THE SUN ON-DEMAND™

AZENTIVE

Growing with Indoor Sun: Bringing Outdoor Cultivation Indoors with The Sun On-Demand™

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HEALTHY PLANTS PROFITS PEOPLE™

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1 Introduction

At AZENTIVE, we support completely regenerative growing in alignment with Nature, which includes cultivating in living soil and using sunlighting. We foster biomimicry cultivation systems that grow nutrient-rich fruits, vegetables, and plant-based medicines. The healthiest, most compound-rich plant-based medicines and most nutrient-dense foods are nourished in living soil and sunlighting.

The electromagnetic frequencies and the combination and permutations of frequencies of the Sun are imperative for plants and the living soil in which plants thrive. Sunlight drives the stages and funcitons of plant growth and development. From UVB to Far Infrared (IR), the Sun's electromagnetic frequencies are the building blocks of the plant's secondary metabolites forming the compounds in the plant. These frequencies are delivered to the plant via photons.

The Sun On-Demand™ (TSOD) is a hyper-efficient sunlighting technology that mimics the energies of the Sun, including the combinations and permutations of the frequences of the Sun. It biomimics true electromagnetic sunlighting energy, spectrum, and frequencies. No other grow light can do this. TSOD brings sunlighting to your indoor garden.

Treat TSOD like you have sunlight indoors, because you do. This means that you can grow indoors as close to outdoor growing as possible. You can also supplement the outdoors with your indoor garden by overwintering your crops or jump-starting your outdoor farm with ready-to-plant outside, hardened teens that have more internodes, strong immune systems, and more root mass. Your plants started under The Sun On-Demand™ will quickly acclimate to outdoor sunlight, saving you that long transition time from artificial lights.

This document was inspired from and draws upon the collective experiences of cultivators, farmers, breeders, and medicine-makers using The Sun On-Demand™. It is based on the science of biomimicry, as well as general trends and aggregated results of our cultivation partners. Your situation may vary, depending on plant genetics, environmental factors, cultivation methods, and other variables. This document will be updated and revised over time as our cultivation partners share more and the research advances.

1.1 Start Strong with Biomimicry

Once you have sunlighting in your garden, you'll want to start strong by treating it like sunlight. Mother Nature and our cultivating partners have taught us that it is important to grow your garden as close to outdoors as possible, paying special attention to the following factors at a minimum:

- **Genetics** – Bring in outdoor, heirloom, landrace, and/or sativa-dominant genetics. Most genetics today have been selectively bred to grow under the limited energy of LEDs and HPS/MH artificial lighting technologies provide (i.e., less than 25% of the Sun's energy).

- **Sunlighting from the start** – Grow under The Sun On-Demand™ from seeds or from clones from mother plants that are acclimated to and/or bred for sunlight. Use The Sun On-Demand™ throughout every stage of plant growth from day 1 to veg to flower to mother. You may also start your plants under The Sun On-Demand™ and move them directly outdoors to veg or ready-to-flower. We absolutely do not sell The Sun On-Demand™ to cultivators planning to veg under artificial lights and flower under The Sun On-Demand™ as your results will be akin to sticking those plants in direct Sun outside. It just doesn't work (especially with LED- or HPS-genetics).

- **Living soil** – The combination of sunlighting and living soil is the best combination for your plant to express the full bioavailability of secondary metabolites/compounds of its genetics This symbiotic relationship has been honed by Mother Nature, and leads to improved health, stronger immune systems, higher medicinal quality, and much more.

- **Mind the roots** – Roots develop quicker with The Sun On-Demand™, often impacting transplant schedules in your garden. We recommend growing in living soil beds with companion planting, but this is not always pragmatic. So, mind the roots as you may need to transplant to larger pots sooner than you're used to with artificial lights to avoid becoming rootbound (which will likely stunt growth or promote flowering in Autoflowers).

- **Watering** – Plants growing in sunlighting from The Sun On-Demand™ may drink more water than plants growing under artificial lights. You may also want to adjust pH levels, which often vary by the growing medium and lights you are using.

- **Climate control** – The Sun On-Demand™ systems typically reduce lighting-related heat significantly. This has effects on temperature and humidity set points, leaf temperature, respiration, and vapor pressure deficit (VPD). CO^2 levels may need to be turned down, especially when living soil is used.

- **Sunlighting hours** - Since you are now bringing in full electromagnetic sunlighting energy, we recommend reducing the number of hours you are lighting your plants to more closely mimic sunlighting hours in Nature.

1.2 Pitfalls to Avoid: Artificial Growing

- **Genetics** – This is the hardest and most important pitfall to avoid. Sadly, most genetics are polyhybrids that have been selectively bred for generations under artificial lighting conditions (i.e., less that 25% of the Sun's energy). This makes for weak genetics that need time to adjust to full electromagnetic sunlighting. It's best to start with strong genetics that can handle the Sun.

- **Vegging under artificial light** – Do not start orveg plants under artificial light before exposing them to sunlighting from The Sun On-Demand™. Grow under sunlighting from day 1 through veg, flower, and mother stages.

- **Leaf stripping and lollipopping** – Slow down on this (a lot). Extensive leaf stripping robs plants of their energy collectors (i.e., the leaves), limiting their ability to fully collect the energy available from The Sun On-Demand™. This energy is used to grow and produce full expression flowers.
- **Watering and temperature** – Standard Operating Procedures (SOPs) for watering, pH, and climate control that are designed for artificial lights will need to be updated for sunlighting when growing from The Sun On-Demand™.

We dig into these topics in more detail in the rest of this document.

2 Learning Together: Test, Learn, Adapt

Our intention is to share what our team and others have learned and shared so that everyone may benefit. The Sun On-Demand™ is more than a light. It mimics the Sun, which has been designed by the most efficient engineer we know of, Mother Nature. TSOD specifically replicates the full electromagnetic frequencies of the Sun's spectrum that get through the Earth's atmosphere from UV-B to Far IR.

2.1 Sunlighting is not a Panacea

Although it is pretty darn cool, the Sun alone is not a panacea. It is one important factor in Mother Nature's symbiotic growth system that produces the healthiest plants and optimal fruits, flowers, and foods. Other important factors include genetics, growing methods, and environmental conditions. The true potential of The Sun On-Demand™ is that it will allow you to grow like Nature indoors, where plants are immersed in living microclimates very similar to the native conditions in which your genetics evolved. As a team and in alignment with Mother Nature, we are dedicated to helping you circle your plants with a biomimicry system.

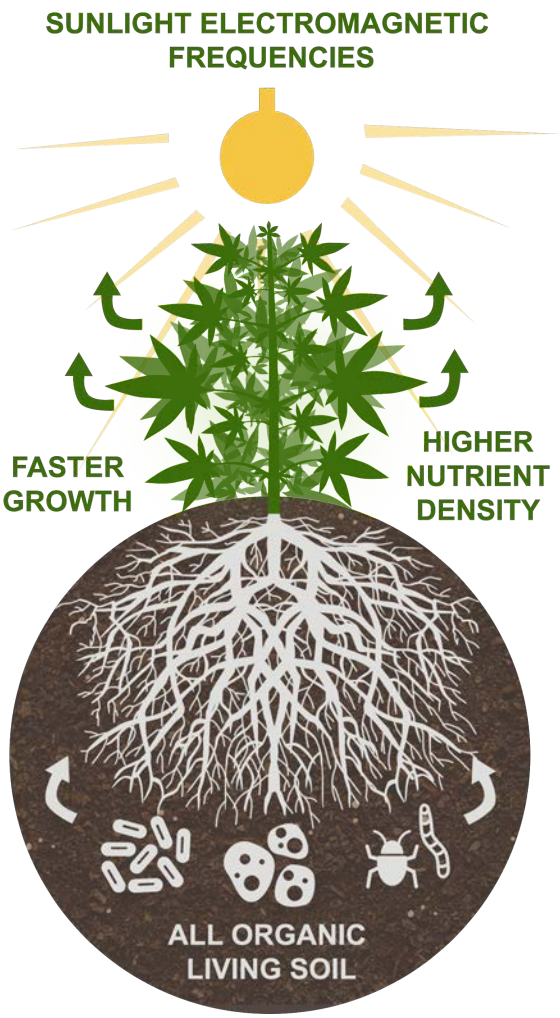
At AZENTIVE, we are life-long learners. We use a process of continuous improvement that we call test, learn, and adapt to constantly improve as we collaborate with like-minded people

like you. This document is a working document, and we issue updates periodically. In the future, we may convert it into a webpage or an open source wiki so that others may contribute lessons learned as we all embark on the road to healthy plants, healthy people, healthy places, and healthy profits™.

2.2 Getting the Most from your TSOD Sunlighting

You are about to have sunlighting in your garden! That means you can achieve complete genetic expression of secondary metabolites, healthier plant immune systems, and wider genetic diversity. It also means your monthly power bill is about to go down. You'll also save on and/or avoid Capital equipment expenses, labor, bottle feedings and other inputs, and Integrated Pest Management (IPM) expenses.

The key to getting the most out of The Sun On-Demand™ (TSOD) is to use the principles of biomimicry, bringing as many of Nature's systems and processes into your indoor garden as possible.



Consider the way you train your plants, the way you defoliate, the temperature/humidity set points you're using, and the genetics you run. If you've been growing under artificial lights (e.g., HPS, LED, Metal Halide, etc.), you should expect that switching to indoor sunlight from The Sun On-Demand™ will change the way you grow—much like if you were to start growing outdoors. That's because the Sun optimizes the way plants grow by providing electromagnetic energy. If you have experience growing outdoors, this will make perfect sense to you. If not, please read this document in detail.

We created this guide to help you get the most out of The Sun On-Demand™. You'll learn how to get your garden working with Nature, rather than resisting it. In addition to growing healthy plants, breeding with The Sun On-Demand™ will allow you to incorporate landrace, heirloom, sativa-dominant, and outdoor genetics that cannot thrive under artificial lights.

This document can help you set your game plan for growing with sunlighting. Some of what we'll share will seem intuitive, especially if you have experience growing outdoors. If you've

only ever grown indoors, some of this may seem strange. Many assumptions, protocols, and SOPs that are taken for granted stem from indoor cultivation without the Sun's energy. Being limited to HPS and Metal Halide, and more recently to LEDs, has necessitated a certain amount of "dialing it in" to compensate for not having the energies of the Sun. It's time to reset back to the future, because Mother Nature has already set up incredibly efficient and effective systems for us.

3 Pitfalls to Avoid

3.1 Weak Genetics and Polyhybrids

Table: Beginning with strong genetics and using outdoor cultivation techniques will help you and your plants start strong in sunlighting indoors with The Sun On-Demand™

Slow Start	Strong Start
Indoor genetics and polyhybrids (i.e., weak genetics, often with viroids and other pathogens)	Heirloom, landrace, and outdoor genetics (i.e., strong genetics)
Vegetation stage under artificial light, or clones started under artificial lights	Grow from the start in sunlighting: seed, mother, clone, vegetation
Extensive leaf stripping, defoliation, lollipopping	Minimal leaf stripping to help spent fan leaves fall off

Our recommendation is to always start with heirloom, landrace, outdoor genetics. Landraces, heirlooms, sativa-dominant, and other sun-loving outdoor genetics can thrive under The Sun On-Demand™, especially in living soil. These plants have not mutated due to growing under limited-energy, artificial light. With The Sun On-Demand™, plants get the sunlight they crave in an environment you control. It's the best of both worlds. These amazing plants are capable of creating unique and complete cannabinoid and terpene profiles, and even adapting to heal the illnesses of nearby plants.

Incorporating unique genetics into your rotation or breeding program will help you differentiate in a market crowded with generic and "me too" polyhybrids. The Sun On-Demand™ allows you to increase genetic diversity and produce full expression plants in your garden. That gives you a huge competitive advantage. Most importantly, diverse genetics and complete genetic expression allows you to offer more varied and effective medicine to those who desperately need it.

Many common indoor cultivars ("strains") have been overly hybridized and homogenized to grow indoors under artificial inputs and artificial light spectra (which is less than 25% of the Sun's energy; see Sunlight vs. PAR section below). Generation after generation, clone after clone, these polyhybrids have been bred and selected for their ability to cope with a fraction of the Sun's frequencies/energies under which their ancestors evolved. These indoor genetics are weaker, more susceptible to pests and infection, and have drifted far from their original

expression, sometimes with the sole purpose of achieving a high percentage of THC at the detriment of all the other secondary metabolites. Many of the clones on the market today are rife with pathogens, and specifically, the market has seen a higher percentage of commercial facilities infected with Hop Latent Viroid (HLV)[1] and aspergillus[2]. Be careful what you buy.

Here's the bottom line: most polyhybrids have been extensively bred and mutated to grow under artificial lights (<25% of the Sun's energy) and it may take multiple runs under The Sun On-Demand™ for them to reset back to their original expression. Instead, we highly recommend starting with clean heirloom, landrace, and other outdoor genetics.

3.2 Vegging Under Artificial Light

To fully understand indoor lighting, please see the Sunlight vs. PAR section below for more information about the energy and frequency differences between sunlighting and artificial lights.

Imagine a non-native plant bred to grow indoors under artificial lighting and raised in that environment. Now imagine putting that plant directly outside on a sunny summer day. You already know what would happen. At best, that plant is going to experience a fair amount of stress and take two to threeweeks to acclimate to this abundance of electromagnetic energies. At worst and not uncommon, the plant will not recover, and your flowering stage will fail. Since that's the basis of your business, no one wants to see that!

With The Sun On-Demand™, you now have sunlighting in your garden. Plants vegged under artificial lights and moved under The Sun On-Demand™ for flower will show signs of stress and may never fully recover before the end of their flower cycle. It's difficult—often impossible—for plants that started under and/or vegged for any period of time under artificial lighting to fully recover from the shock of full sunlighting indoors. Again, this is greatly affected by the chosen genetics (see previous section), growing medium, grow methods and inputs. These plants will develop more slowly than expected, taking time to adjust to sunlighting. As a result, plants take much longer to finish, and bud development will lag behind expected maturation by two-to-four weeks. This leads to lower yields and possibly even a full crop failure.

Plants need to start under sunlighting from the start. They need to go through their vegetative cycle under sunlighting before being placed into flower under sunlighting. The best results with The Sun On-Demand™ come from growing from outdoor, heirloom, landrace, and/or sativa-dominant seeds. Alternatively, you may place your mother plants under The Sun On-Demand™, taking cuts only after mothers have acclimated and the genetics have reset.

[1] https://www.cannabisbusinesstimes.com/article/cannabis-hop-latent-viroid-infections-dark-heart-nursery-crop-loss/
[2] https://www.medicinalgenomics.com/aspergillus-dangerous-cannabis-pathogen/

We have repeated this several times throughout this document. That is because some cultivators have ignored this advice. Please don't ignore it.

Note that The Sun On-Demand™ has been shown to heal and refresh weak or tired mothers, allowing important genetics to be preserved.

3.3 Leaf Stripping and Lollipopping

The leaves are the plant's primary energy collectors. We recommend stripping leaves as little as possible. Creating airflow and "wind" horizontally through the plants (not directed at the tops) to strengthen the plants is a great practice. Stripping off all of the plant's energy capturing leaves (i.e., their "solar panels") and limiting the plant's ability to capture and use electromagnetic energy? Not good practice. This practice likely came about due to a lack of green frequencies that penetrate even "into the shade".[3] The Sun On-Demand™ produces all frequencies of sunlighting, including the green range that penetrates through the plant and down below the soil to activate microbes that feed the plant.

With The Sun On-Demand™, the best results come from treating the plants as if they're outside. Defoliate the same way you would an outdoor plant. In other words, with The Sun On-Demand™, we suggest doing very little aside from helping spent fan leaves fall off. Bringing sunlighting into your garden means light is penetrating from the tops down to the soil or growing medium. Leave more leaves on the plant from the colas down to the lower branches, and your plants will thank you and return the favor in the flowering cycle.

3.4 Roots and Watering

Plants grown from seed or mother plants under The Sun On-Demand™ should show an increase in root mass, micro-hairs, and the rate of root development. This may impact the schedule in your garden. Plants may be ready for transplant earlier than expected. Pay careful attention to the maturation of the roots to maximize these benefits and to avoid plants becoming root-bound. Plants growing under The Sun On-Demand™ tend to drink more than those grown under artificial lighting. This is also impacted by genetics, temperature, and humidity. During your first few runs with The Sun On-Demand™, monitor watering carefully. We also recommend closely monitoring the pH of your plant's water, as even small variations can significantly impact plant health and performance. You may also want to adjust pH levels, which will vary by growing medium and the lights you are using.

One last comment about the roots. We know it's important to track the temperature of the roots. If you live in a cold climate, you may find that your room is not as warm as with HPS or

[3] Ichiro T, Takashi F, Takeshi I, Wah Soon C, Riichi O. (2009). Green Light Drives Leaf Photosynthesis More Efficiently than Red Light in Strong White Light: Revisiting the Enigmatic Question of Why Leaves are Green, *Plant and Cell Physiology*, Volume 50, Issue 4, Pages 684–697

LEDs. Please adjust the temperature of the roots to accommodate this reduction in lighting heat loss.

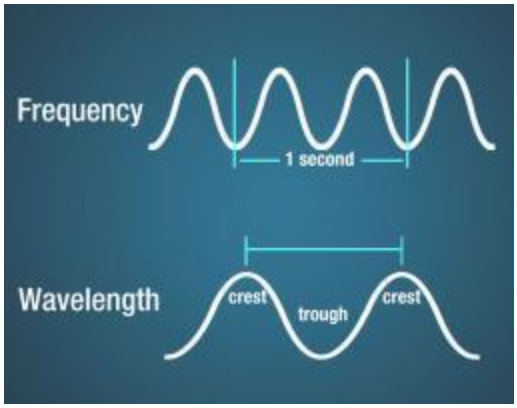
4 Sunlight's Electromagnetic Energy and Plant Growth

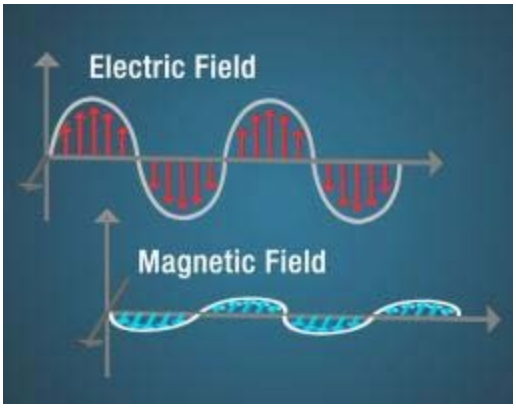
4.1 What is Electromagnetic Energy?

Much of this subsection's research comes straight from NASA's website (see Section 7 for sources). Electromagnetic radiation, or energy, from the Sun is constantly bombarding our atmosphere. The Sun, in fact, is the energy source of almost ALL life on our planet. In fact, our entire World is comprised of electromagnetic energy from the Sun, the Earth, and the Universe, as well as from us humans, plants, animals, and the rest of the microbial structure of our soils and our oceans.

It might seem crazy to think about, but everything is vibrating with electromagnetic energy, and each of us is connected with everything through electromagnetic energy, whether we can see it, touch it, feel it or not. In fact, most electromagnetic energy is imperceptible to most of us, but it is still being used by our bodies and by our plants for many important functions. The portion of the Sun's electromagnetic energy that penetrates through the atmosphere lies between UV-B (Ultraviolet B) and Far Infrared (Far IR). In fact, the atmosphere blocks most of the thermal IR and much of the UV.

Electromagnetic energy is delivered in discrete packets of energy called photons. Photos can be described as both a wave and a particle. These photons travel at the speed of light, have no mass, and carry momentum. All electromagnetic energy (i.e., photons) have both wave-like and particle-like properties. The wavelength is the distance between the *peaks* on either side of the wave's *crest* or *trough* (see right image by NASA below). Particles travel through the air creating electromagnetic fields that transport the electromagnetic energy of the photon (see left image by NASA below).





Both graphics from NASA:
https://science.nasa.gov/ems/02_anatomy

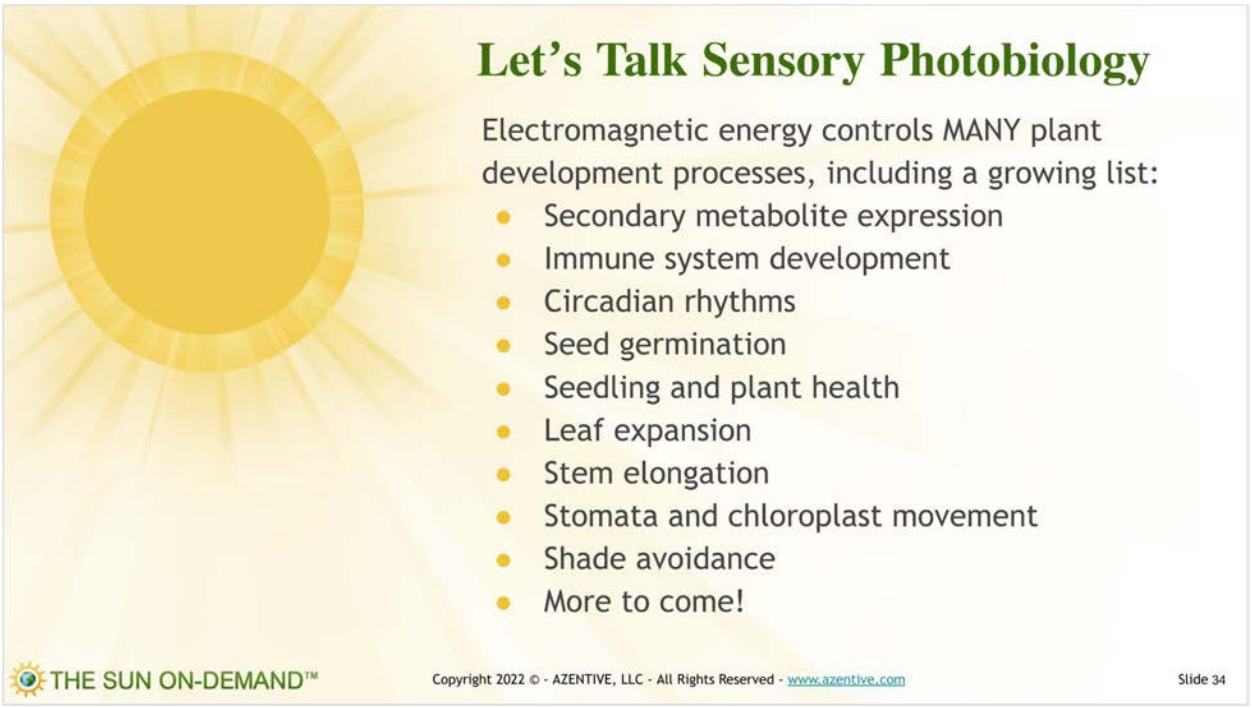
Electromagnetic energy can be measured in the units of electron volts (eV), or the amount of kinetic energy needed to move an electron through one volt potential. UV electromagnetic energy has short wavelengths and, therefore, more energy and higher frequency (Hz), while Far IR wavelengths can reach the size of the Egyptian pyramids and are lower energy. Electromagnetic energy can also be described by frequency, which is how often, or frequent, the wave's crests occur in a given time (Hertz).

4.2 How Do Plants Use Electromagnetic Energy?

Understanding how plants benefit from the infinite number of frequencies and combinations of frequencies that are bioavailable in Sunlight is very important. Electromagnetic energy and the combinations and permutations of frequencies of the Sun and The Sun On-Demand™ are distributed across the entire electromagnetic spectrum from UVB to far Infrared. That means that every wave permutation and the combinations of these wave permutations of sunlighting energies are available for both your living soil (or other medium) and your plants to absorb to create secondary metabolites (i.e., nutrients, Cannabinoids, terpenes, flavinoids, etc.).

You may be used to thinking of light for your plants and thinking of it in terms of color and sometimes wavelengths, because this is how the industry talks about it. Electromagnetic energy is so much more than that. Electromagnetic energy can be described in terms of light, but it can also be described in terms of electromagnetic waves and/or electromagnetic radiation. It can also be described in terms of frequency, wavelength, and other energy metrics.

All electromagnetic energy is transmuted through frequencies and electromagnetic waves. It is NOT transmuted through color. This is a difficult concept because color is what the human eye can see, and it is how all plant lighting companies describe light. Still, color is a perfectly useless metric for plants. This visible spectrum to the human eye is limited to what we are able to easily perceive. Electromagnetic energy extends far beyond what the human eye can see, and plants use electromagnetic energy for almost all of their development processes (see the following slide).

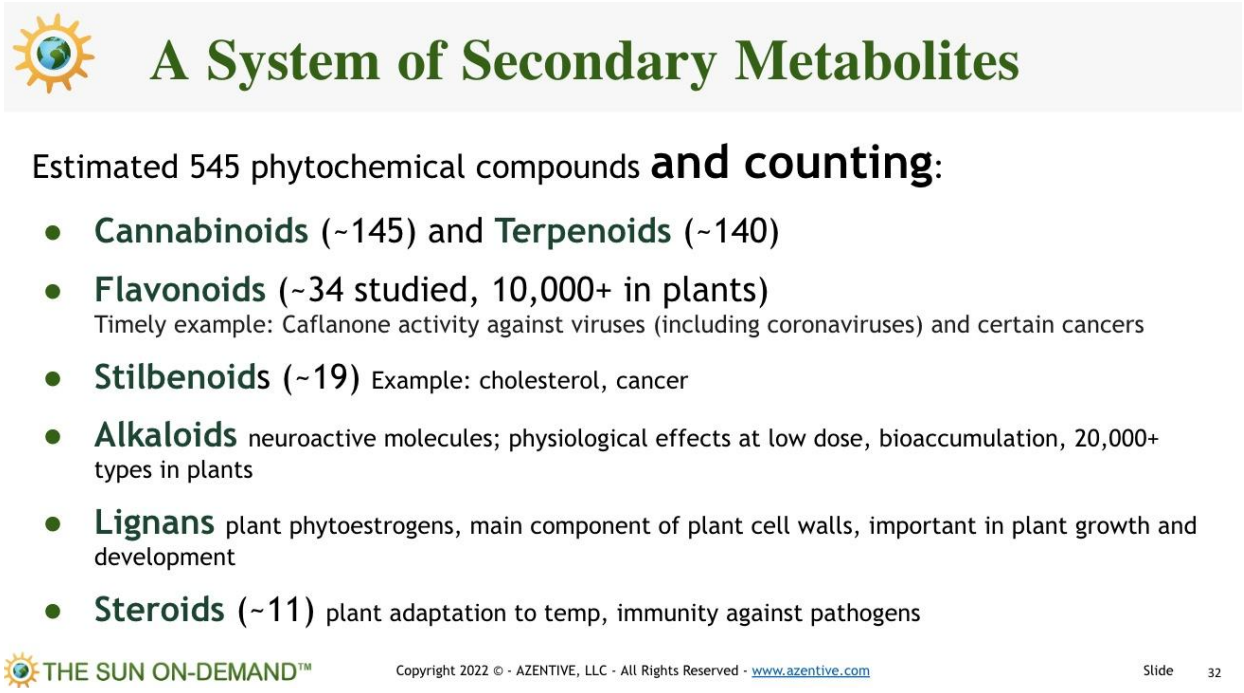


Why does this matter? The complete and uniform range of the Sun's energy, including the frequencies and the combinations of these frequencies make an enormous amount of energy bioavailable for plants to use for all functions of plant development. Plants need far more than visible light for complete development.

Plants are intelligent, sentient beings, and have far more genes than even the human being. That means that plants can use what energies they need, when they need it at different stages of plant growth, at different times of day, and to react to different stressors. UV frequencies develop immune systems, yet most Cannabis is sprouted or cloned without a lick of UV. It's no wonder we're seeing more and more pathogens showing up in nurseries and commercial facilities. Infrared frequencies modulate circadian rhythms. And, on and on. Each function mentioned above is modulated by a different permutation of the Sun's energy. And, we haven't even started writing up how combining this with living soil drives even healthier and heartier plants.

An exciting and emerging research shows that specific permutations of frequencies are tied to the development of specific plant compounds (from the building blocks of secondary metabolites).[4] Today, we know of about 545 Cannabis compounds and counting (see next graphic). Still, we know there are well over 30,000 secondary metabolites in plants and scientists are discovering new Cannabis compounds on a regular, almost daily, basis. Combining sunlighting energy, living soil with the mycelium network, and strong genetics ensures complete expression of your plant's potential.

[4] Personal conversations with Dr. Steven Newmaster, Guelph University.



Science is starting to catch up to Mother Nature. And, more and more people are beginning to understand the complexity of full expression Cannabis and food, along with the myriad of secondary metabolites that combine to produce the effects of the medicine and the nutrient density of the food. What an exciting time to be working with this intelligent Cannabis plant! (And, we are equally excited to be learning about our food, too!)

4.3 To PAR Meter or Not to PAR Meter

Different instruments measure wave-like or particle-like properties of different ranges of the electromagnetic spectrum. For instance, spectral analysis instruments are limited to observing the wave-like properties of light, including PAR meters that only measure within the visible range of Sunlighting and fail to take the electromagnetic energy into account. It's been an interesting adventure of comparing the myriad of readings on the many handheld PAR meters we've run across over the years. TSOD cannot be measured with a PAR meter.

Meters such as those in expensive digital cameras observe the particle-like nature of electromagnetic energy, where individual photons free up electrons that are used to detect and store image data. This is why some digital cameras are better tools to measure the full spectrum of The Sun On-Demand™. Still, these tools are limited in their ability to observe the complete amount of electromagnetic energy emanating from the Sun or The Sun On-Demand™.

We don't know of any handheld meters that are capable of measuring the energy of TSOD. Don't be fooled by those asking for a PPFD or PAR map. See the next section to learn about

why these don't begin to measure TSOD's energy and plant growing potential. We've had to hire specialized laboratories to measure TSOD, and even then, they are unable to measure the full far IR spectrum, which has had to be extrapolated.

5 Differences Between Sunlighting and Artificial Lights

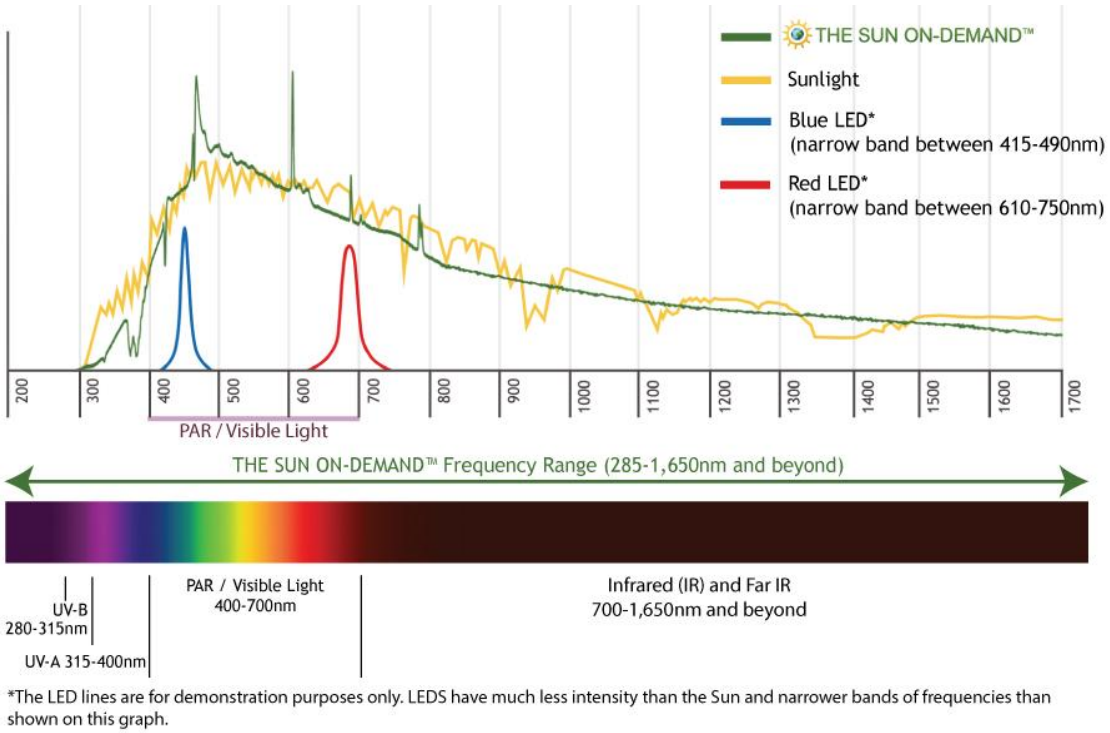
5.1 Sunlighting vs. PAR

Sunlighting from The Sun On-Demand™ matches the uniformity, distribution, and ratio of the electromagnetic frequencies of natural outdoor Sunlight from UVB to Far IR (See Figure below). Visible light, or the PAR range (erroneously dubbed Photosynthetically Active Radiation). This PAR range between 400 nm and 700 nm represents only 43% of sunlight.[5]

As discussed in the previous section, plants use energy outside of the PAR range for many development functions, including "feeding" the living soil as well as plant photomorphogenesis, which impacts plant development, morphology, cell structure, biochemistry, and plant functions.

[5] Benston, Harlan, Electromagnetic Spectrum in Electromagnetic Waves of Solar Radiation: Components. Retrieved from: https://www.brighthub.com/environment/renewable-energy/articles/63714.aspx

Sunlight vs. Artificial LED Light Spectra. The purple line indicates the PAR range (visible light), representing about 43% of the sun's electromagnetic spectrum.

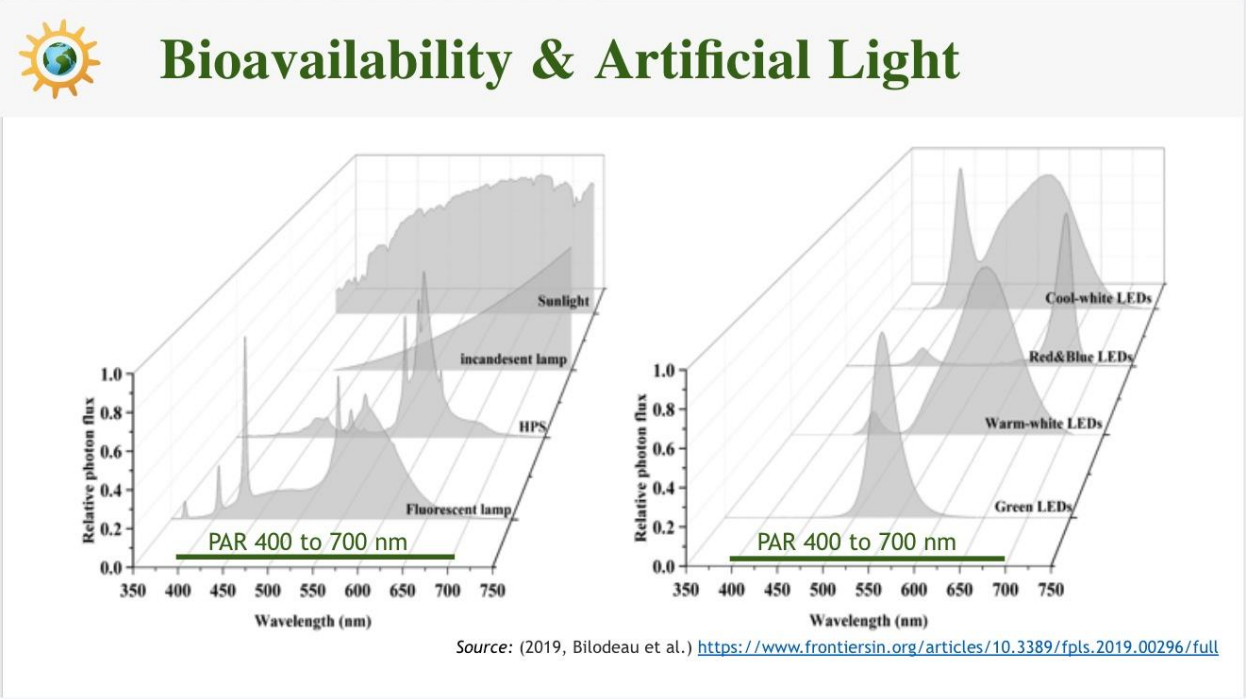


*The LED lines are for demonstration purposes only. LEDS have much less intensity than the Sun and narrower bands of frequencies than shown on this graph.

In contrast, artificial lights like LEDs and HPS deprive plants of the full range of electromagnetic energy that sunlight provides. Artificial lights are limited to the visible part of the spectrum. Unfortunately, the LED artificial lighting industry markets their narrowband technology as "full spectrum". In reality, as explained in the previous section, visible light includes only what the human eye can see. That's not how plants use the energies of the Sun.

In the next Figure, you will see two graphs comparing a portion of the Sun's electromagnetic spectrum (you can see how the Sunlight graph is cut off at 350 nm and 750 nm). Only half of the Sun's spectrum is represented in the Figure, leaving out UV-B, part of UV-A on the left, as well as most of Infrared and far Infrared on the right side of the graphic.

Artificial light spectra compared with natural sunlight. Note that frequencies are concentrated in the PAR range (see the green line). only within the PAR range).[6]



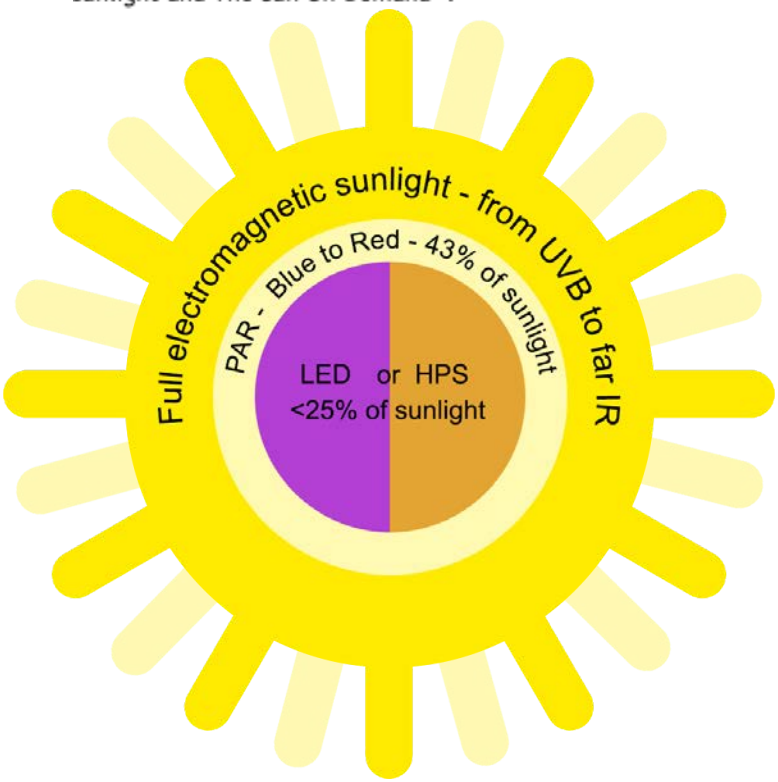
The Figure above also depicts the spectra of many other lighting types, including the commonly used HPS and LEDs, as well as fluorescent lamps. What you should notice from the two Figures above is that the Sun has a broad and complex spectrum. On the other hand, LEDs are narrowband technologies, limited to only a few narrow bands of wavelengths/frequencies (and a normalized and misleading smooth curve). Sunlight's spectrum is not a smooth curve, it has peaks and valleys of energy and continues out well past 1650 nm.

It's interesting to note that after sunlight, fluorescent lamps provide the most complete spectrum, but they are weak in power. Still, compared to the Sun, the spectrum can't begin to meet all of your plant's energy needs, which is why growers limit their use to sprouting, cloning, and early cycle vegetative growth.

Both LEDs and HPS lights are technologically limited and can only provide a portion of the PAR/visible spectrum. LEDs and HPS lights produce less than 25% of the Sun's spectrum (see Figure below). Artificial lights lack ultraviolet, far red, and infrared, or are able to produce it for a very limited period of time (i.e., short spectral lifetime). Artificial lights can only produce partial green, yellow, and orange, depriving plants of full immune system development, stunting secondary metabolite synthesis, disrupting plant circadian rhythms, and necessary light penetration.

[6]Eichhorn Bilodeau S., Wu B.S., Rufyikiri A.S., MacPherson S., and Lefsrud M. (2019) *An Update on Plant Photobiology and Implications for Cannabis Production*. Front. Plant Sci. 10:296. Doi: 10.3389/fpls.2019.00296

Figure: Artificial lights provide less than 25% of the electromagnetic frequency range provided by natural sunlight and The Sun On-Demand™.



The Table below provides a comparison of The Sun On-Demand™ and the most popular artificial lighting options (LEDs and HPS) in terms of the characteristics of Sunlight. Sunlight should be the baseline for all plant growth, and it is important to understand how artificial lighting does not stack up to what Mother Nature provides.

Table 2: The Sun On-Demand™ delivers sunlight that includes all electromagnetic frequencies that plants need.

Sunlight Characteristics	The Sun On-Demand™	Artificial Lighting
PAR	✓	✓ **(Portions of PAR)**
UV, Far-red, IR	✓	✗
Uniform frequencies	✓	✗
Stable light quality	✓	✗

5.2 LED Spectra

The technological limitations of light emitting diodes (LEDs) produce very poor light uniformity and photon density. As can be seen in the right-hand side of the Figure above, LED spectrum graphs are "normalized" to account for this, which means the curves are smoothed

and erroneously appear to produce frequencies that are not present. The physical limitations of diodes, the building blocks of LEDs, can only emit a narrow band of light at a very specific narrow band frequency range. Due to technological limitations such as heat, spectral degradation, and mismatched input power, most LED fixtures can only use red and blue diodes, often in combination with blue diodes that have been overlaid with phosphorus filters to create an appearance of white light.

This is important because the plant doesn't perceive colors. That's for the human eye. The plant perceives the red or the blue narrow band of wavelengths or frequencies, and suffers from the lack of the rest of the Sun's energy that is needed for optimal plant development.

Green, UV, and far red diodes are rare in LED grow lights. These diodes are not only too power intensive to be cost effective, but they also degrade quickly as they begin to shift from the intended spectrum after a short time in the facility (two to three weeks). Technologically, LEDs cannot efficiently produce ultraviolet (UV) or infrared (IR) frequencies, nor many of the visible frequencies that penetrate into the canopy (e.g., greens and oranges). Subsequently, plants growing under LEDs are forced to adapt to a fraction of the energy that sunlight provides. This limits plant health, its defenses against pests/infections, and the synthesis of secondary metabolites (and the corresponding compounds in the plant), along with many other plant functions discussed in an earlier section.

5.3 Artificial Lights Degrade Quickly

Aside from forcing plants to adapt to a fraction of Sunlight's energy, artificial lighting technologies show rapid degradation in light quality. For example, HPS and metal halide lose 20% of their power within the first 200 hrs.[7] Ceramic metal halide completely loses UV frequencies over the same time period. Finally, LEDs begin to color shift at 140 hrs.[8]

Cannabis is an amazing plant. It will adapt to grow under a flashlight if that is all the light to which it has access. However, the question we ask is: How do we encourage complete and true genetic expression, maximum yield, and optimum plant health and do so consistently, run after run? All of this together is simply not possible with artificial lights. Artificial lighting companies choose for you: to either provide you with yield at the expense of quality or so that you must hybridize your plants to show a limited and narrow genetic expression. They do this because the limitations of their technologies are such that they cannot produce full sunlight energy, power, density and most importantly full electromagnetic spectrum.

5.4 Impacts to Genetics

We discuss the weakening of indoor genetics due to artificial growing methods in Section 3.1. We won't repeat it here, but you'll want to pay considerable attention to what genetics you

[7] Hopper, E (2016) *How to Tell When Your Lights Need Replacing*. Maximum Yield.
[8] LED Systems Reliability Consortium (2017), *LED Luminaire Reliability: Impact of Color Shift*.

use and how they have been developed. If they've been developed or grown under LEDs, HPS, or other artificial light sources, you can bet it will need time to adjust to Sunlighting energy.

You'll need to cultivate genetics accustomed to the electromagnetic energies of the Sun. If the genetics have traditionally been grown indoors under artificial lights, like LEDs or HPS, your results will gradually improve under The Sun On-Demand™ and reach their best after a few cycles. Outdoor genetics in living soil are best! And, your plants will stand out in a crowded, commercialized market.

5.5 Lighting-Related Heat and Climate Control

The Sun On-Demand™ is highly efficient, converting 75% of input electricity into light. It will reduce lighting-related heat in your garden or cultivation facility dramatically (e.g., typically by 50% compared to LEDs and by more than 70% compared to HIDs). In addition to lowering your HVAC bill, this will impact your temperature and humidity set points, vapor pressure deficit, and respiration rates of the plants. We recommend monitoring your set points closely and taking soil and leaf temperature readings to ensure that parameters remain in the optimum range for your cultivars. For landraces, outdoor, and heirloom genetics, we recommend biomimicking your cultivars' native climate conditions for optimum plant health and full genetic expression.

5.6 Mounting Height

For the best results, plants should grow under The Sun On-Demand™ from seed or from cuttings taken from mothers acclimated to sunlight. We've seen the best results with The Sun On-Demand™ hung about nine (9) feet from the growing medium.

6 Aligning with Nature

6.1 What Sunlight Means for Plants

Sunlight bathes plants in frequencies and combinations of frequencies across the full electromagnetic spectrum. UVA and UVB help plants develop strong immune systems and promote trichome development during flower production.[9] The combination of UVA and blue light allows for photoreactivation which facilitates repair and hardy growth.[10] Green frequencies improve the efficiency of photosynthesis by penetrating into secondary layers of chloroplasts and permeating the canopy (not just the top third).[11] Red and far red frequencies generate the Emerson Effect which improves the efficiency of photosynthesis.[12] Infrared frequencies activate the phytochromes which help to regulate the plant's circadian rhythms and strengthen the plant's immune system.[13]

[9] Eichhorn Bilodeau S et al. (2019)
[10] Britt, A. B. (2004) Repair of DNA damage induced by solar UV. Photosynth. Res. 81, 105–112.
[11] Eichhorn Bilodeau S et al. (2019)
[12] Ibid
[13] Ibid

The multitude of secondary metabolites expressed in Cannabis plants does so due to the complete electromagnetic spectrum of the Sun that makes it through the atmosphere and reaches the Earth's surface.

See Section 4.2 for a deeper dive into this topic.

6.2 Sunlight and Living Soil

Aligning with nature is about bioavailability. If you feed the beneficial microbial, bacteria, and fungal communities in your soil, the soil will feed your plant (aka the soil food web).[14] Like with sunlight, plants can take and use what they need, when they need it from the soil food web. Unlike all artificial lights, sunlight penetrates through the canopy and excites the microbes and other biologics in the soil.[15] The plant is better able to produce the exudates that attract the nutrient-fixing microbes that it needs and better able to adapt as it grows and matures.[16]

For more information on the soil food web and cultivating in living soil, we recommend *The Teaming Series* books by Jeff Lowenfels, an advisor of AZENTIVE. In these books, he talks about the benefits of building up true living soil versus growing lazy plants with NPK. They are available for purchase on our website (https://www.thesunondemand.com/the-teaming-series-by-jeff-lowenfels/).

6.3 Sunlight, Temperature, and Humidity

The Sun On-Demand™ dramatically reduces lighting electricity and lighting-related heat compared to HID and LED systems. This means that your HVAC and dehumidification parameters may need to be adjusted if they've been optimized for energy-intensive HIDs or LEDs. This can result in a significant reduction in operational costs, particularly in warmer climates.

In colder climates, you may need to add heat to the room in the winter to keep plants in the optimum temperature and humidity range. We suggest taking both ambient temperature and humidity readings, as well as leaf and soil temperature readings to ensure that vapor pressure deficit (VPD) is not adversely affected by the reduction in lighting heat with The Sun On-Demand™.

6.4 Fans and Airflow

Providing airflow around your plants is as important as sunshine, water, and organic matter. Airflow on the plants should mimic the way the breeze jostles and pushes plants outdoors.

[14] Lowenfels, J (2010) *Teaming with Microbes: The Organic Gardener's Guide to the Soil Food Web, Revised Edition.* Portland, OR: Timber Press.
[15] Personal Conversations with Jeff Lowenfels.
[16] Lowenfels, J. (2010)

This means the air should flow horizontally through the garden, with at least some airflow focused around the base and lower halves of the plants. This mild stress allows the plants to develop strong stems and stalks.

Horizontal airflow is different from what we see in many gardens with the fans and HVAC vents raised high above the plant's canopy and blowing down on the plants.

VERY IMPORTANT: Wall mounted fans or HVAC vents should not be directed at or blowing directly on The Sun On-Demand™. The Sun On-Demand™ fixtures should be stable at all times. They should not rock, swing, sway, or vibrate during operation.

6.5 Reflective Walls

The Sun On-Demand™ is not a point source, which means that an enormous amount of energy is being emitted uniformly from every point on the spherical bulb. Adding highly reflective coatings or materials to the walls in your cultivation area will allow more photon bounce, reducing light loss and directing more sunlighting energy onto and back into your canopy.

6.6 Photoperiods

With The Sun On-Demand™, your garden is going from a fraction of sunlight to full sunlight. Cannabis plants grow mostly in their dark period. You should be able to reduce veg and flower photoperiods.[17] This is dependent on genetics. You may want to experiment over a series of runs, gradually reducing the number of lights-on hours for both veg and flower in small increments (30 minutes to one hour at a time). This saves in electricity costs and may accelerate the veg cycle with larger filled-out plants.

You may also want to experiment with mimicking light hours based on Mother Nature, gradually building up sunlighting hours and decreasing sunlighting hours based on the patterns in the geographic origins of your genetics.

6.7 Re-Vegging and Perennial Cultivation

Imagine being able to grow the same genetics run after run without relying on mother plants, clones, and continual replanting. We have seen evidence that plants grown under The Sun On-Demand™ may be re-vegged after harvest to begin a new growing cycle. Essentially, the plants may be treated as perennials rather than annuals. This is an emerging area of research and this style of cultivation has not yet been widely adopted due to a previous lack of indoor sunlighting.

However, the capacity to bring sunlight indoors with The Sun On-Demand™, combined with living soil and even the emergence of stable autoflower breeding stock, has led to increasing

[17] Note that several of our partners recommend that plants be vegged under The Sun On-Demand™ for a minimum of four weeks (instead of two weeks), again mimicking Mother Nature's seasonal progression.
Note: Genetics trained under LEDs and T5s will experience a different growth pattern under The Sun On-Demand™ than under artificial lights (See Genetics section for more information).

interest in this technique. One cultivator growing under The Sun On-Demand™ is testing our theory, where plants were flowered, re-vegged, then flowered and harvested again (and again). We have received reports from cultivators that reverted plants back to veg stage after accidentally triggering them into flower due to timer issues under The Sun On-Demand™ in half the time that they expected and without hermaphroditism. We believe this represents a new frontier in sustainable, cost-effective cultivation, and potentially healthier profits.

6.8 Data Collection and Tracking

Bringing sunlight into your garden with The Sun On-Demand™ will change the way your plants grow. It will also impact standard operating procedures (SOPs) related to climate control, watering, feeding, plant training, and canopy management. We recommend tracking these changes carefully each run in order to continuously improve and optimize your garden in alignment with nature.

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