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Baker Hughes

Breaking the Climate Barrier

The Promise of Climate Technology for a Sustainable Future

2023

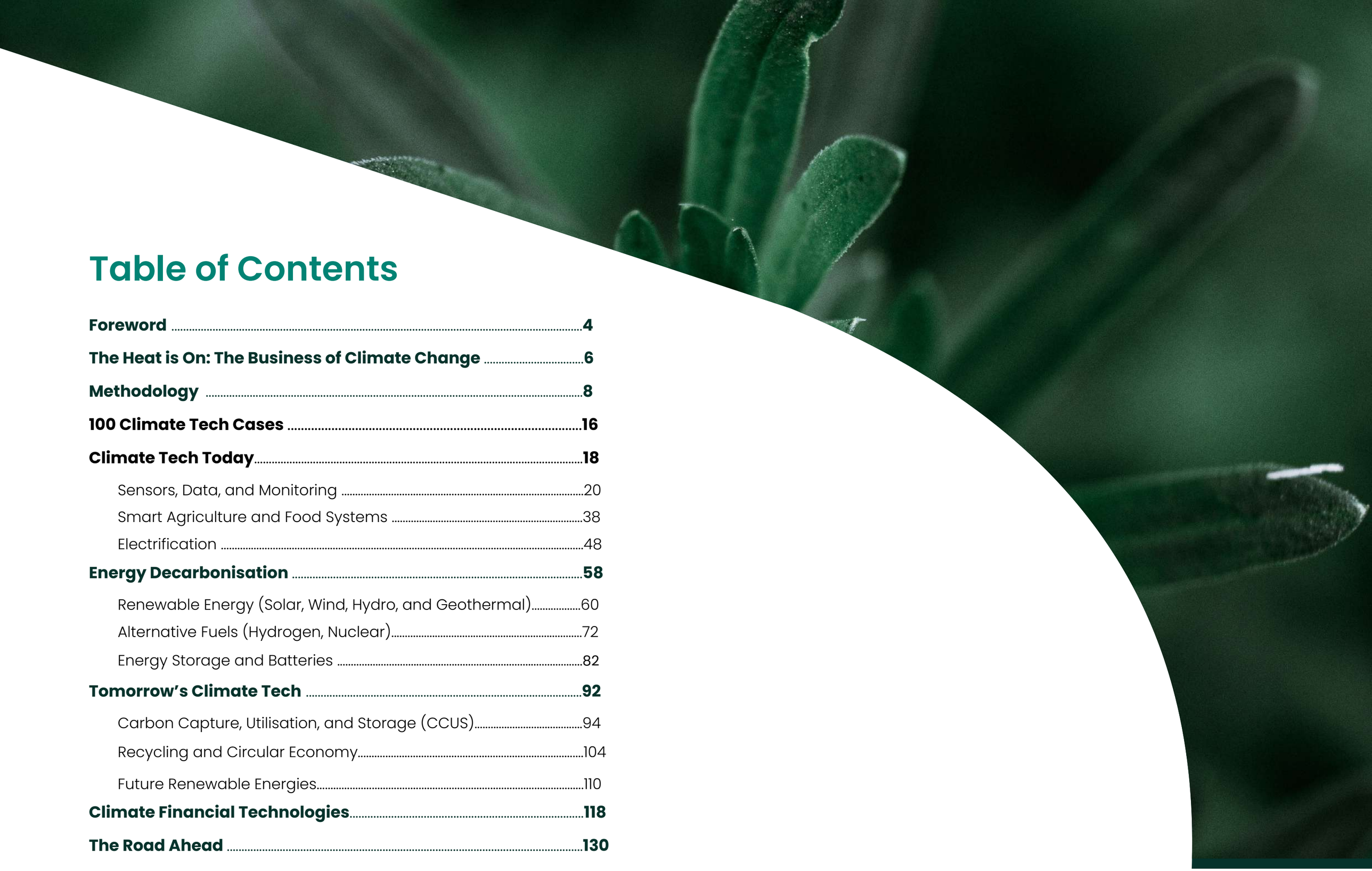

Table of Contents

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Baker Hughes Harnessing Innovation For a Sustainable Future

Baker Hughes is an energy technology company that provides solutions to energy and industrial customers worldwide. Built on a century of experience and conducting business in over 120 countries, our innovative technologies and services are taking energy forward – making it safer, cleaner and more efficient for people and the planet.

Part of the Baker Hughes – Industrial & Energy Technology business segment, Climate Technology Solutions encompasses carbon capture, utilisation & storage, hydrogen, emissions abatement, and clean power solutions.

"By taking a portfolio approach to the energy transition, we offer customers our extensive portfolio of reliable technology solutions that are available today while simultaneously accelerating development and deployment of new technologies that are crucial to achieve our net -zero target"

The Heat is On:
The Business of Climate Change

Climate change continues to be one of the defining challenges of the 21st century, and holistically addressing it requires a coordinated effort from governments, businesses, and individuals. Despite all the actions and commitments by nearly every country over the last decade, and many grand plans by large and small firms alike, the world is falling behind in its climate action agenda. In a report from October 2022, the UN Environment Programme (UNEP) confirmed that there is "no credible pathway to 1.5 [Celcius] in place" today, despite legally binding promises made at the 2015 Paris Climate Conference.

According to the International Energy Agency (IEA), investments in clean energy now represent a ratio of 1.5 to 1 with fossil fuels, but these expenditures need to be scaled up dramatically, to a ratio of 9 to 1, by 2030 to be consistent with a credible Net Zero path. If we hope to reach such stratospheric investment numbers within the decade, we need transformative innovation. We need the focus to encourage a global race on climate-tech, and we need all stakeholders to be engaged, from all walks of life.

It is clear that business-as-usual is neither sustainable nor credible, and we need a major re-think. The message on the road to COP28 is clear: we need to pick up the pace in creating global collaborations that deliver both economic and climate progress through pragmatic, realistic, practical, and commercially viable initiatives.

While the urgent need to reduce greenhouse gas emissions and transition to a more sustainable economy is widely recognised, it is often assumed that this will require significant sacrifices and trade-offs. However, recent developments in climate technology (climate-tech) suggest that this assumption may not be entirely accurate. In fact, economic growth and increasing emissions do not have to be synonymous. Today, technology could be a critical piece of the puzzle in transformative climate action, providing novel opportunities for businesses to thrive while simultaneously reducing their environmental impact. As we work on various policies, business models, and consumer behavioral change in our climate action agenda, sufficient attention should be given to climate-tech.

Climate-tech refers to the use of innovative solutions to address the challenges of climate change. It encompasses a wide range of technologies, from renewable energy sources to sustainable agriculture, carbon capture and storage, and smart cities.

The promise of climate-tech lies in its potential to reduce greenhouse gas emissions, mitigate the impacts of climate change, and create a more sustainable future for all. For example, renewable energy sources such as solar and wind power can replace fossil fuels and reduce greenhouse gas emissions. Sustainable agriculture practices can improve soil health and reduce carbon emissions from farming activities. Carbon capture and storage technologies can capture carbon dioxide emissions from industrial processes and store them underground or in other long-term storage solutions.

In addition to environmental benefits, climate-tech can also create economic opportunities, such as the development of new industries and the creation of new jobs. For example, the transition to renewable energy sources can create new jobs in the manufacturing, installation, and maintenance of renewable energy infrastructure.

Another key advantage of climate-tech is that it can help businesses reduce their costs and increase their competitiveness. By adopting more efficient and sustainable practices, companies can save money on energy, waste, and resource management. They can also differentiate themselves from competitors by offering eco-friendly products and services that appeal to environmentally conscious consumers, who are becoming increasingly common in younger and more climate-conscious generations.

Demand for climate-tech solutions is steadily increasing. Globally, some studies show that more than 25% of all venture capital is currently flowing into the climate-tech space, which has already produced over 83 unicorn startups.[3] Unsurprisingly, the most common sectors for investment are energy production and mobility/transportation; global renewable energy capacity increased by an estimated 8% in 2022 (accelerated in part by a supportive geopolitical environment), and the electric vehicle (EV) revolution continues to rapidly expand. Norway is already surpassing 50% market share of EVs as the market matures, but this is not purely a narrative for wealthy economies: Vietnam and India both have homegrown EV scooter brands that are chasing new markets from Hanoi to Hamburg.

However, we must also acknowledge the challenges to adopting climate technology, including the high upfront costs, regulatory barriers, and technical complexities. The deployment of climate-tech requires significant investment and research. Many climate-tech solutions are in the early stages of development and will require time and many future iterations to bring them widely to global markets. We are also at the cutting edge of human capabilities, with gaps remaining for many climate-tech ideas to be commercially viable. To overcome such arduous obstacles, businesses - and countries - need to be strategic in their approach, investing in the right opportunities while collaborating with stakeholders across the value chain.

This white paper focuses on the business aspect of climate change and overviews a variety of promising solutions in climate-tech. Specifically, we look at a snapshot of some of the most important industries implementing climate-tech today, as well as preview some powerful upcoming technologies that are gaining traction for the future. From renewable energy and electric vehicles to smart grids and circular economy solutions, there are countless opportunities for businesses to innovate and succeed in a low-carbon future. With the right mindset and approach, businesses can – and should – embrace climate-tech as a catalyst for transformative change, not just for their bottom line, but for the planet as a whole.

Methodology

The methodology for compiling the 100 climate tech cases is structured around a thorough research approach encompassing four overarching categories and their respective sub-themes. The report's methodology encompasses the following steps:

Data Collection and Categorisation

Our research team initiated the project by conducting extensive desk research to identify and collect information on climate technology innovations from around the world. The research was structured into four main categories:

- **Climate Tech Today**
- **Energy Decarbonisation**
- **Tomorrow's Climate Tech**
- **Climate Financial Technologies**

Each category was further subdivided into specific sub-themes as outlined in the report below, ensuring a comprehensive coverage of the climate technology landscape.

Scope Definition

Within each category and sub-theme, we clearly defined the scope, outlining the specific technologies and innovations to be considered.

Identification of Key Players

To identify the most impactful climate technology innovations, our team identified key organisations, projects, and individuals at the forefront of each sub-theme. This involved research into industry leaders, pioneers, and emerging players driving innovation in the climate tech space.

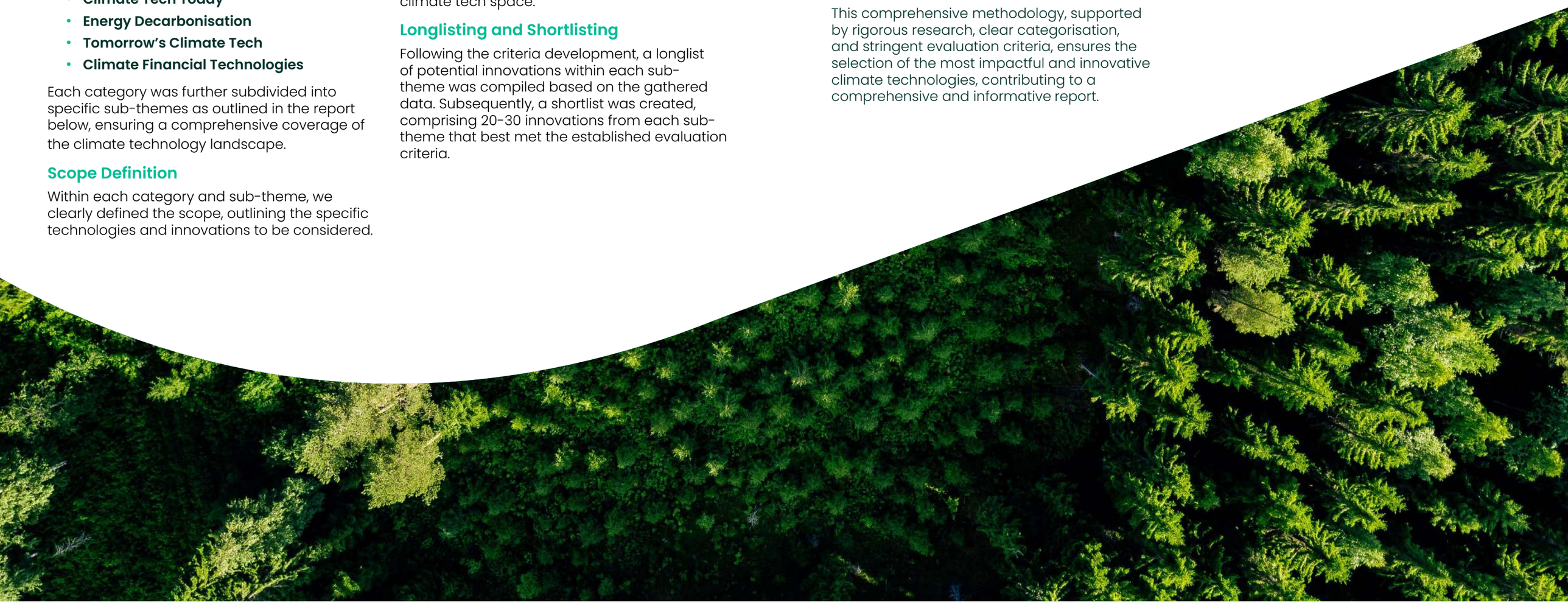
Longlisting and Shortlisting

Following the criteria development, a longlist of potential innovations within each sub-theme was compiled based on the gathered data. Subsequently, a shortlist was created, comprising 20-30 innovations from each sub-theme that best met the established evaluation criteria.

Cross-Category Ranking

The shortlisted innovations were evaluated using a unified set of criteria, allowing for the collection of 100 climate tech innovations across all categories. This holistic approach ensured a balanced representation of innovations from a wide range of climate technology sectors.

This comprehensive methodology, supported by rigorous research, clear categorisation, and stringent evaluation criteria, ensures the selection of the most impactful and innovative climate technologies, contributing to a comprehensive and informative report.



Climate Tech Today

Sensors, Data, and Monitoring

To start looking forward, we begin with the same building blocks used universally by the tech sector: data-powered technologies. Real-time sensors, the Internet of Things (IoT), and machine learning analytics all play a crucial role in the fight against climate change as well as facilitate breakthroughs in climate-tech.

Just like fuel and logistics equipment are necessary to enable the movement of tens of thousands of container ships around the world every single day, data and analytics are key ingredients to coordinate and minimise the risks in these trips, including climate risks.

By providing accurate and real-time information about the environment, innovative tools can help optimise resources and provide hitherto unforeseen insights.

For example, sensors can be used to monitor air quality and water levels, allowing for targeted interventions that reduce pollution and conserve resources. Data can also be analysed to identify patterns and trends, sometimes untapped, or other times difficult to obtain, enabling scientists and policymakers to make informed decisions about climate policies and interventions.

Smart Agriculture and Food Systems

One of the most well-known side effects of climate change is its impact on agriculture. Crops that have been cultivated for generations are no longer as viable in the same fields due to increasing temperatures. Crops that require enormous water inputs are becoming prohibitively expensive in drought-stricken areas. In truth, agriculture accounts for the vast majority of freshwater use on Earth today. While all humans need to eat, we also need to learn to be efficient and careful with our limited resources in the face of more extreme weather.

Many agricultural practices are continued simply out of habit or to take advantage of antiquated regulations.

Electrification

Battery-powered drones are rapidly replacing their gasoline-powered helicopter ancestors. The advent of drones transitions nicely into the broader topic of electrification. This involves replacing fossil fuels with electricity as the new fuel. Battery-powered EVs, buses, construction equipment, mopeds, and more, are replacing gasoline- or diesel-powered equivalents. Electric heat pumps are replacing gas-powered furnaces for heating homes and businesses. While media headlines often focus on splashy new EV companies like Tesla and Lucid Motors, industry veterans like Sweden's Volvo and China's Geely are also busy electrifying their fleets. Plus, there are exciting newcomers.

Besides lower pollution, there are some amazing hidden benefits to electrification as well. Electric motors are significantly quieter than combustion engines, meaning that local construction and public transit operations are less disruptive to communities. Electric motors also enjoy lower maintenance costs compared to combustion engines. Heat pumps mean fewer pipes need to be installed in homes and commercial buildings, leading to lower installation costs.

However, electrification has some interesting drawbacks. Modern electricity grids cannot store power; electricity must be generated within minutes of demand. This means that electrification is only as environmentally clean as its source of electricity generation, and usage costs can vary more widely with spikes in electricity demand. Ideally, electrification is accompanied by renewable energy sources, such as solar, wind, and hydropower. The increasing availability and affordability of renewable energy technologies have made electrification a viable solution to reduce greenhouse gas emissions and mitigate the impact of climate change.

Also, in the event of a power outage, potentially more systems are non-operational, which can be a problem for emergency services.

Nevertheless, this just means that innovators will need to be more creative! In fact, new business models are emerging that were not possible with non-electric counterparts.

Ultimately, widespread electrification will only be compatible with a Net Zero future if the electricity comes from clean and renewable sources. This means that energy sector decarbonisation must take priority in the upcoming decade.

Energy Decarbonisation

Renewable Energy (Solar, Wind, Hydro, and Geothermal)

The energy sector is responsible for virtually all of humanity's activities, upon which the livelihoods of billions depend. Today, it is in transition. It is a matter of when, not if, that society sources its energy from renewable sources instead of hydrocarbons. The exact timeline is unclear, but that future goal is approaching with greater haste. For energy providers, this global energy transition is also an opportunity to shift their generation portfolio to also rely on renewable energy sources.

Of course, the specific mix of renewable energy sources will vary not only on a national level, but also on a local level. Some regions, such as Brazil and Iceland, are blessed with plentiful rivers for easy hydroelectricity. For the vast majority of communities, however, a tailored mix of solar panel arrays, wind turbine farms, hydroelectric dams, and geothermal plants will all be necessary.

Of course, switching production to these means, alongside mass electrification, is easier said than done. It will take decades of hard work, and trillions of dollars in investments, even if everything goes perfectly.

Moreover, the procurement, construction, and maintenance of solar panels and wind turbines require numerous polluting processes. Again, this is an invitation for innovators to improve, tinker with, and disrupt the current status quo.

This is a space where innovation is needed, should be encouraged, and is producing promising results.

Alternative Fuels (Hydrogen, Nuclear)

While solar, wind, and hydropower will be sufficient to handle most domestic energy needs, these renewable sources are insufficient for heavy industries. The low power-to-weight ratios of batteries make them impractical (as of yet) for airplanes, for instance, or certain energy-intensive processes like smelting steel. For these use cases, alternative fuels – especially hydrogen and nuclear – will play an important role in our sustainable future.

Hydrogen can be burned as a carbon-neutral fuel that emits water as exhaust instead of carbon dioxide. In many ways its operations mimic hydrocarbons today: hydrogen can be liquified, transferred via pipes, and quickly added to a vehicle from a pumping station. However, these steps are far more expensive than their gas counterparts, and require specialised equipment that is not widely available. This has led to some unorthodox workarounds: it is significantly cheaper, for example, to transport hydrogen long distances in the form of ammonia. Ammonia itself can be produced from desalinated water powered by solar and wind, which ultimately creates a carbon-neutral feedback loop.

Hydrogen's economic potential for aviation, metal refining, transportation, and more, have made it an important source of investment for a variety of multinationals around the world. The UAE's ADNOC, the UK's BP, China's Sinopec, and India's Reliance Industries, among many others, are each laboring diligently to expand the hydrogen production ecosystem.

Nuclear is the other alternative fuel that requires discussion. Nuclear power is incredibly clean and safe, despite its sometimes fearful reputation in popular culture. While there have been two highly dramatic and well-publicised reactor meltdowns (decades apart), all the deaths involved were far fewer than the millions that die from fossil fuels every year. We must not let fear dictate our energy policies. Nuclear power is also reliable and efficient, requiring tiny amounts of fuel to provide electricity compared to fossil fuel alternatives. If we hope to wean ourselves from hydrocarbons within the 21st century, nuclear power will need to be involved.

Nuclear energy has drawbacks, of course, namely its costs, technical requirements, and arduous regulations. Once more, such shortcomings make the industry ripe for improvement, and we are likely at the edge of another boom in smaller and safer reactors.

Energy Storage and Batteries

As alluded to earlier, there is a gaping hole in our electricity ecosystem when it comes to storage. Electricity grids cannot store electricity, and our most powerful batteries are incredibly small when compared to a city's daily consumption. Some creative alternatives already exist, most notably pumped storage: surplus electricity during slow periods is used to pull water uphill into a large reservoir, where it can later activate gravity-powered generators during peak demand. Pumped storage batteries are used from Switzerland to California to the UAE, but they are relatively small in terms of electricity outputs and capacity.

Luckily, we are in the middle of an enormous wave of innovation in this space. When electricity prices are cheap, a powerful winch hoists up a giant weight, and when needed, the weight slowly drops and turns a dynamo to produce electricity. Of course, even with these storage solutions, regular batteries will continue to be necessary. Furthermore, electrification is causing the demand for batteries to spike. Since all batteries today require intensive mining to source the raw materials, this news is not ideal for the environment.

Tomorrow's Climate Tech

Carbon Capture, Utilisation, and Storage (CCUS)

Plants use photosynthesis to absorb carbon dioxide from the atmosphere and store it in their body; CCUS technologies do the same thing artificially. While capture and storage are usually grouped together in this technology space, there are two processes at play: the first is capturing carbon dioxide directly from the air, which can then be reused for industrial purposes, or, it can be placed into long-term storage capable of nullifying its impact on climate change. These technologies are only available on a small scale today, but with the right investment and focus will become commonplace in the future. CCUS technologies are necessary to undo the damage we have already caused; however they are not intended to subsidise continued unsustainable lifestyles.

Nature is the kingpin in this space, with forests and peatlands acting as the world's largest and most important carbon sinks. Humanity has destroyed reportedly one-third of the world's forests since the last Ice Age, but a combination of policy action and (ironically) changing climates is helping trees make a comeback. Social media and grassroots activism are beginning to play a larger role in this space too, with leading YouTube personalities facilitating successful crowdfunding campaigns to plant millions of trees. Other tree planting campaigns are paid for by companies hoping to neutralise their pollution as well as receive tax benefits for helping the environment. Having noted that, and while tree planting today is a vital component of corporate carbon offsets, it is not enough to fully mitigate the impact of climate change. New technologies are needed to give nature a hand.

Recycling and Circular Economy

Waste is an often overlooked issue by the general public as it is collected and disposed of in areas unoccupied for residential purposes. We inhabit an extremely linear economy, meaning that virgin resources are used to make a product, we use said product, and then we throw it away to either sit forever in a landfill, or be incinerated. Not only is this lifestyle highly polluting, but it is highly inefficient.

So much of what we throw away is perfectly suitable for further use, whether through recycling the individual components, or through up- and downcycling to receive new life. For example, smartphones have rare metals inside them that can be reused again and again in new electronics. Broken glass bottles can be transformed into trendy countertops and benches. This is the essence of the circular economy. According to the 2023 Circularity Gap Report, the world is only 7.2% circular; that means over 90% of our economy is driven by new resource extraction.[11] The circle economy is a deceptively tricky space – one where climate-tech is thriving.

Future Renewable Energies

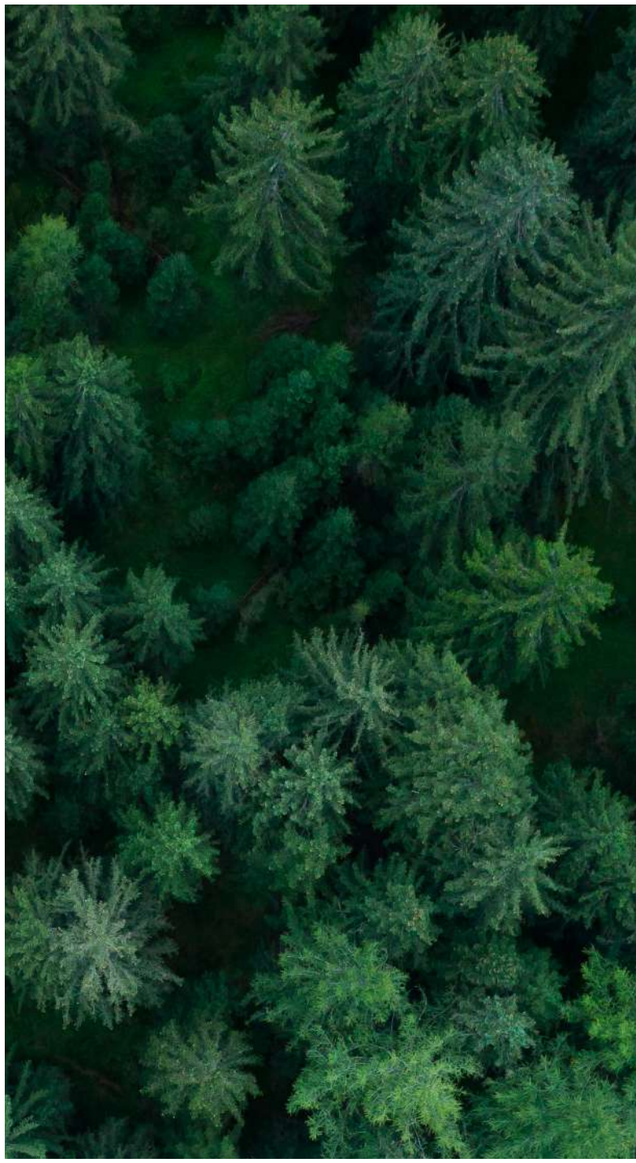
Human imagination is limitless, and in the face of climate change, we are constantly exploring new solutions. We have already chronicled the rise of renewable energy in this report, but new technologies are still on the horizon. New ways of generating electricity promise to tap unused sources of energy from our skies and oceans, and even from space!

Climate Financial Tech

In a world marked by pressing environmental challenges, economic inequalities, and the urgent call for climate action, the spotlight on climate financial technologies has never been more critical. From 2020 to 2021, nearly 65% of venture dollars were invested towards climate tech start-ups in the United States (US$56.6bn). These innovations hold the promise of sparking transformative change, paving the way for a more sustainable, inclusive, and resilient future. In a rapidly changing world, the intersection of finance and climate action has never been more critical. Climate FinTech, the fusion of financial technology and sustainability, is playing a pivotal role in driving positive change.

These technologies encompass a wide range of applications, from digital platforms that enable green investment and carbon trading to data analytics tools that assess climate risks and opportunities for businesses and investors. They play a crucial role in supporting the transition to a more sustainable and environmentally responsible global economy. Climate fintech matters because it helps bridge the gap between the financial sector and climate action.

By providing tools and services that facilitate informed decision-making and investments in green initiatives, climate fintech contributes to a more efficient allocation of capital to environmentally friendly projects, renewable energy, and carbon reduction efforts. Furthermore, these technologies enhance transparency, enabling stakeholders to monitor and track the environmental impact of their financial decisions, ultimately fostering greater accountability and responsible financial practices in a world grappling with the urgent need for climate action.



100 Climate **Tech Cases**

These innovative solutions represent a diverse array of approaches and technologies aimed at combating climate change and building a more sustainable future. From renewable energy projects to cutting-edge carbon capture methods, these cases offer a glimpse into the global effort to address one of the most pressing challenges of our time.

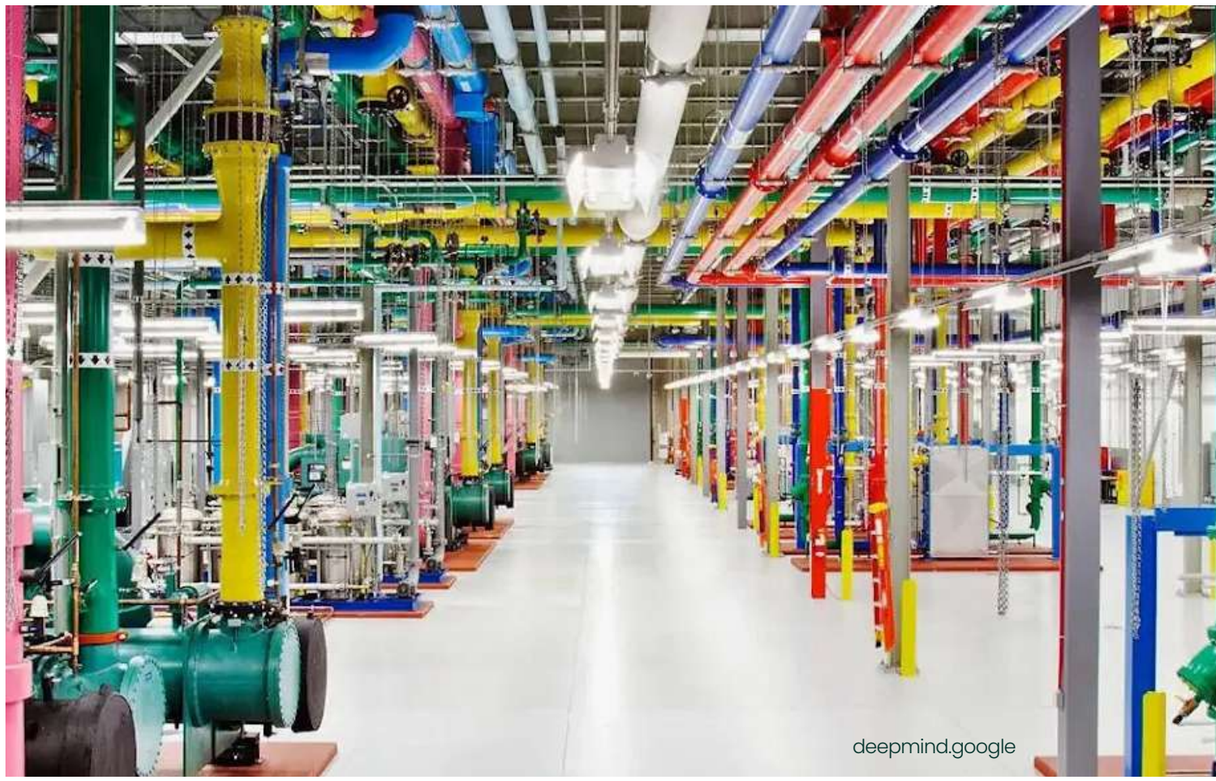
Climate Tech Today

Sensors, Data, and Monitoring

1. High-efficiency Flare Combustion

United Kingdom

Incomplete flaring is a major cause of methane emissions; 86 times more potent than CO2 over a 20-year period, methane is one of the most harmful forms of emissions. By using Baker Hughes' flare.IQ technology and its advanced analytics platform, operators can pull critical information about their flare systems, including temperature, pressure, vent gas velocities and gas composition, to calculate the optimum levels of flare performance and ensure 98%+ high-efficiency flare combustion and therefore minimise emissions. A major IOC recently adopted flare.IQ – it can now accurately determine the efficiency of the flare performance and the volume of flare emissions of its upstream plants operating worldwide, initiating quick and effective interventions to minimise emissions. flare.IQ is easy to deploy, cost effective and has a proven track record in optimising flare operations and significantly reducing methane emissions.



2. Data Center Cooling

United Kingdom

The increasing demand for data storage and processing has led to a significant challenge: the rise in heat generated by data centers. This surge in heat poses a threat to the efficiency and reliability of these centers, potentially causing hardware malfunctions and decreasing overall performance. DeepMind, an artificial intelligence subsidiary of Alphabet (Google's parent company), has pioneered a system that harnesses the power of machine learning algorithms to enhance cooling operations in data centers to address this issue. Through the analysis of various data points, including temperature, power usage, and environmental factors, DeepMind's AI algorithms make instantaneous adjustments to the cooling systems. It's not just about managing server-generated heat; it's a practical pursuit of optimising energy use and improving performance boundaries. The impact of this technology is evident in its remarkable results, showcasing a 40% decrease in energy consumption for cooling processes and a substantial reduction in the carbon footprint associated with data center operations.

3. Smart Thermostats

United States

Putting climate control at the fingertips of users is now a reality for many people, cultivating a more personalised and sustainable way of living. Smart thermostats, exemplified by products like the Nest, represent a revolution in home climate control. These innovative devices seamlessly blend cutting-edge technology with energy efficiency. Nest, in particular, employs machine learning to understand and adapt to users' heating and cooling preferences, gradually creating personalised schedules. They can also be controlled remotely via smartphones, offering convenience and the ability to adjust settings while away from home. What truly sets smart thermostats apart is their eco-friendliness. They optimise energy usage by learning from users' behaviors, such as their sleep patterns, resulting in reduced energy consumption and lower utility bills. Additionally, they often have features like occupancy sensors to automatically adjust settings when no one is at home.

4. Blue Ocean Gear

United States

The increasing strain on marine ecosystems and the imperative to address environmental sustainability have highlighted the challenges associated with conventional ocean and fishing gear. Traditional fishing methods often result in overfishing, habitat destruction, and the unintended capture of non-target species, leading to ecological imbalances. Blue Ocean Gear, based in the USA, focuses on developing and deploying smart, IoT-based fishing gear that is eco-friendly and sustainable. Blue Ocean Gear's technology incorporates sensors and real-time data collection to enhance the traceability and sustainability of fishing operations. By promoting responsible and transparent fishing practices, their solutions aim to reduce overfishing, bycatch, and the environmental impact of fishing.

5. Optimising Energy Technologies

United States

The escalating global demand for energy, coupled with environmental concerns, have underscored the urgent need for optimising energy technologies.

Optimising Energy Technology, spearheaded by Heila's Technologies, offers cutting-edge control and optimisation solutions for microgrids and distributed energy resources, paving the way for a more resilient, sustainable, and efficient energy ecosystem.

The platform facilitates intelligent coordination among diverse energy assets such as solar panels, battery storage systems, and generators. Through the use of real-time data and machine learning, Heila optimises both energy production and consumption, resulting in improved grid reliability and enhanced energy efficiency.

This technology is especially crucial for communities, businesses, and utilities seeking to fortify their energy resilience and decrease their carbon footprint.

6. Underwater Drones

Spain

Exploring the depths of marine environments can unlock a world of possibilities for marine research and inspections. Underwater drones contribute to addressing safety, efficiency, and talent-related challenges in marine research and data collection.

These technologies are autonomous and artificial intelligence-driven drones designed for various applications, particularly in aquaculture and marine research. Although the underwater drone market is the strongest in North America, other countries are introducing this technology.

Nido Robotics in Spain, for instance, manufactures underwater drones that are equipped with HD sensors and cameras, enabling real-time data collection and analysis in aquatic environments. By harnessing underwater drones, we not only enhance our understanding of the underwater world but also promote sustainable practices in aquaculture and marine conservation.

7. Sentinel Satellites

Europe

Traditional methods of Earth observation often fall short in providing real-time and extensive data about our planet's dynamic systems.This gap in information hinders our ability to respond effectively to environmental changes, such as deforestation, natural disasters, and climate shifts. Sentinel Satellites, operated by the European Space Agency (ESA), are an indispensable component of the Copernicus programme. This revolutionary Earth observation project comprises multiple Sentinel satellites, each designed for specific monitoring tasks, including land, ocean, atmospheric, and climate-related observations. These advanced satellites capture a wealth of data, delivering critical insights into environmental changes, natural disasters, and climate shifts. Sentinel's imagery aids in disaster management, agriculture, forestry, and urban planning.

Moreover, they play a crucial role in tracking deforestation, sea-level rise, and the melting of polar ice. Sentinel Satellites, with their free and open data policy, contribute to global efforts in climate change mitigation and sustainable resource management.

8. Asset Performance Management

Mexico

In heavy process industries, business and sustainability outcomes are closely linked to asset performance and safe, sustainable, and profitable production requires real time maintenance and operation decisions. However, the traditional approach to asset performance management - with data held in functional silos across an enterprise of complex assets - is reactive and unscalable resulting in perpetual firefighting, loss in performance and negative ESG impacts. Baker Hughes' Cordant Asset Performance Management adopts a new approach, combining health, strategy and defect elimination capabilities into an integrated environment for a complete and quantified view of asset related risk and cost opportunity. It leverages advanced analytics and connected data sets to surface insights that enable customers to drive intelligent and insight-led decision making to drive continuous improvement and unlock productivity.

Earlier this year, Baker Hughes and BP announced the companies would collaborate on Cordant, with a pilot to deploy Cordant Asset Strategy in select locations across BP's Gulf of Mexico production assets, where Baker Hughes has a large installed base of rotating equipment, controls, and associated digital services.

9. Climate Modeling

United States

The intensifying challenges posed by climate change have underscored the critical role of climate modeling in understanding, predicting, and mitigating the impacts of global environmental shifts. Climate modeling by NASA involves the use of sophisticated computer simulations to understand and predict Earth's climate system.

NASA's climate models incorporate vast amounts of data and variables, such as atmospheric conditions, ocean currents, ice cover, and greenhouse gas concentrations, to simulate climate behavior over various time scales. These models are instrumental in studying climate change, its causes, and potential future scenarios. They help scientists and policymakers make informed decisions by providing insights into the impacts of global warming, extreme weather events, and sea-level rise. NASA's climate modeling contributes to our understanding of the complex interactions within Earth's climate system, helping society prepare for and mitigate the effects of climate change, making it a critical component of climate science and environmental policy.

10 Earth-i's Satellite Imaging

United Kingdom

The surging need for precise and up-to-the-minute Earth observation data has driven the rise of cutting-edge technologies like Earth-i satellite imaging.

Unlike conventional satellite imaging approaches that grapple with constraints in resolution, frequency, and real-time capabilities, Earth-i is reshaping the landscape of Earth observation with its advanced capabilities.

Their cutting-edge technology involves the use of innovative Earth Observation (EO) satellites equipped with advanced sensors.

These satellites capture high-quality images of the Earth's surface, offering a wealth of valuable data for various applications. Earth-i's satellite imaging provides actionable insights for industries such as agriculture, forestry, infrastructure monitoring, and disaster management. With the ability to capture images and videos in full color and high definition, this technology facilitates precise and real-time monitoring, contributing to sustainable resource management and informed decision-making.

11. Descartes Labs' Climate Data Analytics

United States

From tracking wildfires and droughts to optimising renewable energy production, data is the driver behind decision making in the field of climate analytics.

Descartes Labs' approach involves harnessing vast amounts of Earth observation data, satellite imagery, and climate information to provide valuable insights into our changing environment. By applying advanced machine learning and artificial intelligence techniques, Descartes Labs processes and analyses this data to monitor climate trends, assess environmental risks, and support decision-making across various industries.

Their climate data analytics help organisations, governments, and researchers better understand and address climate change impacts.

12. Photon Spacecraft

New Zealand

In response to the challenge of making space more accessible for small satellites, Rocket Lab pioneered a small spacecraft called Photon, built using parts from a successful rocket called Electron.

The spacecraft uses a special engine called Curie, known for working well in space.

It provides a versatile and streamlined approach to building and launching small satellites into space.

Photon offers a range of customisable satellite platforms, from Earth observation to communication, making access to space more affordable and accessible for various customers. By incorporating an in-house design, manufacturing, and launch service, Rocket Lab's Photon platform simplifies the satellite development process, reducing cost and time-to-orbit.

13. Synthetic-aperture Radar Satellite (SAR) Technology

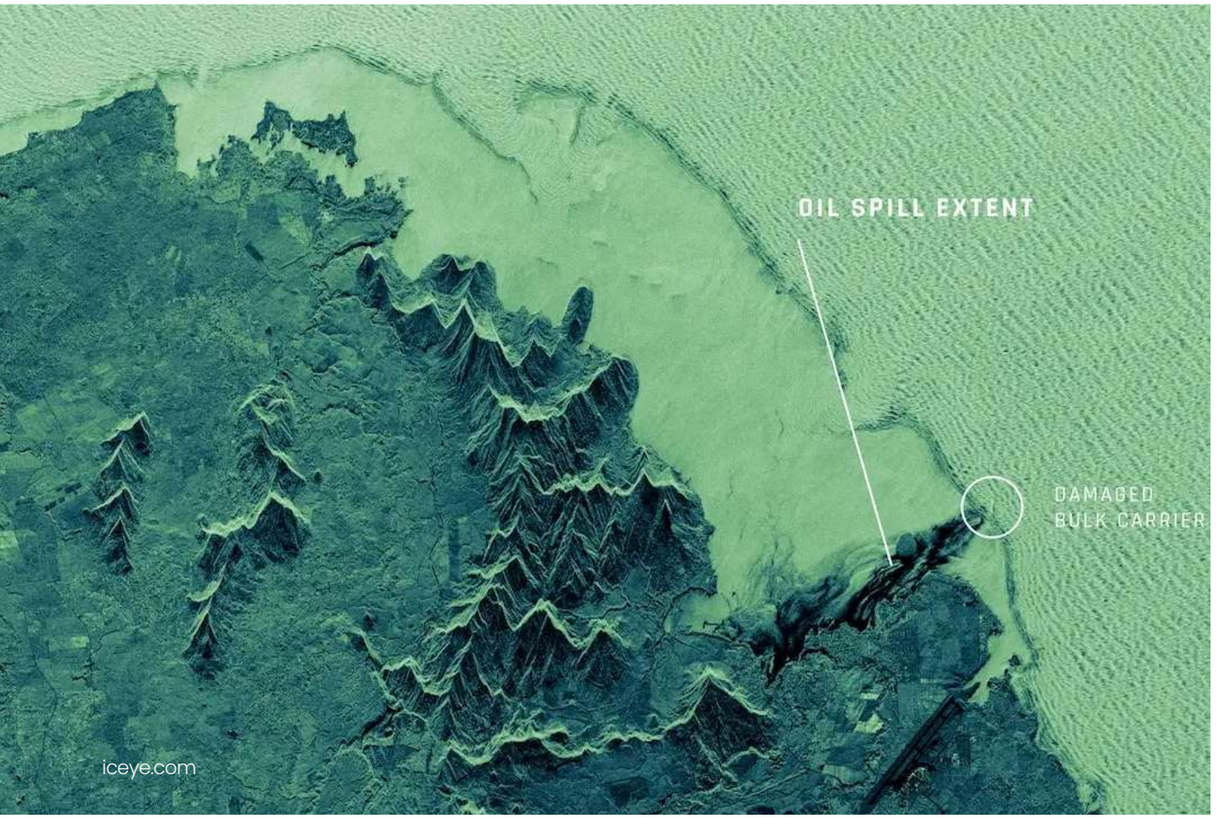
Finland

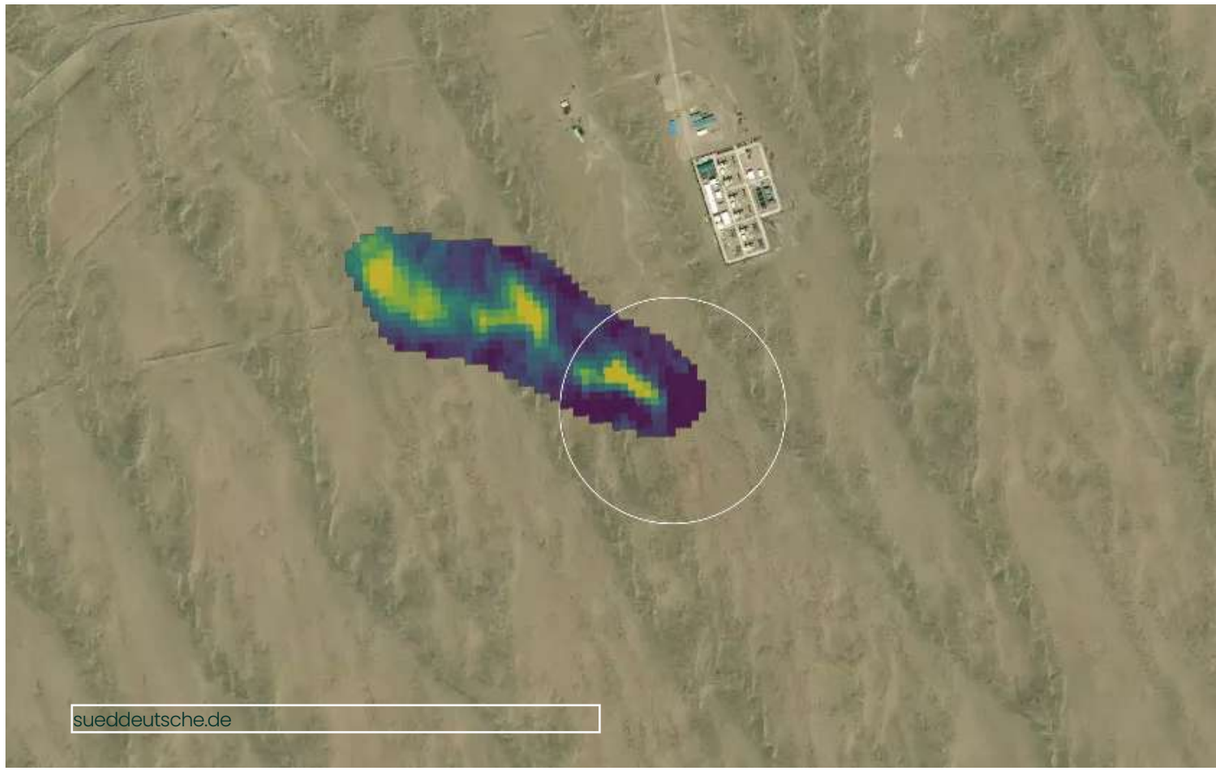
In the face of the pressing challenge of obtaining timely and accurate Earth observation data, Iceye stands out as a pioneering company specialising in synthetic-aperture radar (SAR) satellite technology.

They have made significant advancements in providing timely, accurate, and accessible information about our planet.

Iceye's microsatellites offer frequent and reliable imaging of Earth's surface, regardless of weather conditions or time of day.

These capabilities are instrumental for applications like maritime surveillance, disaster monitoring, and infrastructure management.





14. Methane Leak Detection

France

Methane is a potent greenhouse gas, and leaks from oil and gas infrastructure contribute to environmental concerns and climate change.

This is where companies like Kayrros come in to provide timely solutions. Kayrros deploys satellite imaging technology to detect methane leaks and trace their exact source, a feat previously unattainable through satellite data alone.

Instead of merely observing the situation passively, this newfound ability enables them to levy fees or taxes on methane leaks, introducing a new era of environmental accountability and responsibility.

This approach is a valuable tool in enhancing environmental monitoring and promoting sustainable practices in the energy industry.

15. FortyEngine, AI-based Platform

United Arab Emirates

Data gathering and Artificial Intelligence are becoming inextricably linked today to promote personalised and accurate results.

Companies like FortyGuard in the UAE, for instance, are revolutionising the way we understand and address urban heat challenges through innovative data-driven solutions, harnessing existing untapped data sources to create hyperlocal thermal maps of urban infrastructure, a crucial response to the pervasive heat island effect that exacerbates climate change in cities.

Their FortyEngine platform integrates predictive analytics, machine learning models, and AI-powered visualisations to provide a comprehensive solution.

The result is interactive dashboards seamlessly integrated with 2D mapping, offering users real-time temperature insights with an exceptional 1-meter accuracy.

16. SpaceTime™

India

In the contemporary landscape, businesses face the imperative of comprehending and leveraging extensive climate data to make informed decisions.

To meet this demand, a sophisticated visualisation platform is essential, facilitating users in extracting insights effortlessly across various devices.

SpaceTime™ addresses this challenge by offering a cutting-edge platform specifically tailored for visualising insights. This platform is engineered to deliver detailed spatial and temporal context, ensuring that users can easily derive meaningful insights from the wealth of climate data available.

SpaceTime™ distinguishes itself with key features that enhance the user experience, allowing seamless interaction with climate data across multiple devices.

17. Digital Solutions to Optimise Carbon Emissions

Europe

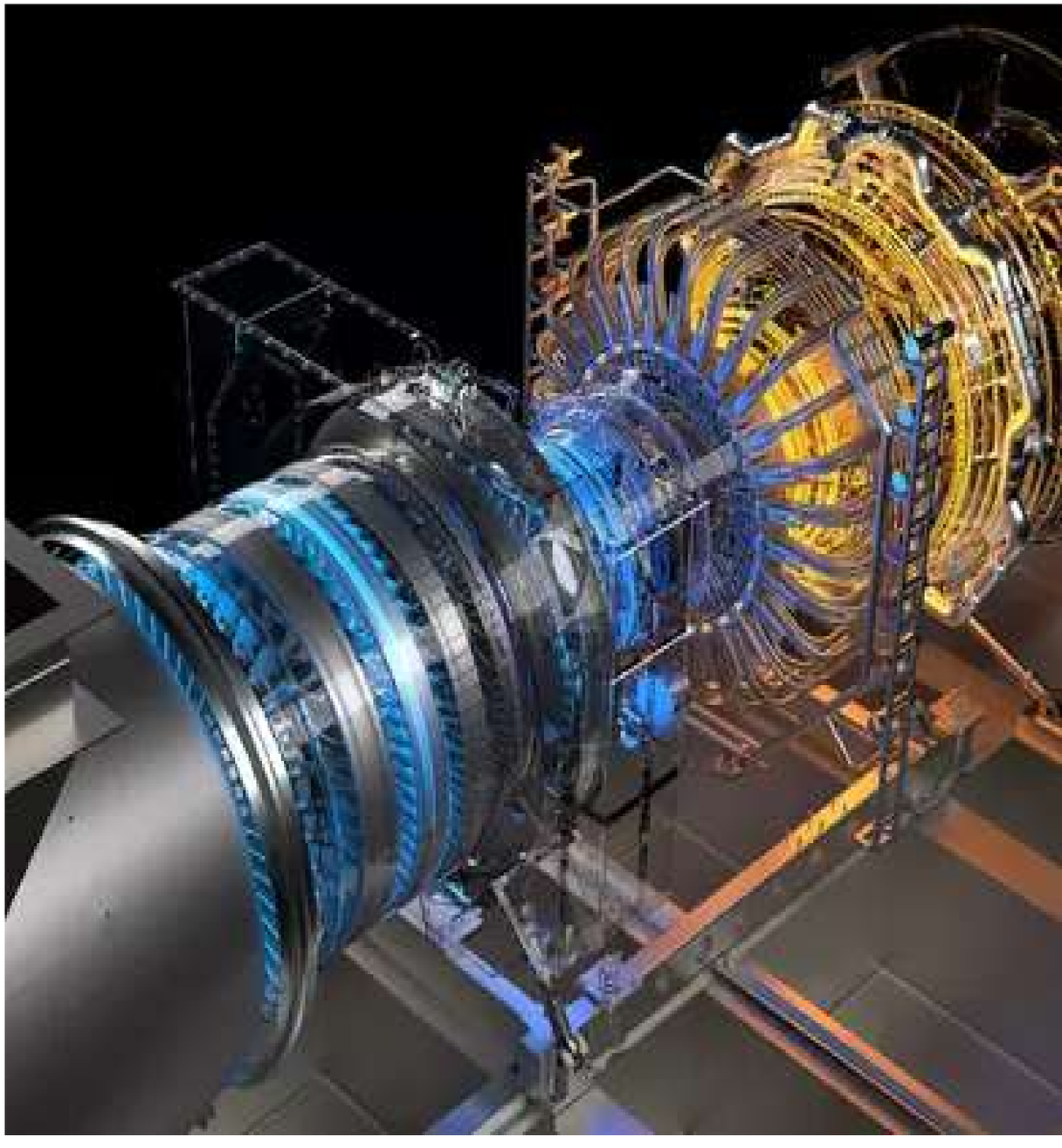
one of the key challenges in the current dynamic energy landscape is to reduce carbon emissions footprint leveraging on existing technologies and capabilities to ensure a gradual transition towards new energy frontiers.

Practical conditions often limit gas turbine fuel efficiency for many reasons including operating environment and conditions as well as equipment aging.

Baker Hughes iCenter - carbon optimiser is a suite of solutions – edge and cloud based – that optimises gas turbine fuel consumption and CO2 emissions by tuning control system variables (such as gas turbine inlet guide vane, bleed valve opening) or individual power set point on multi-unit applications.

Carbon optimiser deployed in North Sea - Europe for an offshore platform operating 2 gas turbines for power generation, provided a potential CO2 saving estimated in 6532 metric tons – approximately 4% of total annual CO2 emissions of the two units.

bakerhughes.com



Smart Agriculture and Food Systems

18. Artificial Intelligence in Agriculture

United States

AI is increasingly playing a crucial role in the agriculture industry's efforts to ensure sustainable food production amidst climate change.

Companies like Bowery Farming, that incorporate indoor farming techniques to grow thousands of crops, are using AI to keep track of each crop's individual needs.

Their Bowery OS technology collects billions of data points through a network of sensors and cameras to help identify how each crop can grow.

As the company gathers more data, it enhances its ability to pinpoint the ideal conditions for the thriving growth of each crop.

19. Automating Reforestation

Canada

Wildfires have been posing profound and often devastating impacts on forests, affecting both the ecosystem and the communities that depend on them.

Between 2001 and 2022, fires were responsible for 27% of tree cover loss. To mitigate the impacts of wildfires, and accelerate the planting of more trees, Canada-based Flash Forest uses an army of automated unmanned drones to help forests recover more quickly after wildfires.

Their technology merges UAV, AI, GIS, and plant science to scale up reforestation efforts. By leveraging automation and streamlined manufacturing, Flash Forest produces over 200,000 seed pods per day.

This eliminates the energy-intensive nursery phase typically needed in conventional tree planting methods, leading to a reduction in both waste and energy consumption during transportation, thanks to the compact size of the seed pods.

20. Farm To Fork Marketplace Technology

India

Revolutionising the way society interacts with agriculture, this innovative technology empowers users to handpick the produce they want even before it takes root.

India's Farmizen offers a subscription-based service to directly access produce from local farmers. Users can choose the produce they wish to purchase before it is planted, monitor its progress on the farm remotely (there's even a gamification aspect here), and then receive it directly after it is harvested.

These disruptions to agriculture supply chains are changing diets so that people eat healthier and more local varieties – which at the same time reduces pollution.

21. Drought Resistant Seeds

Kenya

During the past three years, communities in East Africa, especially Kenya, have experienced the worst drought since the 1980s. Water scarcity is now more than ever becoming a pervasive issue, impacting agricultural productivity in many drought-sensitive parts of the world. Drought-resistant seeds can alleviate these issues. Also known as drought-tolerant seeds, these seeds are specifically developed to withstand periods of limited water availability. They are developed to withstand prolonged periods of drought and erratic rainfall patterns, which are increasingly common due to climate change. Researchers at the Kenya Agricultural Research and Livestock Organisation (KARLO) have created enhanced green gram seeds, branded as Katumani mung bean 26, capable of yielding up to 1,500 kilograms per hectare. By providing farmers with the tools to adapt to changing climate conditions, Kenya's agriculture becomes more sustainable and better equipped to withstand the challenges of a warming world.

22. Plant-based Protection

United States

Preserving the shelf life of fruits and vegetables is crucial to reduce food waste, ensure prolonged availability, and maintain nutritional quality, contributing to sustainable agriculture and healthier food systems. Innovations in this area are up and coming.

Apeel's approach, for instance, centers around developing a plant-based, edible coating that extends the shelf life of fruits and vegetables. Apeel's coating is made from naturally derived materials and is designed to reduce food waste by slowing down the spoilage process. This breakthrough technology not only minimises the need for chemical preservatives and refrigeration but also helps reduce food waste, a critical issue in the global food supply chain.

23. Plant-based Protection

Switzerland

The growth of specific molds and fungi lead to spoilage, exacerbating food wasted due to microbial contamination.

AgroSustain's develops natural, non-toxic solutions to extend the shelf life of fresh produce. One solution, for instance, is the development of both natural and bio coatings on fruits and vegetables to reduce food waste. By minimising food waste, the company contributes to a more sustainable and efficient food supply chain.

24. Sustainable Pest Control

Canada

Conventional pest control practices exacerbate the challenge of controlling infestations, consequently reducing the effectiveness of pesticides. Additionally, these practices may result in environmental pollution, harm to non-target species, and adverse health effects on humans, highlighting the urgent need for adopting sustainable and eco-friendly pest management approaches. To counter these issues, companies like TerraMerra, focus on developing natural and eco-friendly solutions to manage and eliminate pests while promoting healthier and more productive crops.

Terramera's technology includes biopesticides and plant-based products that target pests and diseases in an environmentally responsible manner.

By reducing the reliance on synthetic chemical pesticides, they help safeguard both the environment and the health of farmers and consumers.

25. Aeroponic Technology

United States

Indoor farming represents a revolutionary approach to sustainable agriculture.

These high-tech indoor farms utilise cutting-edge vertical growing systems to cultivate crops in stacked layers or shelves, often in urban environments. This innovative method optimises land use, conserves water, and reduces the need for pesticides and herbicides.

AeroFarms, in particular, leverages aeroponic technology to grow leafy greens and herbs. Their controlled environment, free from external weather and pests, enables year-round production with minimal ecological impact. LED lighting, precise nutrient delivery, and data-driven monitoring create ideal growth conditions, resulting in faster crop cycles and increased yields.

26. Earth Observation Satellites for Climate Resilience

China

Climate-resilient farming techniques are crucial to address climate change and promote sustainable food production.

Customising monitoring activities to local and specific conditions is one way for countries all over the world to become more climate resilient.

CropWatch, a company specialising in this area, uses Earth observation satellite systems and other climate-related data to monitor crop conditions and bolster agricultural productivity.

What sets this technology apart is its ability to leverage data to cater to different countries and communities all over the world, accounting for local conditions.

27. Modular Growth Rooms

United States & United Arab Emirates

Creating controlled environments for farming is now a means to overcome issues like water scarcity and the overuse of pesticides.

Instead of lining up crops in greenhouses or rural fields, American-based firm Crop One intricately packs together crops in special warehouses on bookshelf-like rows in modular growth indoor facilities.

The indoor facility automatically monitors and can instantly change lighting, humidity, nutrients, and other factors to maximise plant growth.

On top of this, they reportedly use 95% less water than a traditional outdoor farm, and crops do not need to be treated with expensive pesticides since it is a controlled environment.

Electrification

28. Proliferating Electric Vehicles

United States, China and Germany

China and Germany: Embracing electric vehicles is crucial for a sustainable future, as they significantly reduce greenhouse gas emissions, diminish dependence on finite fossil fuels, and pave the way for a cleaner, more environmentally friendly transportation system.

Tesla's Gigafactories, for example, are sprawling manufacturing hubs strategically located around the world, where cutting-edge electric vehicles, batteries, and energy products are produced at an unprecedented scale to achieve this goal.

These state-of-the-art facilities are at the forefront of sustainable technology, employing advanced automation, renewable energy sources, and innovative production processes. They not only drive the global shift toward clean energy and transportation but also bolster local economies by creating jobs and fostering innovation.

29. Chinese Electric Buses

China

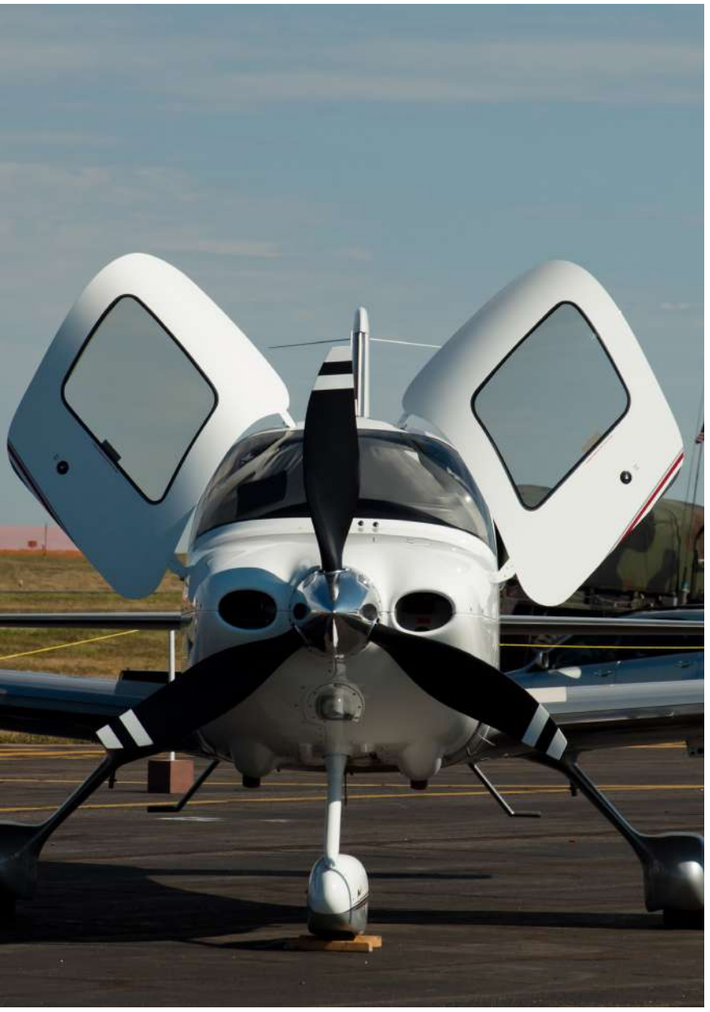
Electric buses address two critical challenges: urban air pollution and reducing carbon emissions.

These buses are powered by electricity, primarily from renewable sources, significantly reducing air pollution and the reliance on fossil fuels.

They offer a quieter, smoother ride, and emit no tailpipe emissions. Chinese electric buses are equipped with cutting-edge battery technology, allowing for long-range journeys on a single charge. Chinese manufacturers like BYD are at the forefront of this revolution, producing electric buses that are not only environmentally friendly but also technologically advanced, with features like intelligent route optimisation and real-time monitoring.

30. Electric Vertical Takeoff and Landing (eVTOL) Aircraft

United States



Aircrafts not only release carbon dioxide through fuel combustion but also emit additional pollutants during flight.

Enter Joby Aviation, a pioneer in electric aviation, specialising in eVTOL aircraft. Their approach is set to transform urban air mobility, ushering in an era of sustainable, noise-free, and efficient air transportation.

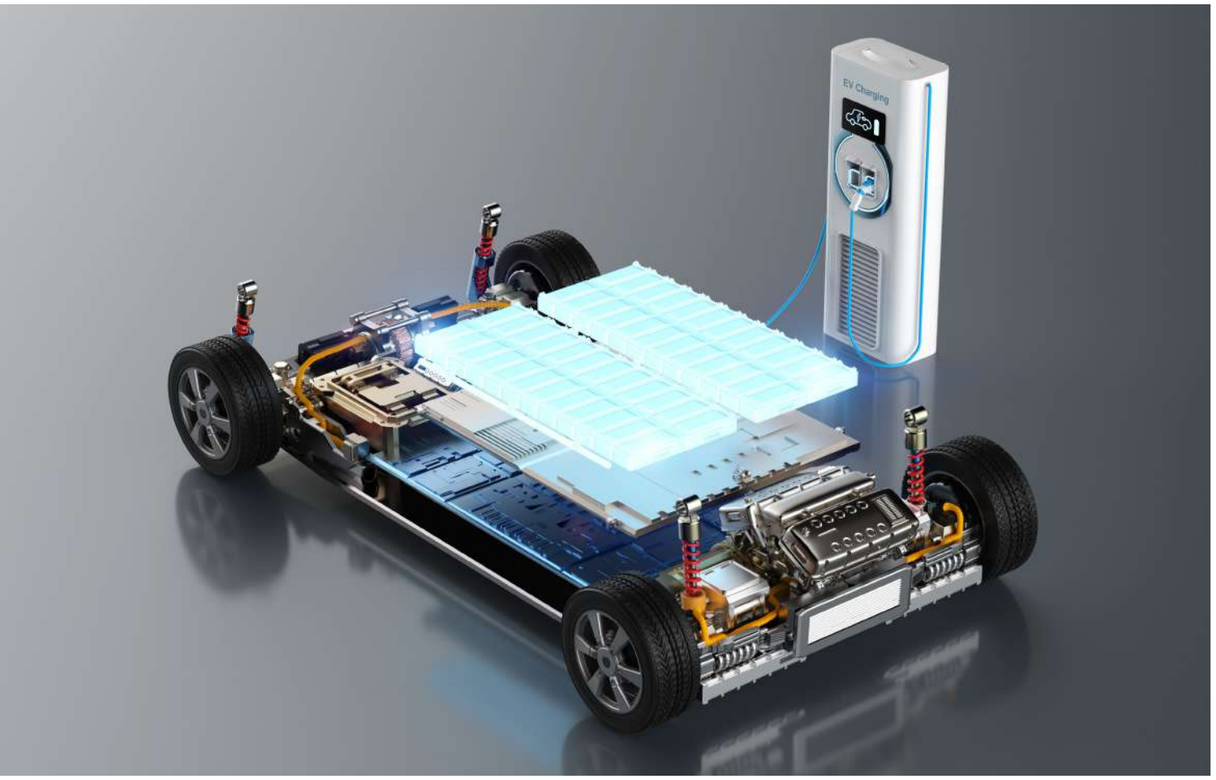
Tailored for urban aerial commuting, Joby's eVTOL aircraft boast advanced electric propulsion systems, ensuring a quiet and emissions-free operation.

Their vertical takeoff and landing capability eliminate the need for traditional runways. With an all-electric design, they substantially minimise environmental impact and noise pollution, presenting an optimal solution for urban air travel.

31. Electric Scooters

India

The high levels of air pollution in India, particularly attributable to transportation emissions, pose significant environmental and public health challenges for the densely populated urban areas. Electric scooters offer impressive range, advanced battery technology, and smart connectivity features to drive sustainable transportation. Ola Electric, a subsidiary of the Ola ride-sharing app, is dedicated to accelerating the adoption of electric mobility solutions in India and around the world. Ola Electric aims to address the urgent need for clean and affordable urban transportation, with a strong emphasis on solving last-mile connectivity challenges.



32. Battery Swapping Stations

China

Electric cars take between 30 minutes to 12 hours to fully charge.

While they do promote sustainable transportation solutions, users are experiencing range anxiety and convenience issues with this approach.

A prominent electric vehicle (EV) manufacturer and technology company, NIO, has introduced battery-swapping stations, allowing for quicker battery replacement and addressing range anxiety concerns.

Leveraging more than 1,400 patented technologies, the NIO Power Swap delivers an unparalleled power service experience, representing the first of its kind.

With a swift 3-minute battery exchange time, it incorporates automatic checks of the battery and electric system during each swap, ensuring optimal conditions for both the vehicle and battery.

33. Electric Vehicles Microfactories

United Kingdom

While electric vehicles themselves reduce the carbon footprint of transportation, their manufacturing processes pose environmental challenges on their own.

To counter this, microfactories are built to alleviate this issue. Arrival's vehicles, for example, are built using micro factories, which are smaller, more flexible manufacturing facilities designed for local assembly.

This approach reduces production costs and decreases the carbon footprint associated with transportation. Through the localisation of the supply chain, microfactories effectively diminish the environmental footprint of manufacturing.

Catering to specific cities and crafting products tailored to regional demands, these facilities create employment opportunities, foster local supply chains, and empower communities, fostering a sustainable, circular, and more equitable future.

34. Electric Tuk-Tuks

Thailand

Tuk Tuks have been around in Thailand since the 1960s and are still a widely used form of transportation in big cities like Bangkok.

Electric Tuk-Tuks, commonly referred to as “e-Tuk-Tuks,” are an innovative and eco-friendly version of this means of transportation. They are the modern adaptation of the traditional tuk-tuks.

Electric Tuk-Tuks are equipped with electric motors and batteries, replacing traditional internal combustion engines. As opposed to traditional Tuk Tuks, they contribute to reduced air pollution and noise in urban areas. These vehicles are especially well-suited for navigating congested city streets, offering an economical and environmentally responsible mode of transportation.

35. Volocopters

Germany

The modern urban landscape grapples with challenges such as traffic congestion and the increasing demand for sustainable transport options.

Volocopters recognise these challenges as a driving force behind the need for innovative solutions in urban transportation.

Volocopters address these challenges by presenting a fleet of multi-rotor eVTOL vehicles. These distinctive aircraft not only capture attention for their innovative design but also showcase the potential to revolutionise urban transportation.

The electric-powered vertical takeoff and landing capabilities of these vehicles promise to provide swift, eco-friendly, and efficient transport options within city environments.

36. Electric Motor Driven Compression

United States

In industrial installations such as oil and gas infrastructure, compression stations are traditionally powered by gas engines or gas turbines. In areas with reliable electrical grids, these gas turbine-powered equipment can be substituted with electric motors, allowing them to eliminate Scope 1 greenhouse gas (GHG) emissions related to combustion.

However, even fully electric conventional gas compressors can emit Scope 1 emissions, such as methane, due to compressor dry gas seal vents and blowdowns. Being sealed less and allowing unlimited pressurised standstill, the Baker Hughes Integrated Compressor Lines (ICL) technology can virtually eliminate Scope 1 emissions from compression stations and Scope 2, when fed by renewable electricity. ICL is zero-emissions during operation and pressurised stand by: being an electrical driven compressor, emissions are proportional to electrical grid power generation emissions and in case of green electrical power, ICL is removing up to 99% of emissions compared to gas-fired solutions. Tellurian awarded Baker Hughes, a contract for advanced electric-powered ICL technology for the natural gas transmission project, proposed to be located in Beauregard and Calcasieu Parishes, in southwest Louisiana.

Energy Decarbonisation

Renewable Energy
(Solar, Wind, Hydro, and Geothermal)

37. Offshore Wind Farms
United Kingdom

Offshore wind farms in the UK have emerged as a cornerstone of the country's ambitious clean energy agenda.

These installations, positioned in the blustery waters of the North Sea and other coastal regions, are technological marvels.

Comprising an ever-expanding sea of towering wind turbines, these farms harness the relentless power of the wind to generate substantial amounts of renewable electricity.

This green energy source not only curbs carbon emissions but also contributes significantly to the UK's energy security, reducing reliance on finite fossil fuels.

38. AgroSolar Irrigation
India

Water scarcity poses a major challenge to agricultural communities in rural India, affecting the livelihoods of farmers and impeding crop cultivation.

In response to this, companies like AgroSolar (Solar energy-based irrigation systems) combine solar power and agriculture to provide sustainable irrigation solutions.

Their approach integrates solar panels with irrigation systems, offering farmers reliable and eco-friendly access to water for crop cultivation. AgroSolar Irrigation addresses the common problem of water scarcity in rural India.

Solar panels generate electricity, which powers water pumps, allowing farmers to efficiently irrigate their fields. This not only enhances agricultural productivity but also reduces reliance on fossil fuels and grid electricity.

39. Geothermal Plants

Italy

Geothermal plants in Italy exemplify a commitment to sustainable energy products. Located in the geothermally active Tuscan region, Enel Green Power's facilities harness the Earth's natural heat to generate clean and renewable electricity.

Italy's volcanic landscape provides an ideal setting for geothermal energy.

These geothermal plants utilise the steam and hot water produced by underground reservoirs, driving turbines to produce electricity.

They significantly reduce greenhouse gas emissions and reliance on fossil fuels. Geothermal plants not only bolster renewable energy capacity but also contribute to a more diversified and eco-friendly energy portfolio.

40. Portable Wind Turbines

Peru

Portable wind turbines in Peru are innovative solutions that bring clean, renewable energy to remote and off-grid communities.

These innovative, small-scale wind turbines harness the region's abundant wind resources to provide a reliable source of electricity where traditional grid connections are unavailable.

They are designed to be easily transportable and quick to set up, making them ideal for rural areas. Despite its modest average velocity ranging between 7 and 9 miles per hour, it has the capacity to generate sufficient electrical power for recharging your portable power station or power bank, ensuring a continuous and reliable supply of electricity to sustain the operation of your devices. By delivering electricity to schools, health centers, and homes, WindAid's turbines enhance the quality of life and educational opportunities for local communities in the country's rural areas.

41. Energy Performance Contracts

Germany

A persistent challenge faced by organisations across diverse sectors is the need to enhance energy efficiency and sustainability without incurring significant upfront capital costs.

Recognising this dilemma, Siemens introduces Energy Performance Contracts (EPCs) as an innovative and results-driven solution. EPCs are innovative and results-driven solutions aimed at enhancing energy efficiency and sustainability in various sectors.

Under EPCs, Siemens conducts a comprehensive energy audit to identify opportunities for efficiency enhancements. They then design, install, and maintain the necessary systems, such as HVAC, lighting, and building automation, to optimise energy performance. These contractual arrangements enable organisations to implement energy-efficient technologies and infrastructure improvements without upfront capital investment. Siemens guarantees energy and cost savings over the contract term, ensuring that the improvements pay for themselves.

siemens.com

42. Portable Solar Home Systems

Nigeria

Providing affordable and sustainable electricity solutions for off-grid and underserved communities in Nigeria and beyond is an important factor to consider in the climate tech innovation space.

BeebeeJump in Nigeria, for instance, specialises in solar power products, offering innovative solar home systems and other energy-efficient solutions.

Beebeejump's flagship product is a portable solar home system that includes solar panels, energy-efficient LED lights, phone charging capabilities, and even a television.

These systems are designed to cater to the energy needs of households and small businesses that lack access to the conventional electricity grid.

With a focus on clean energy and affordability, Beebeejump is contributing to improved living standards and economic opportunities in remote areas.

beebeejump.ng

43. Portable Solar Panels

United States

ecoflow.com

As the demand for renewable energy sources grows, the challenge of providing clean and sustainable power in remote or off-grid locations becomes apparent.

Traditional energy solutions may be impractical or costly in such settings, prompting the need for innovative alternatives.

Portable solar panels come in as a solution to these issues. These solar panels are compact and lightweight devices equipped with photovoltaic cells that capture sunlight and convert it into electrical energy.

These panels work by absorbing sunlight, which energises electrons in the photovoltaic cells, generating a direct current (DC) electric flow. US-based EcoFlow manufactures portable solar panels and storage accessories, allowing users to produce and store electricity for their needs on-the-go. Their technology can power homes in the event of a blackout, or businesses in the field with limited access to the electricity grid – such as food trucks or documentary filmmakers.

44. Organic Solar Panels

Sweden

Unlike traditional silicon-based solar cells, organic solar panels feature organic polymers or small molecules that can be manufactured using cost-effective, flexible, and lightweight processes.

In Sweden, Epishine has invented organic, flexible solar panels that are so efficient they can power small devices using only indoor lighting.

The company wants to replace batteries for low-power devices, especially IoT devices and sensors inside of offices and supermarkets.

This technology can lower production costs, improve versatility in design, and expand the potential for transparent or semi-transparent applications.

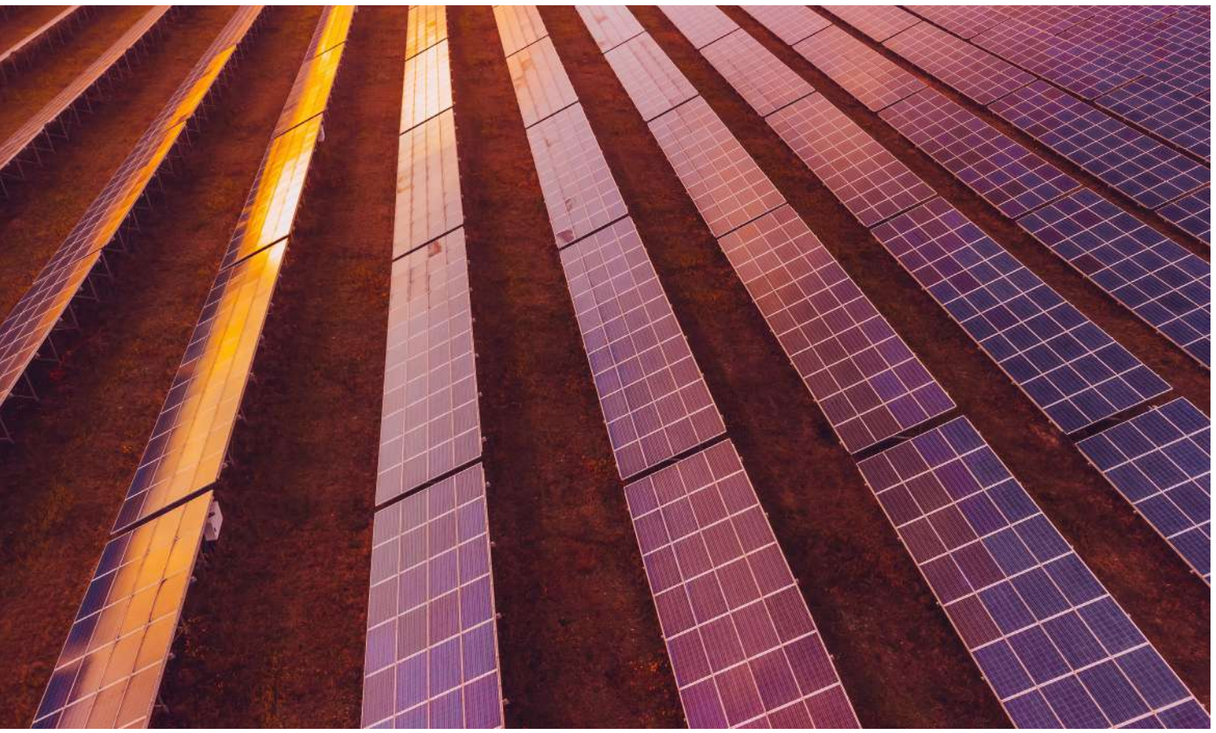
45. Insolight's Solar Panels

Switzerland

Traditional solar panels can often fall short in conditions of partial shading or low light. Insolight's solar panels address these inherent insufficiencies through cutting-edge technology.

These panels incorporate micro-tracking technology, which allows them to follow the sun's trajectory throughout the day, optimising energy production. What sets Insolight's solar panels apart is their ability to achieve industry-leading energy yields without the need for complex tracking systems.

This innovation significantly increases the efficiency of solar panels, making them an attractive option for residential and commercial installations, especially in regions with variable sunlight.



46. Solar Microgrids

Puerto Rico

In response to the persistent challenges of unreliable or inaccessible centralised power grids, solar microgrids have emerged as a viable and unique solution for underserved communities.

Solar microgrids are distributed energy systems powered by solar panels and energy storage.

These microgrids provide a decentralised and reliable source of electricity, reducing the island's dependence on centralised grids that are vulnerable to extreme weather events, such as hurricanes.

Puerto Rico's solar microgrids are strategically located to serve critical community facilities, ensuring that essential services like hospitals, schools, and emergency response centers have continuous access to clean and resilient power, even in the face of natural disasters.

47. Biomass Based Solar Microgrids

India

Solar microgrids in India are a transformative solution to address the nation's energy access challenges, particularly in rural and off-grid areas. These microgrids harness solar energy and other renewable sources to generate electricity, which is then distributed to local communities.

Husk Power Systems, in particular, specialises in biomass-based solar microgrids, utilising agricultural waste to generate clean energy.

By providing these remote regions with reliable and sustainable power, solar microgrids not only illuminate homes but also support local businesses, healthcare facilities, and educational institutions.

They play a crucial role in enhancing the quality of life for people living in energy-poor areas while contributing to India's clean energy goals.

48. Pay-as-you-go Solar Energy

Kenya

Bringing clean and affordable electricity to off-grid and underserved communities across Africa, as developing countries in the region continue to lag behind in the transition to affordable and clean energy.

M-KOPA's solar home systems provide lighting, phone charging, and appliances for homes, schools, and businesses.

Their business model combines mobile technology, solar power, and mobile banking, making clean energy accessible to those who were previously without reliable electricity.

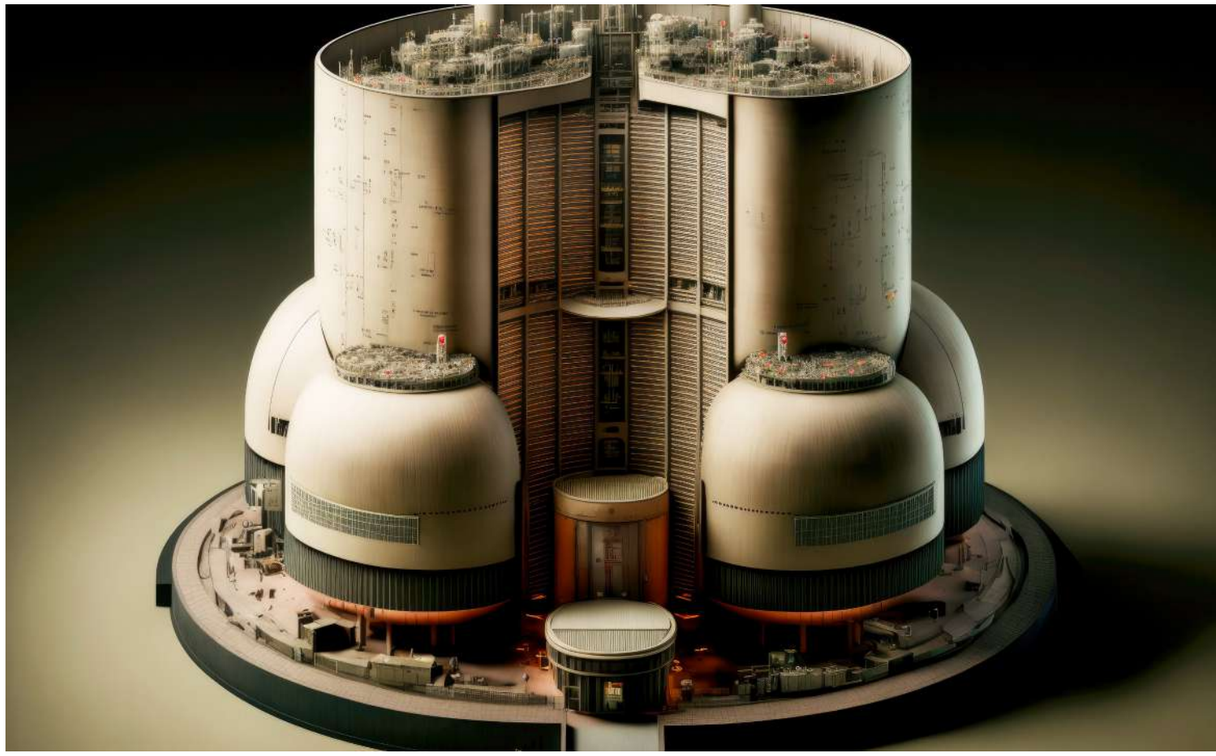
Customers can make affordable daily payments via mobile money, ensuring affordability and accessibility. This approach significantly improves living standards, supports economic activities, and reduces dependence on dangerous and polluting kerosene lamps.

Alternative Fuels (Hydrogen and Nuclear)

49. 100% Hydrogen Gas Turbines

Canada

In the global effort to reduce greenhouse gas (GHG) emissions, hydrogen plays a crucial role in being one of the major carbon-free energy carriers to drive the progress towards net-zero emissions. Baker Hughes NovaLT™ gas turbine is designed for wide fuel flexibility, achieving single-digit NOx with the standard natural gas equipment or reaching full decarbonisation with the recently developed design for 100% hydrogen. NovaLTTM can operate with pure hydrogen across the whole range of operating conditions, from start-up up to full-speed full-load. The gas turbine can also switch from natural gas to blends or burn 100% hydrogen with no hardware changes. Baker Hughes is providing advanced technology for various hydrogen projects, including NovaLT16 turbines for Air Products' net-zero hydrogen energy complex in Edmonton, Alberta, Canada. Baker Hughes has the track record and experience burning a range of fuel mixtures with high hydrogen content, including ~70 projects globally using frame and aero-derivative gas turbines, including the first 100% hydrogen gas turbines in a commercial project back in 2009.



50. Sodium-cooled Fast Reactor

United States

In a landscape where nuclear energy is a focal point for sustainable power generation, promoting safety and efficiency is vital in this transition.

The US-based TerraPower, backed by billionaire Microsoft founder Bill Gates, has designed the first-ever sodium-cooled fast reactor that uses liquid sodium as a coolant; this works at higher temperatures and lower pressures, making the reactor safer overall.

Leveraging liquid sodium as a coolant allows for higher operating temperatures and lower pressures, fundamentally improving the safety profile of the reactor.

51. Hydrogen Compression Technology (NEOM)

Saudi Arabia

compression of hydrogen is today widely adopted and referenced in refinery and petrochemical processes, setting a solid background for applications in emerging green hydrogen applications. One of the greatest technological challenges with hydrogen are (1) the high pressures that are required for the various fields of use, (2) the need to maintain the gas free from contamination and the use of materials that are not subject to embrittlement as well as the expected increase in volumetric flows and (3) fluctuations in operation, coming from market scale-up and availability of renewable power in production. Baker Hughes, an established technology leader in compression, developed a high-pressure ration compression (HPRC) - centrifugal compressor solution that provides remarkable improvements in green hydrogen applications. As part of their collaboration, Baker Hughes is providing Air Products with advanced hydrogen compression and gas turbine technology for global projects, including advanced compression technology for the NEOM carbon-free hydrogen project in the Kingdom of Saudi Arabia. Baker Hughes developed its first hydrogen compressor in 1962 and today has more than 2,000 units operating around the globe.The HPRC centrifugal compression technology is equipped with high-head, high-efficiency impellers that exceed currently available technologies and is designed and optimised to satisfy the challenging requirements of the new green hydrogen applications.

52. Methane Decarbonisation

United Arab Emirates

Flaring is one of the primary causes of methane slip emissions across the oil and gas industry. Operators increasingly turn to advanced solutions to drive down the emission of methane – a potent greenhouse gas - during process upsets, even more so taking this as an opportunity to put gas that would otherwise be flared, to good use. Currently, very limited solutions are available that can enable flare gas decarbonisation while simultaneously producing valuable byproducts. Baker Hughes is investing in Levidian's LOOP technology as an example of a circular economy in action. The system can be deployed anywhere with a methane source and is designed to function as a self-contained modular system that can quickly and easily be retrofitted to existing infrastructure. Once in place, it captures the carbon from methane and locks it away in carbon negative graphene, while also producing hydrogen. Graphene has unique characteristics that make it possible to enhance a wide range of materials, improving product performance, increasing lifespan, and reducing carbon footprint. Baker Hughes and ADNOC are field-testing Levidian's patented methane plasma technology to capture carbon in the form of consistent, high-quality graphene in ADNOC Gas' facilities. The produced graphene will then be tested for industrial use cases by a multidisciplinary group of researchers at ADRIC, Baker Hughes, Levidian, and Khalifa University.

53. Hydrogen-powered Automobiles

Europe

As the automotive industry increasingly explores alternative fuel sources, hydrogen-powered vehicles such as the Toyota Mirai represent a promising avenue for sustainable transportation.

The Toyota Mirai is a hydrogen-powered automobile for sale in the handful of cities that maintain liquid hydrogen refuel stations.

In contrast to drawing power from stored electrical energy in a battery, hydrogen fuel cell electric vehicles (FCEVs) produce their electrical power via a chemical process that involves the interaction of hydrogen and oxygen within a fuel cell stack.

54. European Airbuses

Europe

As the aviation industry grapples with the imperative to reduce carbon emissions, Airbus stands at the forefront, aiming to transform air travel with a hydrogen-powered aircraft. Europe's Airbus is aiming to have zero-emission, hydrogen-powered planes flying commercially before 2035. The company is experimenting with iterations of familiar narrow-body airframes, as well as radically reimagined designs that look like giant single wings. In the UK, for example, Airbus stands as the foremost civil aerospace entity within the nation and is the dominant entity in the space satellite sector, the primary supplier of large aircraft to the Royal Air Force, and also accountable for approximately 50% of the United Kingdom's civil helicopter fleet.

55. Anion Exchange Membrane Electrolyser (AEME)

United Arab Emirates

Hydrogen production via water electrolysis enabled by renewables will play a crucial role towards achieving net zero emissions, especially in the energy and industrial sectors. Nemesys – a start-up Baker Hughes has invested in - is developing disruptive innovations in the hydrogen sector. Together we are developing an electrolyser technology that converts water into hydrogen and byproducts oxygen at increased efficiencies and lower cost. This AEM electrolyser technology has a highly dynamic response for efficient coupling with renewable energy. Furthermore, AEM electrolysers allow a low capital expenditure through inexpensive and widely available materials, compared to competing technologies. Baker Hughes and ADNOC announced their partnership to pilot the AEM electrolyser technology and explore its installation and operation at the ADNOC Research and Innovation Center (ADRIC) in Abu Dhabi, UAE, building upon the research center's ecosystem of technology development capabilities.

56. The Energy Observer

France

The integration of hydrogen in maritime exploration is imperative as the industry seeks more eco-friendly alternatives to its current practices. To move forward in this direction, innovations like The Energy Observer are trailblasing the use of hydrogen to mitigate the environmental impact of maritime exploration. The Energy Observer a French racing catamaran that was converted into a self-sufficient hydrogen-powered research boat, with solar panels and fixed sails to help. The Energy Observer's commitment to sustainability is evident in its innovative features, including solar panels and fixed sails. These elements contribute to the vessel's self-sufficiency by harnessing solar energy and wind power.

Table of Contents

57. Waste-to-Hydrogen Conversion

Poland

Hydrogen, as a versatile energy carrier, can be used in various applications, including fuel cells and industrial processes, while producing minimal greenhouse gas emissions. Bioelektra's waste-to-hydrogen conversion process, for instance, not only addresses the challenges of waste disposal but also provides a sustainable source of clean energy. Their approach involves converting organic waste, such as biomass and agricultural residues, into hydrogen gas through advanced gasification and electrolysis technologies. By leveraging hydrogen as a clean energy source, Bioelektra contributes to reducing reliance on traditional fossil fuels and minimising greenhouse gas emissions.

58. High-pressure Direct Injection (HPDI™) Fuel Systems

Europe

Traditional port fuel injection systems often struggle to deliver fuel with precision and in a timely manner, resulting in incomplete combustion, inefficient fuel utilisation, and elevated emissions.

Westport's HPDI ™ fuel system operates on hydrogen to improve the efficiency of internal combustion engines. It sends small amounts of diesel fuel and large amounts of natural gas into the combustion chamber using high pressure.

By optimising fuel combustion, enhancing performance, and reducing emissions, this technology represents a pivotal advancement in automotive efficiency.

Energy Storage and Batteries

59. Sand Batteries

Finland

The traditional approach to renewable energy storage, like pumped storage, faces limitations in meeting the demands of seasonally variable energy production. Finland-based Polar Night Energy recently constructed the world's first so-called sand battery.

It uses the same premise as the pumped storage, albeit in a different medium: during the summer, renewable energy is used to heat up a giant silo of sand to almost 600 degrees Celsius.

This sand can retain its heat for months, and in the wintertime when the heat is needed, it can be released directly to heat homes and offices, or as produce steam to generate electricity.

By storing excess energy during times of plenty and releasing it when demand peaks, the sand battery contributes to a more reliable and sustainable energy supply.

60. Underground Energy Storage

United Kingdom

As intermittent sources like solar and wind become primary contributors to electricity generation, there is a critical need for solutions capable of capturing and storing energy during periods of low demand, releasing it swiftly when needed. British startup Gravitricity develops long-life, below-ground technologies that not only ensure safe energy storage but also offer a more cost-effective lifetime solution compared to current alternatives. Their cutting-edge technologies, centered around gravity and hydrogen storage, offer the dual advantage of safety and a lower lifetime cost when compared to existing alternatives. The below-ground design ensures secure storage, contributing to the longevity and sustainability of the energy storage infrastructure.

61. Clean Lithium Ion Batteries

Sweden

As the automotive industry shifts towards electrification, the need for sustainable battery solutions becomes paramount.

Northvolt's journey focuses on not only producing cleaner lithium-ion batteries but also reshaping the recycling landscape, contributing to a more sustainable and circular approach to battery production. The company wants to build out a fully sustainable supply chain for EV batteries within the decade. Founded by former Tesla Motors executives, the firm already specialises in producing lithium-ion batteries for automakers more cleanly than any competition.

62. Advanced Lithium Ion Batteries

Singapore

Advanced lithium-ion batteries are an upgraded iteration of traditional lithium-ion batteries, distinguished by their heightened performance, safety, and energy storage capabilities. Green Li-ion in Singapore, for example, recycles lithium-ion batteries to make battery cathode. These batteries incorporate higher energy density, enabling extended power longevity for devices and electric vehicles within the same form factor. They feature enhanced safety mechanisms, faster charging, and an extended cycle life, while ongoing research strives to make them more environmentally sustainable.

63. Redox Flow Batteries

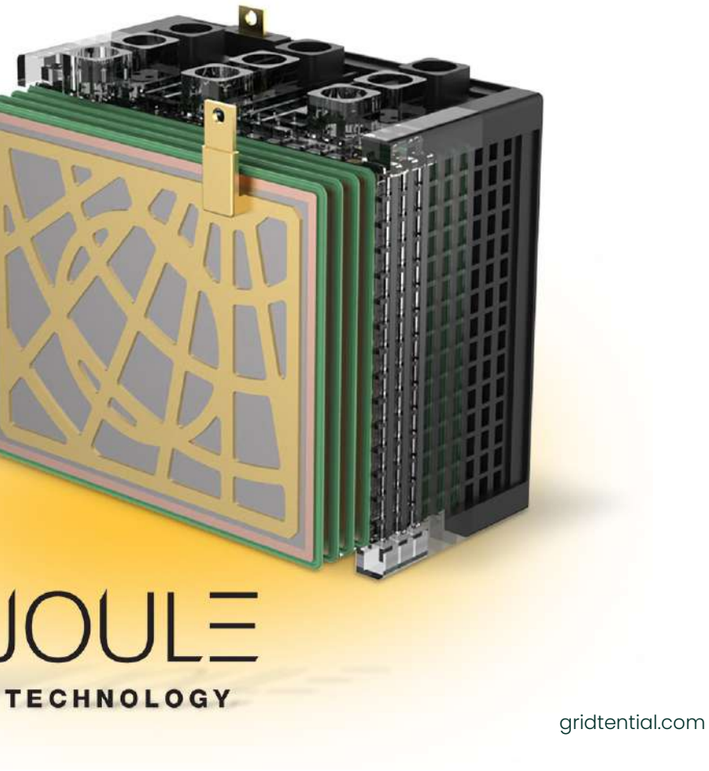
United States

In response to the increasing demand for efficient energy storage solutions, redox flow batteries have emerged as a transformative solution. These batteries address the limitations of traditional energy storage systems by offering scalable and flexible options for storing electricity. Redox flow batteries serve dual purposes as either fuel cells or rechargeable batteries. They are composed of a pair of interlinked tanks, each containing electrolytic fluids and electrodes with opposing charges, facilitating the transfer of ions across a membrane from one tank to the other. This design allows for decoupling the power and energy capacity, enabling customisable and modular energy storage solutions. XL Batteries, a US startup, offers saltwater-based flow batteries. XL employs cost-effective organic molecules derived from industrial feedstock to store electrical charge within the battery

64. Silicon Joule Technology

United States

Traditional lead-acid batteries, while widely used, face limitations in terms of energy density, lifespan, and environmental impact. Gridtential's Silicon Joule technology transforms conventional lead batteries into high-performance, environmentally friendly energy storage solutions. Silicon is safer and more cost-effective for manufacturers and showcases remarkable benefits such as a 4X longer life, up to 5X dynamic charge acceptance, and a substantial 35% reduction in weight compared to conventional lead-acid batteries. By incorporating silicon wafers into the traditional lead-acid battery design, these batteries become more energy-dense, longer-lasting, and suitable for a wide range of applications, including renewable energy integration, uninterruptible power supplies, and electric vehicles.



gridtential.com

65. ZincGel Batteries

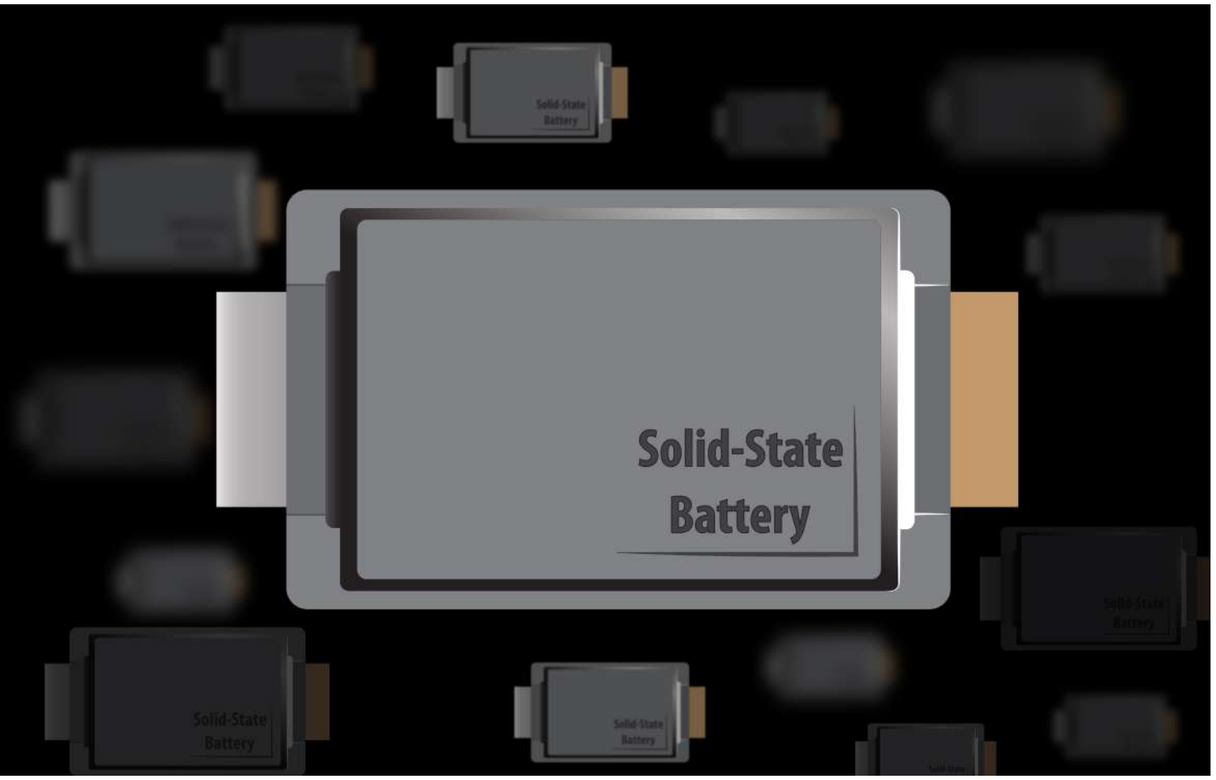
India

Lithium is known for its detrimental effects on the environment, prompting the search for more eco-friendly alternatives. Offgrid Energy Labs in India, for instance, develops ZincGel, a proprietary battery technology which uses a highly conductive zinc electrolyte and carbon-based cathode. The zinc electrolyte is self-healing, temperature-stable, and does not evaporate, thereby warranting a higher life. The innovative design ensures not only improved environmental sustainability but also enhanced battery performance.

66. Sodium-ion Batteries

Sweden

These batteries exhibit extended operational lifetimes, an elevated number of charge/discharge cycles, impressive energy density, and are constructed using cost-effective materials. Altris, a Swedish company, creates Fennac, a cathode material for use in sodium-ion batteries, using low-temperature and pressure synthesis technology. Sodium-ion batteries are made from salt, wood, iron, and air, making them easily recyclable and sustainable in use. The composition of these batteries, derived from common and eco-friendly materials, positions them as easily recyclable and inherently sustainable in use, further contributing to the overall environmental responsibility of the technology.



67. Solid-state Batteries

Germany

To mitigate safety concerns associated with flammable liquid electrolytes, there is ongoing research into solid-state electrolytes. These alternatives aim to provide comparable energy density while reducing the risk of fire and improving overall safety. Solid-state batteries replace the flammable liquid electrolyte in batteries with a solid compound that facilitates ion migration, promoting high ion conductivity. A German startup called Theion utilises a technique called direct crystal imprinting (DCi) to create wafers from melted sulfur. These wafers contain a unique solid-state polymer electrolyte, which fills the empty spaces within them, while a lithium metal foil serves as the anode. This solution offers longer life cycles, faster charging and lower costs than conventional batteries.

Tomorrow's Climate Tech

Carbon Capture, Utilisation, and Storage (CCUS)

68. Metal-organic frameworks for Direct Air Capture (DAC)

United States

Innovative chemistries and advanced materials science research are critical to advancing carbon capture solutions in the industrial space. Baker Hughes' Mosaic Materials technology envisaged to cater to various energy transition solutions, starting with direct air capture (DAC) applications. Mosaic's innovative metal-organic framework (MOF) technology is a proprietary sorbent material, a high-capacity "nano-sponge," that captures CO2 selectively even at a low concentration, such as the ones present in the atmosphere. As gases stick to surfaces, MOFs offer exceptionally high surface areas, >7,200 m2/gram (a standard football pitch area is 7,140 m2), and are advantageous for gas sorption applications. This porosity enables MOFs to act as "sponges," able to take up a significant amount of CO2 molecules and subsequently regenerate via a low-energy process. Baker Hughes is also engaged in global partnerships with key market players in the space – using the captured CO2 from DAC for further utilisation, such as conversion to e-fuels. These scenarios highlight not only the advantages that can be achieved by MOFs as a DAC sorbent with a high CO2 uptake but also by using the captured CO2 as an additional revenue stream.

69. Orca Carbon Capture (A Climeworks Project)

Iceland

Located in the geothermally active region of Hellisheidi, this facility utilises innovative DAC technology to capture and permanently store carbon dioxide from the atmosphere. The captured CO2 is not only removed from the air but also mineralised by injecting it deep underground into basalt rock formations, where it undergoes a natural mineralisation process, turning into stone over time. Operators claim that the plant can suck 4,000 tonnes of CO2 out of the air every year. This process ensures a long-term and eco-friendly storage solution, minimising the risk of CO2 release.

70. Carbon Capture in Cement Production

Switzerland

The cement industry has been under increasing criticism due to its substantial contribution to carbon emissions.

Holcim is actively involved in carbon capture technologies that focus on mitigating the environmental impact of cement production.

Holcim's approach involves capturing CO2 emissions from cement kilns and other industrial processes to capture and minimise these emissions. They are committed to both reducing the carbon footprint of their operations and developing sustainable construction solutions.

Their Carbon2Business initiative, for instance, implemented at their cement facility located in Lägerdorf, Germany, is strategically positioned to achieve an annual carbon dioxide (CO2) capture exceeding one million metric tons.

71. Compact Carbon Capture

Norway

Engineering optimisation and innovative design concepts are pivotal to improving the efficiency and economics of carbon capture solutions.

Baker Hughes compact carbon capture solution is a novel process intensification technology that utilises centrifugal forces to intensify mass transfer in the capture process, thereby reducing the equipment size and cost. It is solvent-agnostic and, in principle, can be applied to any chemistries developed for post-combustion carbon capture.

Using its rotating packed bed technology, the system drastically increases the vapor-liquid contact area, overcoming the traditional hydraulics limitations.

Compared to traditional solvent-based systems using static equipment, the enhanced mass transfer results in reduced residence time in both the absorber and the regenerator, with a much smaller equipment and reduced footprint.

The compact capturing system is currently validated at the lab scale at dedicated test facilities in Porsgrunn, Norway.

Steps for further advancement are ongoing, with a demonstration plant at the 30 tons per day (tpd)-scale currently in the planning stage.

72. Carbon Engineering's Direct Air Capture

Canada

Implementing scalable solutions and tangible applications for captured carbon is key to address pressing environmental concerns posed by these emissions.

Carbon Engineering's DAC technology, for example, operates by pulling in ambient air and using liquid solvent, which absorbs the CO2 and is then turned into calcium carbonate.

The captured CO2 can be stored or utilised in various applications, including the production of sustainable synthetic fuels and the reduction of emissions from industrial processes.

Carbon Engineering is in the process of constructing a substantial direct-air-capture facility that surpasses the scale of the Iceland-based operation in Iceland. Notably, this new facility is designed with the objective of annually extracting up to one million metric tonnes of CO2, which is equivalent to mitigating the emissions of approximately 217,000 automobiles.

73. Solid Adsorption for Carbon Capture

United States

Recognising the imperative to combat climate change by reducing CO2 levels, Global Thermostat is well placed to respond to these challenges.

Global Thermostat's DAC technology is designed to combat climate change by capturing CO2 emissions and repurposing the captured CO2 for various applications, including in sustainable fuels, beverages, and manufacturing. What sets this DAC technology apart from others is its solid adsorption process which utilises fans to blow air through proprietary contactors that bind to CO2. Afterwards, the CO2 is separated through low temperature heat. The company's technology is highly energy-efficient and flexible, offering a scalable solution for reducing CO2 levels in the atmosphere.

74. Biochar Production and Carbon Sequestration

Finland

There is a dire need to address the environmental challenges posed by biomass waste. Carbo Culture's approach, for example, centers around converting biomass waste into biochar, a highly stable form of carbon that can be used to enrich soil, capture carbon, and reduce greenhouse gas emissions. Biochar not only enhances soil fertility and carbon sequestration but also provides a sustainable alternative to traditional carbon black used in industrial applications. The company's Carbolysis™reactors are engineered to efficiently transform discarded biomass into a durable biochar, thereby securely sequestering carbon for extended periods while simultaneously yielding renewable energy as a valuable byproduct.

75. Zero-emissions Power Plants

United States

Global goals for net-zero carbon emissions and the growing need for low-cost CO_2 that can be either sequestered, or utilised in industrial processes is creating the right market conditions for the adoption of clean and reliable energy generation. NET Power technology uses natural gas and oxygen to fuel a supercritical CO2 cycle that generates electricity, while also capturing CO2. New clean power plants constructed with this technology will operate with high efficiency and produce only electricity, water, and pipeline-ready or sequestration-ready CO2 that will be permanently locked away from the atmosphere. Baker Hughes is developing a dedicated turboexpander, critical pumping, and compression technology – the critical pieces of equipment in the process - to support the scaling of the NET Power solution to industrial scale. With the NET Power technology, nearly all CO2 is ultimately captured throughout the process, producing CO2 that is pipeline or sequestration-ready, always locked away from the atmosphere.

76. Carbon Mineralisation Technology

United States

Reducing CO2 emissions from industrial processes and redefining the construction industry's reliance on traditional materials with high environmental footprints is now more important than ever.

To counter this, Carbon mineralisation technology comes in as a solution, which involves capturing CO2 emissions from industrial processes and converting it into synthetic limestone, effectively removing CO2 from the atmosphere. Blue Planet's technology, as one example, not only reduces emissions but also provides sustainable construction materials.

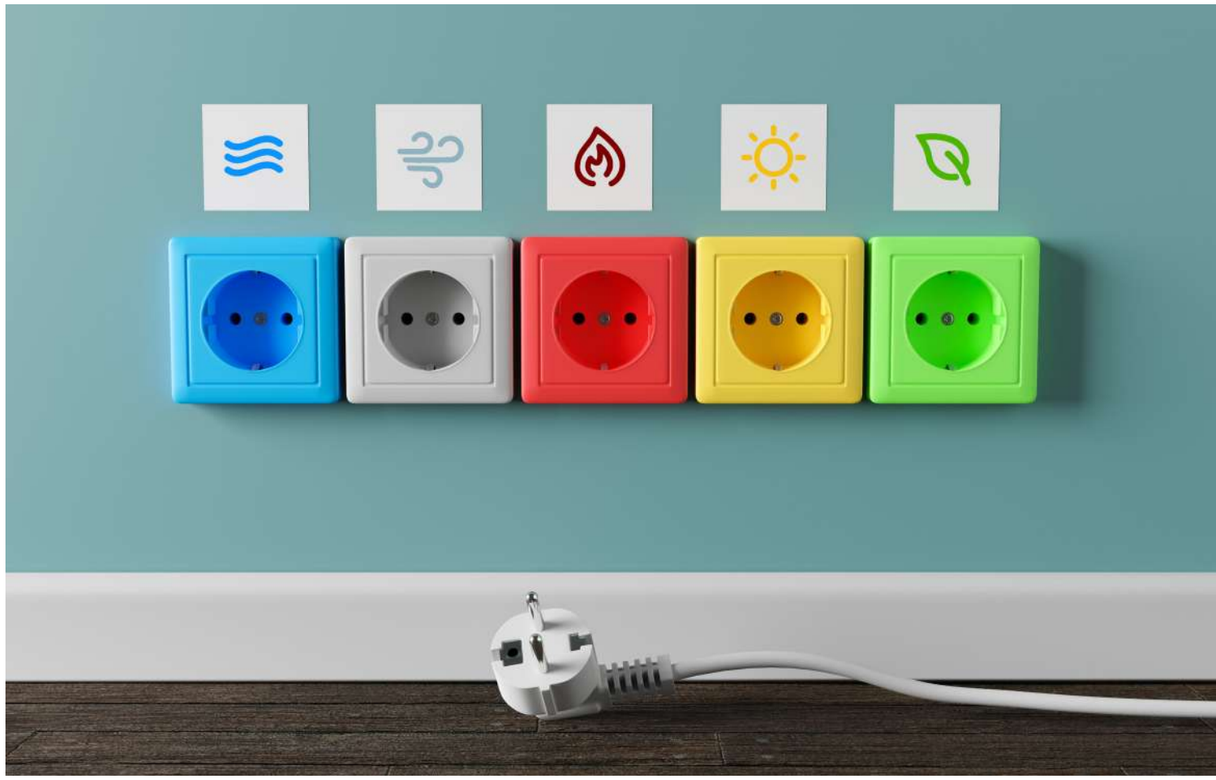
The synthetic limestone, known as GreenCert, can be used in various construction applications, aligning with the construction industry's efforts to reduce its environmental impact.

Recycling and Circular Economy

77. Waste-to-Energy Plant

Sweden

As global concerns about waste management and carbon emissions escalate, solutions to these issues become vital. Sysav's Waste-to-Energy Plants are examples of sustainable waste management and energy production. These state-of-the-art facilities, like the iconic one in Linköping, efficiently convert municipal solid waste into heat and electricity. The process involves incinerating the waste at high temperatures, reducing its volume while simultaneously generating energy. The produced heat is often used for district heating, keeping homes warm during the winter, while electricity is fed into the grid. Sweden's WtE plants are equipped with advanced emission control technologies, ensuring that the combustion process produces relatively low carbon emissions, making them environmentally friendly.



78. Heat Conversion

United States

Traditionally, excess heat as a byproduct in industries where substantial thermal energy is released has been regarded as a loss rather than an opportunity. Echogen shifts this paradigm. Their approach converts waste heat into valuable energy, offering significant efficiency gains and reduced emissions in industrial processes. Echogen's technology uses Organic Rankine Cycle (ORC), a cutting-edge process that effectively captures and transforms low-temperature waste heat into electricity. This innovation is especially crucial in industries where substantial heat is released as a byproduct, such as steel manufacturing or power generation.

79. Agraloop™ Bio-Refinery

United States

In an era where sustainability is at the forefront of global consciousness, addressing the environmental footprint of the fashion industry is imperative. Dedicated to advancing sustainable and circular fashion, circular systems' approach centers around creating sustainable fibers and textiles by repurposing waste materials, such as agricultural residues and textile waste. Central to Circular Systems' mission is the Agraloop™ Bio-Refinery, a technology designed to transform crop residues into high-quality natural fibers. By repurposing agricultural waste, the Bio-Refinery not only minimises the ecological footprint associated with conventional farming practices but also addresses the environmental impact of textile production.

80. Thermoplastic Composites

Israel

The escalating concerns surrounding organic waste and plastic pollution underscore the critical need for innovative solutions. UBQ's converts unsorted household waste, including food scraps and mixed plastics, to a thermoplastic composite, a sustainable and highly versatile material. This material can be used in various applications, including manufacturing and construction, as a sustainable alternative to traditional plastics. Not only does it reduce the burden on landfills and incineration, but it also lessens the demand for virgin plastics.

81. Interceptors™

Netherlands

Plastic pollution in rivers is widely acknowledged and extensively documented. Yet, the dynamic nature of rivers, encompassing variations in depths, flows, and seasonal patterns, necessitates solutions tailored to specific conditions and case-by-case evaluations.

The Ocean Cleanup Project non profit aims to combat the escalating problem of plastic pollution in the world's oceans. Their Interceptor Original cleanup technology, for instance, uses solar power, smart processing and connectivity to enhance its performance. These interceptors are placed based on flow-velocity, the width of the river, and other conditions, to ensure strategic and effective extraction of waste.

Currently, this technology has been deployed in Indonesia, Malaysia, the Dominican Republic, Vietnam, USA, now being designed for mass production.

82. River Interceptors

Netherlands

Amid the urgent global issue of plastic pollution in water bodies, river interceptors enter as a unique solution to this challenge. These advanced floating devices tackle the pivotal challenge of curbing plastic waste infiltration into rivers and waterways, acting as a frontline defense to prevent its further progression into the oceans. These autonomous, solar-powered floating devices are strategically placed in rivers, where they intercept and collect plastic waste before it can flow into the ocean. Equipped with a conveyor belt system, the River Interceptors funnel collected plastic debris into onboard containers for later responsible disposal.

The Ocean Cleanup's River Interceptors play a crucial role in mitigating the adverse environmental impacts of plastic pollution, aligning with the organisation's mission to rid the world's oceans of plastic debris and create a more sustainable and cleaner marine ecosystem.

Future Renewable Energies

83. Membrane Aerated Biofilm Reactor (Wastewater Treatment)

Ireland

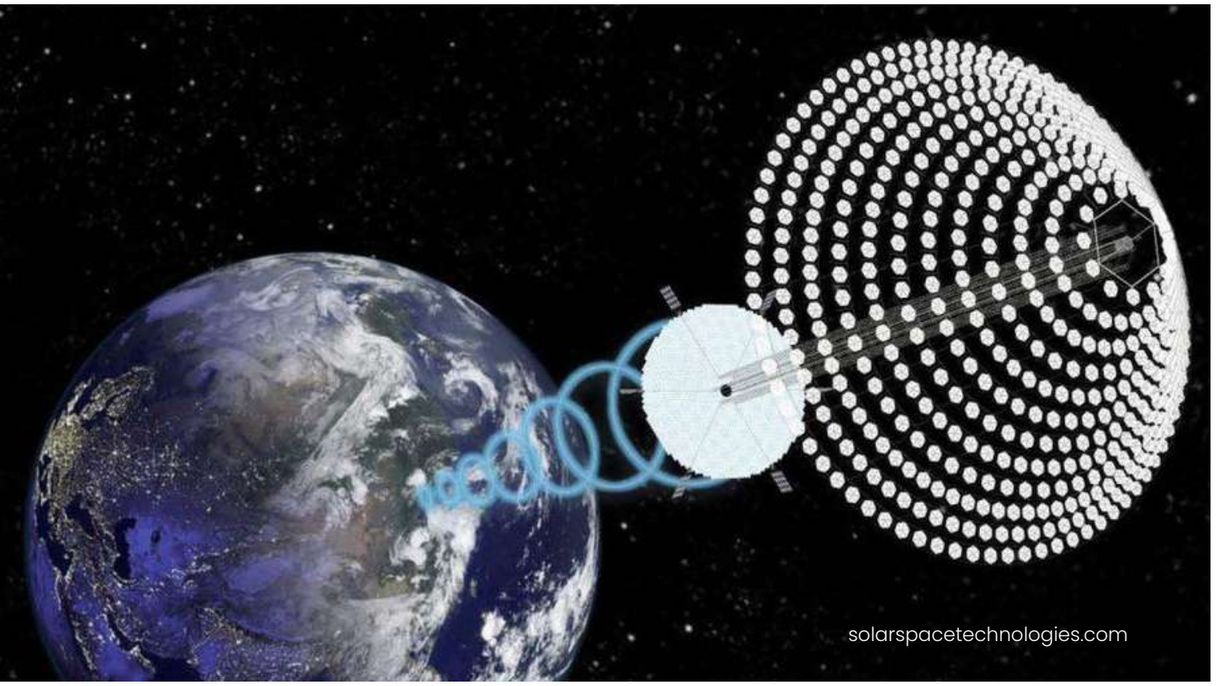
Growing concerns about water treatment efficiency and environmental impact present the need for novel approaches to mitigate these risks. Oxymem's Membrane Aerated Biofilm Reactor (MABR) system, for instance, is revolutionising wastewater treatment by significantly improving efficiency and sustainability. The MABR technology promotes the growth of beneficial microorganisms on gas-permeable membranes, allowing for efficient oxygen transfer and wastewater purification. It requires less energy compared to traditional aeration methods, making it highly cost-effective and eco-friendly. This technology not only minimises energy consumption but also reduces the production of sludge, lowering operational costs and environmental impact. Oxymem's system is particularly relevant in the context of modern water management, as it can be integrated into existing wastewater treatment plants, making them more efficient and environmentally responsible.

84. Solar Power Aircrafts

Switzerland

There is a push toward transcending beyond the need for traditional fuel for long distance flights. Solar-powered aircrafts, as one solution, are designed with sustainability and innovation at their core to address this issue. Solar Impulse, for instance, has been at the forefront of this innovation.

The project's flagship achievement, the Solar Impulse 2, stands as a testament to human ingenuity. With a wingspan larger than a Boeing 747, the aircraft is covered in over 17,000 solar cells, allowing it to harness the sun's energy for propulsion and powering its systems, effectively flying day and night without traditional fuel. This initiative showcases the immense potential of renewable energy in aviation, proving that solar technology can enable zero-emission, long-distance flights.



85. Solar Power Satellite

Australia

While the concept of space-based energy has long captured the imaginations of scientists and science fiction enthusiasts, recent technological breakthroughs have brought it within the realm of theoretical feasibility. Solar Space Technologies is at the forefront of this innovation. Their approach involves the deployment of solar panels in geostationary orbit, capturing boundless solar energy and transmitting it to Earth wirelessly through safe microwave emissions. This energy is then seamlessly received by colossal ground-based flat antennas.

86. Alcohol-to-jet Technology

United States

In the context of an urgent need for sustainable aviation solutions, there is a growing concern about the environmental impact of traditional fuels. To counter these challenges, LanzaJet pioneered its Alcohol-to-jet technology (ATJ), a process that transforms ethanol into two distinct types of fuel: Synthetic Paraffinic Kerosene (SPK) and Synthetic Paraffinic Diesel (SPD). Recognised as an approved pathway for Sustainable Aviation Fuel (SAF) production under ASTM D7566 Annex A5, it allows for blending up to 50% with conventional Jet A aviation fuel. LanzaJet's ATJ technology demonstrates versatility in processing any sustainable ethanol source, encompassing materials such as municipal solid waste (MSW), agricultural residues, industrial off-gases, and biomass. These fuels can be seamlessly integrated into existing aviation infrastructure, making them a viable and environmentally responsible alternative to traditional jet fuels.

87. Lilac Solutions' Lithium Extraction

United States

There is a surging industrial demand for more efficient, faster and sustainable lithium extraction for a wide range of production streams. Lilac Solutions is reshaping the landscape of lithium extraction through their cutting-edge ion exchange technology.

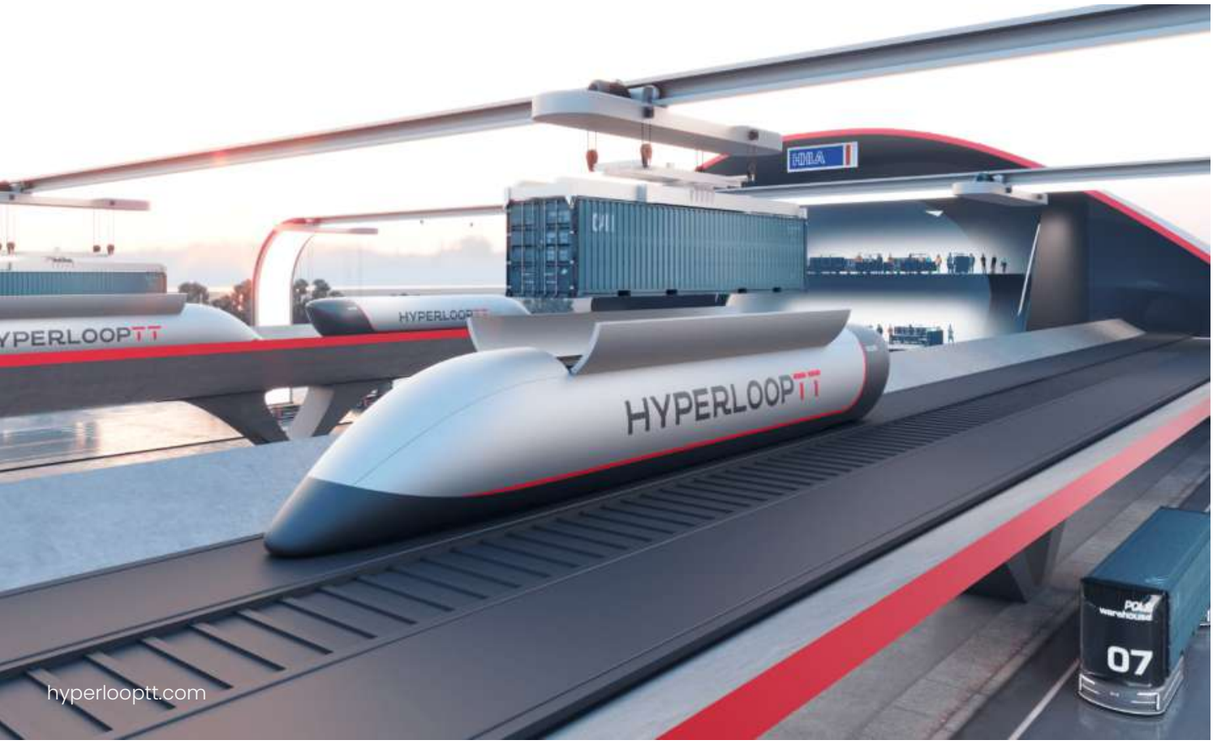
Lilac's technology, known as ion exchange, streamlines the lithium extraction process, making it faster, more efficient, and environmentally friendly. By utilising specially designed absorbent materials, this system extracts lithium from brine sources, such as those found in salt flats and underground reservoirs. The result is a more sustainable and cost-effective method for lithium recovery.

Their innovative approach to lithium production addresses the growing demand for this vital resource while minimising environmental impact.

88. Solein for Food Production

Finland

Sustainable protein production is a vital pathway towards global food security. By merging renewable energy and air-captured carbon dioxide to create a versatile protein source, Solein, Solar Foods presents one solution to global challenges in food security and environmental sustainability. Solein's versatility allows it to be used as a key ingredient in a wide range of food products, from meat substitutes to dairy alternatives. Their method, which replicates the natural process of photosynthesis, holds the promise of addressing global food security and environmental challenges. This breakthrough technology offers a sustainable alternative to traditional agriculture for protein production, reducing land and water use while minimising greenhouse gas emissions.



hyperlooptt.com

89. The Hyperloop

United States & United Arab Emirates

The need to redefine transportation includes an emphasis on shortening air time travel. Hyperloop Transportation Technologies (HTT) is one of several companies working to make this a reality, introducing the hyperloop. The hyperloop is a proposed high-speed transportation system that involves passenger pods traveling at very high speeds through low-pressure tubes elevated above the ground. The hyperloop envisions ultra-high-speed travel in near-vacuum tubes, capable of reducing journey times significantly. With projects and partnerships worldwide, HTT is driving the future of sustainable, high-speed transit. In the UAE, HTT is actively exploring the feasibility of constructing a hyperloop route between Abu Dhabi and Dubai. This revolutionary transportation system is designed to be energy-efficient, sustainable, and faster than conventional high-speed trains.

90. SkySails Power

Germany

In response to the shortcomings of conventional wind technology in tapping into the most potent winds at high altitudes, German firm SkySails Power has pioneered a system that utilises colossal kite-surfer-like sails connected to extensive cables, which captures wind energy from the upper atmosphere. Designed to harness strong winds at elevated altitudes, these systems present a more efficient and cost-effective approach to wind energy generation compared to traditional ground-based turbines. By introducing this transformative paradigm that leverages high-altitude winds, SkySails Power stands at the forefront of reshaping the future landscape of wind energy.


SkySails Power - Web

Climate Financial Technologies

91. Sustainable Living for Everyday Purchases

Switzerland

In the realm of sustainable living, the integration of eco-conscious practices into daily purchases poses a considerable challenge for many individuals. Enter Mympact, an application meticulously crafted to equip users with the resources and insights essential for monitoring and mitigating their carbon footprint. Through seamless integration with users' bank accounts, the app adeptly utilises transaction data, employing advanced algorithms to precisely gauge the environmental repercussions of each purchase in terms of carbon dioxide emissions. Currently, the application boasts an extensive database comprising over 20,000 sustainable products and a curated selection of 350 verified brands, providing users with a comprehensive array of eco-friendly choices.

92. Green Financing in Africa

Kenya

The challenge of facilitating a green transition in African countries is inherently complex, and for small and medium-sized enterprises (SMEs) in the region, accessing credit for this purpose proves particularly arduous. Melanin Kapital, a pioneering shift from conventional crowd lending to an innovative platform focusing on green credit and carbon offsets. With an unwavering commitment to reshape the financial terrain for African SMEs, Melanin Kapital is on a transformative journey. This evolution not only aims to enhance the accessibility and affordability of financing but also actively strives to contribute to environmental sustainability throughout the African continent.

93. Accessible Green Energy Investing

Germany

One of the primary challenges in green investing lies in the gap between capital and opportunity, hindering the acceleration of the global shift to clean energy. Businesses often struggle to access renewable energy producers and carriers efficiently, limiting their ability to contribute to a more sustainable future. Bullfinch addresses this challenge by providing businesses with streamlined access to renewable energy producers and carriers through its proprietary alternative asset platform. Through strategic partnerships with institutional investors and innovative energy hardware providers, Bullfinch not only simplifies the green investing process but also qualifies green energy infrastructure projects for larger funding sources.

94. Green Financial Business Research

China

The imperative to construct ecological civilisations necessitates the development of robust green financial systems. However, financial institutions and local governments often encounter challenges in implementing impactful green finance initiatives due to a lack of comprehensive and efficient solutions. Uni Inclusive addresses this challenge through its cutting-edge digital solutions, meticulously designed to empower financial institutions and local governments in their pursuit of green finance. The platform serves as a catalyst for collaboration between green finance and technology experts, providing a holistic solution to maximise the impact of green finance initiatives.

95. Decarbonising Investment

Australia

Recognising the urgency of climate change, the investment community faces the challenge of incorporating sustainability into their decision-making processes. The complexity of assessing the environmental impact of investment portfolios poses a barrier to the seamless transition towards a net-zero future.

Netfolio's platform simplifies sustainable investing for Asset Managers and Owners, providing them with the tools needed to assess and understand the financed emissions associated with their investment portfolios thoroughly.

Through this method, Netfolios facilitates a more straightforward path for financial stakeholders to transition seamlessly towards a net-zero future.

96. Holistic Carbon Accounting

United Arab Emirates

Traditional approaches to carbon accounting often fall short of providing the holistic guidance needed for a transformative journey towards achieving net-zero emissions. SUMA's platform is uniquely positioned to guide both businesses and entire ecosystems on their transformative journey towards achieving net-zero emissions. Through its carbon footprint calculator tool, for example, technology and Web3 companies can calculate their accurate carbon footprint, including energy consumption of cloud services, blockchain holdings and transactions.

97. Accessible Climate Action

France

The imperative to reduce greenhouse gas emissions and mitigate climate change demands innovative solutions and substantial investments in projects that align with zero-emission objectives. However, accessing dedicated funding for such initiatives poses a significant challenge.

The Zero Fund stands as an innovative marketplace platform and Software as a Service (SaaS) solution that serves as the vital bridge between buyers, whether they are public entities or private enterprises, and their closest carbon suppliers. The fund collaborates with innovative businesses, startups, and established enterprises, offering financial support, mentorship, and resources to accelerate the development and implementation of sustainable solutions.

98. Monitoring Climate Activity

Sweden

In a world grappling with the urgent challenges of climate change, there is a need for both businesses and individuals to measure the environmental impact of their financial decisions. Platforms like Doconomy integrate a user centric approach to ensure that users can effortlessly monitor and manage their carbon footprint without disrupting their regular financial activities. By leveraging data analytics and artificial intelligence, Doconomy provides real-time insights into the carbon footprint associated with various transactions, empowering individuals and businesses to make environmentally conscious choices. Through their Climate Activity module, launched in partnership with UNFCCC, users gain a deeper understanding of their own environmental footprint based on individual lifestyle activities.

doconomy.com

99. Ethical & Personalised Investment

Switzerland

In a financial landscape where ethical considerations are gaining prominence, there is a growing demand for investment solutions that reflect personal values.

Inyova provides a platform that seamlessly integrates financial goals and ethical choices, allowing users to invest based on their own ethical preferences.

For example, some users prefer to invest in industries that promote gender equality. Inyova's algorithm meticulously constructs investment portfolios, typically comprising 30 to 40 stocks selected from a pool of approximately 300 companies.

iraqoilreport.com

100. Associated Gas De-flaring

Iraq

The stark contrast between the growing demand for gas and routine flaring of associated gas at oil fields is a pivotal opportunity in the climate technology solutions space. Through gas processing facilities, the Iraqi Government targets reducing greenhouse gas emissions via de-flaring initiatives. Transforming raw gas into natural gas, liquefied petroleum gas (LPG), and gasoline not only fulfills local energy needs but also diminishes dependence on hydrocarbon imports. Typically designed for major flare emissions, this technology is adaptable, with skid-mounted solutions catering to smaller applications. This strategic shift benefits the community, gaining access to natural resources and the environment by unlocking local resources and mitigating CO2 emissions. As per the agreement Iraqi Ministry of Oil and Baker Hughes, is developing advanced solutions for flare gas at the Nassiriya and Al Gharraf oil fields, using modular gas processing technology.

The Road Ahead

Mitigating and adapting to climate change can seem daunting, even impossible in some instances. However, and thanks to incredible climate-tech innovations, the future looks brighter. Deserts are more fertile than ever before thanks to vertical farms and more efficient farming techniques. Renewable energy energy adoption is accelerating from Santiago to Shenzhen. Hydrogen and nuclear projects are leaping forward. Batteries are being produced cleaner than ever. We are beginning to siphon carbon dioxide straight from the air. We are learning how to treat our economy in a more circular fashion.

The development and implementation of climate-tech will play a crucial role in shaping a better tomorrow for humanity. By utilising innovative solutions, some of which have been described in this report, we can reduce our reliance on fossil fuels and mitigate the effects of climate change. This will not only benefit our planet's health but also promote economic growth, social equity, and improve quality of life for all. It is essential that we continue to invest in research and development of climate-tech and work towards a sustainable future for generations to come.

Breaking the Climate Barrier

The Promise of Climate Technology for a Sustainable Future

2023