techUK
SUPPORTING COP26

Climate Tech: The Innovators

Insights from some of the country's leading digital innovators on the role of emerging digital technologies in the global transition to net zero

Quantum | Geospatial | Cloud | AI | Blockchain | 5G | Digital twins

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Foreword

Julian David, CEO, techUK

This year, everyone has seen the Climate Crisis take hold, from fires, floods, and extreme weather. The latest report from the Intergovernmental Panel on Climate Change only further confirmed our fears. Their global and unequivocal consensus exemplifies the severe consequences we face if the narrow window to avert a rise in temperature of more than 1.5C is not immediately grasped. Solutions are required at a systemic level to transition the real economy and the lives of millions.

It's easy to be pessimistic. The challenges surrounding the climate crisis and the impacts of a changing climate are daunting, but there are reasons to be cautiously optimistic. As a champion of the tech sector, I see day in, day out, how innovation is driving positive change and playing its part in addressing the climate emergency.

Firstly, I want to speak to our sector's own impact. As tech has become embedded in all parts of the economy we have contributed to the level of emissions. The whole sector is therefore responsible for making sure that our own house is in order and that we are driving our own emissions down. Tech has rightly faced scrutiny given that we contribute 2-3% of global emissions. We need to address this.

I am enthused that 40% of the sector has signed up to the Race to Zero or embraced tough emission reduction targets, however, this means 60% have not yet done so. I encourage all technology businesses to set robust climate targets, and to look at what other transformations are needed, whether that is redesigning business models, changing supply chains or innovative new solutions.

In this spirit of innovation, I am delighted to present this 'art of the possible' collection of essays on the technologies and innovations that can help us transition to a net zero society. Each highlights specific opportunities and as a combined resource their message is even clearer. Digital technology will underpin the just transition to a zero-carbon economy and the only question concerns the ability of society to accelerate and enable this contribution.

Every day, developments in digital technologies are pushing the boundaries of what is possible. This report demonstrates how the ingenuity of the tech sector is being increasingly applied to the climate crisis. Digital technologies are, of course, only part of the solution to address, manage and reverse the impact of climate change, but they undoubtably provide us with some incredibly powerful tools to support the transition to a zero-carbon economy.

I encourage you to read this collection of seminal essays from techUK members. Together they form a unique and essential briefing for representatives at COP26 and for anyone engaged in this most urgent challenge.

Finally, I want to revisit the point I started off with about the sector's responsibility to meet net zero, and to add the importance of transformational change. With the science setting out so clearly what needs to change we must all come together to prepare for what comes next and deliver a better future for our planet.

Using the Internet of Things to deliver sustainable solutions

Helena Hunter, Program Office Leader,
Country Digital Acceleration, Cisco

Cisco, the worldwide leader in technology that powers the internet, aims to inspire new possibilities for its customers by reimagining their applications, securing their data, transforming their infrastructure, and empowering their teams. Helena is part of Cisco's Country Digital Acceleration program which aims to accelerate the digitization of countries around the world.

The Internet of Things (IoT) – the term used for sensors and end-devices combining with advanced software on a communications network — can help us transform our world for the better. IoT is being used to do things as varied as reducing air pollution in some of our world's biggest cities, creating smarter agriculture and food supply systems, and improving energy efficiency in business processes. Here, we highlight three case studies of how Cisco, working closely with our partners, has managed to leverage IoT to deliver solutions that benefit the long-term sustainability of our planet.

Each of these solutions was supported by Cisco's Country Digital Acceleration program which sees Cisco collaborate with governments and other stakeholders around the world to build sustainable, secure and inclusive communities powered by ethical and innovative technology solutions.

The Port of Rotterdam

The Port of Rotterdam is a major logistical gateway for Europe, and critically important to the economy of the Netherlands. It is an asset of strategic and historic importance (first opening in the 14th century) and must continuously innovate to remain an attractive location ahead of competing European and international ports. The Port's goal is to become the most innovative port in the world and to be ready for autonomous shipping by 2030. It also needs to comply with CO_2 caps agreed with the city of Rotterdam to limit the amount of pollution generated annually.

Cisco partnered with the Port and IBM to deliver a data extraction and delivery service using products with military-grade security to optimize safety and movement of incoming and outgoing vessels.

By installing hundreds of land, weather, and water-based sensors rolling up into a dashboard, ships get a mandatory moment when it is safe to enter the Port without running aground. The Dashboard calculates both the fastest and most eco-friendly way for port entry, giving the Port the tools to manage ships movement into the Port, taking into account the in-time delivery of goods. Thanks to the data delivery into the application cluster dashboard, the Port can respond to conditions dynamically and advise or demand ships reduce their speed (and CO_2 emissions) to arrive at the Port at the optimal time. Logistics partners can also optimize how they work with ships, sending lorries for cargo as ships dock rather than waiting idly in the Port for ships to arrive.

Village Knowledge Centers in Kerala

Over the last two decades, the real income of small farmers has fallen by 30% due to weather-related yield shortfalls and lack of access to technology. The government of India is aiming to double farmer income by 2023, utilizing advances in irrigation to enable “more crop per drop” in an increasingly water-scarce world, and empowering farmers to take innovative approaches to long-held farming practices.

Cisco has partnered with the Kerala State IT Mission to build an “Agri-Digital Infrastructure” (ADI), an end-to-end digital agriculture blueprint for rice paddies and shrimp farms. We also set up “Village Knowledge Centers” (VKCs) in villages across Dharmadam and Taliparamba to provide farmers with real time information on the status of crops in their village, current crop pricing, and expert farming advice.

We installed IoT sensors in rice paddies and prawn farms to collect data on moisture levels, temperature, and pH levels. Data from these sensors is combined with satellite images and AI analytics to create insights on crop yields, weather forecasts, and enable early detection of plant diseases or destructive insects. All of this data is viewable as a dashboard that shows the real time status of farming conditions. Farmers can access the data through a web portal or via an app on their mobile phones and receive alerts when farming conditions change, enabling them to proactively adjust their farming activities (i.e. adjusting water and pesticide usage in response to local conditions).

IoT Connected Conservation for environmental monitoring & biodiversity

LoRaWAN (Long Range WAN data) is a communications technology that requires a small amount of power and can communicate over long distances (unlike Wi-Fi and bluetooth). It's ideal for remote areas where there is no existing network, however the data rates that can be transmitted by the technology are low. The Harry Butler Institute in Murdoch University is focused on environmental research that enables communities, businesses, and biodiversity to co-exist. The university wanted to examine the how LoRaWAN technology could be used to support remote environmental monitoring and biodiversity use cases.

To support trialling of remote environmental and biodiversity use cases, we donated two Cisco LoRaWAN gateways to the university's IoT lab to enable testing of proposed networks before live deployment. To date the team has deployed two use cases - air quality monitoring and tracking of Quenda (a small nocturnal marsupial) population levels.

For air quality monitoring, the team deployed LoRAWAN sensors in a university campus parking lot and surrounding Australian bushland to measure the Total Volatile Organic Compounds (TVOC). Tracking TVOC levels through LoRAWAN technology enabled the university to measure how emissions were impacting air quality in real time.

Our partnership with Murdoch University is developing sustainability focused IoT/LoRAWAN use cases that can be adopted by agencies seeking to preserve Australia's biodiversity and limit their impact on the environment.

How Quantum Computing can help tackle Climate Change

Steve Brierley, CEO and Founder, Riverlane

Steve is founder and CEO of Riverlane, which is a building the common operating system for all quantum computers. He founded the company in 2016 to ensure quantum computers capable of helping humanity tackle urgent challenges like climate change are available far sooner than previously imaginable. Steve sits on the UK Government's Quantum Computing Expert Group, having spent nearly a decade as a senior research fellow at the University of Cambridge leading major research projects in quantum computing.

Quantum computing is a new revolutionary computational technology that will have a massive impact on everything from creating new materials to discovering new pharmaceutical drugs, but nowhere will its impact be more important than in combatting climate change. From carbon sequestration to electrolysis of water and the invention of new batteries, quantum computing has the potential to harness nature in our campaign to halt and then reverse climate change.

What is Quantum Computing?

At the atomic level different rules of physics apply to those that we observe around us. These quantum rules determine how atoms interact with each other, and this new understanding will enable us to use quantum rules for incredibly advanced and rapid calculations that are far beyond the abilities of the classical computers we work with today.

Without getting into the details of how a quantum computer works (there is an excellent video here from Scientific American) they offer an exponential increase in processing capacity. A quantum computer can consider all possible outcomes to a problem at the same time, rather than sequentially as classical computers do. The result, a computer that could potentially deliver speeds for these atomic-level calculations that are millions of times faster than the very best conventional computers in existence today.

Quantum Computing and Climate Change

In the 1980s, one of the forefathers of quantum computing, physicist Richard Feynman, observed that "Nature isn't classical, dammit, and if you want to make a simulation of nature, you'd better make it quantum mechanical". In the context of climate change, the emission of carbon dioxide into the atmosphere, and its reversal through new clean fuels and energy storage, are functions of nature and must be seen at the quantum level.

Our studies into managing climate change seek to understand in complete detail the atomic-level forces at play when molecules bond with other molecules or when they split.

This knowledge could provide the means to invent new processes and materials that could be massively beneficial.

Today's classical computers, even the largest and fastest supercomputers, have nowhere near the ability to simulate atomic level quantum interactions. Even with Moore's Law they would not reach that capability in a thousand years. Quantum computing could have this ability within the next decade, as it uses quantum states of atoms to simulate the quantum forces of nature.

Where will Quantum Computing be used?

Battery Evolution

Batteries are set to be a major part of our lives as we transition away from fossil fuels. They will not only power our cars, but also be a critical storage system for renewable energy. Today's batteries, however, lack the energy density for long journeys and are too expensive for long duration energy storage.

Current battery R&D relies on long cycles of experimentation and computational simulation. Quantum computing offers the ability to simulate every element of the battery chemistry in a virtual experiment at the atomic level. Variables such as electrode materials, electrolyte formulas, binders and separators can be manipulated and analysed in virtual experiments to find the combination that will enable a breakthrough in energy density.

IBM and Daimler have teamed up to discover next generation batteries through quantum computing. Riverlane is also engaged in this research programme focussing on Lithium-Air batteries, with the ambition to double battery energy density every year.

The Future of Fertilisers

The production of nitrogen containing fertilisers relies on catalysts that consume 3%-5% of the world's natural gas, cost nearly $300 billion a year and are responsible for 2% of annual worldwide CO_2 emissions. Nature creates nitrates for free and with no emissions. Research is needed to understand and emulate these processes. Here is where quantum computing can help.

The next decade will see quantum computers support the creation of new catalysts needed to make energy-efficient fertilisers and significantly cut carbon emissions. According to Boston Consulting's R&D initiative on quantum computing and technology, conventional computers would take over 800,000 years to model the molecules to replace existing chemicals. A quantum computer would require just one day.

Companies including Microsoft and IBM have already stated looking at how quantum computing could help us understand and replicate the nitrogen-fixing root nodule. To do so would eliminate the CO_2 cost of man-made fertilisers.

Energy Production & Hydrogen

Hydrogen is the ultimate clean fuel with the only by-product being water, however, we are still unable to produce it at an affordable cost. The major problem is we are only able to produce hydrogen with a 70%-80% efficiency. This is due the complexity of water which, while ostensibly being a very simple molecule, is highly complex in the liquid state.

Quantum computers are already being employed to help in the search for efficient hydrogen production by simulating the electrolysis process. In 2020 Shell worked with physicists from Leiden University to do exactly this.

Similarly, IonQ, a quantum computing technology company, successfully calculated the simulation of a water molecule on one of its quantum devices in 2019.

Carbon Capture & Storage

Carbon capture, usage, and storage (CCUS) will make up 50% of heavy industry's emissions reductions by 2050 according to the International Energy Authority.

Today, no cheap and readily available catalysts for CO_2 reduction exists. This is because most techniques involve precious metals or expensive processes. Quantum computers, through the simulation of quantum-level atomic interactions, could pave the way to discovering a new catalyst for carbon capture, heralding a new era of scrubbing carbon directly out of the air. This captured CO_2 could then be used in the production of metals, plastics, and concrete.

The work to discover new CCUS processes through quantum computing is already underway. In 2020 the energy company Total announced that it would be working with Cambridge Quantum Computing to improve materials for CO_2 capture.

Making Quantum Computing Happen

The potential for and benefits of quantum computing in combatting climate change are clear and compelling. The challenge is to take what, to date, has been a lab technology and to make it available at a production level. Once done, these models and simulations will form a library of knowledge, allowing us to evolve a deep understanding of natural systems and how to combat the existential threat of climate change.

Using geospatial to support climate action and improve resilience

Carly Morris, Head of Geovation, Ordnance Survey

Established 230 years ago, Ordnance Survey is a world-leading geospatial organisation and experienced geospatial partner. It shares its location insights with governments and businesses around the world to help them make better informed decisions. Carly Morris is Head of Geovation– a community of over 1800 start-ups, investors, corporate innovators, and developers who all understand the power of location data. Carly was named a Tech Women 100 winner in 2020.

Geospatial information is an essential resource with proven societal, economic and environmental value. It enables governments and organisations to address the key global, regional and local issues that affect people and the planet as a result of climate change, which the UN called the "world's most urgent mission".

At Geovation, Ordnance Survey's geospatial start-up accelerator, many of the start-ups we support are location-data and proptech collaborators, all with the same goal of making positive change happen. We connect industry problems to start-up solutions, so that, together, we can have a positive impact on people and the planet. Our insights help businesses that wish to profit sustainably.

Entrepreneurs are critical to addressing the biggest global challenges. Geovation has been at the forefront of emerging ideas on topics such as carbon capture, renewable energy, and pollution prevention since its foundation in 2009, but with a surge in investment in sustainable tech, there has been a substantial increase in the number of sustainable 'green' companies especially in the UK. Early-stage investment into climate tech is also increasing, with total venture funding growing three times faster than investment into artificial intelligence.

One notable success story is The Land App. Its vision is to harness geospatial technology to create a future that empowers resilient businesses, fosters a thriving natural environment, and delivers meaningful action on everything from climate change to sustainable food production. The Land App software is used by thousands of estate managers, farm business consultants, environmental consultants and land agents throughout the UK to manage all their spatial data in one place, helping them make well-informed land-use decisions.

Another Geovation startup is BioCap, which uses data to develop a mapped plan for a region, allowing citizens, businesses, agencies and government to engage with landowners to use nature to offset carbon and enhance biodiversity.

This creation of a local "marketplace" for carbon and biodiversity offsetting will allow communities to address climate change and biodiversity loss in their local countryside – planting the right tree in the right place. 15% of all greenhouse gas emissions are directly caused by deforestation but new forestry can provide a net carbon sink for decades during growth and bring wider environmental benefits.

Natural disasters, such as floods, droughts, tropical storms and heatwaves, are becoming more frequent and severe under climate change, the impact of which is already threatening lives and livelihoods globally. In response, start-ups are looking at ways to build better resilience in affected areas. Take Earthscope and WatchKeeper for example, who are leveraging data to create unique, valuable insights on wildfire, storm and flood risks so that governments and organisations can respond more effectively, protecting communities and important natural habitats.

Construction is one of the biggest contributors to waste in the UK today, being responsible for approximately 32% of all waste going to landfill.

Geospatial is vital to improving sustainability performance in this sector. Skanska UK, one of the industry's leading pioneers in sustainability, has deployed Qflow as a system to track waste across 5300 miles of roadworks. Through a unique combination of artificial intelligence and machine learning, Qflow automates data capture and analysis to help drive both commercial and carbon savings whilst mitigating risk.

The UK government is turning to geospatial expertise and data to safeguard the environment, promoting biodiversity, protecting people and places from flooding, and planning greener public transport. OS is supporting all areas of the UK Government to achieve this by giving easier access to OS data which has been made possible via the Geospatial Commission's Public Sector Geospatial agreement (PGSA). The new APIs have been made available to the public sector for free, providing valuable location data to support a range of initiatives, including reaching net-zero.

By opening geospatial data up to more users across the public and private sectors, the conditions for innovation are enhanced.

The government can effectively join up information across different sectors for more powerful insights, improving decision making. The public sector is seeing geospatial becoming a key tool in helping to deliver sustainability projects of all sizes. This is particularly true in areas such as transport, utilities and energy.

Transport for London (TfL) is trialing an electric scooter rental scheme to explore whether e-scooters have a part to play in the move to greener modes of transport. In addition, the Department for Transport is using location data and aerial imagery to support infrastructure planning for electric vehicle charge points.

The utilities industry has huge transformation challenges ahead. Delivering on these challenges quickly requires much greater collaboration. Therefore, OS is combining its know-how with the strengths of other organisations such as 1Spatial to deliver innovative solutions for net-zero outcomes.

A key energy project is the mapping of the UK's entire energy network. This will help understand where renewable energy can plug into the grid and decide where electric car charging points can be implemented, driving decarbonisation in the energy system.

In Scotland, OS greenspace data helped to reveal that 60 per cent of Edinburgh and Aberdeen are made up of green space. Scotland's parks and greenspace charity, Greenspace Scotland, says this green space is a vital source of clean energy, which can be harvested using ground source heat pumps (GSHP), and used to heat our homes.

By working together towards one common goal, we can accelerate viable solutions and how countries respond to climate change. The impacts of global warming are one of the biggest challenges we are facing. Geospatial data can be a key tool in helping to measure and monitor how the environment is changing and identify solutions that support the 2030 Vision. But we all need to do our part because climate change is a global effort.

For more information about Geovation visit – Geovation.

Blockchain-enabled supply chain traceability

Veera Johnson, Co-Founder, Circulor

Veera is a social entrepreneur and Co-Founder of Circulor. Circulor is a global technology business that enables companies to gain visibility into their supply chains, improve their ESG performance, reduce greenhouse gas emissions and demonstrate responsible sourcing and sustainability.

Amidst the many factors that contribute to the climate crisis, the significant role of industrial supply chains can no longer be ignored.

World Leaders, the C-suite and Heads of the Procurement are increasingly aware of the critical role they play in driving the required changes, with supply chain decarbonisation, responsible sourcing of critical minerals and measuring ESG impact finally being prioritised on their agendas. A confluence of all these actions is essential for accelerating the energy transition, achieving net-zero and instating supply chain sustainability. However, a key obstacle many organisations face is that supply chains are global and complex - meaning very few have visibility of their supply chains beyond their own operations and immediate suppliers. It is no longer accepted by consumers, investors or regulators to just say you care about ethics and sustainability; organisations are increasingly having to prove it.

The cornerstone of decarbonisation is achieving traceability in our supply chains. Understanding the provenance of source materials across their supply chains enables organisations to make informed sourcing and manufacturing decisions, whilst enabling them to prove responsible sourcing of primary critical materials.

We all know that critical minerals are the building blocks of renewable energy technologies and essential to supporting the energy transition. Transparency is key to this transition, particularly as we move towards a circular economy and need to track the recycling of materials back to their primary state, ready for re-use. Building this level of transparency enables organisations to capture and build an understanding of the GHG emissions beyond their own operations, the principle being that “if you don’t know about what is truly happening in your supply chain then you can’t make changes that are going to be impactful”. This principle is at the heart of what Circulor does.

Our solutions create a dynamic picture of a company’s supply chain to provide a high level of transparency, including its carbon footprint at every stage. We are on a mission to make the world’s most complex industrial supply chains more transparent in order to prevent the exploitation of people and our planet.

During last years' lockdown the global economy all but ground to a halt. Global carbon emissions fell by 7% in this period. This is coincidentally the same amount which the Paris Agreement requires every year if we are to reach our climate goals. The reason for the relatively small dip is that the automotive, construction and consumer electronics sectors are amongst the eight largest global supply chains which account for more than 50% of global emissions. In addition to addressing their carbon responsibilities, all companies, regardless of their sector, must be vigilant to improve working conditions, labour standards, and pay in their value chains. Transparency provides OEMs with the visibility needed to enforce such improvements, or to simply stop working with certain suppliers or manufacturers who do not uphold the same ethical standards.

We are also seeing how pioneers like Polestar and Volvo Cars are spearheading a movement for transparency by setting ambitious goals of ethical sourcing and producing climate-neutral cars by 2030. Polestar CEO Thomas Ingenlath made this statement in relation to Circulator: "Caring about ethics and the environment is key to Polestar. This unprecedented level of traceability, provided by Circulor, means that Polestar can promote sustainable and ethical practices in its supply chain, and provide better transparency for consumers".

This level of visibility characterised by dynamically tracking the flow of materials and attributing CO_2 footprint by aggregating emissions at each production step is also crucial for upcoming regulations including the EU Battery Regulation and the Carbon Border Adjustment Mechanism (CBAM). This Battery Regulation will replace the current Batteries Directive (2006) and aims to make batteries a true enabler of the green transition by minimising both their carbon and social footprints.

The CBAM will help reduce the risk of carbon leakage by encouraging producers in non-EU countries to 'green' their production processes. It is promising to see that this is becoming a priority outside of Europe. Similar CBAMs are already in place in some regions around the world, including California, and being introduced in Canada and Japan. President Biden's recent Executive Order announced a commendable target of 50% Electric Vehicle sales by 2030 cementing the global drive to tackle a global problem.

Another important example of the impact of traceability is through our work with Vulcan Energy to ensure a fully traceable production of zero-carbon lithium. This will be the world's first fully transparent and zero-carbon lithium product extracted and consumed in Europe. Our traceability solution assigns a digital identity to commodities, allowing us to track supply-chain data and environmental impacts at each stage of production, including recycling and end-of-life. This will help Vulcan and other European OEMs meet their sustainability objectives, setting a new standard in the European commodity market.

Circulor are also working with NGOs in Indonesia to establish safe and fair working conditions for plastic pickers, big issues for manufacturers using recycled plastics content in their products. Monitoring and reporting on different aspects of human rights will improve the lives of disadvantaged communities who serve the rest of the world.

There is no denying that it is complicated. Supply chains are global, complex and have a significant number of diverse actors. Whilst there are many amazing innovations in manufacturing and recycling capabilities, they will not drive a sustainable future on their own. To achieve net zero targets, organisations must address the need for transparency in their global supply chains.

Ensuring social and environmental standards are effectively applied is equally important. According to the World Economic Forum there are **nine major actions** that every CEO can take to reduce their ESG impact, all of which are underpinned by increasing transparency with technologies that are readily available and can be deployed at low costs.

We all know in our hearts that things aren't quite right. Our key observation is that it is critical for organisations to better understand their GHG emissions and sustainability impact, right from material source and those communities involved, through to second life and recycling. The importance of developing and making circularity the mainstream in supply chains is understood but the progress toward this broader focus is not sufficient to deliver significant change yet.

Circulor provides the most complete and mature solution that enables companies to gain visibility into their supply chains, improve ESG performance, reduce GHG emissions and demonstrate responsible sourcing and recycling. We provide data in real-time to meet the granular detail required to make comparisons, informing decisions to choose lower emitting routes and drive improvements with suppliers in countries whose governments are not enacting the same level of change.

The time is now to make complex, global supply chains traceable, ethical, and sustainable.

Green Cloud: How collaboration is unlocking the green potential of cloud computing

Clay Van Doren, Chief Executive Officer, Northern Europe, Atos

Clay Van Doren leads Atos' vibrant fifteen country Northern Europe business. During his tenure, Atos has used its Digital Vision thought leaderships series to outline how digital technologies offer new ways to meet society's most pressing challenges, such as increasing productivity and economic opportunity, supporting an ageing population and ensuring clean growth. Atos has also set out how the vital role of digital in accelerating progress towards Net Zero, releasing the Digital Vision: COP26 in June 2021.

Accelerating towards net zero

With world leaders gathering in Glasgow to participate in the 2021 United Nations Climate Change Conference, the need to step up the fight against climate change could not be more urgent or more obvious. This year we have seen extreme weather conditions caused by climate change, with flooding across Northern Europe, blizzards in the Southern United States and wildfires across Turkey and the Eastern Mediterranean. We now face a choice: we can continue as we are and risk further catastrophic climate change; or we can transform and future-proof our economies by transitioning to net zero.

Reducing impact through digital innovation

Achieving net zero will require a fundamental transformation of our economies and industries, something that can only be achieved by deploying new technologies on an unprecedented scale. Technologies including AI, IoT and cloud computing have the potential to unlock massive efficiencies for individuals and businesses alike, delivering less waste, significantly reducing the use of resources, and cutting carbon emissions.

Cloud computing can play a particularly prominent role in helping to arrest climate change and make net zero a reality, potentially preventing more than 1 billion metric tons of CO_2 emissions over the next 4 years according to some forecasts. Cloud reduces the use of material resources such as paper, electricity, and packaging, at the same time as cutting the energy consumption associated with the operation of on-site data centers and making clean-tech applications like smart grids possible. However, if the full potential of this technology is to be realized over the long term, organizations will need to coordinate their cloud strategies and effectively share resources and infrastructure.

1 **Cloud Computing Could Eliminate a Billion Metric Tons of CO2 Emission Over the Next Four Years, and Possibly More, According to a New IDC Forecast** (IDC, 08.03.2021)

Making sustainable cloud a reality

Cloud technology is not without sustainability challenges, every digital action carries with it an energy cost and where this is supported by cloud technology, the data centers making this possible must be powered and – critically – kept cool. This means that cloud technology cannot be deployed in isolation, instead organizations will need to phase out legacy data centers, investing in fewer data centers, powered by renewable energy if the operational benefits of cloud are to be matched with progress towards a more sustainable world.

Cloud partners can help unlock substantial sustainability gains for their customers by providing centralised energy efficient data centres that allow the sharing of physical infrastructure across thousands of customers, while keeping applications and data securely protected. When these benefits are combined with automation and cloud-native features such as autoscaling, applications only use computing resources on demand rather than consuming them unnecessarily 24 hours a day in customer data centres.

The critical insight for organisations, however, is that the performance of their cloud partners could make or break their own sustainability strategies. The best cloud partners will ensure sustainability feeds deep into their own supply chains, assessing strategic suppliers for their corporate social responsibility performance and examining how procurement processes can embed sustainability at every stage.

A model for collaboration using cloud

Recent years have seen the consolidation of data centers into larger-scale facilities that can more efficiently manage power capacity, optimize cooling technologies, utilize sustainable energy sources and increase server utilization. The world's leading technology firms are also driving this transformation, Atos has been at the forefront of this action as well, committing to major operational change that will ensure that our business – and those of our partners – can operate successfully and sustainably into the future, employing cloud technology as part of this. In 2018, we extended our commitment and decided to offset 100% of our entire carbon operational scope. As a result, from the last 3 years, we were able to offset 100% of our greenhouse gas emissions from data centers, as well as our offices and business travel. This carbon offsetting is only the start, but provides an important steppingstone to achieving net zero. Meanwhile, in Spain, France, Germany, Denmark, Finland, Luxembourg, the Netherlands, and the United Kingdom, between 80 to 100% of the electricity consumed by Atos came from decarbonized sources in 2020. Our efforts to improve energy efficiency have translated into a 15% decrease of global energy consumption at Atos data centers in 2020 vs. 2019 and a switch to carbon-free and renewable energy, which powered 55% of all Atos data centers in 2020 (versus 32% in 2019).

By incorporating these and other critical steps into our own ways of working, Atos has earned unparalleled sustainability credentials – having been recognised as the most sustainable IT Services company in the world by the Dow Jones Sustainability Index (DJSI) for two years in a row. Most importantly, however, Atos supports clients to meet their own sustainability challenges through our fully carbon-compensated sustainable solutions and new technologies to reduce energy consumption. As a result, Atos can help its customers achieve their Sustainable Development Goals as defined by the United Nations – in fact, clients of Atos can report "zero" in their own carbon reporting for the solutions they host in Atos data centres.

Setting the highest decarbonisation standards for its industry, Atos has pledged to achieve net zero carbon emissions by 2028, 22 years ahead of the aim set by the Paris Agreement. Crucially, however, this commitment applies not only to the emissions under its direct control but also across its entire value chain – a standard known as GHGP Scope 3.

This will result in a reduction by half in the carbon footprint of everything Atos buys and the carbon resulting from the use of everything we sell. This hugely ambitious pledge also commits Atos to offset any residual emissions under its influence through carbon sequestration.

The approach deployed by Atos can provide a model for how cloud technology can effectively be leveraged by businesses as they transition to a net zero way of operating. For this to be successful, collaboration is key. We are entering an era of what have been called "hyperscale" data centers, these offer us an opportunity to leave the inefficient and wasteful practices of the past behind by sharing resources and coordinating action. There is much more to be done, but the impact that cloud technology can have in terms of CO_2 emissions when deployed at this scale is now increasingly recognized by consumers, policy makers and investors. The path towards a sustainable future, however, will remain the same – solidly built on smart and effective collaboration between trusted partners.

Digital Twins: a new way to imagine, plan and manage the built environment

Neil Thompson, Director, Digital Construction, Atkins

Neil is a Director of Digital at SNC Lavalin's Atkins leading on Digital Twins for UK and Europe. He is the Head of the Construction Innovation Hub Programme for the Centre for Digital Built Britain and an Honorary Associate Professor at the Bartlett School of Sustainable Construction at UCL. Neil is also Chair of the Built Environment at the Institute of Engineering & Technology and Vice Chair of the Digital Twin Working Group at techUK.

There is no dispute, the time for action is now.

"We are clearly the last generation that can change the course of climate change, but we are also the first generation with its consequences." Kristalina Georgieva, CEO of the World Bank

This piece is not about convincing you of the weight of the situation we are in. This is about highlighting how we can start to work together to build a real solution to supporting the global net zero transition. Together being the key word. Meeting the challenge of climate change is a planetary problem that must unify our attention today to mitigate the consequences of failing to collaborate and act; but working together is not enough. We need vision, ambition, and the resources to execute.

Digital twins are a relevant, virtual representation of the state and behavior of something physical or non-physical with a functional output in the real-world. It brings together sensors, edge, data analytics and models, and actuators to enable an enhanced understanding of the state and behavior of the real-world, empowering people to decide on what they want to do next.

In thinking about how digital twins can be applied to the climate crisis, I am inspired by the CTO of Ocado, Paul Clarke's vision of a planetary digital twin and encouraged by the ambition of the European Union's Destination Earth Program to build one. We have made a start, however, change at that scale is hard for us to think about, let alone try to enact. My proposal is to be mindful of where we have influence and access to resources, so we can contribute to this cause.

I work within the construction industry and represent a series of organizations that have reimagined the role of our built environment: shifting the vision of the built environment from 'just building things', towards a role in the integration of systems of systems, a key enabler in supporting the transition to a low carbon world.

This “bigger vision” of the built environment must demonstrate the role that social and economic infrastructure plays in our everyday lives, supporting an inclusive and sustainable ecosystem of services. For example, being able to connect our decision making with weather forecasts. This would enable operators of wastewater treatment plants to prepare for adverse weather, understand its impact on water supply and manage surges within the plant.

Understanding how the built environment behaves as a system of systems is primarily a data and information management problem. We do not have to go far to see case studies of how building data systems can transform the performance of industries.

Let’s examine this through the evolving technology of the internet. In the first 20 years of the internet, we built a network of desktop computers and enabled the global connection of documentation. In the second 20 years we connected mobile devices and connected media and some assets to the network. During these 40 years we have seen the transformation of printed media, the entertainment industry, and the leisure industry.

We are now at the very beginning of the third 20 years, where we have started to connect more digital assets to the internet (the internet of things). If the first 20 years was about documents and the second was about services, the third is about building an internet of the built environment. In our context, the human made side of the planetary digital twin (where nature if on the other side). In turn, this will bring about much-needed disruption in the built environment sector, not unlike disruptions seen in media, entertainment and leisure in the 40 years prior.

This is not a pipedream. There are many examples of digital twins being implemented already. In the UK, the climate resilience demonstrator CReDo, led by the country’s National Digital Twin Program will demonstrate how the Met Office, telecom operator BT, Anglian Water and UK Power Networks can share data to improve climate resilience across infrastructure networks.

A second example is the Geospatial Commission's National Underground Asset Register NUAR. This is a digital map of underground pipes and cables that will help improve efficiencies in infrastructure development, reduce disruption, reduce waste and improve worker safety.

This is not about building a single and proprietary system that centralises the command and control of data. It is about making data connected and interoperable to deliver actionable insights, allowing us to test and prototype before deployment. In short, digital twins extend the functionality of the internet to incorporate our built environment and these are just the first steps. We can apply this technology in many ways to support urgent carbon reductions in response to climate change.

I am leading a piece of work in partnership with techUK, the Construction Innovation Hub, the Advanced Manufacturing Research Centre, the Institution of Engineering and Technology, the Construction Leadership Council, and the Alan Turning Institute. Our purpose is to begin to explore how the manufacturing sector can communicate with the built environment, building better performing products and encouraging the built environment sector to be discoverable through data by manufactured products and services. The outcome we want is for products and services to perform more intelligently out in the wild of the built environment. This could ultimately form the basis of an operating system and be a key enabler for a circular economy.

There are other things for us to consider.

The second 20 years of the internet, our internet of media, digitally connected media created a complex cultural impact, namely a market for consumer data and fake news. When building an internet of the built environment or a planetary twin we must learn from this.

The potential impacts of connecting data in our built environment are profound. It is therefore essential that we take a human centric design approach. The National Digital Twin Program created the Gemini Principles that provide a starting point for building an ethical approach to any data related program.

We need stronger data governance to build digital twins that can ethically meet these challenges. If we look at the medical industry and national health in the UK, there is a National Data Guardian that advises and challenges the health and care system to help ensure that citizens' confidential information is safeguarded securely and used properly. Other sectors need Data Guardians for the same purpose and to enable collaboration between sectors.

In summary, we must use data and information management to ensure we build the right evidence base, make the right decisions and track our progress in reducing and meeting the global net zero transition. Our internet of the built environment, or digital twin, is critical to our success as it is a powerful tool in navigating the complexity of a crucial net zero transition.

Unlocking 5G connectivity for climate action

Ian Caveney, Head of Tech for Good, BT

BT is the world's oldest telecommunications company. As well as being one of the UK's best-known companies, BT is a truly global organisation, providing products and services in around 180 countries. Ian leads BT's Green Tech Innovation Platform which supports the development of 'break-through' tech and new business partnerships that can support BT's customers on their Net Zero transition.

5G connectivity and the tech it enables will play a critical role in supporting climate action. We are on the cusp of a revolution in full-fibre connectivity, unlocking 5G, which in turn can be used to tackle climate change, improve air quality, and support better health. In this 'decade to deliver', the ICT sector must be 100% committed to harnessing the opportunity.

In the UK, BT's technology and networks will underpin many of the innovative solutions needed to achieve a net zero carbon economy. We already connect millions of people, homes, businesses, towns and cities. This can help us transform how we all live, work, and move in a low carbon economy, through a digital backbone of technology:

- In the future, clean transport will be enabled by 5G Connected Autonomous Vehicles (CAV's), supporting the low carbon movement of people and goods.
- A 5G enabled internet of things (IoT) will power smart traffic solutions and enable real time air quality and CO_2 monitoring, informing local climate action plans.
- Artificial Intelligence is already being used to today in the energy sector and will play an even bigger role in future in managing our clean energy supply when 5G is available.

It's a massive opportunity for everyone involved in the tech sector, and what we are doing in the UK can be replicated internationally.

These improvements in utility will be paired with advances in efficiency. While 5G networks are likely to drive a dramatic increase in mobile traffic, they are also designed to be more energy efficient than their predecessors. 5G and related technologies give mobile operators precise control over their networks' performance and, by extension, energy consumption.

Additionally, mobile operators will increasingly be able to use network function virtualisation, software defined networks and network slicing to tailor connectivity to the needs of the application. This will mean less energy is wasted. While 5G is likely to drive a massive expansion in the number of 'things' connected, many of these connections will consume very little energy. In practice, some IoT connected devices will be able to function for up to a decade using a single battery.

At the same time, 5G networks will be much denser than their predecessors, employing more base stations and other infrastructure. Moreover, many mobile operators will run 2G, 3G, 4G and 5G networks in tandem for much of the next decade, placing upward pressure on their energy usage before they are able to realise savings by decommissioning legacy networks. To give some context, BT currently consumes around 1% of the UK's grid electricity. Our investments in Fibre To The Premise (FTTP) and 5G should help to reduce this significantly.

We already have strong evidence that our products and services can support customers in reducing their carbon footprint.

In 2019/20, we helped our customers avoid 13 million tonnes of carbon – equivalent to the carbon consumption of 3 million UK households. And this year alone, around £5.3bn (25%) of our revenue came from carbon-cutting solutions – from teleconferencing and cloud storage to smart manufacturing and Internet of Things (IoT) technology.

We are already starting to deploy examples of how 5G can continue this trend. Working with the University of Stirling, we've helped to launch a living laboratory: a state-of-the-art environmental monitoring system designed to help businesses in central Scotland make more intelligent, data-driven, and – importantly – sustainable business decisions. Using sensors, satellite data, and AI, the laboratory will capture, process, and share data from across the Forth Valley using BT's EE 5G network. This will provide vital information to inform decisions that could help deliver major economic and sustainability benefits in the area.

Initially, the platform will monitor water quality in reservoirs, deliver near-real time forecasts of bathing water quality, provide early warning and monitoring of floods, and demonstrate environmental compliance in the brewing and distilling sector.

In the future, the technology could be applied across a range of sectors, including agriculture, biodiversity and conservation, and renewables, ultimately playing a fundamental role in the region's broader environmental efforts.

And another example is the BT Green Tech Innovation Platform which has been developed with US-based tech company Plug and Play. The aim of the platform is to uncover new green technology solutions to help our business and public sector customers reach net zero carbon emissions.

To date, the focus of the platform has been on three areas for new and emerging technologies that have a real potential to transform the environment of local communities – smart streets, smart buildings, and remote working. These technologies include environmental monitoring and traffic optimisation sensors that can be easily embedded into our new street hub units; IoT-capable solutions that support energy and water management in social housing; and the use of 5G to support innovative products and solutions such as video or virtual reality, reducing the need to travel.

As a sector, the telecoms industry should be proud of our achievements to date, and the opportunities we are creating to support climate action. A 2020 GSMA study showed that climate disclosure has grown significantly across the telco and tech sectors over the past few years, with 50% of the mobile telco industry committed to Science Based Targets (SBTi) and 31% to Net Zero. For the 50% of those operators who have signed up to SBTi, they are aligned to a 1.5C trajectory which should see their operational emissions cut by around 80%. The sector is advocating strongly for governments to set Net Zero emission targets by 2050, which will help to enable those telcos in markets where it is currently not possible to set Net Zero targets do so.

BT itself has been leading on climate action for 30 years. We have been using science-based targets for over a decade and in September 2021, we announced plans to curb our carbon emissions sooner than planned: bringing forward our net zero target from 2045 to 2030 for our operational emissions and 2040 for our supply chain and customer emissions. Since 2016, BT has reduced the carbon emissions intensity of its operations by 57% and supply chain emissions by 19% over the same timeframe. We're already using 100% renewable electricity worldwide and we've outlined plans to electrify our fleet of 33,000 commercial vehicles by 2030.

The reality is, however, that the transition to a low carbon economy will take time. We should recognize there is more we can all do to support it.

Collaboration and mobilization are now essential, and we need to do more to support consumers, small businesses, and SMEs. We are mindful that BT's customer base of 30 million households puts us in a unique position to help households cut their emissions. We're also working with Small Business Britain and the UK Government to help SMEs overcome the barriers they face. We're founding members of the Supply Chain Leader's initiative and helped to launch the SME climate hub in 2020.

We need to move forward in hope and optimism. Governments, business and society must continue to work together to overcome the challenge of transitioning to a low-carbon economy. At the same time, we want to see greater investment in infrastructure alongside clear policies which focus on and encourage, green technologies.

AI in the Race to Net Zero

Will Wells, Founder and President, Hummingbird Technologies

Hummingbird Technologies is an award-winning, world leading imagery analytics provider which combines AI, data analytics and satellite imagery to support regenerative agriculture and measure carbon sequestration in soils. It is a Sunday Times Fast Track 100 company and was awarded KPMG's technology start-up of the year in 2019.'

Climate change has locked us all in a race against time that I believe only super computational power and artificial intelligence can help us win. As the IPCC's most recent report laid bare, we are in the decisive decade to mitigate a near term 1.5 C global temperature rise. We need technology to help us revolutionise the way we produce energy and food, as well as manage industry and transportation (together, these four activities account for over 95% of global GHG emissions). AI should be at the forefront of this paradigm shift.

From Turing to Deepmind

If Alan Turing's work at Bletchley Park in 1943 forever changed the course of World War II, his electronic computing program of later years, what he imagined as 'machines that think', altered history at a deeper level. Moore's Law of computing power has precipitated a supercharging of deep tech.

Neural networks, built on NVIDIA (GPUs), are fast becoming pillars upon which, you can build intelligent and climate positive applications. They are powerful tools benefitting from enormous datasets.

Insights from *Deepmind's* recent AlphaFold 2 breakthrough, will ripple through the AI community working on climate change. This initiative has been hailed as a solution to the 50-year-old protein folding problem.

Deepmind's founder, Demis Hassabis on the subject:"Proteins are like tiny exquisite biological machines. The same way that the structure of a machine tells you what it does, so the structure of a protein helps us understand its function". The scientific paper and source code are a trove of information.

This innovation has doubled humanity's understanding of the human proteome, and in turn, opened the door for thousands of start-ups to leverage its AI to advance their own climate work. As we are beginning to witness with first vintage CRISPR-enabled DNA sequencing breakthroughs from Pairwise and Tropic Biosciences, the great biological data science revolution has also begun.

Concurrently, funding for AI technology ventures has smashed all records. In Q2'21, over 550 AI start-ups globally raised a combined total that surpassed $20bn. This surge was driven by an all-time high of 50 mega-rounds ($100m+ deals) to AI start-ups.

Emerging AI Leaders

This progression has spawned emerging AI stars in climate modelling. Cervest's cloud-based Earthscan system allows enterprises, governments and financial services to manage climate risk at an asset-level.

AI powerhouses such as Palantir have also been able to achieve technical dominance through petabyte-scale, outsourced data labels. Its Foundry product integrating data from sensors, IoT and other third-party sources is helping drive decarbonisation in energy production and alleviating renewable energy wastage through smart grid capacity predictions. Net Zero, Palantir argues, "is a data integration problem".

Hummingbird Technologies, founded in 2016, is leading the way in terms of enabling regenerative agriculture through AI. By harnessing deep learning and remote sensing data at a vast, pixelated scale, it creates maps from optical and radar satellites, facilitating 30% less chemical inputs in food production, while allowing users to monitor, verify and report agri-food supply chain sustainability practices (for carbon trading, govt subsidy or corporate insetting purposes).

As with NCX and Pachama – two forestry carbon offset AI players – this allows the agri-food industry to quickly scale up an objective audit of headline sustainability metrics. Land use classifications (key to understanding deforestation), measuring biodiversity net gain, natural capital, and climate friendly farming practices are all included. If harnessed correctly, this sector has huge potential as a trillion metric tonne carbon sink.

AI success here is being mirrored in the vertical farming space, with advanced machine learning based climate control (iUNU), aeroponics and hydroponics (Saturn Bioponics). Edinburgh-based Intelligent Growth Solutions is developing imagery systems to track crop growth autonomously. These new technologies work in tandem to optimize resource usage, a philosophy mirrored by cellular protein technologies (see Agronomics fund for the star players here).

Finally in waste, a major contributor to greenhouse gas emissions, pioneers such as Olio (AI enabled food sharing marketplace) and Winnow (computer vision-based classification of food waste on plates) are enhancing the final mile, food chain efficiencies needed to curtail unsustainable practices.

Future growth

We can expect more leaders to emerge. AI has specific characteristics which makes it extremely useful when applied to the climate crisis:

1. **AI insights are actionable.** We are now able to use thermal data and AI to detect building heat emissions (Satellite Vu), spot methane leaks (Kayrros), and even to monitor GHG emissions across entire coal or oil & gas pipelines (GHGSat).
2. **AI can enhance existing systems.** In the energy sector, BrainBox AI combines AI and cloud computing to create a fully autonomous and efficient commercial HVAC solution, whilst Bulb uses an internal deep learning based language encoder to provide better service to its 100% renewable energy customers.
3. **AI can accelerate scientific breakthroughs.** The discovery of alternative hydrogen fuels that could transform the energy sector is being powered by data science at Ryze. CarbonRe's deep reinforcement Delta Zero platform for heavy industry is revolutionising the way cement or steel is manufactured, whilst in terms of standalone breakthroughs, "no code AI" is a recent phenomenon worth tracking.
4. **AI can help us run simulations and digital twins.** Most researchers now use AI to cut the time needed to run big, complex models. Companies like namR are producing geospatial contextual data to build a digital representation of the physical world e.g., digital twins of 44 million French homes to pinpoint green savings.
5. **AI data as predictive intelligence.** Other AI players like Arup are optimising complex electricity systems by creating their digital representations of how they're operating in real time. This assists in predicting where efficiencies might lie. AI is now also central to weather event prediction and our future climate change resilience.

Turning pledges into pathways

This decade of climate action is a golden opportunity to operationalise AI for decarbonisation in pursuit of the UN's Sustainable Development Goals. While there are some notable disruptors, the full potential of AI will only be realised if we set the right conditions:

1. Organisations must integrate data across their departments safely and ethically, including into other borders or jurisdictions. **Collaboration will lead to utility.**
2. There needs to be a **migration from corporate 'data lakes' to open data exchanges**, e.g. Subak, Ark and the Rainforest Connection. This will scale climate impact through data platforms, linking conservationists to poacher trackers and bio-acoustic devices that listen out for deforestation.
3. Up to 80% of AI project costs are spent on obtaining, cleaning, and organising data for training sets and algorithms. **Robust data infrastructure and open-source libraries are a must.** This journey can be enhanced by accelerators.
4. AI and science need **continued strong funding.**
5. Modelling capabilities need to be advanced to **simulate different carbon scenarios**, including the widespread use of digital twins for audits and scenario planning.
6. Many companies lack the technical resources to scale up AI infrastructure. **Better access to research** (e.g. Alan Turing Institute) can alleviate this pain point.
7. Without **values-aligned AI,** we may well achieve Net Zero, but in doing so create more social unfairness.

techUK
FOR WHAT COMES NEXT

About techUK

techUK is a membership organisation that brings together people, companies and organisations to realise the positive outcomes of what digital technology can achieve. We collaborate across business, Government and stakeholders to fulfil the potential of technology to deliver a stronger society and more sustainable future. By providing expertise and insight, we support our members, partners and stakeholders as they prepare the UK for what comes next in a constantly changing world.

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