A beginner's guide to energy in CEA

Published April 2023

Written in collaboration with

UK URBAN AGRITECH

District Eating

LettUs GROW

Contents

The definitions of words marked in **bold** font can be found in the Glossary.

Introduction	3
Sources of energy	4
Where energy is used in your farm	6
Energy efficiency	8
The scale of your project	10
Location	11
Sustainability	12
Profitability	13
Case studies	16
Glossary	19
Contributors	21

Introduction

Starting an indoor farm involves getting your head around an overwhelming array of concepts and calculations. Ultimately though, the two biggest and most consistently identified challenges for **Controlled Environment Agriculture (CEA)** are energy and labour. The purpose of this guide is to help you get to grips with the basics of energy in CEA.

Energy is one of the largest operational costs for CEA, particularly for **Total Controlled Environment Agriculture** (TCEA) operations like vertical farming. Energy is crucial for 'grow lights' (usually, but not always, LEDs), **HVAC** systems (heating, ventilation and air conditioning), pumps, control systems, and much else. Furthermore, any farm looking to reduce the operational cost of labour will move towards automation, inevitably requiring more energy use. Getting this cost element right can be the difference between success and failure for a CEA business.

But energy is not just a question of cost; it's also one of sustainability. One of the most frequent critiques of CEA (especially TCEA) is that all that energy has a high carbon footprint, especially if it's coming from non-renewable sources. And that's not to mention the other sustainability impacts of energy production and supply. When it comes to sustainability, energy must be thought of in terms of source, absolute use amount, efficiency of use and wider environmental impacts.

Trying to balance all of these considerations can be difficult for anyone new to the industry, which is why we've put together this guide. In this beginner's manual we've put together simple guidance on the sources of energy, elements of your farm requiring energy, how the scale of your farm affects energy use, how to use energy efficiently, wider sustainability impacts of your energy source, and economics and profitability. To bring these to life, we've included some case studies at the end of the document to help you see how all these apply in real-world situations.

It's worth viewing this document in combination with our previous **Rough Starter Guide**, which gives some basic middle-of-the-road numbers for calculating the possible costs and revenues of a CEA operation. While reading each of these, it is important to remember that every operation is unique. These should only be used as a springboard to conduct your own research about your individual project. Ultimately, if you do decide to embark on the journey of starting a CEA project, we recommend that you get professional advice which is specific to your prospective business.

We wish you every success, and invite you to join the **UK Urban AgriTech** network as a member, when the time is right for you.

Sources of energy

Energy is available from a variety of sources, each with their own trade-offs between environmental sustainability, financial cost and convenience. Some sources will be more or less feasible or appropriate for different farm locations. Table 1 summarises some of the options available.

While having many benefits, implementing your own energy generation on site will incur a substantial up-front financial cost. This is unless you are able to enter an agreement by which the cost is spread over time. As an alternative, you may be able to partner with another organisation which bears the risk of the energy asset and offers you a competitive price in return for your reliable demand.

You may also wish to consider building resilience into your energy supply by connecting to two or more sources, such as the national grid and a local solar farm with battery storage. This way, if one supply is interrupted, the second supply will be able to maintain farm operations without interruption, at least partially or for a limited time.

It's important to consider that choosing fossil fuel energy sources could also negatively impact your PR and marketing strategy. If you are wanting to promote yourself as a sustainable operation, it will difficult to escape the negative PR that comes hand-in-hand with fossil fuels, and could harm your chances in receiving environmental accreditations such as a B Corporation Certification and the Sustainable Indoor Farming Standard.

Table 1: Energy sources reliability, limitations, benefits & risks

Grid sources

Source	Reliability	Limitations	Benefits	Risks
Grid sources (general)	Very high	Poor environmental performance or untraceable sourcing	Ease of use	Price uncertainty
Grid - standard mix	Very high	Inherits footprint of grid sources	Simple to use	Price fluctuations
Grid - renewables only agreement	Very high	Truth of benefits should be verified	Removes site specificity compared to local sources	Price fluctuations
Grid mediated power purchase agreement from 3rd party renewables provider	Very high	Worse price than owned local sources	Removes site specificity compared to local sources	· Length of agreement · Uncompetitive pricing

Local sources

Source	Reliability	Limitations	Benefits	Risks
Local sources (general)	Good to high	High capex	· Potentially much cheaper · More environmentally friendly · Ownership or partnership options	Planning objections
Solar photovoltaics	Good but variable	Weather/daytime dependent	Lower carbon impact	· Upkeep · Fluctuations in supply of source
Wind turbines	Good but variable	· Site specific · Weather dependent	Lower carbon impact	Planning rejection
Combined heat and power (CHP)	High	· Requires gas supply · Produces CO_2 · Regular services needed · Nuanced power supply required	CO_2 produced can feed plants	· Planning rejection · Less financially attractive as gas price falls relative to electricity
Anaerobic digestion (AD)	Good	· Produces methane · No electricity directly but can feed CHP	Utilisation of organic waste	· Price fluctuations in gas · Homogeneous feedstock supply
Hydroelectric	High	Site specific	Lower carbon impact	Planning rejection
Storage (e.g. battery)	High	Some materials & life-cycle concerns	Balances intermittency of renewable sources	Planning rejection
Heat networks	Good	Associated costs of connection	Lower carbon impact	Upkeep of piping can be costly
Wastewater treatment (heat)	Good	Site specific	Use of waste resources	Planning rejection
Industrial waste heat	Good	Site specific	Use of waste resources	Planning rejection

Where energy is used in your farm

While on-farm operations are likely to have the most direct impact on your farm's energy usage and related financial viability, its energy impact extends in both the pre- and post-farm directions. Even though lighting and **HVAC** will be the biggest energy draws in almost every situation, it is important to consider every part of the broader system to minimise your footprint and costs. Table 2 provides a framework to consider each element on these terms.

This table also includes symbols which indicate overlaps with other sustainability issues which you may wish to consider:

Ⓜ = Material footprint: Everything is made of something. Material resources are extracted from the environment to produce goods. These resources are often large but they are always finite, and the extraction processes (e.g. mining) can displace natural habitats and people's livelihoods. Furthermore, the extraction and purification processes can result in unnaturally high concentrations of materials having a toxic effect on the natural environment.

Ⓦ = Water footprint: Although it falls freely from the sky in many places, water can still be a scarce resource where demand and processing needs are high. In drier climates, non-renewable ancient aquifers may be the primary source of freshwater. It is important to consider where water is being used for any purpose (e.g. cleaning, irrigation or industrial processing) and what it might otherwise have been used for (e.g. drinking, sustaining a wetland habitat). After water is used it is often sent back into the environment where it will carry traces of what it has been used for. This could be concentrated nutrients or other materials that can have a toxic effect (e.g. algal blooms, heavy metal contamination).

Ⓛ = Land use change: One major impact of outdoor agriculture is the way it repurposes natural habitats into less ecologically diverse spaces for the production of crops or raising of animals. Natural habitats provide self-sustaining environmental services which regulate environmental conditions in a beneficial way (e.g. carbon sequestration and storage, organic waste processing) so it is important to leave as much as possible intact. Where elements of your farm's infrastructure or consumables place an indirect pressure on near or remote habitats or vulnerable human populations, then you may wish to find an alternative.

Sites of energy consumption on a CEA farm, including activities occurring before, during & after on-farm operations

Infrastructure related

Pre-farm	Farm stage	Post-farm
Building construction • Material production Ⓜ Ⓛ • Delivery Ⓜ • Construction Ⓛ Ⓦ	**Building maintenance** • Repairs • Cleaning Ⓦ • Upgrades Ⓜ	**Building end-of-life** • Demolition, disposal, reuse & recycling Ⓛ
Equipment production (including grow systems, control systems, sensors, office, lab & plant equipment) • Material production Ⓜ Ⓛ • Manufacturing Ⓜ • Delivery Ⓜ • Energy sources Ⓜ Ⓛ	**Equipment maintenance** • Repairs • Cleaning Ⓦ • Upgrades Ⓜ • Energy sources Ⓜ Ⓛ	**Equipment end-of-life** • Disposal, reuse & recycling Ⓛ • Energy sources Ⓜ Ⓛ

Operations related

Pre-farm	Farm stage	Post-farm
Nutrients • Production Ⓜ Ⓛ • Delivery Ⓜ	**Nutrient delivery** Ⓦ • Pumping • Heating/cooling • Monitoring, mixing & dosing	**Nutrient disposal** Ⓦ • Remediation Ⓛ • Repurposing & recycling
Seedlings • Production Ⓜ Ⓛ Ⓦ • Delivery Ⓜ	**Plants** Ⓛ • Carbon sequestration • Maintenance & harvesting (human or automated)	**Produce** • Storage • Packaging Ⓜ • Delivery Ⓜ
Substrate • Production Ⓜ Ⓛ Ⓦ • Delivery Ⓜ	**Lighting** Ⓜ • Illumination • Cooling Ⓦ • Human occupied areas	**Waste material** Ⓛ Ⓦ • Disposal, reuse & recycling
Packaging material • Production Ⓜ Ⓛ Ⓦ • Delivery Ⓜ	**HVAC** • Heating & cooling • Humidity control • Human occupied areas	**Waste material** Ⓛ Ⓦ • Disposal, reuse & recycling
	Control systems • Computation	

Connection to other sustainability factors:

Ⓜ = material footprint   Ⓦ = water footprint   Ⓛ = land use change

Energy efficiency

The section above has presented an overwhelming selection of energy sinks to consider when planning your farm. Fortunately, operational energy use is dominated by only a handful of these, so it's not too difficult to choose where to prioritise efficiency measures for maximum impact. The table below lists the biggest sinks and suggests some strategies for making these more efficient.

Lighting

Efficiency	When considering different models of lights, you should compare the amount of light produced (measured in $\mu mol/m^2/s$) at the wavelengths you care about with the amount of power (in W) required to produce that light. More $\mu mol/m^2/s$ per W is better.
No lighting	If a glasshouse suits your site and you are willing to accept the daily and seasonal variations in cloud cover and daylight hours then opting to use the free, natural light from the sun is among the best energy-saving choices you can make.
LEDs	While it is hard to find any older lighting technologies these days (such as fluorescent, metal halide or high-pressure sodium), it is still worth stressing that LEDs are much more energy efficient than predecessor technologies[1]. So if you are tempted by some cheap second-hand high pressure sodium (HPS) lamps then resist the urge to save on your initial capex because the LED alternative will last longer and use far less energy to produce the same amount of light.
Age of equipment	Extending the previous point, LED technology is much improved on what it was five years ago, and this is likely to be true again in five years time. While it might be tempting to up-cycle old stock, you will be better off in the long term to buy the most efficient product available today and push back the date at which you will need to upgrade by several years.
Spectral choices	Depending on your crop, and to some extent your aesthetic choices, you may wish to opt for broadband (white) lighting or for a limited spectrum concentrated on red and blue wavelengths which are most strongly associated with flowering/fruiting and vegetative growth respectively. This limited spectrum is a more efficient way to turn electrons into photons. However, other wavelengths have been shown to have many effects on growth rate, flavour and nutrition[2] which might incline you towards a broadband solution or the more expensive variable wavelength lamps which are available from most suppliers.
Flickering	The best way to save on lighting costs is to not have the lights on at all. Obviously this is impractical, but it has been shown that some plants will not notice the difference if you switch the lights off and on again at certain frequencies and on-off ratios[3].

HVAC

Insulation

As the ambient temperature outside your farm changes, from day to night and across the seasons, good thermal insulation in the structure of your farm will protect you from both eventualities and reduce your heating and cooling requirements.

Heat from lights

Even relatively efficient LED lamps generate a significant amount of waste heat, which should be factored in when calculating your heating requirements. Depending on the insulation and other site-specific details, this excess heat could contribute to keeping your farm warm in colder months. Anecdotally, however, we often hear that the most energy-efficient option is usually to insulate robustly and cool your farm actively for most or all of the year. Running your lights at a lower intensity can significantly lower the cooling load, perhaps even to the point of needing active heating, if not now then potentially in the future as LEDs become more efficient and thus emit less waste heat. Because of this, we recommend that you do not ignore the heating component of environmental control. A heat pump which is also capable of cooling the space may be a sound flexible option for all eventualities.

Thermal storage

Greenhouses get cold at night and hot in the day. While some of this can be mitigated with advanced glazing materials, it might be worth investigating systems which can store some of the excess heat available in the daytime and release it during the cooler hours.

As always, this is a complex picture and the best options will look vastly different in different locations, especially if your farm's energy flows are integrated into other buildings and systems. That said, you will not go far wrong if you prioritise insulation and make well-informed lighting decisions[4].

While one can never prepare for every eventuality, it is best to future-proof as much as possible by making the right investments at the outset. If you get it right the first time, you can avoid the vast expense and headaches which will come from retrofitting.

A note on measuring efficiency

Any energy consuming appliance can be defined in terms of its efficiency by dividing the relevant output by the energy input (e.g. usable photons per Watt-hour for a light fixture). It is worth paying attention to these details in every component of your farm whenever energy is converted.

For the overall farm system you might want to consider a metric such as kg of edible produce per kWh as the ultimate measure of efficiency. This can also be easily converted into the business-critical measurement of £ of profit per kWh.

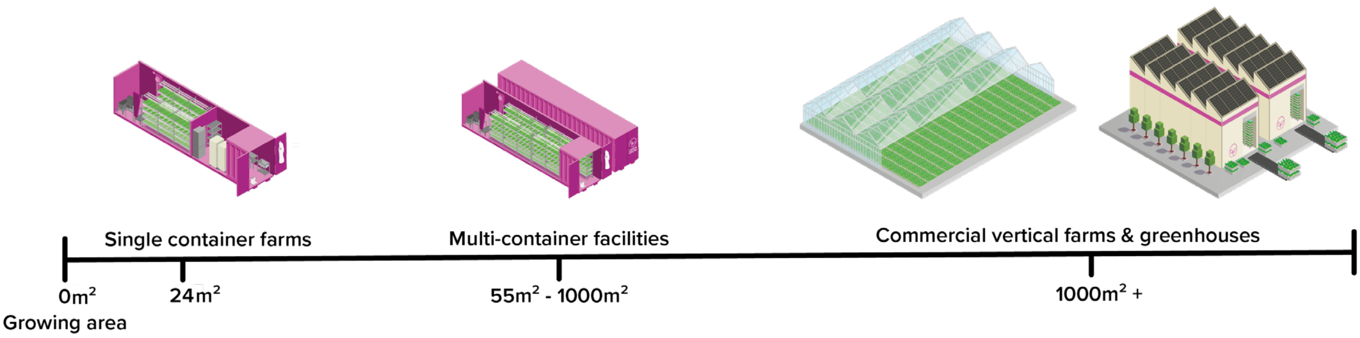
[1] VANQ LED (2020). **Available here**
[2] Santin et al., Plants, (2021). **Available here**
[3] Olvera-Gonzalez et al., Energies, (2021). **Available here**
[4] The literature around optimal lighting, both scientific and anecdotal, is as vast as it is incomplete. Ultimately 'well-informed lighting decisions' will rely on reviewing the range of what is available on the market at present and cross referencing any manufacturers' specifications against your crop(s) needs, taking into account your desired growth rate and phenotypic characteristics, and keeping the efficiency of energy use as a foundational criterion to optimise for.

The scale of your project

The scale of your project will determine the amount of energy you will need. It is important to ensure you have a balance between size and the cost you're willing to spend on energy. For example, if you have a vertical farming business model that you want to add an extra layer of shelving to, this means buying more lighting which means being supplied with more power. It is best to weigh up the income from your produce vs the cost that will come from larger energy consumption. Finding the correct balance may not come instantly within your project.

Being large scale can also make your CEA project a more appealing partner to businesses supplying heat or power. Although not always the case, it is important to determine your scale by having conversations with potential energy connections e.g. solar farms or farmers with **anaerobic digestion**.

Economies of scale for indoor farming



+ Transportable
+ Scalable
+ Easily decommissioned

- Limited automation
- Serves smaller areas
- Higher cost per crop kg

+ Transportable
+ Scalable
+ Easily decommissioned
+ Serves wider areas

- Limited automation
- Increased manual labour

+ Serves wide areas
+ Cheaper energy per wattage
+ Cheaper crop cost per kg

- Expensive start-up costs
- Not transportable
- Purpose built green energy source required

Modular farming systems might be a beneficial option if you are wanting to start small and scale up over time. Container farming options are easily transportable, so are advantageous for moving to an area where you can utilise localised waste heat or green energy sources. This is also useful if you are looking to lease land temporarily with the intent to relocate. With no planning permission required, containers can be rapidly redeployed (cost of power supply and water connections notwithstanding), allowing flexibility to re-establish yourself in more favourable locations.

Economies of scale can apply to capital costs as well as heat and electricity consumption. Grid connections and planning permission costs are always large, thus it may be tempting to scale quickly to make the most of them. But make sure you don't bite off more than you can chew. Other large costs to think about are; concrete pads, planning permission, buildings, water treatment and water connection.

It is important to build a strong business case for your project to find an acceptable return on investment. One way of keeping costs down is to look for sources of waste heat and renewable energy that aren't reliant on volatile fossil fuel prices, and partner with the organisations which administer these, whether by setting up next door or through a power purchase agreement.

Location of your farm

If you already have a location in mind for your site, before you get going it's good to have a look around the area for any local sources of energy that could help to supply your project, whether that be heating for a greenhouse or power for lighting. It is a lot easier to integrate these ideas into your project before you start building and could reduce your project's environmental footprints from the outset. Mapping and engagement studies can be done for you by consultancy firms (such as **District Eating**) to find sources that are most relevant to your project and gather interest in partnership.

Whether you're looking for energy for heat or electricity will determine how useful a local source would be. For example, if you're wanting to set up a vertical farming site, your predominant needs will usually be power for the lighting and **HVAC** systems. Whereas, if you're interested in greenhouse development, heating will be more of a focus.

If you're wanting to use energy sources from section one and have received permission, proximity will be important for the next stages of determining your exact location. Having a closer proximity to your source of energy can save money on lengthy pipe runs and power cables as well reducing the quantity of your heat or power lost in transmission.

If using local sources of energy isn't an option for you, there could be an opportunity to connect or partner with other businesses. If you're opting for a containerised indoor farming system, it is worth connecting with local partners or businesses with ample land upon which to site your operation. For example, if your commercial goals are complementary, a green energy partnership could be reached. Estate or land owners who are already operating in the agricultural field and have green energy built into their operations could be a particularly good match.

Impacts on sustainability

Using solar and wind energy sources to power a CEA system provides large improvements across most sustainability impacts. When **LettUs Grow** performed a life cycle analysis on their DROP & GROW container farm, improvements were seen in 14 out 19 metrics when switching to renewables[5].

While these results will not match your farm exactly, they will be a good indicator of how different energy sources could impact the sustainability of your farm. For example, climate change potential reduced by 68% and 80% when replacing the UK grid electricity with solar and wind energy, respectively. However, sustainability is about more than just carbon emissions, the other 13 improvements were:

Ecosystems

Reduced freshwater **eutrophication**
Reduced marine **eutrophication**
Reduced marine **ecotoxicity**
Reduced **photochemical ozone formation** in ecosystems
Reduced **terrestrial acidification**
Reduced **stratospheric ozone depletion**

Resources

Reduced primary energy demand
Reduced fossil fuel depletion
Reduced land use

Pollution

Reduced fine particulate matter
Reduced ionising radiation

Human health

Reduced human toxicity related to cancer
Reduced **photochemical ozone formation**

Different types of renewables have different benefits and some drawbacks. For example, using wind power increases fresh water consumption by 183%[5], but improves another four environmental metrics including:

Freshwater **ecotoxicity** is reduced by 65%
Human toxicity (not related to cancer) is reduced by 57%
Terrestrial **ecotoxicity** is reduced by 46%
Metal depletion is reduced by 8%

However, these metrics are worsened by changing from the UK grid to solar power[5]:

Freshwater **ecotoxicity** increases by 31%
Human toxicity (not related to cancer) increases by 25%
Terrestrial **ecotoxicity** increases by 148%
Metal depletion increases by 63%
Fresh water consumption increases by 276%

The use of **anaerobic digestion** to generate electricity has also been assessed, however little improvements were offered as only four impacts improved. Climate change potential was reduced by 39%, terrestrial **ecotoxicity** is reduced by 94%, primary energy demand was reduced by 90% and fossil depletion was reduced by 58%[6].

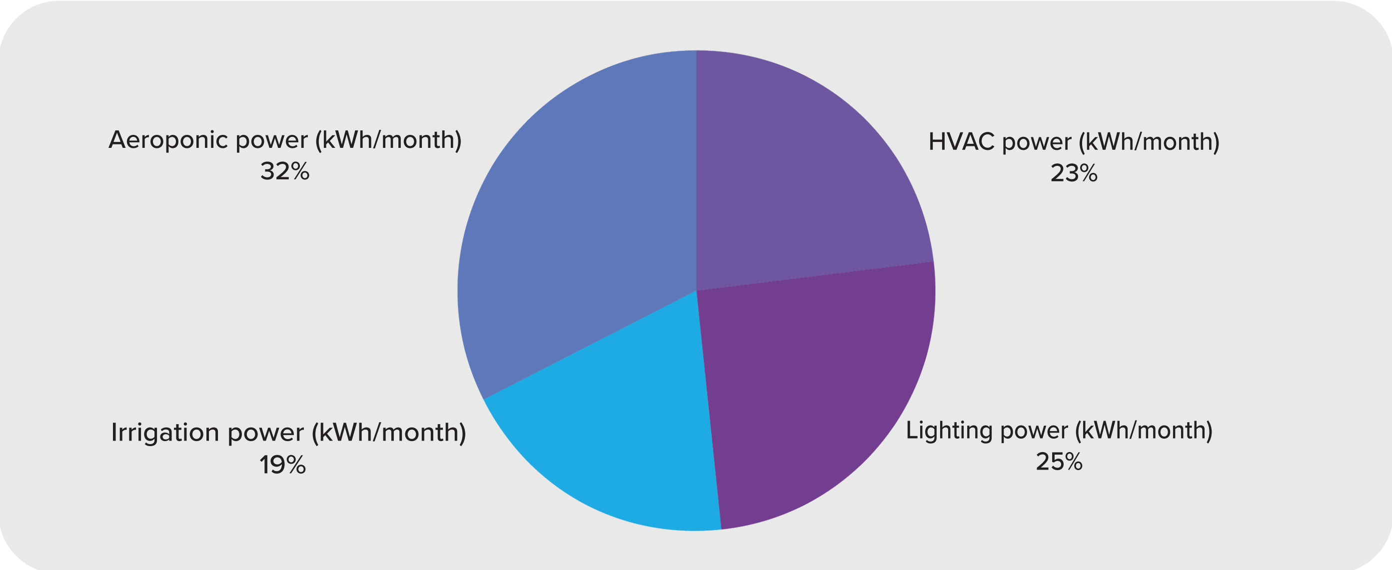
Impacts on profitability

Controlling your own energy supply will allow you to have vastly increased oversight, not only on the sustainability of your business but also how the cost per kWh will impact your business model's profitability. The energy market may remain volatile, but this is just one factor you can adjust within your business plan and appropriately scale to ensure your model remains profitable.

Your annual crop yields, crop selection and market conditions are also vulnerable to change so it's important to scale, review and recalibrate whenever there are significant changes which will impact your outputs.

Depending on your chosen farming system, there will be a multitude of irrigation, lighting, fertigation and environmental control factors which will all determine how much energy your farm requires.

In this example, we breakdown the energy required to power one aeroponic DROP & GROW™ container farm:



The majority of the power supplied will be used by the aeroponic system, followed by the lighting system, irrigation and **HVAC**.

If possible, look to use a farm management system which allows you oversight on energy usage throughout the growing process. Farm management software will allow you to make changes to your lighting, irrigation, fertigation and environment to not only enhance growth performance but monitor energy usage remotely using a laptop, tablet or smartphone.

[5] Schmidt Rivera et al., Science of The Total Environment (2022) **Available here**

[6] The data from this Life Cycle Assessment (LCA) was collected and evaluated by a research team at Brunel University. However, if you would like to do a DIY version for your own business, you can follow this **handy guide.**

Your profitability model

Once you have sourced your energy and confirmed the price per kWh, you must account for other key areas that make up the bones of your business model.

You should consider:

Crop selection

You should tailor your crop choices to your local market, so do your research before committing to crop selections. High-value micro herbs are very popular in restaurants and bespoke catering services, while leafy greens and salad mixes might be better suited for retail and wholesalers.

Distance

Understand the local demand and the distance it will need to travel to reach consumers. The energy spent once the product leaves your farm will also impact your profit margin, so consider what is a profitable radius before engaging with potential customers who are based further afield.

Sale price

Consider not only how much your off-takers are willing to pay for your produce, but also the energy required to grow it. To make sure you are getting the most efficient use out of the system, you should opt for predefined crop recipes and, if possible, use a farm management system which you can control remotely. If you are using lights which are calibrated incorrectly, you will not only be affecting your plant growth but also negatively impacting your profit margins considerably.

Labour

After energy costs, labour is the other major expenditure as part of your business model. This factor will vary significantly depending on whether you've opted for a compact business model such as a container farm or whether you'll be operating a much larger operation such as a vertical farm or commercial glasshouse, and how much automation you deploy.

A note on profitability models

Complex profitability and economic modelling systems are readily available from indoor farming suppliers, so ensure you are being supported in your business model from your technology provider ahead of large purchasing decisions.

The example economic model on page 15 is based on the energy usage of one DROP & GROW container - other containers' power usage will differ greatly.

DROP & GROW™ container farm from LettUs Grow

Your economic model

The example below demonstrates how much energy can impact revenue, payback period and the overall profitability of your business. This model also assumes that you will be running your business with a limited labour force of one full-time employee, selling micro radish for £20 per kilogram.

Make sure you are reviewing your economic model at regular intervals throughout the year, as the smallest increases in cost or reduced efficiency will all impact your bottom line if left unchecked.

Example basic economic model

	Low cost energy example	High cost energy example
Crop type	Radish micro	Radish micro
Percentage of production (%)	100%	100%
Percentage marketable (%)	90%	90%
Sale price (£/kg)	£20	£20
Production (kg/month)	420	420
Packaging / unit weight (g)	£0.5	£0.5
Labour cost (£/hour)	£12	£12
Facility rent (£/month)	£500	£500
Electricity rate (£/kWh)	£0.07	£0.35
Distribution (£/month)	£200	£200
Units per month (#/month)	4202	4202
Revenue per month (£/kg)	£8,403	£8,403
Operational costs (£/month)	£5,359	£6,554
ROI (%)	318%	193%
Payback period (years)	3.1	5.1

Case studies

DES BV Greenhouses

Location	Sirjansland, Netherlands
Size	25 hectares under glass
Year of construction	2019
Type	Three greenhouses receiving waste biomass heat and CO_2 capture

Model

DES BV is a stand-alone company established by three local commercial growers situated close together to supply heat and carbon dioxide to their greenhouses.

The greenhouses comprise:

- Tomatoes – VOF Prominent Grevelingen
- Tomatoes - DT Van Noord
- Aubergines – Van Duijn (which need more CO_2 and heat than tomatoes)

The biomass plant supplies the base load heat to the greenhouses which is locally topped up by natural gas fired **combined heat and power** system (CHP). The gas fired CHP provides contingency in the event of downtime in the biomass system and to sell export electricity into the distribution network when electricity export prices are high.

Their 7 MW boiler is fed with high-quality chips mixed with low grade local wood waste. The boiler provides 3.5 MW of thermal power which is used for the CO_2 recovery system in which the CO_2 is stripped using 145°C steam. The CO_2 and heat are then piped to the growers on a metering system to ensure costs are fairly distributed.

Website des-bv.nl

DES b.v.

Jones Food Company

Location	Lincolnshire, UK / Gloucestershire, UK (in development)
Size	5,120m2 / 14,449m2
Year of construction	2019 / under construction
Type	Vertical farms powered by renewable energy

Model

Jones Food Company runs the largest vertical farm in Europe. Their Lincolnshire site is powered by 100% renewable solar energy and has the capacity to grow 180 tonnes of light herbs each year. This site has 300 kW of installed solar array on its roof and is connected to 55 MW of co-located ground-mounted solar. There are plans to combine this with a 99 MW battery by the end of 2022.

Their second site based in Lydney has plans to have 800 kW of solar installed on the roof and a fuel cell. They are also exploring the use of a 2 MW wind turbine to be located next to the site.

These clean-grow methods of using renewable power allow Jones Food Company to set long-term power prices, avoiding the struggles that unpredictable fossil fuel prices can cause.

This commitment to growing low-carbon food is constantly developing through JFC's dedicated R&D site in Bristol. This R&D site is getting 50 kW of additional solar. JFC's use of renewable power also highlights to customers their focus on growing fresh and sustainable produce.

Website jonesfoodcompany.co.uk   in JonesFoodCompany

Jones Food Company's site in Lincolnshire, UK

Flex Farming

Location	Somerset, UK
Size	500 m2
Year of construction	2022
Type	Vertical strawberry growing using renewable energy and battery storage

Model

Focus on energy costs has always been of key importance to Flex Farming. This is why their vertical farm is powered by battery storage, charging through the combination of on-site solar panels and grid connection, when the price is lowest. Their solution aims to connect food production with energy generation.

Their Somerset strawberry farm is a proof-of-concept model with the site being chosen due to the existing infrastructure for packing and transport. The site is co-located with the Agri Sgj polytunnel strawberry farm. This location choice was also due to surrounding agronomy expertise.

Flex Farming have plans to develop a 500 t production facility and have calculated that 7,000 MWh* will be needed to supply it each year. By focusing on renewable energy, Flex Farming has calculated that their strawberries' CO_2 emissions could be reduced by up to 80% (compared to imported strawberries). Not only does their model reduce CO_2 emissions but can also have significant reduction on water usage and land consumption (over 90%).

The type of renewable energy connection used by Flex Farming will be dependent on the availability and location of their farm. Their first farm focuses on solar, but they are open to opportunities to use wind, geothermal or hydro at their next location. For Flex farming's large-scale production site, they are actively looking for reliable, renewable and affordable electricity.

*This number is subject to change based on Flex Farming's trial and optimisation.

Website flexfarming.co.uk

FlexFarming

Glossary

Absolute energy use - Absolute energy use is the total amount of energy used to produce a certain output.

Anaerobic digestion - A process in which bacteria break down waste materials to produce biogas and digestate. This process takes place within an anaerobic digester. The input waste materials could be food, manure, crops or waste water. The biogas output from an anaerobic digester can be used for heating, electricity and converting into biomethane. The digestate output can be used for fertiliser or livestock bedding. This is a low-energy process that can produce low-carbon heat and power.

Solar photovoltaics - Photovoltaic (PV) devices such as solar panels utilise the energy from incident light to generate a useful electric current.

Combined heat and power - The production of usable heat and electricity from the same source (e.g. power plant). Commonly known as CHP or cogeneration.

Controlled environment agriculture (CEA) - a technology-based approach to food production that optimises growing conditions for the crop. The growth environment is partially or completely closed to protect it from the elements, and the system is precisely controlled.

Ecotoxicity - when a chemical or physical agent has a negative impact on the environment and some or all of the organisms living within it.

Energy efficiency - a reduction in energy intensity corresponds to an increase in efficiency; i.e. achieving the same outcome for less energy usage. E.g. a more efficient lighting fixture will produce more light for a given amount of electricity consumed, or the same amount of light for less energy consumed.

Energy intensity - The amount of energy required per unit output. E.g. a more energy intensive farm will consume more electricity to produce a given amount of edible crop.

Eutrophication - a process by which a body of water (predominantly lakes and ponds) accumulates an excess of nutrients and minerals, allowing harmful algae to bloom and fill the area. This can lead to a deterioration of water quality, and eventually create dead zones which are incapable of supporting life.

HVAC - Heating, ventilation and air conditioning.

Hydroelectric - An electricity generation method in which the force of gravity pulls water through a turbine to generate power. This often requires the construction of large dams to ensure a reliable supply, although smaller localised systems can be viable. Hydroelectric systems can also be used for storing excess energy by pumping water uphill to be used later.

Industrial waste heat - Unused heat that is produced as an outcome of an industrial process.

Photochemical ozone formation - ground level formation of ozone caused by the oxidation of Volatile Organic Compounds (VOCs) and carbon monoxide (CO) in the presence of nitrogen oxides (NOx) and sunlight.

Stratospheric ozone depletion - the gradual thinning of Earth's ozone layer, which absorbs harmful ultraviolet-B (UV-B) radiation from the Sun.

Terrestrial acidification - an increase in the acidity in soil, leading to losses in plant life and biodiversity.

Total controlled environment agriculture (TCEA) - A subsector of CEA, that includes vertical farming, in which all aspects of the growing environment can be controlled: light, temperature, humidity, irrigation, nutrition and even air composition.

Wastewater treatment - The process of removing contaminants from wastewater, resulting in unpolluted, safe water that can be returned to the water cycle. This process can generate usable heat.

Contributors

District Eating

District Eating Limited (DEL) focus on the production of food and flowers using low-carbon sources of heat and power. From community to commercial scale, DEL's projects are designed to create jobs, increase food security and promote economic growth, while reducing emissions. DEL believe that their approach can help make growing food locally more viable, by reducing reliance on fossil fuels and international supply chains.

The team study, assess and model sources of waste heat/low-carbon power to be used for CEA projects. This solution not only helps growers move away from expensive and high-carbon heat/power sources but also can generate income and reduce emissions of the heat/power provider.

District Eating

UK Urban AgriTech (UKUAT)

UKUAT is a members association for the CEA industry in the UK. It brings together the UK's key players in modern agricultural technologies. Membership spans all aspects of the industry, comprising growers, researchers, equipment producers, logistics companies, architects, educators and enthusiastic individuals, all devoted to promoting urban agritech as a solution for food and environmental crises. Activities include, advocacy, consortia building, education and pre-competitive collaboration.

UK URBAN AGRITECH

LettUs Grow

LettUs Grow is an indoor farming technology provider based in Bristol, UK. They believe that careful innovation in farming can make the world a better place. LettUs Grow's ultrasonic aeroponic irrigation systems allow farmers to grow up to twice as fast as hydroponics, while using zero soil, zero pesticides, as well as less water and fertiliser than in outdoor farming.

LettUs Grow conducts world leading research into controlled environment agriculture from their research centre in Bristol, working with partners such as John Innes Centre, Harper Adams University & Agritecture. The team achieved B Corp status in 2022 and are dedicated to improving food systems by working towards a future where affordable, healthy food can be grown with minimal impact on the planet.

LettUs GROW

Reviewed by

CALIBRE

PERFECTLY FRESH!

Qudos ENERGY achieve more for less

VERTICALLY URBAN

Zayndu