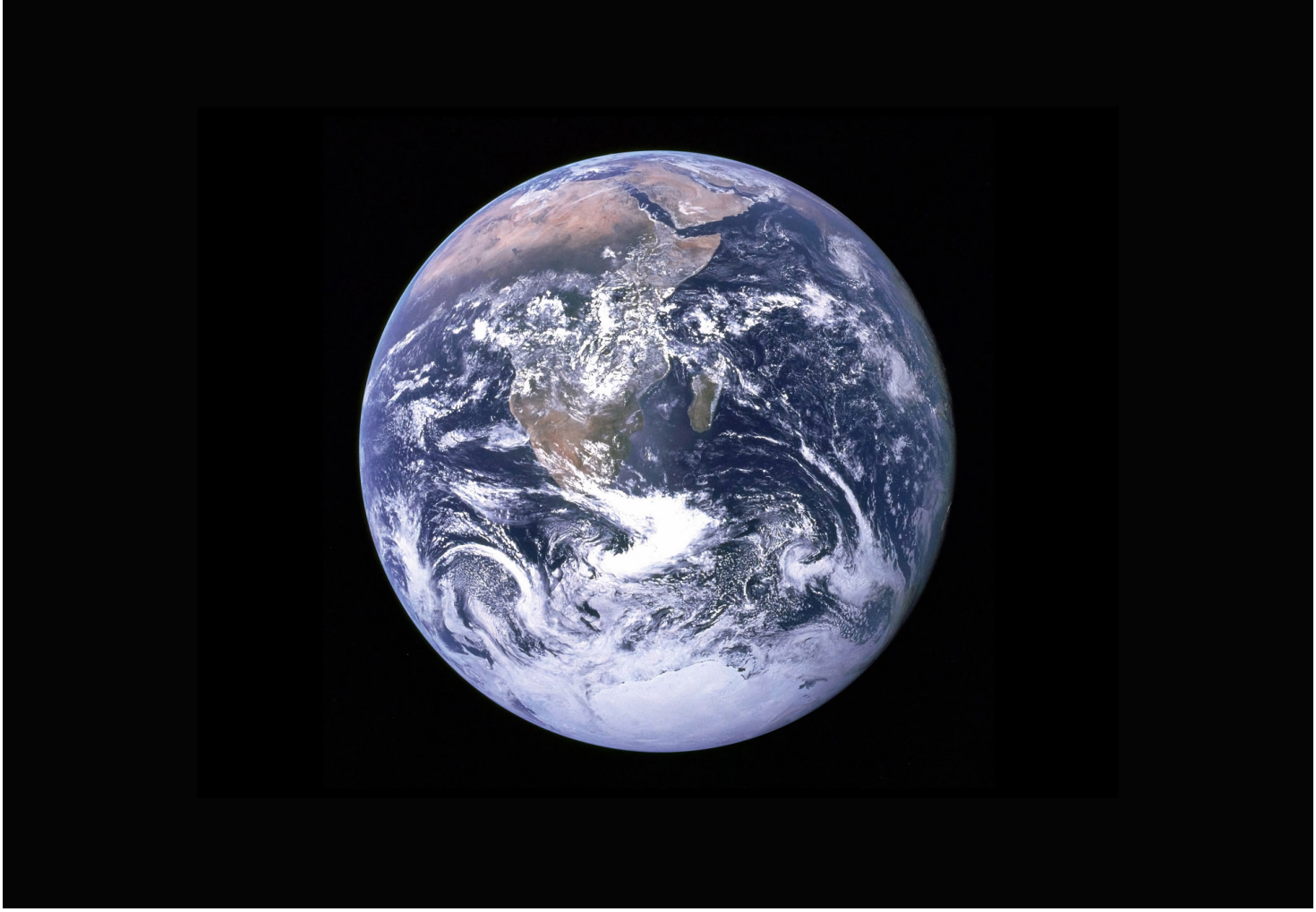

Race to Zero - global views on the highest-stake race

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.

The 2021 event, entitled 'Race to Zero', took place online over three days exploring international perspectives on the 2050 net zero emission target. With COP26 on the horizon, our invited speakers from government agencies and businesses in the UK, US and Europe shared their diverse views and reflections on the Race to Zero challenge.

International perspectives on the Race to Zero

Shortly, international leaders will meet at COP26 to accelerate their plans for net zero carbon emissions by 2050. It's an ambitious goal that brings with it challenges for policymakers, researchers and innovators.

However, to suggest that it is politicians leading the change towards a more sustainable future would be a disservice to a world-wide coalition of leading net zero initiatives.

The Race to Zero is a global campaign that has now harnessed the support of 733 cities, 31 regions, 3,067 businesses, 173 of the biggest investors, and 622 Higher Education Institutions. All are committed to creating a healthy, resilient economy with the aim of achieving net zero carbon emissions by the second half of the century.

It will be a gruelling race, but one where everyone is a winner. Supporters recognise that a de-carbonised economy goes hand in hand with recovery from the COVID-19 crisis to mitigate future climate change threats, create decent jobs and unlock sustainable growth.

In the net zero race, the key actors come from the UK, US and Europe, covering nearly 25% global CO2 emissions and more than 50% GDP. Their impact will be significant and in the build-up to COP26 they want to send governments a resounding message that they are united in meeting the Paris Agreement targets, including limiting global heating to 1.5˚C.

Californian perspectives on a successful circular economy

The effects of climate change have never been more apparent in California, where significant weather events such as wildfires and storms are on the increase.

"Climate change is here, we all know it," says **Meredith Williams, Director, Department of Toxic Substances Control in California.**

"In California, that reality gets stronger and stronger every year. This year we were stunned when a warm-up event in the Spring melted a significant amount of the snowfall. That snowfall is our water supply for the dry months and the loss of that stunned everyone. It was different to any modelling we'd used in the past and was another indicator of how dramatically things are changing."

It's this very real impact of climate change that has sparked Meredith Williams' interest in the benefits of Europe's circular economy action plan. Her colleagues in California are adopting their own frameworks for creating, using and preserving new materials as part of a more sustainable economy.

She explains: "The EU's Circular Economy Resolution pointed to a GDP increase of 0.5% and the creation of 700,000 jobs by 2050. That is tremendous possibility for disruption, and we know this is already driving disinvestment in fossil fuels."

BP has announced that its operations will have reached their peak by 2025, signalling that fossil fuel production is coming to an end.

However, this does not mean the demise of oil giants altogether. Companies like Aramco are building large facilities in Yanbu, Saudi Arabia. In Shenzhen, China, two facilities are coming online with double the capacity.

But why build more facilities now?

"The future of oil is in chemicals," explains Meredith Williams. "Their new refineries aren't just bigger, they're more versatile. As well as refining oil and fuel, they are capable of petrochemical manufacturing."

It's expected that the consumption of chemicals will grow by more than 300% by 2050 - from about $450 per capita in 2010 to more than $1,600.

Oil companies are gearing up to meet this demand while scaling back their fossil fuel production. Meredith Williams welcomes the environmental gains this will bring but highlights the risk of creating more new chemicals without considering how their toxicity will impact the circular economy.

"The circular economy will not work if we don't address toxic chemicals in the products that we use," she says. "Under the Lautenberg Chemical Safety Act the US Environmental Protection Agency (EPA) gathered data on how many chemicals are actually in commerce. Whereas before people had estimated 88,000 chemicals in commerce, that estimate has fallen significantly to something like 42,000 chemicals. Despite that, the new chemical review program within US EPA is under tremendous pressure to work faster and to clear new chemicals so that they can be introduced in commerce. New chemicals are coming onto the market all the time.

"Here in California, we are implementing our Safer Consumer Products Regulations. They're designed to incentivise the pursuit of safer alternatives so that manufacturers move away from toxic chemicals in their product formulations and product designs."

Wildfires in California are are causing the release of chemicals from the built environment

California's Safer Consumer Products Candidate Chemicals List currently contains 2,000 toxic chemicals that manufacturers should avoid due to their hazardous nature for people and/or the environment.

Meredith Williams added: "Climate change has the potential to exacerbate the impact of harmful chemicals. Humidity changes and temperature changes can have unintended consequences when it comes to chemical toxicity and chemical harm.

"The other sad truth for us in California is that the wildfires are creating additional problems in that they are causing the release of chemicals from the built environment. It's possible that the debris that's left behind can release chemicals during rainfall events and have wildlife or aquatic resource impacts."

Another cause for concern in California is an increase in plastic production, estimated at more than 40% in the next decade, regardless of the development of bioplastics.

"From a holistic perspective a lot of people have been very optimistic about the potential for bioplastics," said Meredith Williams. "But even that's not as simple as we might have hoped. For instance, not all bio-based plastics are biodegradable, and a closer look shows that there are other reasons not to oversimplify the benefits of bioplastics."

In 2020, Zimmerman et al ('What are the drivers of microplastic toxicity? Comparing the toxicity of plastic chemicals and particles to Daphnia magna', Environmental Pollution, vol. 267) highlighted that microplastics, whether conventional or biodegradable, can be harmful in the environment because of the culmination of their chemical properties and their physical attributes.

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Understanding this cumulative impact is key to making the circular economy viable.

"Taking on the whole class of chemicals is the way to avoid a whack-a-mole situation that could be endless," explains Meredith Williams. "We've made a very deliberate approach as part of the Safer Consumer Products framework to ask manufacturers to take an exhaustive look at the unintended consequences of switching over to possible alternatives.

"This makes it a slow process and there are limitations. One fundamental regulatory challenge we have is that plastics, for instance, are not considered a chemical and therefore it makes it harder to take action."

A positive step forward is that scientists are starting to work across frameworks to look at chemicals in a new way.

"We're seeing toxicology work done at a much higher rate based on computational toxicology and high throughput methods. We're now able to look at the chemistry at the mechanistic level and tie that to the toxicology at the cellular level. This is an exciting development that helps us look at chemicals in a new way.

"If we look toward the future and towards solutions, green chemistry holds a lot of promise. We're pleased by the products and chemicals that Safer Consumer Products has highlighted and begun to regulate."

Meredith Williams concludes: "There's still room for more innovation in the green chemistry space. I encourage everyone working in the field of sustainability to speak to people working in slightly different spaces to yours and get their take on these issues. See where the linkages are and explore them. Break down some of the barriers around the jargon, the language you use. Prioritise research that looks at things in a holistic way."

Europe's response to the climate challenge

In 2019 the EU launched its European Green Deal road map with a raft of initiatives to help it achieve net zero by 2050. Most recently, in July 2021, it adopted Fit for 55. This is an intermediary step to achieve a 55% carbon reduction by 2030 with targets for increasing energy efficiency, the production of renewable energy sources, and supporting sustainable mobility and transport.

All of this comes with a massive financial commitment to tackle climate change across Europe. In 2020, the EU agreed a multi annual financial framework of €1,100 billion for 2021 to 2027 and the

NextGeneration EU recovery plan of €750 billion. 30% of these funds will be spent on fighting climate change with a focus on building efficiency, clean energy, sustainable transport, a circular economy and ecosystem restoration.

Alongside this investment there is the €95.5 billion Horizon Europe research programme. At least 35% of its funding will be dedicated to finding new solutions for implementing the European Green Deal.

The EU's innovation fund – one of the world's largest funding programmes for the demonstration of innovative low-carbon technology – has a budget of €20 billion for the next 10 years. It will bring to market industrial solutions to decarbonise Europe.

The ultimate goal is to help businesses to invest in clean energy and help the industry associated with this. There will be a focus on low-carbon technologies and processes in energy-intensive industries, including products substituting carbon-intensive ones. The road map extends to carbon capture and utilisation, construction and the operation of carbon capture and storage, innovative renewable energy generation and energy storage.

The EU expects its efforts to boost economic growth by creating local, future-proof jobs that will reinforce Europe's technological leadership on a global scale.

Transformation is the key to UK's net zero target

In 2008 the UK passed the Climate Change Act, which was updated in 2019 to commit to net zero emissions of greenhouse gases – comparable to the 1990 levels – by 2050. Interim targets are set out in Carbon Budgets every five years. The most recent, Carbon Budget 6, has committed to reduce the country's greenhouse gas emissions by 78% by the mid-2030s.

Paul Monks, Chief Scientific Advisor to the Department for Business, Energy and Industrial Strategy, admits this this is no small task.

"It's really very ambitious and requires a countrywide transformation. What you can clearly see as part of Carbon Budget 6 is a huge expansion of low-carbon energy, a real need to take up low-carbon solutions, drive much less carbon-intensive activities as well as thinking about emissions in agriculture and the land as well. I'm also beginning to think about the role for negative emissions, which is often called greenhouse gas removal technologies, as well as we move toward the goal of net zero by 2050."

The UK government has published a whole series of strategies including the Ten-Point Plan for a Green Industrial Revolution, which came out about November 2020, and an energy white paper in early 2021.

"Both really point in a powerful way towards a 2030 goal," explains Paul Monks. "We've got to accelerate our efforts. The problem with net zero is that it does not just require a technocratic change, it requires behaviour change as well.

"Just to look at the sectors that are emitting the greenhouse gases: transport, business, power, land use, buildings and technologies. What you begin to realise is to meet net zero we're going to require an economy-wide transformation to change the power, energy and materials we use in all its forms throughout our systems.

"We won't achieve this net zero transition by introducing new technologies alone. The Climate Change Committee showed well over 50% of the changes required are a combination of technology and behavioural change. They include things like healthier diets, reducing growth in aviation demand, choosing products that last longer and recycling. Therefore, the circular economy really comes into its own because what we actually want to do is reuse more of the stuff that we've already got out of the ground. That can be much more energy efficient."

He adds: “Product designers also have their part to play. Commodities need to be designed to last longer and be easier to recycle. In the energy sector, electricity generation will need to double to heat people’s homes and power transport going forward. This energy generation needs to be decarbonised. Helpfully there have already been efficiency gains in the past decade. Coal usage has been replaced with wind and renewable energy, as well as gas. New technology is key to continuing to deliver this change.

“Things like carbon capture utilisation and storage, biomass, as well as the negative emission technologies and greenhouse gas removal technologies are going to allow us to do that.”

One of the next pieces of policy to support the UK’s climate change agenda will be a Hydrogen Strategy, which Paul Monks says will be vital to meet net zero.

“Science is going to be at the fore of COP26 this autumn,” he concludes. “We’ve got to work more closely on this vision for net zero, work together closely on our science and innovation in order to think about how the international community can help us deliver the innovation and engineering, in particular that we’re going to need for the race to net zero.”

Europe’s chemical industry embraces green innovation

As part of the Race to Zero, the European chemical industry is taking a lead in developing safe and ‘sustainable by design solutions’. Its Chemical Industry Council (Cefic) brings together European chemical companies and policymakers to find common approaches to the economy, climate change and the circular economy.

Marco Mensink, Cefic’s Director General, says: “We’re at that moment where the companies of the future will be defined. We’ll see a lot of changes going through the chemical industry for which we need a lot of new ideas, new science, new solutions. We know that if you are actually the one now inventing direct air capture or artificial photosynthesis or biodegradable polymers, you’ll be among the winners of the next century. At Cefic, we looked to the smartest people we could find, and we said, ‘how will we do it?’.”

To develop their mid-century vision report, 'Molecule Managers', Cefic took a deep dive into the geopolitics of its industry, sizing up its global market competitors and trade partners against the net zero challenges. Two of Europe’s biggest chemical trade partners, the US and China, are growing to meet their own internal demand for chemicals. The US in particular has seen tremendous growth through shale gas, which has a low cost base. Meanwhile Europe focuses on more advanced chemistry. This raises questions about how Europe can maintain its lead and survive as the global chemistry industry evolves. Its priorities were coordinating its approach to the circular economy, recycling, taking care of the legacy of chemicals and the changing nature of international trade. It was also important that Europe remained competitive while addressing net zero.

“We believe first and foremost that the circular economy is a massive opportunity,” says Marco Mensink. “The main reason is very geopolitical. Europe has a stable population in cities and is organised to collect recyclables. Chemicals from waste, chemical recycling, recycling in general can be a massive game changer and an asset for industry. The question is, can we optimise these processes - the pyrolysis process and other processes - to reuse chemicals in an efficient and climate efficient way?

“The second reason why the circular economy presents an opportunity is that the European chemical industry is quite close to each other. This means it is possible to transfer the waste gas and the carbon monoxide from a steel plant to a chemical plant, developing the hydrogen economy as a feedstock for the chemical industry. That is where we see that being in this geopolitical

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Professor Matthew Davidson

economical industry landscape is the solution for us.

"And if you look at it in energy terms, industry could be the battery of the energy grid, which currently it's not. Industry can be the hubs on the hydrogen network. Industry can balance renewables much more than today, turn them into power, enabling many more renewables to come onto the grid."

Marco Mensink says that becoming climate neutral by 2050 is one of the biggest challenges for the European chemical industry. While there are some short term wins to be made, in the longer-term breakthrough technology will be the answer. Namely, electrification and hydrogen but also an increase of use of bio-based feedstocks.

"That's where Cefic has followed up The Molecule Managers with the design of a new forecasting tool: IC2050," he explains. "This will show us when decarbonisation technologies will become available and how that will impact the pathway we're going through as an industry to get to climate neutrality."

All of this requires financial backing. Finding investment to deliver net zero is another challenge for Cefic. Meanwhile, its sustainable chemistry panel, SusChem, is working on what constitutes a safe and sustainable by design chemical, much like its counterparts in California.

"The criteria are being developed to define what exactly that is. What is the next generation of molecules for aviation, for automotive, for renewables? And what is safe and sustainable by design for cosmetics, for fragrances, for paints? How do you design molecules that are easy to recycle instead of hard to recycle?

"It is a very, very interesting moment to be in the industry," concludes Marco Mensink. "The production of chemicals is likely going to double in the next decades worldwide. As the European chemical industry, we'd like to take as big a share of that market as we can get."

Global ambitions for net zero

While there are a range of motivating factors driving the UK, US and Europe's net zero ambitions – from a desire for a viable circular economy in California to future-proofing the chemical industry in Europe – the strongest narrative to come out of the CSCT's showcase was collaboration.

Governments, industry and scientists must work even more closely in the Race to Zero; working across specialisms to deliver innovative sustainable technologies and at the same time realising behaviour change in the wider population.

The pandemic has also presented a new angle: to build back better and greener. Global leaders will attend COP26 in Glasgow to set out their plans for recovery while enhancing their commitment to Paris Agreement and the UN Framework Convention on Climate Change.

"This is the seminal time for the global community to come together and address the climate emergency," says **Professor Matthew Davidson, Co-director of the Centre for Sustainable and Circular Technologies (CSCT) at the University of Bath.**

It was fascinating to get insights from the influential policymakers, from the US, Europe and the UK. Although the finer points of strategy and instruments to be deployed varied across jurisdictions, there was consensus that transformative transitions to a low carbon economy must accelerate.

"The development of new technologies is vital for sustainable and greener alternatives to current chemicals and low carbon processes for energy intensive industries. There's also great

The pandemic has presented a new angle: to build back better and greener.

opportunities in ergonomic solutions and carbon capture utilisation technologies.

He adds: “Achieving net zero will not happen without new science and the people committed to delivering that new science.

“At the CSCT we have a key role to play: in training scientists and engineers who will be tomorrow's leaders in growing a green and sustainable chemical industry; in delivering fundamental research, new ideas, new science and new technologies to work in combination with a broad range of scientists, technologists, policymakers and behavioural experts to deliver the necessary transformations; and to work with industry to translate science and engineering to commercial opportunities for low carbon circular businesses."

Professor Matthew Davidson concludes: “COP26 will bring together political leaders from across the globe. This will provide extra impetus for the important work that our researchers are doing in collaboration with industry and government. But we can't wait for policy to be the driver.

"Winning the Race to Zero will partly be driven by global consensus in policy and political instruments, but it also requires major scientific breakthroughs to give our leaders the necessary options. It’s a challenging but exciting time to be contributing to something so vital for the future sustainability and prosperity of the planet.”

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