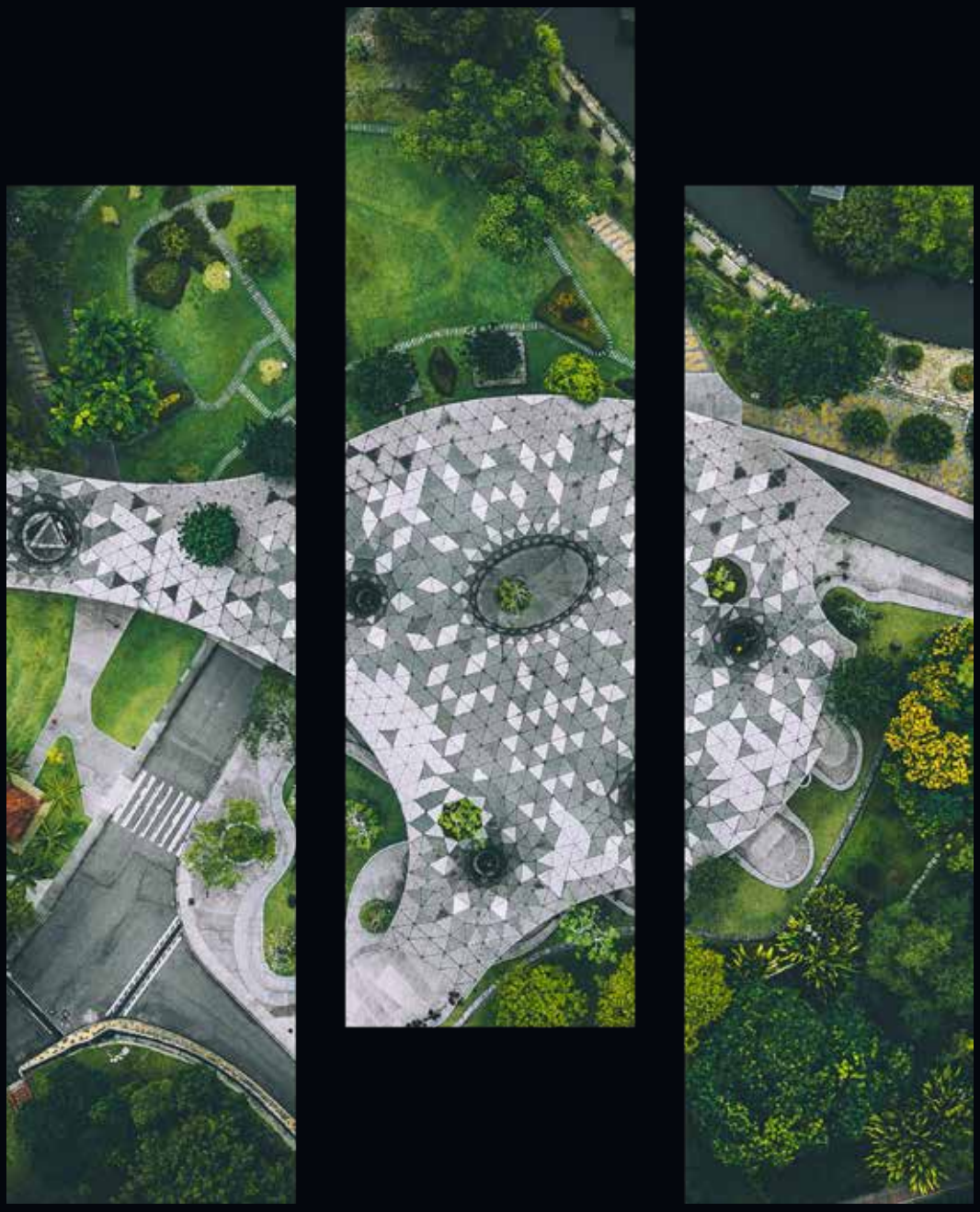
CLEANTECH | GREENTECH | CLIMATETECH

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HALSTON B2B

ENTERING THE GREENTECH ERA

An in-depth investigation into the technological advancements that are preventing climate change.



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CONTENTS

CONTRIBUTORS 7

SECTION 1 _ THE CURRENT STATE OF THE CLIMATE 9

SECTION 2 _ THE CLEANTECH, GREENTECH & CLIMATETECH CONUNDRUM. 1 2

SECTION 3 _ THE HISTORY OF GREEN TECHNOLOGY 1 3

SECTION 4 _ THE GREENTECH MARKET 1 7

SECTION 5 _ EMERGING TECHNOLOGIES 2 1
- 5.1 _ CLEAN MOBILITY
- 5.2 _ AGRITECH
- 5.3 _ CIRCULAR ECONOMY
- 5.4 _ EMISSIONS CONTROL & REMOVAL
- 5.5 _ SMART ENERGY
- 5.6 _ CLEAN ENERGY

SECTION 6 _ GREENTECH TRENDS 4 9
- 6.1 _ GREATER NEED FOR BATTERY STORAGE
- 6.2 _ THE YEAR OF THE EV
- 6.3 _ GREATER AWARENESS
- 6.4 _ DEMOCRATISATION OF POWER GENERATION
- 6.5 _ COLLABORATION
- 6.6 _ SCOPE 3 EMISSIONS

SECTION 7 _ CLIMATE FUNDING 5 7
- 7.1 _ REGIONS
- 7.2 _ SMEs AND START UPS
- 7.3 _ SECTOR
- 7.4 _ RATE OF INVESTMENT

SECTION 8 _ LOW CARBON CAREERS. 6 7
- 8.1 _ GROWING OPPORTUNITIES
- 8.2 _ TRANSITIONING CAREERS

SECTION 9 _ HOW TECHNOLOGY IS TAKING ON CLIMATE CHANGE. 7 3
- 9.1 _ CALCULATING CARBON FOOTPRINT
- 9.2 _ TRANSITIONING TO RENEWABLES
- 9.3 _ AN EFFECTIVE EV TRANSITION
- 9.4 _ SOLVING THE WATER CRISIS
- 9.5 _ REMOVING HARMFUL POLLUTANTS
- 9.6 _ PROTECTING HABITATS

SECTION 10 _ INDUSTRY ADOPTION 8 1
- 10.1 _ LEVEL OF ADOPTION
- 10.2 _ MANUFACTURING
- 10.3 _ MARINE & POWER PLANTS
- 10.4 _ BUILT ENVIRONMENT
- 10.5 _ ECO CITIES

SECTION 11 _ SUSTAINABILITY AT THE CORE OF GREENTECH 8 9

SECTION 12 _ WHY IS TECHNOLOGY PINNACLE TO A CARBON NEUTRAL FUTURE?. 9 1
- 12.1 _ CONTINUING WITH OUR WAY OF LIFE
- 12.2 _ REMOVING OUTDATED APPROACHES
- 12.3 _ REMOVING ASSUMPTIONS
- 12.4 _ MAKING A GLOBAL IMPACT
- 12.5 _ ACCESSIBILITY & AFFORDABILITY

SECTION 13 _ UK GREENTECH INNOVATION. 9 9

SECTION 14 _ IS THE UK READY FOR NET-ZERO? 1 0 3

SECTION 15 _ PREDICTIONS FOR THE FUTURE. 1 0 7
- 15.1 _ FAST-PACED CHANGE
- 15.2 _ GEOTHERMAL ADOPTION
- 15.3 _ EV WILL BECOME MORE ACCESSIBLE
- 15.4 _ REPLACING INCUMBENT TECHNOLOGIES
- 15.5 _ SOLAR POWER GROWTH
- 15.6 _ LEGALISATION DRIVING CARBON REPORTING

CONCLUSION. 1 1 5

REFERENCES. 1 1 7

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GREENTECH

CLEANTECH

CLIMATETECH

PREFACE

Climate change will be a phrase you're all very familiar with and after the most recent Cop26 meeting, it seems a bigger topic than ever before. That's why we felt it was the right time to create our 'Entering the GreenTech Era' whitepaper.

Climate action is imperative, and it will only be possible through innovative, ground-breaking technology.

In this paper we will be delving into the topic of GreenTech and how this monumental sector will aid our global and local move towards carbon neutrality. It compiles industry analysis and first-hand insight from experts in the sector to delve into the emerging technologies that are entering the space and how they will play their part in the decarbonisation of the planet.

Entering the GreenTech Era will uncover the amazing innovations being delivered in the UK, the seismic shifts happening within the market and expert insight into the future of GreenTech and more critically our planet.

From all of us at Halston B2B, we hope you enjoy reading.

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OUR WHITE PAPER CONTRIBUTORS

HALSTON B2B HAS BROUGHT TOGETHER A PLEATHER OF EXPERTISE TO DELIVER FIRST-HAND INSIGHT TO THE PAPER.

CeraPhi® deliver advanced geothermal energy solutions at scale. CeraPhi's mission is to deliver an impact change to carbon reduction, providing a decarbonising baseload 1-2-1 energy transition solution. As an energy developer "utility light" model they use their proprietary technology and project delivery expertise to enable the supply of baseload energy to their clients and customers. The technology enables the use of thermal energy from the ground to be delivered to a point of commercial access to direct power, heat and even cooling.

KARL FARROW – CHIEF EXECUTIVE OFFICER

Powerstar is a leading manufacturer of behind-the-meter battery energy storage systems, providing complete power resilience with site-wide uninterruptible power supply. On top of improving power resilience, these technologies support companies on their path to net zero, which is becoming increasingly important in a world reliant on rapid electrification and digitisation. To make energy as cheap, as green and as efficient as possible is now the core of the business.

ALASTAIR MORRIS – CHIEF COMMERCIAL OFFICER

Tribosonics is a transformational technology business that uses its unique sensing technologies to create digitally enabled products and services that generate value and improve sustainability for its global industrial customer base. From their Sheffield headquarters they design and supply end-to-end solutions that are based on innovative hard-tech transducers (sensors) that gather data from industrial components which is captured in a cloud platform and converted to insightful engineering metrics using algorithms, machine learning and advanced analytics. They have a visionary and multi-talented team of 30 people who are a combination of technologists, engineers, data scientists and commercial experts that bring the technology to market.

CHRISTINA KING - CCO **GLENN FLETCHER - CEO**

Hydrock is a British-owned engineering design, energy and sustainability consultancy firm shaping places, communities and infrastructure that everyone can be proud of. Their multi-disciplinary team of over 700 specialists works across various sectors, futureproofing the built environment.

MARK PEARCE – SENIOR DATA ANALYST, MOBILITY ANALYTICS DIVISION

JAMES MCKECHNIE – DIVISIONAL DIRECTOR FOR TRANSPORT PLANNING

The technology driving Power Roll is the brainchild of Chief Scientist Dr John Topping who developed the concept of a microgroove, a very small micron-sized pattern that would be embossed into a plastic film. Together with Saul Joicey and strong UK investors, Power Roll was born. They have different applications of innovation using microgrooves, but the most exciting development using microgrooves is solar film. Their primary objective is to scale the use of solar around the world by creating a product that is a fraction of the cost of existing technology.

DON SCOTT – CCO

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Tallarna is a climate tech company for the built environment. They combine data analytics, insurance, and efficient funding to propose and execute decarbonisation strategies.

TIM MEANOCK, CEO

The Pacific Green Technologies Group is becoming a world leader at providing sustainable cleantech solutions to help solve climate warming, green energy and resource scarcity challenges. They are committed to managing the change to a cleaner more sustainable planet.

TONY GRAINGER, COO

Solar Water PLC's vision is to create an end to water scarcity with a solution that will also create a better future for our planet, by combating climate change. Our fully decentralised Concentrated Solar Power Desalination system provides a GreenTech, zero GHG solution that can sustainably desalinate seawater into scaled supplies of freshwater using the concentrated power of the sun.

JAMES WHITEHEAD, CCO

Spherics is a carbon footprinting software company for business. Their carbon accounting based methodology is award winning and they have a track record of delivering for both SMEs and multinational enterprise businesses.

CONRAD LANGRIDGE, HEAD OF MARKETING

Earth Blox is a no-code platform giving effortless access to the power of satellite intelligence. Delivering incredible insights into our world and how it's changing. There is an amazing amount of high-quality satellite data available for gaining insight, but the bar is set high for many companies who wish to access it, often requiring coding expertise and high associated costs. Earth Blox was founded to lower this bar to entry by putting high-quality satellite observations into the hands of non-experts and empowering businesses to translate raw satellite data into actionable insights without needing to write a single line of code.

GENEVIEVE PATENAUDE, CEO

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SECTION 1:

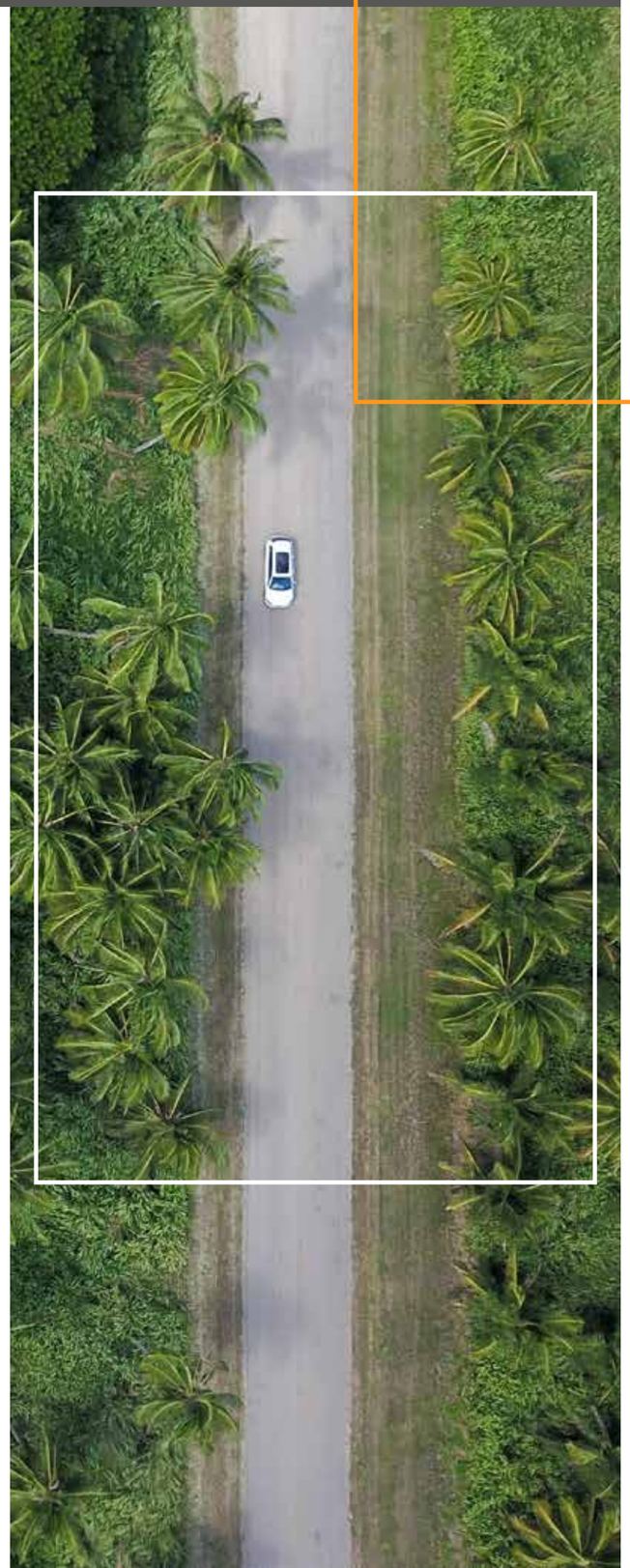
THE CURRENT STATE OF THE CLIMATE

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Climate change is intensifying, and the race is truly on to achieve carbon neutrality. Whilst we often hear the devastating impact climate change is having it is often hard to comprehend what exactly this means.

Climate change has been in motion since the beginning of the industrial revolution, but has intensified in recent years. The past year has seen an accelerated rate of climate-related disasters. Scientists from around the world have collated and analysed data[1] and below are the key findings over the past year and what the current state of the climate looks like.



RECORD OCEAN HEAT

Last year was the warmest on record for the heat content of the world's oceans. Ocean heat content has increased by around 417 zettajoules since the 1940's, 14 zettajoules between 2020 and 2021 alone, which is around 23 times more than the total energy used by everyone on Earth in 2019.

EXTREME WEATHER

2021 saw the warmest northern-hemisphere summer on record, which promoted several extreme weather events such as heavy rainfall and flooding, wildfires and storms.

GREENHOUSE GASES

Greenhouse gas concentrations reached a new high driven by human emissions. Carbon dioxide levels in the air are at their highest in 650,000 years.[2]

Whilst the figures are daunting and rightly so, it isn't too late to make a change. Luckily there are those that are willing to make a change and companies with incredible, ground-breaking technology that can combat all the contributing actions to climate change and help build a greener world. These solutions can help minimise our carbon footprint, whilst instantaneously support vital ecosystems such as biodiversity, access to fresh water and food security.

THE NEED FOR GREEN TECHNOLOGY HAS NEVER BEEN MORE CRITICAL.

SECTION 2

THE CLEANTECH, GREENTECH & CLIMATETECH CONUNDRUM

There are various debates to the definitions of CleanTech, GreenTech and ClimateTech and more often than not these phrases are used interchangeable. So for the first point of call is to define the above.

GREENTECH

Green technology is the encompassment of all terminology surrounding innovative solutions that mitigate or reverse the effects of human activity on the environment. That inclues energy production include energy production, pollution reduction and climate change reversal. It is the umbrella under which both ClimateTech and CleanTech sit. Between both of these areas, the technologies within them are tackling and eliminating both existing and any future damage caused to the environment.

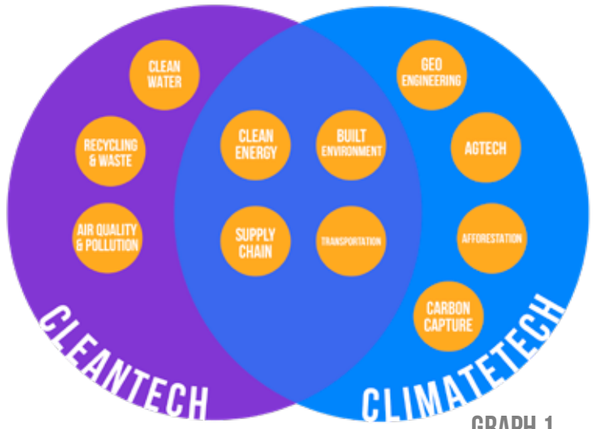
CLEANTECH

CleanTech was popularised by Nick Parker and Keith Raab, founders of CleanTech Group[3] from 2002 onwards. At its first inception it was a term to describe green and clean technologies that venture capital investors were turning to. Today, it means so much more. Clean Energy Ventures defines CleanTech as "any business model or technology that increases the performance, productivity and/or efficiency of production while minimising negative impacts on the environment." It is essentially those that look to minimise humans' impact on the environment.

CLIMATETECH

On the other side, there is ClimateTech that rather than being a synonym for CleanTech is operating alongside and is specifically focused on addressing climate change and is defined as any new business model that mitigates the impacts and drivers of global greenhouse gas emission. For example, carbon capture, which actively removes carbon emissions already in the atmosphere.

Clean Energy Ventures have graphically demonstrated the differences and overlaps between the two terminologies CleanTech and ClimateTech.



Graph 1. Source: Clean Energy Ventures

GRAPH 1

Whilst these phrases are not interchangeable, the two areas share a common purpose, which is of course tackling climate change. Both of these sectors are the amplifiers of intent, they are sectors that are emerging rapidly as a critical mechanism to drive down carbon emissions.

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SECTION 3. THE HISTORY OF GREEN TECHNOLOGY

When discussing green technology today, it comes with an array of abbreviated phrases and often terms like “cutting-edge”, “advanced” or “revolutionary”. Which for some may invoke images akin to a future dystopian world, and for the sci-fi fans may look similar to Blade Runner.

In actual fact, green technology is a lot more down to earth and some of the concepts under this term have been around for hundreds of years, before they even knew they were green. As mentioned earlier on, green technology and the sectors within are focused on undoing the damage we have already done or minimising the current impact we are having. The expansive sector includes the likes of carbon capture, clean energy or afforestation. Whilst many of these include recent innovations or strategies focused around turning back the clock, the likes of renewable energy can be traced back considerably further. Renewable energy is defined as any form of energy that can be renewed and one of the first forms is hydropower which can be traced back to 200 BC[4] with the Waterwheel or wind power which began in 1590 in Netherlands with the first ever windmill.

Over the course of history there have been many more examples such as these, but during the industrial revolution the use of renewable resources waned and shifted to a greater reliance on coal and gas energy sources, which at the time opened up a host of new opportunities and it seemed there may be an abundance of these resources.

During this period, focus was centred on moving forwards and delivering new inventions from the steam engine to the Spinning Jenny to make Britain a powerhouse. Unfortunately, they were unaware of the damage they were doing to the environment.

In modern history, the term ‘GreenTech’ cropped up during the 90’s and was very much driven by the venture capitalist area, with firms investing billions in GreenTech start-ups. During the financial crash, the pace of investment dropped and the popularity surrounding the technology saw a significant reduction. Since 2012, the industry has been gaining pace once again, with the growth rate of ClimateTech being sizable, with more than 3750%[5] increase between 2013 and 2019.

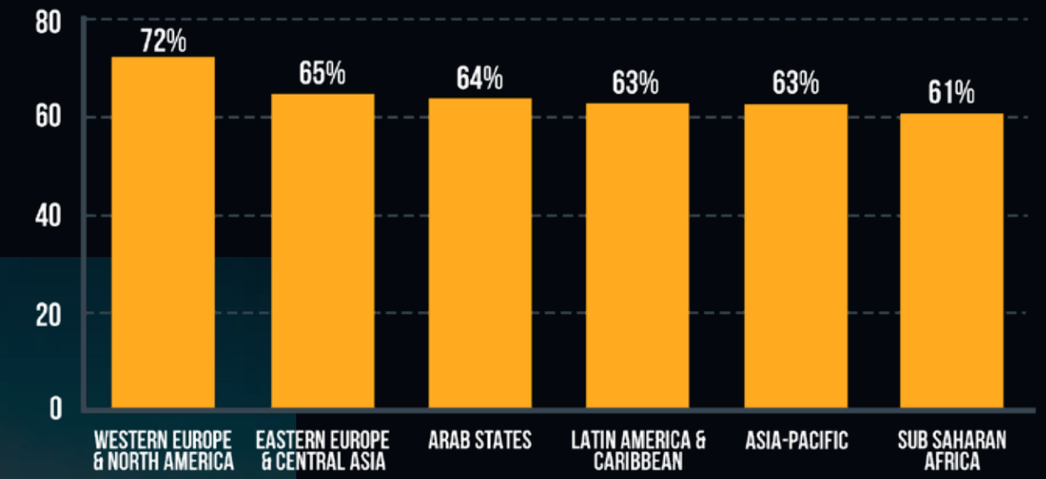
Today the popularity surrounding green technology is at an all-time high. There is a greater sense of urgency from the public globally, which are holding businesses and governments to a higher standard and demanding change. The Paris Climate Agreement and the recent Cop26 conference have placed sustainability at the top of the agenda.

The United Nations Development Programme conducted the largest survey in history surrounding public opinion on climate change, which included 50 countries and over half of the world’s population. The results which were published last year found that nearly two-thirds (64%)[6] of those surveyed believed that climate change is a global emergency. The two countries that had the highest proportion of people that believed it to be an emergency was the United Kingdom and Italy and the two lowest are Sri Lanka and Moldova.

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PUBLIC BELIEF IN THE CLIMATE EMERGENCY, BY REGION

GRAPH 2

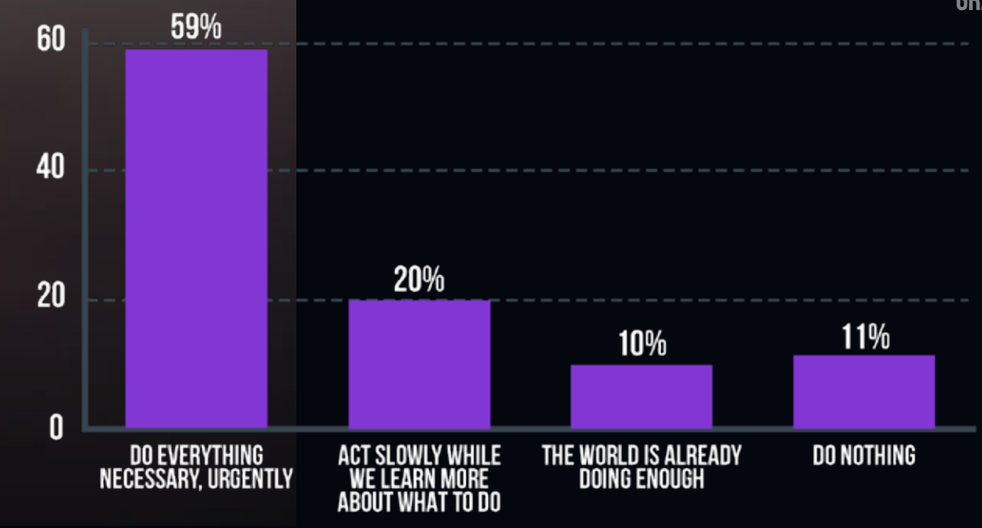


SOURCE: THE UNITED NATION'S DEVELOPMENT PROGRAMME

When the same respondents were asked what they wanted in terms of a response from their countries to address this challenge, the results were as follows.

URGENCY OF RESPONSE AMONG PEOPLE WHO BELIEVE IN THE CLIMATE EMERGENCY

GRAPH 3



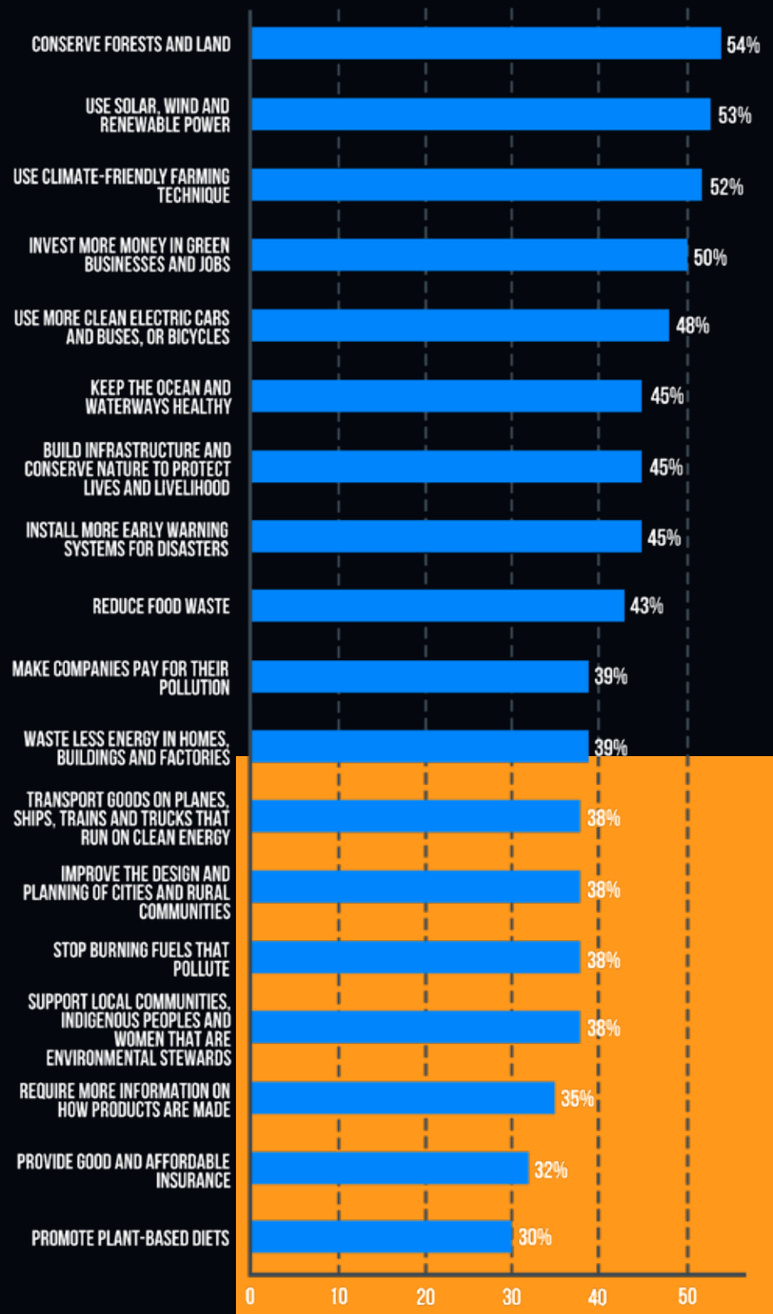
SOURCE: THE UNITED NATION'S DEVELOPMENT PROGRAMME

The majority of respondents wanted those in charge to do everything necessary, urgently. The top considerations that they felt needed to be tackled immediately were conserving forest and land, using renewable power and applying climate-friendly techniques.

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GRAPH 4

THE WORLD'S MOST POPULAR CLIMATE CHANGE POLICIES

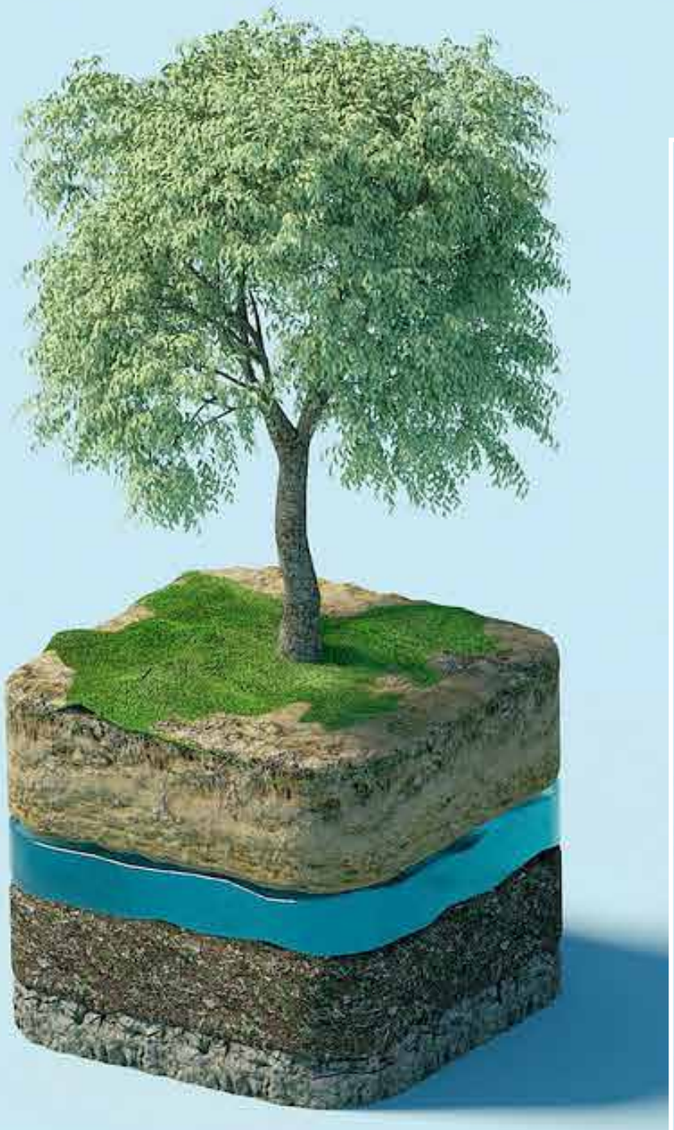


SOURCE: UN & UNIVERSITY OF OXFORD. PEOPLES' CLIMATE VOTE

The graph illustrates numerous opportunities for improvement, across a broad range of industries. The move towards a carbon neutral world must be one that is achieved holistically, planting trees alone will not achieve carbon neutrality. There are so many interlinking actions that are causing climate change, and they need to be tackled separately and often with very different approaches. The green technology market aims to address these issues, and each innovative solution will be addressing these systematic problems.

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SECTION 4:
THE GREENTECH MARKET

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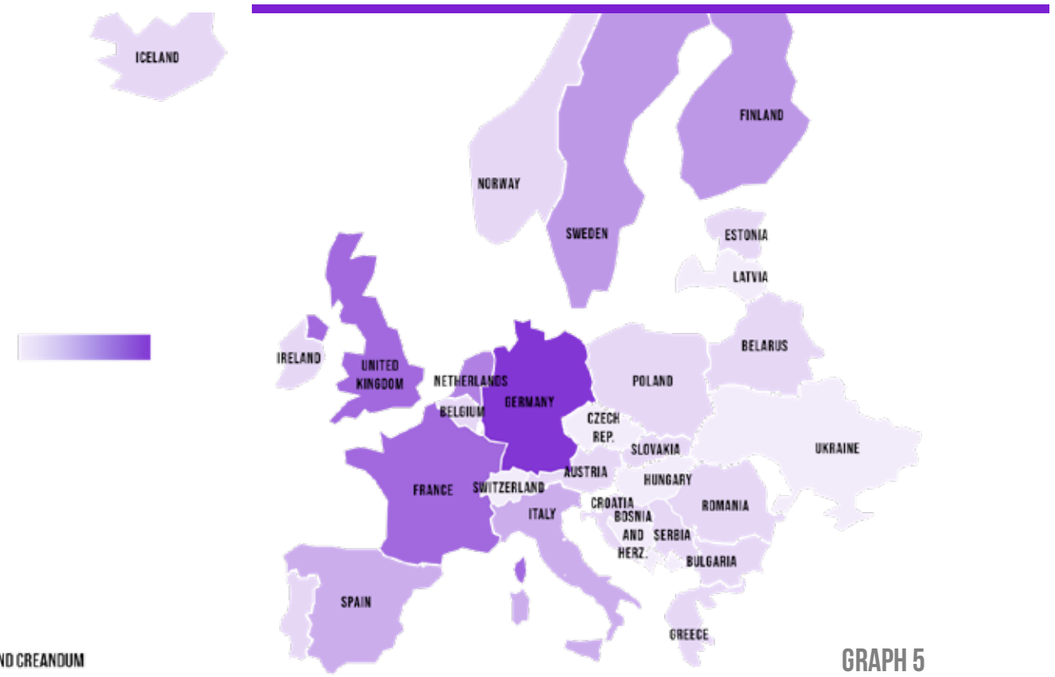
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The growing awareness from the public, policy changes and political drivers have all meant that sustainability and implementing environmentally-conscious practices have been high on the agenda for both businesses and governments. This has created a snowball-effect in demand for technological breakthroughs that will help achieve net-zero.

Prospects for the industry look positive, with global revenues in environmental technology and resource efficiency set to reach 9.4 trillion euros[7] by 2030, equivalent to an average annual growth rate of 7.3 percent.

EUROPE

More than €11 billion[8] was invested in EU CleanTech VC in 2021, more than double the 2020 record. Europe currently boasts at least 800[9] climate tech start-ups, with more launching every year. In terms of concentration, Germany is leading the race being home to 252[10] start-ups, followed by the UK (139) and France with 96.



SOURCE:SPEEDINVEST AND CREANDUM

GRAPH 5

When specifically honing in on the UK, there are currently 978[11] companies operating in the GreenTech space, and there is a stronghold in both London and Scotland for density of companies.

There are notable examples of high-achieving GreenTech companies across Europe. For instance, Arrival, the electric vehicle company dedicated to public transport, plans to go public soon at a valuation of $13bn.[12] Battery manufacturer Northvolt is set to be next and Oat milk unicorn Oatly is currently valued at $2bn.[13]

US

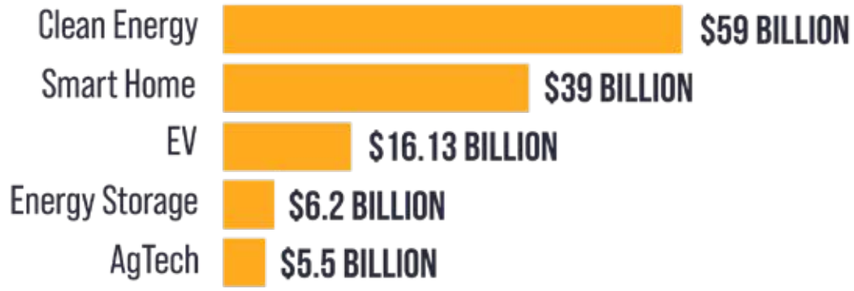
According to a recent study[14] conducted by climatologist Mark Maslin and researcher Lucien Georgeson, the green economy in the US generates $1.3 trillion in annual sales revenues, and creates 9.5 million full-time jobs.

Whilst the green economy can encompass a wide range of sectors, being specific to CleanTech, the US is one of the most heavily invested in, and is home to over 10,100[15] CleanTech's and the Bay Area in California is where the highest proportion are located.

The sectors that these companies are mainly dedicated to include Clean Energy, Smart Home and EV and the US makes up 72% of all CleanTech Unicorns worldwide. Some of the most notable companies include Rivian[16], the creators of off-road electric vehicles who are now valued at $8.9 billion. Another is Redwood Materials,[17] who recycle materials to deliver a circular economy and have been valued at an impressive $3.7 billion.

GRAPH 6

CLEANTECH MAKEUP: BY SECTOR





33 CleanTech unicorns can be found in the CleanTech hubs of the US, which make up 72% of all CleanTech unicorns worldwide.



The US accounts ofr 54% of the global CleanTech market as of Q3 2021.

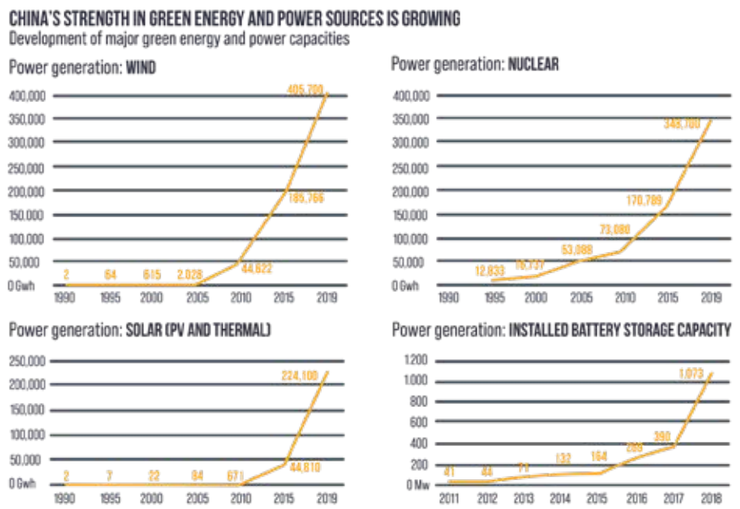


There are 53 dedicated CleanTech VC firms operating in the US' CleanTech hubs.

SOURCE: STORM4

CHINA

China is another major player in the global GreenTech game, especially when it comes to clean energy. China has been particularly successful in scaling up solar power, as well as minimising costs in wide energy and batteries for electric vehicles. Aside from this, they have been a major player in the invention of new green technologies, with Chinese patent filings in green energy tech increasing by more than 42,000[18] between 2005 and 2015. Whilst their composition of renewable energy sources still remains below Europe, China's production of green energy is on a fast growth trajectory.



SOURCE: IEA

GRAPH 7

China has been striving for new sustainable technologies, with over 800 projects[18] taking place as part of the 'National High-Tech R&D Program'. China's tech giant Alibaba are promoting GreenTech with their subsidiary Ant Financial co-founding the 'Green Digital Finance Alliance' alongside launching the Ant Forest App which gamifies carbon footprint tracking and has already planted over 100 million trees[19] as of August 2019 in Northwest China.

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SECTION 5

THE GREENTECH SECTOR IS SO EXPANSIVE AND IS HOME TO MANY SUB-SECTORS EACH WITH THEIR OWN STRATEGIC APPROACH TO REDUCE OUR ENVIRONMENTAL IMPACT AND PROTECT THE PLANET.

Below we will delve into the core segments that are driving the GreenTech sector and direct insight from the innovators within, exploring their technological advancements.

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5.1 CLEAN MOBILITY

Clean mobility is the concept of decarbonising the transport sector. This is tackling both public and private transportation needs and overall reducing the public's reliance on transportation. This is perhaps one of the most prominent areas in the carbon neutral transition and in the EU alone, the transport sector requires a 90%[20] reduction in greenhouse gas emissions, whilst still ensuring net-zero solutions are democratised and accessible to everyone.

For the UK specifically, the Government released the Transport Decarbonisation Plan[21] outlining their strategic approach, including both timings and the technologies that will be utilised to decarbonise the UK's highest-emitting sector. The major considerations in the plan include:

- THE DEVELOPMENT IN EV'S AND THE REQUIRED CHARGING INFRASTRUCTURE
- HGV'S AND BUSES
- DECARBONISING THE RAILWAY
- SUSTAINABLE AVIATION
- MARITIME EMISSION REDUCTION

Within this sub-section the EV transition remains high on the agenda. It is a core area that will deliver climate-neutral mobility, especially when it is combined with renewable energy sources. This sector is experiencing a considerable rise in investment and therefore being the impetus behind the technological innovation across battery development, EV design and charging ports.

Automotive manufacturers across the globe have unveiled their plans to meet the net-zero target and the production of electric and hybrid vehicles are on a fast growth trajectory. Analysts[22] expect the number of EV's sold in the UK to double in 2022, potentially taking 15% of the total new car market by the end of the year.

According to EY's[23] EV Country Readiness Index, the UK is currently positioned 4th globally in terms of probability of an effective transition towards electric mobility. And as a leading country, 60% of model launches are expected to be electrified from today to 2025.

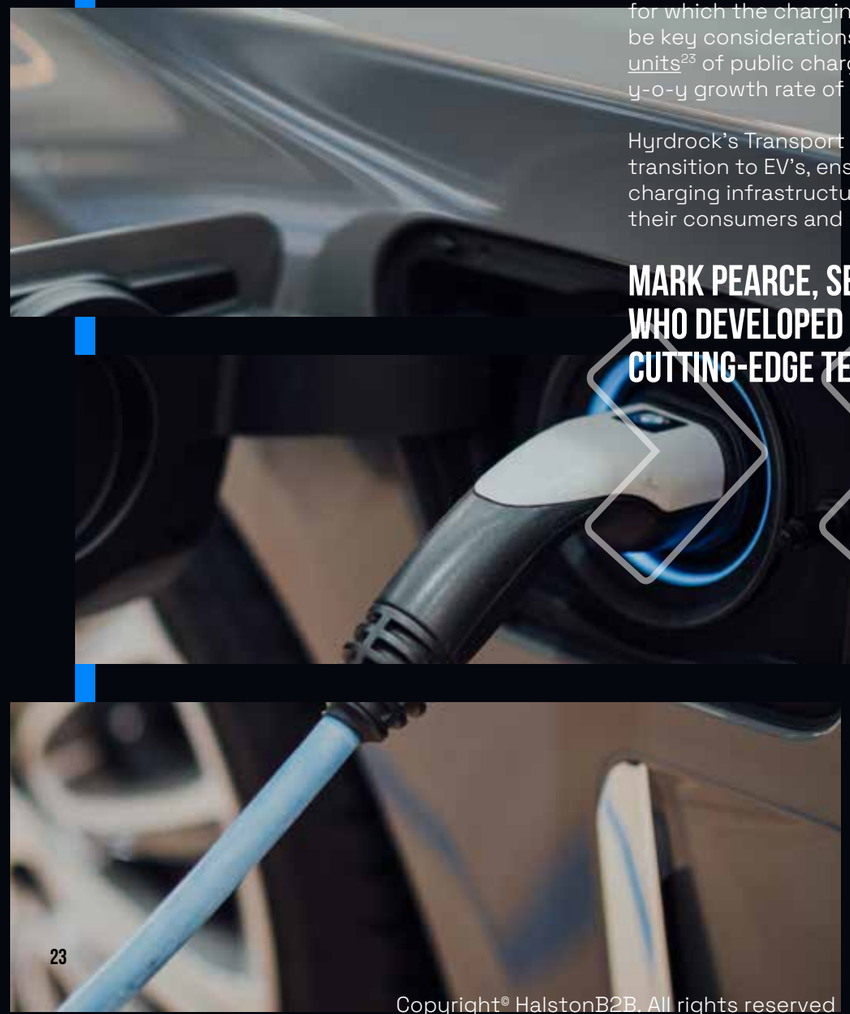
GRAPH 8

COUNTRY RANKINGS- EV COUNTRY READINESS INDEX



1. CHINA
2. SWEDEN
3. GERMANY
4. UK
5. SOUTH KOREA
6. US
7. JAPAN
8. CANADA
9. ITALY
10. INDIA

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Whilst automotive manufacturers are holding up their end of their bargain, the adoption rates still need considerable uptake, and one of the main areas halting consumers from transitioning over to EV's is it having the same level of convenience as petrol, for which the charging infrastructure and cost will be key considerations. In 2020, there were 1.3 million units[23] of public chargers reported, and expected a y-o-y growth rate of 45%.

Hyrdrock's Transport Division is helping ease the transition to EV's, ensuring businesses implement a charging infrastructure that reflects the needs of their consumers and one that has a strong ROI.

MARK PEARCE, SENIOR DATA ANALYST WHO DEVELOPED STRATEV, EXPLAINS THIS CUTTING-EDGE TECHNOLOGY.

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StratEV is a revolutionary tool that enables businesses and councils to better prepare for the EV transition and more accurately predict the charging needs in their area or site. It compiles a range of datasets both historical and live to give an accurate picture of potential demand. Essentially it uses big data to get a correct output and the algorithm behind it enables us to determine trends based on the possible ways that EV demand will change, specific to the requirements of our clients.

StratEV uses current data to understand travellers' origins and where they are going. It lets us know how far EV drivers will have travelled, which helps us to estimate the battery percentage left in the vehicles. Weather profiles allow us to estimate how efficient the battery is. This all helps us to figure out whether EV drivers are likely to charge or not at certain locations and how much they would need to charge - meaning we can advise our clients based on what they actually need to invest in and when.

StratEV predicts the future based on different scenarios, ranging from the assumption that we'll achieve net-zero as planned, through to a worst-case scenario where EV sales don't take off as predicted. We provide the client with this information and then give them the tools to watch how uptake is going so they can see which scenario is most relevant, and so they can determine the number of charging points they may need. It's flexible and adapts over time.

The tool enables our clients to make more data-driven decisions about their EV infrastructure investment, but it also provides insight on how they can capitalise on their site. For example, big car parks are often really quiet overnight, so we look at alternative uses such as night time EV charging for logistics companies' vans. That gives the retailer or landlord more revenue, and reduces infrastructure costs for the delivery company.

Another way that we reduce costs is by looking at times of the day when charging is at its highest and whether a battery storage system would help meet that power demand without having to upgrade the grid connection.

- Mark Pearce, Senior Data Analyst, Mobility Analytics Division, **Hydrock**

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5.2 AGRI TECH



Feeding the future population is of paramount importance, especially since food production needs an increase of 70% by 2050, according to the UN.[24] That's not all, agriculture is currently responsible for 25%[25] of global greenhouse gas emissions, and the future of food needs to be achieved sustainably.

At the forefront of this monumental challenge is AgriTech. The industry is innovating to adapt to new practices that have less of an associated footprint. Technological advancements and new ways of thinking are supporting an adapted sustainable food system. To prepare for the future there have been developments in micro-farming, alternative proteins, vertical/indoor farming, vegan products and crop precision technologies.

Unicorn GreenTech Beyond Meat is a prime example of the demand for exciting AgriTech companies. Its plant-based alternatives reduce reliance on meat and have an exponentially lower associated carbon footprint and the company is now worth $3 billion.[26]

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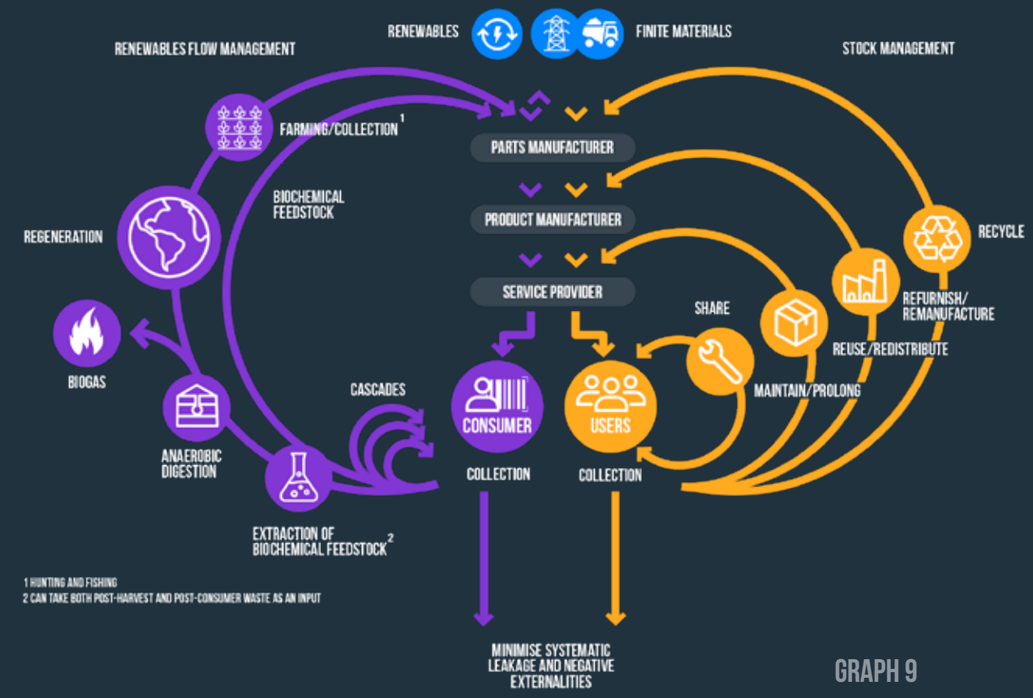
CIRCULAR ECONOMY 5.3

A circular economy is regenerative by design, transitioning from the make and waste framework to one that is circular by design and follows the principles of recycle and reuse. The model considers both production and consumption and involves decoupling from consuming finite resources and circulating product and materials.

The circular economy is built on the attitude of re-think and re-design. How can we redesign a manufacturing process to release less emissions? How can we produce the same product without the use of finite materials?

The Ellen MacArthur Foundation[27] developed the butterfly diagram to illustrate the continuous flow of technical and biological materials through the value circle. All of which is based on three principles:

- DESIGN OUT WASTE AND POLLUTION
- KEEP PRODUCTS AND MATERIALS IN USE
- REGENERATE NATURAL SYSTEMS



GRAPH 9

SOURCE: ELLEN MACARTHUR FOUNDATION

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GreenTech companies across the globe are innovating incredible solutions to minimise the impact of production processes, through efficiency or delivering innovative ways to reuse the waste that is unavoidable.

TRIBOSONICS HAVE TAKEN AN INNOVATIVE APPROACH TO REMOVE WASTE FROM MANUFACTURING PROCESSES BY FOCUSING ON TRIBOLOGICAL CONTACT.

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Tribology is the study of wear, friction and lubrication and it's incredibly important. 23% of the world's energy is lost through tribological contact. If you begin to make inroads in their area for major sectors, then you can make massive savings. Having said, that we focus primarily on the customers' needs to drive sustainability and create value and we innovate to provide the right solutions across all aspects of their business, whether that has a tribological angle or otherwise.

To best explain our technology, we can use the polymer industry as an example. Within their process, they have a screw and barrel system that's part of extrusion or injection moulding machines. What we have been able to achieve through our innovative technology is measuring the screw and barrel wear. We measure the gap between the edge of the barrel and the screw going round because as it pushes through the polymer it wears and at some point the machines have to be stopped and taken apart to replace the screws. Manufacturers and operators wanted a way to non-invasively measure the wear and conduct predictive maintenance. We have a transducer that sends an ultrasonic wave into the system where encoded data is sent back and captured, this is then decoded through an algorithm to become meaningful data with a series of measurements that can be formatted to their needs. It provides information that has never been available before in the polymer industry and it's providing all-round visibility on asset performance.

- Christina King, CCO, **Tribosonics**

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5.4 EMISSIONS CONTROL & REMOVAL



Carbon capture is exactly what is says on the tin. It is the act of capturing carbon dioxide, removing it from the atmosphere and storing it deep underground in geological formations. It is considered a ClimateTech as it actively looks to remove the carbon emissions that already exist in the atmosphere.

Carbon capture is a very specific technology and has been one of the hardest to master, but those that have are experiencing incredible levels of investment. For example, Massachusetts-based Verdox has raised an astonishing US$80 million[28] from investors, including tech billionaire Bill Gates' Breakthrough Energy Ventures.

HOW DOES IT WORK?

CARBON CAPTURE WORKS BY SEPARATING CO2 FROM THE AIR OR EXHAUST GASES FROM FACTORY SMOKESTACKS. MANY CURRENT TECHNOLOGIES UTILISE LIQUID SOLVENTS TO ATTRACT CO2 LIKE A MAGNET PULLS IRON FILINGS. THE LIQUID CAPTURES THE GAS AND IT'S HEATED TO A TEMPERATURE THAT ALLOWS THE CO2 TO BE RELEASED, WHICH THEN CAN BE COMPRESSED AND INJECTED DEEP UNDERGROUND FOR STORAGE. HOWEVER, THE TRADITIONAL METHOD USES A HUGE AMOUNT OF ENERGY, WHICH IS THE PRIMARY REASON IT REMAINS SO EXPENSIVE AND THEREFORE HINDERING ITS SCALABILITY.

VERDOX TECHNOLOGY CLAIMS TO BE MORE EFFICIENT AND THEREFORE CHEAPER. THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY SPINOFF HAS DEVELOPED A SPECIAL TYPE OF PLASTIC THAT CAN SELECTIVELY PULL OUT CO2 FROM A MIX OF GAS, IN THE AIR OR EXHAUST, WHEN CHARGED WITH ELECTRICITY. ONCE TRAPPED, A CHANGE IN VOLTAGE RELEASES THE CO2. THE START-UP SAID ITS MATERIAL COULD CUT THE TOTAL ENERGY USED IN DIRECT AIR CAPTURE BY 70% OR MORE. THE START-UP WILL HAVE TO RELY ON LOW-CARBON ELECTRICITY TO POWER THE PROCESS.

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Technologies such as these could be a game changer for carbon capture, harnessing its capability to become more accessible to a wider range of businesses. Companies will no longer be fully reliant on carbon offsetting where the return and actual proportion of carbon offset is often hard to predict, particularly when planting trees where you cannot guarantee growth and lifespan.

Whilst carbon capture is an exciting and growing area, at this point in time it's still very much in a concept phase and remains very expensive due to the nature of the process, limiting its scale and adoption potential.

EMISSION CONTROL TECHNOLOGY

PACIFIC GREEN TECHNOLOGIES GROUP HAVE DEVELOPED A GROUND-BREAKING EMISSION CONTROL TECHNOLOGY, THAT IS ENABLING CLIENTS WORLDWIDE TO MINIMISE HARMFUL POLLUTANTS TODAY! TONY GRAINGER, COO, EXPLAINS THEIR TECHNOLOGY FURTHER.

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Our scrubbing technology can be used to remove harmful pollutants from a wide variety of combustion gas streams. These include coal-fired thermal power plants, diesel engine exhaust and waste-to-energy plants burning municipal and industrial solid waste. Our principal target pollutants are acid gases such as sulphur dioxide and particulate matter in the form of ash and other solid combustion by-products.

Our technology is based on creating a high energy interaction between the polluted exhaust gas and the appropriate reagent solution, using one or more layers of our patented TurboHead™ technology. The TurboHead™ produces a turbulent froth comprised of tiny bubbles, formed by the exhaust gas passing through the reagent solution.

Sulphur dioxide is a noxious pollutant that has largely been eliminated from ambient urban air by reducing the sulphur content of automotive fuels, and scrubbing the exhausts of coal-fired power plants using flue gas desulphurization (FGD) systems.

A major sources of sulphur dioxide is from ship engine exhausts. Pacific Green's ENVI-Marine™ Exhaust Gas Cleaning system removes the sulphur dioxide from ship engine exhausts down to a level that is equivalent to the permitted, lower sulphur fuel limits, thus making it possible for ships to burn heavy fuel oils, for which they were designed, with a sulphur content that is as high as 3.5%.

These fuels are less expensive than the regulated lower sulphur fuels with a maximum sulphur content of 0.5% and in SECA (Special Emission Control Areas), a maximum sulphur content of 0.1%. They also have a lower carbon footprint, when measured "well to wake".

In the case of marine applications, the absorption and neutralizing agent is seawater, which is sprayed onto the TurboHeads to form a high surface area froth for gas-liquid interaction with the ship engine exhaust, removing the sulphur dioxide with high efficiency. The sulphurous and sulphuric acids formed when the seawater absorbs the sulphur dioxide are neutralized by the carbonates found naturally in seawater to form sulphates. When discharged into the ocean, the sulphates add to the enormous quantity of dissolved sulphate already in the ocean. Sulphates are the third most common ion found in seawater after chlorides and sodium, and exist in equilibrium with other elements such as magnesium, calcium and potassium to form minerals that deposit on the ocean floor. Other potential pollutants are also monitored in the scrubber effluent to make sure the ocean environment is not harmed by the discharged water.

Land-based operations such as thermal coal-fired power plants and waste-to-energy, utilize limestone slurry or hydrated lime solutions as reagents. These calcium-based slurries react with acidic components in the combustion exhaust gas to form calcium-based compounds. In the case of sulphur, it is calcium sulphate commonly known as gypsum. The gypsum is separated from the reagent slurry using hydro-cyclones, to concentrate the slurry and machines such as a vacuum belt filter to dewater the slurry resulting in a gypsum cake. This gypsum can be combined with natural gypsum (which is mined) to make gypsum board (interior drywall or wallboard) or non-structural concrete products.

- Tony Grainger, COO, **Pacific Green Technologies Group**



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TALLARNA TAKES A DIFFERENT APPROACH TO EMISSIONS' CONTROL.

THEY DELIVER TECHNOLOGY-LED, RISK-MANAGED FUNDING FOR DECARBONISATION BUILDING PROJECTS.

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Britain has some of the leakiest homes in Europe, with approximately 35% of heat escaping through our walls. Greater emphasis must be placed on reducing this inefficiency as the more energy needed to heat a home, the more fossil fuels burnt.

Tallarna's retrofit ecosystem helps large-scale landlords reach their decarbonisation and energy efficiency targets by connecting all parts of the building value chain. Customers are empowered to identify, design, insure, fund, and contract projects in one place.

Our holistic approach enables a 60% reduction in carbon emissions per building on average. However, further reductions are possible and encouraged.

Our AI platform, KESTREL, works by identifying optimal decarbonisation measures for thousands of properties at a time. It forecasts projects' Return on Investment (ROI) and carbon savings, and quantifies their risk of underperformance. This empowers guaranteed retrofit outcomes and access to off-balance sheet, efficient finance.

We specialise in the social housing sector but our AI platform is applicable to commercial real estate and, soon, industrial facilities.

- Tim Meanock, CEO, **Tallarna**

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5.5 SMART ENERGY

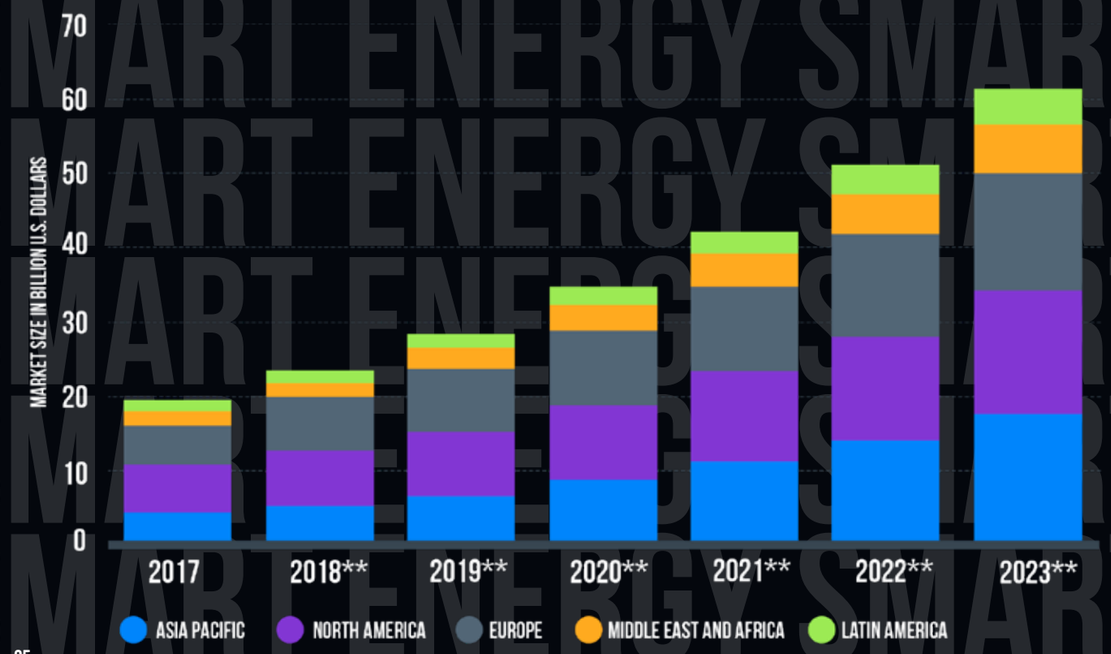
As we evolve to a carbon neutral energy infrastructure, the way we produce and consume energy must categorically change.

Smart energy encompasses smart metering, new forms of grid management, energy storage and a wide variety of other technologies that are enabling companies and consumers alike to use energy more efficiently, and therefore reducing their carbon footprint. Not only this, smart energy focuses on powerful and sustainable energy sources that promote greater eco-friendliness.

GRID MANAGEMENT

The current grid infrastructure and system cannot yet support the modern era of renewable energy and so new ways of operating, upgrading and implementing alternative infrastructures will become paramount to supporting the renewable energy transition.

To be able to effectively shift our energy supply, we must create a 'smart grid'. Essentially, a smart grid is an electricity network enabling a two-way flow of electricity and data, meaning the grid has greater visibility over current demand and for consumers to have greater control over consumption. A smart grid can detect, react and even pro-act to energy usage.



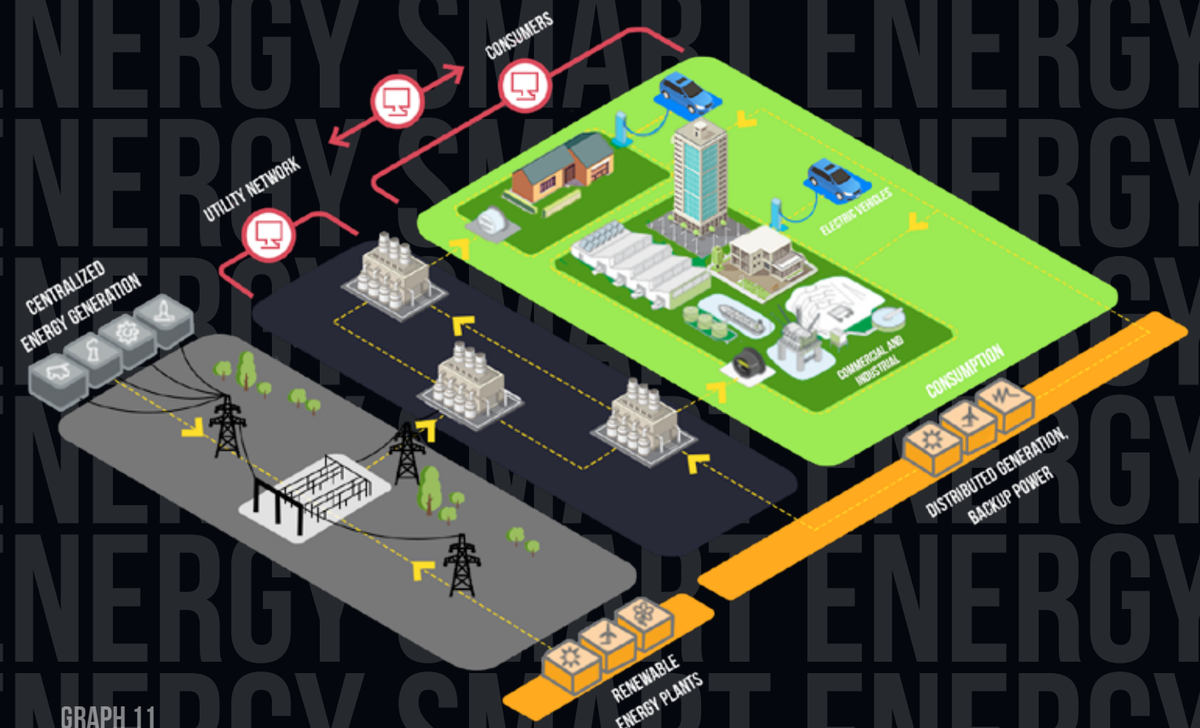
SOURCE: STATISTICA

GRAPH 10

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The market value of smart grids in Europe is anticipated to reach just over £15 billion[29] by next year. Driving factors promoting the upgrade of the current grid infrastructure are the adoption of more renewable energy sources, the EV charging point movement, decentralisation and the rise of microgeneration and microgrids.

To achieve this reactive energy infrastructure, big data analytics, IoT and smart metering are often applied to create a fountain of information. The innovative technologies are the ones that will be enabling the grid to modernise.



GRAPH 11

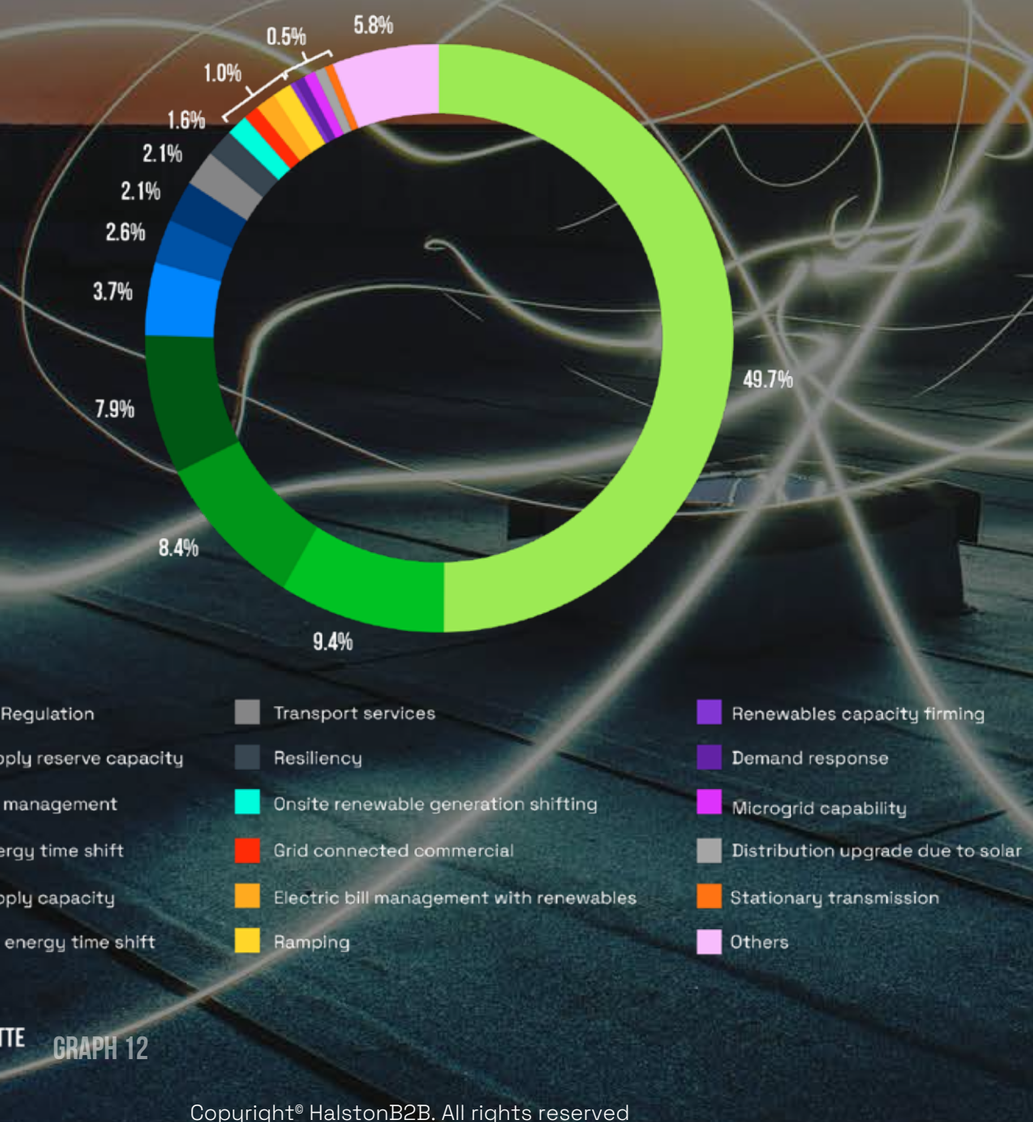
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ENERGY STORAGE

The modernisation of the grid is not going to be plain sailing and energy storage is a critical element that will support the grid, decentralising energy production, consumption and storage.

According to Deloitte,[30] the most common use for battery storage globally is frequency regulation, followed by reserve and bill management.

GLOBAL BATTERY STORAGE CAPACITY BY PRIMARY USE CASE



SOURCE: DELOITTE GRAPH 12

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POWERSTAR, WHO ARE PROVIDING RESILIENCE FOR A NET-ZERO WORLD EXPLAIN HOW THEIR POWER STORAGE CAPABILITIES CAN ENABLE BUSINESSES TO INSULATE THEMSELVES FROM EXTERNAL CHANGES.

Our core technology is a battery storage system that's used on a commercial or industrial site and a control system which then manages the electricity through that battery. It decides when to charge and discharge the battery in order to make the electricity for the site as reliable, as green and as cheap as possible. It can balance those different requirements however the customer wishes. The complexity of this is increasing as everybody strives towards net zero. Sites may now be generating their own electricity on-site with renewables, and adding in more electric technology. Electric vehicles and electrified heating, such as heat pumps, have big impacts on an organisation's electrical demand. We can help manage those big peaks in electrical requirements, we can help connect them to the grid and we can help make them as efficient as possible.

- Alastair Morris, CCO, **Powerstar**

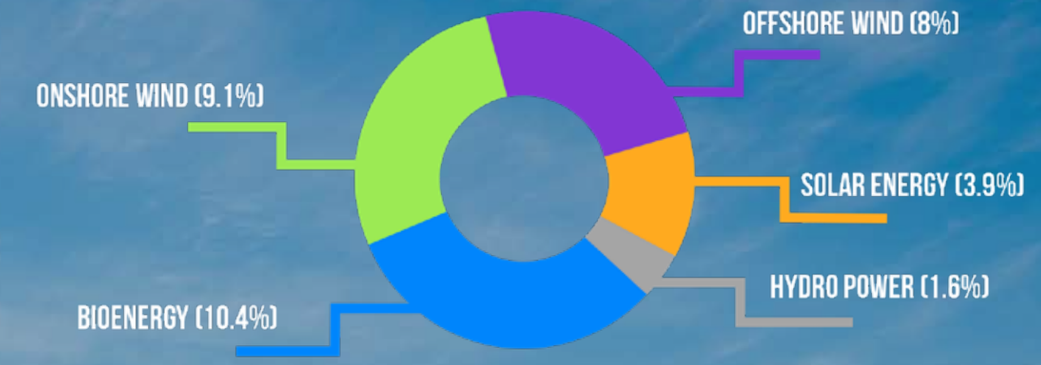
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5.6 CLEAN ENERGY

CLEAN ENERGY IS POWER GENERATED FROM RENEWABLE, ZERO EMISSION SOURCES THAT DO NOT POLLUTE THE ATMOSPHERE. WHILST THERE IS A DEGREE OF CROSSOVER BETWEEN RENEWABLE AND GREEN ENERGY, GREEN ENERGY DOESN'T NECESSARILY NEED TO BE NATURALLY REPLENISHED. CLEAN ENERGY SOURCES WORK TO PRODUCE POWER WITHOUT HAVING NEGATIVE ENVIRONMENTAL IMPACTS, SUCH AS THE RELEASE OF CARBON DIOXIDE BUT ALSO REMOVE IN-DIRECT NEGATIVE IMPACTS SUCH AS OIL SPILLS AND GAS LEAKS THAT CAUSE DISASTROUS HARM TO THE SURROUNDING ENVIRONMENT.

RENEWABLE ENERGY SHARE IN THE UK

In the UK, renewables comprised 33% of the energy generation for 2018. The biggest share went with bioenergy production, while solar energy finished on 4th position.



GRAPH 13
SOURCE: GREENMATCH

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SOLAR POWER

One of the more widely known forms of clean energy is solar power. Solar power works by converting energy from the sun into power, more specifically electricity and heat. The current composition of renewables in the UK energy generation is around 33%, from which solar is 4%.[31]

Solar power is anticipated to grow steadily in the UK over the next few years, for example the estimated capacity by 2023 is 15,674 M.[31] Yet, solar power is not expected to be one of our majority energy sources for the simple fact that the UK does not have a sunnier climate that experiences higher levels of solar concentration, so the ROI is relatively low in comparison to other sources. However, there is a lot of innovation that is being driven here in the UK which is making solar generation more cost-effective for the UK or exporting to those regions who have hotter climates.

Solar panels are typically made from silicon installed in a metal panel frame with a glass casing. When protons, or particles of light, hit the thin layer of silicon on the top of a solar panel, they knock electrons off the silicon atoms. The PV charge creates an electric current which is captured by the wiring in solar panels. The direct current electricity is then converted to alternating current by an inverter.

Traditional forms of solar panels require a high CapEx and that has therefore been hindering their adoption rates across both businesses and consumers. However, Power Roll is flipping solar generation on its head, with their revolutionary solar film concept. Don Scott, CCO explains their innovative technology further.

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> We have developed a completely new way to generate solar power. We utilise microgrooves that are embossed into a flexible substrate that are 40 times smaller than a human hair. Each microgroove acts as individual solar cells and can be connected in virtually any series and parallel configuration to generate the energy required for various applications.

Power Roll fits within the GreenTech category as we can create clean energy from the sun and achieve this in a way that has a low carbon footprint. Solar film is made via roll-to-roll manufacturing, very similar to crisp packets and wallpaper, which has exceptionally lower cost production than traditional silicon PV panels. Due to the automated roll-to-roll manufacturing process, it can be produced cost-effectively anywhere in the world. Meaning, solar energy can be produced where it is consumed rather than being shipped from Asia to local markets.

It's not just the cost-efficiency of the film either; the CAPEX investment required for the solar film production facility is considerably lower than silicon PV. Take, for example, a gigawatt manufacturing facility: a billion watts a year of solar PV in silicon to build that factory would require a capital investment of approximately $250-$300 million, whereas the CAPEX required for a gigawatt factory for solar film is roughly $40 million. So, the level of investment that is needed to produce an equivalent amount of energy is considerably lower, and therefore so is the accessibility to the products.

If energy is cheap, easy to generate, and can be produced by the people and organisations using the energy, people can have access to much more energy and different energy-related services that they do right now. With affordable green energy we can see the transition from carbon as an opportunity to take a step forward." Abundant, cheap and clean energy – produced where it is needed, whether on a large warehouse or small farm.

Aside from the cost aspect, solar film has the capability to be more adaptable to various environments and applications.

> AS AN EXAMPLE, THE MILLENNIUM DOME HAS 90,000 SQUARE METRES OF SURFACE AREA ALL SITTING PROUDLY UNDERNEATH THE SUN WHICH IF COVERED WITH SOLAR FILM WOULD HAVE THE POTENTIAL TO POWER 2,000 HOMES! THE DOME HAS A ROUNDED SHAPE AND IS ALREADY COVERED IN CANVAS FABRIC, WHICH IS A SURFACE WE CAN UNIQUELY ADAPT TO. WE HAVE THE CAPABILITY TO TURN THE DOME INTO A POWERHOUSE. ONLY 2% OF THE WORLD'S ROOFTOPS ARE PV ENABLED, AND WE COULD TURN WAREHOUSES, DATA CENTRES, ALL TYPES OF INDUSTRIAL BUILDINGS INTO POWERHOUSES.
>
> - Don Scott, CCO, **Power Roll**

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Solar power isn't purely a source for direct power generation or to be fed into the grid, Solar Water PLC are solving the water crisis through the power of the sun. James explains this unique technology further.

Our GreenTech solution focuses on both sustainable water and renewable energy. Existing solutions in both of these sectors tend to create a significant carbon footprint in the world, Solar Water PLC's aim is to provide a solution that solves water scarcity and mitigates against climate change.

Our technology will play a significant role in solving growing issues for millions of people and the future of how we live. This is sustainability in action to combat the planet's fresh water crisis.

Solar Water's technology spans across both the energy and water side of the desalination systems, as well as pure renewable energy provision. Our ambition is to make desalination and energy provision as sustainable and environmentally-friendly as possible.

We use no fossil fuels for our energy needs, versus the existing traditional industry solutions that use high levels of fossil fuels.

Our concentrated solar power technology rotates on two axes to follow the path of the sun through the day, for optimal efficiency. Our solar concentrators harness the sun's energy into a connected fixed focal point, with temperatures reaching 1,200 degrees C and above. This energy then drives our water desalination system, a new approach for desalinating water, converting saline water from either the sea or brackish sources to fresh or potable water. Solar Water's desalination innovation design remains under confidentiality.

Our overall solution is completely decentralised from the grid and self-contained. By being 100% off-grid and decentralised, we can assure our clients and their mid-scale needs, can be fully contained and self-sustaining and receive a pure sustainable and carbon-zero supply. In contrast, centralised systems or systems that supply and draw from the grid ("grid top-ups"), will be using a blend of energy from different sources, and for many years to come this will remain majority fossil fuels, so can offer only a partial green solution if any at all.

Solar Water's pure green solution also doesn't have variable costs over the multi-decade lifetime of a plant and offtake agreement, versus fossil fuel driven solutions that suffer from significant, unknown variations in energy costs – just look at the variation in the price of oil recently from $60 per barrel to $150+. These two approaches then have diametrically opposing impacts for commercial planning over the mid-long term.

Our innovative 5th generation CSP concentrators also have advantages over classic solar PV-driven systems:

- the unique energy storage capability allows longer-term thermal energy storage, which can be slow-released and used to drive and operate the desalination system past daylight hours, through the night, 24 hours a day, 7 days a week. Classic solar PV only works through daylight hours and the majority of energy storage used, such as batteries, can only store for 4-5 hours for use.
- the unique technology operates at higher efficiency rates in higher temperatures and solar radiation levels; with such increases, classic solar PV reduces in effectiveness. This is critical in parts of the world with highest temperatures and levels of solar radiation that equally suffer from the worst levels of water scarcity, such as the Middle East, Africa, Australia, the West Coast of America and South America and parts of Asia.

- James Whitehead, CCO, **Solar Water PLC**

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WIND

Wind power has been at the forefront of the renewable energy transition, particularly here in the UK, with wind farms being deployed across both off-shore and on land.

Electricity generation from wind power in the UK has increased by 715%[32] from 2009 to 2020 and the UK is home to the largest offshore wind farm in the world, located just off the coast of Yorkshire. In 2020, the UK generated 75,610 gigawatt hours (GWh) of electricity, which would be enough to power 8.4 trillion LED light bulbs.

As the drive for electrification gathers pace, new wind power buyers are coming forward. The number of businesses signalling their interest in buying clean power is growing. The RE100 group[33] of companies, which is committed to sourcing 100% of their electricity from renewable energy, has more than doubled its membership over the past few years, from 155 in January 2019 to more than 330 in September 2021.

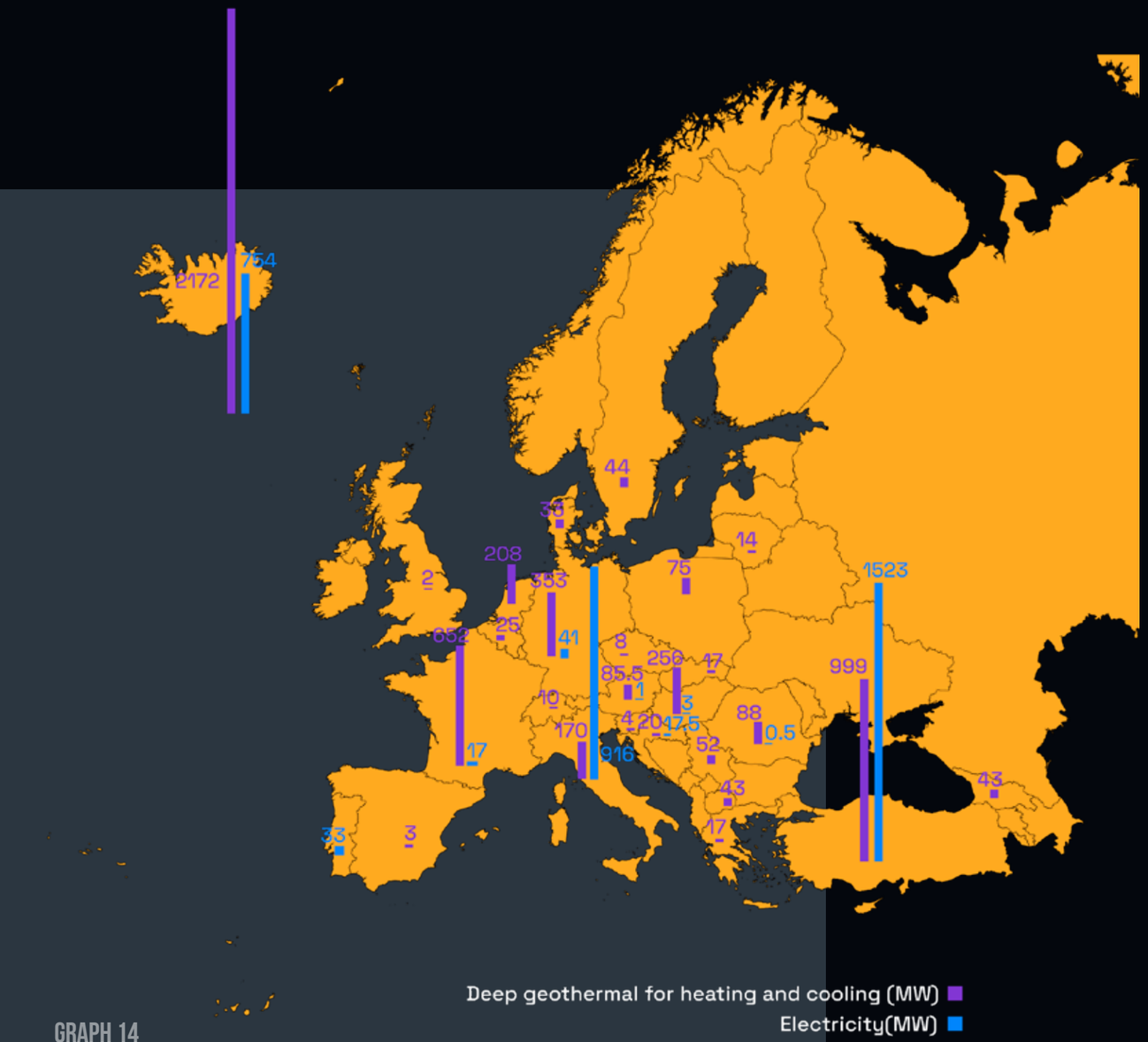
Whilst the industry is certainly progressing in the right direction, there is still considerable scale that needs to be achieved, in order to contribute to the full decarbonisation of the UK energy infrastructure. This won't just be owned by the larger players in the market, smaller wind turbines are empowering businesses and communities to decarbonise their energy production and manage their energy costs. Decentralised low carbon generation will be at the heart of a smart energy system, by deploying a greater use of local generation and flexibility to meet local demand spikes. Technological developments are also enabling those to participate more actively in the energy system.

As technology matures, advancements are on the horizon to extend the lifespan of wind turbines and enable them to be more reactive to energy demands.

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GEOTHERMAL

Geothermal energy is heat derived within the sub-surface of the earth. Depending on its characteristics, geothermal energy can be used for heating or be harnessed to generate clean electricity. The geothermal energy market has been growing at a fast pace in Europe since 2019, and the number of operating power plants (130[34] in 2019), with baseload could double in the next 5-8 years.



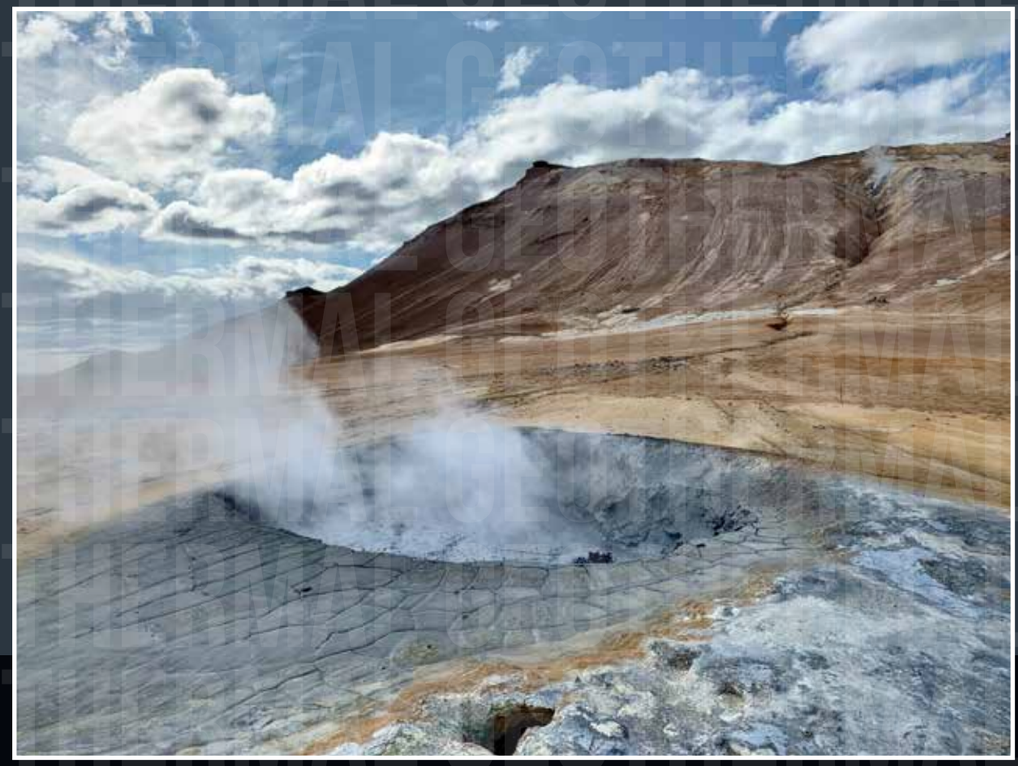
GRAPH 14

SOURCE:ECEG

Iceland is a pioneer in the use of geothermal energy for space heating, and currently 90%[35] of their primary energy use comes from renewable sources, which around 70% comes from geothermal.

The core advantage of using geothermal compared to other renewable sources is that it's not dependent on weather conditions and has very high-capacity factors; for the fact it is capable of supplying baseload activity as well as ancillary services. CeraPhi specialise in geothermal production and Karl Farrow explains why it's so critical to add geothermal into the energy mix.

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66

The great thing about our solution is that it doesn't rely on the grid network. One of the challenges with renewable energy as we see it today is that it feeds into the same grid as everything else, so the actual benefits get diluted. Whereas, if you are doing it behind the fence, you're delivering renewable energy directly to a source.

I think we have a massive challenge ahead of us. We have been building wind farms and solar arrays for the best part of 20-30 years at a scalable, commercial level and we are still only at 11-12% of the global capacity of renewable energy. And we are trying to get to net-zero in the same timeframe. What geothermal will bring to the table, if it's scaled with importance, is that baseload element to be able to underpin baseload energy quickly and in a scalable manner. Then we have large amounts of energy being supplied to the grid in a fairly quick period of time and it enables us to transition the oil and gas industry more effectively. Geothermal is very suited for transitioning expertise over from the oil and gas sector, due to its subsurface exploration type approach.

- Karl Farrow, CEO, **CeraPhi**

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HYDROGEN POWER

Hydrogen is the most abundant element in the universe and has become a huge talking point in the market due to its ability to unlock the potential of other green power sources. Hydrogen enables excess energy created through wind and solar sources to be stored, levelling the supply of those weather-dependent renewable sources. Green hydrogen can be produced when the supply of renewable energy is greater than its demand, the surplus electrical current is passed through water which causes electrolysis, and the hydrogen created at this point can be stored and transported.

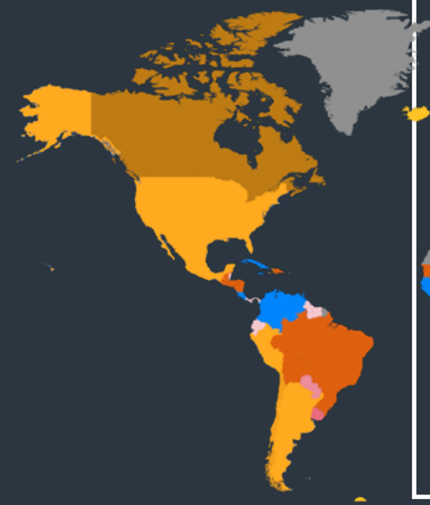
It can be used directly (especially as fuel), injected into the natural gas supply network or converted back to electricity. When captured hydrogen has potential to power cars, buses homes and even cities.

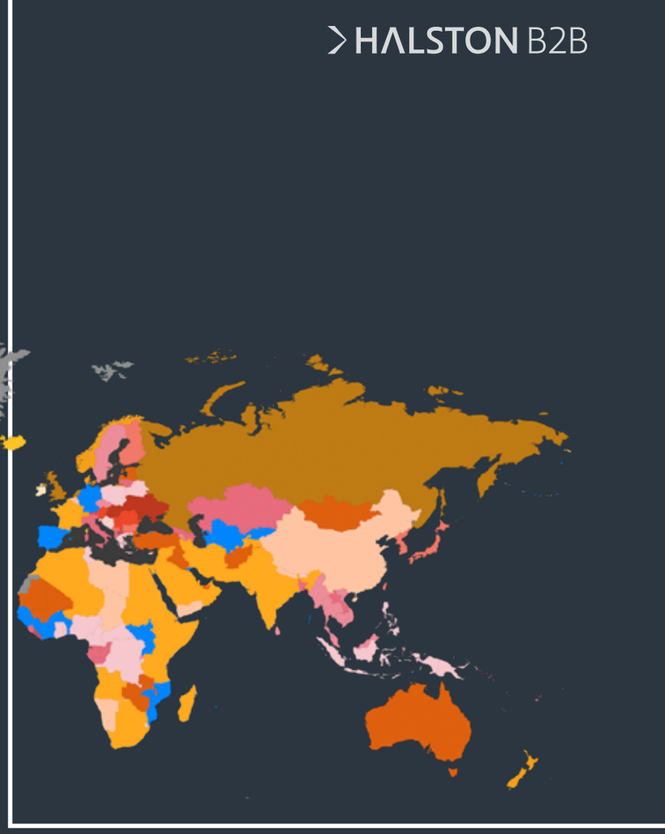
According to PwC,[36] hydrogen demand by 2050 could vary from 150 to 500 million metric tonnes per year, depending on global climate ambitions and a multitude of external factors. A major focus in the industry right now is driving down the cost of developing 'green' hydrogen and making the storage and transportation aspect more effective. PwC shows that the current costs for hydrogen globally sits around to 5-7€kg mark, but could swiftly drop to 3-4€kg by 2030.

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2020

8€/KG
7€/KG
6€/KG
5€/KG
4€/KG
3€/KG
2€/KG
1€/KG

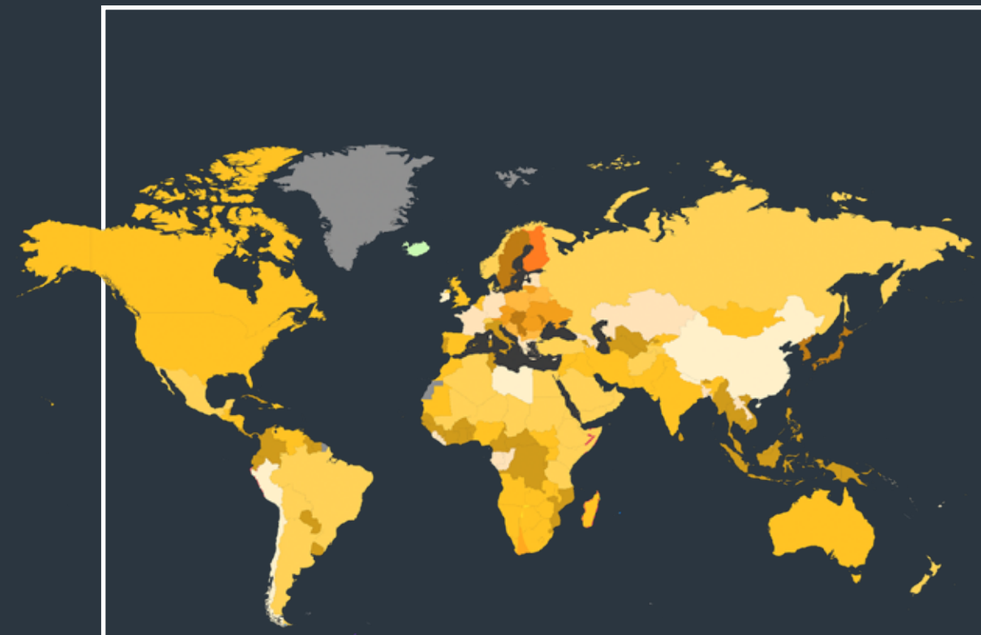




SOURCE:PWC

2030

8€/KG
7€/KG
6€/KG
5€/KG
4€/KG
3€/KG
2€/KG
1€/KG



SOURCE:PWC

GRAPH 15

SECTION 6:

GREENTECH TRENDS

THE GREENTECH MARKET IS CONTINUALLY EVOLVING AND THE PAST COUPLE OF YEARS HAS BEEN THE FASTEST PACE OF CHANGE THE INDUSTRY HAS EVER EXPERIENCED. WITH SUCH IMMENSE SHIFTS IN THE MARKET, IT CAN BE HARD TO DETERMINE WHAT DIRECTION THE MARKET IS GOING AND WHICH TECHNOLOGIES WILL STAND THE TEST OF TIME AND ULTIMATELY BE EMBRACED BY ADOPTERS.

TO DELVE A LITTLE DEEPER, WE SPOKE TO THOSE INGRAINED IN THE SUB-SECTORS TO UNDERSTAND THE TRENDS THEY SEE EMERGING.

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6.1 GREATER NEED FOR BATTERY STORAGE

One immediate need that is becoming apparent is the necessity for battery storage within the energy infrastructure. Alastair Morris explains further.

> Implementing some form of battery storage is already important, but it will become increasingly so over the next 10 to 15 years. As the UK transitions to renewable generation at a national level, there's going to be a big shift in our relationship with our electricity supply. It's going to become much more variable and much less stable. There's the obvious fact that renewable generation suffers from seasonal variations. Then there's the less understood elements of variations in voltage and frequency of the electricity that's supplied by renewables. And it's going to create a lot more risk for organisations in terms of disruptions to their power. So, blackouts, but also what we call brownouts will become more of an occurrence - these create a drop in supply, which can damage and interrupt electrical equipment.
>
> The volatility of pricing will also continue. With battery storage on site, businesses can insulate themselves from these risks to protect their bottom line from fluctuations and variations.
>
> - Alastair Morris, CCO, **Powerstar**

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6.2 THE YEAR OF THE EV

The automotive sector is accelerating the design and development of electric vehicles at a steadfast pace and EVs sales are now outpacing combustion engines in the new car market.

> We think the industry is way ahead of government legislation. The future ban on petrol and diesel cars has been a major motivation, but the industry is pushing on at a rate which requires consultants and government alike to closely follow developments.
>
> This year is the year of the EV, when EVs will come to market at the same price point as internal combustion engine cars - that's going to be an absolute game changer in terms of accessibility. Alongside that, the speed of charging is going to keep improving - the range, practicality and costs – the improvements will be universal.
>
> - James McKechnie, Divisional Director for Transport Planning, **Hydrock**

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6.3 GREATER AWARENESS

IN ORDER TO MAKE A CHANGE, YOU MUST FIRST BE AWARE OF THE PROBLEM.

Sometimes businesses are not aware as to what is happening on their shop floor and a trend that we are seeing at the moment is them understanding how they can do more with the same or fewer resources. A lot of this is through smart factories, smart power and smart components and we are seeing movement towards this way. This is coupled with a lot of businesses now having sustainability and ESG targets front and centre on their agenda and the leadership teams are championing this way forward.

- Christina King, CCO, **Tribosonics**

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6.4 DEMOCRATISATION OF POWER GENERATION

To make the level of carbon reduction that is required, solutions must be accessible to all and offer flexibility to users.

One thing I am excited about is the idea of democratising power generation and storage, but even further than this of using a mobile battery source; using your car as a power source for your home. Your car could be charging at work all day and then be used to power your home in the evening. I think the idea of using the car as the primary storage and that two-way transcribing is an exciting idea that is being piloted and tested already.

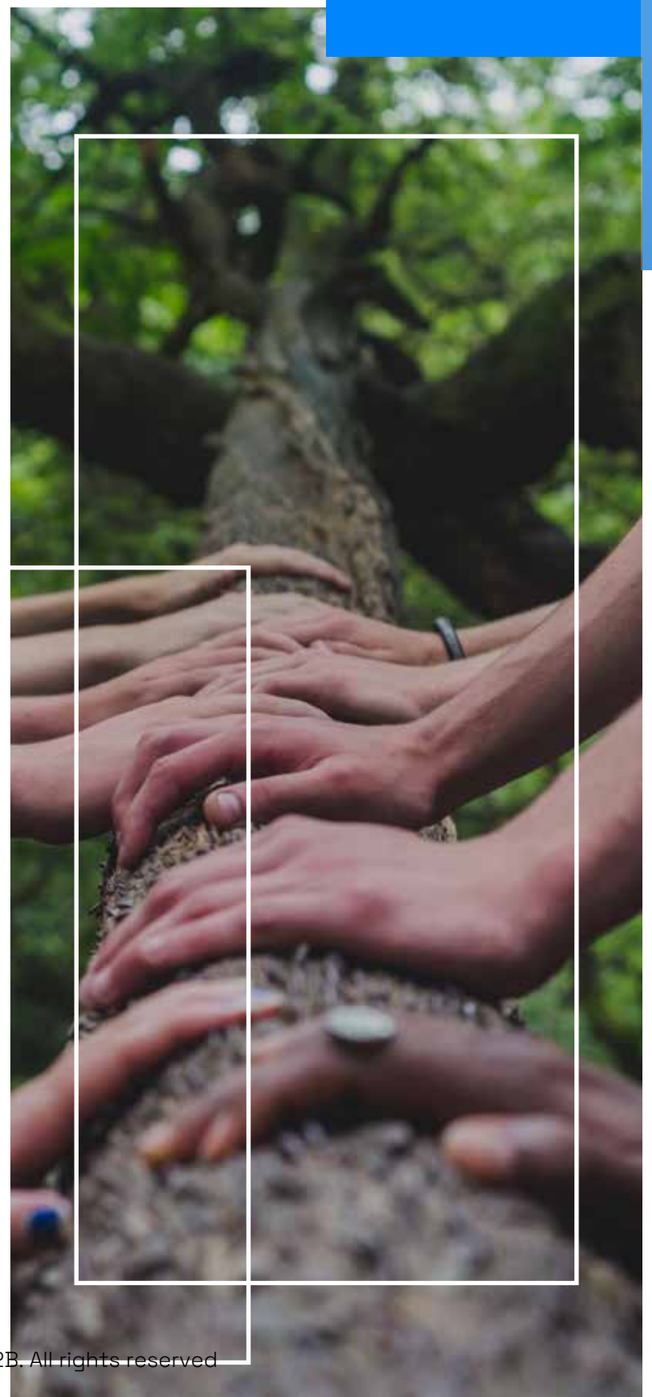
- Don Scott, CCO, **Power Roll**



6.5 COLLABORATION

Climate prevention must be a collaborative approach, including investors, technology providers and adopters.

> A trend we are seeing is more partnerships between small tech companies and larger corporates, and this is happening more in some countries than others. Creating those innovate environments can be quite hard for large companies as they are less agile and have a lot of internal processes. Whereas if they partner with agile and innovative technology companies to actually bolt into their processes, that can drive productisation much quicker across the whole spectrum from ideation, to development, to productisation and commercialisation.
>
> - Glenn Fletcher, CEO, **Tribosonics**



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SCOPE 3 EMISSIONS 6.6

FOR BUSINESSES TO TRULY DECARBONISE THEY MUST LOOK BEYOND THEIR OWN PRACTICES AND CONSIDER THEIR ENTIRE VALUE CHAIN. SCOPE 3 INCLUDES INDIRECT EMISSIONS THAT OCCUR IN A COMPANY'S VALUE CHAIN.

> Scope 3, value chain emissions is the hot topic. Anecdotally many businesses have had their head in the sands when it comes to value chain emissions but now with new legislation coming in businesses are forced to act. Scope 1 and 2 is easier to manage, and businesses already have a good steer on both measurement and emission reduction, scope 3 is the problem area that needs to be addressed.
>
> - Conrad Langridge, Head of Marketing, **Spherics**

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SECTION 7

Venture capitalist investment in climate technologies is once again booming, with technology start-ups combating climate change raising an impressive $32 billion[37] globally last year. This figure has more than quadrupled since 2016. From new battery storage technologies to lab-grown meat, to carbon capture, investors are lining up to put their money behind companies fighting climate change.

CLIMATE FUNDING CLIMATE FUNDING

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US $222BN
invested in climate tech between 2013 and H1 2021

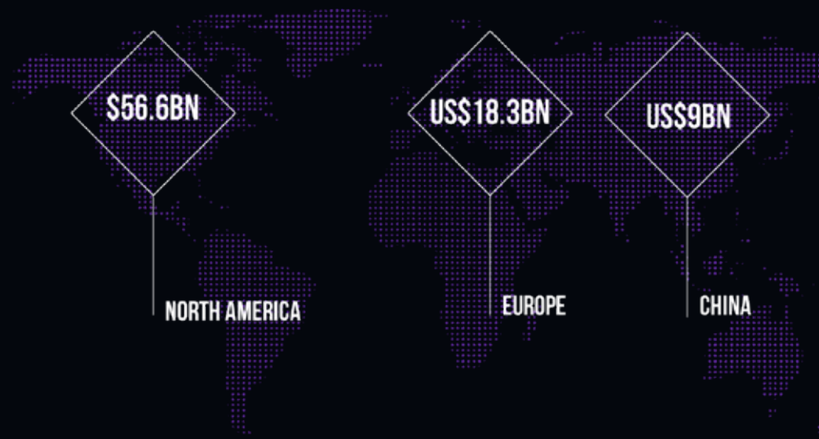
210%
growth in investment year on year

3,000+
climate tech start-ups identified

US$60BN
more than US$60bn invested in climate tech in H1 2021

14%
climate tech investment now accounts for 14 cents of every VC dollar

REGIONAL FINDINGS (TOTAL CLIMATE TECH INVESTMENT H2 2020- H1 2021)



MOST ACTIVE INVESTMENT HUBS (H2 2020-H1 2021)

1. San Francisco Bay Area, CA, US
2. London, UK
3. Berlin, Germany
4. New York, NY, US
5. Boston, MA, US

MOBILITY & TRANSPORT

60% of total climate tech investment

US$132bn invested in the area, more than any other challenge area

133% CAGR

UNICORNS

78 climate tech start-ups valued at US$1bn+

43 of which are Mobility and Transport start-ups

INVESTORS

6,000+ unique investors identified

2,500 active in H2 2020 to H1 2021

1,600 active in H1 2021

IMPACT ANALYSIS

Of the 15 specific climate technology areas analysed, the top five that represent over 80% of future emissions reduction potential by 2050 received just 25% of recent climate tech investment between 2013 and H1 2021.

SOURCE: PWC
GRAPH 16

Findings from PwC,[38] have demonstrated that $222 billion has been invested in ClimateTech between 2013-21, an annual compound growth rate of 84% and this figure has grown exponentially over the past two years.

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7.1 REGIONS

In terms of regions, North America received the highest level of investment with $56 billion between 2020 and 2021, attracting nearly 56% of global venture capital investment. Key players in the market such as Goldman Sachs plan to invest $40 billion[39] in clean energy products over the next decade.

The second largest player in the global GreenTech market is Europe, receiving $18.3 billion in investment between 2020 and 2021. The investment in the region is still booming and will continue to see investment growth over the next 10 years. To accelerate growth in the market even further, the European Commission has announced a partnership with Bill Gates' sustainable energy funding vehicle. The goal is to unlock new investment for CleanTech and sustainable energy projects, totalling up to $1 billion[40] over the next five years. The initial focus of this fund will include green hydrogen, sustainable aviation fuels, direct air capture and long-duration energy storage.

7.2 START-UPS AND SMEs

While investment is strong across the market, there is a strong appetite to support upcoming innovation and propel those smaller firms with exciting new technology. The majority of course is being driven by private investment but there are Government initiatives supporting that as well.

For example, recent plans have been announced by the UK government for an Energy Entrepreneurs Fund, which will have a dedicated budget of up to £30 million[41] to provide financial support to SMEs. They will receive grants to develop and demonstrate new technologies across energy efficiency, power generation, heat generation and energy storage. Aside from the grants, these businesses will also be given support and business development advice led by the Carbon Trust to drive their innovative technology to the market.

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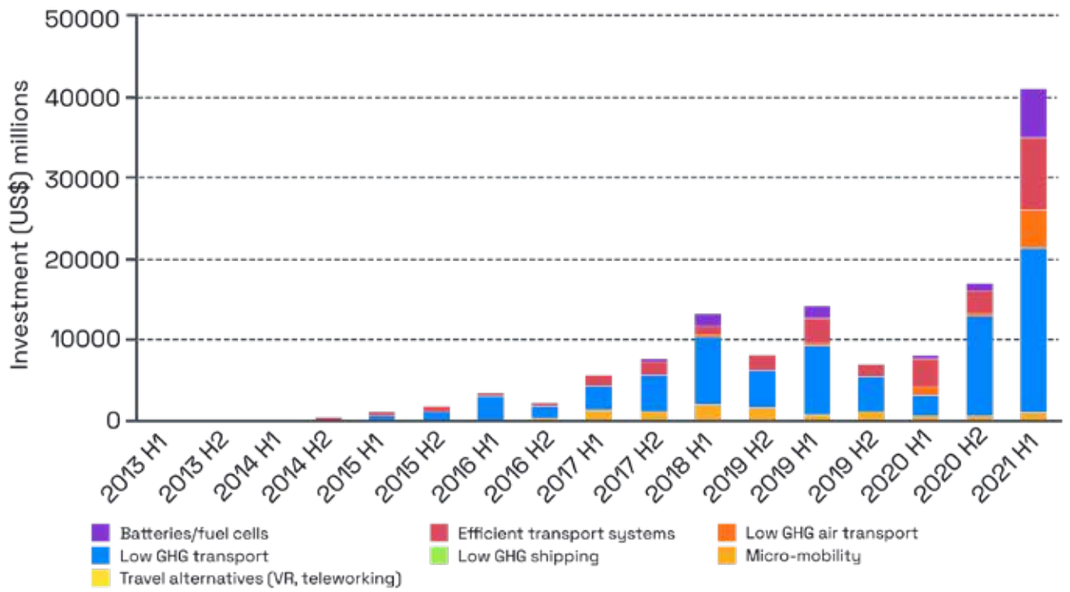
7.3 SECTOR

For climate investors, there's now a cornucopia of areas, each of which is striving to improve the planet in their own way. Whilst some of the more up-and-coming sectors are still gaining traction, there are a few that are top of the agenda for many investors.

CLEAN MOBILITY

One of the key sectors is clean mobility and that isn't just the Tesla's of the world, the sector encompasses so much more. It includes technologies such as charging points, battery development, public transport electrification, decarbonising marine and of course, EVs. Last year was the strongest year on record for investment, with over $40 billion[38] invested just in the first half of the year. With legalisation targets being brought forward, this area has a real immediate need attached and for investors the potential for a faster ROI. Low GHG transport and efficient transport systems received the greatest proportion of investment. In addition, mobility and transport contains the largest number of unicorns within PwC's analysis, with 43 of a total 78 across all challenge areas.

INVESTMENT IN THE MOBILITY AND TRANSPORT SECTOR OVER TIME



SOURCE: PWC

GRAPH 17

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Hydrock who is an engineering design, energy and sustainability consultancy firm have found that clean mobility is an area where several clients are looking to invest in, and therefore the reason as to why they developed StratEV.

> EV has been a major growth area for us in terms of client interest, even before the Building Regulations changes affecting EV charging in new developments. This reflects the massive uptake in electric vehicles and the technology maturing to a point where EVs are a viable, attractive option for many people, however a number of commercial unknowns remain. Providing clarity on these gives clients the confidence they need to meet demand.
>
> - James Mckenchnie, Divisional Director for Transport Planning, **Hydrock**

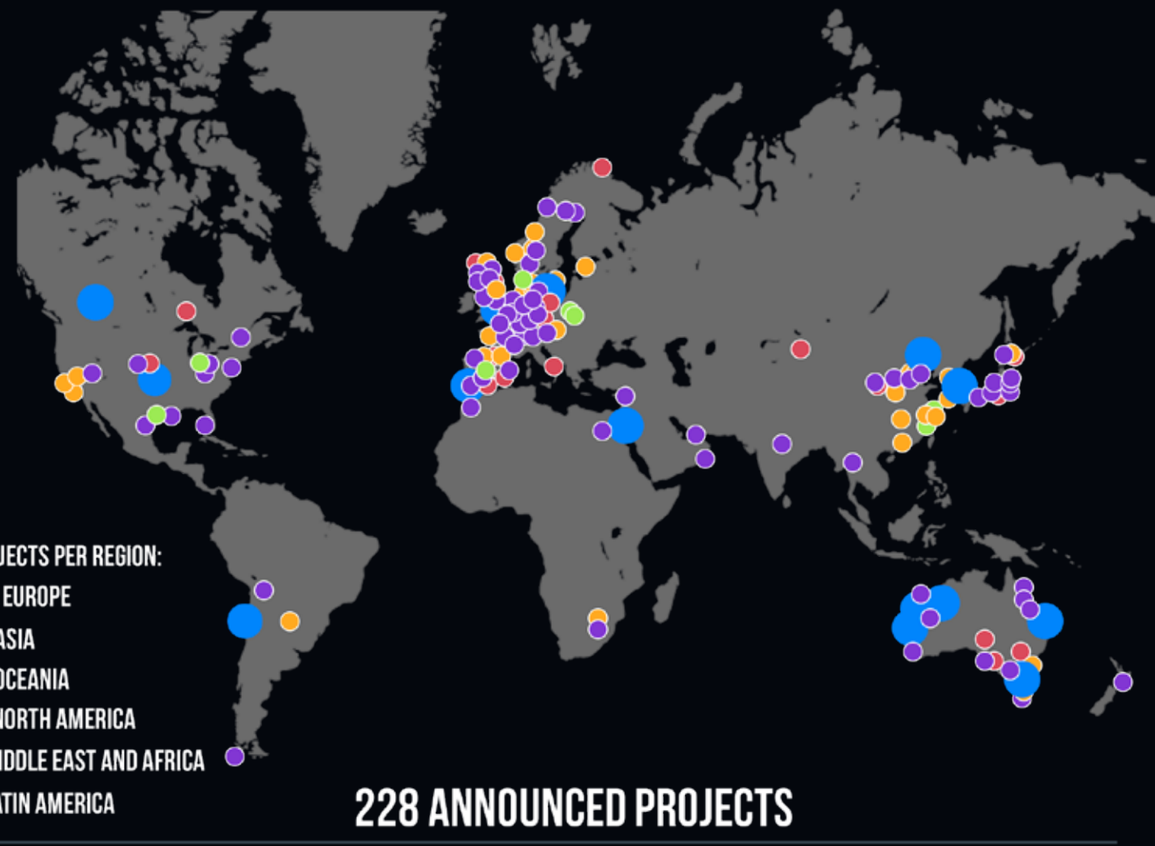
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HYDROGEN REVOLUTION

Another sector that is experiencing a lot of buzz is hydrogen power, which has been receiving high-level of investment both from private investors but also from major corporations who are looking to expand into the market. For investors, they are particularly focused on those that can produce low-cost green hydrogen.

According to the Hydrogen Council, there have been 200 projects announced globally that have approximately $80 billion[42] in mature hydrogen investment. Most of the investment at this point is in the production phase, but as green hydrogen becomes more accessible, investments will divert towards transport and distribution.

GLOBAL HYDROGEN PROJECTS ACROSS THE VALUE CHAIN



SOURCE:HYDROGENCOUNCIL

GRAPH 18

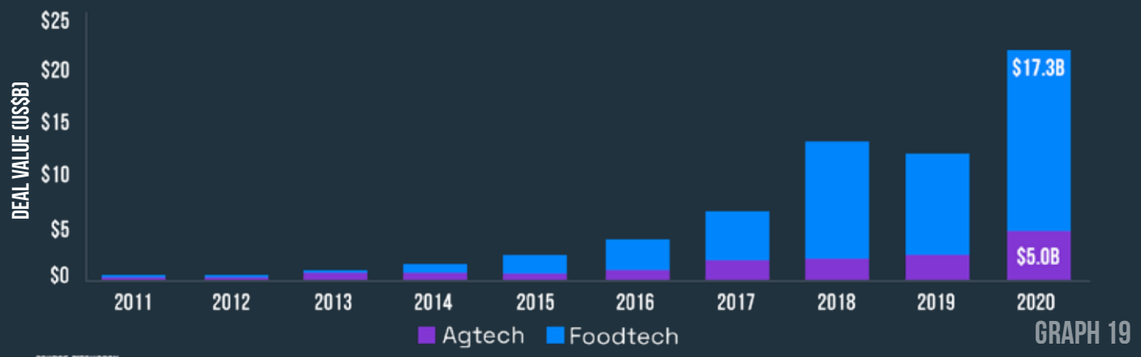
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GREENING UP AGRICULTURE

A lot of venture capitalists are investigating climate-friendly technologies across the agriculture ecosystem and those delivering non animal-based food products. The companies are expansive in this region, ranging from soil composition technologies to the production of insect protein.

Despite the tumult of 2020, investment in agrifood tech space soared to $22.3 billion[43] over the year, which accounted for 34% of the total investment in the category since 2010. However, Foodtech took a huge proportion of this investment with $17.3 billion,[44] encompassing alternative proteins, meal kits and e-commerce.

AGRIFOOD TECH VC DEAL ACTIVITY

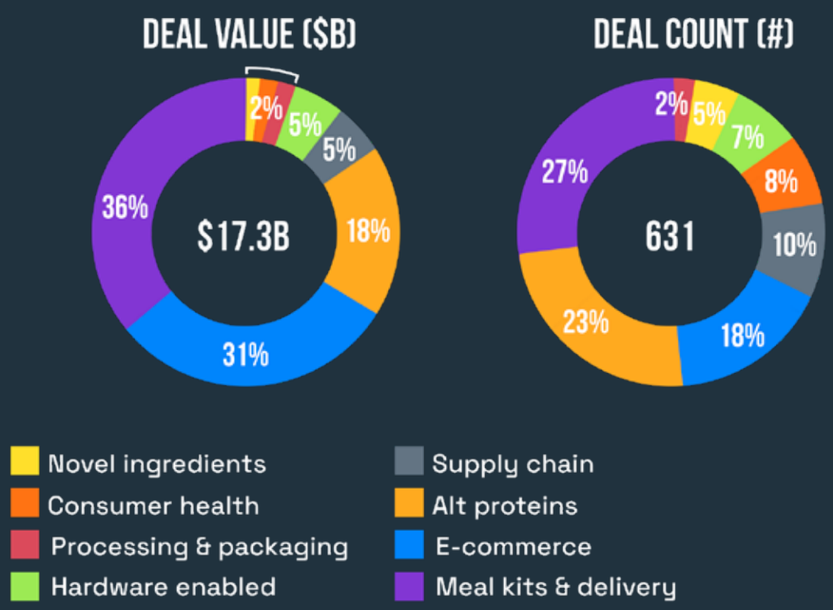


GRAPH 19

SOURCE:PITCHBOOK

There is a drove of investors flooding into the climate space and investors are expected to invest aggressively in the agriculture market globally.

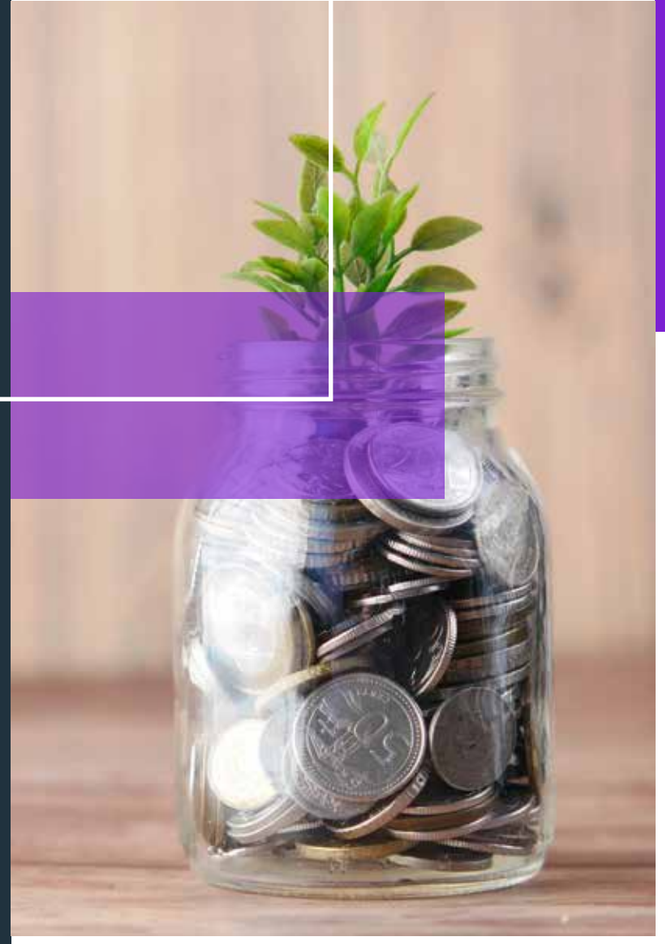
SHARE OF GLOBAL VC DEAL VALUE (%) IN AGTECH BY SUBSECTOR FOR 2020



GRAPH 20

SOURCE:PITCHBOOK

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> Yes, there's a massive increase in investments in CleanTech and GreenTech companies. I think there's been a general acknowledgement that the next unicorn companies, the next really big businesses are going to be within this sector. I think of a lot of money that was probably going into software companies, tech companies and digital, is now moving quite rapidly into the GreenTech sector. And because there's so many different technologies and solutions that are needed for the world to achieve net zero, there's going to be new entrants all over the place and there's the opportunity to take a small business and really create an entirely new sector out of it.
>
> - Alastair Morris, CCO, **Powerstar**

7.4 RATE OF INVESTMENT

As shown in the data, there has been increasing investment across the board. However, we wanted to speak directly to those in the sector to see how investment is being felt on the other side and learn from their visibility into the market.

First, we speak to Alastair Morris at Powerstar to gain his view on the market.

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TIM MEANOCK, CEO OF TALLARNA AGREES WITH THIS PREMISE AND HIS INSIGHT IS PROVIDED BELOW.

Investment in climate tech is accelerating. Over the past few years, the world has woken up to the scale of the climate crisis and the speed at which we need to innovate. While this was led by legislative requirements initially, the driver now is the first-mover advantage, particularly in the financial sector.

Organisations have realised that their ESG performance will be directly linked to their market share. Around half of companies in the FTSE 100 correlate executive pay to ESG metrics. As such, investment in climate tech solutions is going through a massive period of growth and will continue to do so over the coming years.

- Tim Meanock, CEO, **Tallarna**

JAMES WHITEHEAD, CCO OF SOLAR WATER PLC EXPLAINS THAT WHILST THERE HAS BEEN A NOTICEABLE INCREASE IN INVESTMENT, TO MAKE CHANGE HAPPEN IT MUST COME WITH A COMBINATION OF INVESTMENT AND ADOPTION.

There's been a very noticeable increase in GreenTech investment, technology and market adoption. The influence of the COP conferences and process on investment, adoption and technology is very significant and we were pleased to be a part of Cop26 last year. The takeaway from that was that to solve these problems, we are going to need an expanding combination of private investment, innovative technology providers, and smart adopters with the right motivations and ambitions. Certainly, from where we stand in the market there's a noticeable increase in the access of capital for GreenTech businesses and in the majority of conversations that we are having with clients and prospective clients, their plans are increasingly framed around green growth objectives."

"If we're going to make change happen, we must all think differently, behave differently and demand differently. And it is through green technological innovation that we're going to deliver that.

- James Whitehead, CCO, **Solar Water PLC**

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DON SCOTT, CCO OF POWER ROLL EXPLAINS HOW HE CAN SEE AN INCREASE, BUT IT'S NOT YET SIGNIFICANT ENOUGH.

There's definitely been more than there was before; the curve is going up which is good. I think realistically though it's not as significant as I think it should be. When you look at continued investment in carbon fuels, there's still a massive amount of money being pumped into carbon-based technologies. I think there are so many flavours to GreenTech such as hydrogen, batteries, solar and wind. There are some really innovative and adventurous ideas out there, and a massive amount of small companies. I think the investment community is trying to decipher the best route for investment, There is still significant investments in building new silicon PV plants, and that's because it's familiar and they know the market; Our ambition is to innovate and create new opportunities for solar energy and dramatically reduce the cost to produce. A point to mention, however, is that we have had over £20 million invested into Power Roll over the years and that has come from a really supportive investment community who share our vision. So, there are visionary investors out there making bets and backing these promising new technologies.

- Don Scott, CCO, **Power Roll**

KARL FARROW, CERAPHI DESCRIBES THE NEED FOR MORE DIVERSIFICATION IN INVESTMENT.

Certainly, in the last 24 months, there has been a big push in GreenTech for climate impact solutions. There is certain bias in different countries, for example, the UK focuses on wind, but I would say there is not enough research into up-and-coming technologies or even big impact technology, like the geothermal space. This area is underinvested when you look at the scalable potential it has to provide baseload energy in comparison to the likes of wind and solar. However, I do accept that everything needs to play a role in the energy transition.

- Karl Farrow, CEO, **CeraPhi**

GLENN FLETCHER, CEO OF TRIBOSONICS ILLUSTRATES HOW IN TERMS OF INVESTMENT, THERE IS NOW A MORE STEADFAST FOCUS ON THOSE THAT WILL DELIVER.

There has been a change from an investment perspective towards technologies that can have a real impact in terms of sustainability. For several years and even until quite recently there has been a lot of greenwashing in the marketplace, whereas now there are more investors with a real focus on scalable technology with a proven sustainability impact. There's certainly more attention now on Green Tech investment because there's a necessity for it; when you combine innovative and scalable technology with a strong market and environmental drivers the investment case is compelling.

- Glenn Fletcher, CEO, **Tribosonics**

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SECTION 8:
LOW CARBON CAREERS

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In the growing field of GreenTech and renewable energy, there is now a greater demand for expertise to transition the market, which are now being dubbed as ‘low-carbon careers’ or ‘clean’ and ‘green’ jobs.

8.1 GROWING OPPORTUNITIES

According to the Local Government Association, the boom in the green economy could lead to 1.18 million[45] new jobs being created in low carbon sectors by 2050 in England. Globally, the transition could lead to 24 million jobs emerging by 2030 according to ILO.

LinkedIn jobs data[46] has clearly represented the movement in demand in 2015 the ratio of US oil and gas jobs to renewable and environment jobs was 5:1 but by 2020 this ratio has inched closer to 2:1. At this rate, renewable roles are expected to outweigh those in oil and gas by 2023, causing a major pendulum shift in a relatively short space of time.

GREEN SKILLS GROWING ACROSS MOST INDUSTRIES

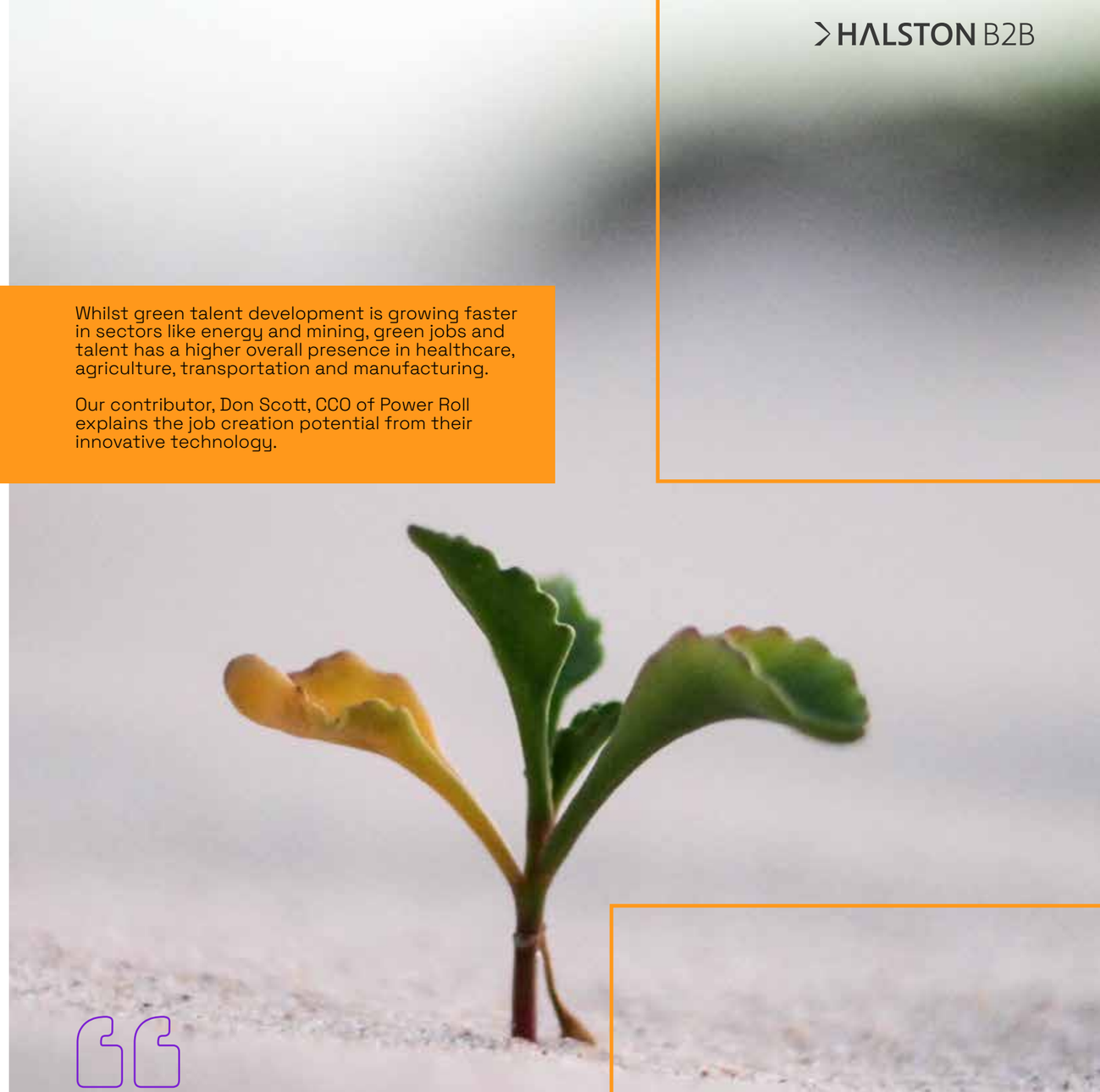


SOURCE:WEFORUM
GRAPH 21

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Whilst green talent development is growing faster in sectors like energy and mining, green jobs and talent has a higher overall presence in healthcare, agriculture, transportation and manufacturing.

Our contributor, Don Scott, CCO of Power Roll explains the job creation potential from their innovative technology.



As our technology is deployed globally, we envisage thousands of green jobs including manufacturing the film and also installing the film. A large-scale UK plant could create another 50-100 green jobs.

- Don Scott, CCO, **Power Roll**

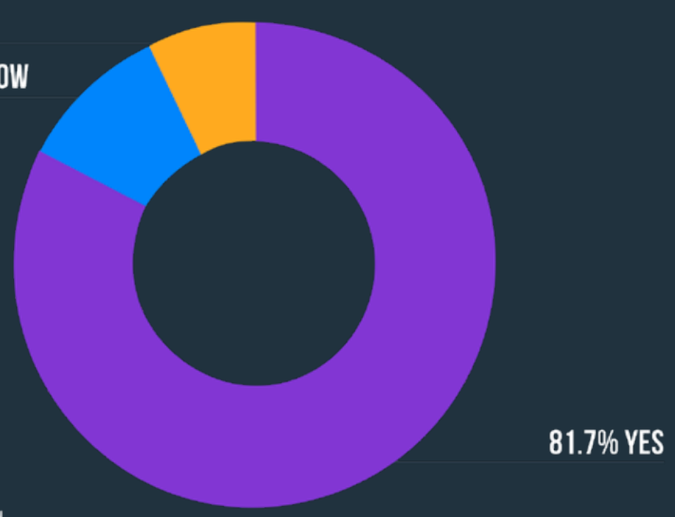
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TRANSITIONING CAREERS 8.2

With a zero-emissions society, current roles within the oil and gas sector or mining will be severely depleted, with an estimated 6 million jobs globally that will be lost, so an effective transition to new markets is critical. Due to the practices and skills developed in the oil and gas sector, there is a natural skillset that can be transferred to the likes of wind farms or geothermal plants.

In a recent survey by Platform, Friends of the Earth Scotland and Greenpeace asked 1,383 people employed in North Seas oil and gas to give their thoughts on climate change and the industry's future. 82% of respondents said they would consider moving to a job outside of the oil and gas industry, over half expressing an interest in renewables and offshore wind.

WOULD YOU CONSIDER MOVING TO A JOB OUTSIDE OF THE OIL AND GAS INDUSTRY?



GRAPH 22

SOURCE:PLATFORMLONDON

Converting expertise to these emerging sectors is no small feat and there must be training, resources and the empowerment to move to a new sector. Climate change will be achieved by the people.

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SECTION 9.0:

HOW TECHNOLOGY IS TAKING ON CLIMATE CHANGE

There is no doubt that climate change is one of the greatest challenges of our time. Technological innovation will be the 'silver bullet' to climate change.

> We need to do things differently, think differently, behave differently with different solutions - GreenTech innovation is key to this.

- James Whitehead, CCO, **Solar Water PLC**

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9.1 CALCULATING CARBON FOOTPRINT

Whilst climate change prevention must be taken, it must be done in a strategic way that enables companies and government bodies to target those high-problems areas, to offer the most carbon reduction, as quickly as possible. Spherics is a carbon accountability software that scopes out businesses carbon footprint, including scope 3 emissions.

> Spherics helps businesses get a crystal-clear picture of their emissions, fine emissions hot-spots in scope 1 and 2 and often totally uncover scope 3 (which most businesses really struggle with). From the conversations we have most businesses have a real interest in making an impact. The trouble they have, is often "guesstimations" is all they can manage, without quality footprinting software. With the Spherics approach, we first run a completely automated footprint, using a spend based approach, and from there we build out the accuracy of the report " using activity based questions and also introducing primary data sources from real suppliers. You can expect a perfect footprint overnight, but with Spherics you can build one in weeks. With the data at their fingertips, businesses can make data-led procurement decisions that are based on science not speculation. Real tangible impact on emissions can be made, and importantly they can be measured. For some sectors scope 3 is less significant, but for the majority of businesses it plays a very significant part of the total GHG protocol emission make up. Often, scope 3 makes up 90+% of emission, so ignoring it is going to be catastrophic.

- Conrad Langridge, Head of Marketing, **Spherics**

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9.2 TRANSITIONING TO RENEWABLES

One core element of becoming carbon neutral is removing our reliance on fossil fuels and instead utilising a range of renewable energy sources. However, transitioning the power infrastructure will require the latest advancements in technology.

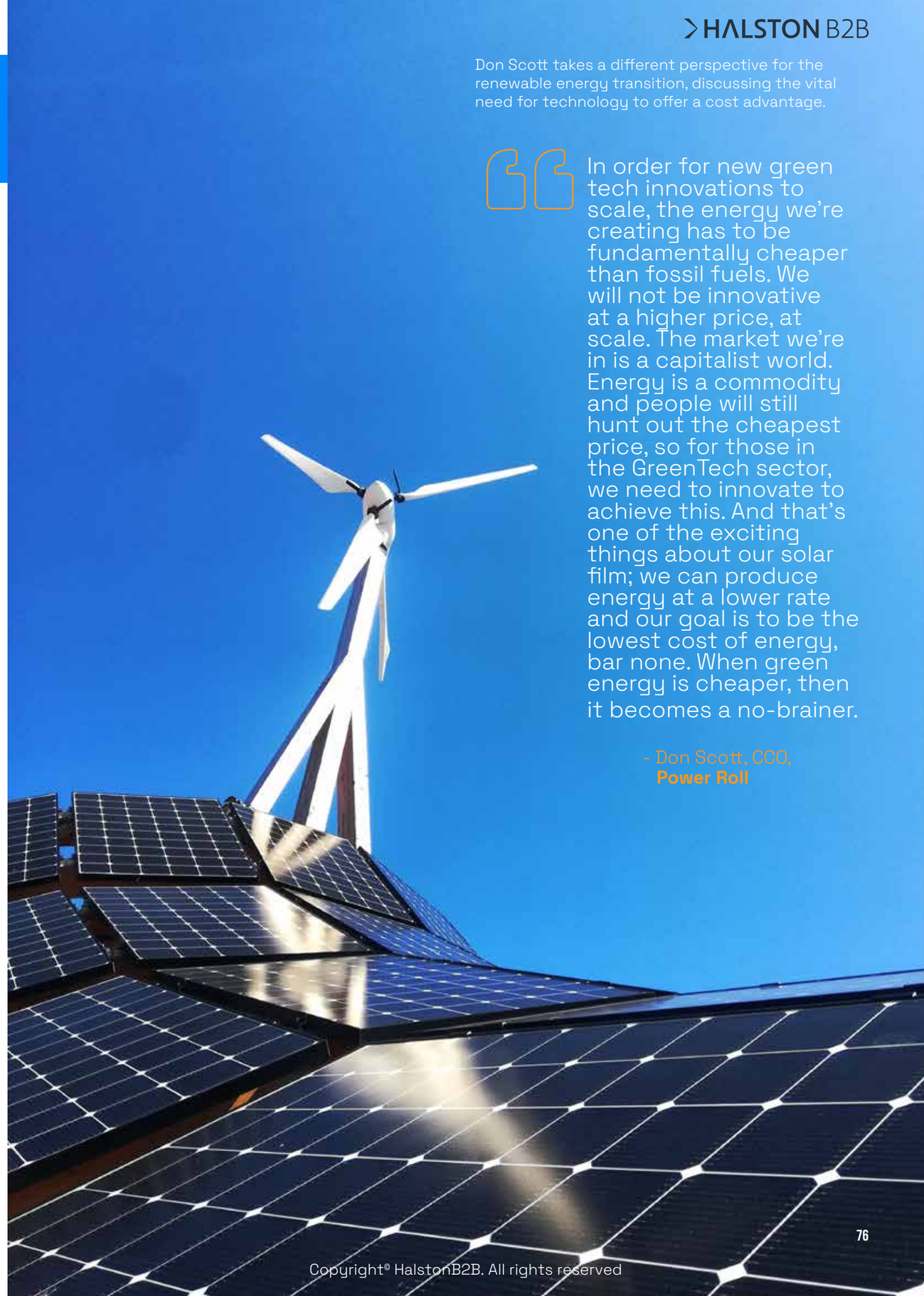
Alastair Morris, CCO of Powerstar illustrates how battery storage will underpin this transition.

> There's a massive upgrade of infrastructure needed to achieve this transition. It's going to cost a lot of money and take a lot of time. We're talking about the substations, the actual cables that transmit electricity around the UK and to our properties. They all need increasing and upgrading. Now, there's a plan in place for that to happen, and it will clearly happen at a national level. But as an individual organisation, you cannot guarantee when your own substation is going to get upgraded or when you're going to have the capacity to put electric vehicle chargers in your car park. And it takes time and money for these things to happen. And it could be that you're going to be charged for it. It could be that it's not going to happen for a year or two, and you don't have any control over it.
>
> The battery storage again, it really insulates the organisation from that. You can directly use it as a buffer, so you don't need as big of a connection to the grid because you're using your battery to support your electrical demands. And of course, it enables you to maximise the use of your own generation.
>
> - Alastair Morris, CCO, **Powerstar**

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Don Scott takes a different perspective for the renewable energy transition, discussing the vital need for technology to offer a cost advantage.

> In order for new green tech innovations to scale, the energy we're creating has to be fundamentally cheaper than fossil fuels. We will not be innovative at a higher price, at scale. The market we're in is a capitalist world. Energy is a commodity and people will still hunt out the cheapest price, so for those in the GreenTech sector, we need to innovate to achieve this. And that's one of the exciting things about our solar film; we can produce energy at a lower rate and our goal is to be the lowest cost of energy, bar none. When green energy is cheaper, then it becomes a no-brainer.
>
> - Don Scott, CCO, **Power Roll**



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9.3

AN EFFECTIVE EV TRANSITION

For EVs to be adopted at scale they must be convenient and cost-effective for users and have a strong ROI for those implementing charging points. Hydrock's StratEV solution is delivering a revolutionary way for businesses to effectively develop an EV infrastructure.

We found early on that people were having to make some broad assumptions when they were installing EV charging. So, for example, we're working for a logistics company who have just invested in a load of electric vans. They're building a big car park to charge them up overnight, and our electrical engineering team are working with them to understand what they need. Without a tool to assess exactly how much charge each van will need, people have had to make average assumptions about when EVs would be plugged in, and how much charge they would need. But that's an inaccurate picture as not all vehicles will be returning at the same time each night, with the same residual charge remaining.

So, what does that mean? It meant that people providing EV charging were predicting massive surges in demand – which we know probably won't occur in reality - and specify a grid connection on that basis, often costing millions of pounds, just to connect this car park up to the electrical grid. So, it struck us that if we were to look at this in a more sophisticated data-driven way, that would be to everyone's benefit. If we know how many vehicles are charging, that's of interest to everyone involved, particularly EV charging companies. If we know how much power they're using, we can make savings on the grid connection. If we know why they're there, that tells us what sort of chargers are needed and what value the EV charging is adding – for example, how many more retail customers or hotel guests might be drawn to a site because there is EV charging provision?

As the rollout of EVs accelerates, if you're not providing charging, you're falling behind. To help on all these fronts we developed StratEV.

- James Mckechnie, Divisional Director for Transport Planning, **Hydrock**

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9.4 SOLVING THE WATER CRISIS

Water scarcity and global warming are two of the most critical crises facing humankind and the two are inextricably linked.

Water is the fuel of life itself – it is and will remain central to all our needs – without water, there is no future - for drinking, sanitation, washing and maintaining hygiene ("wash your hands against Covid!"), for domestic use, for our agriculture, for urban development, for all industry, for energy creation, for almost everything you can think of. "How long could you last without water?

70% of the planet is covered in water but only 2-3% of that is fresh water and only 1% of that is readily accessible, with the remainder tied up in snow caps. Over a billion people worldwide lack access to water and a further three billion people experience water scarcity for a significant part of the year; it's estimated that global demand for water will exceed supply by 40% by 2030.

Large parts of the world are literally dying of thirst. Groundwater is quietly disappearing, being used faster than it can be replaced – as the groundwater disappears, our ability to grow food for the world and supply water for all of our needs is diminishing.

The existing global water desalination industry (the current primary and growing water provision solution) requires a high level of energy intensity to drive their systems, most of which comes from burning fossil fuels. That is producing a carbon footprint of around 80 million tonnes of Co2 per annum globally. And the estimations are that this will triple to around 240 million tonnes of Co2 by 2040."

At current rates of CO2 emissions and global warming, we are heading towards a temperature rise of at least 2.5 °c by the end of the century, significantly above the 1.5 °c, which we will miss by a long way.

Some estimations suggest that the impact of climate change will shrink rainfall, snowpack and freshwater availability by a further 40% by 2050; and when you look around the world at the places that have significant water stress and scarcity, these are the places that will be most impacted by increases in drought, driven by global warming and climate change.

"Governments, water municipalities and business leaders are facing these circular, interlinked crises - how do they solve the water crisis without increasing the climate impact? How do they mitigate against global warming, in order to solve the water crisis?

- James Whitehead, CCO, **Solar Water PLC**

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Many of our current practices are harmful to both the planet and our health. It is essential to remove these pollutants from the environment. Tony Grainger explains how Pacific Green Technologies Group solutions achieve this.

9.5 REMOVING HARMFUL POLLUTANTS

It is essential to look upon the environmental impact of emissions in a holistic way, rather than concentrating solely upon the direct impact of certain airborne gases.

High concentration of SOx levels in the atmosphere are known to harm trees and foliage, to the point of stunting normal growth. This has a knock-on effect on the amount of CO2 that these plants can absorb from the air around us, leading to global warming.

Further up in the troposphere, SOx and NOx interfere with the natural breaking down and re-generation of the ozone layer, an important shield or filter that protects us from the sun's UV rays that, long-term exposure to these can cause skin cancer and higher incidence of cataracts within humans. At the same time, unfiltered UV rays kill phytoplankton, a micro organism found within the oceans that are responsible for the absorption of high concentrations of CO2 and the production of a large percentage of Oxygen, that support marine life. Additionally, they are one of the most important organisms within the marine food chain and the impact of lowered numbers would be dramatic

A regular question asked is; "How is taking airborne SOx through a scrubber and then discharging the absorbed sulphates directly into the sea water, environmentally acceptable?"

SOx are absorbed within the scrubber to form harmless sulphates. If all the Sulphur in the worlds oceans was sedimented and spread evenly across the Earth, it would form a layer 1.7m thick. Adding all the sulphur from the planet's oil reserves would add a further 10 microns, an increase of 0.00059%.

- Tony Grainger, COO, **Pacific Green Technologies Group**

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9.6 PROTECTING HABITATS

Earth Blox is a cloud-based, code-free analysis tool for quickly and easily monitoring natural assets and assessing environmental risks across the globe. Earth Blox provides users with a measurable, repeatable, affordable, and rapid process to gain actionable insights into Earth's environment, making achieving their sustainability goals far easier. Our straightforward and customisable drag-and-drop interface is underpinned by Google Earth Engine, a vast 40 petabyte repository of data which includes more than thirty years of historical imagery and 700 datasets from sources including Sentinel-1, MODIS, ESA's GlobCover, and the USGS National Land Cover Database.

Our technology can be applied in a number of ways, monitoring supply chains, verifying carbon credits for nature-based resources, and in particular monitoring forests and deforestation.

In total, Earth's forests cover around 30% of Earth's land surface and absorb around 8 Gt (gigatons) of CO2 from the atmosphere each year. Their potential to absorb carbon means that forests play a crucial role in the Earth's carbon cycle and climate system. Forests also provide more benefits than simply acting as a sponge to mop up carbon emissions — they are the most biologically diverse ecosystems on land, providing a habitat to more than 80% of the terrestrial species of animals, plants, and insects. Despite these benefits, forests remain at risk from deforestation and degradation. Over half of the tropical forests worldwide have been destroyed since the 1960s, and every second, more than one hectare of tropical forests is destroyed or drastically degraded.

To counteract this many companies are now investing in carbon offsetting, replanting trees and protecting degrading forests. Making this decision requires several factors to be checked. The first, and most important, is verifying if there is indeed forest to protect at a given location and determine if it is at risk, which will require analysis of historical trends of deforestation rates and land use change. However, visiting these locations is not always possible and as a result, companies looking to offset their carbon emissions by investing in forests have turned to remote sensing data — images and measurements from satellites in orbit. Satellites provide a wealth of data on forests, providing measurements of deforestation, forest health, and biomass efficiently over large areas. techniques using both optical and microwave sensors on the ESA Sentinel satellites can detect logging and deforestation over large swathes of forest. Spaceborne LiDAR and Synthetic Aperture Radar instruments are also capable of measuring forest degradation.

- Genevieve Patenaude, CEO, **Earth Blox**

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SECTION 10:

INDUSTRY ADOPTION LEADERS

AS DISCUSSED EARLIER ON, THERE IS A PLETHORA OF INVESTORS FLOWING INTO THE GREENTECH SECTOR, BUT IS THIS LEADING TO A HIGHER RATE OF ADOPTION AND WHERE EXACTLY ARE THESE TECHNOLOGIES BEING ADOPTED?

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10.1
LEVEL OF ADOPTION

Whilst there have been incredible moves in the GreenTech sector in terms of innovation, and adopting GreenTech has certainly been a hot topic for discussion, these cutting-edge technologies are not impactful unless they are adopted.

Our experts discuss the level of adoption that is being experienced and where it is being felt both from an industry and location perspective.

Through necessity and increasing ESG requirements there are undoubtedly more companies considering sustainable technology. When talking specifically about the UK, this country doesn't have a great track record in getting technology adopted. It's difficult to get into those large corporates who are needing sustainable technology. We have a great start-up culture in the UK and some great plc's, but we need to be better in this country at the flow through of bringing scale-up technology into those large corporates. Other countries, such as France or parts of the US, have a more open and collaborative approach and are more willing to accept innovation and implement technology partnerships. The SME tech sector is the engine of our country, and we need to support and drive that sector to drive growth and the adoption of sustainable-related technology.

Yes, there has been a higher rate of adoption, but there hasn't been enough.

- Glenn Fletcher, CEO, **Tribosonics**

I think the awareness of ESG is rapidly increasing and becoming more of a board level consideration. Property developers and building owners are being more thoughtful regarding a building's carbon footprint for both environmental and financial reasons. Owners of inefficient buildings are already paying a premium due to increased energy costs, and there is a growing recognition that future carbon costs must be included in the Return on Investment calculation for new building projects.

- Don Scott, CCO, **Power Roll**

Whilst there has been a rise in adoption, there are certainly variations between the industries in terms of which technologies are being adopted by which sector.

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10.2
MANUFACTURING

Powerstar, CCO, Alastair Morris found that the manufacturing sector was one of major adopters of battery storage.

I would say that we've seen the manufacturing sector is probably slightly ahead of other sectors in this respect, as I think they are under more immediate pressure from their customer base to decarbonise. There's a real competitive edge within the manufacturing industry to provide products that have lower carbon footprints. It's pushed down the supply chain quite rapidly. And all of these risks that I've been talking about are felt very strongly by manufacturing sites, they're often running on very critical margins, and they're very vulnerable to fluctuations in power. So many are doing more to insulate themselves from those changes.

- Alastair Morris, CCO, **Powerstar**

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10.3 MARINE & POWER PLANTS

For Pacific Green Technologies Group and the specificity of their emissions technology, it is being predominately adopted by those directly emitting harmful pollutants such as ships and power plants.

We predominantly offer our systems within the commercial marine industry and currently have over 130 Exhaust Gas Cleaning Systems onboard a variety of ships, both by type and size.

For the land based systems, we have an (Flue Gas Desulphurisation) FGD system installed at a steel plant power boiler that burns blast furnace gas, and a particulate and acid gas scrubber installed on a wood-fired boiler that provides heat for a greenhouse complex

- Tony Grainger, COO, **Pacific Green Technologies Group**



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10.4 BUILT ENVIRONMENT

AT HYDROCK THEY HAVE FOUND THAT DUE TO NEW BUILDING REGULATIONS, THERE IS A GROWING DEMAND FOR EV PORTS AND ASSOCIATED TECHNOLOGY WITHIN THE RESIDENTIAL AND COMMERCIAL CONSTRUCTION SECTOR.

EV infrastructure needs to be designed around our daily lives to make it as convenient as using a petrol pump. We're working with government to understand how subsidies can help make charging more accessible and inclusive.

It's really important to understand clients' objectives – some will be interested in charging revenue; others in advertising or increased footfall; or it could be about accessibility to key services – there's no single motivation.

The Building Regulations changes have had a major effect on residential providers – for example, house builders who need to provide charging across their developments. There are obvious cost concerns, but our view is that, within a few years, EV charging will be something people are looking for specifically when buying a house and it could make the difference between selling it or not. We have clients that are already installing fast-charging units, because they know there's going to be a demand for it as part of a local mobility hub, on top of the on-plot provision.

- James McKechnie, Divisional Director for Transport Planning, **Hydrock**

TALLARNA ON THE OTHER HAND HAS FOUND THAT THE BUILT ENVIRONMENT IS SHOWING A HIGHER RATE OF ADOPTION OF TECHNOLOGY THAT WILL ENABLE THEM TO REDUCE EXCESS ENERGY.

Solving buildings' energy inefficiency is going to be a key focus over the next few years. This is because buildings are a low-hanging fruit, making up around 40% of the UK's carbon emissions. We already have all the technology we need to reduce energy usage by 60%. That means that very quickly, energy efficiency retrofits can take a lot of carbon out of the equation and go a long way to lowering our impact on the climate.

Net zero affects every person who lives or spends time in buildings. While our technology has particular resonance in the social housing space due to our ability to address poor balance sheet capacity and mitigate fuel poverty, we have experienced wide-spread interest and adoption in the commercial real estate sector

- Tim Meanock, CEO, **Tallarna**

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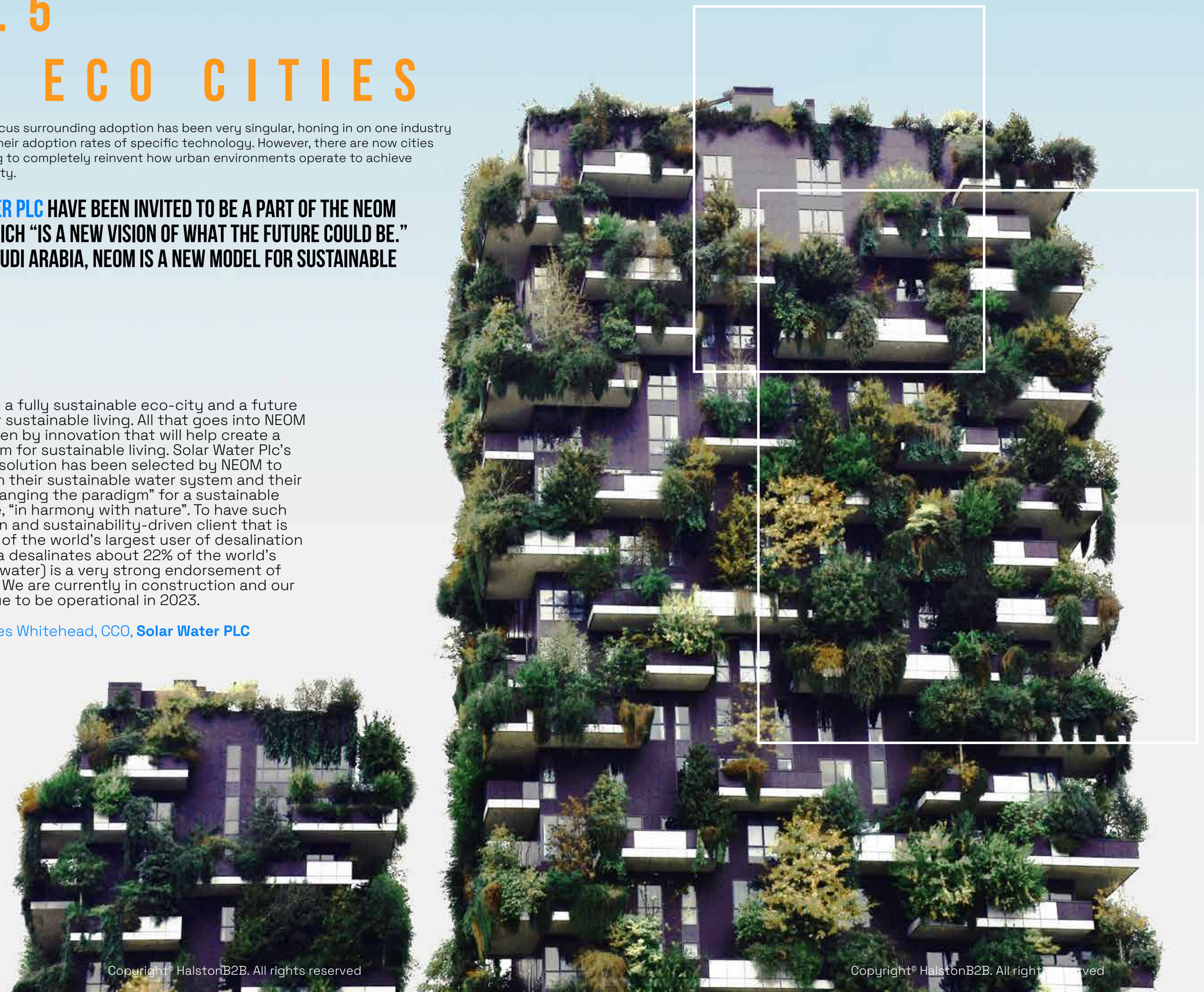
10.5 ECO CITIES

Much of the focus surrounding adoption has been very singular, honing in on one industry at a time and their adoption rates of specific technology. However, there are now cities that are looking to completely reinvent how urban environments operate to achieve carbon neutrality.

SOLAR WATER PLC HAVE BEEN INVITED TO BE A PART OF THE NEOM PROJECT WHICH "IS A NEW VISION OF WHAT THE FUTURE COULD BE." BASED IN SAUDI ARABIA, NEOM IS A NEW MODEL FOR SUSTAINABLE LIVING.

NEOM will be a fully sustainable eco-city and a future blueprint for sustainable living. All that goes into NEOM must be driven by innovation that will help create a new paradigm for sustainable living. Solar Water Plc's technology solution has been selected by NEOM to play a part in their sustainable water system and their vision of "changing the paradigm" for a sustainable water future, "in harmony with nature". To have such an innovation and sustainability-driven client that is at the heart of the world's largest user of desalination (Saudi Arabia desalinates about 22% of the world's desalinated water) is a very strong endorsement of our offering. We are currently in construction and our system is due to be operational in 2023.

- James Whitehead, CCO, **Solar Water PLC**



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SECTION 11

SUSTAINABILITY AT THE CORE OF GREENTECH

GREENTECH SOLUTIONS ARE REVOLUTIONISING PEOPLES AND BUSINESSES PRACTICES ACROSS THE WORLD, BUT THIS NEEDS TO BE ACCOMPANIED BY INTERNAL ACTIVITIES THAT PROMOTE SUSTAINABILITY IN THEIR OWN ACTIONS.

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> It's important for companies offering sustainable solutions to practice what they preach. To achieve net zero globally or nationally, it needs everybody to get on board with the solutions being offered. And there will always be someone looking for flaws in that technology to try and prevent the transition. For example, people are critical of electric vehicles because of the lithium in the batteries or the fire risk of the batteries and ignore what a huge step forward it is from where we are today with internal combustion engines. To achieve net zero we can't let perfection stand in the way of progress. So, as CleanTech companies, we need to be the best that we can be to encourage that transition.
>
> - Alastair Morris, CCO, **Powerstar**

> I think you've got to walk the walk as well as talk the talk. We're a relatively small business but we put ourselves through a lot of review and audit processes to make sure we're doing the right things in the right way from a quality, safety and environmental perspective. Even though (because of our size) we don't necessarily need to report externally under ESG regulation, we are looking at and reporting on all aspects of ESG to ensure the manufacturing and implementation of our technology is done sustainably. But as sustainable as we can be, the biggest way to move the dial is for us to get our technology adopted into the industries that need it.
>
> - Glenn Fletcher, CEO, **Tribosonics**

> It's actually a really great exercise for GreenTech to practice what it preaches. As a SaaS solution provider our carbon footprint is never going to be astronomical, but there are still hotspots and we need to be on top of them. At Spherics, we use our own tool and know our problem areas have historically centred around our staff behaviours, particularly travel. It's why we have introduced slow travel days into our working practice where we pay our staff to travel for work trips & holidays via more sustainable methods (e.g. train over plane).
>
> - Conrad Langridge, Head of Marketing, **Spherics**

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SECTION 12:

TAKE ACTION:
WHY IS TECHNOLOGY PINNACLE TO A CARBON NEUTRAL FUTURE?

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THROUGHOUT THIS PAPER WE HAVE SEEN THE INCREDIBLE OPPORTUNITIES GREENTECH PROVIDES, BUT WE CHOSE TO ASK THE EXPERTS JUST HOW CRITICAL TECHNOLOGY WILL BE TO CLIMATE ACTION.

> There is going to be a myriad of driving forces behind climate change prevention and innovative technologies will be a significant player
>
> - Conrad Langridge, Head of Marketing, **Spherics**

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12.1

CONTINUING WITH OUR WAY OF LIFE



We need to transition how we do so many things. There are basically two alternatives. One is, we stop doing all of the activity that we've been doing that's been causing pollution or we find different ways of doing it. And there's clearly much more appetite for that within us as human beings and consumers to find clean ways of doing things. For example, there will be a huge push to make flying as green as possible, because people want to carry on flying.

- Alastair Morris, CCO, **Powerstar**

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12.2 REMOVING OUTDATED APPROACHES

To change the direction of travel and how people are working you need to replace or enhance incumbent technologies. The only way the planet will be improved is if we change those incumbent technologies, which are inherently inefficient and carbon-based. Therefore, new technology must be the answer, encompassing development, funding and the cycle of adopting new technology.

- Glenn Fletcher, CEO, **Tribosonics**

12.3 REMOVING ASSUMPTIONS

A lot of companies EV transition plan is being based on assumptions, leading to inaccuracies in their strategies. Hydrock explains why the access to accurate data and predictive technology is going to be crucial to effectively increase adoption across the board.

Using StratEV to assess charging provision helps make it more accessible and democratic for all users – you don't want to be paying for a fast-charge if you're parking all day, and you don't want to be waiting all day if you need a fast-charge. It's important for people who don't have at-home charging too, making sure everyone has fair access.

- Mark Pearce, Senior Data Analyst, Mobility Analytics Division, **Hydrock**

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12.4 MAKING A GLOBAL IMPACT

When we consider sustainability, how can an SME in Sheffield change the world?

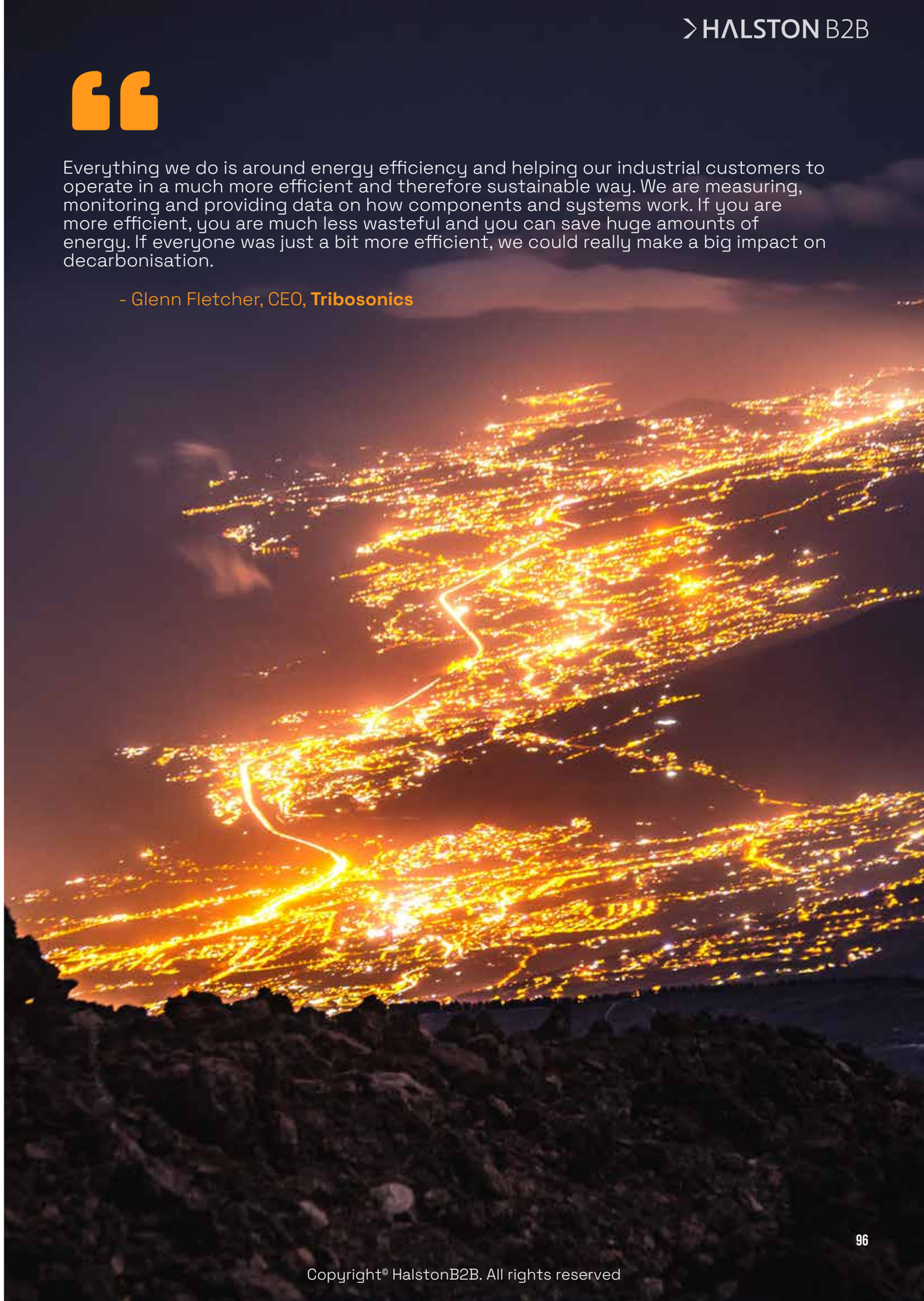
Well actually, the way we do that is to work with large corporates that have a significant footprint with factories across the globe. One of the core benefits of our technology is waste reduction and preventing waste from reaching landfills. When industries adopt our technology on one, two or multiple sites, the amount of waste we can help them reduce scales massively. The other side would be process efficiency, for example, fuel efficiency in the marine sector where our technology can drastically reduce emissions released. But even further than this, there is the social sustainability aspect such as a safer working environment and practices. For instance, one of our products measures bolt tensioning for wind turbines which would typically be checked manually offshore in dangerous conditions for engineers, whereas our technology can minimise the number of visits.

- Christina King, CCO, **Tribosonics**

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Everything we do is around energy efficiency and helping our industrial customers to operate in a much more efficient and therefore sustainable way. We are measuring, monitoring and providing data on how components and systems work. If you are more efficient, you are much less wasteful and you can save huge amounts of energy. If everyone was just a bit more efficient, we could really make a big impact on decarbonisation.

- Glenn Fletcher, CEO, **Tribosonics**



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12.5 ACCESSIBILITY & AFFORDABILITY

POWER ROLL'S AMBITION IS TO MAKE "SOLAR POWER THAT IS ACCESSIBLE AND AFFORDABLE FOR ALL."

Right now, we have just launched a pilot plant so that gives us the ability to produce solar film and prove the roll-to-roll low-cost manufacturing process. Our business model is to license our technology internationally to enable fast scaling, local manufacturing and green jobs. As the material is coming off the line, we will be applying it to our business to lighten our carbon footprint.

We are building an ecosystem of partnerships with companies all over the world, including Japan, India, UK, and Africa to develop solar film in all corners. Due to our film being extremely cost-effective and agile, it becomes a lot more accessible to different regions. For example, in India there are over 9 million water pumps being used in agriculture – mostly powered by diesel today. Farming communities in India would receive immediate economic and quality-of-life benefits by converting those dirty diesel generators to clean solar energy. The lightweight nature of our solar film makes it ideal for transporting and installing in remote villages and farms. We have modelled a 5KW solar film system which would weigh less that 2kg and can be easily moved around the farm to provide power directly to the water pumps.

- Don Scott, CCO, **Power Roll**

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SECTION 13: UK GREENTECH INNOVATION

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INNOVATION IS AT THE CORE OF CHANGE.

THE UK HAS ALWAYS BEEN HOME TO INNOVATORS AND CREATORS AND TODAY IS NO EXCEPTION. FROM INDUSTRY DATA IT IS CLEAR THAT THE UK IS HOME TO HUNDREDS OF GREENTECH COMPANIES, THOUSANDS OF PATENTS AND THOSE THAT HAVE BEGUN PROGRESSING TO A CARBON-NEUTRAL FUTURE.

WE GAINED THE OPINIONS OF OUR CONTRIBUTORS ON HOW THEY BELIEVE THE UK IS COMPETING IN THE GLOBAL GREENTECH LANDSCAPE.

> We're a really innovative country. We are really good at innovation and coming up with solutions to things and really thrive in this phase. The point at which the UK never does quite as well is the next phase, the expansion. So, while we've invented these things, we're then never good at scaling those organisations and we need to concentrate on doing that and making sure that we can reap the rewards from all this innovation in the country and it doesn't just get bought up and shifted off to everywhere else. We ought to try and scale the organisations rather than just come up with innovative ideas.
>
> - Alastair Morris, CCO, **Powerstar**

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> The UK has always been a pioneering, global leader in technology. And not just the technology, the implementation and scalability of that as well. There are hundreds of companies in the UK working towards net zero, with their own specialisms. Also, the UK government, in my experience has been very supportive, particularly exporting expertise but I would like to see technology given more of a chance here in the UK. There is a lot of innovation here that doesn't get the attention for various reasons and a lot of small tech companies need a lot more support. I think in general we have a great knowledge base in energy and manufacturing.
>
> - Karl Farrow, CEO, **CeraPhi**

> All the innovation is here, we have world class universities, scientists, talent and innovative tech businesses. If you were to do a chart of the origination of innovation, we would appear very high. Whereas for deployment, I think this is a slower than other countries and that's where we really need to improve. All of the innovation and talent is here but the benefits accrue quicker elsewhere.
>
> - Glenn Fletcher, CEO, **Tribosonics**

> Power Roll have received support from the UK government in terms of grants as we've developed our technology at different stages, and all of that has been highly supportive. Could there be more work to be done? Absolutely I think more could be done to speed up the renewable transition.
>
> - Don Scott, CCO, **Power Roll**

> The UK continues to play a growing role in the GreenTech space and there is a great emphasis from innovative businesses, investment and from the government on GreenTech export around the world. Solar Water PLC has been privileged to be very well supported by the UK Government and the Department for International Trade in markets around the world. GreenTech solutions such as ours are of great importance for Britain in a post-Brexit era where we want to be on the global stage bringing future-focused innovations to the parts of the world that need it.
>
> - James Whitehead, CCO, **Solar Water PLC**

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SECTION 14:

IS THE UK READY FOR NET-ZERO?

ENCOMPASSING INNOVATIONS AND TACTICS ACROSS ALL INDUSTRIES. BUT AT THIS POINT IN TIME, IS THE UK READY FOR THIS TRANSITION AND WILL IT BE READY FOR THE ALL CRITICAL 2050 TARGET?

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Firstly, Don Scott explains how vast infrastructure improvements must be achieved to make net-zero possible.

> Currently, we are not even close to a renewable transition. Generation, transmission, and storage all need considerable work. The infrastructure is behind the innovation and that needs to be flipped. When the infrastructure for the internet was being developed, there was a vision behind what it would be, and I think that's missing here. I think energy companies, in particular The Grid, are lagging and just following demand. They need to get in front of the demand.
>
> - Don Scott, CCO, **Power Roll**

Karl Farrow delivers his insight on how we can effectively achieve carbon-neutrality.

> I think to transition successfully we need to look at building a new infrastructure, and at the same time making a way to transition the old infrastructure to carbon-neutral standards. The infrastructure that we have today is certainly not suitable for the future. I am not sure we fully understand how to achieve this yet either, we are still very much in that learning phase. One of the big challenges we have in the UK is that the systems we distribute energy on are outdated and not designed to deal with the different types of energy. Even if you want to buy renewable energy you can't guarantee that the energy is coming from a renewable source.
>
> Wind and solar are weather dependent, and that's why it's important to look at baseload energy like Geothermal to help support these. It's not to say that one is better than the other, it's all part of the same renewable mix which helps support the scalability of wind and solar."
>
> I think the challenge we have today is the magnitude of the challenge we have ahead of us. It's been 100 years since the industrial revolution and to revert that it will realistically take just as long. I think we are going to come against more issues in the next 20-30 years before people take it really seriously, as there is still too much of a commercial focus. If you want to solve a major catastrophe, the last thing you should be considering is making money.
>
> - Karl Farrow, CEO, **CeraPhi**

Glen Fletcher, CEO of Tribosonics discusses how the integration of both government and business is going to be crucial to becoming carbon neutral.

> I think the UK is absolutely capable of doing so, but that's a different thing from actually doing it. We have the technology, we have the people, and we have the ability to build it. But we've got to pull it all together, and this needs to be done quickly and we need to stop waiting for the government to get its act together, and get on with it in the business community and join the dots between collaborative innovation ecosystems and tech adoption and funding and businesses of all sizes working together to be more sustainable and hit the decarbonisation targets.
>
> - Glenn Fletcher, CEO, **Tribosonics**

Conrad Langridge, Head of Marketing at Spherics describes how we need not only consider our current practices, but the harm that has been in the past.

> Yes. We are in a privileged position to do so. Can we undo all of our historic emissions what have allowed us to get to the position that have allowed us to get to the position we are in? That's a much harder question. As with all things, we should all be looking at holistic emissions reduction, and we need to solve this globally. This might be one for the politicians.
>
> - Conrad Langridge,
> Head of Marketing, **Spherics**

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SECTION 15: PREDICTIONS FOR THE FUTURE

The GreenTech sector is expanding and evolving at unprecedented rates, going above and beyond expectations. Therefore, it can be hard to comprehend what the next decade of GreenTech will look like. Our expert contributors delve into the possibilities and examine what they think the future could be.



> It is the obligation for all of us that we accelerate GreenTech adoption and that it becomes the norm, the benchmark for expectations across industries and around the world

- James Whitehead, CCO, **Solar Water PLC**

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15.1 FAST-PACED CHANGE

> There's clearly going to be a lot of changes. There are a lot of innovative technologies and some of them will thrive and some of them won't. And so, there's going to be a period of quick change. Undoubtedly, large traditional companies are going to then buy up what's successful and what's working so that it will consolidate again, but we're nowhere near that at the moment. We're still on this real innovative push to figure out what are the big things that are going to get globally adopted. So, it's an exciting time to be involved in the industry, because it cuts across everything. There are so many technologies that are needed in so many areas.

- Alastair Morris, CCO, **Powerstar**

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15.2 GEOTHERMAL ADOPTION

We have our own set of goals for 2050, where we aim to produce 500 gigawatts of geothermal energy, which is exponentially higher than the 15 gigawatts being produced today worldwide. Even at that stage, it will only represent about 3% of the global renewable energy capacity, and that's scaling geothermal 30 times its current rate. A lot of change needs to happen, and I don't think our current approach with wind and solar is going to achieve this if we still want to maintain a healthy countryside and sustainable environment as they need to cover a lot of land, whereas with geothermal 90% of its footprint is underground. We are a small country, and we don't have the value of space. And in countries that are susceptible to hurricanes and other natural disasters, this infrastructure could require significant reparation annually.

- Karl Farrow, CEO, **CeraPhi**

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15.3 EVs WILL BECOME MORE ACCESSIBLE

We need to install as many charging points as possible to meet future demand but it needs to be done proportionately and based on data, otherwise money and valuable resources are wasted. In situations where funding provision is tight, intelligence-led investment is the only way to ensure a return on that outlay.

EVs are just part of the story. Car ownership, and attitudes to ownership, are changing. Most people who have a new car don't actually own it themselves, they're leasing it or paying it off in some way. This makes EVs more accessible, especially to those who don't have a driveway or a garage or somewhere they can charge their car on-street.

Beyond that, we're already talking to clients about how to plan for shared ownership or use of vehicles in the shape of 'Mobility as a Service' models potentially involving autonomous EVs called up on your 'Uber' style app.

One thing's for certain; our cities and towns will change. We work on design scenarios for new housing developments, towns and cities where we look forward 20-30 years to houses which no longer need driveways, streets with less parking, delivery drones, and the potential re-use of parking areas as places for people and activity.

- James McKechnie, Divisional Director for Transport Planning, **Hydrock**

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15.4

REPLACING INCUMBENT TECHNOLOGIES

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The upcoming trends are all going to be around replacing those existing incumbent technologies and turning factories and assets into smart factories or smart assets and equipment. That not only impacts the energy efficiency and sustainability drivers of those businesses but also lends itself to more automation. There has been talk around Industry 4.0 for as long as I can remember but there is hardly anyone really achieving this. It's not only about creating sustainable factories, but also inherently sustainable practices that create better working environments.

- Glenn Fletcher, CEO, **Tribosonics**

Tim Meanock, CEO of Tallarna follows on from this with the potential for retrofitting in the future.

In the retrofit space, expensive technologies such as heat pumps and solar panels will come down in price, making the business case for decarbonisation stronger. This will create a domino effect, accelerating retrofits and helping build a more sustainable future for all.

- Tim Meanock, CEO, **Tallarna**

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15.5 SOLAR POWER GROWTH

Looking purely at the solar power market, the rooftop solar industry today is worth around $10 billion. We think that the market with a lighter product at a lower cost could probably be worth £150-190 billion in a decade. It will be huge; we just need to unlock it and prove it can be done.

- Don Scott, CCO, **Power Roll**

15.6 LEGISLATION DRIVING CARBON REPORTING

The scale of the problem we have is unprecedented, and there are plenty of problems that CleanTech can solve. Even within business carbon footprinting, there is still massive growth potential for the existing players, we have only just begun scratching at the surface. The big driver of change is legislation and it's coming from the top and driving down through supply chains. It is only a matter of time before the pressure propagates down the supply chain and smaller suppliers see increased pressure to report emissions.

- Conrad Langridge,
Head of Marketing, **Spherics**

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15.7 CARBON OFFSET WILL ROCKET

MORE AND MORE COMPANIES ARE INSTIGATING CARBON OFFSETTING MEASURES TO REMOVE THOSE CARBON EMISSIONS THAT ARE UNAVOIDABLE FROM THEIR CURRENT PRACTICES.

With the need to drastically cut emissions, offsetting carbon emissions in forests and other natural landscapes will be a necessity of reaching net zero quickly enough to avoid the most excessive impacts of climate change. Earth Blox provides effortless access to actionable insights based on a vast store of satellite imagery, giving companies access to the information they need to meet their net zero commitments.

- Genevieve Patenaude, CEO,
Earth Blox

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GREENTECH

CLEANTECH

CLIMATETECH

_CONCLUSION

GreenTech will be the catalyst to climate change prevention. But only if they are adopted at pace and scale.

Climate prevention can never be a one-pronged approach only being actioned by a singular division, the collaboration from all sectors is paramount! It must encompass a wave of new innovation, investors backing up-and-coming technologies, government legislation and businesses and the public sector reinventing the way they work and adopting multiple forms of GreenTech.

It's now vital for countries to embrace a common vision for the future and harness innovation and the power of sustainable technologies.

GreenTech innovators will be the pioneers for the new future and will determine the trajectory of life on this planet.

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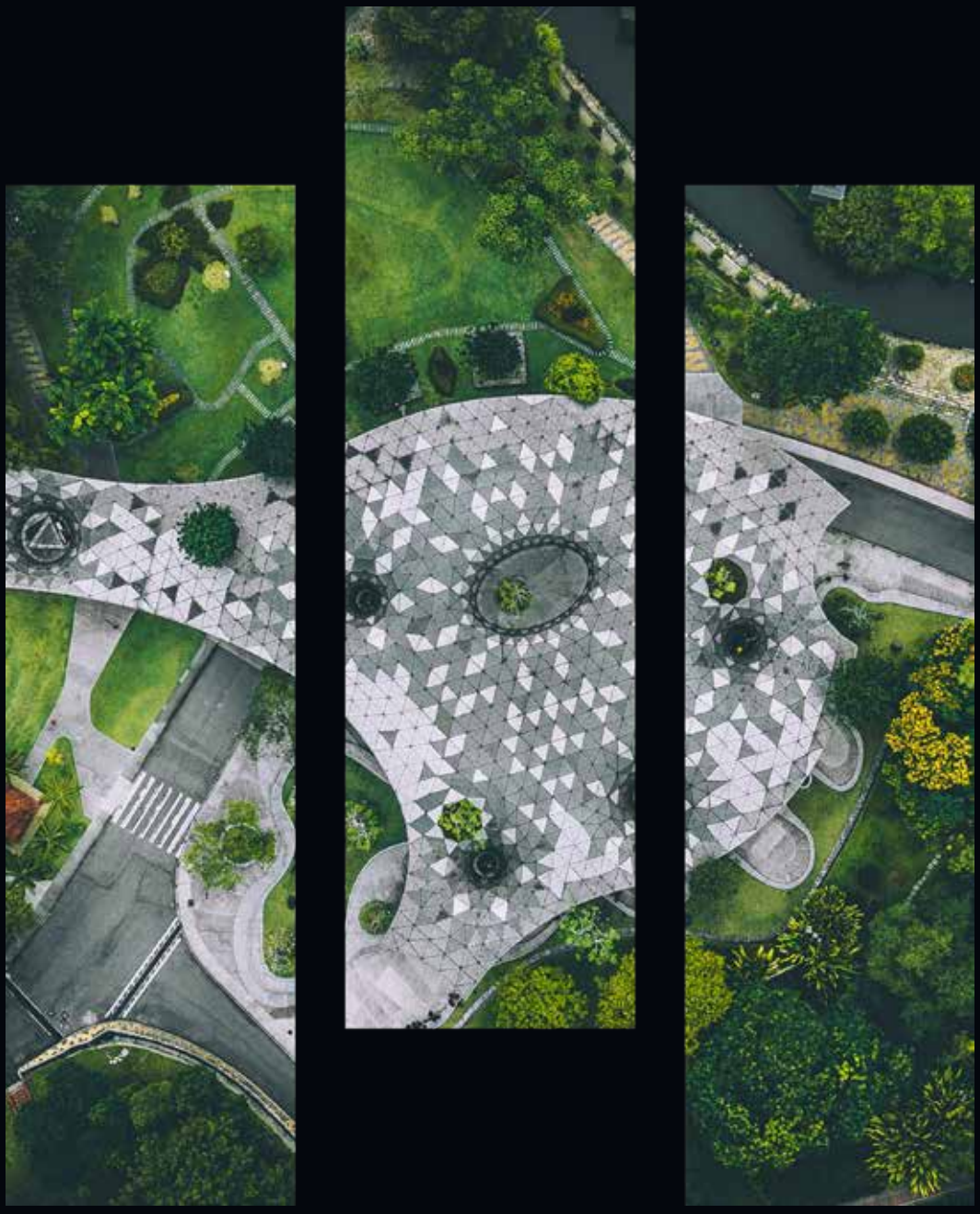
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