \text{ BTUs/kWh} + 12,000 \text{ (tons/BTU)} \times \text{HVAC kW/ton}
\]

(BTUs = British Thermal Units. The amount of thermal energy required to change the temperature of one pound of water by one degree in one hour (2018)).

**Deschutes Growery Highlight**

Deschutes Growery in Bend, Oregon converted their facility to a solar powered, vertical, sea of green grow with SGS 48VDC LEDs. Their facility is 8,000 square feet. However, Deschutes is growing 10,000 square feet worth of canopy due to the four tier, mobile vertical racking system (2018). Deschutes has achieved a lighting power density of less than 20 watts per square foot. In a standard indoor grow, lighting consumes about 150 watt per square foot (Mulqueen, Lee, & Zafar 2017). Though the project had a large initial investment, they will be saving nearly $200,000 each year in energy consumption. In addition, they will be saving 2.5 million kWh and around 1,300 tons of CO2 annually (Energy Trust of Oregon 2018).

**Tokyo Starfish Highlight**

Tokyo Starfish in Bend, Oregon did a side by side comparison between flower rooms using SGS 48VDC LEDs and dimlux HPS lights. One flower room contains sixty 500 watt Smart Grow Systems LEDs, while the other room contains thirty 1,000 watt dimlux HPS lights. In one month, the LEDs flower room used only 5,000 kWh, compared to the dimlux lights which used well over 10,000 kWh. The LEDs used roughly half the energy consumption in one month with double the amount of lights.

**The Smart Grow System**

Smart Grow Systems has developed highly engineered, LED lights that are tailored to each phase of the grow cycle. They are available in two main spectrums: the Baby Blue for propagation and the GOLDENi for flowering. Smart Grow lights contain aluminum-plated boards, are one inch thick and designed for maximum stacking capabilities in vertical racks. Each light contains thermal gaps, allowing heat to escape from the canopy. Smart Grow lights thrive when it comes to growing sea of green but can be used for traditional growing methods as well. The combination of Smart Grow lights and a mobile, vertical rack system allows for a larger biomass yield each grow cycle. Utilizing vertical racks also makes perpetual growing a more viable option when compared to traditional one-level methods.

Smart Grow LEDs use 48VDC remote power servers. Remove power removes a majority of the heat from the canopy area and grow room. DC remote power servers can also extend up to 350 feet away from the lights. In standard grows using AC (or a combination of AC and DC), the power supply is forced to be placed adjacent to the light source. AC drivers extend no more than 15 feet away from the lights. The need for air conditioning systems is significantly reduced when heat is removed from the room. In addition, DC remote drivers can power up to 6 lights per box, compared to the AC drivers which only supply power to one light. Remote power has shown to increase efficiency up to 250%.

<table>
<thead>
<tr>
<th>DC Advantages</th>
<th>Fluence Spyder AC Power</th>
<th>GOLDENi 500 DC Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabling Distance</td>
<td>8-12 ft</td>
<td>330-375 ft</td>
</tr>
<tr>
<td>Heat Reduction</td>
<td>All heat stays in room/building</td>
<td>40-45% Less Heat than Fluence</td>
</tr>
<tr>
<td>Input Watts Efficiency</td>
<td>AC power is 35% less efficient than DC</td>
<td>35% better Efficiency than Fluence</td>
</tr>
</tbody>
</table>

Figure 12: Remote DC power advantages compared to AC powered LEDs.
SGS Vertical Frame Specs

### 48 Vdc LED Drivers

<table>
<thead>
<tr>
<th></th>
<th>Baby Blue 100</th>
<th>Baby Blue 250</th>
<th>GOLDENi 500</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Watt</strong></td>
<td>100 watt</td>
<td>250 watt</td>
<td>500 watt</td>
</tr>
<tr>
<td><strong>V &amp; A</strong></td>
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<td>110 volts, 2.7 amps</td>
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<tr>
<td></td>
<td>240 volts, 0.65 amps</td>
<td>240 volts, 1.25 amps</td>
<td>240 volts, 2.2 amps</td>
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<tr>
<td></td>
<td>208 volts, 1 amp</td>
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<td></td>
<td>277 volts, 0.65 amps</td>
<td>277 volts, 0.75 amps</td>
<td>277 volts, 1.8 amps</td>
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### 250 Vdc Drive-USA

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<th>Baby Blue 250</th>
<th>GOLDENi 500</th>
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<tbody>
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<td><strong>Watt</strong></td>
<td>100 watt</td>
<td>250 watt</td>
<td>500 watt</td>
</tr>
<tr>
<td><strong>V &amp; A</strong></td>
<td>NA</td>
<td>110 volts, 1.3 amp</td>
<td>110 volts, 2.7 amp</td>
</tr>
<tr>
<td></td>
<td>240 volts, 0.26 amp</td>
<td>240 volts, 1.25 amp</td>
<td>240 volts, 1.7 amp</td>
</tr>
<tr>
<td></td>
<td>208 volts, 0.8 amp</td>
<td>208 volts, 0.35 amp</td>
<td>208 volts, 1.1 amp</td>
</tr>
<tr>
<td></td>
<td>277 volts, 0.22 amp</td>
<td>277 volts, 0.55 amp</td>
<td>277 volts, 1.1 amp</td>
</tr>
<tr>
<td></td>
<td>480 volts, 0.16 amp</td>
<td>480 volts, 0.42 amp</td>
<td>480 volts, 0.85 amp</td>
</tr>
</tbody>
</table>

### 250 Vdc Drive-Canada

<table>
<thead>
<tr>
<th></th>
<th>Baby Blue 100</th>
<th>Baby Blue 250</th>
<th>GOLDENi 500</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Watt</strong></td>
<td>600 watts, 0.12 amp</td>
<td>600 volts, 0.3 amp</td>
<td>600 volts, 0.5 amp</td>
</tr>
</tbody>
</table>

### Frame Dimensions

<table>
<thead>
<tr>
<th></th>
<th>Baby Blue 100</th>
<th>Baby Blue 250</th>
<th>GOLDENi 500</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dimensions</strong></td>
<td>46” x 7.5”</td>
<td>46.5” x 22”</td>
<td>46.5” x 22”</td>
</tr>
</tbody>
</table>

Figure 13: Smart Grow System’s vertical frame specs for the Baby Blue 100, 250, GOLDENi 500. The SGS Baby Blue spectrum is tailored to the propagation phase of the grow cycle. The GOLDENi has a higher red/orange spectrum, which is designed for flowering.

Figure 14: Sea of Green growing method with Smart Grow System’s LED GOLDENi flowering lights.
Biobased

Smart Grow Systems uses The Original CHO feeding regimen. The Original CHO is USDA Certified Biobased. Biobased products are derived from plants and other renewable agricultural, marine and forestry materials (USDA). Biobased refers to the amount of “new” versus “old” carbon. New carbon sources are considered organic, where carbon is bonded to hydrogen, full of active energy. An example of new carbon would be a tree. Old carbon sources are used, processed or spent. Examples of old carbon sources would be coal or styrofoam (USDA). Using biobased products reduces the use of petroleum and promotes utilizing renewable resources instead. In turn, this reduces environmental and health impacts (USDA).

Conclusion

Indoor cannabis facilities will be built as the industry continues to grow. It’s important for growers to migrate away from traditional growing methods in order maintain a baseline level of sustainability. Old grow methods use an enormous amount of energy, space, water and other resources. Growing cannabis can be more eco-friendly by using VDC powered LEDs, mobile vertical racks and zero drain to waste systems. LEDs powered by 48VDC rectifiers can significantly cut down energy consumption. Using VDC LEDs produces nearly 40% less heat. Ultimately, this transition reduces the need for HVAC systems, which contribute to half of a standard grow’s energy consumption. LEDs have a very small thermal output compared to traditional HPS or MH lighting systems. In addition, 48VDC LEDs are twice as efficient as 24VAC LEDs and up to four times as efficient as traditional HPS lights.

To maximize space within a grow area, using mobile and vertical rack systems has shown to be the most effective method. Mobile racks can be moved together, creating one giant PAR map over the canopy area. They also allow for up to three to four times more canopy within the same square footage. Vertical farming in combination with sea of green has shown to produce the highest yields. There are many metrics that can be measured to determine how sustainable a grow facility is. Smart Grow Systems recommends keeping track of kWh/pound, grams/watt and grams/square foot. Running these numbers helps growers understand their costs, yields and income more precisely. In order for the cannabis industry to sustain itself, growers must transition towards more energy efficient alternatives. Ultimately, the goal is to maximize canopy while saving energy and money with The Smart Grow System.
References


