PwC Net Zero

Future50

pwc

This insight is brought to you using the capability of Strategy&, PwC's strategy consulting business, alongside our PwC industry experts. Together, we transform organisations by developing actionable strategies that deliver results.

We are uniquely placed to combine strategy with technical, industry and execution expertise. We embed our strategy capabilities with expert teams across our PwC network, to show you where you need to go, the choices you'll need to make to get there, and how to get it right.

The result is an authentic strategy process powerful enough to capture possibility, while pragmatic enough to ensure effective delivery. It's the strategy that turns vision into reality. It's strategy, made real.

Contents

Foreword

If COP26 has left us, in the words of UN Secretary General António Guterres, still "careening towards climate catastrophe", is this climate tech's moment? Can the next generation of climate tech start-ups bend the emissions curve and get us back on track for less than 1.5°C of warming?[1] Breakthrough technologies, as shown in PwC's State of Climate Tech 2021 report, are now hitting the market at an unprecedented rate. Commercially viable disruptors are trialling breakthrough approaches across critical sectors, already disrupting the transport, energy and food sectors, which together drive c.50% of global carbon emissions.[2]

The UK has established itself as one of the leading global hubs for climate tech innovation, and ranks first in Europe in terms of attracting investment into climate tech start-ups in the period 2013 – H1 2021.[3] But the flow of funding has been uneven, skewed towards the first movers of lower carbon mobility, with a 'Carbon Funding Gap' emerging for commercially viable innovations across high-carbon sectors from the Built Environment to Food, Agriculture and Land Use. This report aims to explore this broader opportunity, looking at up-and-coming UK start-ups right across the climate tech landscape. From our Climate Tech Investment Index, a database of over 3,000 global climate tech start-ups, we have focused on 50 examples that illustrate the opportunity to decarbonise across industry sectors in the UK.

Technology is not the panacea, it is the amplifier of intent. But if there is a carbon chasm we have to cross, the UK's Net Zero Future50, and their global counterparts, now look critical to success.

Leo Johnson and Zubin Randeria

1 Source: Evening Standard, UN secretary-general in climate warning at honorary degree ceremony
2 Source: Our World in Data, Emissions by sector
3 Source: PwC, State of Climate Tech 2021

About

PwC's Net Zero Future50 includes a selection of companies that illustrate the opportunity to decarbonise across all sectors, but is neither exclusive nor exhaustive. The company information has been derived from publicly available sources and discussions with management, PwC has not independently verified any of the company information. Where statistics or research has been discussed in the bios of the companies, these have been sourced from the company website unless stated otherwise. Alongside the company summary and impact, PwC have provided selected highlights of the opportunity for the technology and some of the possible strategic industry alliances for the start-up.

Key Context

The Challenge

The heat is on. In the 2015 Paris Agreement, 197 countries agreed to try to keep temperature rises to 1.5ºC to avoid the worst impacts of climate change.[4] COP26 convened in October 2021 to assess progress and chart a path forward. It saw advances on multiple fronts, with new commitments on everything from protecting forests to capturing methane. Yet, the policy backed pledges made at COP26 in Glasgow still leave us on course for 2.4°C of warming according to Climate Action Tracker.[5] We now need globally to decarbonise at more than five times our current rate, according to PwC's latest Net Zero Economy Index, achieving 12.9% reductions in intensity every year from now to 2050, compared with the 2.5% rate of reduction in that we have managed since 2000. The UK Government has made binding and internationally leading commitments to decarbonise the economy by 78% on 1990 levels by 2035. For UK business, despite the relatively rapid decarbonisaton of the last decade, there is still a mountain to climb.

> "Never has science around the world been so abundant to meet the challenges that we have."
>
> **Emmanuel Macron**
> President of France, 2019

4 Source: UNCC, The Paris Agreement
5 Source: Climate Action Tracker, Glasgow's one degree 2030 credibility gap

> It is my belief that the next 1,000 unicorns – companies that have a market valuation over a billion dollars – won't be a search engine, won't be a media company, they'll be businesses developing green hydrogen, green agriculture, green steel and green cement."
>
> **Larry Fink**
> CEO of BlackRock, 25 Oct 2021

The rise of climate Venture Capital (VC)

There is a new ecosystem forming rapidly around climate tech start-ups; The State of Climate Tech 2020 report highlighted the rapid increase in the climate tech VC market, growing from £313.5 million globally in 2013 to £12.3bn in 2019. This year's report sees a further acceleration, with climate tech average deal size nearly quadrupling in H1 2021 and showing over 200% growth in terms of total global volume year on year. At the global level, climate tech now accounts for 14p of every venture capital pound.

The UK is emerging as a global climate tech leader

The UK has been at the forefront of a global boom in climate tech investment since the Paris Agreement – ranking top in Europe and third globally, behind only China and the USA, for total climate tech Venture Capital funding between 2013 and H1 2021. We saw investment levels in excess of £6.5bn during this period and, more recently, record VC investment levels, in excess of £2.0bn, between H2 2020 and H1 2021. The UK also has more climate tech start-ups that have received funding than any other country in Europe from 2013 to H1 2021.[6]

However, there is uneven distribution across sectors. For example, in 2021, alongside private sector investors, the UK Government backed a world first programme to build an operational hub for Net Zero air taxis and delivery drones,[7] yet it lags behind in other critical areas, like EV battery production, where manufacturing in China dramatically outpaces the rest of the world.[8]

Investment has also been skewed towards the "low-hanging fruit" of well-proven technologies, leaving a series of sectors underfunded, where there are commercially viable approaches with high carbon abatement potential. With the COP26 process highlighting the need for climate technology as part of the Glasgow Breakthrough Agenda, this report seeks to explore the broader opportunity that is now emerging – looking at up-and-coming UK start-ups right across the climate tech landscape, and shining a light on some of the innovative companies now operating in this space.

6 Source: PwC Analysis of Dealroom data
7 Source: Coventry City Council, World-first electric Urban Air Port® secures UK government backing
8 Source: UKOnward, Green Shoots: Driving Innovation For Net Zero

The UK Carbon Funding Gap

While the overall inward investment environment within the UK is increasingly healthy, climate tech investment in the UK mirrors the global pattern of uneven flows captured in SOCT21, with decarbonisation funding mismatched to the carbon abatement opportunity. Mobility and Transport, for example, has attracted 66.2% (UK: 45.7%) of global funding from H2 2020 – H1 2021 against the sector Greenhouse Gas (GHG) emissions load of 16.2% (UK: 26.9%). Built environment, on the other hand, has 1.6% (UK: 5.1%) of investment from H2 2020 – H1 2021 against 20.7% (UK: 17.0%) of abatement potential.[9]

As PwC's SOCT21 shows, a high proportion of climate tech investment appears to have focused on prioritising near term commercial outcomes rather than longer term, higher carbon impact solutions.[10] In order for investment to align commercial and decarbonisation outcomes, the COP26 agreement for global cooperation around standardised carbon markets will be one of a number of critical accelerators required.

Critical gaps are present across the UK funding landscape, but particularly within the Built Environment, Industry, Manufacturing & Resource Management and GHG Capture, Removal and Storage. The UK, for instance, has none of the 23 green steel foundry plants within Europe.[11] This is indicative of a longer term decarbonisation challenge for the Industry, Manufacturing & Resource Management sector, whose emissions in the UK have remained flat since 2010, and not kept pace with the decarbonisation rate in other sectors.[12]

Despite Mobility and Transport receiving disproportionately more funding than every other sector in relation to its emissions abatement potential, it is still far from fully decarbonised. This suggests that, although a more even allocation of funding may be beneficial, the total amount of investment must also increase across all sectors, Mobility and Transport included, to achieve Net Zero by 2050. This is supported by our recent estimate that on average, £40bn per year will be required to be invested in new low carbon and digital infrastructure over the next ten years, with similar levels thereafter, to deliver this ambition in the UK alone.[13]

Furthermore, certain sub sectors are under invested, for example, funding into low-GHG aviation and shipping is significantly less than electric vehicles (EVs). The same can be seen in Food, Agriculture and Land Use (FALU), where large-scale investment has gone into alternative meat start-ups, but there is less focus on natural carbon sequestration through methods such as oceanic ecosystem regeneration.

Net Zero Future50

The 2022 Net Zero Future50 report looks at examples of innovative UK start-ups across the climate tech landscape; covering Mobility and Transport, Energy, Food, Agriculture and Land Use, Industry, Manufacturing and Resource Management, Built Environment, Financial Services and two cross-cutting themes of Climate Change Management and Reporting and GHG Capture, Removal and Storage. We have allocated the number of start-ups by sector, based on their relative contribution to GHG emissions.[14]

9 Source: PwC, The State of Climate Tech 2021 using Dealroom data
10 Source: PwC, The State of Climate Tech 2021
11 Source: Energy Monitor, 2021. With the Right Policies the UK Could Lead on Green Steel Production
12 Source: Statista, 2021. Greenhouse gas emissions in the United Kingdom (UK) from 2010 to 2019, by sector
13 Source: PwC Report – Unlocking investment for Net Zero infrastructure
14 See appendix for more details

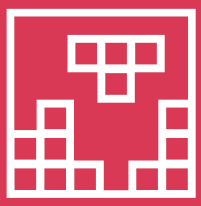
Methodology

Methodology

Figure I

Scan

Scan the ecosystem for **emerging Net Zero trends and innovations**.



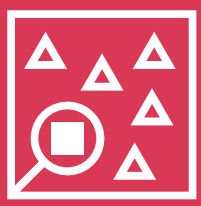
Build a long list of 3,000+ global ESG / tech start-ups.

Score

Develop an **assessment framework**.

Score the start-ups against the assessment framework, and **refine to 250**.

Select



Map **GHG weightings to shortlisted companies** to ensure sectoral coverage.

Select a **list of 50 companies** that represent significant **emerging technologies**.

1

Scan:

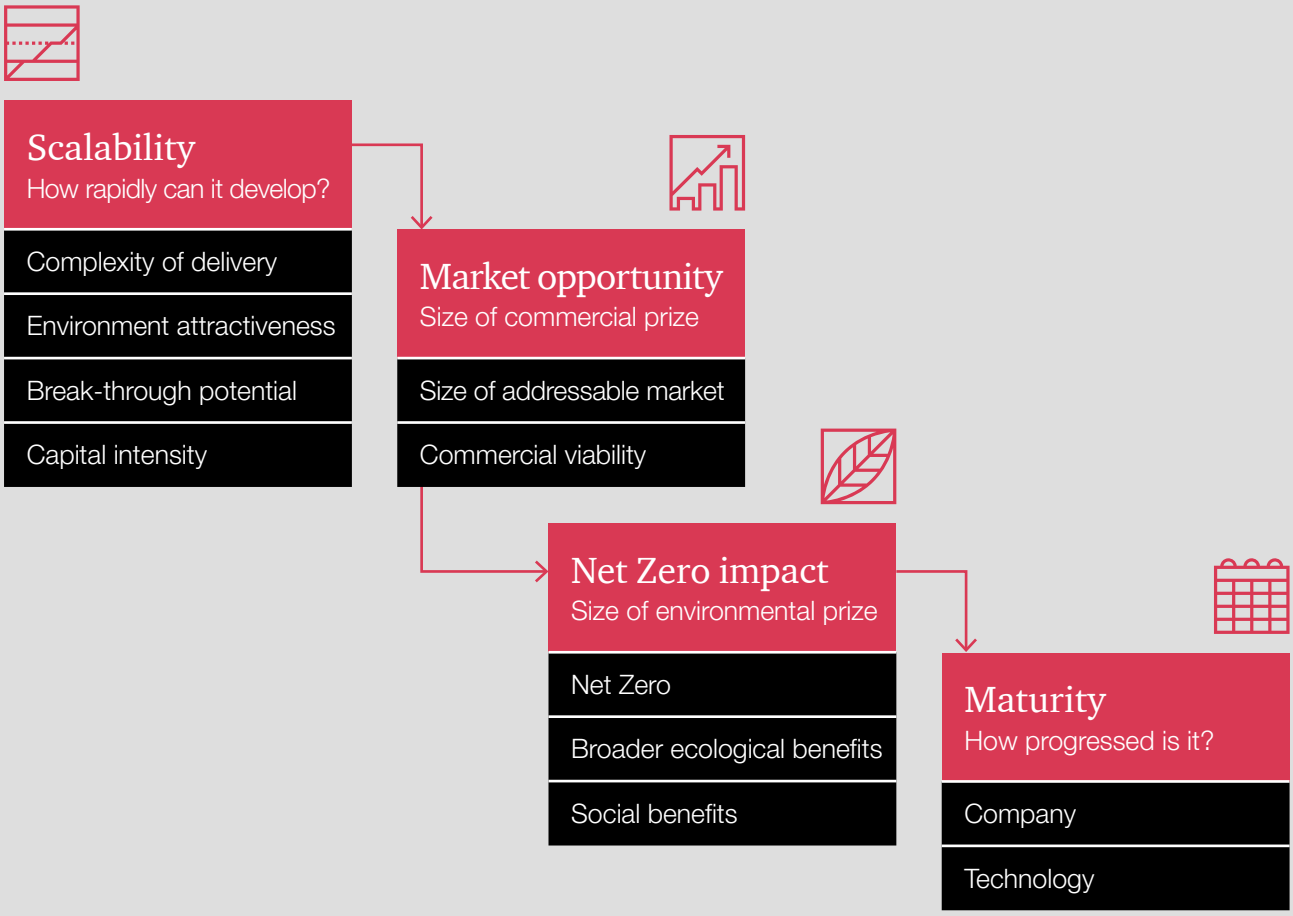
Using multiple resources, including PwC networks and tech partner experts, we scanned the market to map the key innovators that look set to define the climate tech landscape for the next decade, identifying 3,000+ global Climate tech start-ups with the potential to deliver breakthrough solutions across the key challenge areas of decarbonisation, from micromobility to grid management.

2

Score:

We then built an assessment framework (Figure II) to evaluate potential start-ups to include within the Net Zero Future50. From our database of 3,000+ we initially prioritised 250, analysing the size of the prize (both environmental and commercial), the company's maturity (where they are on the journey right now), and finally their scalability (the speed at which we think it is possible for them to accelerate).

Figure II



3

Select:

We then selected the final Net Zero Future50 based on the composite ranking of (i) Net zero impact, (ii) maturity and (iii) scalability. This list is neither exhaustive nor exclusive but intended to show there are decarbonisation opportunities across all sectors. We therefore undertook a cross review to make sure all sub sectors have enough coverage to give readers insight into the breadth of innovation taking place, allocating the number of start-ups by sector proportionately to its relative total GHG emissions at a global and UK level, but noting also an additional number of interesting companies ("ones to watch") within the sector.

Results:

UK 2022 Net Zero Future50

Results: UK 2022 Net Zero Future50

The list

Figure III shows the split of Net Zero Future50 companies across the different sectors and cross cutting themes, which were apportioned approximately according to their contribution to GHG emissions.[15]

Figure III

Start-ups	Sector	F50 Start-ups	Disruptors
6	Mobility	petalite, VELOCYS, signol	#IoT, #Hydrogen, #Hyperloop, #Micromobility, #Mobility-as-a-Service, #AutonomousVehicles, #SustainableFuels
11	Energy	OXFORD PV, enertechnos, HABITAT, equiwatt, H2GO, Highview Power, Lake Parime, Standard Gas	#Microgrids, #Blockchain, #SolarGlass, #OceanEnergy, #Hydrogen, #Fusion
7	Food, Agriculture and Land Use	Descienator, ARC Marine, vertical future	#IoT, #PrecisionAgriculture, #PrecisionFermentation, #SyntheticBiology, #GIS, #Robotics, #VerticalFarming
10	Industry, Manufacturing and Resource Management	NOTPLA, greyparrot, PLASTIC ENERGY, SGMA, ECONIC, MIRICO, Carnfree	#Nanomaterials, #Smartmaterials, #Blockchain, #Spectroscopy, #GIS, #AI
9	Built Environment	PAVEGEN, Adaptavate, Telensa, INFOGRID, welink, 24 7 living	#IoT, #Nanomaterials, #VehicleToGrid, #SolarGlass, #CircularEconomy, #ModularConstruction
2	Financial Services	abundance, EARTHLY	#Blockchain, #CryptoForGood, #PaymentForEcosystemServices, #GIS
2	GHG Capture, Removal and Storage	Deep Branch	#MicroCarbon, #SoilCarbon, #DirectAirCapture, #QuantumComputing, #Biotechnology, #GIS
3	Climate Change Management and Reporting	yayzy, Emitwise, Rezatec	#MachineLearning, #CloudComputing, #DataMapping, #DataVisualisation, #AI

15 See appendix for more details

Sector analysis: Summary of approach

Across each sector we explore the breakthrough role that our tech-enabled shortlist of companies might play, examining a sequence of questions:

Key facts:

- What is the sector's GHG contribution?
- What is the current VC investment on an annual basis?

Industry analysis:

- What are the 'Barriers' to decarbonisation?
- What are the 'Accelerators' to decarbonisation?
- What are the emerging technological drivers to watch?
- What are the 'Growth Areas' where commercially viable start-ups are emerging?
- What are some illustrative examples of potential strategic alliances?

Figure IV – Summary of start-ups by sector and the disruptive themes they present

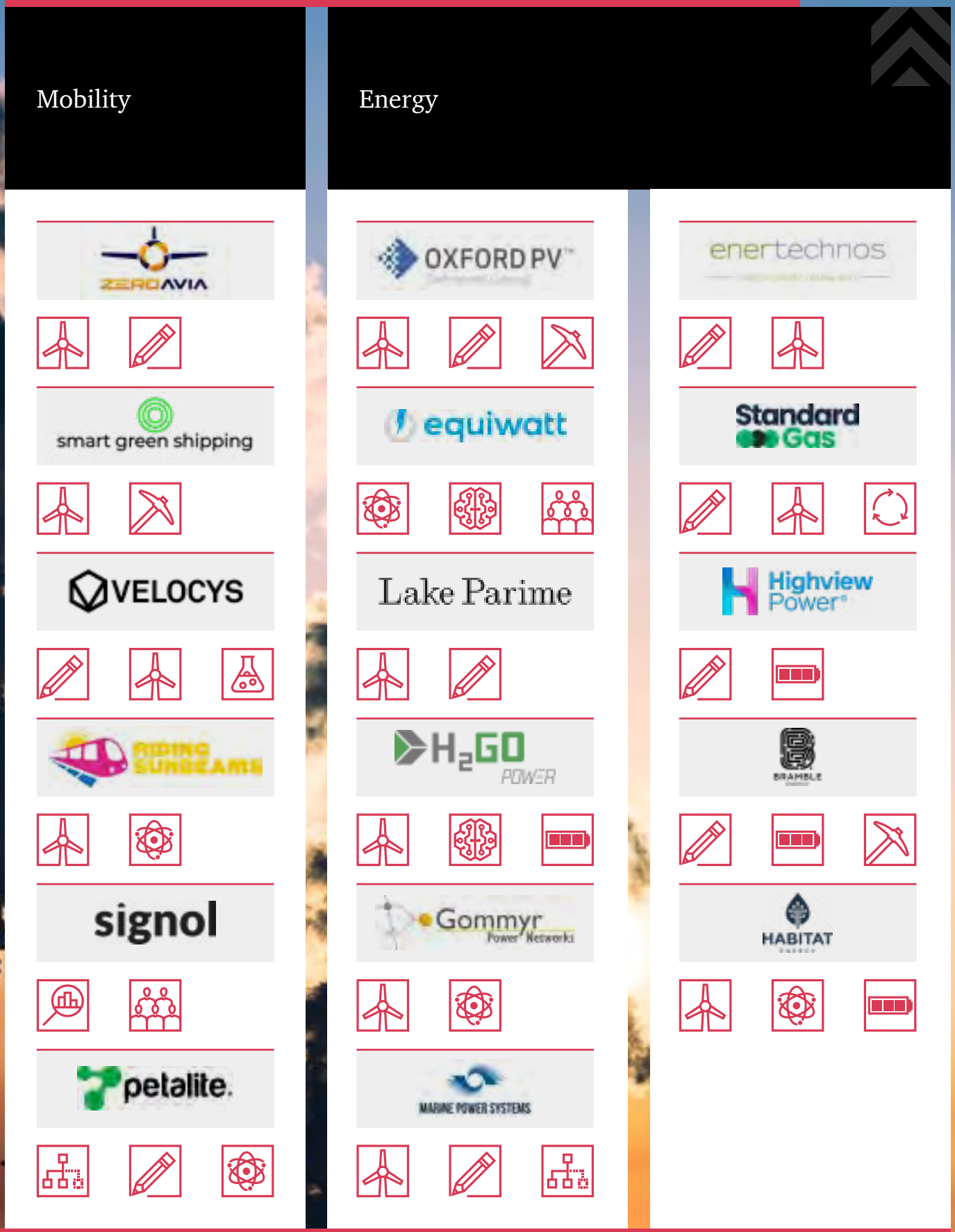


Figure IV – Summary of start-ups by sector and the disruptive themes they present

Industry, Manufacturing and Resource Management

SGMA

Lithion

NOTPLA

greyparrot

Carbon8

PLASTIC ENERGY

Cemfree

QLM

ECONIC

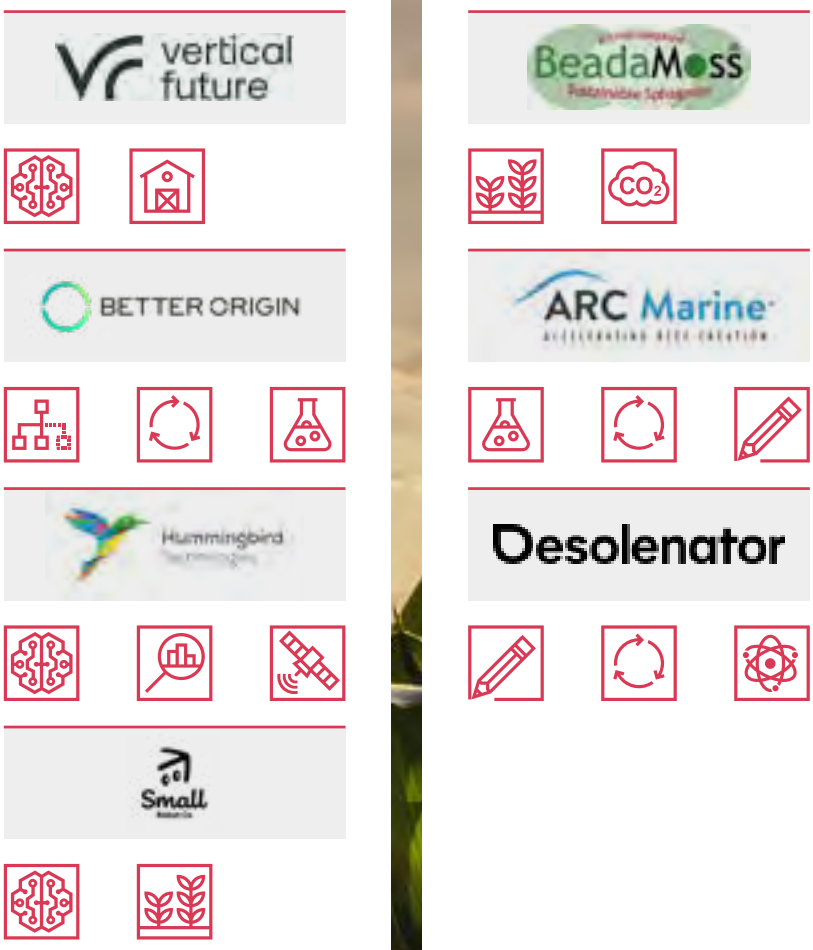
MIRICO

Key:

AI | Carbon capture | Circular | Data | Low-GHG materials | Modular | Retrofit | Smart design

Figure IV – Summary of start-ups by sector and the disruptive themes they present

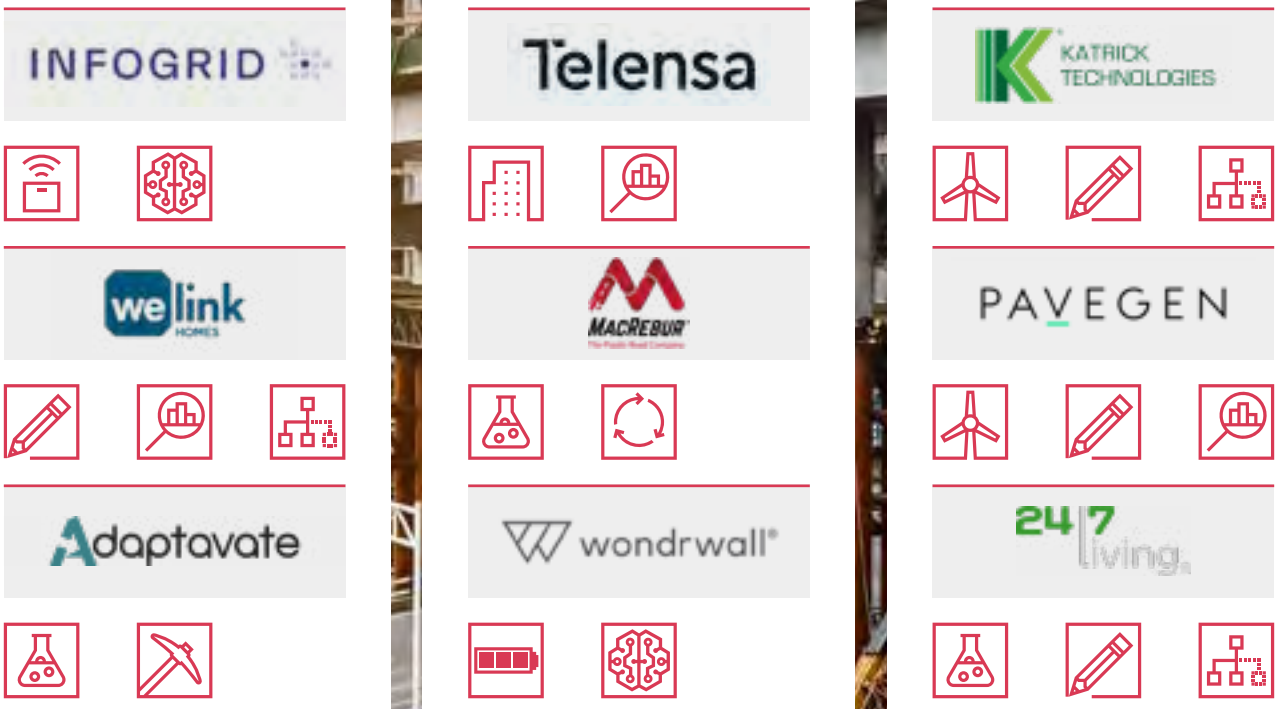
Food, Agriculture and Land Use



Key: AI · Carbon capture · Circular · Data · Low-GHG materials · Micro economy · Modular · Precision agriculture · Satellite · Smart design · Vertical farming

Figure IV – Summary of start-ups by sector and the disruptive themes they present

Built Environment



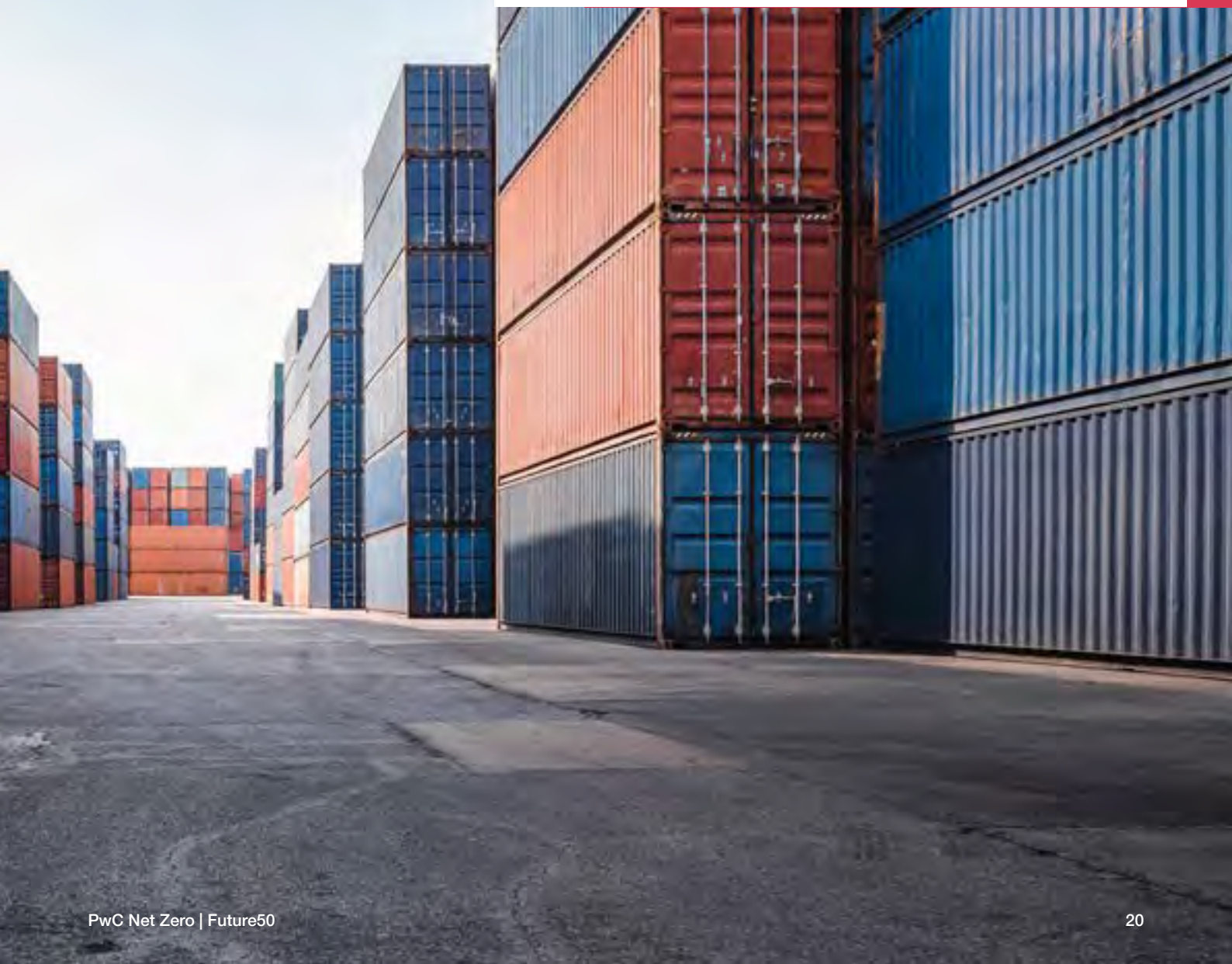
Key: AI, Battery, Circular, Data, IOT, Low-GHG materials, Modular, Renewable, Retrofit, Smart city, Smart design

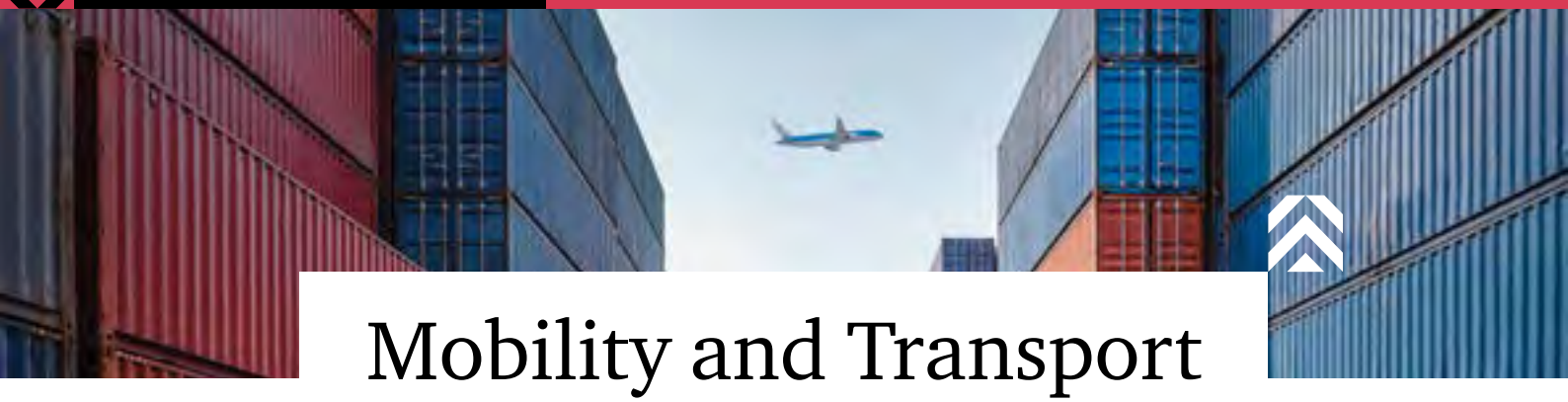
Figure IV – Summary of start-ups by sector and the disruptive themes they present

Financial Services	GHG Capture, Removal and Storage	Climate Change Management and Reporting
abundance.	Deep Branch	yayzy
EARTHLY	carbon design	Emitwise
		Rezatec

Key: AI, Behaviour change, Carbon capture, Data, ESG, Low-GHG materials, Modular, Satellite, Smart design

Mobility and Transport





Mobility and Transport

26.9%
Of UK GHG emissions[16]

£927.9m
UK VC investment (H2 '20 – H1 '21)[17]

6
Start-ups in the Net Zero Future50

Mobility and Transport is one of the fastest growing sources of emissions globally, up by 71% since 1990.[18] At £99bn, the sector has attracted 60% of global climate tech funding from H1 2013 – H1 2020, with a CAGR of 133% – significantly greater than the 68% climate tech average.[19] Whilst the sector has received more investment than is proportionate to its share of emissions, it will need to continue to attract additional investment in the coming years in order to fully decarbonise.

Barriers:

- **Lack of global scalability:** Shortages in raw materials, high costs and insufficient infrastructure have limited and will continue to limit the uptake of sustainable travel. A growing global middle class is increasing demand for mobility and decarbonisation is not yet happening quickly enough to offset this.

Accelerators:

- **Legislation and maturation:** Electric vehicles (EVs) are improving in affordability and acceptability as realistic alternatives to combustion engines. This will be further accelerated by UK legalisation to phase out internal combustion engine cars.
- **Planning across the whole value chain:** The UK unveiled its Transportation Decarbonisation Plan in summer 2021, which included funding allocated to low-GHG emission aviation and maritime transport, along with additional focus on decarbonising rail and reiterating the potential of hydrogen as a sustainable, alternative fuel source.[20]

Technology drivers:

#IoT

#Hydrogen

#Hyperloop

#Micromobility

#Mobility-as-a-Service

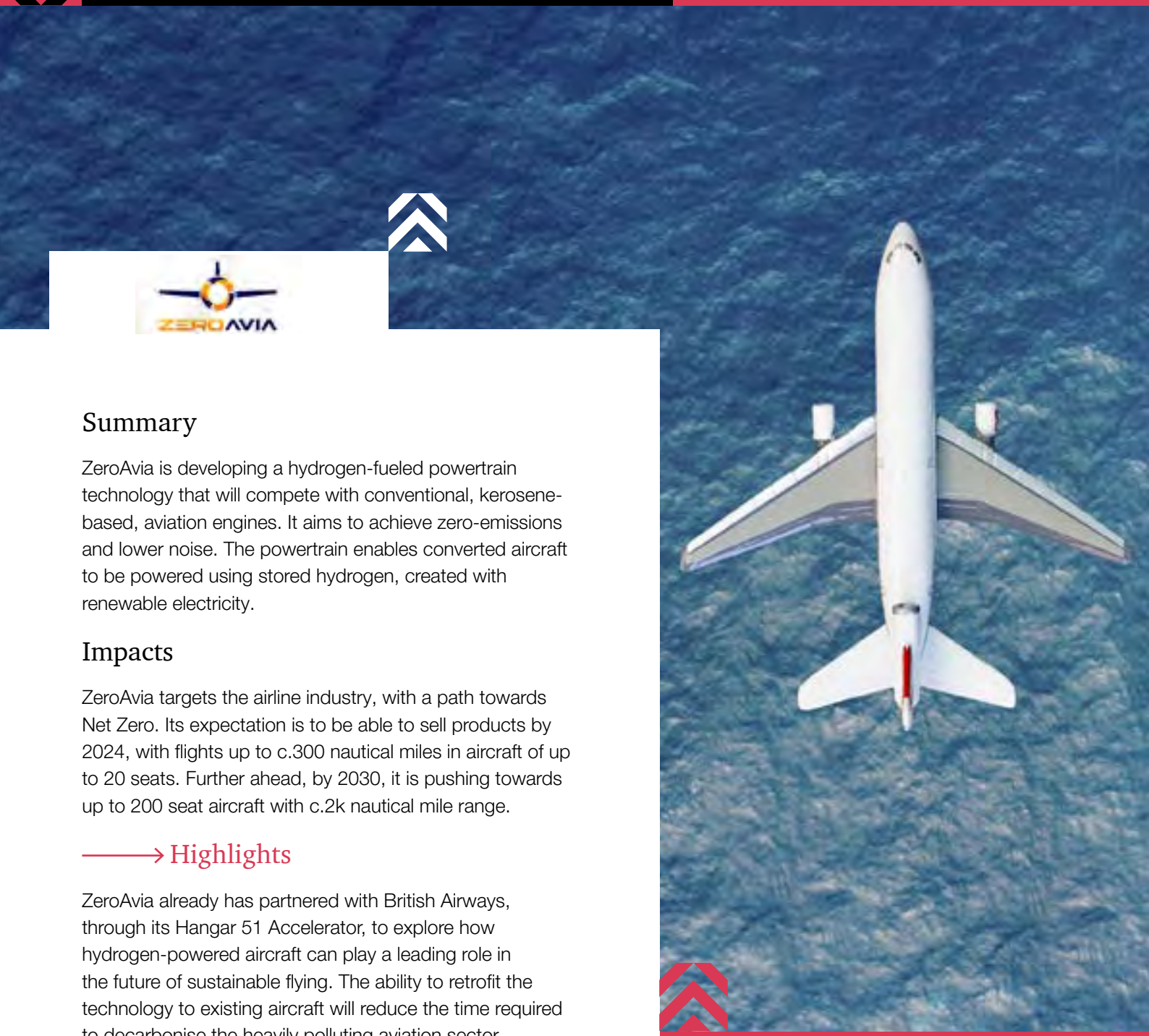
#AutonomousVehicle

16 Source: UK Government, 2019 UK Greenhouse Gas Emissions, Final Figures
17 Source: PwC, The State of Climate Tech 2021
18 Source: World Resources Institute, 4 Charts Explain Greenhouse Gas Emissions by Countries and Sectors
19 Source: PwC, The State of Climate Tech 2021
20 Source: Department for Transport, Decarbonising Transport: A Better, Greener Britain

Growth Areas:

- **Low-GHG air transport:** Air transport comprises 3% of global annual emissions at present but 7% in the UK.[21] However, unless the sector accelerates efforts to lower its GHG emissions, its share could grow to 20% by 2050.[22] Compared with other industries, much of the pathway to Net Zero for air transport doesn't yet exist. This indicates a clear need for innovation, to offer viable low-GHG air transport.
- **Low-GHG shipping:** For a long time it has been thought difficult to reduce GHG emissions in the maritime industry, due to the heavy reliance on cheap, low-grade fuel oils and exclusion from the Paris Climate Accords. However, excitement around new innovation areas and growing political pressure has helped to present Net Zero as an achievable goal. Examples of this include industry giant, Maersk, pledging to invest £1bn[23] on new, carbon-neutral, container ships and the launching of the world's first hydrogen-powered commercial cargo ship.[24]
- **Micromobility platforms:** Micromobility solutions have seen huge growth, resulting in a shift in commuter behaviour away from fossil fuel-based transportation, towards electric or human powered vehicles such bicycles and scooters.[25] These solutions also have the potential to solve the age-old 'final mile' problem of public transport, unlocking further demand for urban transportation which tends to have lower GHG emissions.
- **Low-GHG light and heavy duty road transport – EVs and high-efficiency vehicles:** The past 10 years has seen exponential growth in the global stock of EVs, which now account for over 10 million vehicles, and 4.6% of global annual car sales.[26] However, innovation is needed to develop the battery technology needed for long-distance and constant-use vehicles such as in logistics,[27] along with other harder to abate vehicles such as military applications.
- **Battery technology:** Innovation in battery technology has seen large investment in recent years with much of the transition away from carbon intensive power relying on this technology. In Q1 of 2021, approximately £1bn was raised in VC funding by battery storage, smart grid, and energy efficiency companies, a 410% increase from the £182 million raised in Q1 2020.[28] The mobility sector relies heavily on improvements in battery technology, and innovation here will accelerate the growth in electric and micromobility vehicle usage.
- **Efficient Transport Systems:** Innovative systems that increase the efficiency of transport have huge potential to reduce GHG emissions while improving the user experience and cost-effectiveness at the same time. Areas where innovation can enable this include; vehicle sensors, better journey planning to improve journey efficiency, predictive maintenance, systems to manage traffic and other urban planning improvements.[29]

21 Source: CCC, 2020. Sector summary Aviation
22 Source: BCG, Plotting Aviation's Uncharted Course to Net Zero
23 Source: The Guardian, Shipping firm Maersk spends £1bn on 'carbon neutral' container ships
24 Source: Navigo: Offshore Energy, Flagships set to debut world's 1st hydrogen-powered commercial cargo ship
25 Source: Centre for London, Micromobility in London Report
26 Source: International Energy Agency, Global EV Outlook 2021
27 Source: Department for Transport, Consultation on when to phase out the sale of new, non-zero emission heavy goods vehicles
28 Source: Mercom Capital Group, Venture Capital Funding in Energy Storage Up Significantly with $994 Million in Q1 2021
29 Source: PwC, How AI can enable a Sustainable Future



Summary

ZeroAvia is developing a hydrogen-fueled powertrain technology that will compete with conventional, kerosene-based, aviation engines. It aims to achieve zero-emissions and lower noise. The powertrain enables converted aircraft to be powered using stored hydrogen, created with renewable electricity.

Impacts

ZeroAvia targets the airline industry, with a path towards Net Zero. Its expectation is to be able to sell products by 2024, with flights up to c.300 nautical miles in aircraft of up to 20 seats. Further ahead, by 2030, it is pushing towards up to 200 seat aircraft with c.2k nautical mile range.

⟶ Highlights

ZeroAvia already has partnered with British Airways, through its Hangar 51 Accelerator, to explore how hydrogen-powered aircraft can play a leading role in the future of sustainable flying. The ability to retrofit the technology to existing aircraft will reduce the time required to decarbonise the heavily polluting aviation sector.

⟶ Strategic alliances

- Airports
- Aviation
- Government
- Hydrogen Production
- Manufacturing
- Shipping

#Aviation

#Hydrogen

Link to website:
zeroavia.com

smart green shipping

Summary

Smart Green Shipping (SGS) develops technical, commercially viable wind-powered solutions that enable the shipping sector to reduce fuel and emissions. Existing ships can be retrofitted with its 'sails'. SGS supplements this with its tool, 'TradeWind', which predicts and further optimises the use of wind for ships.

Impacts

SGS proposes that its FastRig can realise c.20% fuel savings with no additional crew members, across a range ship sizes. It is expected that installation would minimally impact load capabilities. As a result, ships using FastRig are expected to maintain similar levels of operational performance.

⟶ Highlights

The International Maritime Organisation has committed the shipping sector to reducing GHG emissions by at least 50% by 2050.[30] This means that new ships operating today, which have a typical 30-year lifetime, must reduce their emissions or will have to be retired early. Technologies that possess the ability to retrofit existing vessels and reduce GHG emissions will be vital to achieving these aims.

⟶ Strategic alliances

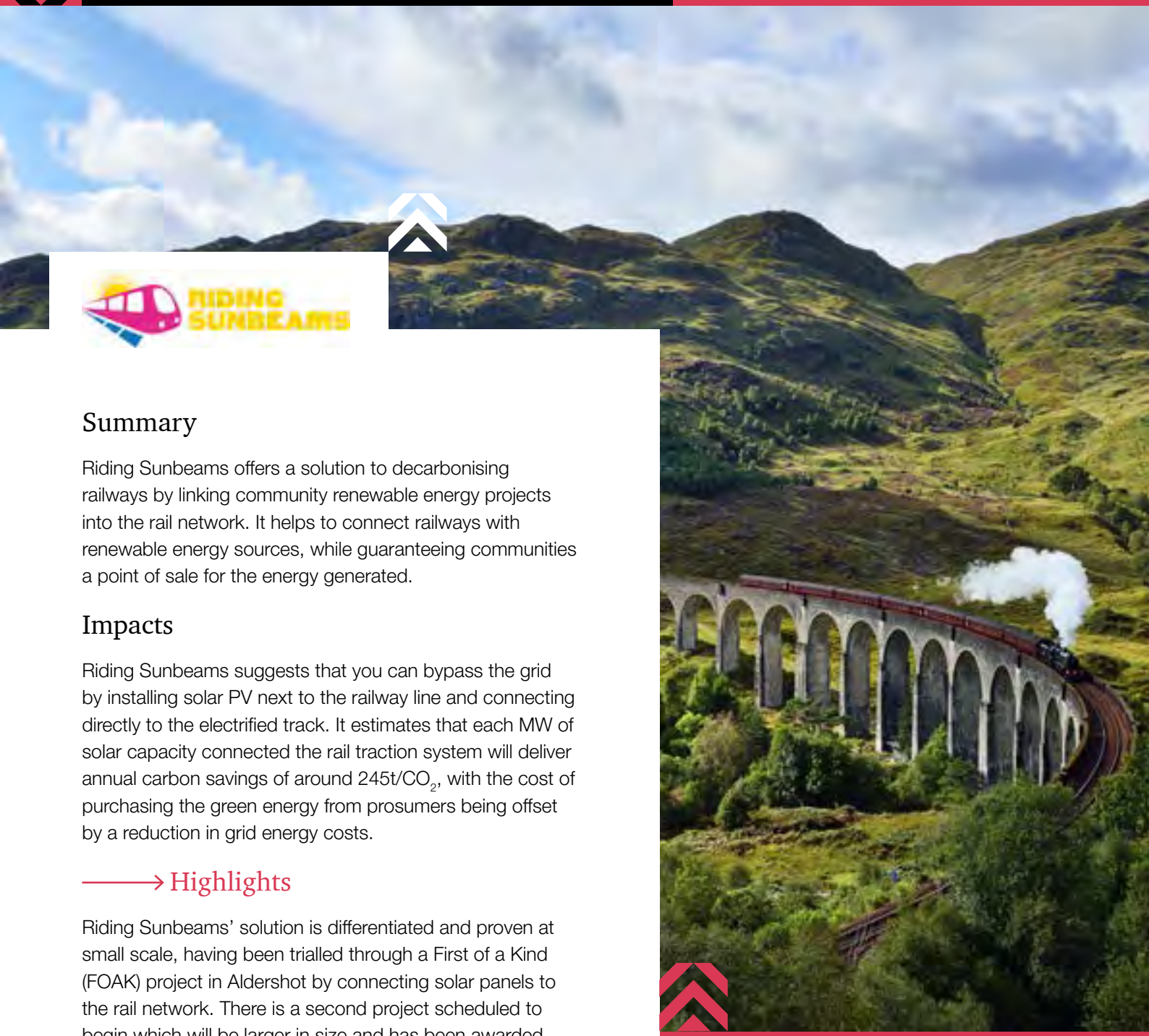
- Government
- Logistics
- Manufacturing
- Ports
- Shipping

#Shipping

#FuelEfficiency

Link to website:
smartgreenshipping.com

30 Source: International Maritime Organization: https://www.imo.org/en/MediaCentre/HotTopics/Pages/Reducing-greenhouse-gas-emissions-from-ships.aspx



Summary

Riding Sunbeams offers a solution to decarbonising railways by linking community renewable energy projects into the rail network. It helps to connect railways with renewable energy sources, while guaranteeing communities a point of sale for the energy generated.

Impacts

Riding Sunbeams suggests that you can bypass the grid by installing solar PV next to the railway line and connecting directly to the electrified track. It estimates that each MW of solar capacity connected the rail traction system will deliver annual carbon savings of around 245t/CO_2, with the cost of purchasing the green energy from prosumers being offset by a reduction in grid energy costs.

Highlights

Riding Sunbeams' solution is differentiated and proven at small scale, having been trialled through a First of a Kind (FOAK) project in Aldershot by connecting solar panels to the rail network. There is a second project scheduled to begin which will be larger in size and has been awarded over £2.5m in funding from the 'Getting Building Fund'.[31] This project will target the whole of the railway networks in East Sussex.

Strategic alliances

- Energy
- Government
- Infrastructure
- Local Authorities
- Micro-Energy Generation
- Railways

#RenewableEnergy

#Railways

#CommunityPower

Link to website:
ridingsunbeams.org

31 Source: Solar Power Portal: https://www.solarpowerportal.co.uk/news/riding_sunbeams_wins_2.5m_from_governments_getting_building_fund

signol

Summary

Signol uses behavioural nudges to improve driving efficiency of employees and managers. The software sends personalised nudges based on travel data and automatic messaging to inform users about their driving behaviour, incentivising better performance and reduced fuel use. Signol's solution is aimed at the aviation, shipping and HGV sectors.

Impacts

Signol provides a positive interim solution for fossil fuels. In the future as alternative energy sources and fuels emerge, Signol's product could be adapted to optimise and manage fuel usage. Signol proposes that the behavioural nudges could help drivers improve efficiency of the vehicles and planes by 10-15%, whilst delivering these benefits at a low cost.

→ Highlights

Signol has received >£1m in grant funding and has had successful implementation results from an airline saving >£4.5m over 8 months. It is highly scalable and can provide a Net Zero impact today, which is important as other low-carbon alternatives are still in proof-of-concept stages.

→ Strategic alliances

- Aviation
- Government
- Logistics
- Shipping

#BehaviourChange

#FuelEfficiency

Link to website:
signol.io

VELOCYS

Summary

Velocys designs, develops and licences technology for the commercial production of Sustainable Aviation Fuels (SAF) from waste materials. Velocys uses high performance catalyst and reactor technology to generate negative carbon emissions SAF with the integration of carbon capture technologies. The synthetic gas (syngas) produced is formed into long hydrocarbons before being turned into jet fuel and naphtha.

Impacts

Velocys uses waste materials to specifically target the aviation industry, helping it move towards Net Zero. The fuels made by Velocys (dependent on feedstock) qualify for the highest levels of renewable fuel credits and are certified by the Roundtable for Sustainable Biomaterials.

⟶ Highlights

Aviation emissions are set to continue growing by 2050, unless there are major changes in the use of technology, and as such, the sector faces serious decarbonisation challenges. Velocys has a retrofittable product that has had successful proof of concepts in multiple countries and therefore, demonstrates a potential solution for the fuel sector.

⟶ Strategic alliances

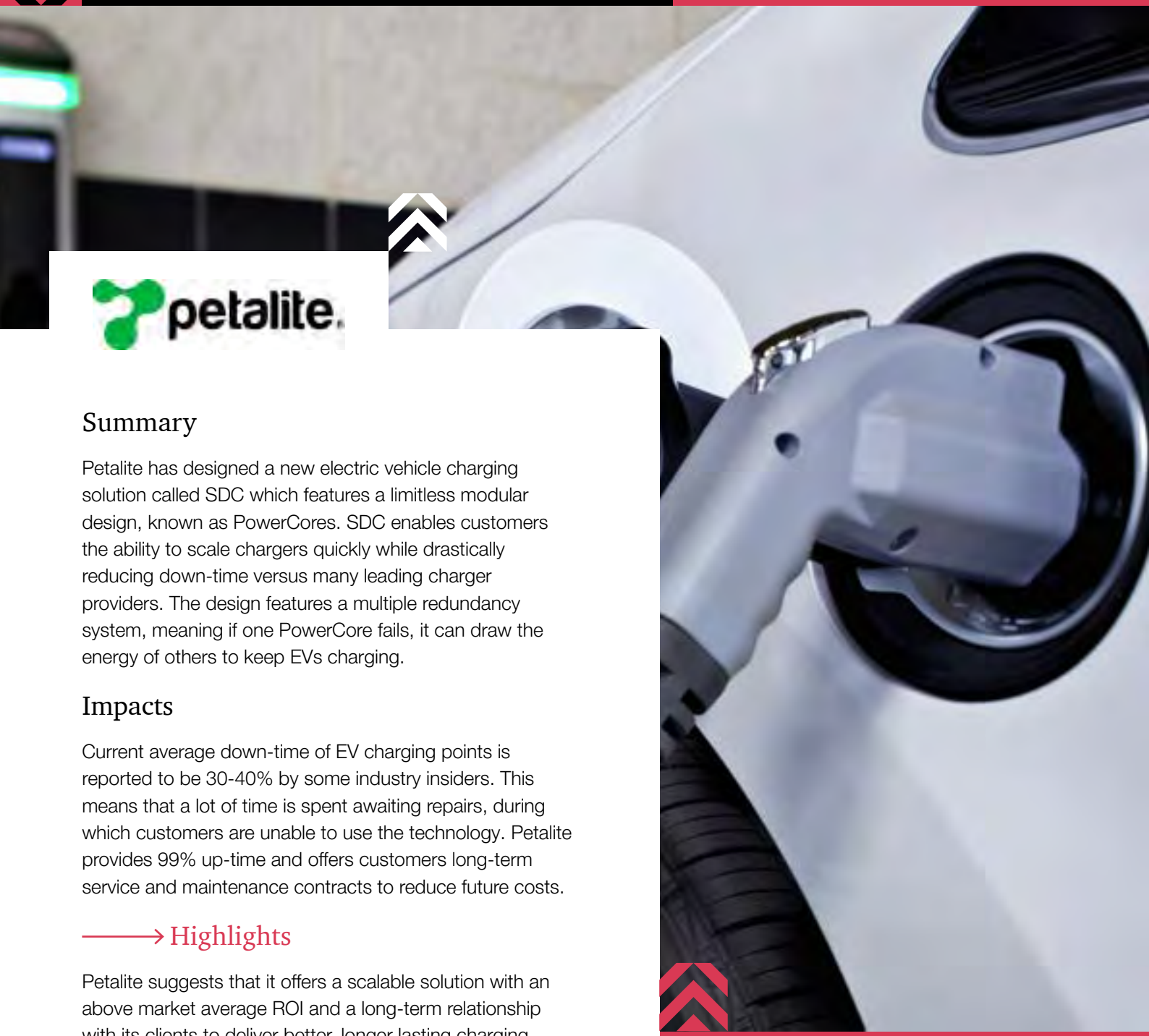
- Aviation
- Airports
- Fuels
- Waste

#CleanFuels

#WasteToFuel

#CarbonCapture

Link to website:
velocys.com



petalite.

Summary

Petalite has designed a new electric vehicle charging solution called SDC which features a limitless modular design, known as PowerCores. SDC enables customers the ability to scale chargers quickly while drastically reducing down-time versus many leading charger providers. The design features a multiple redundancy system, meaning if one PowerCore fails, it can draw the energy of others to keep EVs charging.

Impacts

Current average down-time of EV charging points is reported to be 30-40% by some industry insiders. This means that a lot of time is spent awaiting repairs, during which customers are unable to use the technology. Petalite provides 99% up-time and offers customers long-term service and maintenance contracts to reduce future costs.

⟶ Highlights

Petalite suggests that it offers a scalable solution with an above market average ROI and a long-term relationship with its clients to deliver better, longer lasting charging points. It is also looking at partnerships with Charge Point operators (CPOs), local authorities, commercial fleets and the aviation industry.

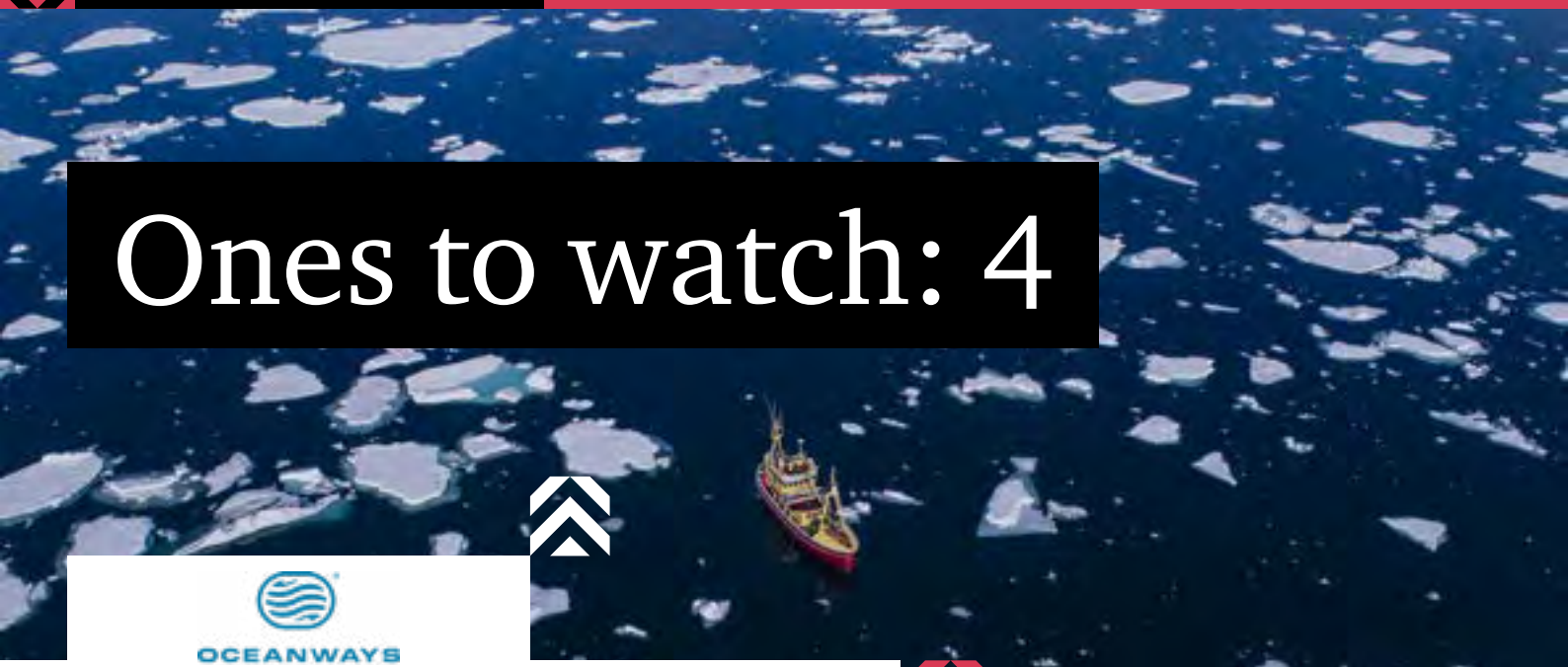
⟶ Strategic alliances

- Cities
- Development
- Electric Vehicles
- Government
- Local Authorities
- Logistics
- Real Estate

#ElectricVehicleCharging

#Modular

Link to website:
petalite.co.uk



Ones to watch: 4

OCEANWAYS

Oceanways is developing a zero-emission submarine fleet that could provide autonomous cargo deliveries, while removing plastic waste from the ocean. Oceanways was one of the winners of the UK Government's £23 million R&D Clean MaritimeDemonstration Competition.[32]

32 Source: UKRI: https://www.ukri.org/news/first-green-submarine-amongst-winners-of-clean-maritime-competition/

#Hydrogen

#MicroPlastics

Link to website:
oceanways.co

faradair

Faradair is developing a hybrid-electric aircraft concept that aims to solve traditional aviation noise, operation costs and emissions problems. It asserts that its multi-functional plane, BEHA, converts from an 18 passenger configuration to cargo in just 15 minutes.

#Aviation

#HybridElectric

Link to website:
faradair.com

FLOC by Urban Mass is a driverless light urban rail system, where it's solar panels provide much of the energy required for operation. FLOC proposes that it can offer for up to 50% lower capital and operational costs; using less land, steel and concrete.

#PublicTransport

#Urbanisation

Link to website:
urbanmass.co.uk

Core-Power is developing a scalable atomic power technology for ocean transport, using a modular, maritime version of the Molten Chloride Fast Reactor (MCFR). It states that their reactors are small, with few moving parts, and can run for decades without refuelling.

#Modular

#Nuclear

Link to website:
corepower.energy

Energy

Energy

21.1%
Of UK GHG emissions[33]

£530.7m
UK VC investment (H2 '20 – H1 '21)[34]

11
Start-ups in the Net Zero Future50

Globally, the Energy sector accounts for 13.6% (UK: 21.1%) of global GHG emissions and attracted 9.2% global climate tech investment from H2 2020 – H1 2021.[35] Total investment between H1 2013 – H1 2020 was £23.6bn globally and within this period investment has grown at a CAGR of 32%, well below the 68% climate tech aggregate.[36] Despite significant progress in decarbonising energy generation in the UK, a recent report by PwC estimated that there needed to be a doubling of capital requirements for existing UK infrastructure investment across energy, water and telecoms to be capable of achieving Net Zero.[37] However, the sector has benefited from learning curves and economies of scale, which have driven costs down, and allowed recent investment to go further.

Barriers:

- **Capital intensity:** Start-ups are often overlooked as investors seek lower risk, non-hardware based investments, which have quicker payback periods.
- **Infrastructure barriers:** To find success by 2035, the UK must improve technology across the Energy sector: improving energy storage, alternative fuels and grid management.

Accelerators:

- **Government targets:** The UK generated 41.6% renewable energy at the start of 2021, with the Government targeting 100% by 2035.[38]

Technology drivers:

#MicroGrids **#Hydrogen**
#Blockchain **#Fusion**
#SolarGlass **#Biofuel**
#OceanEnergy

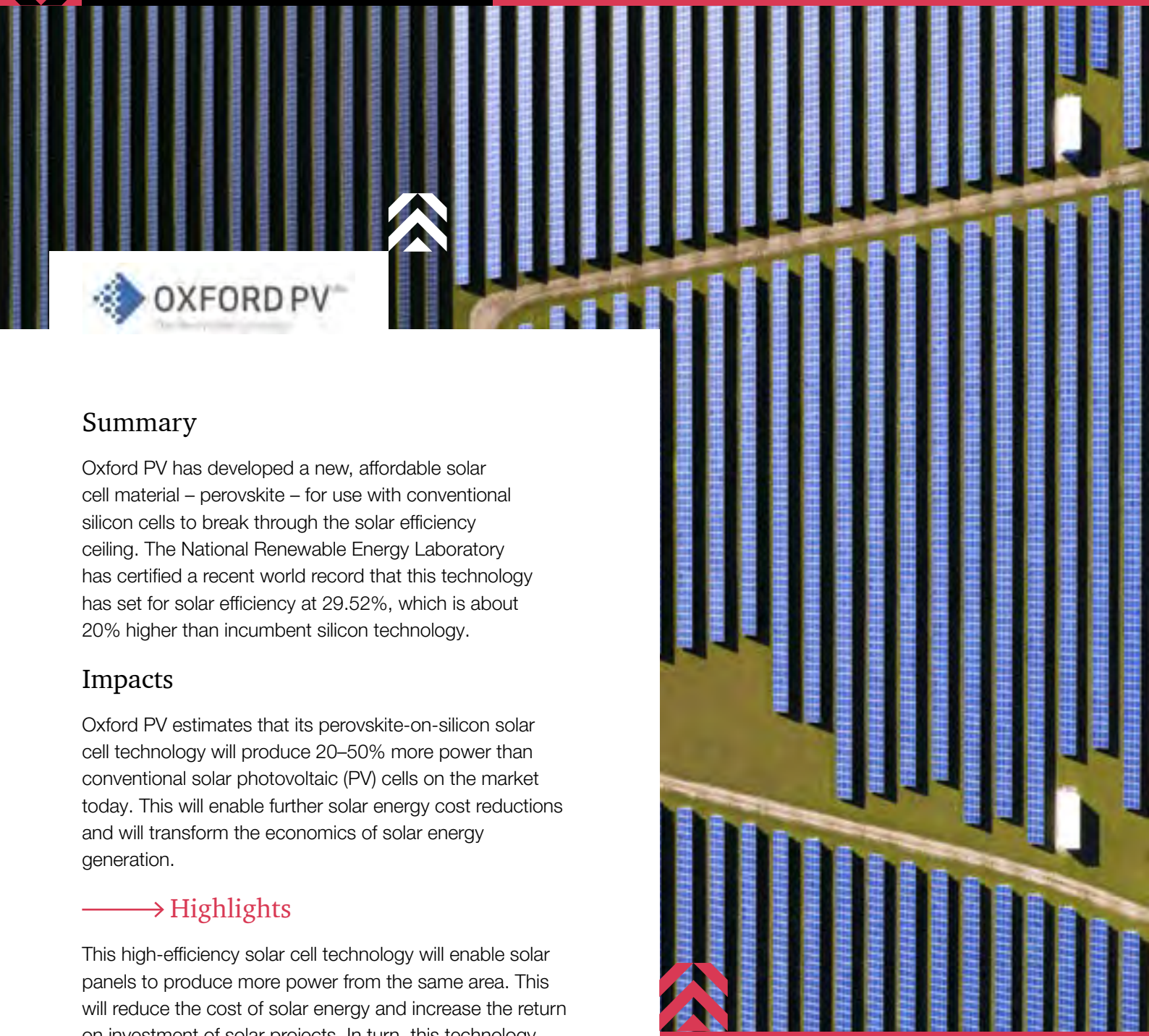
Growth Areas:

- **Renewable energy generation:** The renewable energy sub-sector is concerned with electricity and heat generated from solar, wind, oceanic, hydropower, biomass, geothermal resources, and hydrogen derived from renewable resources. The cost of renewable energy power generation has dropped significantly. For instance, the global average cost of onshore wind fell below fossil fuels for the first time in 2020.[39]

33 Source: UK Government, 2019 UK Greenhouse Gas Emissions, Final Figures
34 Source: PwC, The State of Climate Tech 2021
35 Source: PwC, The State of Climate Tech 2021
36 Source: PwC, The State of Climate Tech 2021
37 Source: PwC, Unlocking capital for Net Zero infrastructure
38 Source: Department of Business Energy & Industrial Strategy, UK Energy Trends
39 Source: International Renewable Energy Association, Renewable Power Generation Costs in 2020

- **Nuclear generation:** UK fission output has been on the decline, with operable nuclear power capacity decreasing by c.44% since 1999.[40] In spite of this, nuclear energy generation sentiment is improving; only 17% (2012: 27%) of UK residents surveyed in 2021 opposed or strongly opposed its use.[41] The UK government has also begun to back nuclear, which may reverse the decline in capacity; construction has commenced on the first of a new generation of nuclear plants, at Hinkley Point C, whilst Sizewell C is in pre-construction development.[42] In addition, the UK intends to position itself as a world leader in fusion, exemplified by allocating £346.7m of funding over the past decade, aiming to prove commercial viability and then export fusion technologies across the globe.[43] Fusion is not yet ready for scalable deployment, but its potential upside is significant. The global fusion industry is also warming up, with increasing levels of investment into the 35 companies founded since 2010, peaking at £2bn worth of investment in 2021.[44]
- **Grid management:** Micro grids are gaining traction; they are a self-sufficient energy system that serves a discrete geographic footprint e.g. a college campus or hospital complex. They provide a number of benefits: the ability to utilise fully renewable energy (as opposed to the grid), the reduced reliance and strain on the grid (power cuts), and the ability to serve points where the grid cannot reach.
- **Waste heat capture / conversion / storage:** Nearly ¾ of all the energy produced by humanity is squandered as waste heat.[45] The likes of data centres and power plants are currently some of the worst offenders. The fundamental problem is that the wasted energy could have been utilised as an energy source. The UK Government has set up the Industrial Heat Recovery Support (IHRS) programme, which will allocate £18m to funding heat recovery solutions.[46]
- **Alternative fuels:** 37% of the Earth's land surface is already being used for agriculture, and an increase in biofuels may result in food shortages as farmers change from food to fuel crops.[47] Hydrogen is a more sustainable alternative, and the UK Government recently unveiled its ambitions for 5GW of low-carbon hydrogen capacity by 2030 – equivalent to the amount of gas consumed by 3 million UK households per year.[48]
- **Energy storage (thermal or electricity):** Alternatives to Lithium-ion batteries are crucial because of energy density concerns and raw material shortages. Flow batteries, or redox-flow batteries, are highly scalable: they can be easily expanded or combined, making them an excellent choice for large energy storage systems. They last much longer than Lithium-ion batteries, while being safer to operate due to fewer flammable components.[49] Molten salt storage is a popular storage method for high-temperature thermal applications (e.g. Concentrated Solar Plants), and are reported to be 33 times less expensive[50] than lithium-ion batteries,making them a more feasible option for grid scale storage. [51]
- **Low-GHG extraction and maintenance:** This refers to technologies that reduce the GHG emissions of extracting materials from the ground or maintaining energy infrastructure. These technologies are centred around robotics, drones, automation, and AI. National Grid has been using a combination of six drones and AI to help inspect its 7,200 miles of overhead lines around England and Wales.[52]

40 Source: World Nuclear Association, Nuclear Power in the UK, 2021
41 Source: Statista, 2021. From what you know, or have heard about using nuclear energy for generating electricity in the UK, do you support or oppose its use?
42 Source: World Nuclear Association, Nuclear Power in the UK, 2021
43 Source: Department for Business, Energy and Industrial Strategy, 2021 Towards fusion energy: the UK Government's fusion strategy
44 Source: PwC, The State of Climate Tech 2021 using Dealroom data
45 Source: Yale School of the Environment: Waste Heat: Innovators Turn to an Overlooked Renewable Resource
46 Source: Department for Business, Energy & Industrial Strategy – Industrial Heat Recovery Support Programme, Guidance Note
47 Source: The World Bank Data – Agricultural land (% of land area)
48 Source: HM Government – UK Hydrogen Strategy
49 Source: Codibly, Flow battery, What you need to know about flow batteries
50 Source: Bundesverband Energiespeicher – Fact Sheet Speichertechnologien, für Hochtemperatur Flüssigspeicher (English analysis available here)
51 Source: Economist – Lithium battery costs have fallen by 98% in three decades
52 Source: Office for Artificial Intelligence – A guide to using artificial intelligence in the public sector



OXFORD PV

Summary

Oxford PV has developed a new, affordable solar cell material – perovskite – for use with conventional silicon cells to break through the solar efficiency ceiling. The National Renewable Energy Laboratory has certified a recent world record that this technology has set for solar efficiency at 29.52%, which is about 20% higher than incumbent silicon technology.

Impacts

Oxford PV estimates that its perovskite-on-silicon solar cell technology will produce 20–50% more power than conventional solar photovoltaic (PV) cells on the market today. This will enable further solar energy cost reductions and will transform the economics of solar energy generation.

⟶ Highlights

This high-efficiency solar cell technology will enable solar panels to produce more power from the same area. This will reduce the cost of solar energy and increase the return on investment of solar projects. In turn, this technology can enable solar energy to become mainstream and allow society to accelerate the transition to renewable energy.

⟶ Strategic alliances

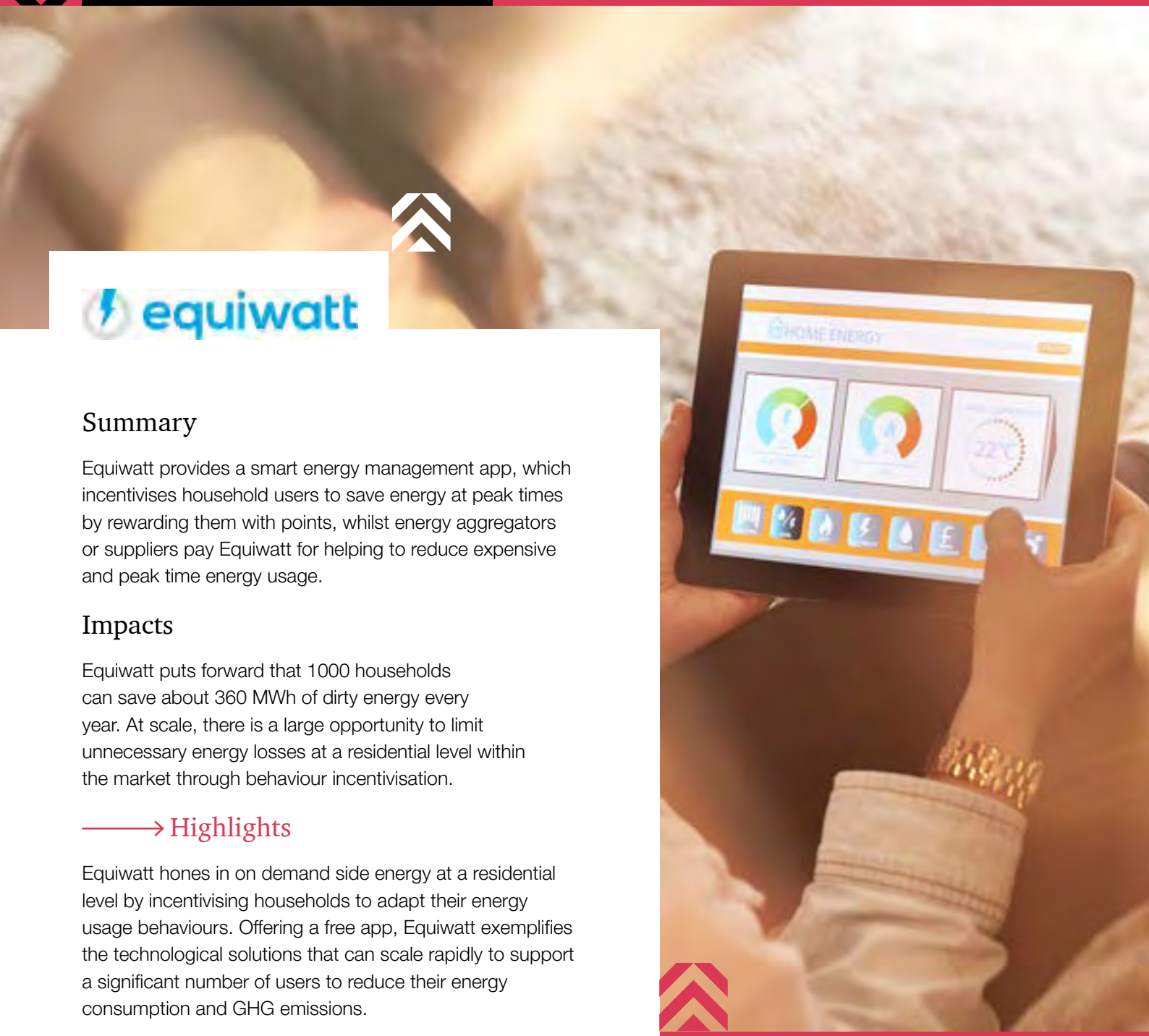
- Agriculture and Land Use
- Construction
- Energy
- Farming
- Government
- Infrastructure
- Real Estate

#ZeroCarbonEnergy

#Prosumers

#SolarGlass

Link to website:
oxfordpv.com



equiwatt

Summary

Equiwatt provides a smart energy management app, which incentivises household users to save energy at peak times by rewarding them with points, whilst energy aggregators or suppliers pay Equiwatt for helping to reduce expensive and peak time energy usage.

Impacts

Equiwatt puts forward that 1000 households can save about 360 MWh of dirty energy every year. At scale, there is a large opportunity to limit unnecessary energy losses at a residential level within the market through behaviour incentivisation.

⟶ Highlights

Equiwatt hones in on demand side energy at a residential level by incentivising households to adapt their energy usage behaviours. Offering a free app, Equiwatt exemplifies the technological solutions that can scale rapidly to support a significant number of users to reduce their energy consumption and GHG emissions.

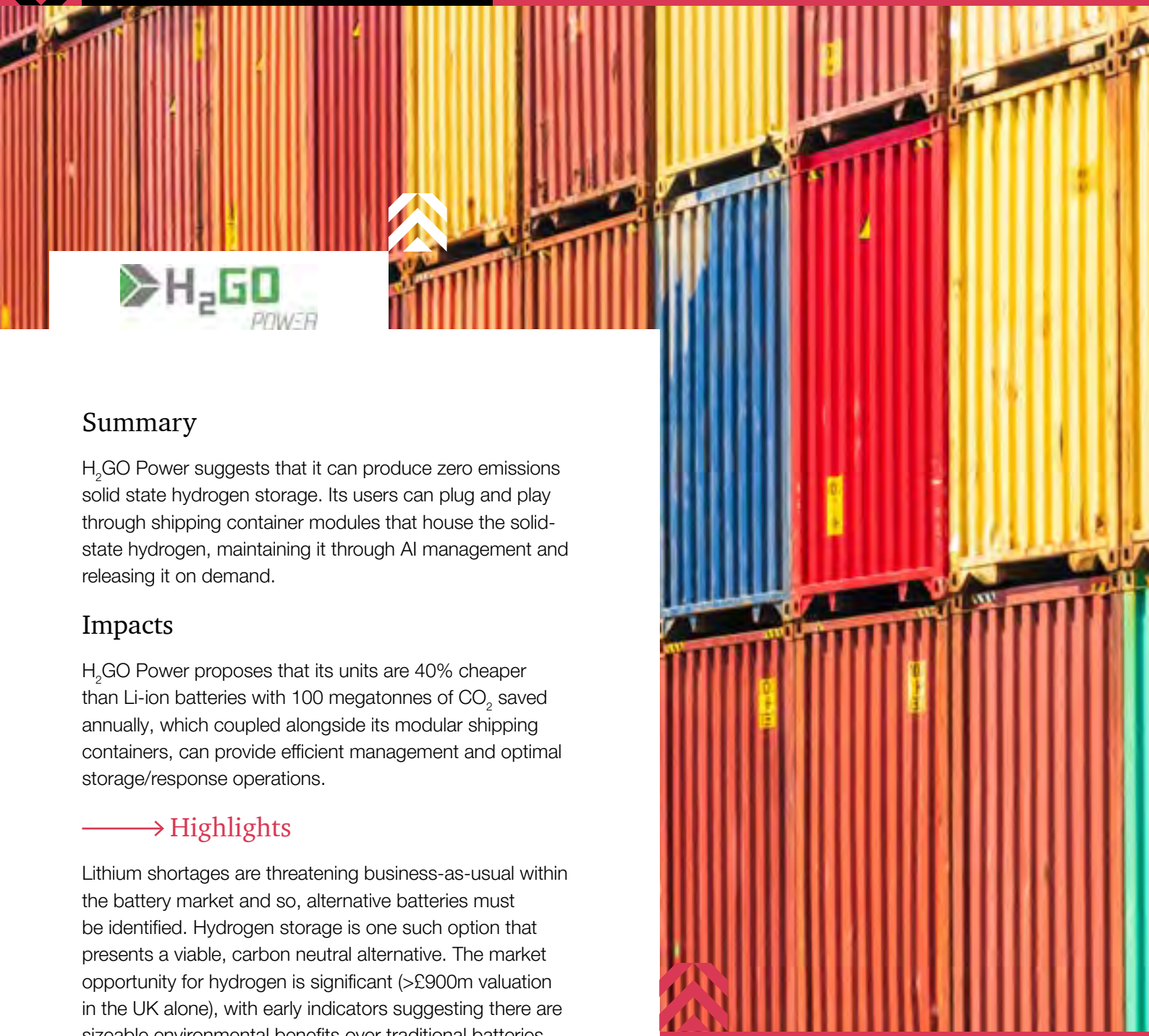
⟶ Strategic alliances

- Energy
- Government
- Real Estate
- Smart Homes
- Utilities

#BehaviourChange

#PeakEnergyStrain

Link to website:
equiwatt.com



Summary

H_2GO Power suggests that it can produce zero emissions solid state hydrogen storage. Its users can plug and play through shipping container modules that house the solid-state hydrogen, maintaining it through AI management and releasing it on demand.

Impacts

H_2GO Power proposes that its units are 40% cheaper than Li-ion batteries with 100 megatonnes of CO_2 saved annually, which coupled alongside its modular shipping containers, can provide efficient management and optimal storage/response operations.

⟶ Highlights

Lithium shortages are threatening business-as-usual within the battery market and so, alternative batteries must be identified. Hydrogen storage is one such option that presents a viable, carbon neutral alternative. The market opportunity for hydrogen is significant (>£900m valuation in the UK alone), with early indicators suggesting there are sizeable environmental benefits over traditional batteries throughout their life cycle, from mining to end of life.[53]

⟶ Strategic alliances

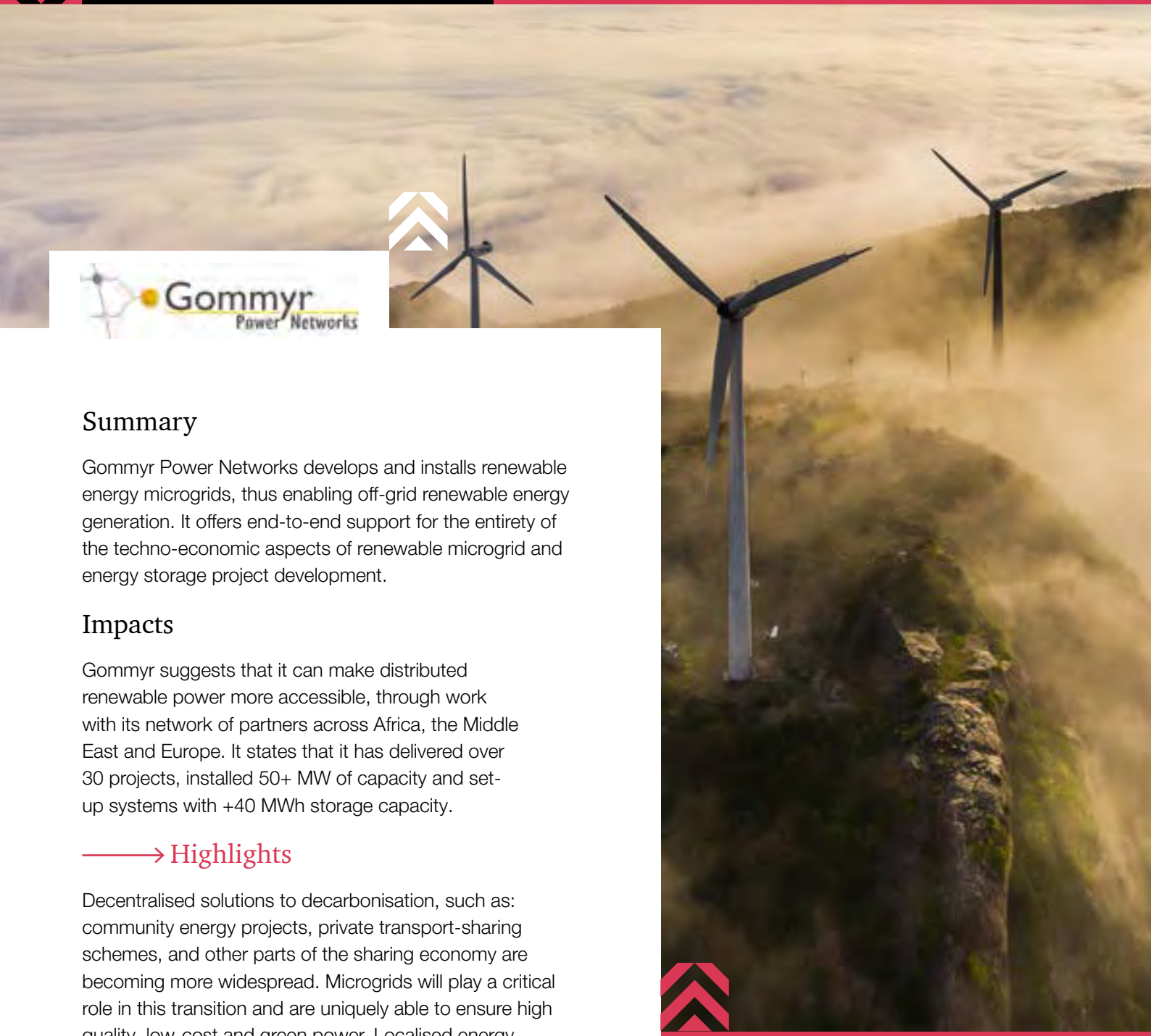
- Grid Management
- Infrastructure
- Manufacturing
- Mobility
- Renewable Energy

#EnergyStorage

#Hydrogen

Link to website:
h2gopower.com

53 Source: UK Government Press Release – UK Government launches plan for a world-leading hydrogen economy



Gommyr Power Networks

Summary

Gommyr Power Networks develops and installs renewable energy microgrids, thus enabling off-grid renewable energy generation. It offers end-to-end support for the entirety of the techno-economic aspects of renewable microgrid and energy storage project development.

Impacts

Gommyr suggests that it can make distributed renewable power more accessible, through work with its network of partners across Africa, the Middle East and Europe. It states that it has delivered over 30 projects, installed 50+ MW of capacity and set-up systems with +40 MWh storage capacity.

⟶ Highlights

Decentralised solutions to decarbonisation, such as: community energy projects, private transport-sharing schemes, and other parts of the sharing economy are becoming more widespread. Microgrids will play a critical role in this transition and are uniquely able to ensure high quality, low-cost and green power. Localised energy empowers businesses and communities, increasing information and control, reducing energy costs, and driving economic growth.

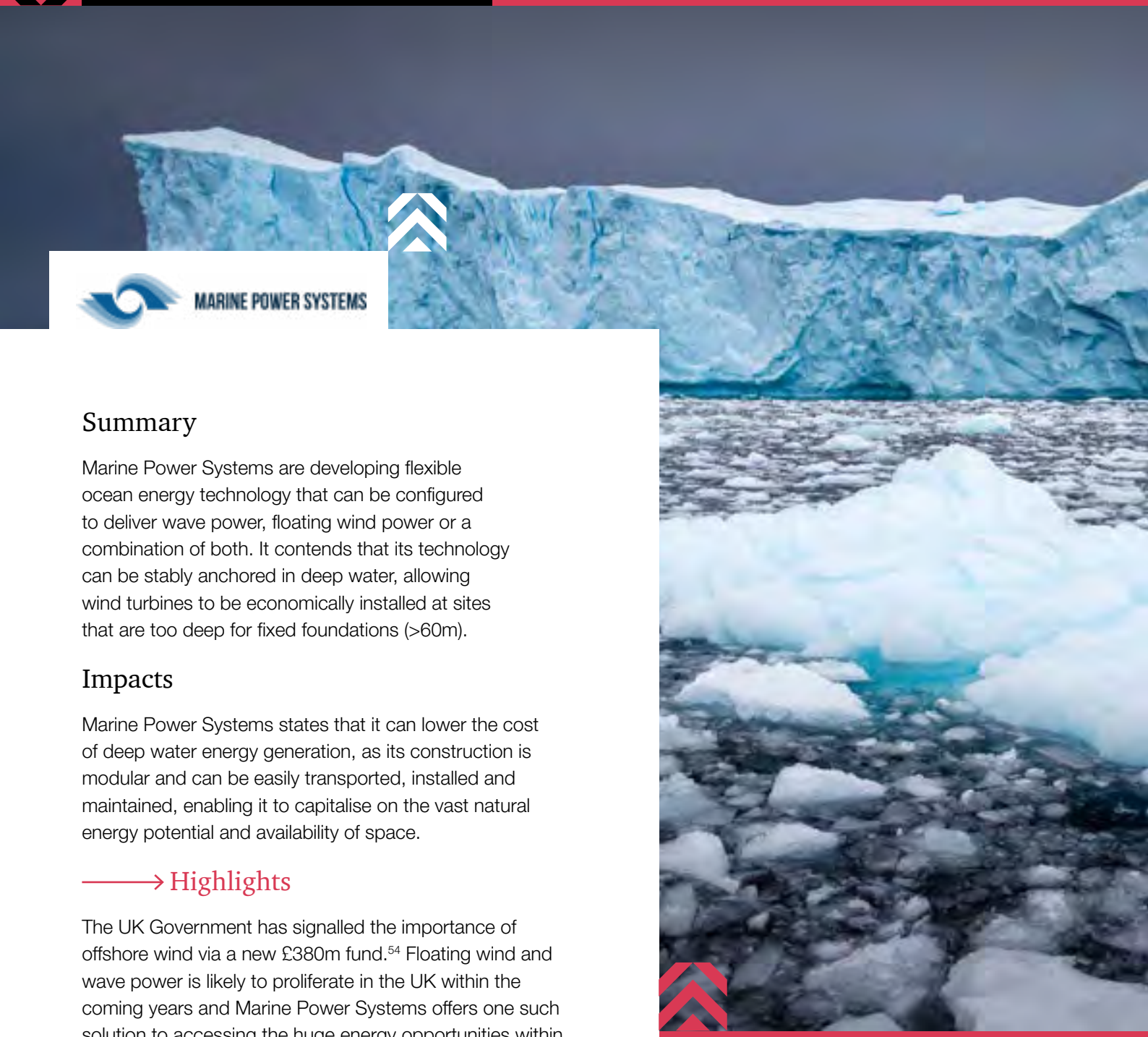
⟶ Strategic alliances

- Charities
- Energy Storage
- Government
- International Development
- Renewable Energy

#RenewableEnergy

#Microgrid48

Link to website:
gommyr.com



MARINE POWER SYSTEMS

Summary

Marine Power Systems are developing flexible ocean energy technology that can be configured to deliver wave power, floating wind power or a combination of both. It contends that its technology can be stably anchored in deep water, allowing wind turbines to be economically installed at sites that are too deep for fixed foundations (>60m).

Impacts

Marine Power Systems states that it can lower the cost of deep water energy generation, as its construction is modular and can be easily transported, installed and maintained, enabling it to capitalise on the vast natural energy potential and availability of space.

⟶ Highlights

The UK Government has signalled the importance of offshore wind via a new £380m fund.[54] Floating wind and wave power is likely to proliferate in the UK within the coming years and Marine Power Systems offers one such solution to accessing the huge energy opportunities within the UK's oceans.

⟶ Strategic alliances

- Construction
- Energy Storage
- Governments
- Local Authorities
- Maritime Infrastructure
- Renewable Energy

#WavePower

#FloatingWindPower

Link to website:
marinepowersystems.co.uk

54 Source: UK Government, 2021. Autumn Budget and Spending Review 2021

enertechnos

Summary

Enertechnos is a clean-tech company dedicated to enabling 'better electricity' by minimising energy losses related to electricity distribution. It suggests that its Capacitive Transfer System (CTS) has been proven to reduce grid losses and deliver more power through the same mass of conductor.

Impacts

Enertechnos promises up to 20% more power, and cabling that can be manufactured in existing factories, on standard cable-making machinery, with only a light and reversible modification.

→ Highlights

Roughly 1.5% of UK CO_2 emissions are due to grid losses and moreover, energy demands are expected to grow exponentially as the UK electrifies and moves away from fossil fuels.[55] As such, finding energy system efficiencies will have an important role to play within national decarbonisation.

→ Strategic alliances

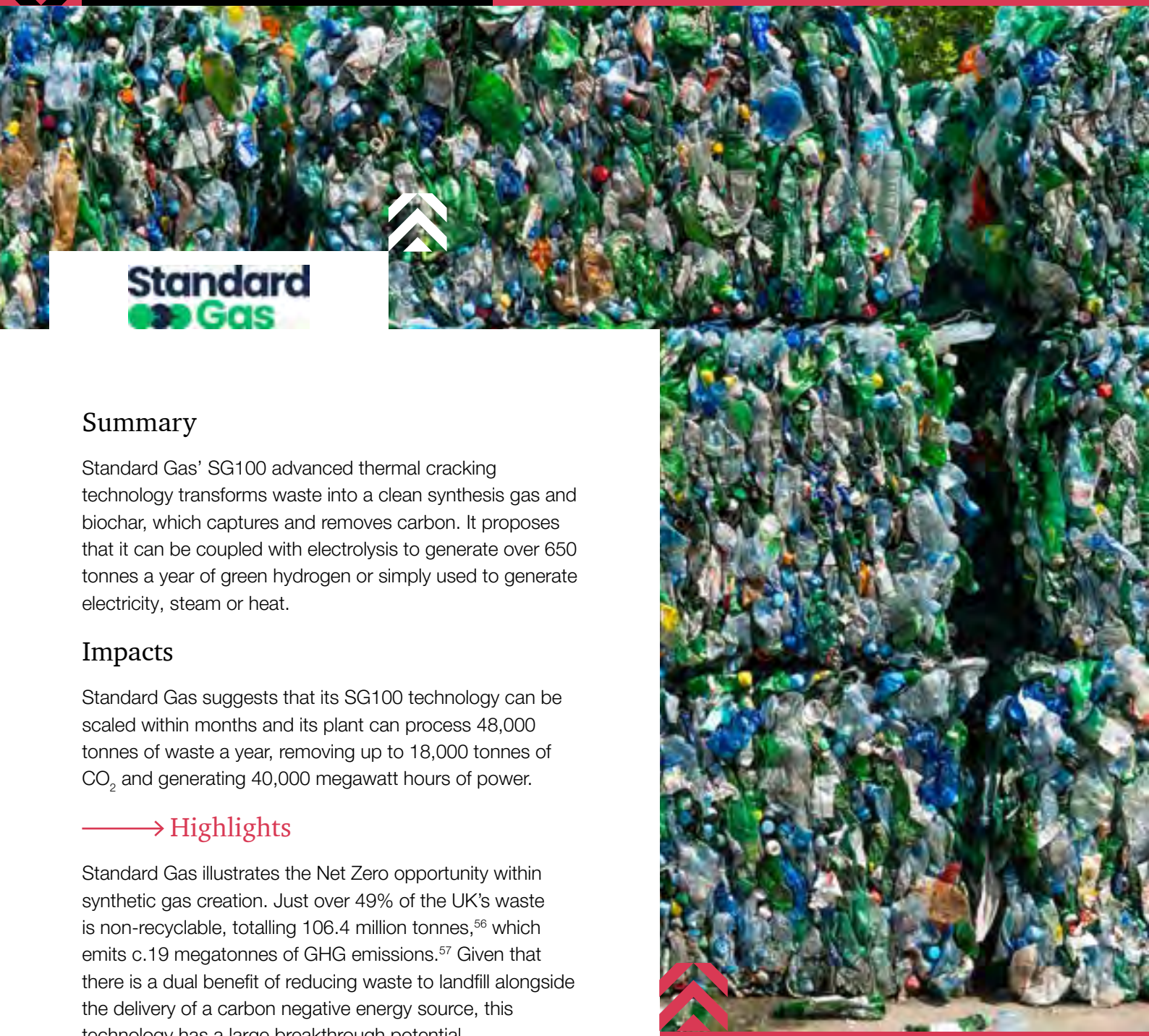
- Energy Storage
- Grid Management
- Infrastructure
- Renewable Energy

#EfficiencyGains

#GridManagement

Link to website:
enertechnos.com

55 Source: UK Parliament Records – Energy network costs: transparent and fair?



Standard Gas

Summary

Standard Gas' SG100 advanced thermal cracking technology transforms waste into a clean synthesis gas and biochar, which captures and removes carbon. It proposes that it can be coupled with electrolysis to generate over 650 tonnes a year of green hydrogen or simply used to generate electricity, steam or heat.

Impacts

Standard Gas suggests that its SG100 technology can be scaled within months and its plant can process 48,000 tonnes of waste a year, removing up to 18,000 tonnes of CO_2 and generating 40,000 megawatt hours of power.

⟶ Highlights

Standard Gas illustrates the Net Zero opportunity within synthetic gas creation. Just over 49% of the UK's waste is non-recyclable, totalling 106.4 million tonnes,[56] which emits c.19 megatonnes of GHG emissions.[57] Given that there is a dual benefit of reducing waste to landfill alongside the delivery of a carbon negative energy source, this technology has a large breakthrough potential.

⟶ Strategic alliances

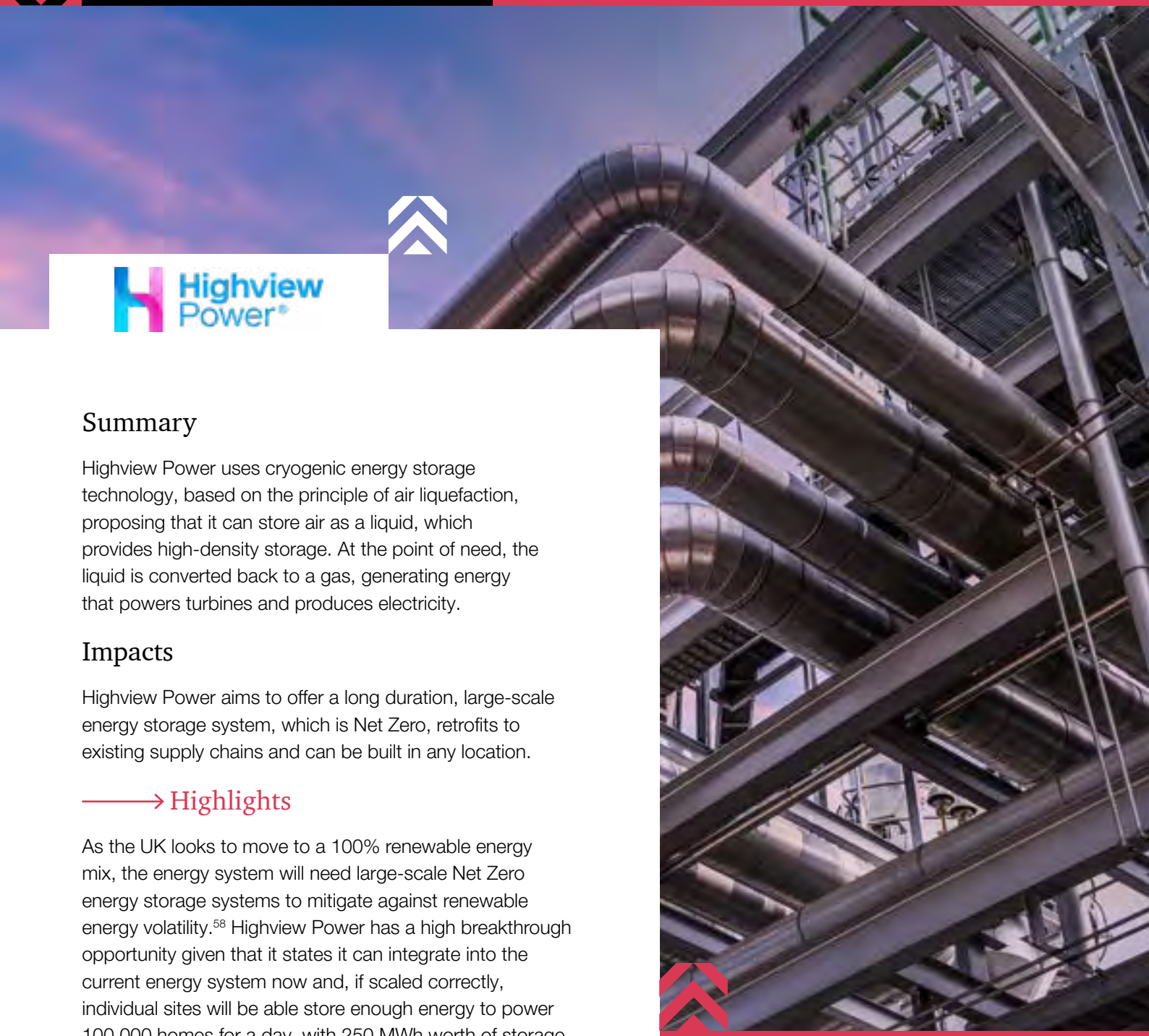
- Energy
- Fuel
- Hydrogen
- Local Authorities
- Waste

#CleanFuels

#WasteToEnergy

Link to website:
standardgas.com

56 Source: Department for Environment, Food & Rural Affairs – UK Statistics on Waste
57 Source: Department for Business, Energy & Industrial Strategy – UK Greenhouse Gas Emissions, Final Figures



Highview Power®

Summary

Highview Power uses cryogenic energy storage technology, based on the principle of air liquefaction, proposing that it can store air as a liquid, which provides high-density storage. At the point of need, the liquid is converted back to a gas, generating energy that powers turbines and produces electricity.

Impacts

Highview Power aims to offer a long duration, large-scale energy storage system, which is Net Zero, retrofits to existing supply chains and can be built in any location.

Highlights

As the UK looks to move to a 100% renewable energy mix, the energy system will need large-scale Net Zero energy storage systems to mitigate against renewable energy volatility.[58] Highview Power has a high breakthrough opportunity given that it states it can integrate into the current energy system now and, if scaled correctly, individual sites will be able store enough energy to power 100,000 homes for a day, with 250 MWh worth of storage.

Strategic alliances

- Energy Storage
- Governments
- Grid Management
- Infrastructure
- Renewable Energy

#EnergyStorage

#Non-Lithium

#Cryogenic

Link to website:
highviewpower.com

58 Source: UK Government: Plans unveiled to decarbonise UK power system by 2035

Summary

Bramble Energy designs and manufactures high-performance, low-cost fuel cell stacks using printed circuit board (PCB) materials and processes. It claims that its PCB fuel cell can reduce the cost and complexity of manufacturing hydrogen fuel cells (PEMFCs).

Impacts

Hydrogen fuel cells convert chemical energy from a fuel into electricity with oxygen taken from the air, completely eliminating harmful emissions. Bramble Energy suggests that its construction methodology creates the opportunity for bespoke and adaptable, low cost hydrogen fuel cells that can be manufactured in almost all PCB factories worldwide.

⟶ Highlights

Technologies such as Bramble Energy's hydrogen fuel cell, which use existing materials and supply chains, can remove the scaling barriers to the adoption of fuel cells. Solutions that can be retro-fit into existing infrastructure and supply renewable fuel cell (hydrogen) hardware across a range of applications, have the potential to offer significant Net Zero gains.

⟶ Strategic alliances

- Construction
- Energy
- Energy Storage
- Infrastructure
- International Development
- Local Authorities
- Mobility

#FuelCell

#Hydrogen

Link to website:
brambleenergy.com

HABITAT ENERGY

Summary

Habitat Energy provides an optimisation and trading platform for grid-scale battery storage, with full route-to-market capability for wholesale and balancing markets in the UK. Its AI-based systems aim to forecast the best times for customers to go to market.

Impacts

Using its AI capabilities, Habitat Energy suggests that it optimises its clients batteries to maximise both their returns and battery life (up to +25 %), which can lower the barriers of entry to new battery owners; enticing them into the market.

⟶ Highlights

Habitat Energy's technology enables the owners of batteries to connect into and optimise their relationship with the national grid. As a result, battery optimisation tools, such as Habitat Energy, could allow more battery owners to enter the market, which is an essential step to ensuring that the UK is capable of reaching a 100% renewable energy mix by 2035.[59]

⟶ Strategic alliances

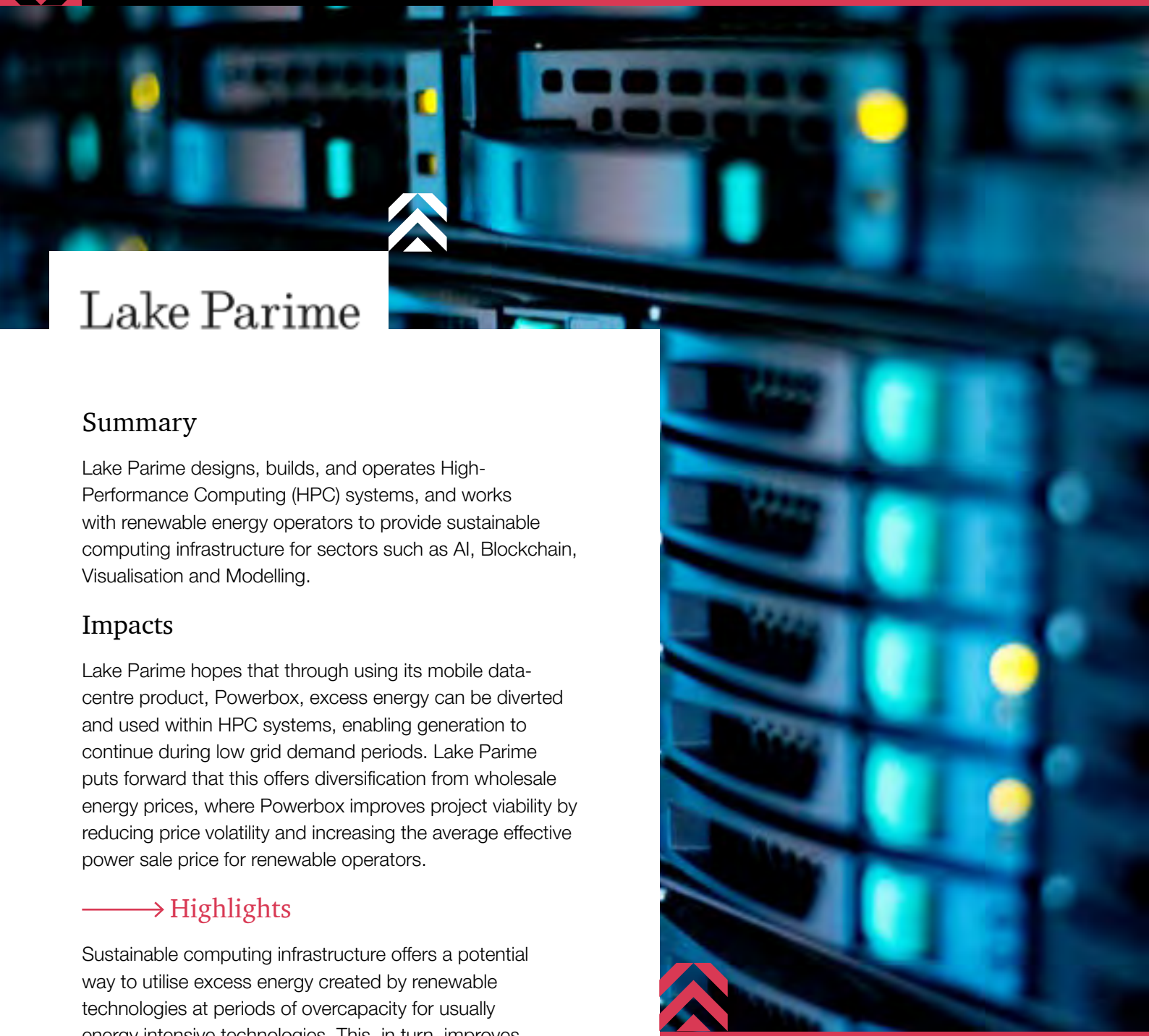
- Energy Storage
- Grid Management
- Infrastructure
- Mobility
- Renewable Energy

#CleanTech

#Grid

Link to website:
habitat.energy

59 Source: UK Government: Plans unveiled to decarbonise UK power system by 2035



Lake Parime

Summary

Lake Parime designs, builds, and operates High-Performance Computing (HPC) systems, and works with renewable energy operators to provide sustainable computing infrastructure for sectors such as AI, Blockchain, Visualisation and Modelling.

Impacts

Lake Parime hopes that through using its mobile data-centre product, Powerbox, excess energy can be diverted and used within HPC systems, enabling generation to continue during low grid demand periods. Lake Parime puts forward that this offers diversification from wholesale energy prices, where Powerbox improves project viability by reducing price volatility and increasing the average effective power sale price for renewable operators.

⟶ Highlights

Sustainable computing infrastructure offers a potential way to utilise excess energy created by renewable technologies at periods of overcapacity for usually energy intensive technologies. This, in turn, improves the return on investment for renewable energy projects and hence, suggests that this technology could accelerate the adoption of renewable technologies.

⟶ Strategic alliances

- Big Tech
- Energy Storage
- Data Centres
- Grid Management
- Infrastructure
- Renewable Energy

#EnergyStorage

#Grid

Link to website:
lakeparime.com

Ones to watch: 5

ACELERON

Aceleron is building modular lithium-ion batteries, assembled using compression technology. Aceleron suggest that this provides two key benefits:

1. Components can be upgraded and replaced; extending the battery life.
2. Recycling shows greater levels of efficiency, compared to traditional batteries.

#ModularBatteryCA

#CircularEconomy

Link to website:
aceleronenergy.com

RFC POWER

RFC Power is designing a low cost flow battery using its patented hydrogen manganese technology. RFC power suggests that although its batteries are not yet commercialised, they could enable cheaper mass energy storage.

#FlowBattery

#EnergyStorage

Link to website:
rfcpower.com

seamach

Seamach Energy is developing smaller and more powerful, vertical wind energy products. It states that its products can be used on and offshore, and hence, could offer dramatic energy efficiency gains across wind farm sites.

#VerticalWind

Link to website:
seamachenergy.com

tokamak energy

Tokamak Energy is a fusion energy company that is aiming to commercialise global fusion power. It reports that its world-class fusion scientists and magnet engineers are solving complex challenges to develop efficient and affordable fusion power.

#Fusion

Link to website:
tokamakenergy.co.uk

Alp Technologies is focusing on developing renewable energy technologies for low-income countries. As low income countries grow over the next decade, it will be important for them to not follow the same path as many developed countries have by expanding fossil fuel energy production.

#SustainableGrowth

Link to website:
alp-technologies.com

Food, Agriculture and Land Use

Food, Agriculture and Land Use

11.5%
Of UK GHG emissions[60]

£220.4m
UK VC investment (H2 '20 – H1 '21)[61]

7
Start-ups in the Net Zero Future50

Food, Agriculture and Land Use was the biggest global growth area in terms of investment received in 2020, nearly doubling in investment since 2019.[62] This has primarily been driven by increased consumer demand for new products to enable more sustainable lifestyles. The sector attracted 11.2% of total global climate tech investment, at £18.7bn between H1 2013 – H1 2020. Within this period, investment grew at a CAGR of 80%; above the 68% climate tech aggregate.[63]

Barriers:

- **Systemic inertia:** Agriculture's principal emissions are not CO_2, but methane and nitrous oxide. The main sources of these two, harder to abate, gases are as by-products released by cattle bred for food production or naturally occurring from soils, both of which are critical components to existing food systems and will require behaviour change as well as technological innovations.

Accelerators:

- **Market opportunity:** The UK produces the highest amount of food waste across Europe, generating around 9.5 million tonnes of food waste in a single year.[64]
- **Rise of eco-conscious communities:** As consumers wake up to the threat of climate change, they have begun to adapt their behaviours, presenting opportunities across the Food, Agriculture and Land Use sector, from more sustainable food choices to eco-tourism to eco-tourism. For instance, between 2014 and 2019 the number of vegans in Great Britain quadrupled.[65]

Technology drivers:

#IoT

#PrecisionAgriculture

#PrecisionFermentation

#SyntheticBiology

#GIS

#Robotics

#VerticalFarming

60 Source: UK Government, 2019 UK Greenhouse Gas Emissions, Final Figures
61 Source: PwC, The State of Climate Tech 2021
62 Source: PwC, The State of Climate Tech 2021
63 Source: PwC, The State of Climate Tech 2021
64 Source: Wrap, Food surplus and waste in the UK – key facts
65 Source: Ipsos MORI, Vegan Society Poll

Growth Areas:

- **Alternative foods:** Lab-grown meats use significantly less land, water and energy than conventional meats. A study has shown fully adopting lab-grown meats could lead to a 92% reduction in meat emissions, by combining the process with renewable energy.[66]
- **Vertical and urban Farming:** Soil free aeroponics requires 95% less irrigation than traditional farming.[67] Vertical farms are closed systems, meaning resources such as water can be recycled, and potentially harmful substances such as pesticides are not at risk of contaminating other areas or species. Whilst urban farming can significantly reduce food miles and associated emissions as the Department for Environment, Food and Rural Affairs estimates that 25% of all UK heavy goods transport is from transporting food.[68]
- **Precision agriculture and robotics:** The use of precision agriculture and variable rate application technology can provide a 20-30% herbicide saving and up to 40% with mineral fertilisers compared to existing manual solutions.[69]
- **Earth and marine Protection:** The National Farmers Union in the UK estimates that a saving of 9 million tonnes of CO_2 can be delivered per year, by enhancing soil carbon sequestration, increasing hedgerows and woodland planting and peatland and wetland restoration across the UK.[70] If the ocean plant biomass was increased by 3%, this could offset anthropogenic carbon and increase fish stocks,meaning that the opportunity and potential of marine regeneration is enormous.[71]
- **Value chain GHG reduction:** WRAP[72] indicates that of the 7 million tonnes of food waste created in the UK, 4.2 million tonnes was avoidable food and drink, worth £12.5 bn.[73] This is due to poor labelling, unnecessary supermarket aesthetic standards, over purchasing by consumers and losses within the production and distribution processes.
- **Low-GHG fertilisers and pesticides:** Synthetic fertilisers are the second largest contributor to agriculture emissions, after livestock (incl. manure), and as such must be reduced to achieve Net Zero. According to Pivot Bio, a small portion of existing chemical fertilisers decompose into nitrous oxide, which is a greenhouse gas that is 300 times more potent than CO_2 and responsible for about 5% of global warming.[74]

66 Source: Good Food Institute, New studies show cultivated meat can have massive environmental benefits and be cost-competitive by 2030
67 Source: SouthWest Agritech, LettUs Grow
68 Source: Department for Environment, Food and Rural Affairs, Foodmiles Report Final
69 Source: European Commission, Farm to Fork strategy
70 Source: National Farmers' Union, Achieving Net Zero
71 Source: My Ocean, Ecopia – Green Oasis in the Deserts of the Ocean
72 Definition: WRAP is a charity, working with governments, businesses and citizens around the globe to create a world in which resources are used sustainably
73 Source: WRAP – Waste prevention activities (Food)
74 Source: AgFunderNews, bnaire-Backed Fund Invests in Pivot Bio's $70m Series B to Address 'One of Largest Sources of GHGs on Planet'

vertical future

Summary

Vertical Future offers advanced Controlled Environment Agriculture (CEA) systems with adaptable lighting, nutrient delivery, automation and monitoring of all growth parameters. Its vertical growing environments are monitored by its software 'DIANA' which can be licensed out to users. Vertical Future's systems offer dual irrigation (aeroponic and hydroponic), software integration with DIANA, optimised space usage and end-to-end monitoring.

Impacts

The global vertical farming market is projected to be worth about £5.1bn by 2023 with potential to reduce food security issues, water shortage and land-based issues including space or soil.[75] Vertical Future suggests that it can offer a c.170% increase in output per m^3 in comparison with wider industry benchmarks with a 20yr asset life.

⟶ Highlights

Vertical Future offers vertical farming that can be adapted to various locales, providing a solution with minimal water usage in a compact space using AI monitoring for its optimisation. This will be increasingly important as more of the population becomes urbanised, whilst also enhancing food security and reducing food miles for local populations.

⟶ Strategic alliances

- Agriculture and Land Use
- Cities
- Development
- Farming
- Government
- Infrastructure
- Local Authorities
- Supermarkets

#VerticalFarming

#AIAgriculture

#AgTech

Link to website:
verticalfuture.com

75 Source: Agritecture – The future of food, why farming is moving indoors

BETTER ORIGIN

Summary

Better Origin utilises black soldier fly larvae to process waste into animal feed. Its solution is an AI powered, modular insect mini-farm called Better Origin X1, which uses insects to convert food waste into high yields of insect protein and fat. After up to 14 days, the larvae are harvested and delivered straight to the animals. The end-to-end process is automated through AI, preparing the feed, feeding the larvae and monitoring factors such as larvae growth, humidity and temperature.

Impacts

Up to 5% of the UK's territorial emissions comes from food waste.[76] The Better Origin solution can be installed individually or grouped into a system to scale for users' requirements to provide a low energy, low-carbon solution to food waste and provide sustainable feed.

⟶ Highlights

The UK Government has committed to halving the UK's per capita food waste by 2030 and acknowledges that helping to change behaviours will require a lot of action and interventions.[77] According to Better Origin, it can help to reduce the high potency methane emissions produced by food waste, whilst simultaneously lowering the strain on arable land.

⟶ Strategic alliances

- Agriculture and Land Use
- Farming
- Government, Infrastructure
- Local Authorities
- Supermarkets
- Waste

#Sensors

#FugitiveEmissions

Link to website:
betterorigin.co.uk

76 Source: WRAP, Action on food waste
77 Source: House of Lords, Food Waste in the UK

Hummingbird Technologies

Summary

Hummingbird Technologies is an artificial intelligence software-as-a-service platform using deep learning and computer vision techniques to provide actionable intelligence to farmers and agri-businesses. It's satellites can map field boundaries, types of crops and can predict potential yield. It also assists with sustainable practices through optimising inputs, verifying sustainable practices and automating sustainability reporting.

Impacts

Since 2016, Hummingbird reports that it has surveyed >54m hectares and helped save >45,000 tonnes of CO_2 emissions. It asserts that through working with key industry players, its regenerative agricultural focus helps producers and farmers alike to monitor and improve efficiency to create a more sustainable process.

⟶ Highlights

Under the UK Government's 2020 sustainable farming policy, the roadmap to independent, efficient farming includes the use of optimised crops. According to Hummingbird Technologies its solution provides monitoring of crops, identification of potential efficiencies, and sustainability reports to substantiate companies' environmental claims and processes.

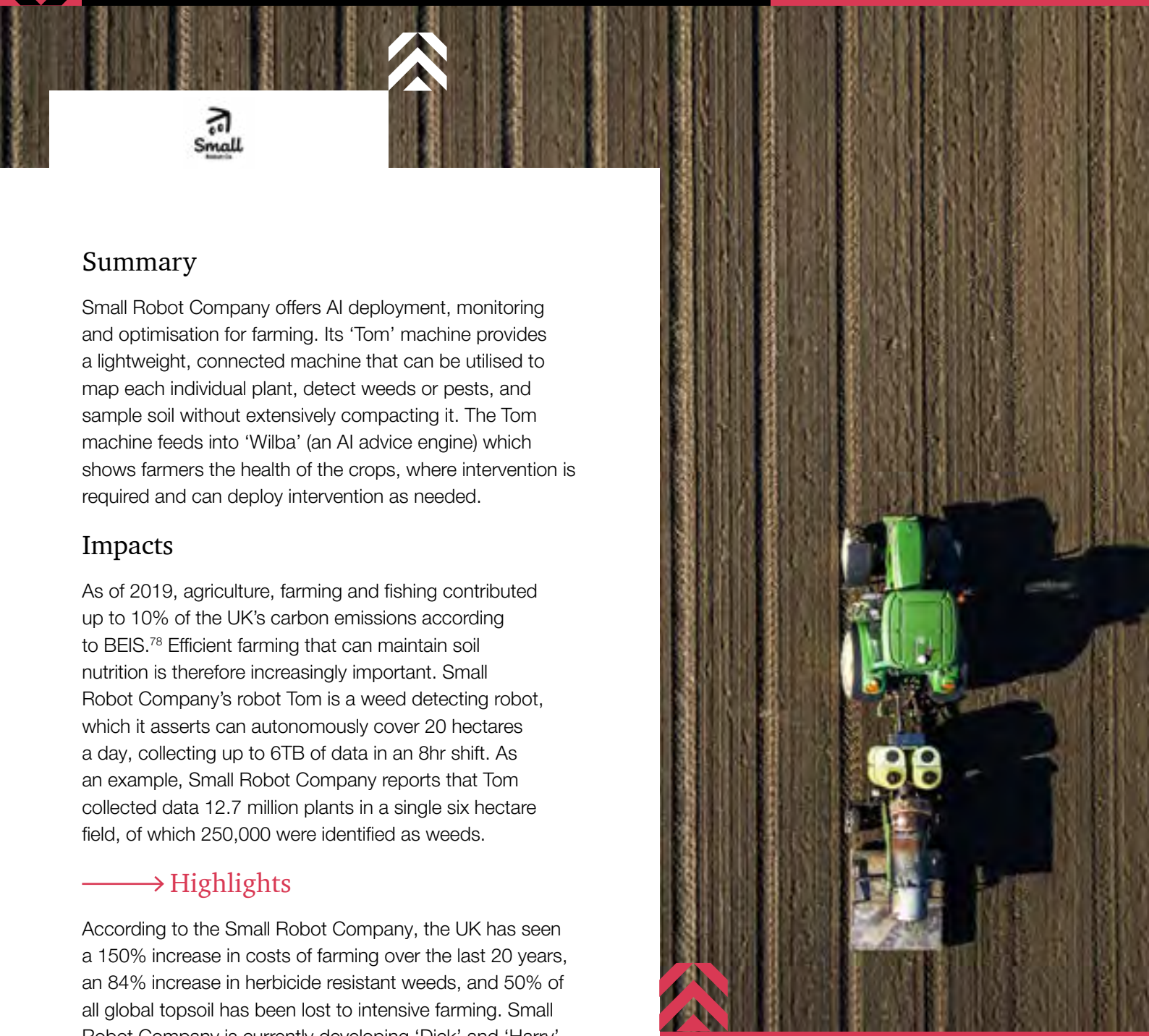
⟶ Strategic alliances

- Aerospace
- Agriculture and Land Use
- International Bodies (e.g. Carbon Credits)
- Farming
- Government

#Satellites

#AgriculturalMapping

Link to website:
hummingbirdtech.com



Summary

Small Robot Company offers AI deployment, monitoring and optimisation for farming. Its 'Tom' machine provides a lightweight, connected machine that can be utilised to map each individual plant, detect weeds or pests, and sample soil without extensively compacting it. The Tom machine feeds into 'Wilba' (an AI advice engine) which shows farmers the health of the crops, where intervention is required and can deploy intervention as needed.

Impacts

As of 2019, agriculture, farming and fishing contributed up to 10% of the UK's carbon emissions according to BEIS.[78] Efficient farming that can maintain soil nutrition is therefore increasingly important. Small Robot Company's robot Tom is a weed detecting robot, which it asserts can autonomously cover 20 hectares a day, collecting up to 6TB of data in an 8hr shift. As an example, Small Robot Company reports that Tom collected data 12.7 million plants in a single six hectare field, of which 250,000 were identified as weeds.

⟶ Highlights

According to the Small Robot Company, the UK has seen a 150% increase in costs of farming over the last 20 years, an 84% increase in herbicide resistant weeds, and 50% of all global topsoil has been lost to intensive farming. Small Robot Company is currently developing 'Dick' and 'Harry' which focus on weeding and planting, creating an end-to-end process of optimising farming and reducing waste.

⟶ Strategic alliances

- Agriculture and Land Use
- Farming
- Supermarkets

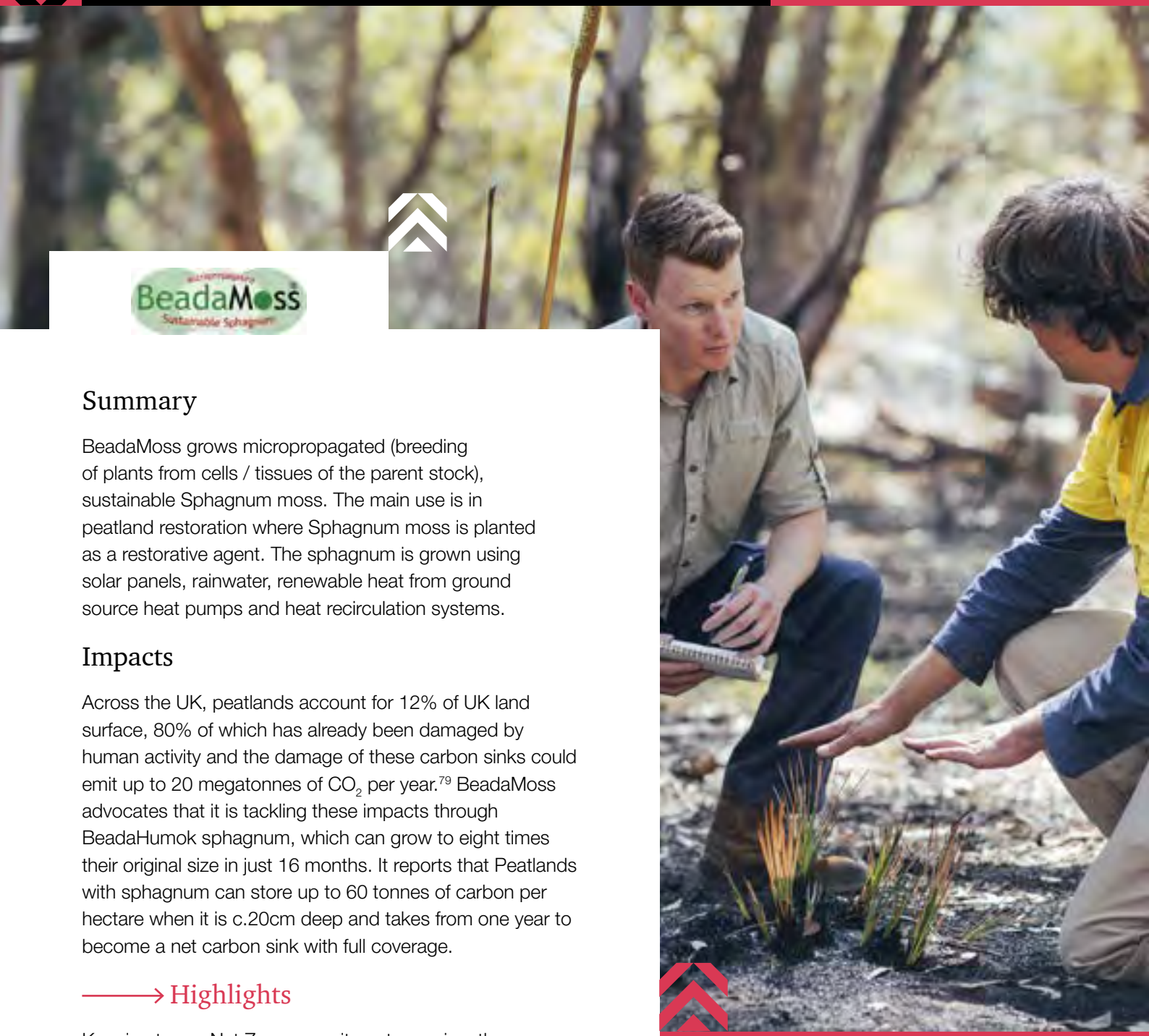
#AutomatedFarming

#PrecisionAgriculture

#Robotics

Link to website:
smallrobotcompany.com

78 Source: Department for Business, Energy & Industrial Strategy – 2019 UK Greenhouse Gas Emissions, Final Figures



Summary

BeadaMoss grows micropropagated (breeding of plants from cells / tissues of the parent stock), sustainable Sphagnum moss. The main use is in peatland restoration where Sphagnum moss is planted as a restorative agent. The sphagnum is grown using solar panels, rainwater, renewable heat from ground source heat pumps and heat recirculation systems.

Impacts

Across the UK, peatlands account for 12% of UK land surface, 80% of which has already been damaged by human activity and the damage of these carbon sinks could emit up to 20 megatonnes of CO_2 per year.[79] BeadaMoss advocates that it is tackling these impacts through BeadaHumok sphagnum, which can grow to eight times their original size in just 16 months. It reports that Peatlands with sphagnum can store up to 60 tonnes of carbon per hectare when it is c.20cm deep and takes from one year to become a net carbon sink with full coverage.

→ Highlights

Keeping to our Net Zero commitments requires the use of natural carbon sequestration, which could include the active protection of peatland. If scaled, BeadaMoss' planting of Sphagnum could have a significant impact on the UKs ability to naturally sequester CO_2.

→ Strategic alliances

- Agriculture and Land Use
- Conservation
- Government
- International Bodies (e.g. Carbon Credits)
- Local Authorities

79 Source: UK Centre for Ecology and Hydrology – Human activity means UK peatlands contribute to climate change

#Peatland

#CarbonSink

#PrecisionAgriculture

Link to website:
beadamoss.com

ARC Marine

Summary

Arc Marine's mission is to improve the well-being of our oceans now and for future generations, developing products that improve subsea safety and infrastructure, whilst minimising the environmental footprint of human marine activity. Arc Marine uses blue-tech and eco-engineering solutions to create sustainable, artificial reef materials that accelerate reef-creation and improve biodiversity in our oceans. Its products can be used for marine projects across Aquaculture, Coastal Defence, Reef Conservation, Eco-engineering and subsea protection.

Impacts

Arc Marine attests that its product line focuses on being CO_2 net neutral, c.90% recycled and designed with circularity in mind. Arc Marine states that it has, so far, deployed 681 reef cubes and supported 20 target species.

⟶ Highlights

Over the next 20 years, it is forecast that nearly 70 to 90% reef systems will disappear.[80] Arc Marine proposes that its products are designed to be left in-situ once deployed, safeguarding our ecosystems and habitats for future generations. This negates the need to recover products at the end of their life and so leaves, habitats undisturbed, other than to monitor and survey marine life.

⟶ Strategic alliances

- Construction
- Climate Adaptation
- Conservation
- Energy
- Fisheries
- Government
- Local Authorities
- Ports

#AquaCulture

#Conservation

#EcoEngineering

Link to website:
arcmarine.co.uk

80 Source: Forbes, Nearly All Coral Reefs Will Disappear Over The Next 20 Years

Desolenator

Summary

Desolenator replicates the water cycle utilising solar-generated heat and electricity to power the desalination process to distil seawater (or other local water source) into clean water. Desolenator proposes that its solution delivers an ocean safe regenerative water supply with low operational expenses, uses no consumables (no filters or membranes) and includes zero harmful chemicals.

Impacts

Desolenator suggests that its photovoltaic-thermal panels capture both electrical energy and thermal energy to raise its solar energy conversion from an average of c.15% to c.60%. Localised production is implemented to eliminate plastic bottles and unnecessary transportation of clean water to the end user.

→ Highlights

The Desolenator solution is grid independent, and the team proposes that it has the ability to deliver 24/7 production offering water security with consistent, high-quality water created from local water sources. It also enables water circularity through upcycling water from wastewater and minimising overall water footprint.

→ Strategic alliances

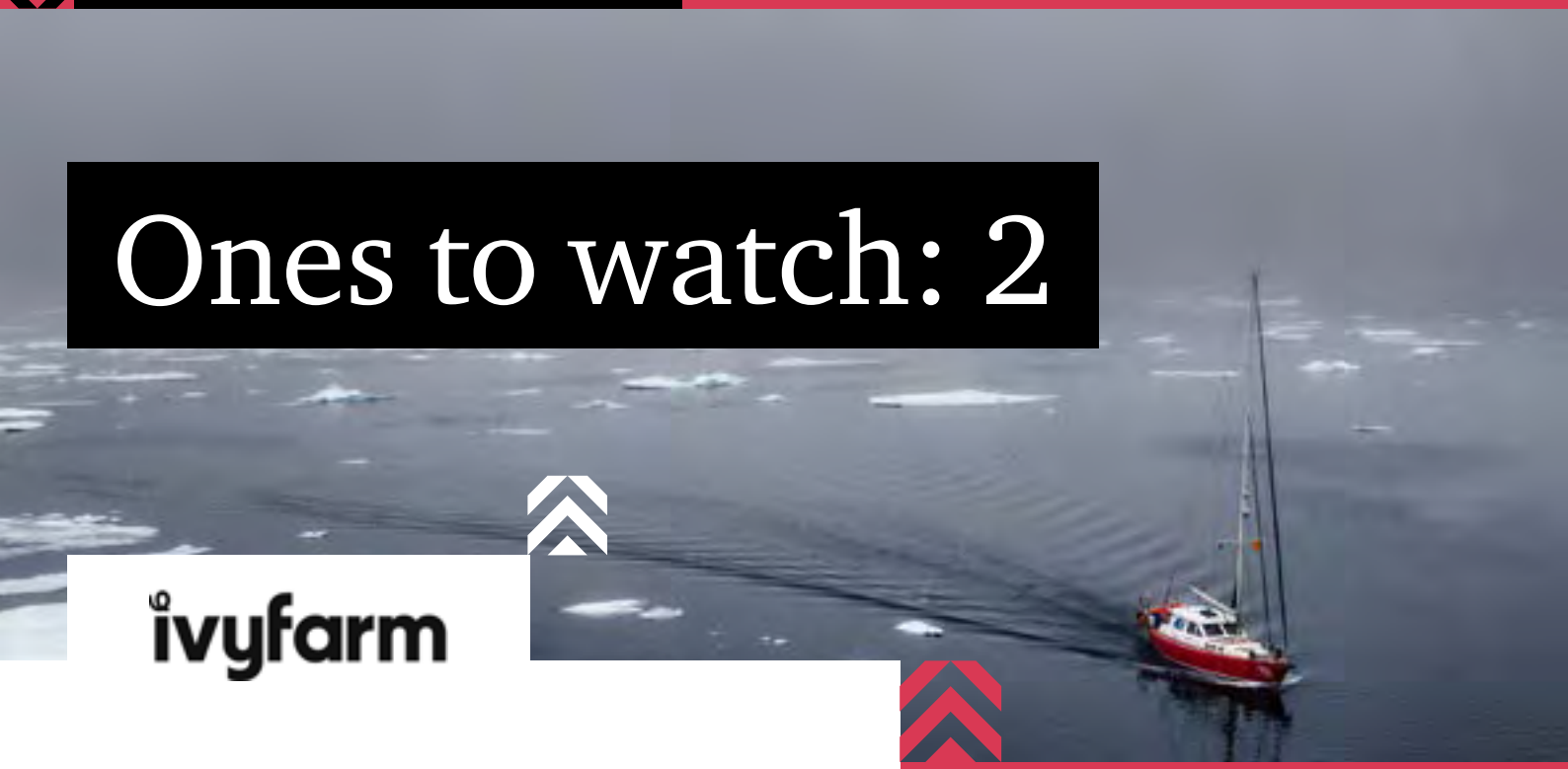
- Cities
- Charities
- Energy
- Government
- Infrastructure
- Local Authorities
- International Development
- Water

#WaterPurification

#OceanProtection

Link to website:
desolenator.com

Ones to watch: 2



ivyfarm

IvyFarm Technologies is developing a lab-grown meat which, as a product, has exponential growth potential. Consumers are struggling to fully withdraw from the meat market, and so, lab-grown meat could offer a guilt-free alternative.

#LabMeat

#FoodSupply

Link to website:
ivy.farm

CCell

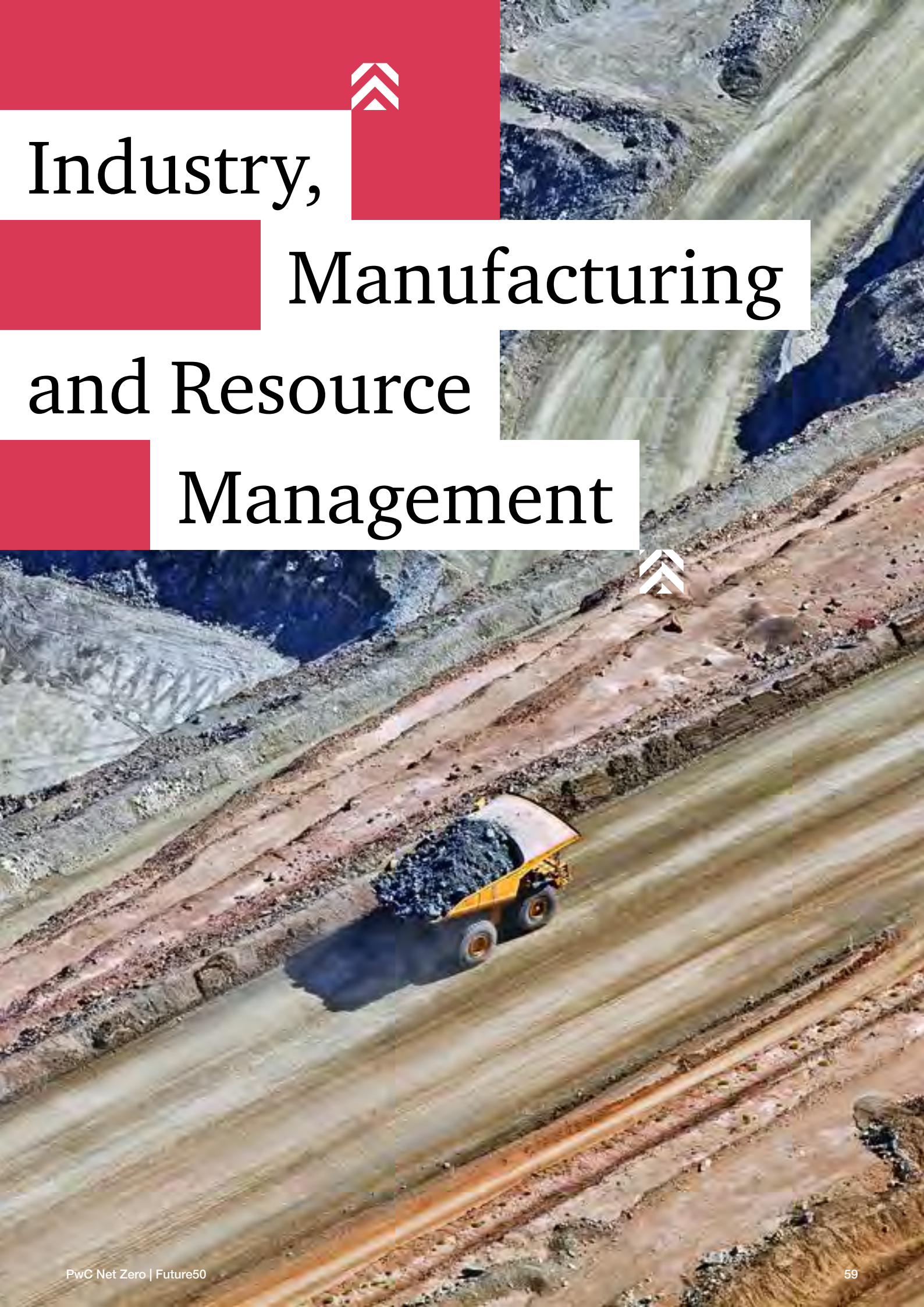
CCell combats coastal erosion by working with nature to restore a sustainable balance to coastal environments and bring lasting protection to communities around the world. It uses renewable energy to grow rock from seawater minerals, forming a barrier against erosive waves. It proposes that these barriers also provide the ideal backbone for corals and oysters, helping them grow 2-3x faster.

#CoastalProtection

#CleanOceans

Link to website:
ccell.co.uk

Industry, Manufacturing and Resource Management



Industry, Manufacturing and Resource Management

23.6%
Of UK GHG emissions[81]

£95.4m
UK VC investment (H2 '20 – H1 '21)[82]

10
Start-ups in the Net Zero Future50

Industry, Manufacturing and Resource Management has been underinvested in. Despite accounting for 29.4% (UK: 23.6%) of global GHG emissions, the sector has raised 8.5% of the total global climate tech investment from H1 2013 – H1 2020. Even with this cumulative deficit, investment has been accelerating; in H2 2020, global investment was c.£0.8bn, but increased to c.£4.5bn in H1 2021. Growth in this challenge area is underpinned by investment into energy / resource efficient manufacturing processes – responsible for nearly 50% of the investment between H2 2020 and H1 2021.[83]

Barriers:

- **Funding:** With rising gas prices and insufficient government funding, the sector is struggling to fund investment into decarbonisation technologies.
- **Lack of government/regulatory support:** Long term failures to fully price in environmental costs, fossil fuel subsidies and inconsistent carbon market standards are inhibiting market action.[84]

Accelerators:

- **Low cost exponential technologies:** Examples of exponential technologies in the area include nanomaterials, 3D printing and AI for resource sorting.
- **Intelligent nature based solutions:** We expect to see biomimicry and next-generation materials take a stronger foothold in the market, and help break fossil fuel dependencies.

Technology drivers:

#Nanomaterials **#Spectroscopy**
#Blockchain **#GIS**
#AI **#SmartMaterials**

Growth Areas:

- **Low-GHG plastics or plastic alternatives:** The UK government is confident that the introduction of a plastic packaging tax from April 2022 at £200 per tonne will increase the use of recycled plastic by 40%, reducing emissions by up to 25%.[85] Given the benefits and practical usage of plastics, the likelihood of their global removal is very low.[86] Instead, we need to focus on removing single use plastics, using recycled plastics where possible and effectively collecting low value plastics at the end of life, which currently cannot be recycled. Furthermore, where virgin feedstock must be used, ensure this comes from a renewable source, like extracted CO_2 or biomass. CO_2 based polymers have demonstrated that they can match the costs of fossil fuel incumbents,whilst biomass based polymers could yield positive results providing that cost, circularity and consumer behaviour barriers are overcome.[87]

81 Source: UK Government, 2019 UK Greenhouse Gas Emissions, Final Figures
82 Source: PwC, The State of Climate Tech 2021
83 Source: PwC, The State of Climate Tech 2021
84 Source: IMF, The Economics of Climate Change, 2019
85 Source: HM Government, 2021. Net Zero Strategy: Build Back Greener
86 Source: The Ellen MacArthur Foundation, 2017. The New Plastics Economy: Rethinking The Future Of Plastics & Catalysing Action
87 Newlight Technologies, 2017. AirCarbonTM Has Been Independently Verified As A Carbon Negative Material

- **Low-GHG iron, steel and aluminium:** Since 1990, emissions from iron and steel have fluctuated significantly, halving in total, yet remaining flat since 2016.[88] In 2019, the UK steel industry contributed 2.7% of all UK GHG emissions.[89] Iron, steel and aluminium recycling all require considerably less energy than raw manufacture and this is one of the key pathways to reducing emissions from this sector. The UK lags behind Europe on green steel production, with none of the 23 green steel foundry plants within Europe. (Duplicate footnote number 11 from earlier in the document here). This is important as demand for these products is forecast to grow, with steel demand expected to rise by 4% to 2030.[90]

- **Low-GHG concrete and alternatives for construction:** According to the Mineral Productions Association, concrete and cement alone account for c.1.5% of all UK GHG emissions. This equates to 7.3m tonnes, of which 4.4m tonnes were process emissions, and a further 2.3m from fuel combustion.[91] The Global Cement and Concrete Association (GCCA) announced that it will become an accelerator of the UN backed Race to Zero campaign, looking to halve global emissions by 2030.[92]

- **Energy and resource efficient manufacturing processes:** Manufacturers have responded to the challenge of designing efficient processes by default, as part of a growing acceptance that material optimisation should not just focus on product functionality, but combined with efficient use of resources as well. Although it is predicted that the manufacturing industry will continue with these efficiencies due to rising energy and resource cost pressures, this will unlikely be fast enough over the next decade, in key resource areas like water.

- **Low-GHG extraction, supply and maintenance:** This encompasses activities relating to fugitive emissions released through infrastructure (e.g. piping), distribution (e.g. container ships) or maintenance of heavy industry infrastructure (e.g. offshore oil rigs, telecoms). It has been reported that there are fewer than two dozen companies investigating fugitive (or leaked) emissions.[93]

- **Transformative circularity, recycling and materials efficiency solutions:** The UK Net Zero 2050 strategy gives a commitment to eliminate all avoidable waste as a part of the 25 Year Environment Plan.[94]

- **Waste management technology and Industrial residuals treatment and management:** According to the Department for Environment, Food and Rural Affairs, the UK generated 222.2 million tonnes of total waste in 2018, of which c.20% was derived from commercial and industrial (C&I) waste.[95] With over half of the UK's current waste sent abroad, opportunities for commercialising circular waste and waste management technologies within the UK are proliferating.[96]

88 Source: Statista, 2019. CO2 emissions from the manufacture of basic iron and steel in the UK from 1990 to 2019
89 Source: Statista, 2019. CO2 emissions from the production of aluminium in the United Kingdom* from 1990 to 2019
90 Source: IEA, 2021. Iron and Steel
91 Source: MPA UK Concrete, UK Concrete and Cement Industry Roadmap to Beyond Net Zero
92 Source: Global Concrete and Cement Association – Cement and concrete becomes first global essential industry accelerator for UN's global Race to Zero
93 Source: Environmental-Experts, Extract from full database [October 2021]
94 Source: HM Government, 2021. Net Zero Strategy: Build Back Greener
95 Source: HM Government: DEFRA: UK Statistics on waste
96 Source, Greenpeace, Plastic Recycling Export Incineration

SGMA
Sol-Gel Materials & Applications

Summary

SGMA produces biodegradable, compostable and recyclable packaging to replace single use plastics. SGMA states that the production process combines silicates and organic components to create a flexible, glass-like coating on paper fibres, making them waterproof, but degradable along with the paper to leave only a silicate residue.

Impacts

SGMA proposes that it can reduce the use of fossil fuel-based chemicals; completely free from micro plastics, the technology also fits seamlessly into the recycling infrastructure by providing a solution that is biodegradable, compostable and recyclable.

⟶ Highlights

SGMA's packaging is free of plastics, which are known to cause climate distress throughout the value chain: using fossil fuels for production, combusted for energy (releasing toxic pollutants) or broken down into micro plastics, polluting the oceans. SGMA offers an alternative to this damaging cycle.

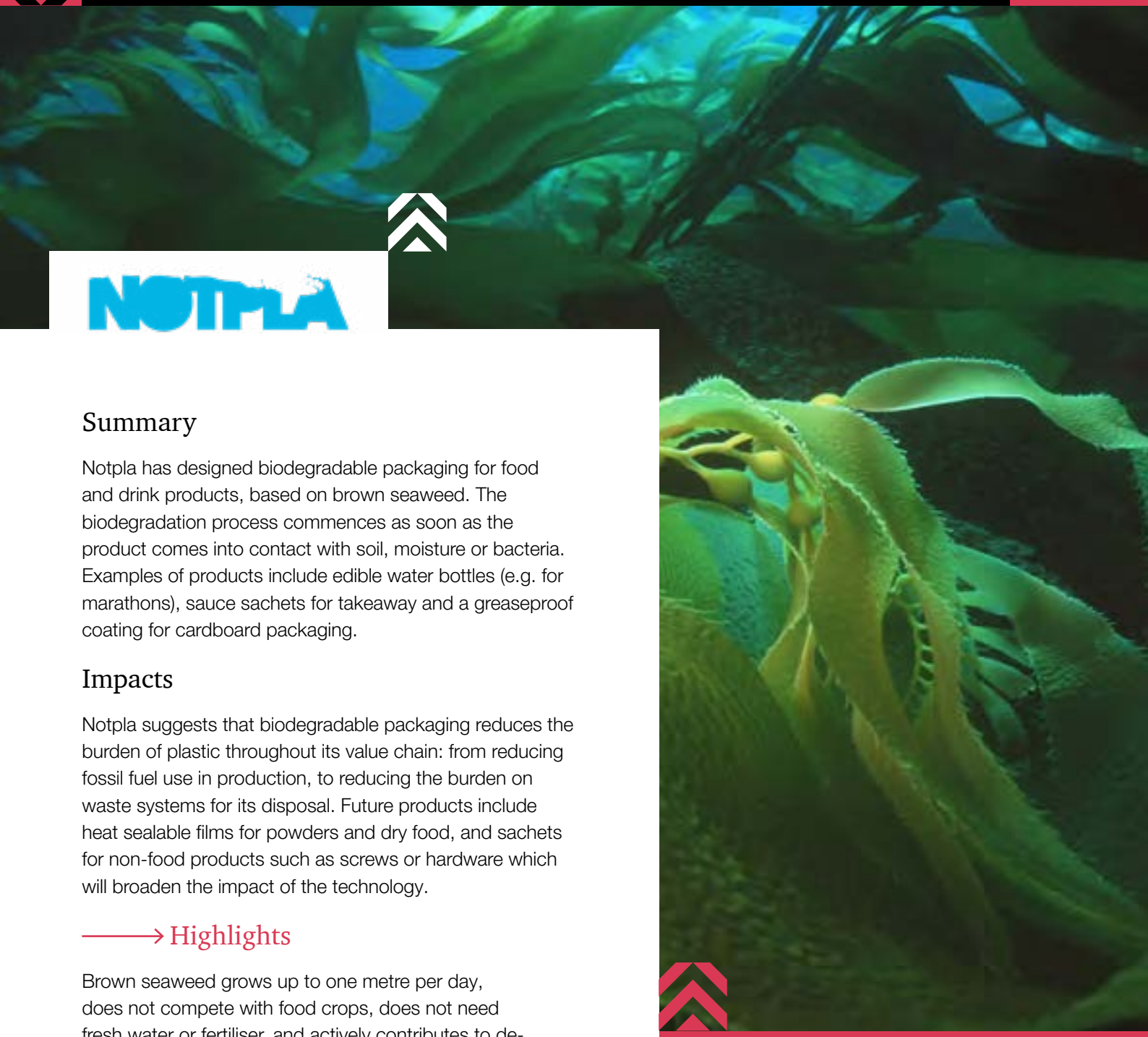
⟶ Strategic alliances

- Agriculture and Land Use
- Farming
- Supermarkets
- Government
- Retail
- Waste

#Biodegradable

#CleanOceans

Link to website:
sol-gel.co.uk



NOTPLA

Summary

Notpla has designed biodegradable packaging for food and drink products, based on brown seaweed. The biodegradation process commences as soon as the product comes into contact with soil, moisture or bacteria. Examples of products include edible water bottles (e.g. for marathons), sauce sachets for takeaway and a greaseproof coating for cardboard packaging.

Impacts

Notpla suggests that biodegradable packaging reduces the burden of plastic throughout its value chain: from reducing fossil fuel use in production, to reducing the burden on waste systems for its disposal. Future products include heat sealable films for powders and dry food, and sachets for non-food products such as screws or hardware which will broaden the impact of the technology.

⟶ Highlights

Brown seaweed grows up to one metre per day, does not compete with food crops, does not need fresh water or fertiliser, and actively contributes to de-acidifying oceans and capturing carbon. Unlike PLA (Polylactic Acid) based 'renewable' packaging, Notpla is home compostable and does not contaminate PET (polyethylene terephthalate) recycling.

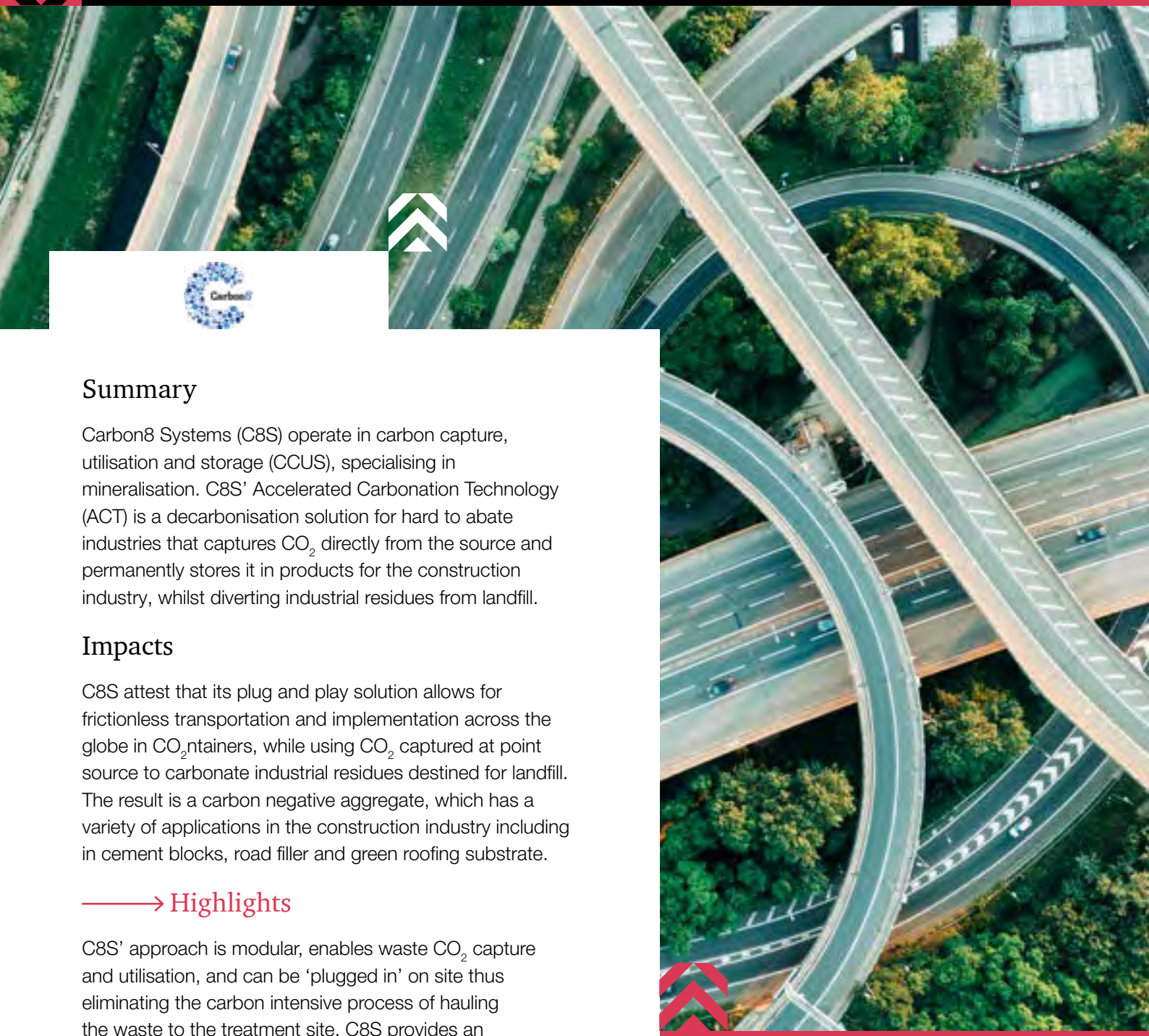
⟶ Strategic alliances

- Agriculture and Land Use
- Farming
- Supermarkets
- Government
- Retail
- Waste

#Biodegradable

#LowCarbonPackaging

Link to website:
notpla.com



Summary

Carbon8 Systems (C8S) operate in carbon capture, utilisation and storage (CCUS), specialising in mineralisation. C8S' Accelerated Carbonation Technology (ACT) is a decarbonisation solution for hard to abate industries that captures CO_2 directly from the source and permanently stores it in products for the construction industry, whilst diverting industrial residues from landfill.

Impacts

C8S attest that its plug and play solution allows for frictionless transportation and implementation across the globe in CO_2ntainers, while using CO_2 captured at point source to carbonate industrial residues destined for landfill. The result is a carbon negative aggregate, which has a variety of applications in the construction industry including in cement blocks, road filler and green roofing substrate.

⟶ Highlights

C8S' approach is modular, enables waste CO_2 capture and utilisation, and can be 'plugged in' on site thus eliminating the carbon intensive process of hauling the waste to the treatment site. C8S provides an economical, scalable CCUS solution that enables the circular economy, it's negative cement aggregate alone could target c.1.5% of all UK GHG emissions.[97]

⟶ Strategic alliances

- Carbon Capture
- Construction
- Development
- Infrastructure
- Manufacturing
- Real Estate
- Waste

97 MPA UK Concrete, UK Concrete and Cement Industry Roadmap to Beyond Net Zero

#WasteConversion

#CarbonCapture

Link to website:
c8s.co.uk

Summary

DB Group's brand Cemfree, is producing a low-carbon alternative to cement, claiming it can save 80% in embodied CO_2 compared to a conventional mix. Cemfree uses 95% ground granulated blast furnace slag (GGBFS) and a 5% alkali activator, removing the need for cement.

Impacts

Cemfree suggest that its product has increased strength and can be deployed across a variety of applications, ranging from walls and capping beams to sea defences. Cemfree offers potentially significant (80%) GHG reductions to the concrete industry, which importantly, can also be introduced now. As such, widespread adoption could have a significant impact on sectoral emissions.

→ Highlights

Around 3.5 bn tonnes of Ordinary Portland Cement, a critical building material worldwide, are produced annually – but every tonne emits up to 622 kg of CO_2, making decarbonising cement one of the biggest Net Zero challenges to tackle. Cemfree alternative could therefore massively reduce UK GHG emissions.[98]

→ Strategic alliances

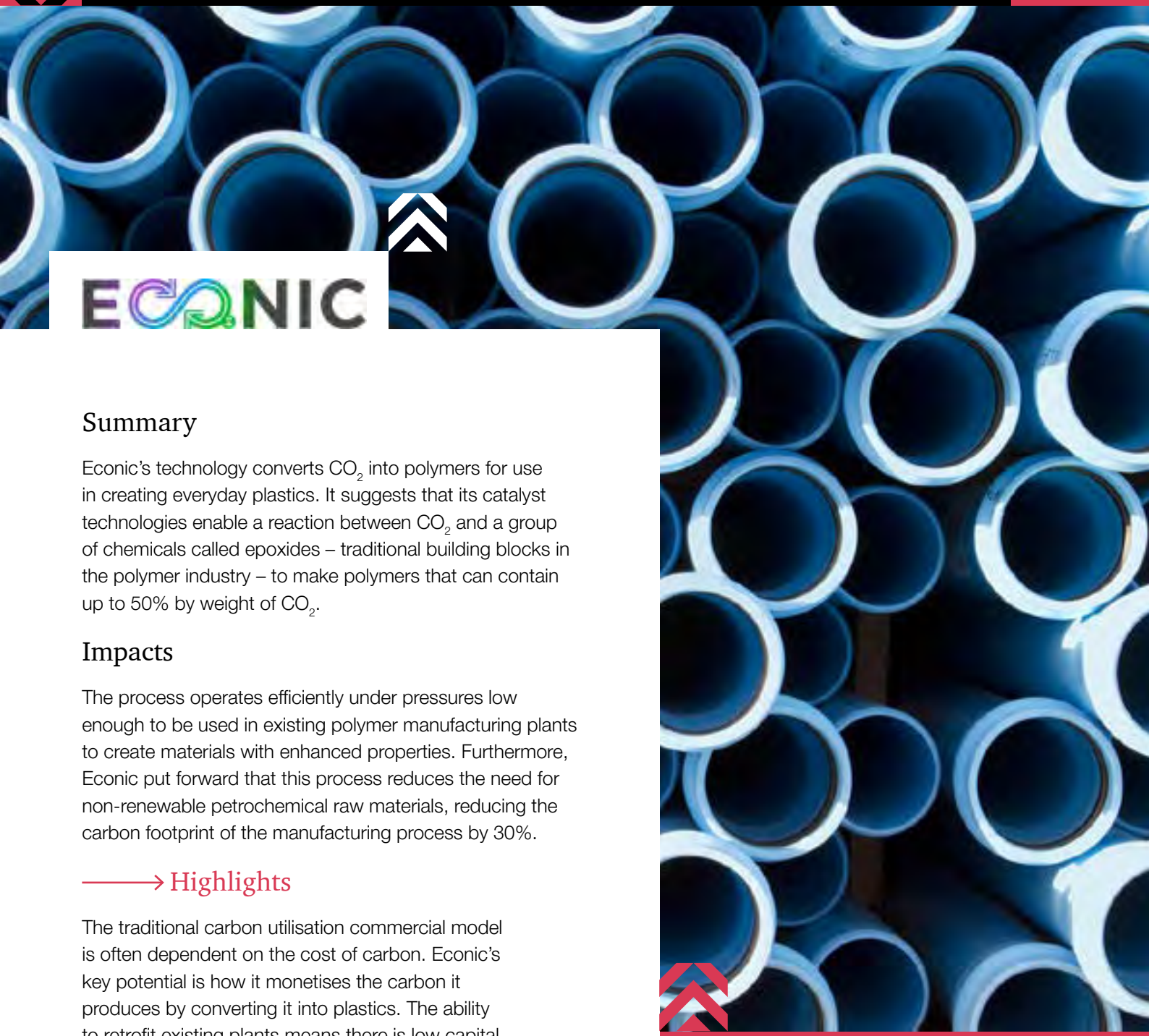
- Construction
- Development
- Infrastructure
- Manufacturing
- Real Estate
- Waste

#CementAlternatives

#AdvancedMaterials

Link to website:
dbgholdings.com/cemfree

98 Source: Imperial 2021, Best ways of removing carbon emissions from cement



ECONIC

Summary

Econic's technology converts CO_2 into polymers for use in creating everyday plastics. It suggests that its catalyst technologies enable a reaction between CO_2 and a group of chemicals called epoxides – traditional building blocks in the polymer industry – to make polymers that can contain up to 50% by weight of CO_2.

Impacts

The process operates efficiently under pressures low enough to be used in existing polymer manufacturing plants to create materials with enhanced properties. Furthermore, Econic put forward that this process reduces the need for non-renewable petrochemical raw materials, reducing the carbon footprint of the manufacturing process by 30%.

⟶ Highlights

The traditional carbon utilisation commercial model is often dependent on the cost of carbon. Econic's key potential is how it monetises the carbon it produces by converting it into plastics. The ability to retrofit existing plants means there is low capital cost of entry to this new, clean technology.

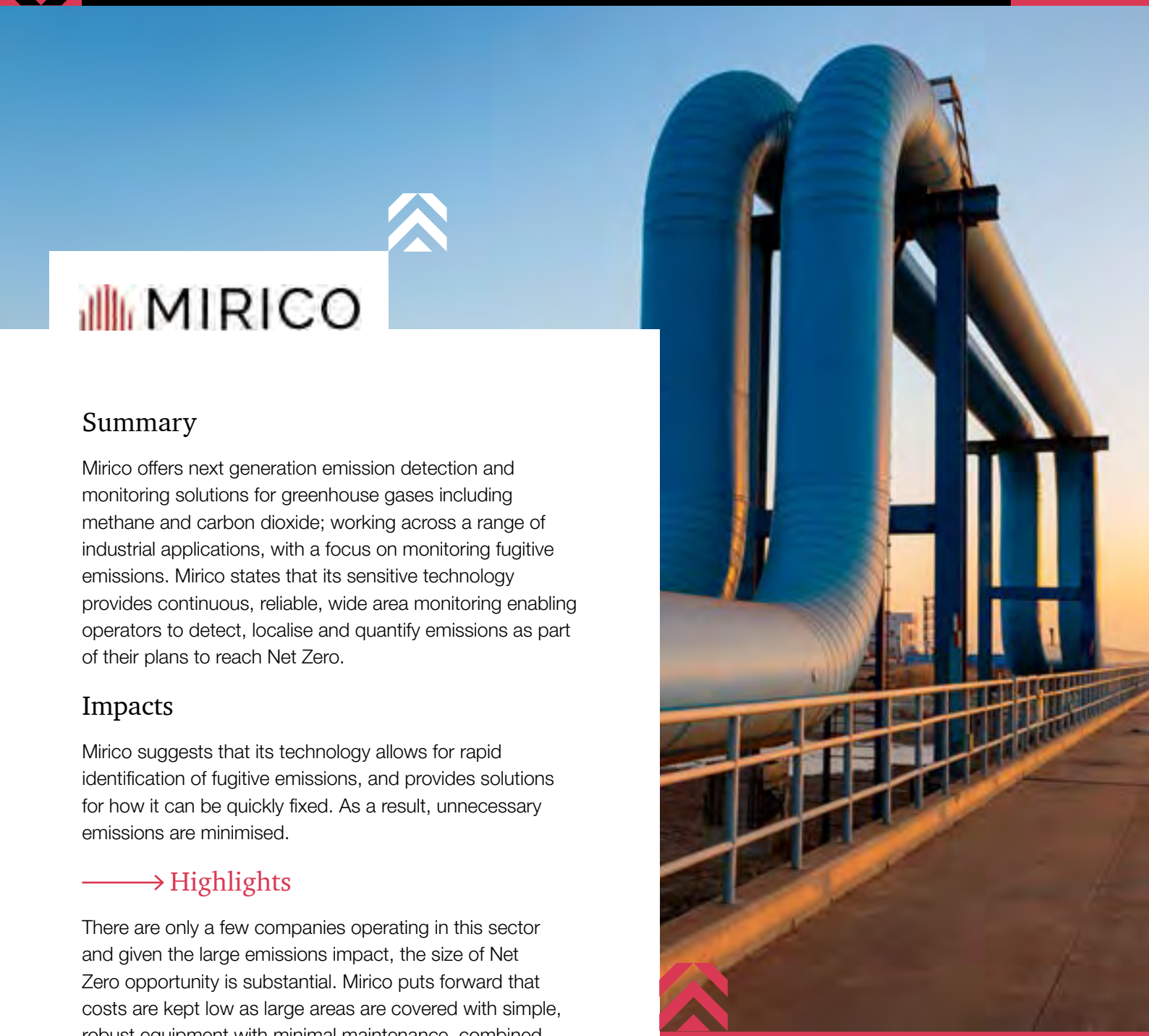
⟶ Strategic alliances

- Carbon Capture
- Chemicals
- Manufacturing
- Supermarkets
- Retail
- Waste

#CarbonUtilisation

#LowCarbonPolymers

Link to website:
econic-technologies.com



MIRICO

Summary

Mirico offers next generation emission detection and monitoring solutions for greenhouse gases including methane and carbon dioxide; working across a range of industrial applications, with a focus on monitoring fugitive emissions. Mirico states that its sensitive technology provides continuous, reliable, wide area monitoring enabling operators to detect, localise and quantify emissions as part of their plans to reach Net Zero.

Impacts

Mirico suggests that its technology allows for rapid identification of fugitive emissions, and provides solutions for how it can be quickly fixed. As a result, unnecessary emissions are minimised.

⟶ Highlights

There are only a few companies operating in this sector and given the large emissions impact, the size of Net Zero opportunity is substantial. Mirico puts forward that costs are kept low as large areas are covered with simple, robust equipment with minimal maintenance, combined with autonomous monitoring to allow for real time data provision, making it scalable across the globe.[99]

⟶ Strategic alliances

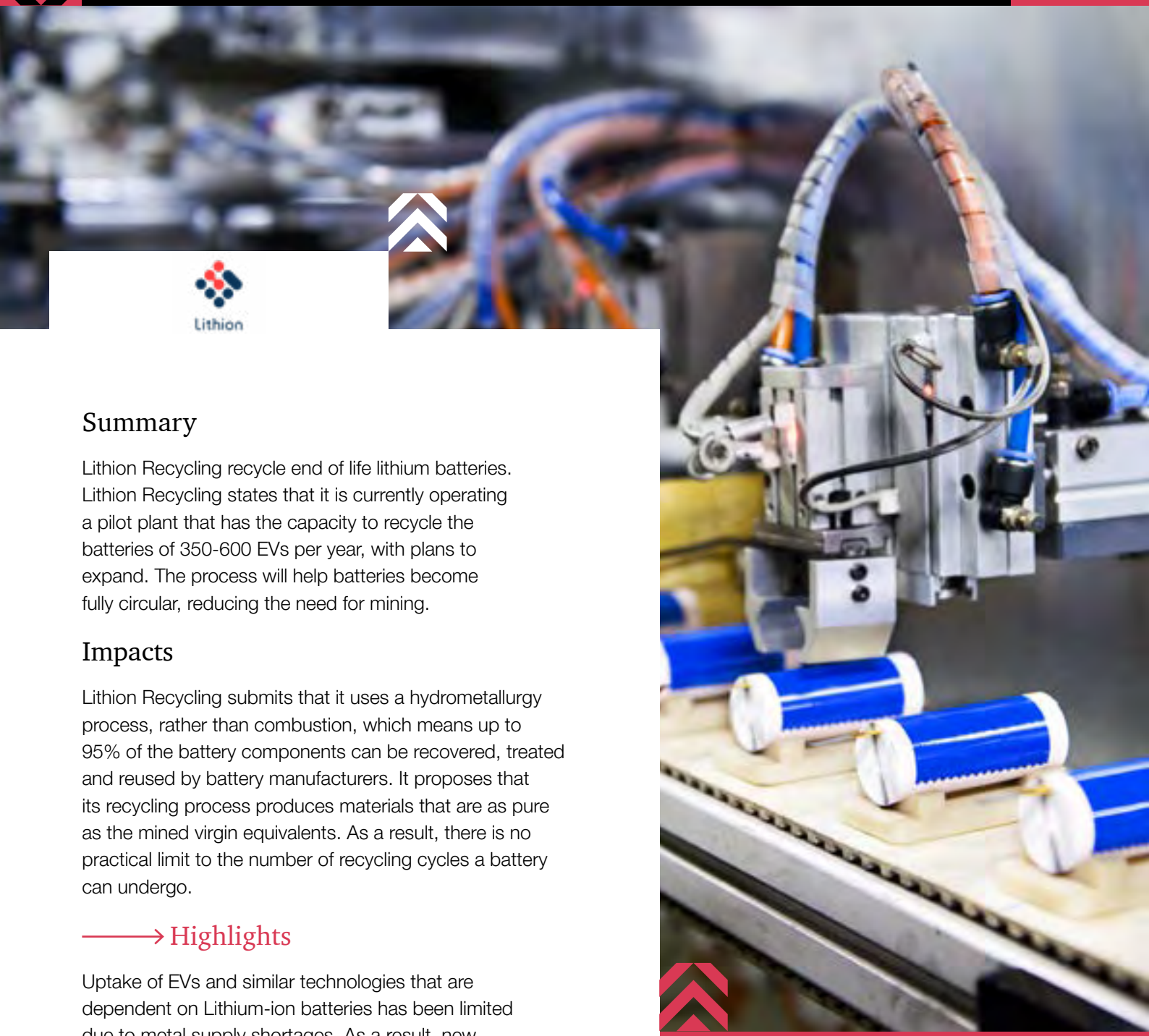
- Agriculture and Land Management
- Farming
- Government
- Oil & Gas

#FugitiveEmissions

#Sensors

Link to website:
mirico.co.uk

99 Source: Environmental expert database as at October 2021



Lithion

Summary

Lithion Recycling recycle end of life lithium batteries. Lithion Recycling states that it is currently operating a pilot plant that has the capacity to recycle the batteries of 350-600 EVs per year, with plans to expand. The process will help batteries become fully circular, reducing the need for mining.

Impacts

Lithion Recycling submits that it uses a hydrometallurgy process, rather than combustion, which means up to 95% of the battery components can be recovered, treated and reused by battery manufacturers. It proposes that its recycling process produces materials that are as pure as the mined virgin equivalents. As a result, there is no practical limit to the number of recycling cycles a battery can undergo.

→ Highlights

Uptake of EVs and similar technologies that are dependent on Lithium-ion batteries has been limited due to metal supply shortages. As a result, new technological methods, such as Lithion Recycling processes, could help create a fully circular Lithium-ion economy, whilst also ensuring that the UK maintains renewable technology progress and uptake.

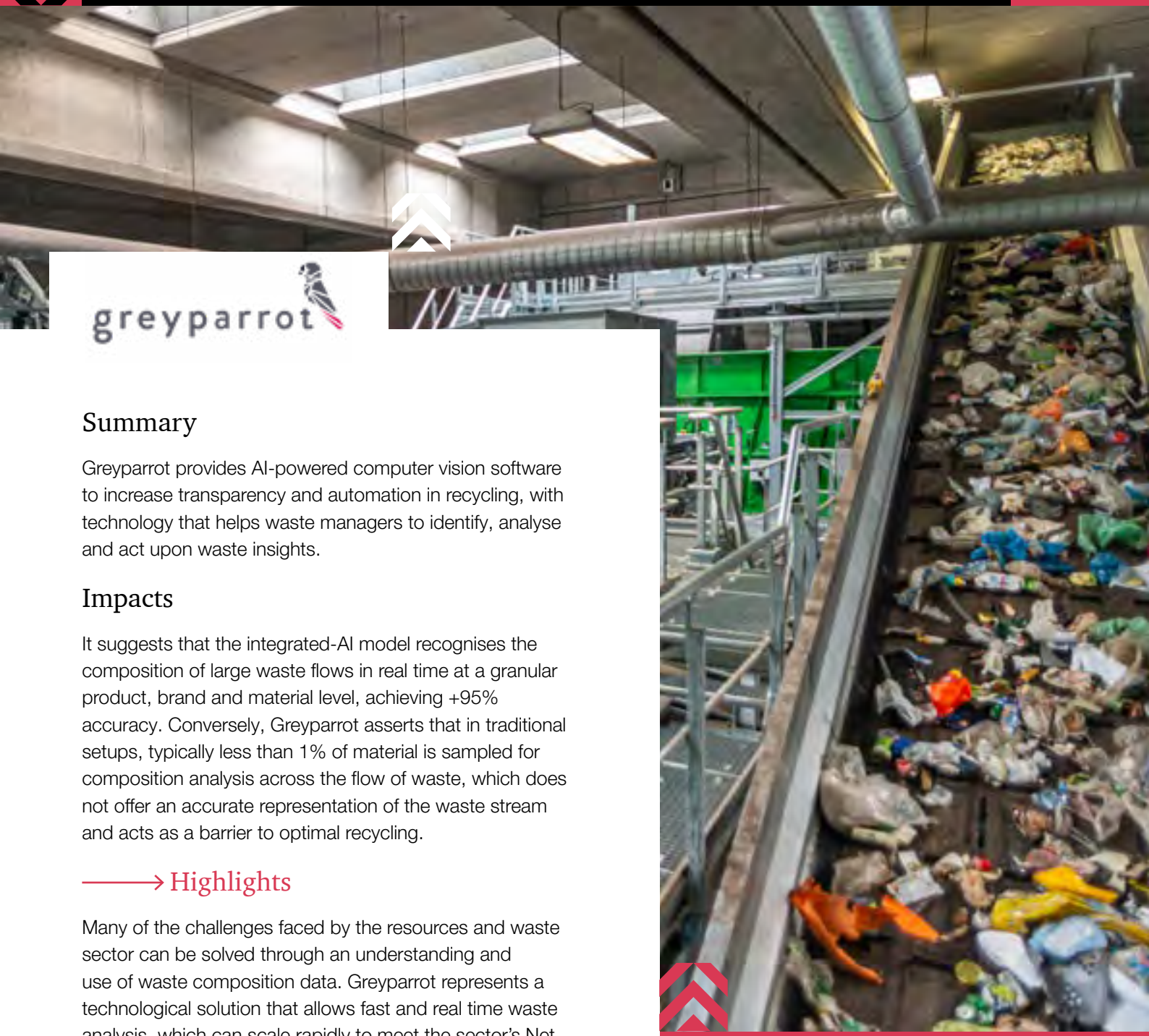
→ Strategic alliances

- Energy
- Manufacturing
- Mobility
- Waste

#LithiumIonBatteries

#Circular

Link to website:
lithionrecycling.com



greyparrot

Summary

Greyparrot provides AI-powered computer vision software to increase transparency and automation in recycling, with technology that helps waste managers to identify, analyse and act upon waste insights.

Impacts

It suggests that the integrated-AI model recognises the composition of large waste flows in real time at a granular product, brand and material level, achieving +95% accuracy. Conversely, Greyparrot asserts that in traditional setups, typically less than 1% of material is sampled for composition analysis across the flow of waste, which does not offer an accurate representation of the waste stream and acts as a barrier to optimal recycling.

⟶ Highlights

Many of the challenges faced by the resources and waste sector can be solved through an understanding and use of waste composition data. Greyparrot represents a technological solution that allows fast and real time waste analysis, which can scale rapidly to meet the sector's Net Zero demands.

⟶ Strategic alliances

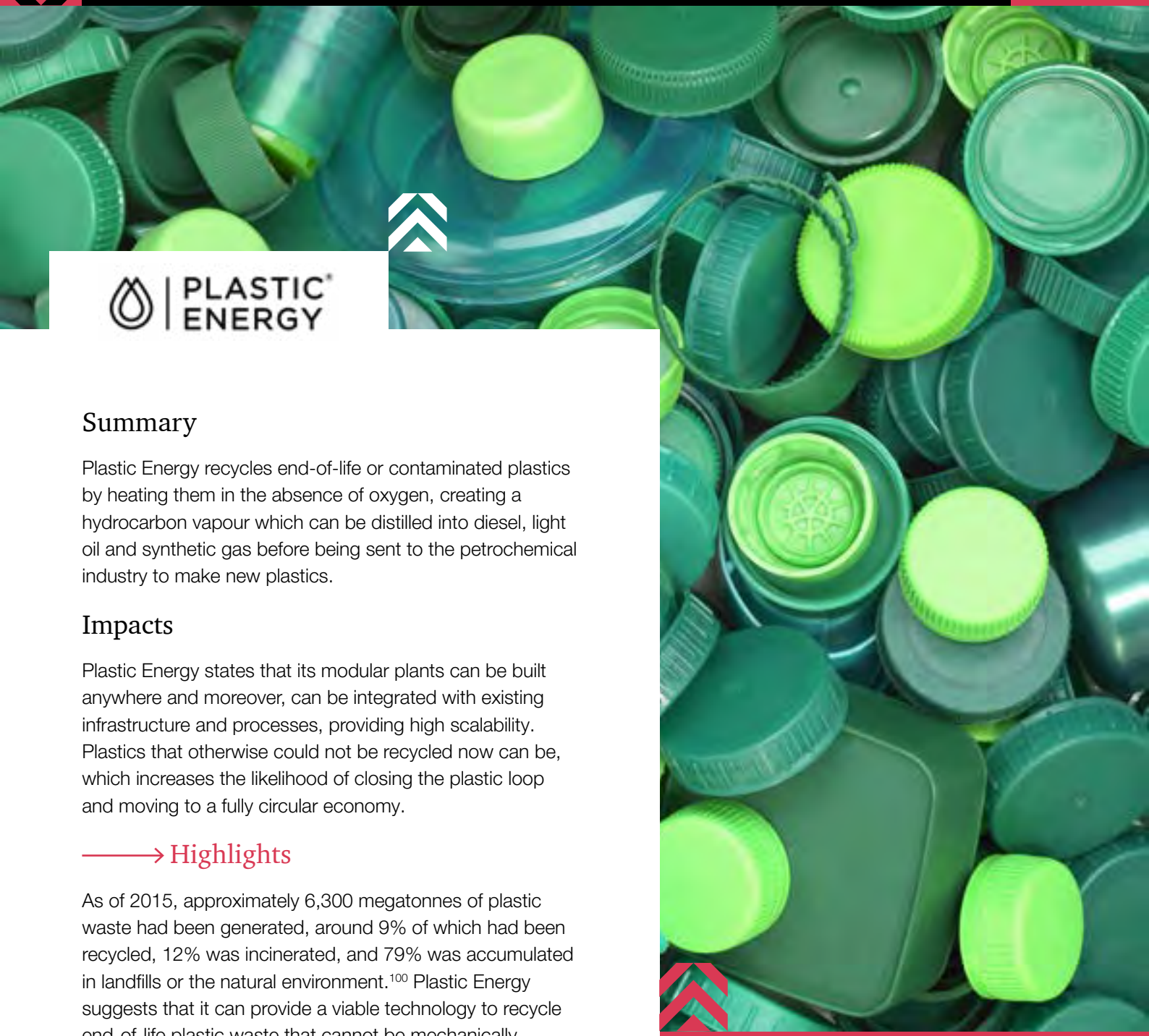
- Government
- Local Authorities
- Retail
- Waste

#AI

#Recycling

#Circular

Link to website:
greyparrot.ai



PLASTIC ENERGY

Summary

Plastic Energy recycles end-of-life or contaminated plastics by heating them in the absence of oxygen, creating a hydrocarbon vapour which can be distilled into diesel, light oil and synthetic gas before being sent to the petrochemical industry to make new plastics.

Impacts

Plastic Energy states that its modular plants can be built anywhere and moreover, can be integrated with existing infrastructure and processes, providing high scalability. Plastics that otherwise could not be recycled now can be, which increases the likelihood of closing the plastic loop and moving to a fully circular economy.

⟶ Highlights

As of 2015, approximately 6,300 megatonnes of plastic waste had been generated, around 9% of which had been recycled, 12% was incinerated, and 79% was accumulated in landfills or the natural environment.[100] Plastic Energy suggests that it can provide a viable technology to recycle end-of-life plastic waste that cannot be mechanically recycled and as a result, less plastic will pollute our ecosystems, and less fossil fuels will be used in plastic production.

⟶ Strategic alliances

- Energy
- Chemicals
- Waste

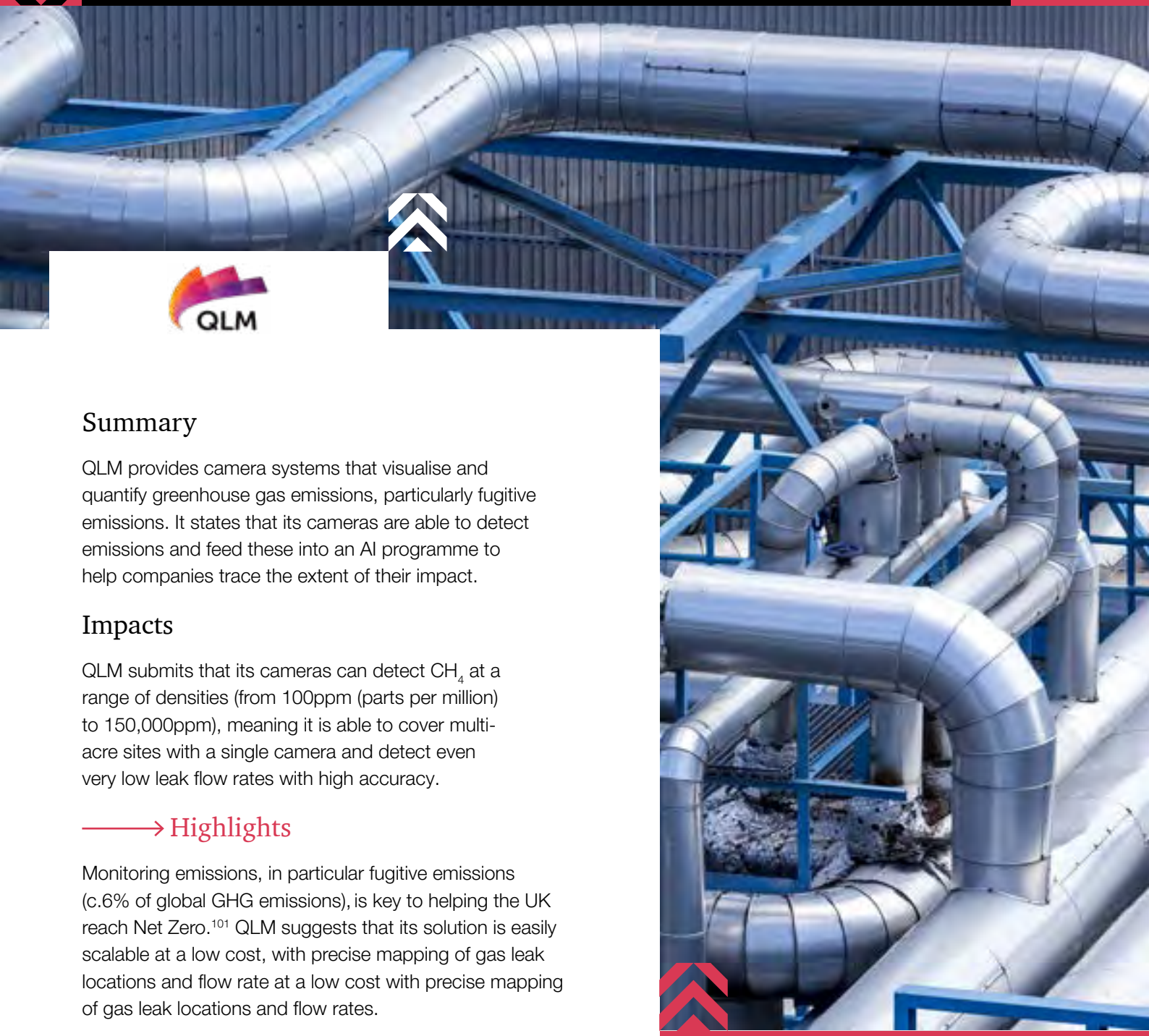
#Recycling

#Plastics

#Circular

Link to website:
plasticenergy.com

100 Source: Science Advances Production, use and fate of all plastics ever made



QLM

Summary

QLM provides camera systems that visualise and quantify greenhouse gas emissions, particularly fugitive emissions. It states that its cameras are able to detect emissions and feed these into an AI programme to help companies trace the extent of their impact.

Impacts

QLM submits that its cameras can detect CH_4 at a range of densities (from 100ppm (parts per million) to 150,000ppm), meaning it is able to cover multi-acre sites with a single camera and detect even very low leak flow rates with high accuracy.

→ Highlights

Monitoring emissions, in particular fugitive emissions (c.6% of global GHG emissions), is key to helping the UK reach Net Zero.[101] QLM suggests that its solution is easily scalable at a low cost, with precise mapping of gas leak locations and flow rate at a low cost with precise mapping of gas leak locations and flow rates.

→ Strategic alliances

- Agriculture and Land Management
- Farming
- Government
- Oil & Gas

#Sensors

#FugitiveEmissions

Link to website:
qlmtec.com

101 Source: Our World In Data, Greenhouse gas emissions by sector

Ones to watch: 2

SoluBlue

SoluBlue proposes that it can develop packaging made from FDA-approved seaweed-based ingredients. It puts forward that the packaging reduces food waste by absorbing excess moisture, allowing contained foods to stay fresh for longer.

#AlternativePlastics

#FoodWaste

Link to website:
solublue.com

JIVA

Jiva Materials produces fully recyclable Printed Circuit Boards (PCBs). Jiva states that its PCBs delaminate in hot water, allowing for easy access to the metals – rather than the traditional energy intensive and wasteful mechanical methods. Further uptake will require waste management facilities to develop the ability to pick out Jiva PCBs from other waste and recycle them adequately.

#AlternativePlastics

#Recycling

Link to website:
jivamaterials.com

Built Environment

Built Environment

17.0%
Of UK GHG emissions[102]

£104.4m
UK VC investment (H2 '20 – H1 '21)[103]

9
Start-ups in the Net Zero Future50

The Built Environment accounts for 20.7% (UK: 17.0%) of global GHG emissions, but has only seen £2.7bn of global VC investment between 2013 and 2019, accounting for just 6.2% of all sector investment.[104] Additionally, it has recorded a CAGR of 25% from 2013 to H1 2020, well below the overall growth rate of climate tech investment of 68%. In H1 2021, globally, the sector raised the least of all of the vertical industries analysed (£474m).[105]

Barriers:

- **Infrastructure lock-in:** Old existing infrastructure makes decarbonisation of existing Real Assets slow and costly.
- **Paybacks:** Large-scale overhaul is unattractive due to the significant capital outlay and long payback period.
- **Narrow targeting of investment:** Investment to date has been focused on sensor technology and smart management of buildings.

Accelerators:

- **Regulatory impetus:** The UK Government announced in October 2021 the new £450 million Boiler Upgrade Scheme to support households who want to make the switch to low-carbon heat pumps with £5,000 grants.[106]

Technology drivers:

#IoT

#Nanomaterials

#VehicleToGrid

#SolarGlass

#CircularEconomy

#ModularConstruction

Growth Areas:

- **High efficiency fixtures and fittings:** At present, 19 million homes across the UK have EPC (Energy performance certificate) ratings of D or worse.[107] In a 2021 survey conducted by the UK Department for Business Energy & Industrial Strategy (BEIS), 77% of respondents used gas as their central heating method.[108]
- **High efficiency space-water heating and cooling:** It is estimated that 29 million homes in the UK will need to be retrofitted with low-carbon solutions if the UK is to meet its 2050 Net Zero ambitions.[109] To support this and achieve the expected results, it's estimated the industry will need to grow by up to 10 times its current size.[110]

102 Source: UK Government, 2019 UK Greenhouse Gas Emissions, Final Figures
103 Source: PwC, The State of Climate Tech 2021
104 Source: PwC, The State of Climate Tech 2021
105 Source: PwC, The State of Climate Tech 2021
106 Source: Department for Business, Energy & Industrial Strategy, Plan to drive down the cost of clean heat
107 Source: UK Parliament Environmental Audit Committee, Energy Efficiency of Existing Homes
108 Source: Statista: UK: heating methods survey 2021
109 Source: Climate Change Committee, Housing Fit for the Future
110 Source: Green Finance Institute & Bankers for Net Zero, Tooling up the Green Homes Industry

- **Smart Management of devices:** This sub-sector accounts for roughly 26% of investments and 139 deals within the built environment space.[111] Start-ups are mainly focusing on cost saving measures relating to energy consumption for residential/commercial consumers, which has immediate financial appeal to investors.
- **Building level (electricity and thermal) storage:** It is projected that £8 bn of savings could be made by the UK, per year, by 2030, if storage and flexibility measures are introduced on a large scale according to the landmark National Infrastructure Commission Report 'Smart Power'.[112]
- **Low-GHG construction processes:** Construction processes are traditionally eco-unfriendly, but with new innovations such as modular construction and 3-D printing combined with imagery and computing there could be a drastic reduction in waste and emissions on construction sites.
- **High efficiency lighting:** The UK is on the right track with two-thirds of all current light sales being Light Emitting Diodes (LEDs).[113] LED-based solutions could yield significant cost savings and reduce electrical energy usage by at least 75%.[114] Combining this with the banning of halogen bulbs in September 2021, it is forecasted that 1.26 million tonnes of carbon emissions could be cut.[115]
- **Low-GHG and energy saving construction materials:** According to research conducted by the UK Green Building Council, around 60% of the UK's total waste output is from construction, demolition, and excavation.[116] Energy saving construction materials are able to combat this issue, if companies can overcome the higher cost barrier.

111 Source: PwC, The State of Climate Tech 2020
112 Source: National Infrastructure Commission – Smart Power
113 Source: UK Government Press Release – End of halogen light bulbs spells brighter and cleaner future
114 Source: Energy.Gov, LED Lighting
115 Source: Department for Business, Energy & Industrial Strategy – End of halogen light bulbs spells brighter and cleaner future
116 Source: UKGBC – Circular Economy – UKGBC

INFOGRID

Summary

Infogrid is a smart building platform combining Internet of Things (IoT) sensors with Artificial Intelligence (AI) to automate and optimise facilities and building management to create healthy, efficient and sustainable buildings, whilst ensuring compliance and reducing costs.

Impacts

Infogrid claims that its sensors are wireless, low-cost and zero-maintenance, meaning it is easy to retro-fit into existing buildings. It reports that its system is able to analyse the data gathered by the sensors using the cloud to highlight trends and create actionable recommendations across the estate.

⟶ Highlights

Infogrid claims that it has designed its sensors to address a large variety of use cases and that its team works closely with estate owners to find new ways to save time on manual tasks, minimise costs, improve safety, and reduce its GHG emissions. Infogrid asserts that its offering is a ready to implement solution that allows clients to see significant decarbonisation gains in a short time frame, whilst also being scalable across existing portfolios of assets.

⟶ Strategic alliances

- Construction
- Development
- Facility Management
- Real estate
- Smart Buildings

#WirelessSensors

#AirQuality

#BuildingManagement

Link to website:
infogrid.io

Summary

WElink Homes are a vertically integrated developer of sustainable homes, deploying Modern Methods of Construction (MMC) and renewable energy to challenge the status quo in the delivery of modern housing.

Impacts

WElink states that the homes use an Off-Site Manufacture (OSM) technology to deliver a high-performing building solution with significantly quicker build times than traditional on-site methods. The homes are designed to generate a significant proportion of their required energy through rooftop solar photovoltaic (PV) renewable energy and are super insulated to reduce carbon, energy demand and cost. The OSM process enables less waste through the construction process and there is a lower impact on the community in terms of time on site, noise, dust and delivery movements.

→ Highlights

WElink homes are designed to exceed the 2025 Future Homes Standard and are EPC rated “A”. WElink analysis suggests this can deliver up to 70% savings in energy demand. WElink Homes illustrates one possible avenue to solve the UK’s housing crisis, and moreover, provides a climate friendly solution.

→ Strategic alliances

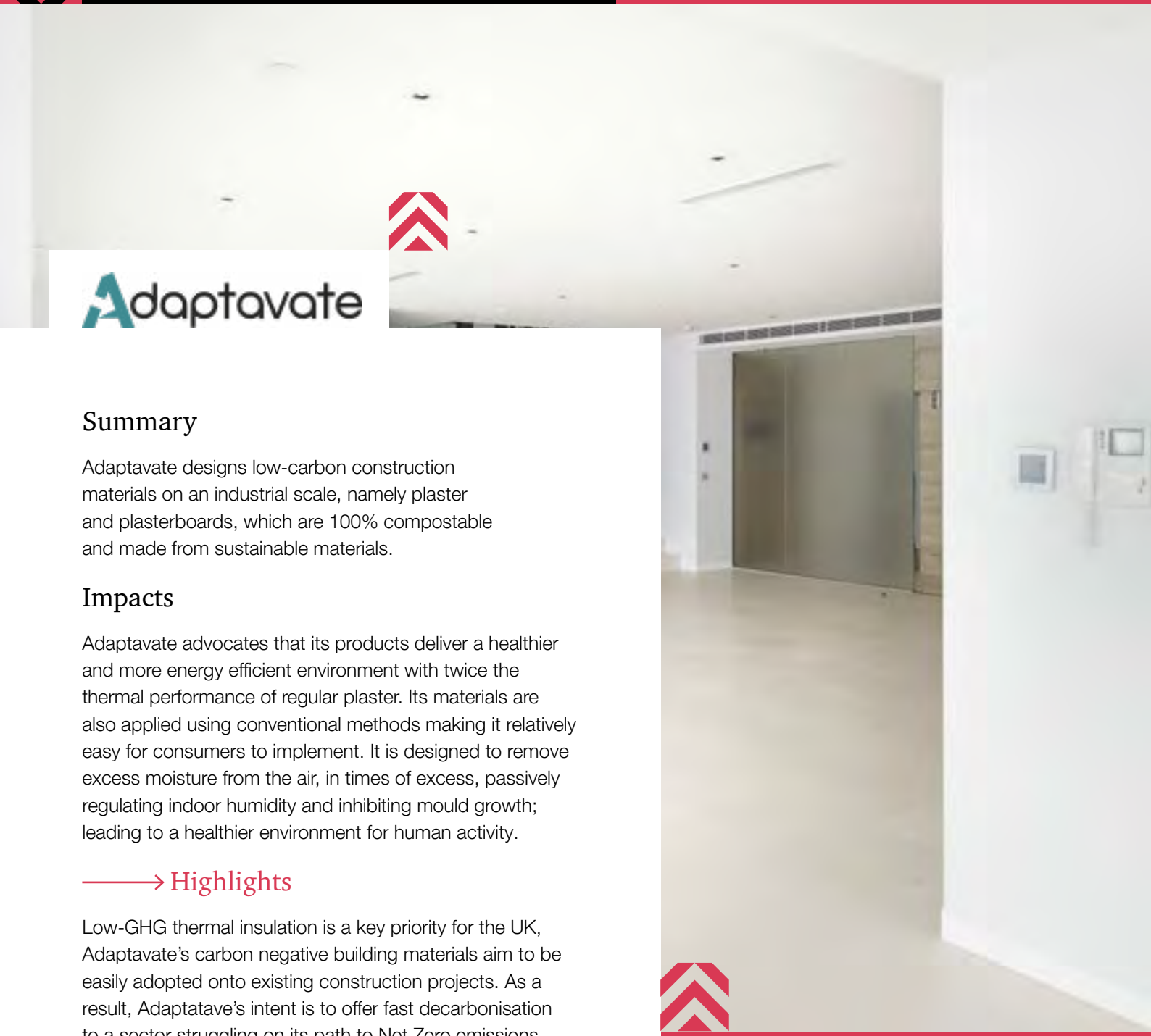
- Construction
- Housing Development
- Real Estate
- Government
- Local Authorities
- Affordable Housing
- Renewable Energy

#EcoTechConstruction

#Modular

#AffordableHousing

Link to website:
welinkhomes.co.uk



Adaptavate

Summary

Adaptavate designs low-carbon construction materials on an industrial scale, namely plaster and plasterboards, which are 100% compostable and made from sustainable materials.

Impacts

Adaptavate advocates that its products deliver a healthier and more energy efficient environment with twice the thermal performance of regular plaster. Its materials are also applied using conventional methods making it relatively easy for consumers to implement. It is designed to remove excess moisture from the air, in times of excess, passively regulating indoor humidity and inhibiting mould growth; leading to a healthier environment for human activity.

⟶ Highlights

Low-GHG thermal insulation is a key priority for the UK, Adaptavate's carbon negative building materials aim to be easily adopted onto existing construction projects. As a result, Adaptatave's intent is to offer fast decarbonisation to a sector struggling on its path to Net Zero emissions.

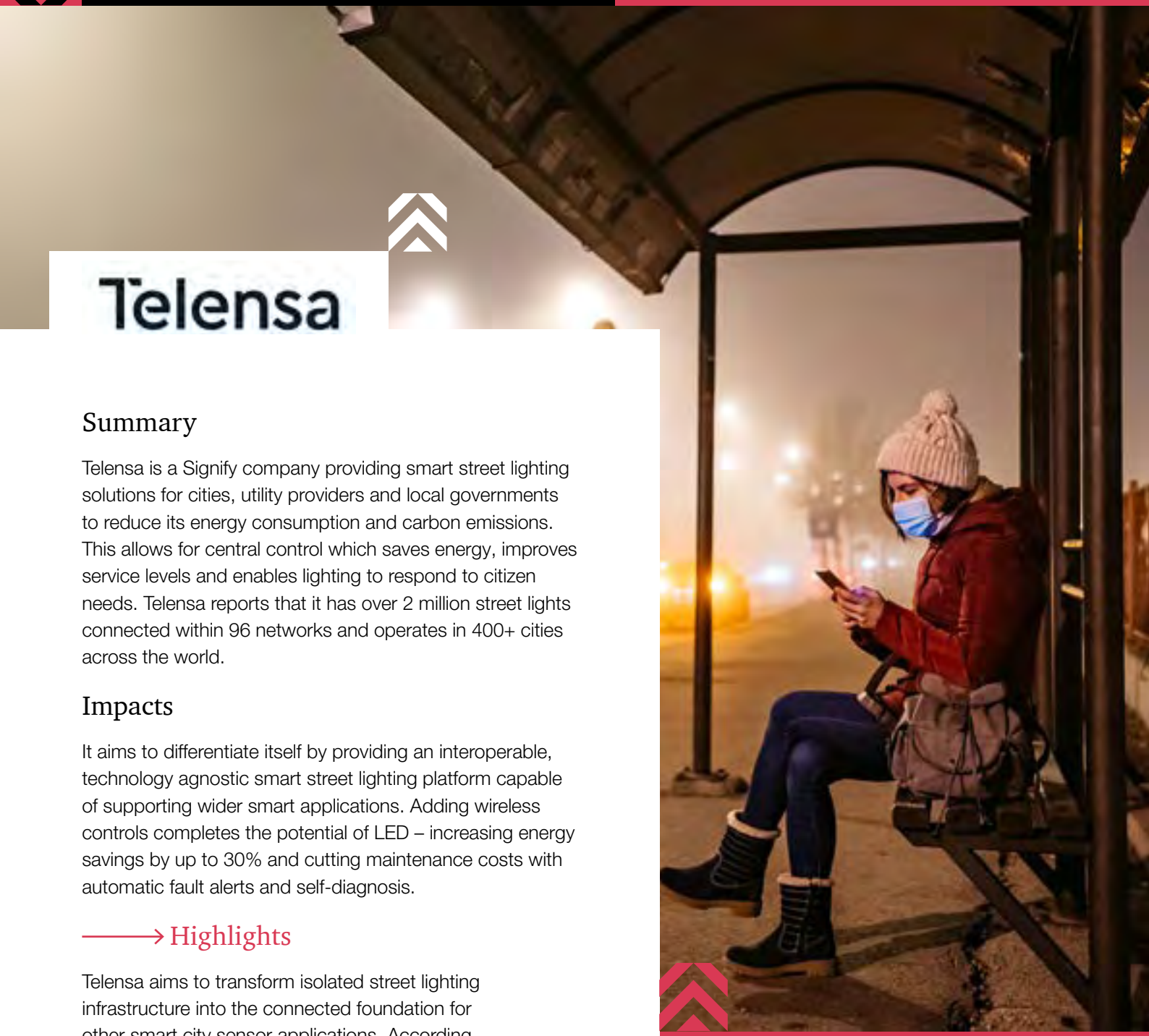
⟶ Strategic alliances

- Construction
- Manufacturing
- Real Estate

#Biomaterial

#LowGHG

Link to website:
adaptavate.com



Telensa

Summary

Telensa is a Signify company providing smart street lighting solutions for cities, utility providers and local governments to reduce its energy consumption and carbon emissions. This allows for central control which saves energy, improves service levels and enables lighting to respond to citizen needs. Telensa reports that it has over 2 million street lights connected within 96 networks and operates in 400+ cities across the world.

Impacts

It aims to differentiate itself by providing an interoperable, technology agnostic smart street lighting platform capable of supporting wider smart applications. Adding wireless controls completes the potential of LED – increasing energy savings by up to 30% and cutting maintenance costs with automatic fault alerts and self-diagnosis.

→ Highlights

Telensa aims to transform isolated street lighting infrastructure into the connected foundation for other smart city sensor applications. According to Telensa, the technology used is highly flexible, enabling it to be used with current systems and ready to be adapted for future applications.

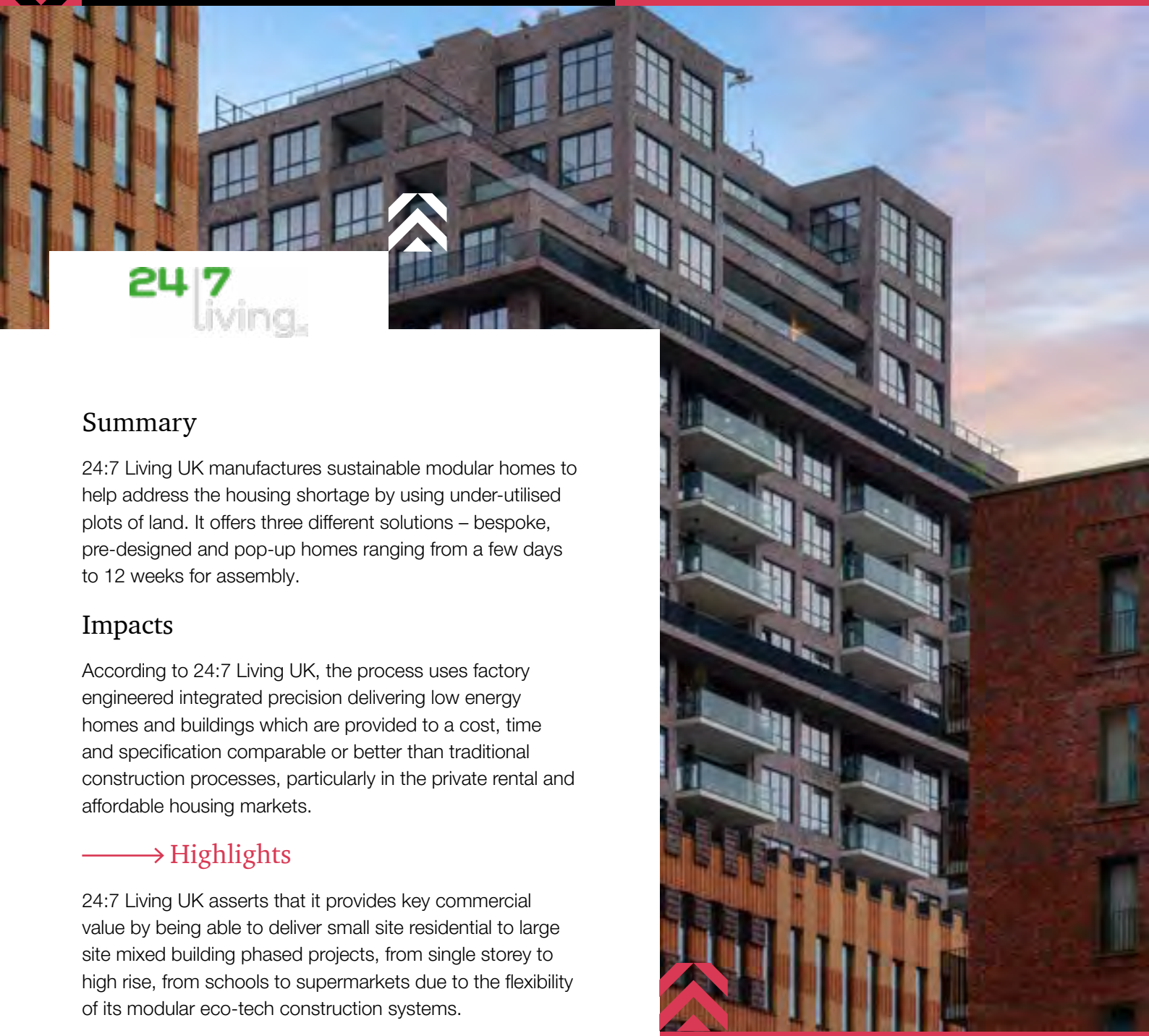
→ Strategic alliances

- Airports
- Education
- Hospitals
- Local Authorities
- Ports
- Retail
- Utilities

#SmartStreetLighting

#SmartCity

Link to website:
telensa.com



Summary

24:7 Living UK manufactures sustainable modular homes to help address the housing shortage by using under-utilised plots of land. It offers three different solutions – bespoke, pre-designed and pop-up homes ranging from a few days to 12 weeks for assembly.

Impacts

According to 24:7 Living UK, the process uses factory engineered integrated precision delivering low energy homes and buildings which are provided to a cost, time and specification comparable or better than traditional construction processes, particularly in the private rental and affordable housing markets.

⟶ Highlights

24:7 Living UK asserts that it provides key commercial value by being able to deliver small site residential to large site mixed building phased projects, from single storey to high rise, from schools to supermarkets due to the flexibility of its modular eco-tech construction systems.

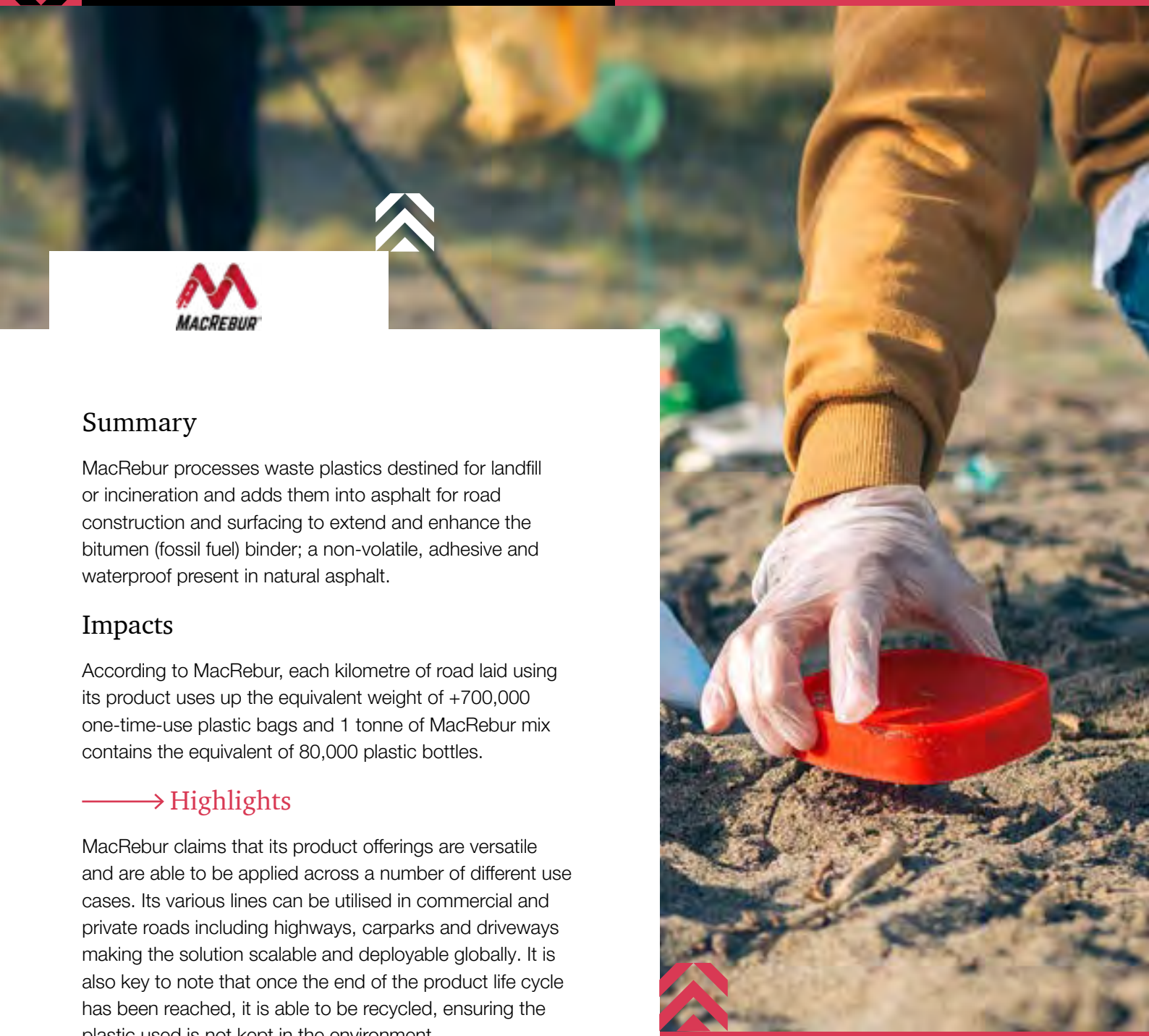
⟶ Strategic alliances

- Construction
- Development
- Government
- Local Authorities
- Real Estate
- Manufacturing

#Eco-techConstruction

#Modular

Link to website:
247livinguk.com



Summary

MacRebur processes waste plastics destined for landfill or incineration and adds them into asphalt for road construction and surfacing to extend and enhance the bitumen (fossil fuel) binder; a non-volatile, adhesive and waterproof present in natural asphalt.

Impacts

According to MacRebur, each kilometre of road laid using its product uses up the equivalent weight of +700,000 one-time-use plastic bags and 1 tonne of MacRebur mix contains the equivalent of 80,000 plastic bottles.

⟶ Highlights

MacRebur claims that its product offerings are versatile and are able to be applied across a number of different use cases. Its various lines can be utilised in commercial and private roads including highways, carparks and driveways making the solution scalable and deployable globally. It is also key to note that once the end of the product life cycle has been reached, it is able to be recycled, ensuring the plastic used is not kept in the environment.

⟶ Strategic alliances

- Cities
- Construction
- Local Authorities
- Infrastructure
- Waste

#WasteManagement

#PlasticRecycling

Link to website:
macrebur.com

wondrwall®

Summary

Wondrwall is a technology company that combines AI powered home automation with clean energy production and efficient heating systems. Wondrwall couples solar power alongside intelligent smart home systems and batteries to reportedly save households up to c.90% on their energy bills.

Impacts

According to Wondrwall, its smart home system uses AI to automate and optimise a household's heating (offering 50% more efficiency than gas powered equivalents), lighting and energy consumption. Wondrwall produces modular systems, and through this is able to optimise energy usage and efficiency.

⟶ Highlights

Household electricity management systems and reporting devices are becoming increasingly important owing to the rise in alternative energy generation systems, such as heat pumps, in the push for ways to reduce our carbon footprint.

Wondrwall affirms that its self-learning system can adapt to a household's needs, and can be coupled with energy generation, storage and usage to result in clean energy through the home.

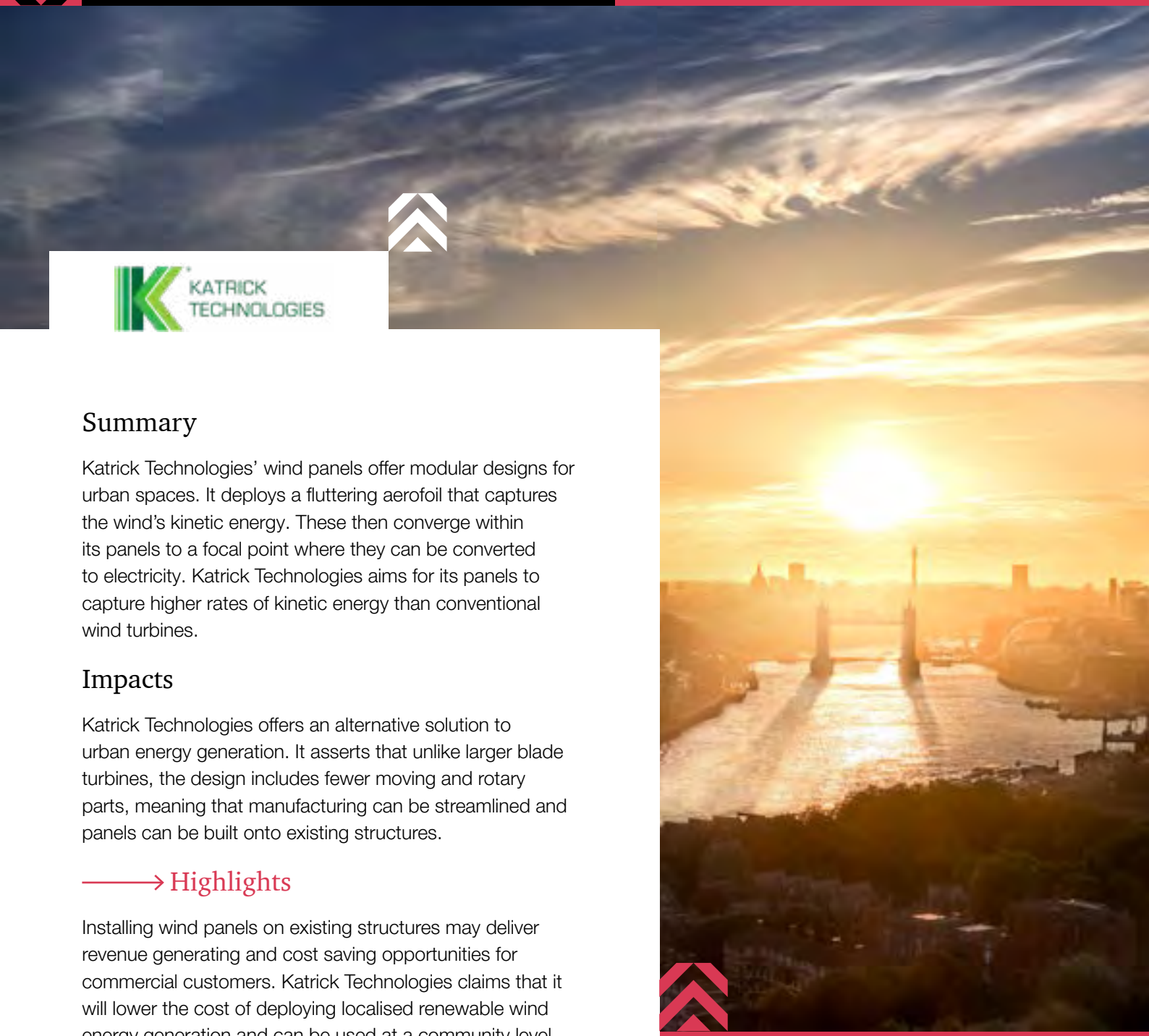
⟶ Strategic alliances

- Energy
- Energy Storage
- Local Authorities
- Real Estate
- Smart Buildings

#AIHomeManagement

#EnergyEfficiency

Link to website:
wondrwall.co.uk



KATRICK TECHNOLOGIES

Summary

Katrick Technologies' wind panels offer modular designs for urban spaces. It deploys a fluttering aerofoil that captures the wind's kinetic energy. These then converge within its panels to a focal point where they can be converted to electricity. Katrick Technologies aims for its panels to capture higher rates of kinetic energy than conventional wind turbines.

Impacts

Katrick Technologies offers an alternative solution to urban energy generation. It asserts that unlike larger blade turbines, the design includes fewer moving and rotary parts, meaning that manufacturing can be streamlined and panels can be built onto existing structures.

→ Highlights

Installing wind panels on existing structures may deliver revenue generating and cost saving opportunities for commercial customers. Katrick Technologies claims that it will lower the cost of deploying localised renewable wind energy generation and can be used at a community level, without the need for large-scale up-front investment.

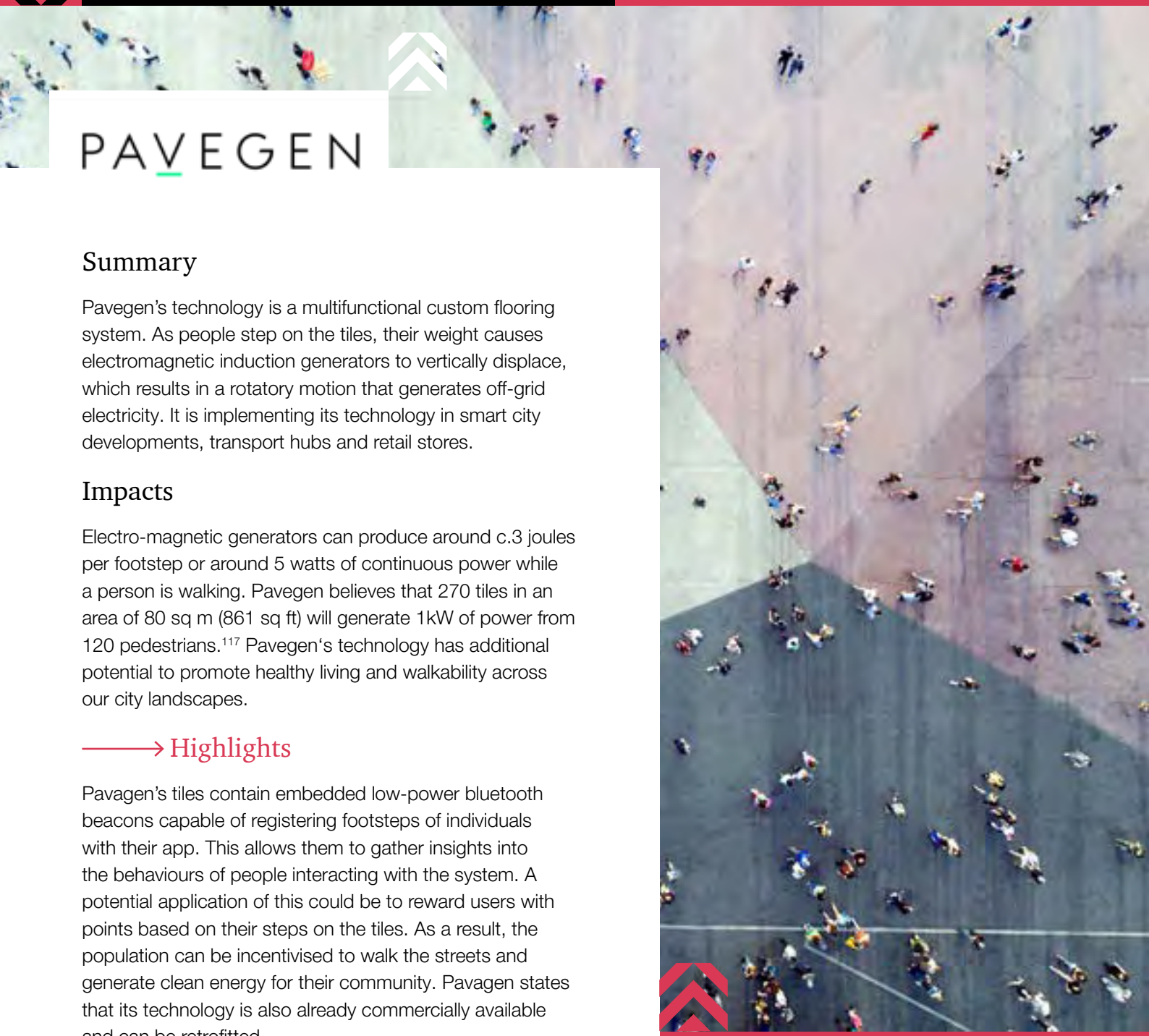
→ Strategic alliances

- Cities
- Construction
- Development
- Energy
- Infrastructure
- Local Authorities
- Real Estate

#ZeroCarbonEnergy

#UrbanDesign

Link to website:
katricktechnologies.com



PAVEGEN

Summary

Pavegen's technology is a multifunctional custom flooring system. As people step on the tiles, their weight causes electromagnetic induction generators to vertically displace, which results in a rotatory motion that generates off-grid electricity. It is implementing its technology in smart city developments, transport hubs and retail stores.

Impacts

Electro-magnetic generators can produce around c.3 joules per footstep or around 5 watts of continuous power while a person is walking. Pavegen believes that 270 tiles in an area of 80 sq m (861 sq ft) will generate 1kW of power from 120 pedestrians.[117] Pavegen's technology has additional potential to promote healthy living and walkability across our city landscapes.

⟶ Highlights

Pavagen's tiles contain embedded low-power bluetooth beacons capable of registering footsteps of individuals with their app. This allows them to gather insights into the behaviours of people interacting with the system. A potential application of this could be to reward users with points based on their steps on the tiles. As a result, the population can be incentivised to walk the streets and generate clean energy for their community. Pavagen states that its technology is also already commercially available and can be retrofitted.

⟶ Strategic alliances

- Development
- Energy
- Infrastructure
- Local Authorities
- Real estate
- Retail

#ZeroCarbonEnergy

#OffGrid

#HealthyLiving

Link to website:
pavegen.com

117 Source: eGI, The Technology behind the tile

Financial Services

Financial Services

N/A
UK GHG emissions

£75.0m
UK VC investment (H2 '20 – H1 '21)[118]

2
Start-ups in the Future50

Net Zero and ESG agendas are becoming key deciding factors in where financial institutions allocate their capital, with, as of November 2021, over 60 institutional investors, representing over £7.5 trillion AUM, committed to Net Zero portfolios by 2050.[119] Start-ups are disrupting the market by providing easy to use platforms for retail investors to invest their money into ESG focused companies and projects.

Barriers:

- **Financial disincentives:** Investments into industries like oil and gas have long provided stable dividends and returns for institutional investors like pension funds who will need to replace this source of cashflow.
- **Indirect impact:** Challenges in quantifying the impact of indirect financial sector emissions have made it hard for financial institutions to prioritise carbon abatement strategies across their portfolio.
- **Reporting standards:** The methodological challenge of assessing indirect omissions across the portfolio is then compounded by a lack of clear and consistent reporting standards for financial companies.

Accelerators:

- **Regulatory change:** Increased regulatory pressures and reporting requirements like TCFD, have forced major Financial Services players to take notice of the sustainability profile of their investment portfolios and services, and the monitoring capabilities required to report effectively.

Technology drivers:

#Blockchain

#CryptoForGood

#PaymentForEcosystemServices

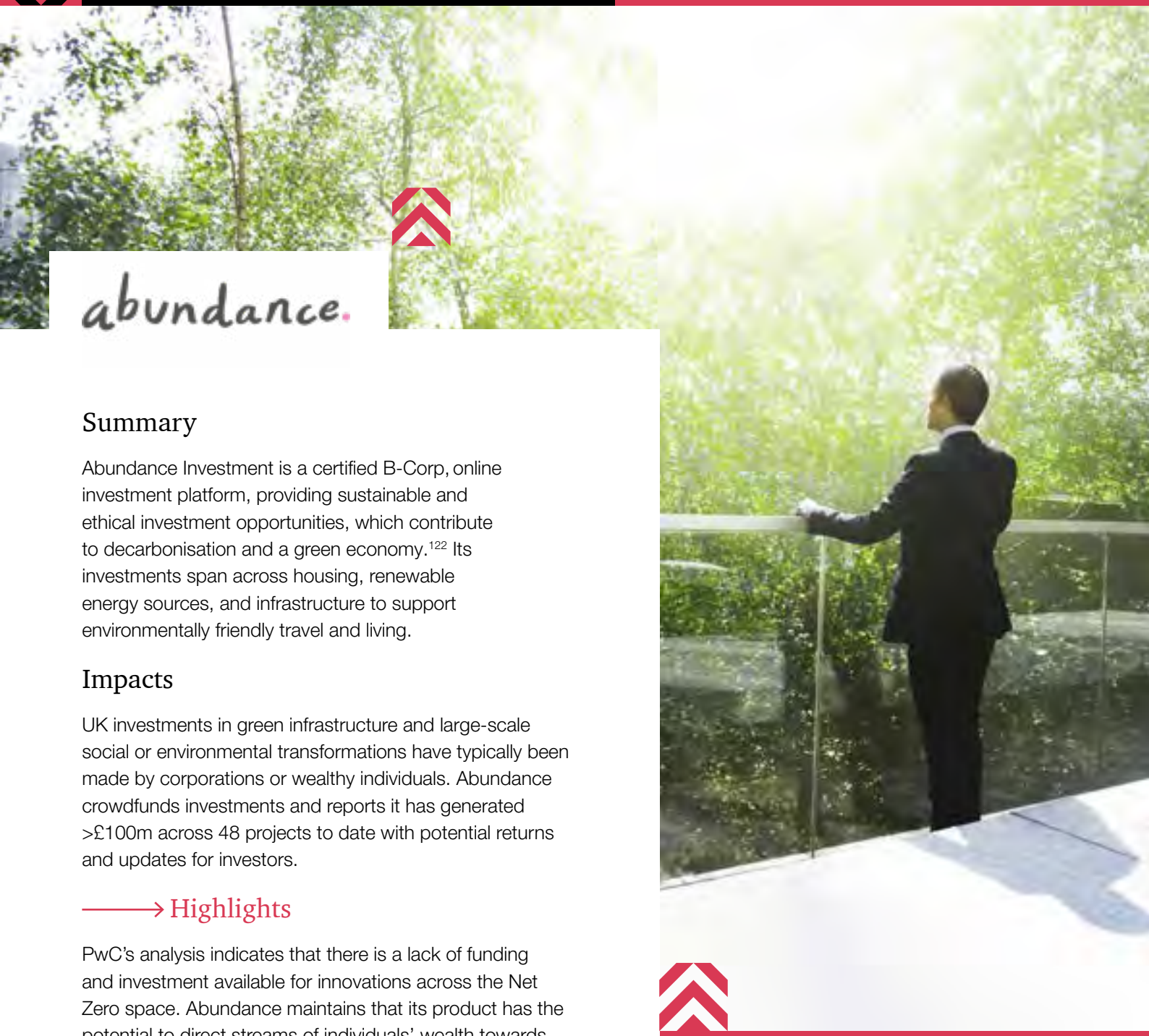
#GIS

118 Source: PwC, The State of Climate Tech 2021
119 Source: UN Environment Programme, Institutional investors transitioning their portfolios to net zero GHG emissions by 2050

Growth Areas:

- **Banking (Business and Retail):** The primary challenge is identifying and setting out practical initiatives to embed Net Zero into business and operating models, and this challenge can be split across three areas: products and services, risk management and regulation, and operations and supply chain.
- **Pensions and Funds:** The recent Morningstar European Sustainable Funds Landscape's 2020 in Review report highlights that just £1 in every £10 of pension holdings is invested sustainably.[120] According to Cushon the average UK pension holder finances 23 tonnes of CO_2 emissions each year through the companies they invest in. Green pensions and funds, and the enablers of these are quickly emerging and capitalising, both financially and environmentally, on investors' changing behaviours and demands.[121]
- **Insurance:** The primary challenge for insurers is the radical change in the type of assets that they are underwriting. To accelerate decarbonisation insurers are now embedding a number of practices:
  - Phasing out underwriting of carbon-intensive assets (e.g. coal mines)
  - Growing investment in green financial products (e.g. green bonds and insurance-linked securities)
  - Committing to Net Zero across the business
  - Including climate impact in corporate risk models and pricing

120 Source: Morning Star, European Sustainable Funds Landscape: 2020 in Review
121 Source: Cushon – So you're thinking about losing 23 tonnes



abundance.

Summary

Abundance Investment is a certified B-Corp, online investment platform, providing sustainable and ethical investment opportunities, which contribute to decarbonisation and a green economy.[122] Its investments span across housing, renewable energy sources, and infrastructure to support environmentally friendly travel and living.

Impacts

UK investments in green infrastructure and large-scale social or environmental transformations have typically been made by corporations or wealthy individuals. Abundance crowdfunds investments and reports it has generated >£100m across 48 projects to date with potential returns and updates for investors.

→ Highlights

PwC's analysis indicates that there is a lack of funding and investment available for innovations across the Net Zero space. Abundance maintains that its product has the potential to direct streams of individuals' wealth towards helping us achieve Net Zero with a ready to deploy and scalable solution.

→ Strategic alliances

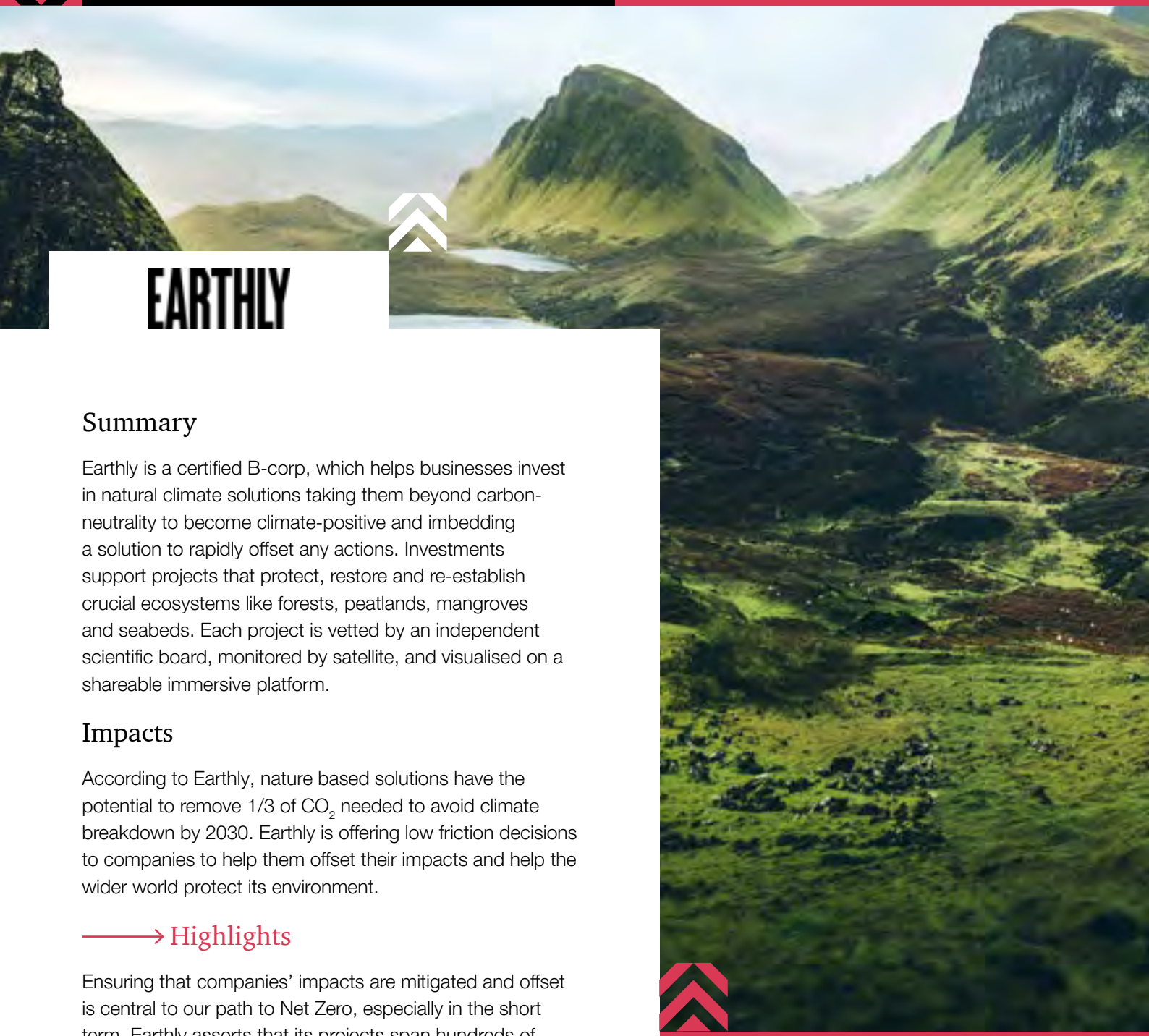
- Agriculture and Land Use
- Energy
- Local Authorities
- Financial Services
- Infrastructure
- Real Estate

#SustainableInvestments

#SocialImpactInvesting

Link to website:
abundanceinvestment.com

122 Definition: Certified B Corporations are a new kind of business that balances purpose and profit. They are legally required to consider the impact of their decisions on their workers, customers, suppliers, community, and the environment.



EARTHLY

Summary

Earthly is a certified B-corp, which helps businesses invest in natural climate solutions taking them beyond carbon-neutrality to become climate-positive and imbedding a solution to rapidly offset any actions. Investments support projects that protect, restore and re-establish crucial ecosystems like forests, peatlands, mangroves and seabeds. Each project is vetted by an independent scientific board, monitored by satellite, and visualised on a shareable immersive platform.

Impacts

According to Earthly, nature based solutions have the potential to remove 1/3 of CO_2 needed to avoid climate breakdown by 2030. Earthly is offering low friction decisions to companies to help them offset their impacts and help the wider world protect its environment.

⟶ Highlights

Ensuring that companies' impacts are mitigated and offset is central to our path to Net Zero, especially in the short term. Earthly asserts that its projects span hundreds of millions of hectares, with aims of restoring nature and preventing the release of c.5.5-8.8 gigatonnes of CO_2 before 2050.

⟶ Strategic alliances

- Aerospace
- Agriculture and Land Use
- Charities
- Governments
- International Development
- Private Business

#Offsetting

#CarbonCredits

#NaturalSequestration

Link to website:
earthly.org

GHG Capture, Removal and Storage

GHG Capture, Removal and Storage

N/A
UK GHG emissions

£27.0m
UK VC investment (H2 '20 – H1 '21)[123]

2
Start-ups in the Net Zero Future50

GHG Capture, Removal and Storage is a relatively nascent area, the sector has raised less than 1% (UK: 1.3%) of the total global Climate tech venture capital since 2013. Investment has grown at a CAGR of 9% from H1 2013 – H1 2020; significantly below the overall growth rate of climate tech investment of 68%.[124]

Barriers:

- **First mover disadvantage:** The first developers of GHG capture plants / technologies will face costs and challenges that subsequent investors will not have to pay, which may delay investment.
- **Carbon prices:** Global cooperation for increased and standardised carbon prices (i.e. the price at which captured carbon can be 'sold' for), will be needed in order to improve the sector's commercial viability.

Accelerators:

- **Government investment:** The UK Government is beginning to intervene. For example, in November 2020, £1bn was allocated to the Carbon Capture and Storage Infrastructure Fund,[125] with initial winning funding bids chosen for 'Track 1'[126] announced in October 2021. There are plans for a further 'Track 2' open for new bids in the future.[127]
- **Peripheral industries:** Commercialising the underlying technologies in other industries may accelerate uptake. One example is biofuels, or BECCS (bio-energy with carbon capture and storage), which has commercial potential in the Energy and Mobility and Transport sectors.

Technology drivers:

#MicroCarbon

#SoilCarbon

#DirectAirCapture

#QuantumComputing

#Biotechnology

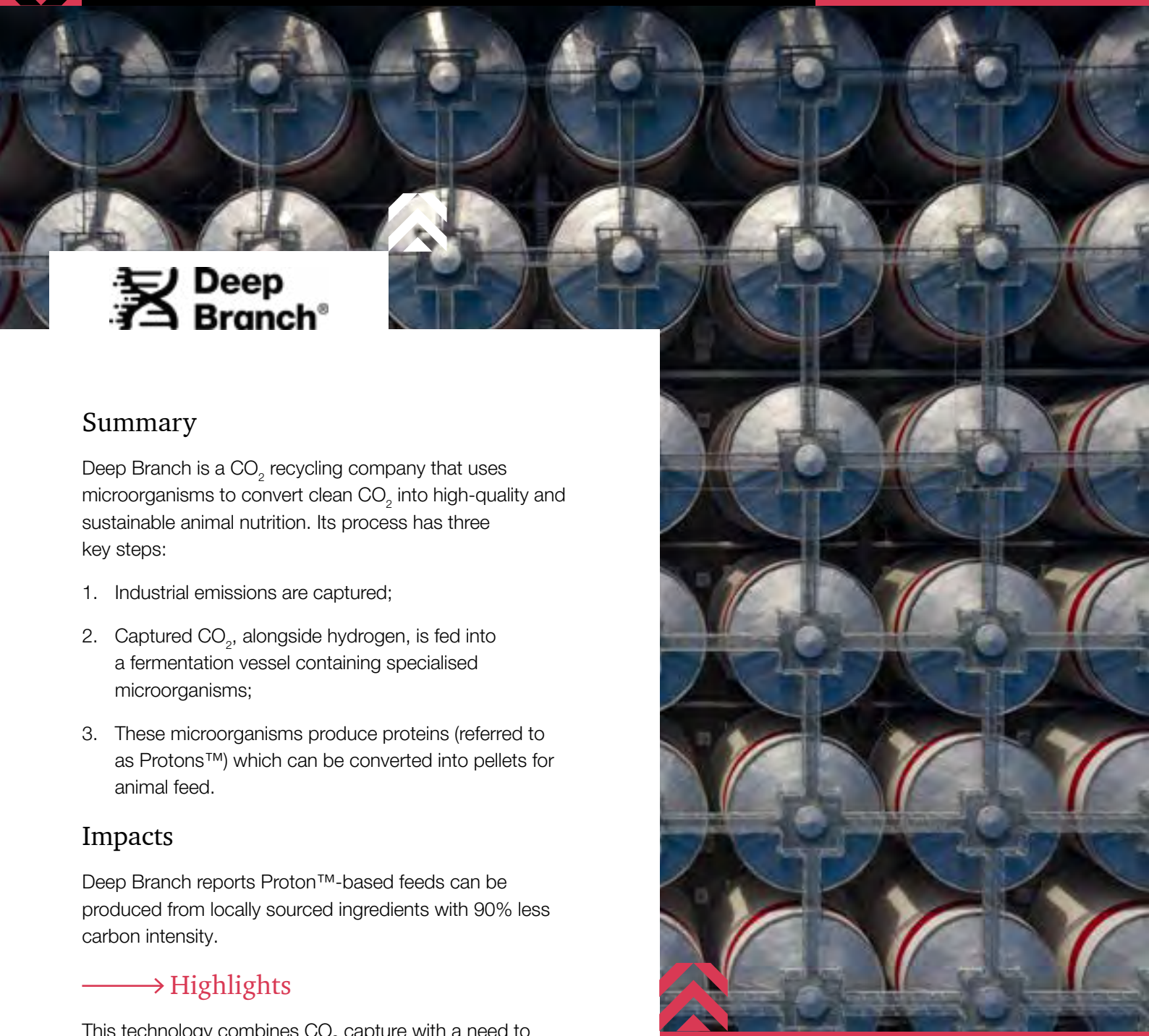
#GIS

123 Source: PwC, The State of Climate Tech 2021
124 Source: PwC, The State of Climate Tech 2021
125 Source: Department for Business, Energy & Industrial Strategy, Design of the Carbon Capture and Storage (CCS) Infrastructure Fund
126 Source: UK Parliament, Climate Change Update Statement made on 19 October 2021
127 Source: Department for Business, Energy & Industrial Strategy, 1 November 2021 update: Carbon Capture, Usage and Storage (CCUS) Track-2

Growth Areas:

- **Carbon Capture Utilisation and Storage (CCUS):** CCUS is the most mature sub-sector within GHG capture, having raised >90% of the overall global investment for the sector.[128] The UK Government has released its 'Clean Growth Strategy'.[129] This outlines its approach to ensuring the UK is a global leader for CCUS, and ensuring CCUS can be deployed at scale by 2030. In November 2020, £1bn was allocated to the Carbon Capture and Storage Infrastructure Fund.
- **Direct Air Capture (DAC):** While not at the level of CCUS, the UK Government is investing in DAC technology. The Direct Air Capture and Greenhouse Gas Removal Innovation Programme looks to develop ways to mass capture CO_2 at a cost of <£200 per tonne.[130] £70m has been allocated to a competitive process to achieve this.
- **Biomass uptake of CO_2:** Constituting natural climate GHG extraction solutions which do not fit within afforestation or land management techniques (covered in Food, Agriculture and Land Use), this category of solutions has the potential to produce commercially valuable products such as plastics, or using microorganisms to lock carbon away for thousands of years in the form of biochar, whilst also improving soil fertility. This is currently significantly underfunded compared to the other two solution areas in this sector.

128 Source: PwC, The State of Climate Tech 2021
129 Source: Department for Business, Energy & Industrial Strategy, Clean Growth Strategy
130 Source: Department for Business, Energy & Industrial Strategy, Direct Air Capture and other Greenhouse Gas Removal technologies competition



Deep Branch®

Summary

Deep Branch is a CO_2 recycling company that uses microorganisms to convert clean CO_2 into high-quality and sustainable animal nutrition. Its process has three key steps:

1. Industrial emissions are captured;
2. Captured CO_2, alongside hydrogen, is fed into a fermentation vessel containing specialised microorganisms;
3. These microorganisms produce proteins (referred to as Protons™) which can be converted into pellets for animal feed.

Impacts

Deep Branch reports Proton™-based feeds can be produced from locally sourced ingredients with 90% less carbon intensity.

⟶ Highlights

This technology combines CO_2 capture with a need to reduce the carbon intensity of animal care, thus finding a market for the captured GHGs and reducing the land required for animal feed. Deep Branch offers a localised way of creating carbon negative animal feed within the UK, and could provide a globally scalable solution.

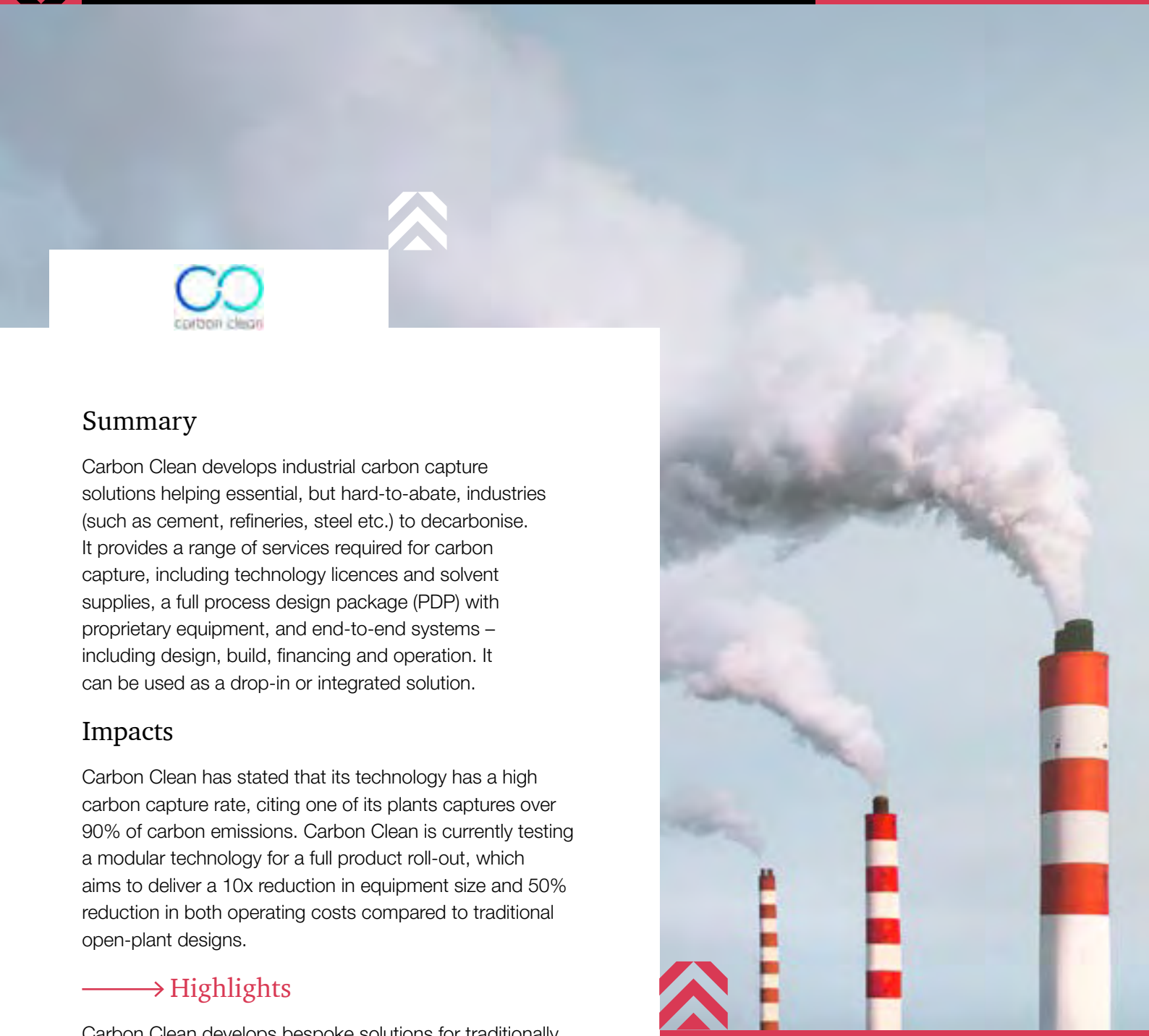
⟶ Strategic alliances

- Agriculture and Land Use
- Farming
- Industry
- Supermarkets
- Waste

#CarbonCapture

#SustainableAnimalFeed

Link to website:
deepbranch.com



Summary

Carbon Clean develops industrial carbon capture solutions helping essential, but hard-to-abate, industries (such as cement, refineries, steel etc.) to decarbonise. It provides a range of services required for carbon capture, including technology licences and solvent supplies, a full process design package (PDP) with proprietary equipment, and end-to-end systems – including design, build, financing and operation. It can be used as a drop-in or integrated solution.

Impacts

Carbon Clean has stated that its technology has a high carbon capture rate, citing one of its plants captures over 90% of carbon emissions. Carbon Clean is currently testing a modular technology for a full product roll-out, which aims to deliver a 10x reduction in equipment size and 50% reduction in both operating costs compared to traditional open-plant designs.

⟶ Highlights

Carbon Clean develops bespoke solutions for traditionally high emission sectors. It claims these can be retrofitted or newly equipped, aiding companies in more easily meeting their emissions targets and reducing the barriers to cheaply removing emissions. According to Carbon Clean, the modularity would provide scalability and significantly reduce site disruption, offering c.£22.5/tonne cost vs. average market rate of c.£52.5.

⟶ Strategic alliances

- Cement
- Steel
- Waste

#CarbonCapture

Link to website:
carbonclean.com

Ones to watch: 2

Cambridge Quantum Computing (CQC) is partnering with leading energy firms to deploy quantum computing and find new ways to capture carbon.[131] Quantum computing could hold the key to solving the scaling issues within carbon capture, making it one to watch.

131 Source: Total Energies, Total is exploring quantum algorithms to improve CO2 capture

#QuantumComputing

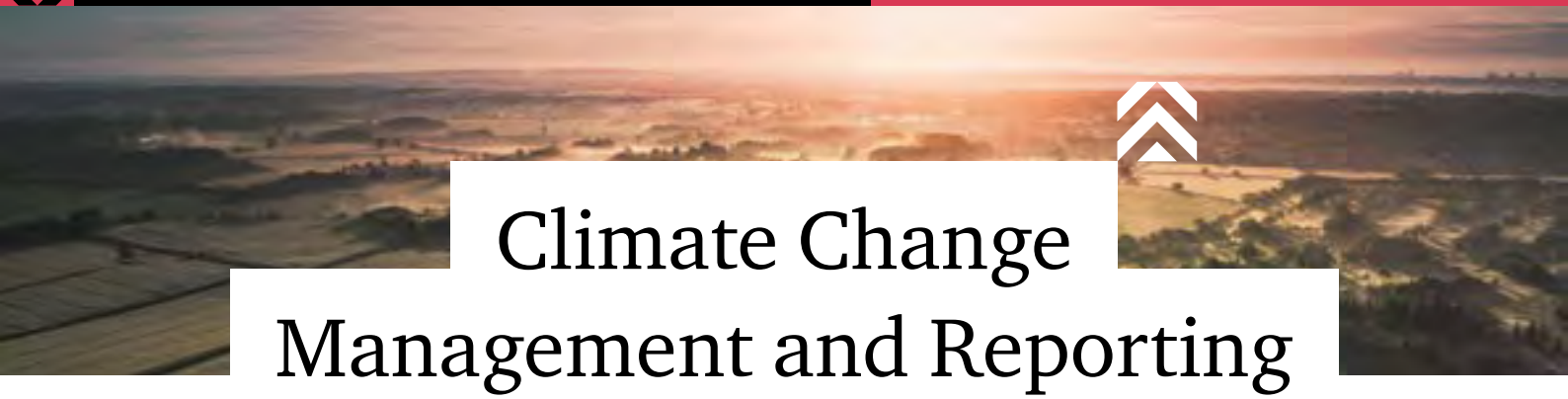
Link to website:
cambridgequantum.com

Cambridge Carbon Capture (CCC) is developing its capability to use rock mineralisation to capture carbon. CCC hopes to improve the cost effectiveness of carbon capture projects, which could catalyse major sector investment.

#CarbonCapture

Link to website:
cacaca.co.uk

Climate Change Management and Reporting



Climate Change Management and Reporting

N/A
UK GHG emissions

£51.4m
UK VC investment (H2 '20 – H1 '21)[132]

3
Start-ups in the Net Zero Future50

Climate Change Management and Reporting received 1.5% (UK: 2.5%) of H1 2013 – H1 2020 climate tech funding globally, with a Compound Annual Growth Rate (CAGR) of 54% in that period, below the overall 68% climate tech investment growth rate.[133] Businesses are increasingly demanding the service as they are placed under pressure to track and reduce emissions.[134] Further to this, as extreme weather events, driven by climate change, grow in intensity around the world, understanding the potential risk and quantifying the impact of these events will become more important if society is to successfully adapt. One recent study has suggested that the last time there were major policy changes to climate change monitoring and reporting, the potential reduction impact was 8%.[135]

Barriers:

- **Lack of standardisation:** The current Climate Change Management and Reporting systems across the UK are impeded by their lack of verification and reporting standards outside the aviation industry.[136] The UK Emissions Trading Scheme (ETS)[137] is currently at a higher price than its EU equivalent (EU ETS), with emissions caps currently above predicted 'business-as-usual' emissions.[138]

Accelerators:

- **New Regulation:** The UK Government has established independent regulatory mechanisms, including the UK ETS, and enshrined TCFD-aligned requirements in law for large companies to report on climate-related risks and opportunities from April 2022.
- **New sustainability standards:** At the global level, the establishment of the IFRS Foundation's new International Sustainability Standards Board (ISSB) sets foundational standards for reporting for investors and has been welcomed by over 40 international governments, including the UK. At the regional level the EU's updated reporting Directive (CSRD), defines a taxonomy and standards for planned ESG impact reporting standards.
- **Stakeholders:** A range of stakeholders including activist investors, employees, suppliers, customers, civil society and NGOs are acting to deliver increasingly powerful incentives to drive corporate performance.[139]

132 Source: PwC, The State of Climate Tech 2021
133 Source: PwC, The State of Climate Tech 2021
134 Source: A PwC estimate of the potential GHG emissions reduction, based on a blend of sources and industry insights
135 Source: Downar et al, The impact of carbon disclosure mandates on emissions and financial operating performance
136 Source: The Climate Change Committee, The Progress in reducing emissions 2021 Report to Parliament
137 Source: UK Government, Participating in the UK ETS
138 Source: House of Commons, Briefing Paper – The UK Emissions Trading Scheme
139 Source: PwC – https://www.pwc.com/gx/en/services/audit-assurance/corporate-reporting/esg-investor-survey.html

Technology drivers:

#MachineLearning

#CloudComputing

#DataMapping

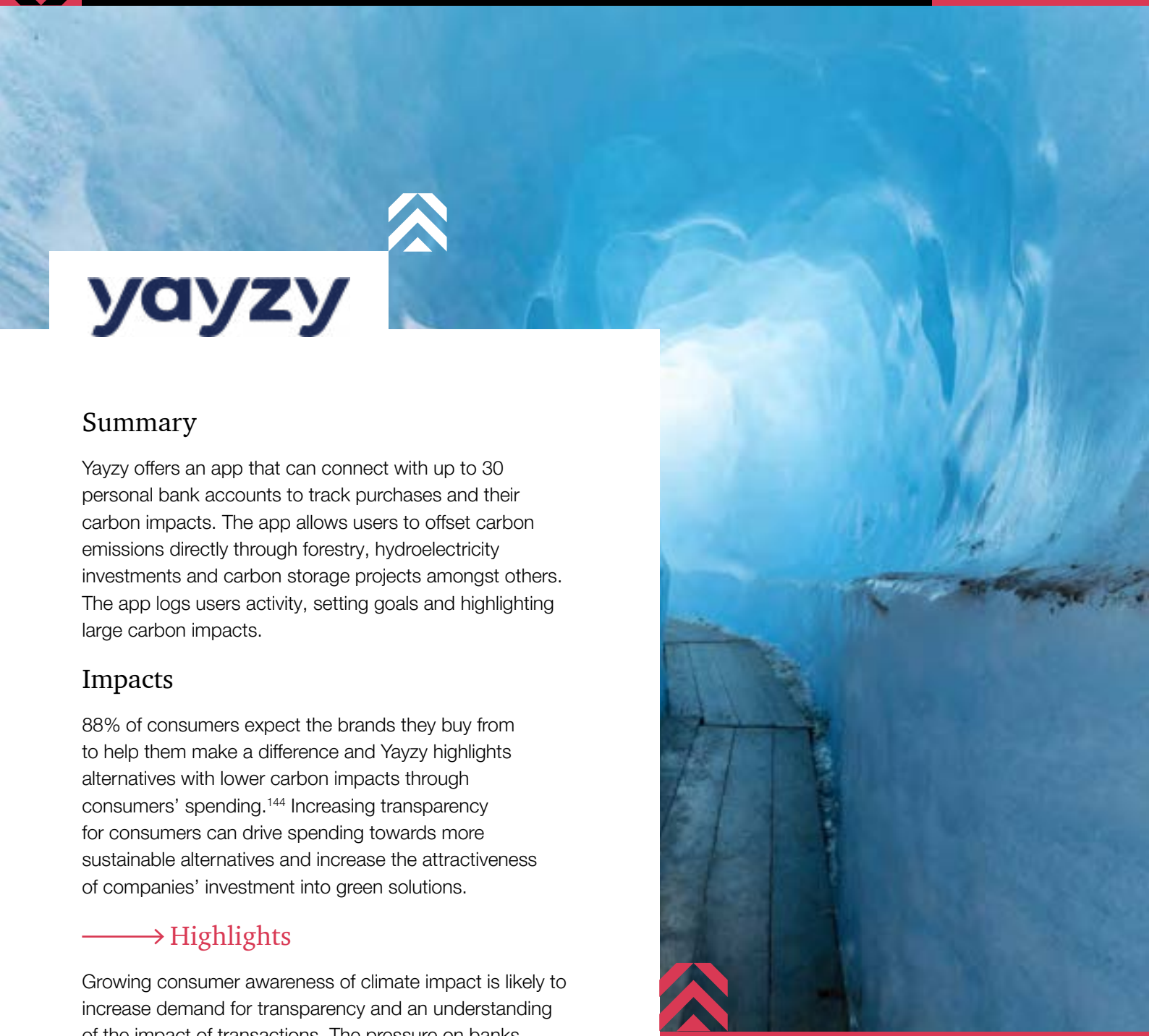
#DataVisualisation

#AI

Growth Areas:

- **GHG data intelligence:** The sub-sector's main use cases are for tracking GHG emissions, analysing potential climate change risks to firms, and substantiating organisations' environmental claims. £22trn in investments now require quantified and evidenced climate change targets.[140] Blockers to progression include high equipment costs, data skill shortages, and a lack of standardised regulations.
- **Supply chain emissions mapping:** The industry and underlying technology for mapping emissions and tracking the environmental impact of supply chains is rapidly developing. Scope 3 emissions account for c.70% of a given business' GHG impact and because of this, attention on managing scope 3 emissions is on the rise.[141] For instance, in 2020, 94% of the companies that signed up to the Science Based Targets Initiative included commitments to reduce emissions in their supply chain.[142]
- **Climate risk management:** The applications of technology in this space range from mapping geographical locations of manufacturing plants to predictive risk assessments of investments based on shifting climate and regulations. The pressure from stakeholders wanting greater transparency, in tandem with regulation, is likely to drive further investment and therefore innovation into the space.
- **GHG offsetting and low-GHG alternatives:** GHG offsetting options, particularly voluntary offsetting, is on the rise, with the US, India and China leading the way.[143] Since the pandemic, the market is continuing to rise with voluntary offsets reaching over 100MtCO_2 which is the highest level in history. The value of carbon offsetting is set to rise, with Mark Carney predicting that the market could be worth £75bn by the end of the decade.

140 Source: https://www.pensionsage.com/pa/UK-pension-funds-back-call-for-science-based-targets-on-climate.php
141 Source: McKinsey, Making Supply-Chain Decarbonisation Happen
142 Source: Science Based Targets, How companies are reducing emissions at scale with Science Based Targets
143 Source: Financial Times, Carbon offset market progresses during Coronavirus



yayzy

Summary

Yayzy offers an app that can connect with up to 30 personal bank accounts to track purchases and their carbon impacts. The app allows users to offset carbon emissions directly through forestry, hydroelectricity investments and carbon storage projects amongst others. The app logs users activity, setting goals and highlighting large carbon impacts.

Impacts

88% of consumers expect the brands they buy from to help them make a difference and Yayzy highlights alternatives with lower carbon impacts through consumers' spending.[144] Increasing transparency for consumers can drive spending towards more sustainable alternatives and increase the attractiveness of companies' investment into green solutions.

→ Highlights

Growing consumer awareness of climate impact is likely to increase demand for transparency and an understanding of the impact of transactions. The pressure on banks monitoring their transactions as well as their clients is also spurring further demand for insights into spending and its impacts, which is core to Yayzy's product offering.

→ Strategic alliances

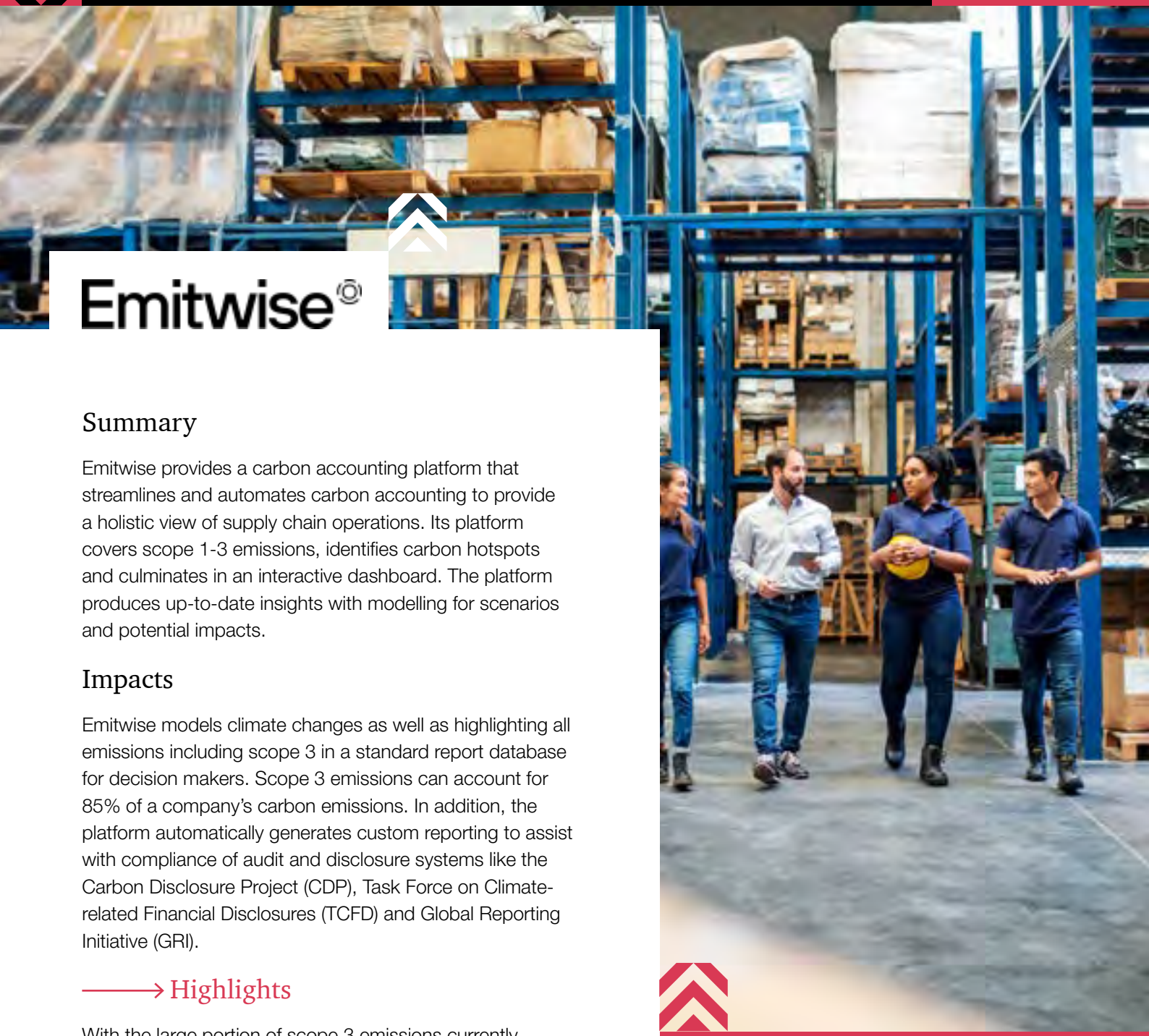
- Big Tech
- Government
- Media
- Retail Banking
- Retail and Consumer

#CarbonOffsetting

#CarbonAccounting

Link to website:
yayzy.com

144 Source: Forbes, 88% of consumers expect the brands they buy from to help them make a difference



Emitwise

Summary

Emitwise provides a carbon accounting platform that streamlines and automates carbon accounting to provide a holistic view of supply chain operations. Its platform covers scope 1-3 emissions, identifies carbon hotspots and culminates in an interactive dashboard. The platform produces up-to-date insights with modelling for scenarios and potential impacts.

Impacts

Emitwise models climate changes as well as highlighting all emissions including scope 3 in a standard report database for decision makers. Scope 3 emissions can account for 85% of a company's carbon emissions. In addition, the platform automatically generates custom reporting to assist with compliance of audit and disclosure systems like the Carbon Disclosure Project (CDP), Task Force on Climate-related Financial Disclosures (TCFD) and Global Reporting Initiative (GRI).

⟶ Highlights

With the large portion of scope 3 emissions currently missing from required reporting, we believe it is likely only a matter of time before regulations require reporting on scope 3 emissions. To reach Net Zero, companies and governments will need a lifecycle view of emissions, provided by companies such as Emitwise. Emitwise asserts that its model is highly scalable and can be deployed across industries in the short term.

⟶ Strategic alliances

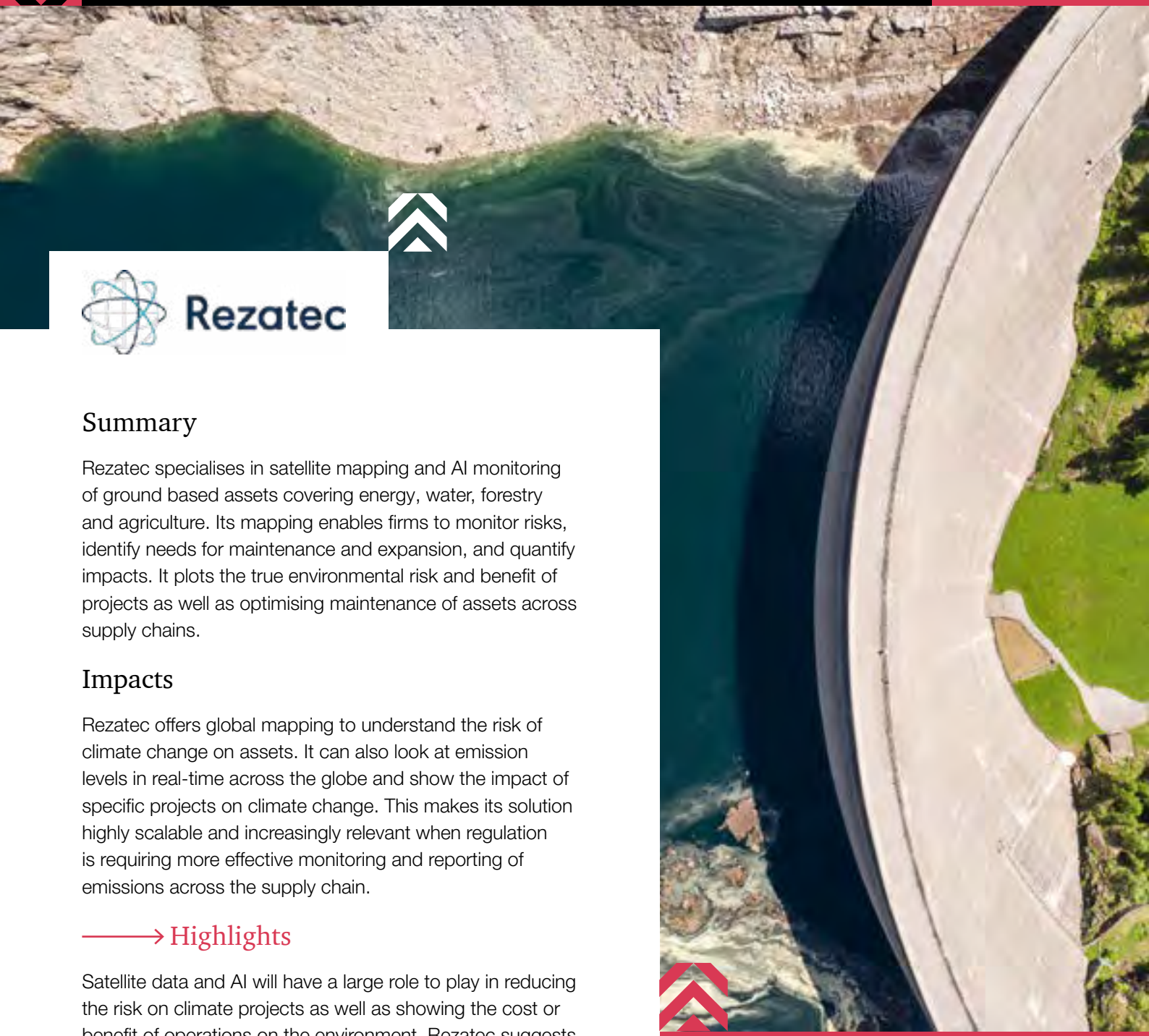
- Government
- Private Business
- Supply chain
- Professional Services

#ClimateRiskManagement

#ScenarioPlanning

#SupplyChain

Link to website:
emitwise.com



Rezatec

Summary

Rezatec specialises in satellite mapping and AI monitoring of ground based assets covering energy, water, forestry and agriculture. Its mapping enables firms to monitor risks, identify needs for maintenance and expansion, and quantify impacts. It plots the true environmental risk and benefit of projects as well as optimising maintenance of assets across supply chains.

Impacts

Rezatec offers global mapping to understand the risk of climate change on assets. It can also look at emission levels in real-time across the globe and show the impact of specific projects on climate change. This makes its solution highly scalable and increasingly relevant when regulation is requiring more effective monitoring and reporting of emissions across the supply chain.

⟶ Highlights

Satellite data and AI will have a large role to play in reducing the risk on climate projects as well as showing the cost or benefit of operations on the environment. Rezatec suggests that its efficacy has been proven by mapping water pipelines, highlighting that c.64% of leaks are across 20% of pipelines, and in focusing peat restoration on crucial areas, saving >£1m.

⟶ Strategic alliances

- Agriculture and Land Use
- Aerospace
- Government
- Insurance
- Private Business, Risk

#Satellites

#ClimateRiskMapping

#ClimateImpactData

Link to website:
rezatec.com

Ones to watch: 1

Carbon Chain

CarbonChain is building a SaaS (Software-as-a-Service) tool that enables organisations in highly polluting industries to track carbon emissions through their supply chain and plan effectively for incoming carbon taxes and regulations. With the rise of ESG reporting, Supply chain transparency will likely increase in demand over the next 10 years.

#CarbonAccounting

#SupplyChain

Link to website:
carbonchain.com

Next Steps

If there is a mountain to climb to get us to less than 1.5°C of warming, the Net Zero Future50 form part of the path forward. From slashing emissions in the Built Environment to rethinking the food system, the climate tech innovators highlighted in this report are a vital mechanism for bending the emissions curve down and delivering on climate goals.

Net Zero, even with robust and validated offsets, isn't the full answer; it's a component of a just transition model that creates a socially as well as environmentally sustainable economy. Technology, equally, is not the sole solution. Delivering on the carbon challenge will require a series of new collaborations between business, government and civil society.

For our part, PwC, with a mission to solve important problems, is committed to trying to help support these game-changing new approaches. Whether you are a start-up wanting to open up access to key markets, a VC looking for the next generation of high impact companies, or an industry giant looking to future-proof your business, please get in touch to see how we could help.

Appendix

Notes and Assumptions on scoring:

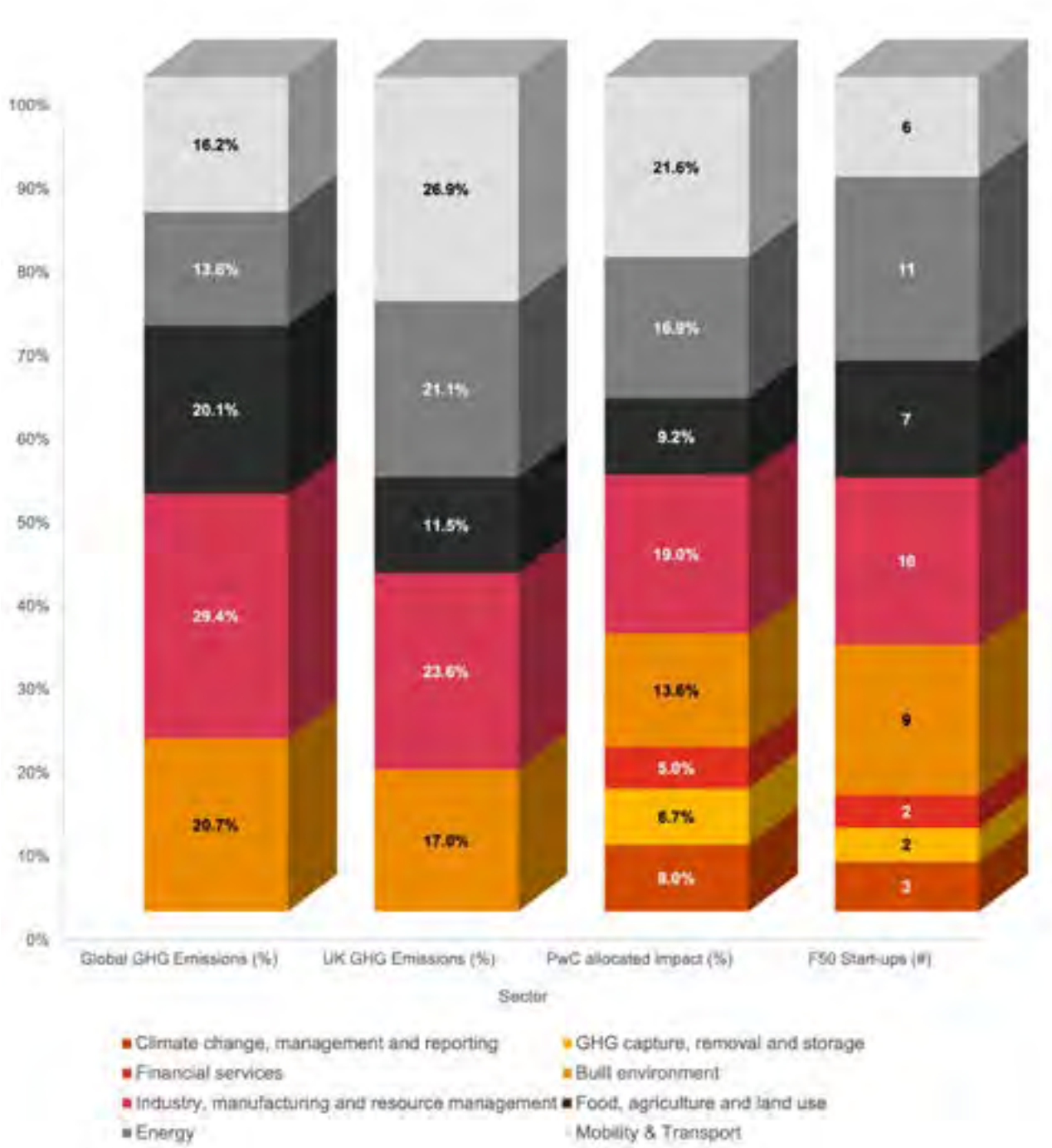
- Each of the three composite factors had multiple sub-criteria within them, as illustrated in methodology overview diagram (Figure II). Using the assessment framework, we scored each of the start-ups high, medium or low, based on the sub-criteria within each scoring category, aggregating to an overall criteria score.
- In scoring maturity, we looked for companies that have a proven technology beyond the concept stage but that also offered a solution which has significant untapped potential.
- In scoring the size of the prize in terms of Net Zero impact, we also evaluated broader sustainability impacts beyond GHG. For instance, a circular model, or processes that used non-rare / hazardous materials would score better within the broader ecological benefits sub-criterion. Similarly, businesses that had a larger addressable market, for example, those that operate in multiple countries, scored well.

Notes and Assumptions on allocating numbers of start-ups across sectors:

- In order to allocate the number of start-ups per sector in the Net Zero Future50, we evaluated both Global[145] and UK emissions[146] by sector and roughly weighted the entries by sector in the Net Zero Future50 to reflect their relative emissions contribution (i.e. highest emitting sector receives the largest segment of the Net Zero Future50). This was also performed at a sub-sector level (within each sector), to ensure that key trends and emission categories were fairly represented. Where they diverged, we balanced the Net Zero Future50 weighting between Global and UK percentages. Energy has been weighted slightly higher with a cross-sector impact given the important decarbonisation role electrification will have to play across all sectors in the next 10 years.
- The cross-sector themes of GHG Capture, Removal and Storage and Climate Change Management and Reporting have also been given a Net Zero Future50 allocation based on their potential to remove GHG emissions.
- To estimate an allocation for the cross-sector themes, we calculated an indicative abatement potential, as follows:
  - For Financial Services, we used an indicative figure of 5%. This is calculated via the World Wide Fund for Nature (WWF) estimation, which suggests the UK impact of Financial Services is c.805 million tonnes.[147] We extrapolated this figure to calculate global emissions by applying the weight of the UK's ratio of global financial exports (40%) against the global impact of the UK's Financial Services emissions (2%) to derive an indicative figure of 5% for global Financial Services emissions.[148] We have also applied this 5% global abatement potential to the UK GHG impact, for consistency, despite the UK's relatively outsized Financial Services sector.
  - For Climate Change Management and Reporting, we used an indicative figure of 8%. This is based on the findings of Downar et al, who suggest that the last time there were major policy changes to Climate Change Monitoring and Reporting in the UK, the potential reduction impact was 8%.[149]
  - For GHG Capture and Storage, we used an indicative figure of 6.7%. The IEA estimates that we need to increase our GHG capture and storage rate by up to 190x[150] (we used 100x for prudence). The current level is c.40 million tonnes, which at 100x, would equate to c.4.0bn tonnes,[151] or 6.7% allocation of the emissions opportunity.
  - We then proportionally added back these indicative cross-sector GHG impacts to the UK GHG emissions to create the PwC allocated Impact of Figure V (below). This provided the relative weightings to guide the selection of the number of companies per sector of the Future50.

145 Source: Our World in Data, Emissions by sector
146 Source: UK Government, 2019 UK Greenhouse Gas Emissions, Final Figures
147 Source: WWF, The Big Smoke. Global Emissions of the UK Financial Services sector
148 Source: The City UK: About the UK as an International Financial Centre 2018
149 Source: Downar et al, The impact of carbon disclosure mandates on emissions and financial operating performance
150 Source: IEA, Net Zero By 2050
151 Source: IEA, Net Zero By 2050

Analysis of GHG emissions and potential reduction impact versus Future50 weightings



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