The Greenery

Energy, Efficiency & Carbon Footprint Guide

Summary

The Greenery is constantly evolving to be more efficient and sustainable. Part of this evolution is tied to innovation in the industry, specifically with LED technology, which is responsible for the greatest energy usage within the farm. This electrical energy usage is also largely responsible for the size of the Greenery's carbon footprint. However, with the new Freight Farms and Arcadia partnership, all US based Freight Farmers can have 100% of their power consumption matched with the equivalent amount of wind and solar energy in the form of Renewable Energy Certificates (RECs). The result is a farming method with a carbon footprint that is a mere one-quarter of the carbon footprint measured within industrial farming.

The Freight Farms Greenery: Moving Farms–Not Food

The Freight Farms Greenery is a controlled-environment, vertical hydroponic farm built inside of a 40-foot shipping container. Built with the same specifications as commercial shipping containers, the Greenery farm can travel anywhere in the world through established trade channels. In this way, Freight Farms is able to move the method of food production closer to the final consumer, instead of moving the food itself. The farm's mobility and unique ability to grow food independently of the surrounding environment enables operators to farm year-round in any location. The result is an infusion of fresh, hyper-local, and clean food into any community. In spite of its small footprint (merely 320 sq. ft) the Greenery farm can support up to 13,000 plants at one time and has an average output of 3 tons/year.

3 Key Greenery Technologies

Hydroponics

Hydroponics is the process of growing plants without soil. Instead the plants are irrigated with nutrient-rich water which provides them with all the nutrients and minerals needed to grow healthy and flavorful. The Greenery farm uses two main types of hydroponics: ebb-and-flow and drip irrigation. Both are extremely water efficient–the average Greenery operation uses just 5 gallons of water per day on average, as much as an efficient dishwasher in a single cycle and 99% less than what's used in industrial farming. Learn more >

Controlled Environment Agriculture

The Greenery's controlled environment unlocks its potential to grow food anywhere. With Freight Farms complementary app, farmhand®, farmers have complete control over all major environmental conditions, such as temperature, humidity, CO_2 concentration, water nutrient levels, and airflow. Learn more >

LED Indoor Grow Lights

While the sun is our planet's main source of energy for food production, it is not infallible. The Earth's rotation causes the sun to constantly change position, meaning most regions of the world experience days that are too short, too cold, or too hot to grow plants. Indoor grow lights–namely high-efficiency LEDs–are the best solution to this problem. The Greenery farm's LEDs are carefully calibrated to have the optimal power and frequency to encourage healthy plant growth indoors. Learn more >

The Sustainability Challenge

Over the past decade, the indoor farming industry has evolved from a niche topic to a major part of the agricultural sector. However, in order to become a viable alternative to our carbon intensive industrial farming system, indoor farming must confront its main weakness: a dependency on electrical power that oftentimes counteracts the sustainable benefits of indoor farming.

The Greenery farm–while being exceptionally carbon neutral in irrigation and transportation– does require a significant amount of energy to operate. Under the average conditions, the Greenery farm uses 150-165kWh per day. The greatest power draws come from the farm's LED arrays and cooling system.

Tackling the Challenge

Our primary approach to reducing the carbon footprint and energy usage of the Greenery is through constant system innovation.

To date, the Greenery uses

(a) The most up to date LED technology which has a higher PPFD[1] without a corresponding energy draw. In the 2020 Greenery, the improved LED efficiency results in much less waste heat. This has the double effect of reducing HVAC usage to save additional energy.

(b) An energy-efficient HVAC system that is automated with farmhand® to run quickly and effectively to cool the farm and then shut off to prevent unnecessary usage.

It is important to keep in mind that innovation in lighting and cooling are evolving with the maturation of the indoor farming industry. Through rigorous testing and precise engineering, Freight Farms is constantly updating the Greenery farm's design with the best technology as quickly and cost-effectively as possible.

[1] **Photosynthetic photon flux density (PPFD**). PPFD is a measure of PAR (photosynthetic active radiation). PAR light is all the visible wavelengths of light within the 400-700 nanometer range which cause photosynthesis. PPFD is a 'spot' measurement of how many photons from the PAR range hit a specific area of the plant canopy over time. It is expressed as micromoles per square meter per second (µmol/m2/s). PPFD is the most accurate measure of light power. Unlike other measures, it considers the entire spectrum of light that affects plants. PPFD also takes into account the amount of light that will actually reach the plant instead of focusing only on the point of origin. A light source can be very bright and powerful, but if it is too away from the plant, or obstructed in some way, the plant won't be getting all the light it needs for photosynthesis. PPFD controls for this kind of inaccuracy.

Additionally, we always guide our farmers on best practices to improve farm efficiency.

Operational efficiencies include:

(a) Careful crop selection. Most farmers grow varieties of leafy greens, roots, and edible flowers, all of which are consumed in their entirety. This means that the energy used in the Greenery is being put to maximum use with minimal energy waste. This efficiency is compounded by the Greenery farm's participation in a hyperlocal food system which delivers fresh food to the final customer within hours of harvest, meaning longer lasting produce that reduces food waste later on in the consumption chain.

(b) Best practices. Farmers can get additional efficiency by operating lights during the night when it is cooler and prices are lower. Additionally, painting the exterior in light colors and choosing a shaded location to reduce the farm's exterior temperature, thus requiring less use of the HVAC systems.

Reducing the Greenery Farm's Carbon Footprint

Ultimately, the goal of all our efficiency initiatives is to reduce the overall carbon footprint of our food production. This applies internally–iterating our technology to be better–and externally by comparing it to the industrial food system that produces, imports, and distributes the majority of the food within the U.S.

Our first step towards a reduced carbon footprint was to conduct a Life Cycle Analysis (LCA) on the produce grown in the Greenery, compared to produce grown commercially. Specifically, we compared lettuce grown in the 2020 Greenery with lettuce grown in Salinas Valley, California[2]. To measure the carbon footprint, we calculated the lbs of CO2 (or equivalent) emitted per head of lettuce.

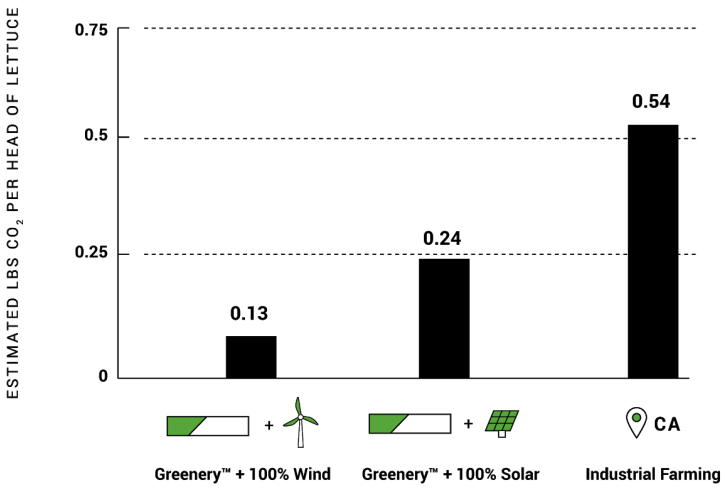
With California lettuce, the carbon footprint was 0.54 Lbs CO2 per head of lettuce. Of this, 25% is attributed to trucking (assuming 1,800 miles as the average distance traveled) and 75% is attributed to water usage, specifically the energy used to irrigate the lettuce fields.

With the Greenery 2020, the carbon footprint was 1.96 Lbs CO2 per head of lettuce, which is notably higher. However, unlike industrial farming, most of the carbon emissions with the Greenery (and most other indoor farming methods) result from fuel-generated electricity. In the Greenery, electricity usage accounts for 96% of the farm's carbon footprint.

While the Greenery's carbon footprint is currently higher than in industrial farming, there is a clear way to reduce each farm's carbon footprint: clean solar and wind energy.

[2] Sources and calculations available upon request: growfoodhere@freightfarms.com

With 100% PV (solar power), the Greenery's carbon footprint would be 0.24 lbs CO2 per head of lettuce–an 87% reduction compared to the Greenery under standard operating conditions and an 55% reduction on an industry scale compared to industrial farming.
With 100% wind power, the Greenery's carbon footprint would be 0.13 lbs CO2 per head of lettuce–an 93% reduction compared to the Greenery under standard operating conditions and an 75% reduction on an industry scale compared to industrial farming.



The Greenery farms are compatible with solar and wind systems, and we have seen multiple farmers install their own solar panels. However, due to climate limitations, financial barriers, and logistical challenges, many of our farmers are not able to integrate renewable energy setups at their farm's location.

In an effort to overcome those hurdles, Freight Farms partnered with Arcadia to make solar and wind energy available to farmers across the United States. Through the partnership, Freight Farmers can simply and easily connect their utilities to the platform and Arcadia will immediately begin matching 100% of the Freight Farm's electricity by purchasing an equivalent amount of wind and solar energy in the form of Renewable Energy Certificates (RECs)[3].

It is important to note that this solution is unique to the Greenery's format as a small-scale container farm. Large agricultural enterprises, such as farms, warehouses, and greenhouses use too much energy to qualify for community solar projects, which are capped by state law at a relatively small size.

When you consider this 75% reduction in carbon footprint along with the Greenery's long-time benefit of using 250 times less water than industrial farming, the long-term sustainability benefits make the container farming platform a clear alternative to our current carbon-intensive system.

[3] **Reusable Energy Credits (RECs)**. In the US, RECs are used to track renewable energy in the power grid. 1 REC is created whenever a clean energy source (like a wind, solar, hydro, or geothermal plant) produces 1 MWh of electricity. When a farm uses 1 MWh of electricity, they can then retire the 1 REC, meaning they have officially used the energy. Arcadia partners with wind and solar farms to source, verify, and purchase RECs. They then retire the RECs on the farmer's behalf for the energy used in the farm.