# *Fighting climate change with data*

By Centre for Sustainable & Circular Technologies, University of Bath

The Centre for Sustainable and Circular Technologies at the University of Bath runs a student-led annual showcase to share the interdisciplinary work of postgraduate students, academics and collaborators. In December 2020, this 5-day event explored the issue of climate change and how we understand where we are today and how to make real change for the better.

Throughout the event, the underlying theme of data and its crucial role to find solutions to the climate crisis was addressed by several speakers – how it can help more accurate definitions of the challenges ahead, aid innovation and scientific discovery, and predict the impact and sustainability of new technologies and behaviours.

Following the event, we approached some of the speakers to continue these conversations about data in our journey to reach net zero emissions.

**Using data in the fight against climate change**

The first step to finding the solution for any problem is understanding as much about it as possible. To understand climate change, we need to know what is happening to our planet and what is causing the most significant environmental changes.

More critically, we need to comprehend how the world of today is different from the world of yesterday, and how we can use that data to predict the state of the world tomorrow.

By understanding the future, we can develop viable solutions for tackling climate change, but we need an accurate measure of where we are now to know whether the solution is having the intended consequence.

Those viable solutions need to be sensible, sustainable and possible

within the timeframe available to make a difference. Can we rely on new technologies to be ready in time?

And does the data around human behaviour and their perceptions of climate change impact what is possible?

**Mapping the past is crucial to our future**

Scientists are asking whether we have entered the Anthropocene Epoch; an unofficial unit of geological time, used to describe the most recent period in the Earth's history when human activity started to have a significant impact on the planet's climate and ecosystem.

Many analysts think the Anthropocene started in the 1800s during the Industrial Revolution, when human activity had a great impact on the levels of carbon and methane in the Earth's atmosphere. Others think the beginning was 1945, when the first atomic bomb was tested and dropped on Hiroshima and Nagasaki, resulting in radioactive particles that have been detected in soil samples globally.

It has now been widely agreed that it began in 1950, with the Great Acceleration.

**Data in the commercial world**

Mario Abreu is Head of Group CSR and Sustainability at Ferrero – the global confectionery business that has pledged to reduce its carbon footprint by 50% before 2030.

"The Great Acceleration shows the trajectory of the Anthropocene," explains Mario Abreu. "When you look at data from Will Steffen et all (2015) it's evident that after the Second World War socioeconomic trends accelerate very fast between 1950 and 2010 – such as population growth, GDP, energy and water use, and fertiliser consumption. This impacts the planet by increasing the atmospheric levels of carbon dioxide, nitrous oxide and methane, and we also see rising trends in stratospheric ozone, surface temperature, ocean acidification and tropical forest loss.

"Then, in 1970, we had Earth Overshoot Day when it was widely accepted for the first time that we had used up all the planet's resources that were available to us. Every year since then, our demand for ecological resources has continued to exceed what the Earth can regenerate in a year.

"Based on data from the Stockholm Resilience Centre (2015), we're already well-beyond what is called the zone of uncertainty (high risk), mostly in regard to biogeological flows associated with agricultural practices –which are increasing the levels of phosphorus and nitrogen– and the extinction of species. Also, land-system change and climate change are growing and are an increasing risk. We need to find solutions to resolve these challenges that we have created for ourselves," added Mario Abreu.

The World Economic Forum ranks and maps global risks. Between 2010 and 2020, out of the 10 most likely and most-impactful global risks, nine are social and environmental – including extreme weather, natural disasters, biodiversity loss, water crises and climate action failure. All of these risks are clustered and orbiting around food crises.

"This environmental pressure on our food resources, combined with population growth, creates a very vulnerable situation for us," said Mario Abreu. "By 2040, it's estimated that we will become a global population of nine billion, needing 30% more energy, 30% more water and 50% more food.

"According to Jason Clay, Senior Vice President of WWF USA, to meet the increasing demand from a growing population we'll need to produce more food in the next 40 years than has been produced in the previous 8,000 years.

"And, the Food and Agriculture Organisation of the UN has said that unless we change our practices and reduce soil degradation, there's only 60 years

Data has become essential in assessing the impact and sustainability of new technologies

of farming left – which is just amazing in terms of the scale of what needs to be done," exclaimed Mario Abreu.

Another issue here is the limited amount of arable land available for agriculture.

"The Center for Sustainability and the Global Environment at the University of Wisconsin estimates that out of 37.1 billion acres, only 3.5 is arable land – which is less than 10%.

"This increases the risk of global yield failure, which the McKinsey Global Institute estimates is an annual risk of more than 15%, and it's projected to double by 2030 and quadruple by 2050.

"Agriculture is obviously facing a lot of issues and it needs huge amounts of new scientific technology to enrich the land, change practices and become more efficient to cope with the rising global demand for food." said Mario Abreu.

Agriculture is just one area of concern in our fight against climate change. There are many other polluters emitting huge amounts of CO2 emissions into the atmosphere, such as transportation, the construction industry as well as steel, iron and cement production.

"All of these emissions cause the Earth's temperature to rise and there are many impacts that will follow – and, for many of them, there is no turning back. The IPCC Special Report (2018) highlights the worst consequences of climate change being the demise of threatened ecosystems, coral and the arctic region. If the global warming temperature is allowed to rise above 20C before 2050, the impact on our ecosystems will be irreversible.

"We already know that a sea level rise of around 1m is inevitable this century, and some analysts estimate that this figure is actually nearer 2m," said Mario Abreu.

He added: "The canvas for solutions and how we should globally re-think how we live on the planet is set out in the Sustainable Development Goals (SDGs) developed by United Nations.

"These are very ambitious and interconnected targets that illustrate what the future should look like. People, organisations and governments are encouraged to think about all 17 SDG as necessary systemic change and not pursue one or some in isolation. And a lot of research and development has been done into how we can support the SDGs.

"One example is the Business and Sustainable Development Commission which looked at where the market opportunities are when fulfilling the SDGs. For example, in Food and Agriculture there are possible solutions in terms of changing our diet, restoring the land, bringing more technology into smallholder farms to help them respond more efficiently and create more urban agriculture.

Mario Abreu concluded: "We can't waste time waiting for new technologies to happen, we need to harness artificial intelligence to help bring about research and development more quickly."

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**Data as a scientific enabler to achieve net zero**

There are many different types of digital technologies that generate and enable interpretation of data. Scientists are harnessing these technologies – from robotics and sensing to modelling, imaging and AI – to discover and innovate faster and to guide decisions that ultimately reduce carbon emissions and other environmental impacts.

In the near future, the world needs to continue its advancements to develop and install renewable energy sources such as wind and solar power. In the mid-term, there are exciting breakthroughs in the development of better capacity batteries to store energy and power electric vehicles. In industry and agriculture, there is huge opportunity to increase energy efficiency and therefore reduce greenhouse gas emissions. This can be in everything – from using sensors to make sure a system only operates when needed, to developing more energy efficient processes to manufacture key products like fertilisers.

Playing a key role in these scientific advancements is big data, artificial intelligence (AI) and machine learning, all of which require funding, whether that be private or public investment – and change needs to be driven by governments around the world.

Dr Deirdre Black, Head of Research and Innovation at the Royal Society of Chemistry (RSC) says there is evidence of strong public investment in R&D: "Estimates like those published by R&D World show that the total global spend by countries on R&D – around $4.3 trillion – has roughly doubled since the recession of 2008. Coupled with policy announcements that explicitly link science and innovation with prosperity, this is a strong signal that governments see R&D as key to growth.

"This intention is reflected nationally with the UK Chancellor announcing a £14.6 billion investment in R&D, which is an increase of £1.7 billion, in the 2020 UK Spending Review. That announcement included a £400 million increase for UKRI, which is about 10% for the next three years. These boosts to public funding are all part of the government's commitment to increase annual public R&D investment to £22bn by 2024/5."

Huge steps are being taken around the world to combat climate change and there are positive signs happening where it once seemed bleak. Within hours of his inauguration, President Joe Biden signed an executive order to re-join the Paris Agreement, an international treaty that has pledged to limit global warming below 2 degrees Celsius. The USA is the second largest emitter of greenhouse gases and it left the Paris Agreement during the Trump Presidency.

"In the UK, the Prime Minister announced his 10-Point Plan for a Green Revolution in November 2020 which sets out a number of green priorities linking economic, energy and environmental policy," said Dr Black. "The objective is to 'build back better' after Covid-19, support green jobs and accelerate our path to net zero."

This positivity is also reflected among private investors who support business start-ups and companies with a solution needing to scale-up. Climate Tech is seen as a growth area and with more public funding being injected into the sector – more private investors are willing to come in.

PricewaterhouseCoopers, in their report The State of Climate Change Tech 2020, stated that, in 2019, total venture capital funding increased to $16.1 billion – a more than 3750% increase since 2013. This is on the order of three times the growth rate of VC investment into AI, during a time period renowned for its uptick in AI investment. It is important to remember, though, that the tech sector is starting from a higher baseline.

"These are positive signs," said Dr Black. "Strong investment in R&D for the past decade coupled with sustainability goals being integrated into R&I policy is key for science and technology targeting sustainability goals. We're also seeing corporate strategies aligned with sustainability goals and this is being backed up by commitments from major corporates to sustainability targets. It's also encouraging to see start-up activity on the increase and private sector investment increasingly linking to sustainability.

"There are some caveats on this positivity, though. These are very big picture trends and there's lots of variability in the detail. There are issues to do with the speed and scale at which solutions will be deployed, and whether they'll take too long to make a difference to climate change mitigation and adaptation. There's also lots of uncertainty due to Covid-19."

Dr Black led the RSC's Science Horizons project in 2018, which explored the major trends, barriers and enablers for scientific research and development in the next 10-15 years. The project engaged with more than 750 leading scientists worldwide through interviews, workshops and a survey.

It found that researchers expect that the solutions to major societal challenges – from environment and energy to human health and agriculture – will be underpinned by chemical sciences. 99% of researchers stated that their work

had potential application in at least one global challenge area.

It was identified in the project that multiple new tools and frontier techniques have been developed and that these are transforming science. And that scientists are getting better at using multiple measurement techniques to solve formidable problems by collating and merging different types of data.

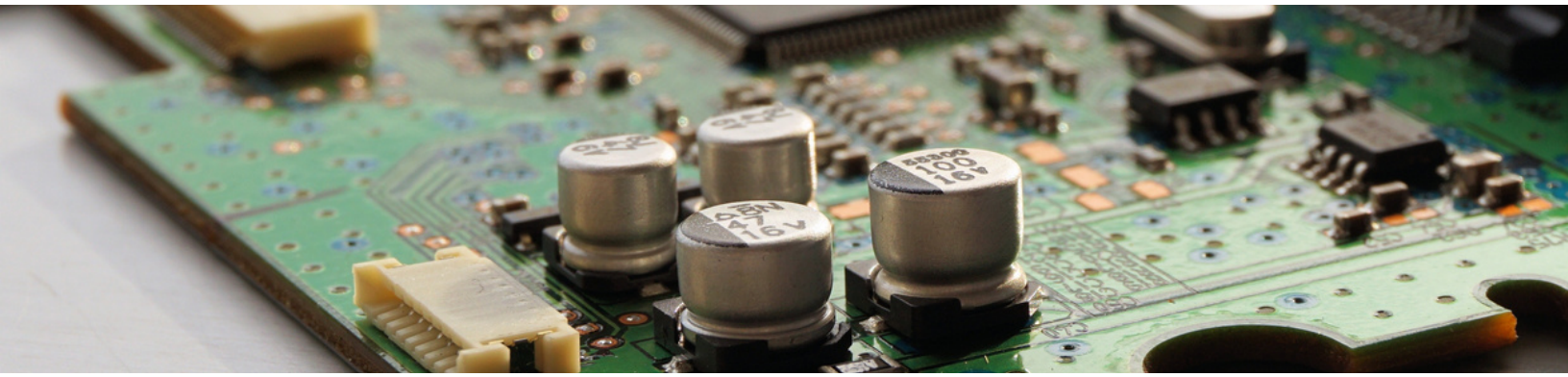
"One example of this is measurement and imaging, which has progressed hugely over the past 10 years in ways that many experts could never have predicted," said Dr Black.

"These new techniques have been applied to all kinds of research including many relevant for sustainability. For example, researchers developing catalysts for applications like carbon capture or synthetic fuel production can now study the catalytic system while it is operating. This allows them to see how the catalyst changes in real time and to correlate structural changes with those in the product distribution.

Another example is in-operando measurements of batteries. There's a massive global effort to find next generation batteries to power electric vehicles and enable grid storage. Scientists are now able to use NMR techniques to study the behaviour of the battery, or components within it, over a full charging and discharging cycle.

Sensing, visualisation and modelling is also another suite of techniques offering huge benefits by enabling decision-making on multiple scales for sustainability.

This ranges from personal decisions like deciding to change your consumption or exercise habits through to systemic decisions by governments to develop and enforce environmental regulations."



Partnership projects using sensors and modelling are helping to raise public awareness by revealing the environmental and health impacts of invisible pollution such as air quality, by producing graphics that have been widely shared in the media.

Dr Black said: "Breathe London is an international project working with Google Street View to use new lower cost chemical sensors and new modelling techniques in order to get a much more localised picture of pollution in cities, and also how that changes over time.

"Another example is a recent study published by the Columbia School of Public Health, showing arsenic concentrations in the water supply in different countries across every US state. Interactive maps showing simulations of plastic flows in the ocean were published by newspapers and these were important in raising public concern about the issue following David Attenborough's Blue Planet series."

In industry, sensors are being used to monitor and minimise energy consumption and waste.

Meanwhile, in agriculture there are huge opportunities to reduce water consumption, increase agricultural yields, reduce food waste and optimise the amount of pesticide and fertiliser used in food production.

"There's still a lot of exciting work for scientists and engineers to do to push the performance if measurement and sensing systems even further," said Dr Black.

"For example, developing sensors that are smaller, portable, robust, durable and cheaper is important now, and also looking at the extent to which it's possible to automate aspects of sensing and measurement."

Dr Black adds that finding new molecules and materials is key for many areas of sustainability. Often researchers are working towards a particular application and operating within certain boundaries or constraints. For example, in drug discovery researchers might be working to discover molecules that interact with a biological target in a desired way, while also having minimal side effects, being low cost, using sustainable resources and creating minimal wastage.

"For example, in photovoltaics, researchers are generally looking for materials with high efficiency in terms of solar energy conversion. Thinking ahead to large-scale production, it's important that the materials do not contain rare earth elements like indium. They also want to ensure that devices will work in real world conditions, for example that materials won't crumble in a humid environment or degrade in locations with high solar energy intensity. Ideally, materials should last for as long as possible and the whole device should be recyclable."

"Data and digital technologies will transform molecular and materials discovery. They will increase the speed, reproducibility and, in some cases, safety of each of the steps in a typical 'design-make-measure-analyse' sequence, as well as enable new kinds of connections between these steps," states Dr Black. "Of course, one question in all of this is about people. The unequivocal message we heard in our Digital Futures project is that we will always need human scientists and that these digital technologies are our tools that enable human scientists to go faster in discovering new patterns and structures.

"It's tremendously exciting because, I think, it will enable human beings to think at a higher level to frame higher level questions and to take on much bigger challenges."

**Making sensible and sustainable steps towards a zero emissions future**

While the promise of tackling climate change with novel technologies is grabbing headlines, there is a real risk that they may not be ready in time to help meet the 2050 zero emissions target. Some may even be a step backwards.

UK FIRES is a collaboration between the universities of Cambridge, Oxford, Nottingham, Bath, Strathclyde and Imperial College London that is calling for government and industry leaders to focus on the technologies available today in order to meet future targets. It argues that tech still in development is yet to be proven at a meaningful scale and may simply not make the necessary impact in time.

Dr Rick Lupton, Lecturer in Mechanical Engineering at the University of Bath is a Co-Investigator at UK FIRES and an author on the Absolute Zero report that has stressed it's important not to rely on breakthrough technologies to deliver net-zero emissions.

"We don't have much time to make the changes needed for zero emissions in 2050, and even less for the ambitious reductions by 2030 the government has rightly recently announced," Dr Lupton said. "That means we need to focus on deploying the technologies we already have. New technology like hydrogen-powered planes could play an important role in the future, and we should keep developing it. But we need to recognise that it probably won't be ready for everyone to use in time for meeting these short-term targets."

Dr Lupton says we need to take a broader view to tackle carbon emissions when it comes to innovation. He said: "Innovation doesn't just mean inventing new materials and products. It's also about innovation in the way that we design things so that they use less material, and innovation in the way we use products so we need fewer of them and consume less energy."

Data has a fundamental role to play in monitoring environmental impacts. Dr Lupton explained: "We talk about the lifecycle of a product. This means thinking about where the raw materials come from, manufacturing, distribution, use and disposal. Using data from across the lifecycle means we can focus on the most significant problems, and make sure changes in one area don't make things worse in another.

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Dr Rick Lupton

"It's important to look at the whole system at once," he said. "That means not just looking at one problem and improving what you're doing in isolation, but also looking at the impact that it has elsewhere.

"So, if you're talking about sustainable construction, building with timber will probably come up as a solution for reducing carbon emissions. If you look at one building at a time, then that seems great. But if you look at all the buildings in the whole system, then you realise that maybe there's a problem with that because we don't have unlimited forests."

Dr Lupton is leading the UK FIRES theme on data and environmental impacts. This includes a major project to map the whole UK production system with the aim of seeing where raw materials come from, which sectors they go through and what products they eventually end up in.

He explained: “Economists keep track of the economy – how money moves between sectors – and we're doing it from a technical point of view, so we can see where metal is being used and how efficiently.

“This will allow us to see where industry needs to come up with new ways of making things that reduces their scrap, and how they can use the technology we already have to create better operating processes.”

The result will be a freely available open data source for the industrial supply chain including details of the mining and metals sector, steel manufacturers, car manufacturers and construction industry, and how these sectors connect to the rest of the economy.

“Ultimately we want to get the message to individuals, either in their home life or in their professional life, to highlight the ways in which people have responsibility or control over some of the emissions caused in the UK production system.”

Dr Will Hawkins, a Lecturer in Architecture and Civil Engineering at the University of Bath, is also working with UK FIRES to encourage the use of existing technology to address climate change sooner. He said: “The big premise behind our work is about dispelling the myth of techno optimism around carbon capture and storage. It's damaging because everyone can use it as an excuse to continue business-as-usual, alongside carbon offsetting.

“It’s possible to read lots of exciting news about carbon capture and storage, because much of the research has been funded by the oil and gas industry. There are vested interests, and this happens in construction as well.”

Having said that, Dr Hawkins has seen changes in the construction industry in the past few years that demonstrate a move towards greener practices.

“Architecture and design have traditionally celebrated flashy, iconic projects,” he said. “But this year, The Pritzker Architecture Prize has gone to an architectural firm that reuses existing structures and basically does as little as possible.

“One of the things that we're really trying to push in the industry is that we should prioritise reusing things rather than making something new. If we avoid having to demolish a building and rebuild something new, then we save a lot of material. Even in the last four or five years there's been a dramatic turnaround in construction with people really starting to worry much more about embodied carbon materials and carbon footprints. A cultural shift is happening.”

So, what actions should the construction industry be taking to become carbon zero by 2050?

“If anything, the first decade or so is going to be relatively easy because there's plenty of low hanging fruit when it comes to building structures,” said Dr Hawkins. “Even without any new technology, or even new materials, you can change a few things in the way that your building is designed to cut out a lot of material.

“For decades, material has been comparatively cheap compared to labour and construction time, so the priority has been speed and risk-avoidance, and this promotes designs which are simple and quick to build. This has come at the expense of inefficient use of material. Small changes could save a lot of carbon without any new technology.

“It’s possible using today’s technologies to halve the embodied carbon of a new building without much impact on cost or functionality, just by making informed design decisions,” he explained. “The difficulty is going to come when trying to just drive that down to zero. And the big issue there is concrete, because it's very difficult to make concrete at scale without emitting some carbon, and it will be for the foreseeable future, unfortunately.”

Concrete is the second largest source of industrial CO2 emissions after steel, so it is an obvious target for research into reducing carbon emissions during the production process. However, experiments with zero carbon concrete have shown that it cannot be made at scale and still has to rely on the by-products of coal-fired power stations, which will soon be a thing of the past.

**Concrete is the second largest source of industrial CO2 emissions after steel**

"There's a lot of very misleading information about zero carbon concrete," added Dr Hawkins. "But digging a little deeper reveals fundamental flaws in many technologies sometimes hailed as game changers by the industry and the press.

"3D printed concrete is also often misleadingly portrayed as sustainable, but the cementitious material which can be printed has a much higher embodied carbon than regular concrete, usually offsetting any savings made through having a more efficient shape. It's a fascinating technical challenge, and engineers are often drawn to these, but just because we can do something doesn't necessarily mean we should.

"Exploratory research is vital, but we always need to keep the bigger picture in mind. That means using data to steer us towards pragmatic and effective solutions, and this is something that UK FIRES has captured very succinctly," said Dr Hawkins.

**Understanding how behaviour can be targeted to tackle climate change**

While researchers and industry work on science and technology solutions to bring down carbon emissions, convincing the wider population that they also need to play their part is a critical challenge for policymakers. Lifestyle changes will be essential between now and 2050, but habits are hard to break.

Research has shown that people often need support and incentives to change deep seated behaviours, even when data makes them aware that doing nothing is adding to the climate crisis.

Professor Lorraine Whitmarsh of the Centre for Climate Change and Social Transformations at the University of Bath, said: "We need a really radical transformation of society in order to cut our emissions. Work by climate change advisors to the UK government, shows that the majority of what we need to do to reach our net zero targets requires at least some degree of behaviour change."

The key behaviours that will make the most impact are getting people to move towards plant-based diets, significantly reducing their material and energy consumption, and changing their travel behaviours, alongside shifting to lower carbon technologies.

Professor Whitmarsh says most people agree the environment is important, but this may not be enough to make them change their behaviour. This is why the Centre's work is also looking at the additional lifestyle benefits of greener living, like wellbeing.

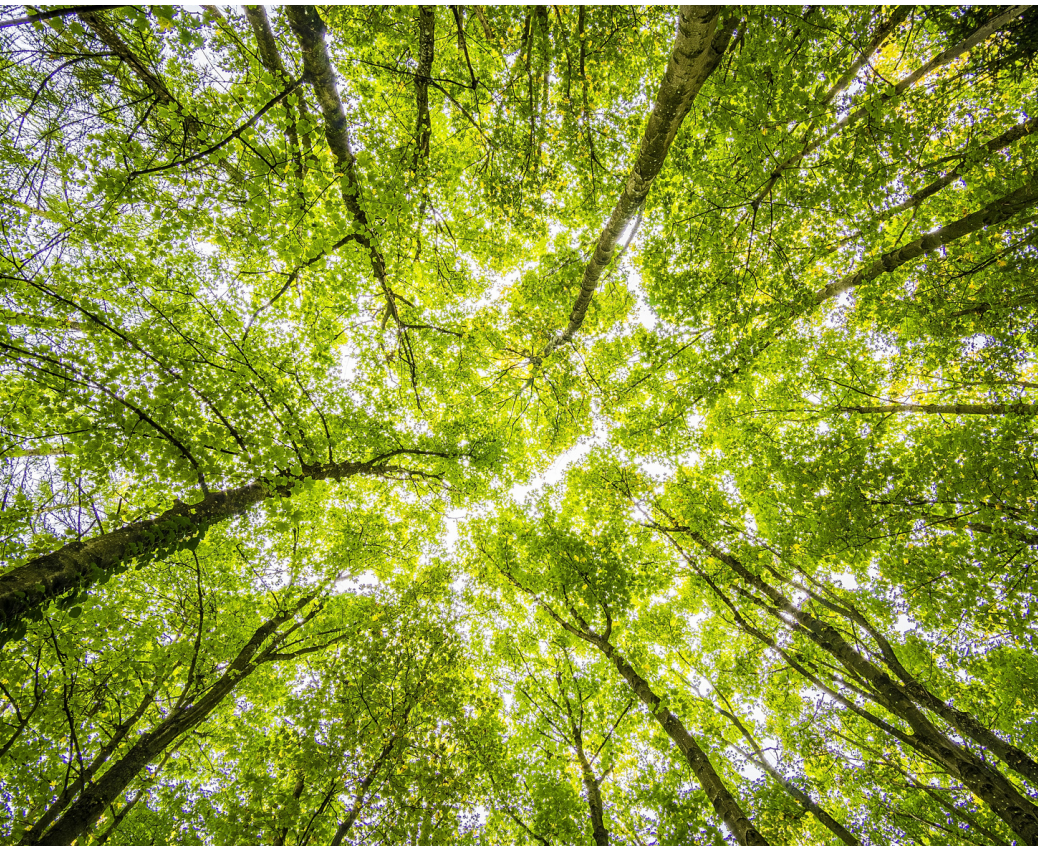
"Everybody is concerned about wellbeing but not everybody is concerned about the environment," explains Professor Whitmarsh. "The more we can highlight these co-benefits, the broader the appeal of tackling climate change will become.

"When we measure people's wellbeing – whether they're stress free and have positive emotions – what you can see is that as income rises, people's levels of happiness start to level out at a certain point."

Research has found that once people earn about $75,000 a year – meeting their basic needs – income plays less of a role in their overall wellbeing. This means becoming richer does not make you happier.

"This has been established across a number of different studies and different types of data," says Professor Whitmarsh. "Having wealth and stuff doesn't satisfy our psychological needs. We also need to feel that we're good at something, that we have a sense of achievement, freedom and good social relationships. Being happy doesn't rely on buying stuff."

The Centre also conducted a study across seven diverse countries



**Research has shown that people with green lifestyles tend to have higher wellbeing**

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Prof. Lorraine Whitmarsh

including Brazil, China, Denmark and the UK and found that taking green action had a positive effect on people's wellbeing by giving them a sense fulfilment.

"People with green lifestyles tend to have higher wellbeing. So, what we're trying to say is that consumption will not make you happy, but it'll damage the climate. Protecting the environment will make you happier," added Professor Whitmarsh.

In 2020, Professor Whitmarsh helped set up the Climate Assembly. It was the first UK citizens assembly of its kind with the purpose to discuss climate change policies and make recommendations to policymakers on how the UK should reach its target of net zero emissions by 2050.

Over six weekends between January and May 2020, the 108 Assembly members questioned experts, discussed different options for reducing emissions and came up with more than 50 recommendations for government.

On the topic of material consumption there was significant support for technological change, using more renewables and being much more efficient in remanufacturing. People would not need to change their personal behaviour much in order for this to happen.

Another scenario considered by the Assembly was creating a sharing economy where people repaired things, bought second-hand and re-gifted items. This was also positively received.

However, when it came to reducing consumption altogether there was less support. Professor Whitmarsh said: "This would potentially be quite a radical change to the economy. People would maybe work fewer hours and have lower income so that they wouldn't have the means to buy so much stuff. But what they would have is more time to grow their own food and share things with neighbours.

"This radical vision of a less materialistic society created quite mixed views. People were worried that it would be politically unacceptable; that if we were moving towards something like universal basic income it would be a licence for people not to work and just be lazy.

"So, there were some quite fundamental concerns about some of the policies we were presenting to the Assembly. It gave us insight into the sorts of policies that the public favour and for what reasons. People could see that the middle ground, the sharing economy, could bring social benefits that might provide ways in which communities could be strengthened as well as cutting emissions."

So, how can policymakers actually get people to change their behaviour?

The United Nations Environment Programme's Emissions Gap Report maps all the factors that need to be taken into account when we want to change people's lifestyles, including structural measures like legal frameworks, economic incentive supply chains and physical infrastructure, informing consumers in order to change behaviour such as labelling the carbon footprint of products, and challenging social norms around consumerism.

Professor Whitmarsh added: "Breaking out of social norms is the most difficult to achieve, as was demonstrated by the insights from the Climate Assembly.

"Habits are a really strong barrier to getting people to change their behaviour. But if we time our interventions with when people's habits are disrupted, we know that we can more effectively promote sustainable behaviours."

The impact of COVID-19 may have created an opportunity to change these social norms.

Data collected by the Centre for Climate Change and Social Transformations has found that climate change concern hasn't been dented by the pandemic. In fact, the sense of urgency around the climate has increased since August 2019.

Added to this is a dramatic change in lifestyle that has been forced upon the population.

Professor Whitmarsh said: "We know that COVID has disrupted habits profoundly and broadly speaking, in a relatively low carbon direction. So, what we need to do now is lock these emerging habits in for the longer term with appropriate infrastructure and other sorts of policy interventions."


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**Summary**

For the past 51 years, the human race has been demanding more of the planet's natural resources than it can provide. This has resulted in a climate change crisis that it will be hard to reverse without action within the next 19 years.

Policymakers must tackle all of the Sustainable Development Goals (SDGs) developed by United Nations in order to have an overall impact. Artificial Intelligence (AI) will play a vital role in bringing about the necessary research and development to make this happen.

The good news is that investment in R&D is growing rapidly. Scientists say they are working towards the SDGs using AI, machine learning and new tools such as sensors, data imaging and modelling to guide decision-making. Robots and automated labs are also contributing to speed-up research and discoveries.

However, new innovation and discoveries are not necessarily going to give us the short and long-term solutions needed to meet the 2050 emission target. In fact, spending time on blue sky thinking could be taking focus away from technologies and processes that can be adapted to make a difference now. Reconsidering existing and old technologies may be disruptive in the short term, but they could prove more reliable.

An area where it is clear rapid change will not be so palatable, is in individuals' behaviour. People are creatures of habit, and while the global population has a broad awareness of climate change, they need additional incentives to make a significantly positive contribution to the zero emissions goal by 2050. However, COVID-19 may have changed lifestyles enough to create an opportunity to accelerate change.

The appropriate use of data from understanding behaviours, assessing environmental impact, justifying sustainable cultures in global companies and optimising sustainable manufacturing processes shows us what is happening at scale – across the entire system. Insights will come from smarter ways of using the data, such as AI, machine learning and data science, as well as new data becoming available from increased digitisation.

Much of the potential for solutions using existing technologies will arise from better application of data, for example ride-sharing apps, enhanced logistics to reduce transport fuel consumption and improved heating controls.

Finally, we need to use data to learn more about what is happening as we develop these new and existing technologies in order to ensure a greener future.

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