Design and Sustainability: Ecological and Food Utopias

Can Vertical Farms help ameliorate world hunger?

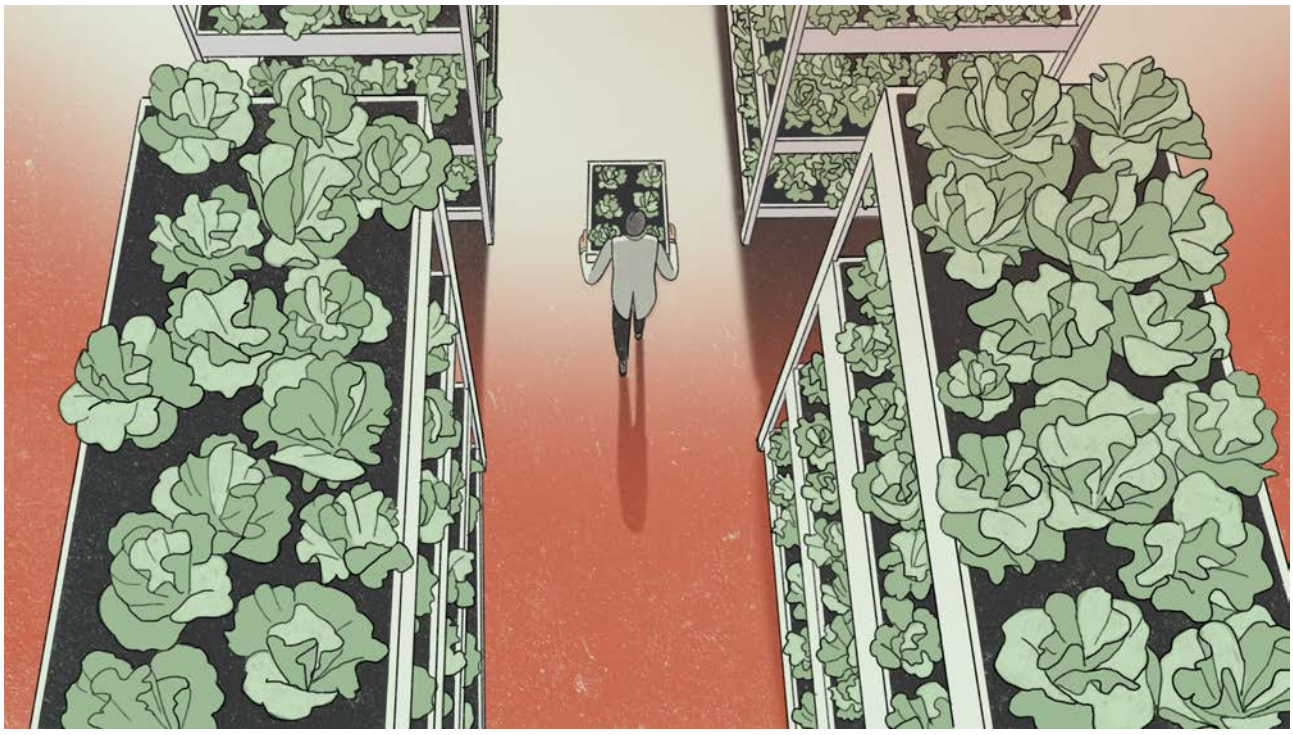

Figure 1 - Vertical farm illustration, (Cen, 2018)

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Contents:

Introduction

Humanity is now faced with dramatic climate change issues, an ever-growing population and food insecurity (UN, 2021). Utopias have become more relevant than ever, allowing the escapism humanity so desperately needs. Utopian literature and thought do not only provide a perfect imaginary world, but it also stimulates positive change by providing solutions.

This paper will look into the historical background of utopian literature, and an insight into William Morris', Ernest Callenbach's and Ebenezer Howard's ecological utopias, with the last two being highly focused on food production, recycling and sustainability. The increased concern regarding the declining state of the environment following the industrial revolutions is what stimulated the emergence of these ecological utopias, and of many other significant movements and organisations.

Along with climate issues, come food production issues. Food insecurity is increasingly worst as the population increases, which calls for a new agricultural technique such as vertical farming, as proposed by Dr. Dickson Despommier. However, the question is, can vertical farms help ameliorate world hunger?

What are Utopias and More's Utopia

The Cambridge Dictionary defines utopia in simple words as *"a perfect society in which people work well with each other and are happy"* (Dictionary.cambridge.org. 2021). It essentially is an imaginary, unachievable and hyper-idealised remodelled society. The word 'Utopia' is derived from the Greek *"ou"* and *"topos"* meaning *"not"* and *"place"* respectively, which when combined, mean nowhere. The first person to use the word 'utopia' was Sir Thomas More (1477-1535), in his 1516 book titled *"Libellus…de optimo reipublicae statu, deque nova insula Utopia"* meaning "*Concerning the highest state of the*

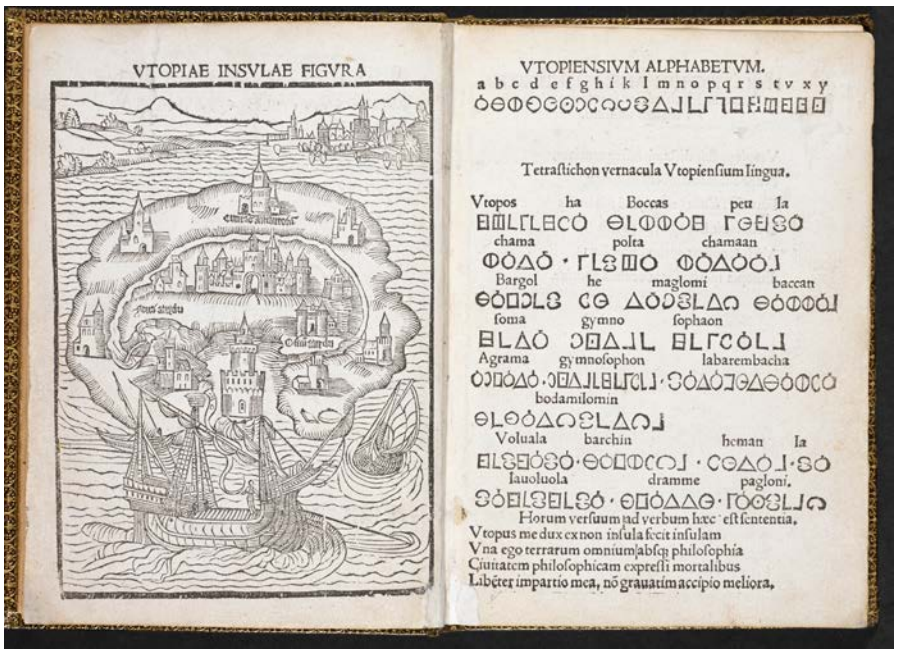


Figure 2 - Image of Sir Thomas More's book Utopia, showing the map of the Utopia island and the new Utopian alphabet (British Library, 2021)

republic and the new island Utopia" from Latin (The Editors of Encyclopaedia Britannica, 2020). The book is a political, philosophical and satirical fiction novel describing the island of Utopia, a society with no money, ceasing of private property, free food and healthcare, tolerance of all religions and, constant surveillance (Course Hero, 2019). More's Utopia is contradictory, promoting egalitarian views at the same time as a patriarchal ruling. The lack of personal freedom, strict worth ethic and puritanical standards, as observed by de Geus, are stemmed from More's monastic lifestyle (Thiele, 2000).

In order to protect himself, More gave the description of Utopia through the tales of fictional character Raphael Hythloday and their dialogues. More also discusses the topics of controlled education, divorce, euthanasia, penology and women's rights. The book's niche target audience — the Renaissance humanists and the elite of public officials, proved it to be a great success (Marc'hadour and Germain, 2021).

The early 16th Century was known as the Renaissance period, a time of economical and intellectual re-birth and growth. However, the emergence of the Protestant Reformation, an

increased gap between the poor and the rich, and the general dissatisfaction with the *“unreasonable polity of Christian England”* (Marc'hadour and Germain, 2021) all contributed to the writing of Utopia, an imaginary society wholly different from 16th Century England. More was also inspired by Amerigo Vespucci’s accounts of the New World’s non-capitalist societies (Hodgkinson, 2016).

An English translation of Utopia became available in 1551, 16 years after More’s execution (Duncombe, 2021). More served Henry VIII as chancellor of England from 1529 to 1532. More’s refusal to accept Henry VIII as head of the new Church of England in 1534 (Spalding, 2021), a result of Henry VIII marriage annulment with Catherine of Aragon and separation from the Roman Catholic Church, culminated in his accusation of treason and beheading in 1535. Thomas More was declared a saint by Pope Pius XI in 1935, 400 years after his death (Marc'hadour and Germain, 2021).

More’s writing resembles and was perhaps an inspiration for the Marxist thought through the *“argument that communism is the only cure against egoism in private and public life”* (The Editors of Encyclopaedia Britannica, 2020). As well as discussions of communal property ownership and the abolishment of private property holding, resulting in true equality and security, a topic which is talked about in Karl Marx’s Communist Manifesto of 1848. Karl Kautsky, an important Marxism theorist who dominated the scene from 1895 to 1914, wrote a book titled Thomas More and His Utopia, proposing that More’s ideas can be deemed as a glimpse into Modern Socialism. More was also sympathised by Vladimir Lenin, the former premier of the Soviet Union, who suggested that More be included in a monument honouring great thinkers (Papke, 2021).

Utopian literature existed long before the term ‘utopia’ was coined by Thomas More, but while he did not invent utopianism, he altered the way in which the yearning for a better, or

different life is articulated (Claeys, 2010). Some of the earlier works include Plato's Socratic dialogue 'The Republic' from 375BC, which talks about a *"communistic, egalitarian city-state"* (Hodgkinson, 2016) and Christine de Pizan's 'The Book of the City of Ladies' in 1405, a sanctuary where women can find shelter from patriarchy (Hodgkinson, 2016).

The main collective characteristics of a utopian society are informational liberty, harmonious living, absence of fear, independent thought, embracing nature, absence of a traditional government but still sharing a concept that brings the citizens together (Utopias and Dystopias: Definitions and Characteristics, 2021)

Utopian concepts have changed numerously throughout history, evolving into and creating derivational neologisms: eutopia (the good place from Latin), dystopia (antonym of utopia, a society which suffers greatly), heterotopia (other place from Latin), and ecotopia (an ideal society designed to minimise the negative impact on the environment).

Ecological Utopias

Ecotopia, a term coined by the author, is a utopian novel by Ernest Callenbach written in 1975 is one on the first ecological utopias of its kind, a state where the society lives harmoniously with their environment and decreasing their negative impact. As told by the author, Ecotopians produce the food they consume in urban settings, are highly involved in tree agriculture, growing nuts and fruits, their farms are labour intensive, but with a high output, they care for the land by using less chemical fertilisers and less polluting machinery, opting for organic fertiliser from food waste, use solar panels on roofs to produce sustainable energy as well as wind and geothermal power. Ecotopians have a friendlier and more human oriented work environment. The people are playful, are present

and conscious and encourage discussions about their emotions, trying to make everyone as comfortable as possible. The values of social responsibility are at the core of this society. As feedback for the book, Ralph Nader wrote: *“None of the happy conditions in 'Ecotopia' are beyond the technical or resource reach of our society.”* (Callenbach, 1982) (Weier, 2009).

In an interview, Callenbach revealed that his inspiration for the book Ecotopia and general interest in ecology was sparked by the book Silent Spring by Rachel Carson which uncovered the dangers of pesticides and, the introduction of environmental legislations, such as clean air and clean water acts (Weier, 2009), which were passed as a result of the successful pressuring of the Congress by environmentalist (Geary, 2021).

Marius de Geus, a political theorist, declared in his 1999 book titled Ecological Utopias: Envisioning the Sustainable Society, that utopian literature is a *“unique and valued resource for contemporary environmental scholars”*. de Geus reviewed and analysed 9 pieces of utopian writing, which he defined as *“utopias of sufficiency”*. These proposed flawless societies’ motive is the fulfilment of moderate human needs through harmonious civic and ecological relationships (Thiele, 2000).

Figure 3 - Morris’s Strawberry Thief remains one of his most popular designs today, (Getty Images, 2019)

Following the industrial revolution in the late 18th Century, the detrimental consequences of machine-based goods production on quality and social conditions were being acknowledged. The society’s desire to

improve the work conditions and the integrity of the products, gave birth to the Arts and Crafts movement in the late 19th Century (V&A, 2021). William Morris was a renowned graphic designer and artisan who heavily influenced the movement. In his 1891 romantic novel, News From Nowhere, Morris writes of an ecological utopia in the real England, which is based on craftsmanship, and unlike any other utopian literature, it establishes its virtues in an aesthetic view of the human condition. His idealistic communist society has no monetary system and, successfully de-industrialised England, putting craftwork at the forefront, making *"wage slavery obsolete"* (Drechsler & Kostakis, 2018). Morris can be regarded to as a *"pre-eco-socialist"*, because, like his fellow socialists, he could not have anticipated just how severe the ecological damage generated by the capitalistic industry would be (Shishin, 2010). Despite the fact that his ideal for the arts and crafts was derived from the 14th Century medieval practices, making his writing a retrotopia, Morris was environmentally mindful ahead of his time. This can be drawn from the beginning of his book, where Morris wakes in an undeniably environmentally cleaner world, with the Thames' water being unpolluted. He strived for an aesthetically enhanced life for all, the beauty of which corresponded to ecological stability. Furthermore, Morris merges the rural with urban areas, morphing England into a 'garden' (Shishin, 2010).

A number of similarities can be drawn between Callenbach's Ecotopia and Morris's News from Nowhere. Both utopian novels focus on the abolition of industrial manufacturing, moving to human centred approach in crafting workshops, with improved work standards. In Ecotopia, its citizens repair their own objects, and if unsalvageable, recycle or compost them, as the majority is organic. This encapsulates the Circular Economy approach, which gained momentum after World War 2. The fondness for artisanal craft is apparent in both utopias, however, the medieval approach in Ecotopia is unexpected as it still talks of

modern technology. This medieval thinking makes these utopian writings, retrotopias in a way, as they strive for something of the past, instead of the future.

The main difference between Ecotopia and News from Nowhere, is the political situation. Morris was an avid communist, and so was his politically radical utopia, whereas Callenbach had a gentler approach which is dubbed as *“capitalism with a human face”* (Shishin, 2010).

The Environmental Movement

The environmental movement has a political agenda focusing on protecting and reducing environmental destruction caused by pollution or unsustainable use of finite resources (Environmental Movements, 2021). While many organisations and movements formed around the world as a result of the environmental movement, this report is focusing on the affaires of the West.

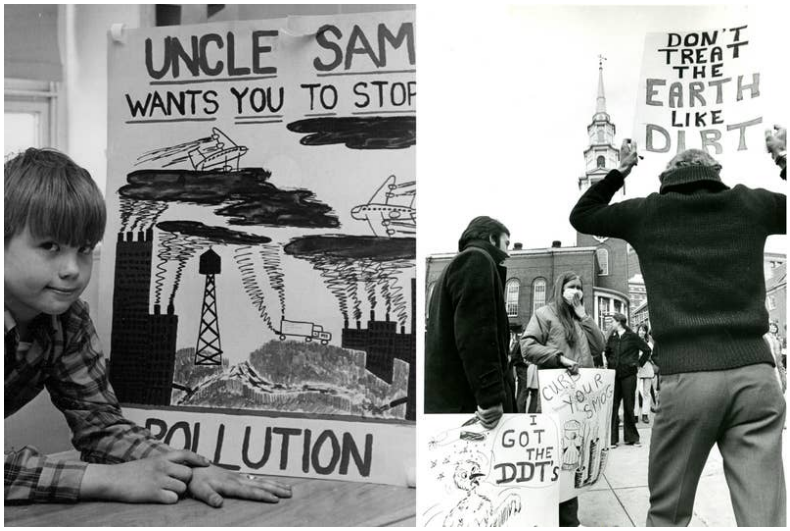


Figure 4 - Left: Kurt Amuedo displays a poster about air pollution for Earth Day at his school. Right: Demonstrators in Boston wore masks to remind people of the perils of air pollution. (The Denver Post via Getty Images | The Boston Globe / Getty Images, 2020)

Carson’s book, Silent Springs, published in 1962, had a pivotal role in the modern environmental movement, resulting in the founding of a presidential advisory panel on pesticides. It raised concerns of the rapidly growing agricultural industry, which if remains unregulated, it would inevitably result in the degradation of human condition and spoliation of flora and fauna

Figure 5 - "Save the Earth - You can't get off" badge" (Lambert / Getty Images, 2020)

(Geary, 2021). The 1960s and 1970s were times of increased public interest and affiliation to conservationist groups, such as Greenpeace, Friends of the Earth, etcetera. Approximately 20 million Americans participated in the first Earth Day, which took place on 22nd April 1970. It was organised by senator Gaylord Nelson as a wakeup call to politicians, urging them *"to do something"* (Geary, 2021). Figure 4 and 5 show some of the activists that took part in the 1st Earth Day in America.

As scientific recognition of the sources and repercussions of environmental deterioration increased during the 1960's and 70's. The concern of the Earth's ability to support human life grew, playing a part in the growth of the grassroots activism. Grassroots is a movement which attempts to persuade individuals to take part in influencing, often, political outcomes (Bergan, 2016). This also led to the formation of green politics, which *"aim to reconstruct the patterns of human activities and relationships so that they come to respect and value the natural systems on which they depend"* (Barnett, 2015). In an interview, Callenbach claims that Germany's green party was inspired by his ecological utopia book, Ecotopia (Callenbach, 2008).

Timeline: The Development of Green Parties Around the World

1968: Worldwide student protests lay the groundwork for a new generation of radical political organizers, including many future green-party founders.

1970s: Protests proliferate against nuclear power and nuclear weapons, which become a central green issue.

1970

1972: The first ecologically oriented parties are founded, including Australia's United Tasmania Group, New Zealand's Values Party, and the United Kingdom's PEOPLE Party.

1980: West Germany's greens contest national elections for the first time but fail to win any seats.

1980

1983: The West German greens enter parliament for the first time, winning 27 of the body's 520 seats.

1987: The first U.S. National Green Gathering is held in Massachusetts. More than 600 activists attend.

1990: Alaska's green party becomes the first in the United States to achieve ballot access. Green parties in Arizona, California, Hawaii, and New Mexico follow in 1992.

1990

1992: The first Planetary Meeting of Greens takes place in Rio de Janeiro alongside a major UN environment summit.

1995: Finland's green party becomes the first to enter a national cabinet when its leader, Pekka Haavisto, is named environment minister.

1996: Ralph Nader heads the first U.S. green-party presidential ticket, though he achieves ballot access in only 22 states.

1998: Germany's Joschka Fischer joins a "red-green" coalition with the center-left Social Democrats, becoming vice chancellor and foreign minister. He influences the phasing out of nuclear power but faces controversy over military interventions in Afghanistan and the Balkans.

2000

2000: Nader again runs for the U.S. presidency. On the ballot in 44 states, he receives 2.7 percent of the popular vote, the highest-ever green-party performance in the United States.

2001: The Global Greens network is founded, with representatives from more than 70 countries signing on to the Global Greens Charter.

2004: Indulis Emsis becomes prime minister of Latvia, making him the first green-party member to lead a national government.

2010

2015: Raimonds Vejonis is elected president of Latvia, becoming the first green-party head of state.

2016: Green Party of the United States presidential nominee Jill Stein wins just over 1 percent of the popular vote, the best green performance since Nader.

Feb. 2019: U.S. Congressional Democrats introduce a resolution calling for a Green New Deal, a sweeping environmental plan long championed by greens.

2020

Apr. 2019: Finland's green party wins 20 seats in Parliament, its most ever. It joins the government as part of a deal with 4 other parties.

2020: Ireland's green party posts its best-ever election result, winning 12 seats and positioning it as kingmaker in coalition talks. Greens negotiate stronger climate targets and 4 cabinet seats.

Sep. 2019: In a snap election, the Austrian Green Party wins nearly 14 percent of the vote and 26 seats in Parliament. Greens enter government for the first time, joining the conservative coalition in exchange for stronger climate policies.

Source: CFR research.

COUNCIL on FOREIGN RELATIONS

Figure 6 - Timeline of the development of green parties around the world, (Council on Foreign Relations, 2021)

As it can be seen from the timeline in Figure 6, green politics struggled to gain momentum, however, this is due to them presenting themselves as a means for wider protest movements such as anti-nuclear and anti-consumerism, resulting in a lack of unity (McBride, 2021). Nowadays, green parties are receiving more support as the environment is becoming a primary concern for voters (McBride, 2021).

The environmental movement was also making an impact on a global scale, the United Nations (UN), an international organisation where nations explore and resolve pressing and prevalent matters (United Nations, 2021). In 1972, the UN held a conference concerning pollution in northern Europe (Creech, 2012), which led to the 1992 Earth Summit, where *"more than 178 countries adopted Agenda 21, a comprehensive plan of action to build a global partnership for sustainable development to improve human lives and protect the environment"* (United Nations, 2021). In 2000, 8 Millennium Development Goals (MDGs) were established to combat poverty, hunger, environmental degradation, disease, illiteracy and discrimination against women by 2015, following which, 17 new Sustainable Development Goals (SDGs) were adopted in 2015 with the goals set to be achieved by 2030, each interconnecting and ensuring success in all areas (United Nations, 2021).

In 2018 another environmental movement arose, Fridays for Future (also called School Strike for Climate), founded by then 15 years old Greta Thunberg, who was striking in front of the Swedish parliament for 3 weeks demanding change. Fridays for Future (FFF) is youth-led movement with a shared goal of pressuring those in power to take action and limit global warming (Fridays For Future. 2021). At the 2019 UN climate event, she famously cried out - *"You have stolen my dreams and my childhood with your empty words…We are in the beginning of a mass extinction, and all you can talk about is money,*

and fairy tales of eternal economic growth. How dare you!" (United Nations - YouTube, 2019). This is true, because in this day and age if something is not financially profitable, it won't be implemented.

A prime example of that is solar power. MIT Technology Review shared on Twitter that - *"The problem is that solar panels generate lots of electricity in the middle of sunny days, frequently more than what's required, driving down prices—sometimes even into negative territory."*, and that - "*the more solar you add to the grid, the less valuable it becomes"* (@techreview, 2021). This caused some backlash with many Twitter users blaming capitalism, one in particular paraphrasing the MIT tweet to - *"The problem with solar is we can't monopolise the sun or make it scarcer than it is"* (@averincm, 2021). The MIT's reasoning for as to why solar power poses an issue, is that developers and investors will not want to build solar plants if it will not generate them financial profit (Temple, 2021).

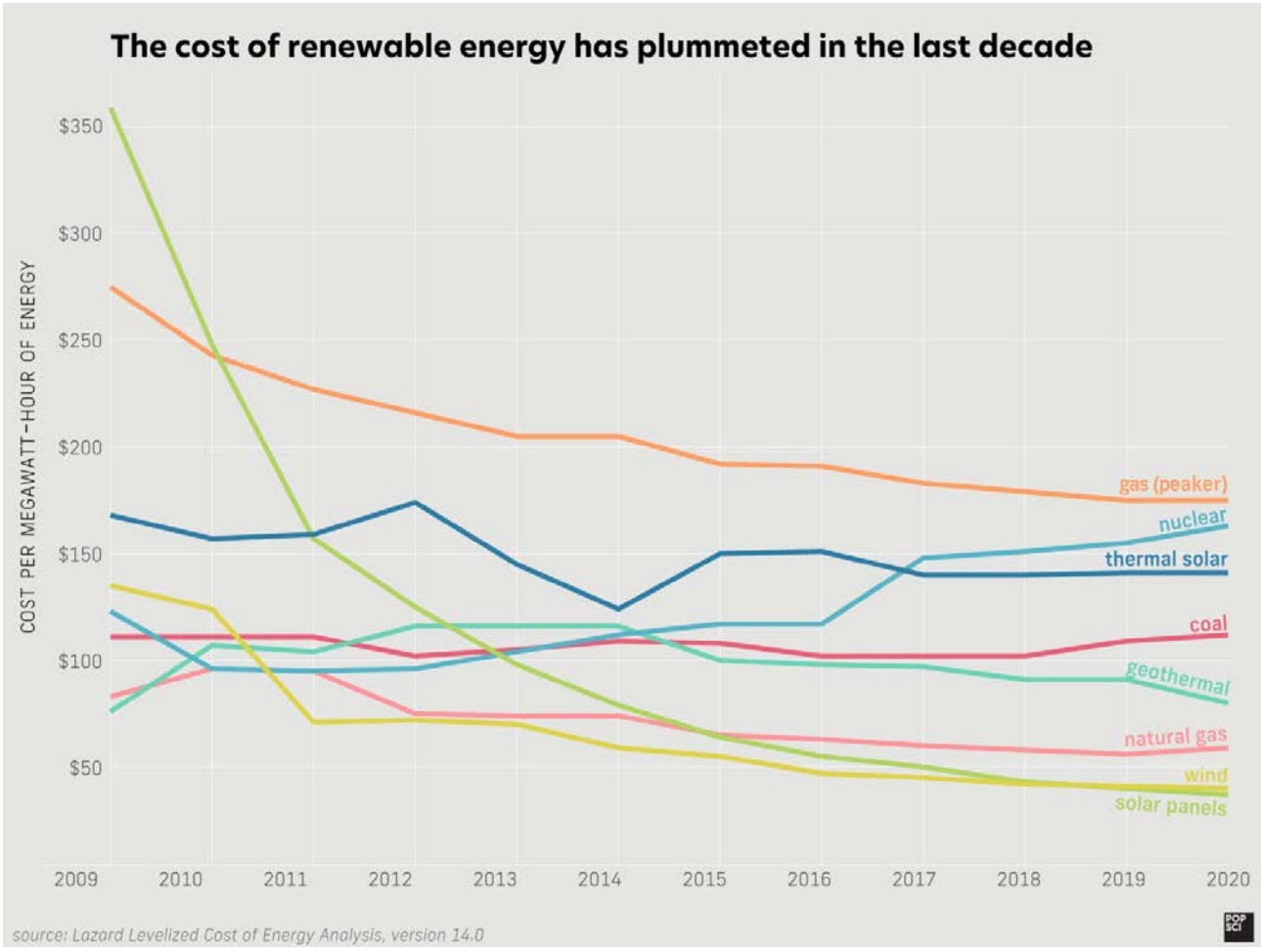


Figure 7 - Graph showing the cost of energy generated from different sources, (Chodosh, 2021)

Figure 7 displays that the cost of solar power has dropped by a staggering 90% since 2009 as the technology enhances and becomes more readily obtainable, and commercial scale solar plants are the least costly energy generation source to construct and manage. Despite these benefits of solar power, *"the investments, policies, and very infrastructure of the energy industry as a whole are very much skewed in favour of fossil fuels"* (Chrobak, 2021).

With solar, wind and geothermal being the cheapest energy sources, Callenbach's Ecotopian way of living could theoretically be achieved, however, that will not happen until those in power stop thinking about financial profit and start realising how damaging fossil fuel sourced energy is for the planet. Humanity is dangerously close to irreversible global warming, yet unfortunately, that is still not enough of a wake-up call.

Garden City Movement

The garden city movement was sparked by Ebenezer Howard, English social reformer, in response to the overpopulation of cities and the subsequent environmental issues, caused by the industrial revolution. Howard's urban planning reform was heavily influenced by utopian idealists and literature, such as Thomas More's Utopia (1516), Henry George's Progress and Poverty (1879) and Edward Bellamy's Looking Backward (1888), as well as anarchist Peter Kropotkin and William Morris (Maggs Bros. LTD., 2021) (Holland, 2017).

The garden city is the perfect planned residential community, combining the best features, or 'magnets' as shown in Figure 8, of urban (e.g. jobs, infrastructure, facilities) and rural living (e.g. proximity to nature, better air quality, space), a concept very similar to Morris' morphing of England into a 'garden'. In his influential book, Tomorrow: A Peaceful Path to Real Reform (1898), Howard describes his model, which is based on a circular configuration, as illustrated in Figure 9. At the centre of each settlement there would be a park, followed by municipal and cultural buildings, residential areas, and industry at the

outermost section, which is then surrounded by a ‘wide agricultural belt’ preventing the expansion of towns. These towns would have good, accessible transport infrastructure and the residential areas would be in walking or cycling distance from the town centre and factories. This merging would also result in high-quality affordable dwellings and improved standard of life. Howard also planned a reinvestment model where the profits from rents were reinvested into the towns for the benefit of the people (The Editors of Encyclopaedia Britannica, 2012) (Historic England, 2016) (Heritage Foundation Letchworth Garden City, 2021).

The

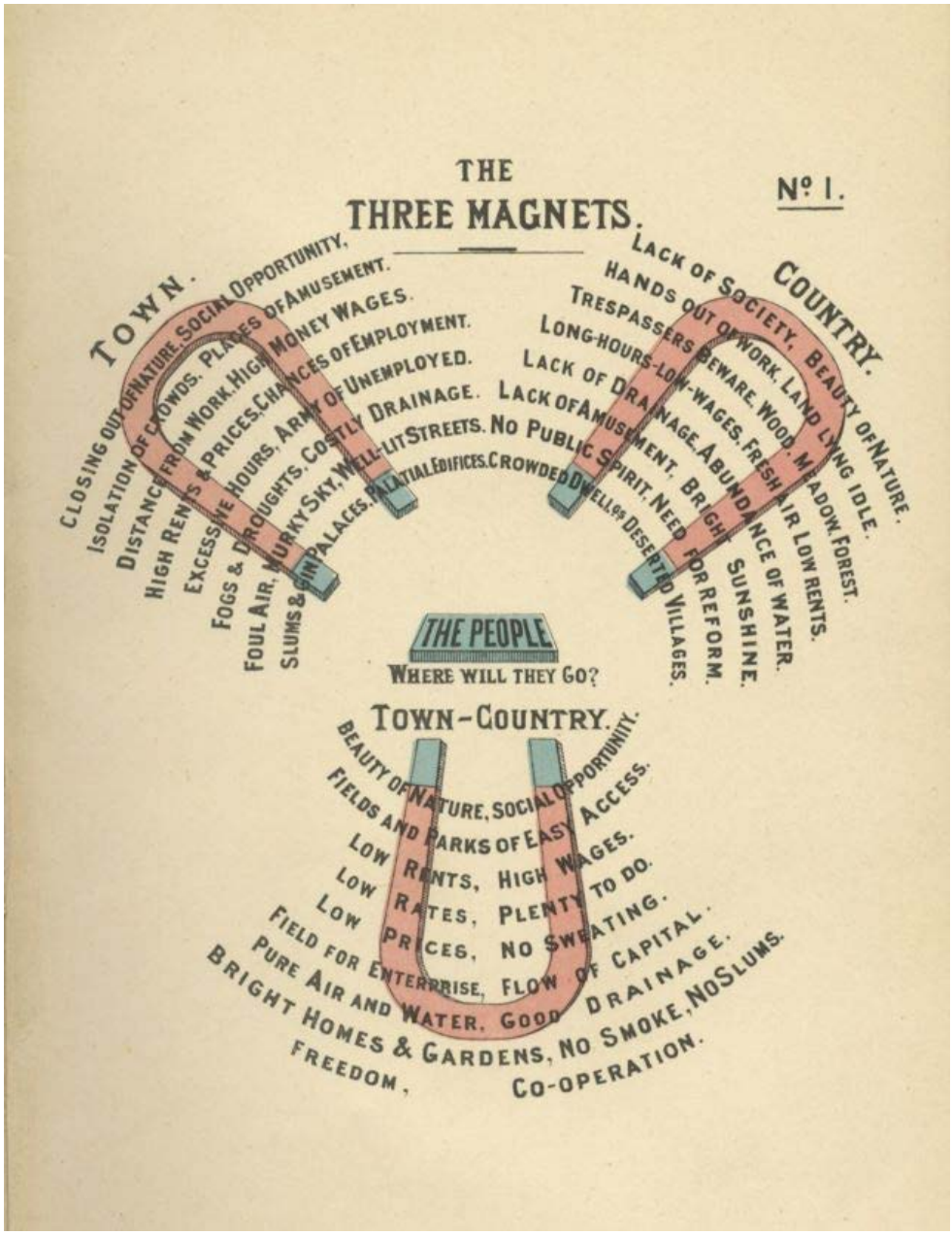


Figure 8 - The Three Magnets, in which Ebenezer Howard brilliantly summarised his concept of a ‘joyous union’ of town and country, (Historic England, 2016)

construction of the world's first planned garden city, Letchworth, began in 1903, with Arts and Crafts architects Barry Parker and Raymond Unwin responsible for designing the town's masterplan (Discover Letchworth, 2021). The key features of their designs were allowing in maximum sunlight, open living plans and using locally sourced materials, which can be seen in Figure 11.

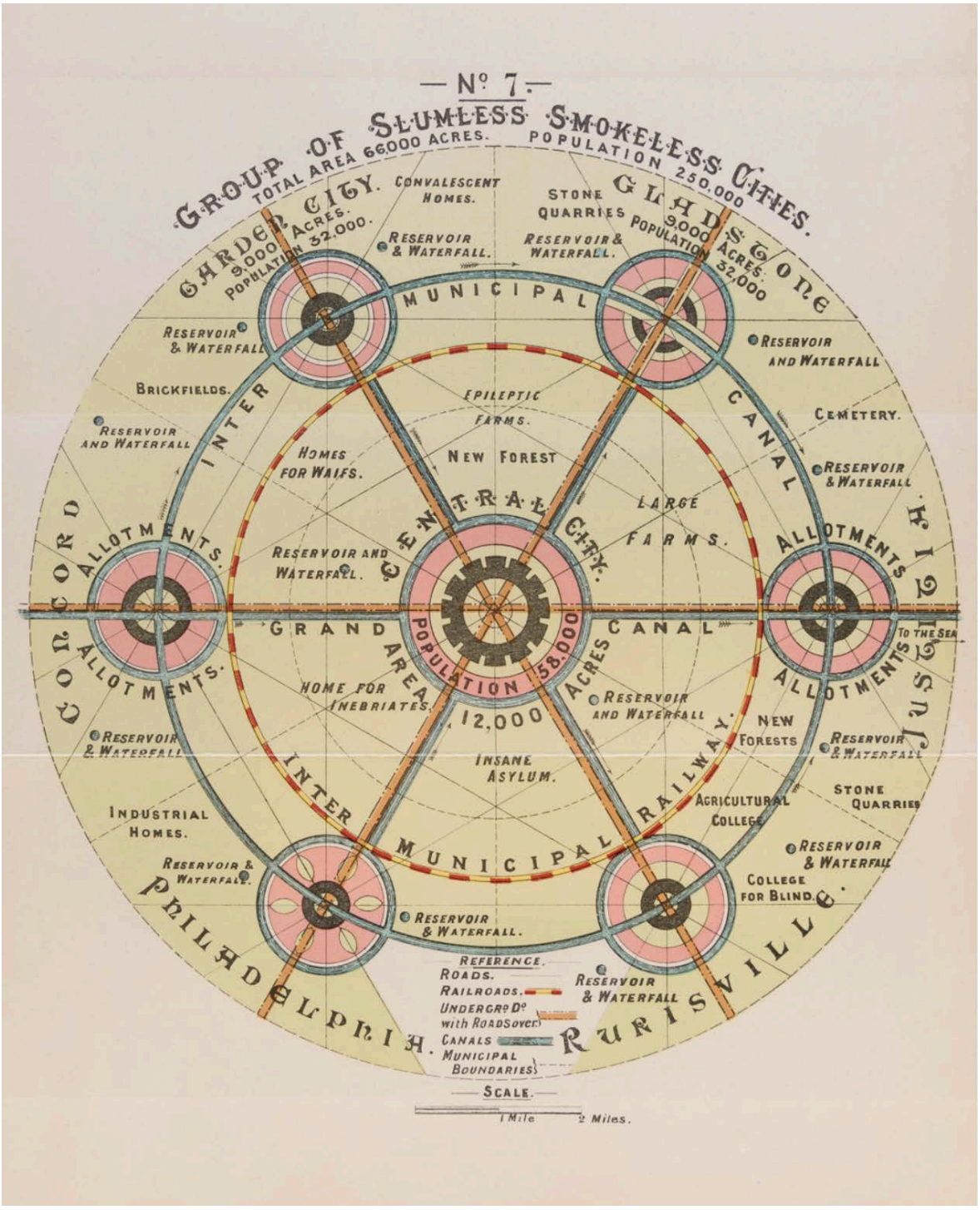


Figure 9 - Illustration of Howard's group of slum-less, smokeless cities (Howard, 2021)

Figure 10 - The sinews of the Parker and Unwin layout for Letchworth, the first garden city, stand out on this aerial photograph from 2009, (Historic England, 2016)

Figure 11 - Sepia tint photograph of Glaed Hame, designed by Parker and Unwin and built 1906, (Letchworth Garden City Heritage Foundation, 2021)

The garden city movement extends further than limits of Letchworth, it had an impact on urban planning and housing provision in a great deal of England, as well Europe, North and South America, East Asia and more (Historic England, 2016).

Howard focused on food production intensely, being influenced by other utopian schemes of purposeful relations with food. Howard described the role of the relation as essential in connecting growers, distributors, retailers and consumers positively. *“On the growing side he proposed an*

agricultural greenbelt of farms, dairies, orchards, allotments and smallholdings on the urban edges, as well as vegetable growing in the town's abundant private gardens." (Dr Parham, 2021).

Providing allotment plots in cities is crucial, it allows people to not only grow their own organic food and reduce the need for plastic packaging, but also get all the health benefits associated with gardening, such as increased physical activity, reductions in mental health issues, and an overall improved wellbeing (Scruby and Suyin Chalmin-Pui, 2019).

These growing amenities are very similar to the ones described in Callenbach's Ecotopia, perhaps Callenbach drew inspiration from Howard's plans. Producing food in situ means that there is less transportation and storing involved, resulting in fresher, longer lasting food on retailer shelves, as well as a decrease in food waste. Apart from the obvious financial benefits, there are environmental benefits, such as lower CO_2 emissions as the travel distance is reduced. Both Howard and Callenbach talk of the recycling of food waste, which transforms it into organic fertiliser and used on agricultural land, enriching the soil quality. This is an environmentally friendly solution as recycling the organic matter reduces 40-60% of carbon emissions compared to composting (Cordis,

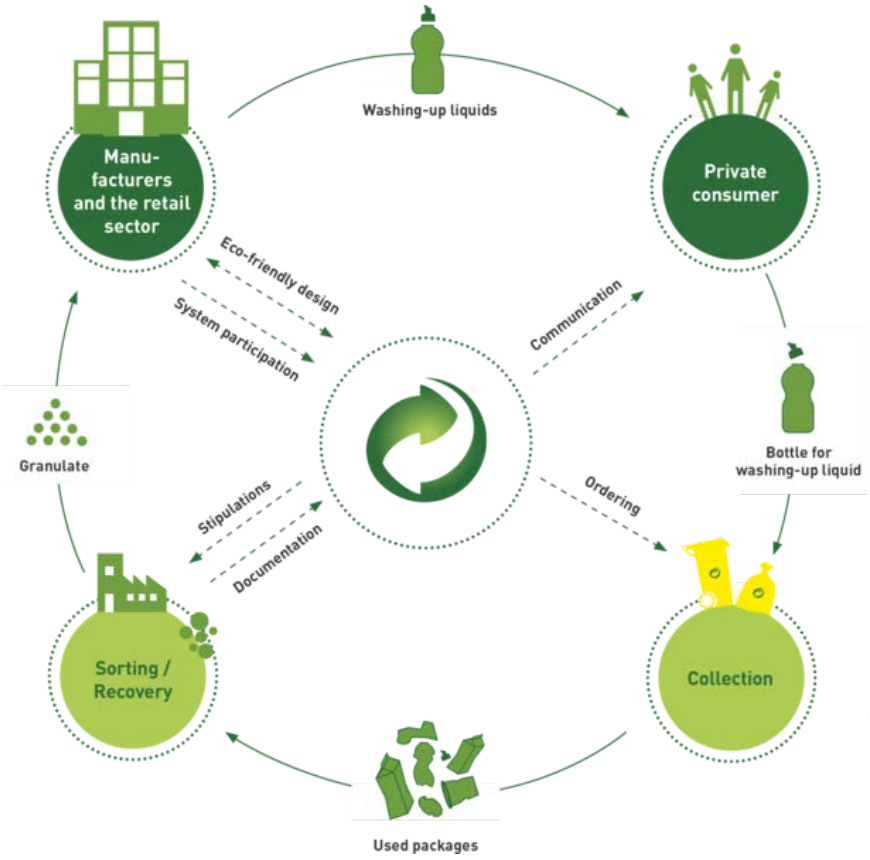


Figure 12 - Der Grüne Punkt - Dual System Germany GmbH with the Green Dot as a trademark has been the first dual system to build this near-to-home collection system, (Der Grüne Punkt, 2021)

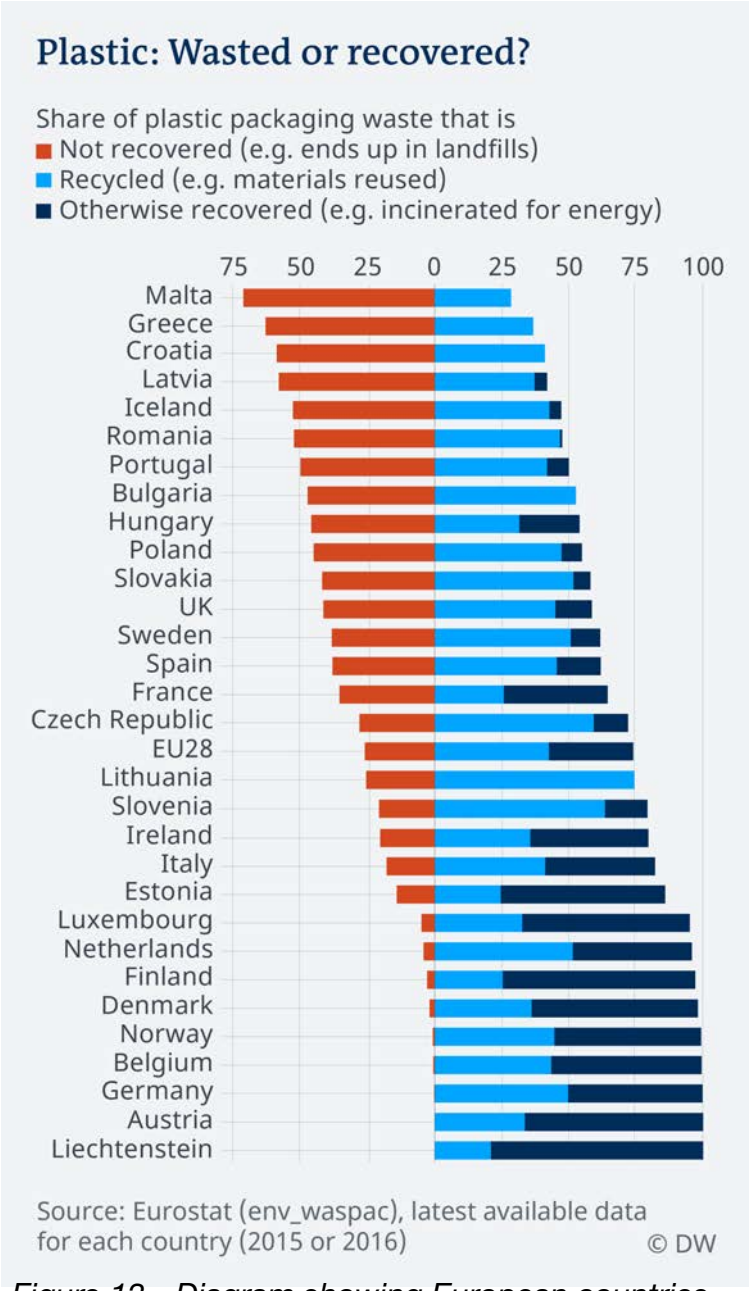


Figure 13 - Diagram showing European countries and their share of plastic waste that was not recovered, recycled, and otherwise recovered, (Eurostat, 2016)

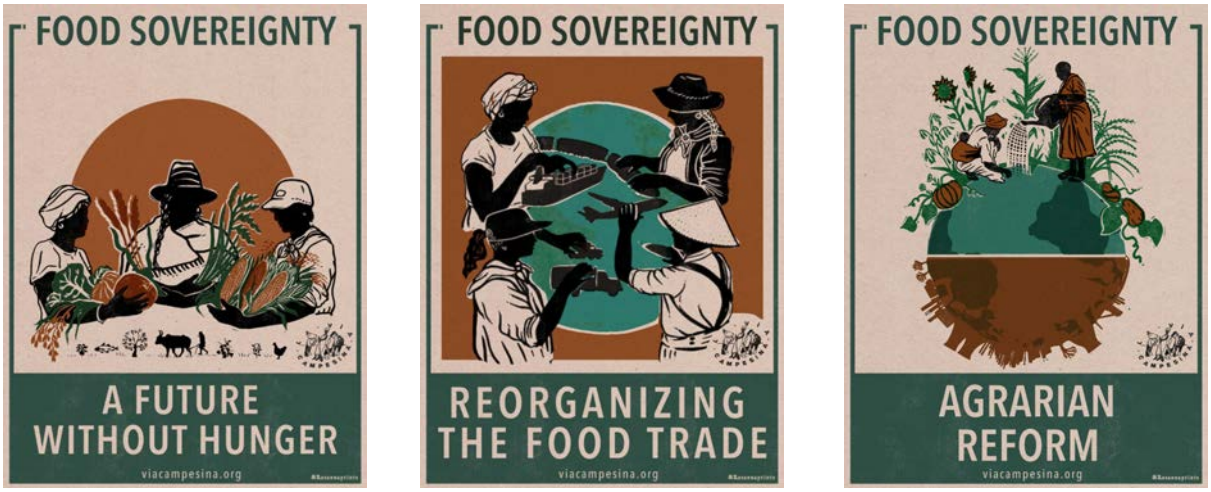
2020). Callenbach also talks of citizen responsibility and obligatory categorisation of all waste into recyclable and compostable (Eder, 2010).

A modern-day example of such a comprehensive recycling system is Germany, leading with a 65% recycling rate of municipal waste (McCarthy and Sánchez, 2016). This has been achieved through the standardisation and colour coding of recycling containers throughout the country.

"There's a blue bin for paper, a brown or green bin for biodegradables, a yellow one for plastic and a black one for the rest. Additionally, Germans return their deposit bottles to the supermarket, and drop glass bottles at public collecting points." (Wecker, 2018). Apart from the citizens enjoying and taking pride in their recycling practices, manufacturers are obliged to use less packaging as they pay a fee corresponding to the weight of said packaging, i.e. the more packaging, the higher the fee (Shaju, 2020).

However, Antonino Furfari suggests that the 65% recycling rate is very deceiving as it refers to how much waste was collected and does not reflect how much material was actually processed. Waste that was wrongly disposed of, or waste composed of multiple types of plastics cannot be recycled, therefore these end up in landfills or incinerated for heat or energy generation (Wecker, 2018). Figure 13 shows that Germany genuinely recycles only approx. 30% of all collected waste. For these disposal methods to be counted under ‘recycled’ is hypocritical, because the incineration of mixed plastics releases a large amount of CO2 back into the atmosphere along with various toxins that will degrade the air quality, subsequently affecting the health of all living things. The TV programme ‘Dispatches’ uncovered that England incinerates more waste than it recycles, and to make matters worse, 60% of that burned litter could have been recycled (Client Earth, 2021).

Food Utopias and Food Insecurity



The majority of utopian literature tends to be perceived as an idealised, imaginary world, instead of an attainable improvement of the future. Because many of these utopias were fuelled by the dissatisfaction of the current political, social, religious or environmental condition, the author tries to solve and improve on that. The food sovereignty movement is an example which stemmed as a result of utopian manifestos for the reorganisation of the

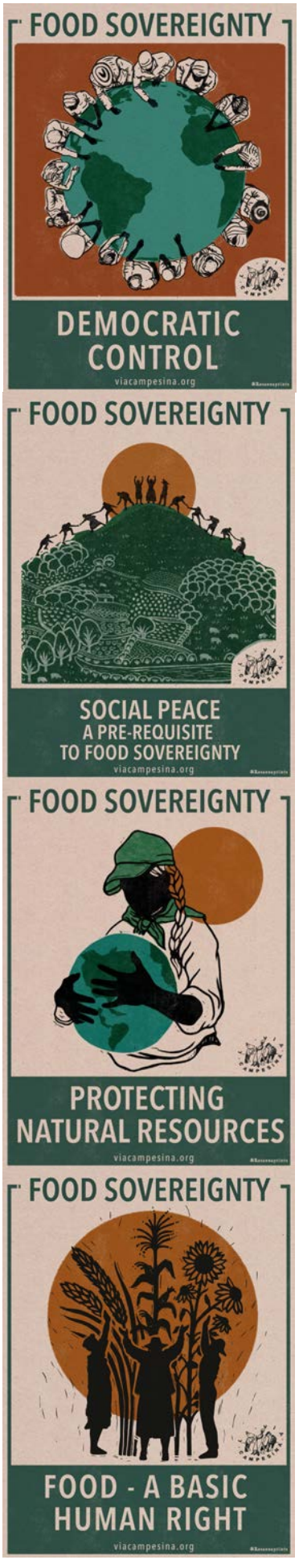


Figure 14 - The 1996 Rome Food Sovereignty Declaration in Postcards (Via Campesina, Morris R., 2021)

food system founded on justice (Gordon, 2019). Both Howard and Callenbach are amongst the utopians who have written elaborate proposals surrounding food production and distribution. The food sovereignty movement emerged with La Via Compesina's concern with the rapid increase in global hunger and poverty levels, which was voiced in 1996 at the UN Food Summit as the 'Food Sovereignty Declaration' (La Via Campesina, 2021). Food sovereignty is a movement which would enable communities have control over food production, trade and consumption, instead of making profits for giant corporations, which currently dominate the global food system by eradicating competition and enforcing strict conditions to producers. This in turn leads to poverty and hunger. Figure 15 shows that instead of eradicating food insecurity, the lack of *"reliable access to a sufficient quantity of affordable, nutritious food"* (Oxford Languages, Google, 2021) it has been on the rise, with the hard impact of COVID-19 pandemic represented on the 2020 figures. In 2020, 768 million people in the world were undernourished, and if the trend continues, over 840 million people will be affected by hunger in 2030 (FOA, 2021) (UN, 2021).

Food sovereignty is constructed on six fundamental principles:

"food for people, valuing food providers, localising food systems, making decisions locally, building knowledge and skills and working

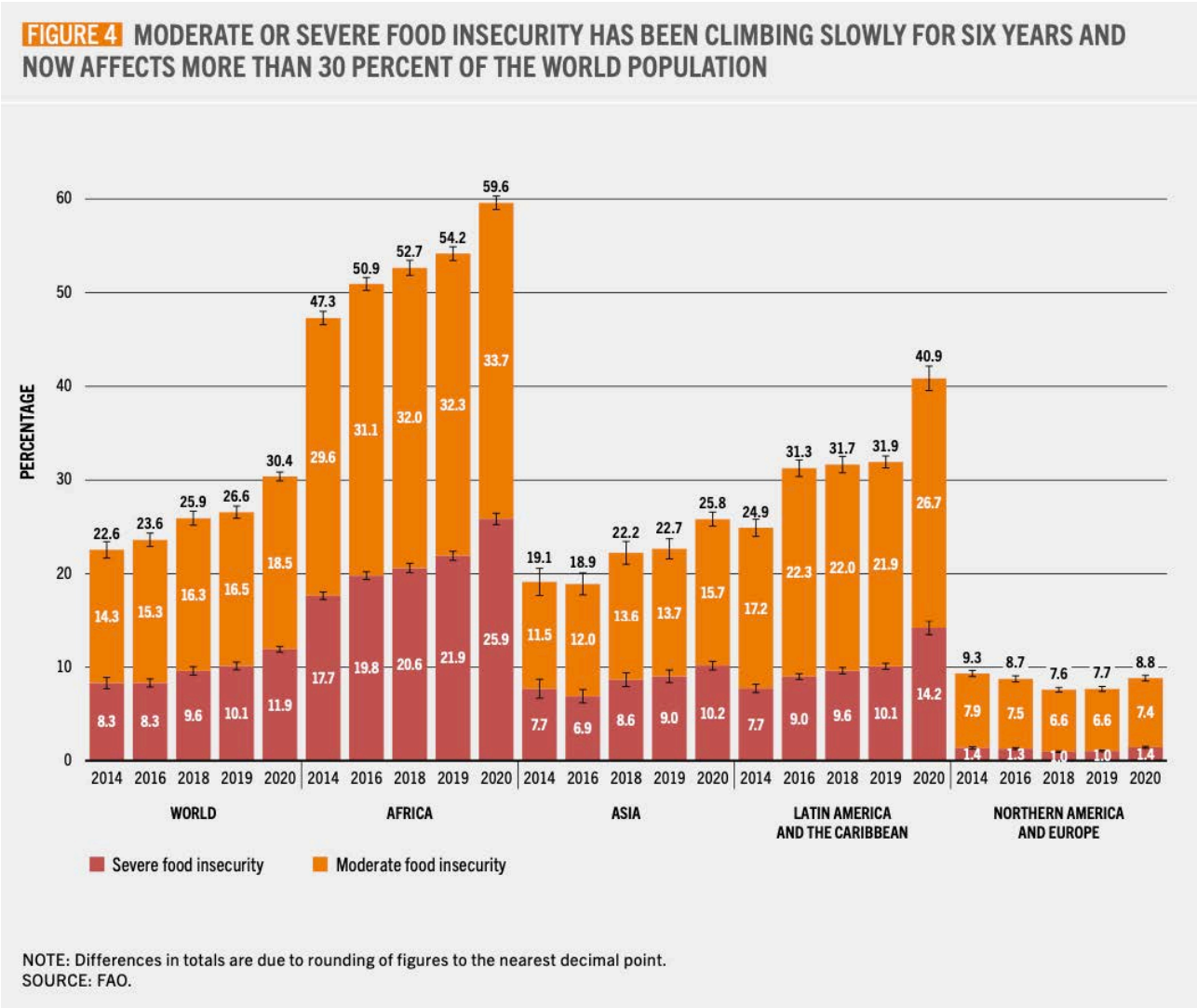


Figure 15 - Graph showing the percentage of moderate and severe insecurity around the world, (Food and Agriculture Organisation of the United Nations, 2021)

with nature" (Grassroots International, 2021). The movement strives to ensure: that the right to healthy food is not violated, that farmers work in dignity and are not exploited, that supplying food to local communities must be a priority instead of commerce, food producers take control of the land and resources and use them in a socially and environmentally sustainable way, suitable development of agricultural understanding and finally, preserving natural resources and minimising greenhouse gas emissions (Global Justice Now, 2021).

With the world population expected to reach 9.7 billion in 2050, the food consumption habits will have to drastically change as the equivalent of 3 Earth's could be needed to support current lifestyles. Per annum, 1/3 of all food produced is wasted due to poor

harvesting and transportation practices. The agricultural sector is also responsible for 22% of greenhouse gas emissions, 69% of fresh water consumption and severe degradation of soil fertility and environments (UN SDGs, 2021). All these facts highlight just how unsustainable the current agricultural practices are. It is projected that 68% of the world's population will live in urban areas by 2050 (UN, 2018), which will further increase the stress on food production and distribution.

Vertical Farms

While it might be too late to construct cities according to Howard's configuration which blurs the line between urban and rural and integrates agriculture into the community, there is another utopian solution to growing food in urbanised areas - indoor vertical farming.

Figure 16 - Illustration of the Hanging Gardens of Babylon, (History.com, 2018)

Vertical gardening however is not a modern concept, the Hanging Garden of Babylon (modern Iraq) are one of the seven wonders of the ancient world which are believed to have been built in 6th century BC by king Nebuchadnezzar II as a present for his wife, Amytis. Though there is no solid evidence that these gardens have actually existed and were located in Babylon, there are Greek and Roman texts describing these luxurious and exotic gardens, however, they are second-hand accounts, meaning the authors have never seen the gardens. For the terraced gardens to have

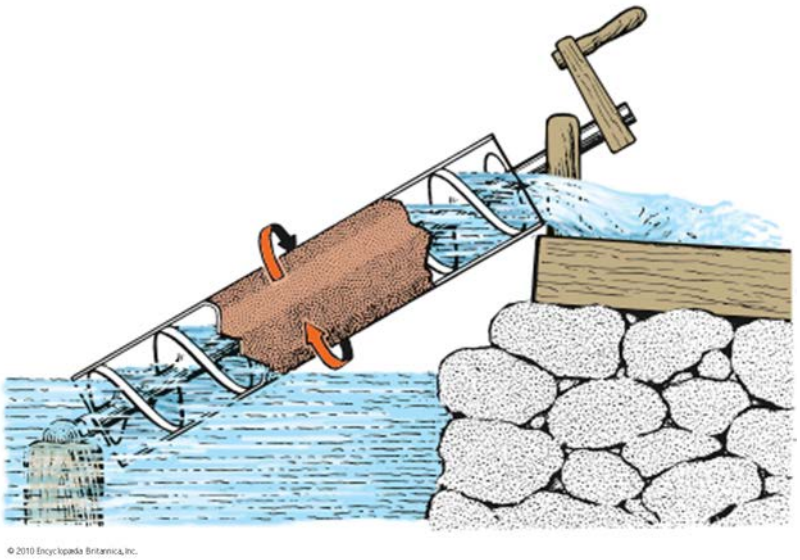


Figure 17 - Diagram of Archimedes screw, (Encyclopædia Britannica, Inc. 2010)

thrived, a sophisticated irrigation system would be needed to reach the top levels, which is thought to be similar to the *"Archimedes' screw developed four centuries later"*, shown in Figure 17 (Klein, 2018). They are also described to be *"roofed with stone balconies on which were layered various materials, such as reeds, bitumen, and lead, so that the irrigation water would not seep through the terraces"* (Britannica, 2020).

Modern day vertical farming was developed by Dr. Dickson Despommier and his students during medical ecology classes since the late 1990s, as a solution to combat food insecurity and issues with food production, one being the use of human excrements as fertiliser and the spread of parasitic infections as a result of that contamination (Platt, 2007). Vertical farming consists of growing food in vertical modular systems in an enclosed, controlled environment that result in higher production yields per acre compared to traditional farming practices. The main advantages of vertical farming are: the lack of soil, which helps prevent the further degradation of fertile soil; recycling of all resources, including the nutrient rich solutions in which plant roots grow, such farms can use up to 90% less water than traditional farming; a hermetic environment eliminates the need for pesticides, herbicides and fungicides meaning that the food produced is organic; extreme weather conditions and geographical location do not affect the harvest; nutrient solutions and light waves can be optimised for maximum flavour; vicinity to consumers reduces

transportation distance and refrigeration periods so food freshness is prolonged (Lawson, 2018)(Moseley, 2021). Utopian idealists Howard and Callenbach emphasised the importance of proximity of food production to consumer, organic farming approach and availability of fresh, wholesome foods as well as environmental consciousness, and despite the fact that neither authors specifically talked of vertical farming, these principles feed perfectly into the concept.

The main drawbacks of vertical farming are: high electricity consumption supplying power to growing lights and climate control systems, however, by using renewable energy sources, the environmental impact can be minimised; a limited range of fruits and vegetables that are viable to grow vertically, although this increases as more research is

STRENGTHS	WEAKNESSES
• Area with a massive potential for growth from a technology perspective. • Technologies like remote sensing, electronic communication system integrated into a single data management system and a growing knowledge of applied hydroponics are strengthening the growth of this field (Thingworks, 2017). • Companies like GE, Philips, Panasonic are investing heavily in technology used in vertical farms. • Seed producing giants are working on producing genetically better seeds specifically designed for vertical farming. • The best brains in several technologies are involved in this field such as Dutch bioengineers, scientists from NASA, staffers in Antarctica Research Centers etc. (Lawson, 2015). • Using IOT, the right amount of fertlizer and water can be added to the plants, eliminating wastage of resources (Farm management, 2017).	• High energy requirement for artificial lighting within the vertical farms. Heating and air conditioning will add considerably to power demands (Brennan and Gralnick, 2015). • Standards for sensor networks and data communication still under development. • The speciality agri softwares for Vertical Farming are are not matured. • Requires high precision monitoring (Beecham research Ltd, 2014).
OPPORTUNITIES	**THREATS**
• New technologies such as cost-effective monitors and controllers used are driving down costs of operation (Farm management, 2017). • More efficient and lower cost LED lights are bringing down high costs of artificial lighting (Lawson, 2015). • Machines used for harvesting crops and packaging them are cutting down labor costs (Brennan and Gralnick, 2015). • Opportunity for new skill development with the increasing need of master growers, plant scientists, engineers trained to design high tech grow systems (Hepler, 2016). • Alternative solutions are being used to generate energy within the farms. Natural energy sources like geothermal energy and solar energy are being harnessed to reduce huge energy costs (Despommier, 2017).	• Risk of information theft. • Failure of even a single component of the IoT system may cause rapid plant death leading to massive losses

Figure 18 - SWOT analysis from the technological perspective, (Infosys, 2019)

STRENGTHS	WEAKNESSES
• Food companies as well as venture and growth equity firms are investing in vertical farming. • Farms such as AeroFarm, Ecopia Farms, Nuvege, Plant Lab etc. are economically viable, on an unsubsidized basis (Cho, 2011). • Uses old buildings by creating suitable warehouses equipped with the right infrastructure for vertical farming, negating the need to destroy old buildings (Despommier, 2017). • As crops are grown closer to the market, reduction in transportation cost of produce from rural farmlands to cities is evident (Lawson, 2015).	• Highly capital intensive to set up a vertical farm. • Energy cost, labour cost and maintenance cost are very high. • Space constraint limits what can be grown (Brennan and Gralnick, 2015). • Difficult and high cost is involved to grow several varieties of crops in the same vertical farming facility. • Approach best works only for salad greens and herbs which have higher margins and can be grown in large quantities. Staple crops such as wheat, soybean, corn etc are not cost-effective options. • Due to lack of soil, the produce does not get an organic label even though it costs as much (Brennan and Gralnick, 2015). • Scalability is the biggest challenge, needs to produce enough crops to sell at a profit at large grocery chains (Lawson, 2015).
OPPORTUNITIES	**THREATS**
• Vertical farm market is expected to grow at a CAGR of 24.8% from 2016 and reach USD 5.8 billion by 2022 (Markets and markets, 2017). • Vertical farms can be used to produce biologically active molecules for novel medical applications. • Demand for skilled workers in vertical farms will create future opportunities for education and training in this industry (Cho, 2011).	• The policy leaders do not have a clear knowledge of what a vertical farm actually is (Hepler, 2016). • Being a completely new industry there is a lot of uncertainity about the return on investment (ROI). • Proper management and investment in technology are highly crucial. Several start ups have struggled or failed in the past decade for these reasons (Lawson, 2015).

Figure 19 - SWOT analysis from the business perspective, (Infosys, 2019)

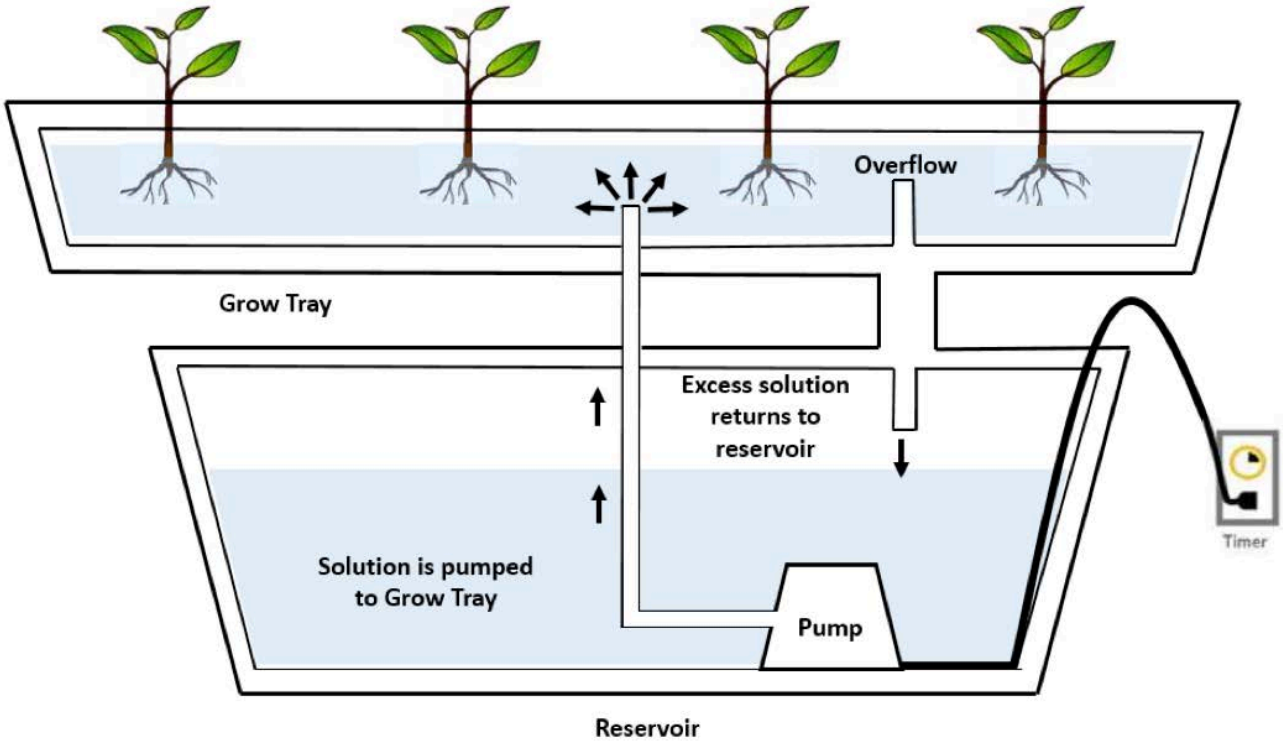


Figure 20 - Hydroponic system diagram, (Infosys, 2019)

being conducted; high set up cost - *"Gordon-Smith says vertical farming costs 2,200 to 2,600 Euro per square meter of cultivation bed space, while high-tech greenhouses cost 250 to 350 Euro per square meter of cultivation space"* (iFarm, 2021), albeit as technology advances and becomes more accessible and widespread, the costs become lower; contamination and potential loss of crop, which can be combated by assuming the highest sanitation levels such as *"a P3 barrier, the second highest level of security, which was originally invented to prevent the Ebola virus from escaping from the laboratory"* (Platt, 2007)(Lawson, 2018). In Figures 18 and 19 Kumar Gupta and Ganapuram highlight the main advantages and disadvantages in their SWOT analyses from a technological and business perspective (Kumar Gupta and Ganupuram, 2019).

The three main irrigation systems for vertical gardens are: hydroponic (plant roots are submerged in a nutrient rich solution, free of soil, in a grow tray), aeroponic (the roots are suspended in the air and are misted with a nutrient rich solution at set timed intervals) and aquaponic (hydroponic and aquaculture combined, fish produce nutrient rich waste and

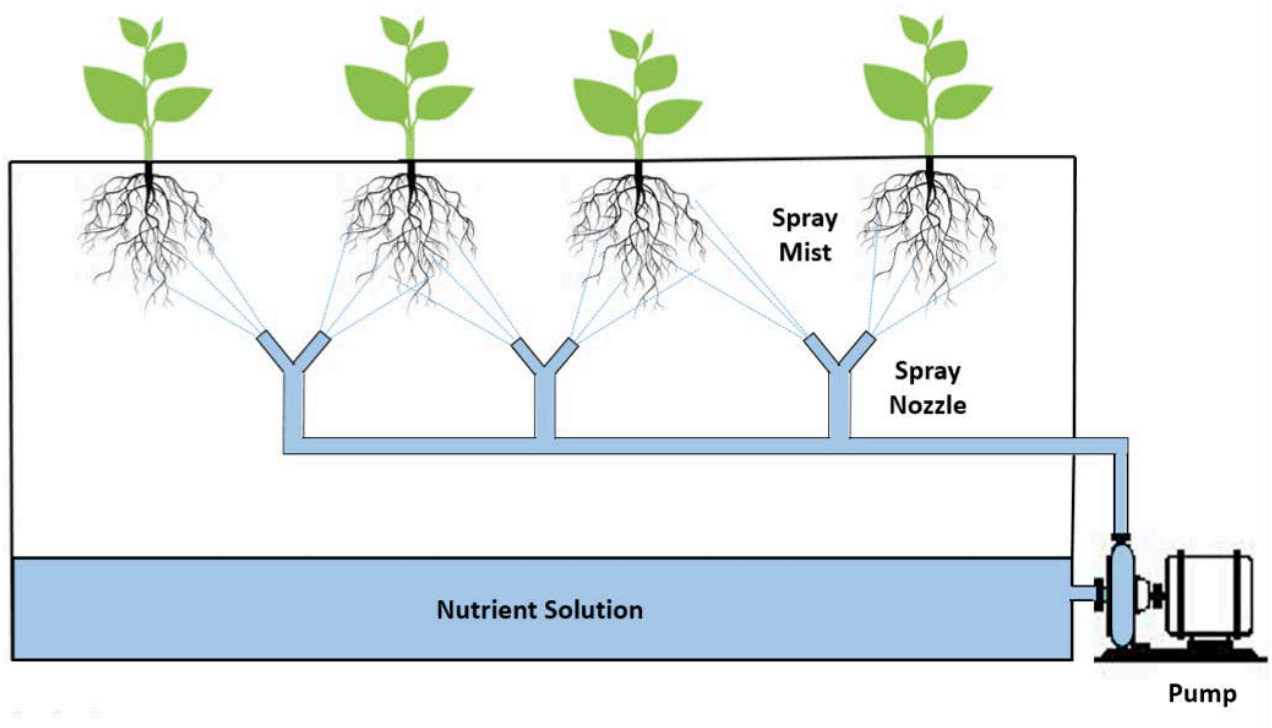


Figure 21 - Aeroponic system diagram, (Infosys, 2019)

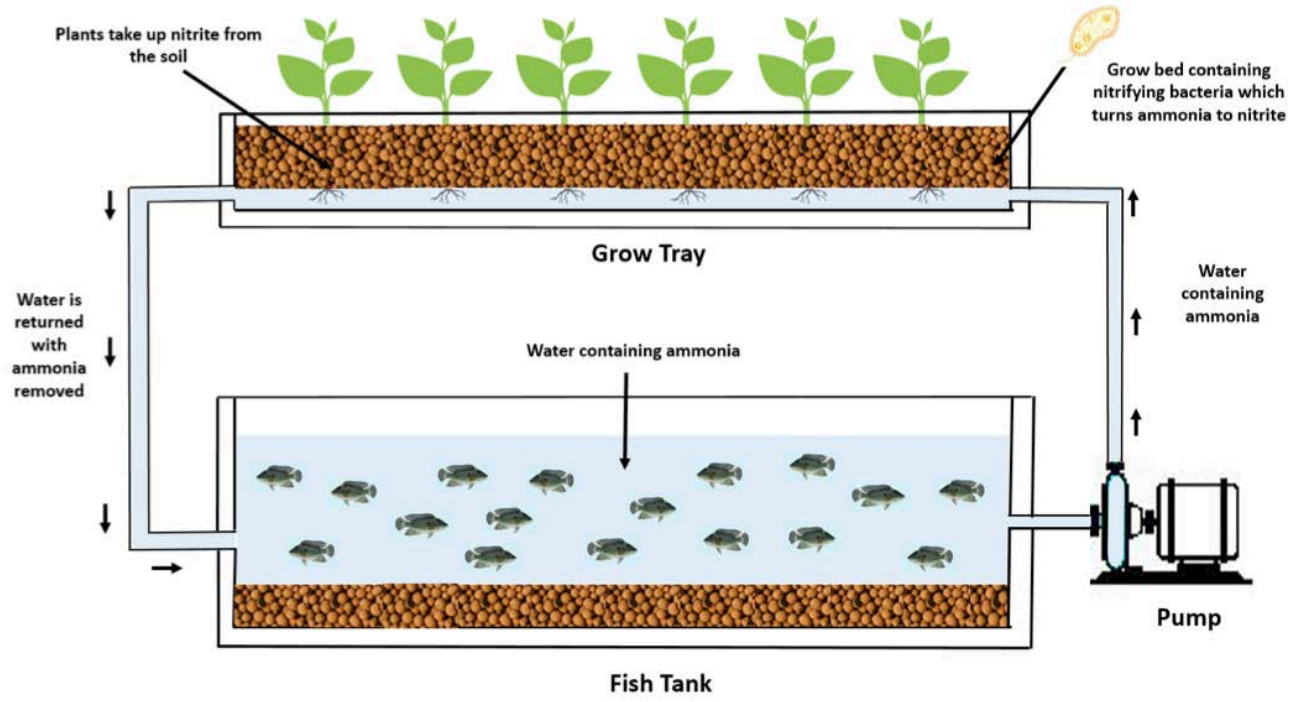


Figure 22 - Aquaponic system diagram, (Infosys, 2019)

the plants filter the water, maintaining a healthy living environment for the fish). Figures 20,21 and 22 illustrate each growing system.

The aeroponic growing system was developed by NASA in 1997 while conducting studies on growing food in zero gravity. This is possibly the most efficient of the three systems as water consumption can be reduced by up to 98% and fertiliser usage by 60%, all while totally eliminating pesticides and increasing crop yields (NASA, 2007).

There are debates regarding which system is the most reliable for commercial use, hydroponics work with excess nutrient solution, meaning if there are power issues, the

Figure 23 - Hyperions by Vincent Callebaut, (Callebaut, 2016)

Figure 24 - Agro-main-ville by ABF-lab, (ABF-lab, 2016)

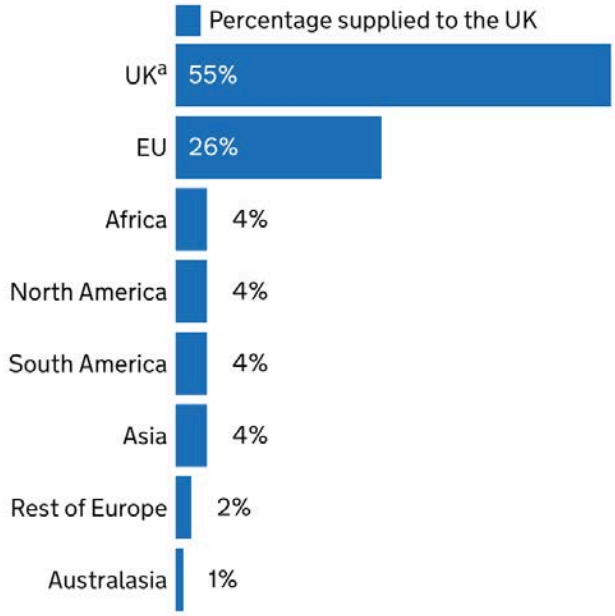
Figure 25 - Growing Underground farm located in a bomb shelter, (Taka, 2021)

plants still have access to those nutrients, whereas if aeroponic systems malfunction, the roots dry out and the entire crop fails, despite the more advantageous revenue it generates (Moro, 2021).

While the vertical farming concept gave rise to a multitude of utopian architectural designs, such as Callebaut's Hyperions and ABF-lab's Agro-main-ville, these farms could tackle empty and misused spaces, reducing the amount of CO2 emissions as a result of remodelling an existing space compared to building new spaces from scratch. In 2019 there were over 617,000 empty buildings in the UK, of which 172,217 were commercial buildings, as claimed by Glide, some of which could be suitable for transformation into vertical farms (Parrin, 2019). For example, the Growing Underground farm, which specialises in micro greens, has made use of a WW2 bomb shelter 33 meters underneath the busy streets of London, and customers are able to have fresh greens on their plate in as little as 4 hours after harvest (Growing Underground, 2021).

The prominent issue of food deserts affected approximately 10.2 million people in the UK in 2018 (Calderwood, 2018). Food deserts are defined as areas with limited access to affordable and nutritious healthy, fresh food. These areas are related to geographic or socioeconomic circumstances i.e. the distance needed to travel to obtain healthy food is great and costly, and even if the food is available, it is unaffordable (Rodgers, 2015). Despommier believes that vertical farms *"will allow us for the first time to feed everyone on earth and still return land to its original ecological function"* (Meinhold, 2014).

With one in nine people hungry or undernourished daily, world hunger is a catastrophic issue which suffered major setbacks as a result of the Covid-19 pandemic, affecting an additional 30 million people. The dominant causes of hunger are: the climate crisis leading to reoccurring droughts and floods and inevitable loss of crops; political conflicts resulting is the displacement of large populations; poverty and unaffordable nutritious food leading to malnutrition and obesity; and gender inequality as women are more vulnerable to malnutrition (Action Against Hunger, 2021). Other causes are the deficit of arable land resulted by *"topsoil erosion, nutrient degradation and salinity" (*Eden Green, 2020).



In 2019, the UK imported 45% of its food, with the EU being the main import source, as shown in Figure 26. These figures suggest that the UK is not self-sufficient, it cannot meet the consumption needs based on its own production alone.

Figure 26 - Origins of food consumed in the UK 2019, (Defra, 2020)

Conclusion

From the information and arguments stated throughout this report, the following conclusion can be drawn - vertical farming, in theory, can ease the pressure on food production and ameliorate world hunger, although, realistically it is unfortunately a long way from that. Despite the fact that the technologies involved in vertical farming, such as LED grow lights and environment control systems are becoming more advanced and affordable as demand

increases, the set-up costs are still high, compared to greenhouses or traditional agriculture. Energy provision is one of the costlier factors of vertical farming, as each shelf must be illuminated, simulating the sun, however as shown in Figure 7, solar power is now the cheapest energy source available, and if adopted, could bring costs down significantly. Another reason why vertical farming is perfect only theoretically at this time, is the small range of produce that can be grown. For example, micro greens, leafy salads and herbs are the most financially viable to grow, and while these could be consumed as part of a healthy diet, these aren't produce that someone in a food desert can base their diet on. Vertical farms however could take the pressure off traditional farming as they would reduce the amount of produce needed to be grown that way, therefore freeing up arable land for other staple foods. Reducing the need for traditional farming through the incorporation of vertical farms would save valuable natural and finite resources such as potable water and fertile land. Additionally, this hybrid agriculture model would be reducing the use of harmful pesticides which pollute bodies of water, deforestation and release of greenhouse gasses contributing to global warming, which makes traditional farming vulnerable to extreme weather conditions.

However, it must be highlighted that this utopian food production concept is only in its early stages of functioning. Being conceived as a result of increased concern for the world's food security, it will become perfected and made viable in the near future to sustain the ever-increasing population. Once vertical farms overcome the present issues highlighted by Kumar Gupta and Ganapuram in their SWOT analyses, Figure 18 and 19, they might be a key component in solving world hunger, decreasing the pollution caused by agriculture by being located in close proximity to densely populated areas and food deserts, as well as reduce food waste created as a result of poor storage methods and during long transits.

Bibliography

1. @averincm, 2021. [online] Twitter.com. Available at: https://twitter.com/averincm/status/1416081492657119232 [Accessed 30 November 2021].
2. @techreview, 2021. [online] Twitter.com. Available at: https://twitter.com/techreview/status/1415359294850011136 [Accessed 30 November 2021].
3. Action Against Hunger, 2021. *World hunger facts*. [online] Action Against Hunger. Available at: https://www.actionagainsthunger.org.uk/why-hunger/world-hunger-facts [Accessed 10 December 2021].
4. Barnett, P., 2015. *An introduction to Green Politics*. [online] Green World. Available at: <https://greenworld.org.uk/article/introduction-green-politics > [Accessed 29 November 2021].
5. Bergan, D., 2016. *grassroots | movement or campaign*. [online] Encyclopedia Britannica. Available at: <https://www.britannica.com/topic/grassroots > [Accessed 29 November 2021].
6. Britannica, 2020. *Hanging Gardens of Babylon | History & Pictures*. [online] Encyclopedia Britannica. Available at: https://www.britannica.com/place/Hanging-Gardens-of-Babylon [Accessed 6 December 2021].
7. Calderwood, I., 2018. *10 Million Britons are Living in a 'Food Desert': Report*. [online] Global Citizen. Available at: https://www.globalcitizen.org/en/content/food-desert-britain-supermarkets-fruit-and-veg/ [Accessed 9 December 2021].
8. Callenbach, E., 1982. *Ecotopia Then & Now : An interview with Ernest Callenbach*. [video] Available at: <https://www.youtube.com/watch?v=tYc9myGMmTc > [Accessed 9 November 2021].
9. Callenbach, E., 2008. *Ecotopia or Bust Interview with Ernest Callenbach*. [video] Available at: https://www.youtube.com/watch?v=pczXBYJuab0&t=1352s [Accessed 30 November 2021].
10. Chrobak, U., 2021. *Solar power got cheap. So why aren't we using it more?*. [online] Popular Science. Available at: https://www.popsci.com/story/environment/cheap-renewable-energy-vs-fossil-fuels/ [Accessed 30 November 2021].
11. Claeys, G., 2010. The Cambridge companion to utopian literature. Cambridge University Press, p.6,.
12. Client Earth, 2021. *The environmental impacts of waste incineration*. [online] Clientearth.org. Available at: <https://www.clientearth.org/latest/latest-updates/stories/the-environmental-impacts-of-waste-incineration/ > [Accessed 4 December 2021].
13. Cordis, 2020. *CORDIS | European Commission*. [online] Cordis.europa.eu. Available at: https://cordis.europa.eu/article/id/421818-transforming-organic-waste-into-fertiliser-for-emissions-free-agriculture-and-forestry [Accessed 4 December 2021].
14. Course Hero, 2019. *Utopia by Sir Thomas More | Summary & Analysis*. [video] Available at: <https://www.youtube.com/watch?v=2au0B5j6ji8 > [Accessed 3 November 2021].

15. Creech, H., 2012. *Sustainable Development Timeline*. [online] Iisd.org. Available at: https://www.iisd.org/system/files/publications/sd_timeline_2012.pdf [Accessed 29 November 2021].
16. Dictionary.cambridge.org. 2021. *utopia*. [online] Available at: <https://dictionary.cambridge.org/dictionary/english/utopia > [Accessed 3 November 2021].
17. *Discover Letchworth 2021.* Discover-letchworth.com.*The History of Letchworth Garden City*. [online] Available at: https://www.discover-letchworth.com/visiting/a-brief-history-of-letchworth [Accessed 1 December 2021].
18. Dr Parham, S., 2021. *Food, utopian traditions and the Garden City | International Garden Cities Institute*. [online] Gardencitiesinstitute.com. Available at: https://www.gardencitiesinstitute.com/think-piece/food-utopian-traditions-and-the-garden-city [Accessed 4 December 2021].
19. Drechsler, W. & Kostakis, V., 2018. Why the utopian vision of William Morris is now within reach: Aeon Essays. *Aeon*. Available at: https://aeon.co/essays/why-the-utopian-vision-of-william-morris-is-now-within-reach [Accessed November 18, 2021].
20. Duncombe, S., 2021. *Sources | The Open Utopia*. [online] Theopenutopia.org. Available at: <https://theopenutopia.org/full-text/sources/ > [Accessed 4 November 2021].
21. Eden Green, 2020. *Hydroponics Is Helping to End World Hunger | Eden Green Technology*. [online] Eden Green Technology. Available at: https://www.edengreen.com/blog-collection/why-hydroponics-is-helping-end-world-hunger [Accessed 12 December 2021].
22. Eder, K., 2010. *Ecological concerns and their collective realisation in Ernest Callenbach´s "Ecotopia"*. [online] Grin.com. Available at: https://www.grin.com/document/171957 [Accessed 4 December 2021].
23. FOA, 2021. *The State of Food Security and Nutrition in the World 2021*. [online] www.fao.org. Available at: https://www.fao.org/state-of-food-security-nutrition [Accessed 5 December 2021].
24. Fridays For Future. 2021. *Fridays for Future – How Greta started a global movement*. [online] Available at: https://fridaysforfuture.org/what-we-do/who-we-are/ [Accessed 30 November 2021].
25. Geary, D., 2021. *Environmental Movement*. [online] Encyclopedia.com. Available at: <https://www.encyclopedia.com/earth-and-environment/ecology-and-environmentalism/environmental-studies/environmental-movement > [Accessed 17 November 2021].
26. Gordon, M., 2019. *Taking Utopian Thinking Seriously*. [online] Food First. Available at: https://foodfirst.org/taking-utopian-thinking-seriously/ [Accessed 5 December 2021].
27. Grassroots International, 2021. *Food Sovereignty | Grassroots International*. [online] Grassroots International. Available at: https://grassrootsonline.org/what-we-do/the-issues/food-sovereignty/ [Accessed 5 December 2021].
28. Growing Underground. 2021. *Growing Underground*. [online] Available at: https://growing-underground.com [Accessed 10 December 2021].
29. Heritage Foundation Letchworth Garden City, 2021. *A brief history of Letchworth Garden City*. [video] Available at: https://www.letchworth.com/who-we-are/our-history?

utm_source=homepage&utm_medium=smallbanner&utm_campaign=our-history [Accessed 1 December 2021].

30. Historic England, 2016. *A Brief Introduction to Garden Cities*. [online] The Historic England Blog. Available at: https://heritagecalling.com/2016/02/18/a-brief-introduction-to-garden-cities/ [Accessed 30 November 2021].
31. Hodgkinson, T., 2016. *How Utopia shaped the world*. [online] Bbc.com. Available at: <https://www.bbc.com/culture/article/20160920-how-utopia-shaped-the-world > [Accessed 4 November 2021].
32. Holland, C., 2017. *Arts and Crafts Utopia*. [online] ribaj.com. Available at: https://www.ribaj.com/culture/arts-and-crafts-utopia-garden-city-william-morris [Accessed 1 December 2021].
33. iFarm, 2021. *Vertical Farms vs Greenhouses – The First Consideration: Location*. [online] Ifarm.fi. Available at: https://ifarm.fi/blog/2021/02/vertical-farms-vs-greenhouses [Accessed 12 December 2021].
34. Kumar Gupta, M. and Ganapuram, S., 2019. *VERTICAL FARMING USING INFORMATION AND COMMUNICATION TECHNOLOGIES*. [online] infosys.com. Available at: https://www.infosys.com/industries/agriculture/insights/documents/vertical-farming-information-communication.pdf [Accessed 12 December 2021].
35. La Via Campesina, Morris R., 2021. *The 1996 Rome Food Sovereignty Declaration in Postcards : Via Campesina*. [online] Via Campesina. Available at: https://viacampesina.org/en/the-1996-rome-food-sovereignty-declaration-in-postcards/ [Accessed 5 December 2021].
36. Maggs Bros. LTD., 2021. *To-Morrow: A Peaceful Path To Real Reform. - HOWARD Ebenezer - First Edition*. [online] Maggs.com. Available at: https://www.maggs.com/to-morrow-a-peaceful-path-to-real-reform_227546.htm [Accessed 1 December 2021].
37. Marc'hadour and Germain, 2021. *Thomas More*. [online] Encyclopedia Britannica. Available at: <https://www.britannica.com/biography/Thomas-More-English-humanist-and-statesman/Career-as-kings-servant > [Accessed 4 November 2021].
38. Marty et al., 2021. *Protestantism - The Reformation in England and Scotland*. [online] Encyclopedia Britannica. Available at: <https://www.britannica.com/topic/Protestantism/The-Reformation-in-England-and-Scotland > [Accessed 4 November 2021].
39. McBride, J., 2021. *How Green-Party Success Is Reshaping Global Politics*. [online] Council on Foreign Relations. Available at: <https://www.cfr.org/backgrounder/how-green-party-success-reshaping-global-politics > [Accessed 29 November 2021].
40. McCarthy, J. and Sánchez, E., 2016. *These Countries Are the Best and Worst Recyclers in the World*. [online] Global Citizen. Available at: https://www.globalcitizen.org/fr/content/best-and-worst-recyclers-in-the-world/ [Accessed 4 December 2021].
41. Moro, M., 2021. *A forest of buildings energy-sufficient as the upcoming Vertical Farming sites*. [online] Lampoon Magazine. Available at: https://lampoonmagazine.com/vertical-farming-dickinson-despommier/ [Accessed 9 December 2021].

42. Moseley, J., 2021. *Is Vertical Farming Really Better For The Planet? - Zero Carbon Farms*. [online] Zero Carbon Farms. Available at: <https://zerocarbonfarms.co.uk/better-for-the-planet/ > [Accessed 6 December 2021].
43. NASA, 2007. *NASA - Progressive Plant Growing is a Blooming Business*. [online] Nasa.gov. Available at: https://www.nasa.gov/vision/earth/technologies/aeroponic_plants.html [Accessed 9 December 2021].
44. Oxford Reference. 2021. *Environmental Movements*. [online] Available at: https://www.oxfordreference.com/view/10.1093/oi/authority.20110803095753651 [Accessed 17 November 2021].
45. Papke, D., 2021. *The Communistic Inclinations of Sir Thomas More*. [online] Scholarlycommons.pacific.edu. Available at: <https://scholarlycommons.pacific.edu/cgi/viewcontent.cgi?article=1006&context=utopia500 > [Accessed 3 November 2021].
46. Parrin, M., 2019. *Empty And Unused Buildings Increase In 2019 | Today's Conveyancer*. [online] Today's Conveyancer. Available at: https://www.todaysconveyancer.co.uk/main-news/empty-unused-buildings-increase-2019/ [Accessed 12 December 2021].
47. Platt, P., 2007. *Vertical Farming: An Interview with Dickson Despommier*. [online] jstor.com. Available at: https://www.jstor.org/stable/pdf/10.1525/gfc.2007.7.3.80.pdf [Accessed 6 December 2021].
48. Resources.finalsite.net. 2021. *Utopias and Dystopias: Definitions and Characteristics*. [online] Available at: <https://resources.finalsite.net/images/v1531855841/springbranchisdcom/x2ah4ijftreakownscaa/Summer-Read-9-Eng1-Utopias.pdf > [Accessed 4 November 2021].
49. Rodgers, K., 2015. *food desert*. [online] Encyclopedia Britannica. Available at: https://www.britannica.com/topic/food-desert [Accessed 9 December 2021].
50. Scruby, L. and Suyin Chalmin-Pui, L., 2019. *Why gardening makes us feel better – and how to make the most of it*. [online] Rhs.org.uk. Available at: https://www.rhs.org.uk/advice/health-and-wellbeing/articles/why-gardening-makes-us-feel-better [Accessed 4 December 2021].
51. Shaju, A., 2020. *Doing it Right - Which Countries Recycle the Most? | Plastics For Change*. [online] Plastics For Change. Available at: https://www.plasticsforchange.org/blog/doing-it-right [Accessed 4 December 2021].
52. Shishin, A., 2010. Utopian Ecology: Technology and Social Organization in Relation to Nature and Freedom. *Proquest*. Available at: https://www.proquest.com/scholarly-journals/utopian-ecology-technology-social-organization/docview/757065201/se-2?accountid=10472 [Accessed November 19, 2021].
53. Spalding, 2021. *Protestantism - The Reformation in England and Scotland*. [online] Encyclopedia Britannica. Available at: <https://www.britannica.com/topic/Protestantism/The-Reformation-in-England-and-Scotland#ref41559 > [Accessed 4 November 2021].
54. Temple, J., 2021. *The lurking threat to solar power's growth*. [online] MIT Technology Review. Available at: https://www.technologyreview.com/2021/07/14/1028461/solar-value-deflation-california-climate-change/?

utm_medium=tr_social&utm_campaign=site_visitor.unpaid.engagement&utm_source=Twitter#Echobox=1626211679 [Accessed 30 November 2021].

55. The Editors of Encyclopaedia Britannica, 2012. *garden city | urban planning*. [online] Encyclopedia Britannica. Available at: https://www.britannica.com/topic/garden-city-urban-planning [Accessed 30 November 2021].
56. The Editors of Encyclopaedia Britannica, 2020. *utopia | Definition, Examples, & Facts*. [online] Encyclopedia Britannica. Available at: <https://www.britannica.com/topic/utopia > [Accessed 3 November 2021].
57. Thiele, L.P., 2000. De Geus, M. 1999. *ecological utopias: Envisioning the sustainable society.* international books, Utrecht, the Netherlands. *Conservation Ecology*. Available at: https://www.ecologyandsociety.org/vol4/iss1/art18/ [Accessed November 18, 2021].
58. UN SDGs, 2021. *Sustainable consumption and production*. [online] United Nations Sustainable Development. Available at: https://www.un.org/sustainabledevelopment/sustainable-consumption-production/ [Accessed 5 December 2021].
59. UN, 2018. *68% of the world population projected to live in urban areas by 2050, says UN | UN DESA | United Nations Department of Economic and Social Affairs*. [online] Un.org. Available at: https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html [Accessed 5 December 2021].
60. UN, 2021. *Goal 2: Zero Hunger - United Nations Sustainable Development*. [online] United Nations Sustainable Development. Available at: https://www.un.org/sustainabledevelopment/hunger/ [Accessed 5 December 2021].
61. United Nations - YouTube, 2019. *Greta Thunberg, Young Climate Activist, at the Opening of the Climate Action Summit 2019*. [video] Available at: https://www.youtube.com/watch?v=u9KxE4Kv9A8 [Accessed 30 November 2021].
62. United Nations, 2021. *About Us | United Nations*. [online] United Nations. Available at: https://www.un.org/en/about-us [Accessed 30 November 2021].
63. United Nations, 2021. *THE 17 GOALS | Sustainable Development*. [online] Available at: <https://sdgs.un.org/goals > [Accessed 29 November 2021].
64. V&A, 2021. V&A arts and crafts: An introduction. *Victoria and Albert Museum*. Available at: https://www.vam.ac.uk/articles/arts-and-crafts-an-introduction [Accessed November 18, 2021].
65. Wecker, K., 2018. *Plastic waste and the recycling myth*. [online] DW.COM. Available at: https://www.dw.com/en/plastic-waste-and-the-recycling-myth/a-45746469 [Accessed 4 December 2021].
66. Weier, A., 2009. *REVIVAL OF A CULT CLASSIC: 'ECOTOPIA,' A 1970S VISION OF AN ENVIRONMENTAL UTOPIA, IS RELEVANT AGAIN*. [online] Proquest.com. Available at: <https://www.proquest.com/docview/395465903?OpenUrlRefId=info:xri/sid:summon&accountid=10472 > [Accessed 9 November 2021].

Figure References

1. Figure 1 - Cen, J., 2018. *Vertical farm illustration*. [image] Available at: https://www.motherjones.com/food/2018/07/vertical-farming-drought-california-plenty-energy/ [Accessed 12 December 2021].
2. Figure 2 - British Library, 2021. *Image of Sir Thomas More's book Utopia, showing the map of the Utopia island and the new Utopian alphabet*. [image] Available at: <https://www.bl.uk/collection-items/thomas-mores-utopia > [Accessed 3 November 2021].
3. Figure 3 - Getty Images, 2019. *Morris's Strawberry Thief remains one of his most popular designs today*. [image] Available at: <https://www.bbc.com/culture/article/20190909-the-first-eco-warrior-of-design> [Accessed 1 December 2021].
4. Figure 4 - The Denver Post via Getty Images | The Boston Globe / Getty Images, 2020. Left: Kurt Amuedo displays a poster about air pollution for Earth Day at his school. Right: Demonstrators in Boston wore masks to remind people of the perils of air pollution.. [image] Available at: https://www.buzzfeednews.com/article/katebubacz/photos-show-first-earth-day [Accessed 29 November 2021].
5. Figure 5 - Lambert / Getty Images, 2020. "*Save the Earth - You can't get off" badge"*. [image] Available at: https://www.buzzfeednews.com/article/katebubacz/photos-show-first-earth-day [Accessed 29 November 2021].
6. Figure 6- Council on Foreign Relations, 2021. *Timeline of the development of green parties around the world*. [image] Available at: https://www.cfr.org/backgrounder/how-green-party-success-reshaping-global-politics [Accessed 29 November 2021].
7. Figure 7- Chodosh, S., 2021. *Graph showing the cost of energy generated from different sources*. [image] Available at: https://www.popsci.com/story/environment/cheap-renewable-energy-vs-fossil-fuels/ [Accessed 30 November 2021].
8. Figure 8 - Historic England, 2016. *The Three Magnets, in which Ebenezer Howard brilliantly summarised his concept of a 'joyous union' of town and country.* [image] Available at: https://heritagecalling.com/2016/02/18/a-brief-introduction-to-garden-cities/ [Accessed 30 November 2021].
9. Figure 9- Howard, E., 2021. *Illustration of Howard's group of slum-less, smokeless cities*. [image] Available at: https://www.maggs.com/to-morrow-a-peaceful-path-to-real-reform_227546.htm [Accessed 1 December 2021].
10. Figure 10- Historic England, 2016. *The sinews of the Parker and Unwin layout for Letchworth, the first garden city, stand out on this aerial photograph from 2009*. [image] Available at: https://heritagecalling.com/2016/02/18/a-brief-introduction-to-garden-cities/#comments [Accessed 1 December 2021].
11. Figure 11- Letchworth Garden City Heritage Foundation, 2021. *Sepia tint photograph of Glaed Hame, designed by Parker and Unwin and built 1906*. [image] Available at: http://www.gardencitycollection.com/object-lbm2551 [Accessed 1 December 2021].
12. Figure 12 - Der Grüne Punkt, 2021. Der Grüne Punkt - Dual System Germany GmbH with the Green Dot as a trademark has been the first dual system to build this near-to-home

collection system. [image] Available at: https://www.gruener-punkt.de/en/politics-and-society/consumer-information [Accessed 4 December 2021].

13. Figure 13 - Eurostat, 2016. Diagram showing European countries and their share of plastic waste that was not recovered, recycled, and otherwise recovered. [image] Available at: https://www.dw.com/en/plastic-waste-and-the-recycling-myth/a-45746469 [Accessed 4 December 2021].
14. Figure 14 -Via Campesina, 2021. *The 1996 Rome Food Sovereignty Declaration in Postcards*. [image] Available at: https://viacampesina.org/en/the-1996-rome-food-sovereignty-declaration-in-postcards/ [Accessed 5 December 2021].
15. Figure – 15 Food and Agriculture Organisation of the United Nations, 2021. *Graph showing the percentage of moderate and severe insecurity around the world*. [image] Available at: https://www.fao.org/3/cb4474en/cb4474en.pdf#page=36 [Accessed 5 December 2021].
16. Figure 16 - History.com, 2018. *Illustration of the Hanging Gardens of Babylon*. [image] Available at: https://www.history.com/news/hanging-gardens-existed-but-not-in-babylon [Accessed 6 December 2021].
17. Figure 17 - Encyclopædia Britannica, Inc., 2010. *Diagram of Archimedes screw*. [image] Available at: https://www.britannica.com/technology/Archimedes-screw [Accessed 6 December 2021].
18. Figure 18 - Infosys, 2019. *SWOT analysis from the technological perspective,* [image] Available at: https://www.infosys.com/industries/agriculture/insights/documents/vertical-farming-information-communication.pdf [Accessed 15 December 2021].
19. Figure 19 - Infosys, 2019. *SWOT analysis from the business perspective*. [image] Available at: https://www.infosys.com/industries/agriculture/insights/documents/vertical-farming-information-communication.pdf [Accessed 15 December 2021].
20. Figure 20 - Infosys, 2019. *Hydroponic system diagram*. [image] Available at: https://www.infosys.com/industries/agriculture/insights/documents/vertical-farming-information-communication.pdf [Accessed 15 December 2021].
21. Figure 21 - Infosys, 2019. *Aeroponic system diagram*. [image] Available at: https://www.infosys.com/industries/agriculture/insights/documents/vertical-farming-information-communication.pdf [Accessed 15 December 2021].
22. Figure 22 - Infosys, 2019. *Aquaponic system diagram*. [image] Available at: https://www.infosys.com/industries/agriculture/insights/documents/vertical-farming-information-communication.pdf [Accessed 15 December 2021].
23. Figure 23 - Callebaut, 2016. *Hyperions by Vincent Callebaut*. [image] Available at: https://inhabitat.com/urban-farming-utopia-in-india-produces-more-energy-than-it-uses/hyperions-by-vincent-callebaut-12/ [Accessed 9 December 2021].
24. Figure 24 - ABF-lab, 2016. *Agro-main-ville by ABF-lab*. [image] Available at: https://inhabitat.com/ziggurat-like-vertical-farming-tower-would-soak-up-the-sun-in-paris/agro-main-ville-by-abf-lab-9/ [Accessed 10 December 2021].

25. Figure 25 - Taka, T., 2021. *Growing Underground farm located in a bomb shelter*. [image] Available at: https://thespaces.com/londons-first-underground-farm-set-to-open-in-wwii-tunnels/ [Accessed 10 December 2021].
26. Figure 26- Defra, 2020. *Origins of food consumed in the UK 2019*. [image] Available at: https://www.gov.uk/government/statistics/food-statistics-pocketbook/food-statistics-in-your-pocket-global-and-uk-supply [Accessed 12 December 2021].