The All-Party Parliamentary Group for Engineering

4 February 2025

Engineering for Net Zero

Discussion over lunch in the House of Lords

Chair – Professor the Lord Mair CBE

Speakers:

- Professor Paul Shearing, Professor of Sustainable Energy Engineering, Director of The ZERO Institute, University of Oxford
- Dr Kristen MacAskill, Associate Professor in Engineering, Environment and Sustainable Development, University of Cambridge
- Professor Andy Sloan Managing Director and Senior Vice-President, COWI UK

Lord Mair began the meeting by thanking everyone for attending and introduced the distinguished speakers, who each then gave a short speech. Following this, the audience asked questions.

Professor Paul Shearing

Paul Shearing is Professor of Sustainable Energy Engineering at the Department of Engineering Science and Director of the Zero-carbon Energy Research (ZERO) Institute at Oxford University. This is a research institute that brings together leading academics from across disciplines to enhance the University of Oxford's reputation as a centre for leadership on zero-carbon energy systems. As Director of the Institute, Paul works to shape ZERO's ethos, strategy, networks, research and teaching programmes. Prior to this role, Paul served as a Professor of Chemical Engineering at University College London. His research focuses on various aspects of electrochemical engineering, with a specific emphasis on studying and understanding materials for batteries, fuel cells, and other energy applications. Paul also holds the Royal Academy of Engineering Chair in Emerging Battery Technologies.

Professor Shearing highlighted the UK's significant progress toward net zero, including the recent decommissioning of the nation's last coal-burning power station. He emphasised the challenges of renewables, such as the need for energy storage and flexibility, and stressed that global collaboration is essential for decarbonising sectors like manufacturing and transport. Reflecting on his own journey into engineering, he encouraged the audience to pursue careers in engineering, stressing the vital role engineers will play in addressing climate change and securing a sustainable energy future.

Dr Kristen MacAskill

Dr Kristen MacAskill is an Associate Professor in Engineering, Environment and Sustainable Development at the Department of Engineering, University of Cambridge. Throughout her career, Kristen's interests have centred on themes of disaster risk management, post-disaster reconstruction, sustainable development of cities and resilience of infrastructure systems. She has four engineering-based degrees and before returning to a role in academia, worked for several years as a consulting engineer in both the water and transport sectors. She now specialises in systems analysis to advance approaches for managing risk and system resilience. The intention of

Kristen's research is to improve the ability of engineers and other key decision-makers to deliver reconstruction projects that address both immediate and long-term infrastructure needs.

Dr. MacAskill began by explaining the concept of net zero, describing it as the balance between greenhouse gas emissions produced and those removed from the atmosphere, either naturally or through technology. She highlighted that achieving net zero involves reducing emissions or utilising carbon capture and storage technologies, with engineers playing a key role in developing and managing the necessary infrastructure. Dr. MacAskill stressed that societal values influence which strategies are prioritised, noting that while she isn't a fan of carbon capture and storage, she is more excited by engineering solutions that work in harmony with nature. Reflecting on the history of engineering, she pointed out how past innovations often overlooked environmental and human impacts, and suggested that the future of engineering for net zero may involve solutions that are seamlessly integrated into the environment. Concluding, Dr. MacAskill emphasised that engineering decisions shape society's future, and the journey toward net zero is a long-term commitment to sustainability.

Professor Andy Sloan

Andy Sloan is Managing Director of COWI UK, one of the world's leading engineering consultancy firms. He is also a Fellow of the Royal Society of Edinburgh, a Fellow of the Institution of Civil Engineers and a Visiting Professor in the Department of Civil Engineering at Strathclyde University. Andy has over 35 years' experience working on tunnelling and cavern projects for mass transit, power, water, mining, rail and highway. He has a strong technical background and is a business leader who remains involved in the technical aspects of projects, in particular those with complex ground conditions. From 2008 to 2012 he was a member of the UK Government scientific CoRWM - the Committee of Radioactive Waste Management which provides independent scrutiny and transparent advice to the UK government on the long-term management of higher activity radioactive wastes.

Professor Sloan discussed the urgency of addressing the climate emergency, noting that young people are especially aware of the issues. He noted that net zero engineering is already here, with every branch of engineering playing a role in this. He highlighted COWI's decision to transition away from oil and gas, focusing entirely on green energy, as morally correct and beneficial for society. Professor Sloan shared a project he's involved with, the development of long-term hydroelectric pumped storage in Scotland, which will help address energy supply issues caused by fluctuating offshore wind power. He explained how the large-scale infrastructure projects, like the Coire Glas scheme, aim to store excess electricity and release it when needed. He also stressed that renewable energy projects require significant infrastructure development beyond power generation, such as improved roads, housing, and schools. Professor Sloan encouraged young people to consider the vast job opportunities in the green transition, highlighting projects in rural areas like the Shetland Islands, where new jobs will be created.

Q1. The Lord Hampton

Question: We are often told that, given the current state of the economy, we can't afford to go green and that it's much easier to continue relying on gas turbines. How do we keep the cost of green energy down?

Professor Paul Shearing: It's crucial to not only make these technologies affordable in the UK but globally, especially in developing economies. Recent research shows that the faster we transition to renewable energy, the cheaper it will become. A quick transition could save as much as $1.3 trillion globally, as it will help achieve economies of scale and lower costs. In places like Germany, solar panels are now so cheap that people are using them as fence panels. Texas, once the heart of the oil industry, is rapidly adopting renewables because it's economically beneficial. A fast transition makes sense not only from an environmental perspective but also an economic one, and it's essential for making a zero-carbon economy affordable worldwide.

Q2. Lord Mackenzie of Framwellgate

Question: What was Professor Shearing's reaction when he heard President Trump announce that the United States would withdraw from the Paris Climate Accord?

Professor Paul Shearing: The business case for the green transition remains strong. Even with setbacks like canceled wind farms in North America due to political factors, the trend of investing in offshore wind in the UK highlights the broader economic sense of renewable energy. In fact, under the first Trump administration, the growth of offshore wind and renewables was significant, proving that green energy can thrive across different political climates. From a business perspective, the renewable energy sector remains optimistic.

Q3. Marco Pereira (King's College London Mathematics School)

Question: I am interested in the hydroelectric pumped storage project Professor Sloan mentioned and specifically whether non-renewable energy is used to power this? Although this could make the project economically viable, it would actually contribute to more carbon emissions.

Professor Andy Sloan: We can't differentiate between renewable and non-renewable electricity on the grid, so we use whatever electricity is available. However, we only pump water in a pump storage scheme when there's excess electricity generated directly from offshore wind. We won't switch off turbines, but when excess renewable electricity is generated, we'll use it to pump water to the top reservoir. The goal is to move the entire grid toward renewables and reduce our reliance on gas, using renewable electricity as much as possible.

Q4. Anhad Pahwa (ACS International)

Question: What is the UK doing to ensure that less developed countries can access the same sustainable technologies we're working on. Given that the UK is responsible for only about 0.2% of global emissions, it makes sense to focus more on supporting developing countries with these technologies.

Dr Kristen MacAskill: I'm aware of a large research project, called Climate Compatible Growth, which plays into your question, though I'm not directly involved. It's a multi-million-pound project funded by the government, with several universities involved. The aim is to give developing countries analytical tools to plan a decarbonised energy future and help them transition. It's about sharing the planning capacity we have here for energy infrastructure, and even transport, to help them build their own capabilities. The project also connects academics and policymakers across those countries.

Q5. Amelie Trower (UTC Portsmouth)

Question: What are the speakers' thoughts on the switch to electric cars?

Professor Paul Shearing: The reason I got into battery technologies and now hold an engineering chair in this field is because of the electrification of road. Since then, we've worked tirelessly to improve EV batteries, leading to much greater adoption in the UK. While electric cars have become more affordable and performant, there's still work to do as the batteries need to be cheaper, last longer, and charge faster. We're researching next-gen technologies to reduce critical materials like cobalt and make batteries more sustainable. The goal is to electrify all transport, from cars to helicopters, and eventually explore even larger challenges like electrifying jumbo jets.

Q6. Dave Doogan MP

Question: When I was younger, my lecturer predicted that the person who cracked high-output portable battery technology would become incredibly wealthy. This was around the time Sony introduced lithium-ion batteries to replace nickel-cadmium. So, when talking about battery generations, are we just seeing marginal improvements in the same technology, or are we on the verge of a big breakthrough in portable power? Additionally, I would like to ask Professor Sloan, in regards to complex tunneling and civil engineering, is it fair to say that countries which don't do it often may not excel at it, while those who do it frequently become much better?

Professor Paul Shearing: In the 1990s, Sony commercialised the lithium-ion battery, replacing older technologies like nickel-cadmium and nickel-metal hydride batteries. The breakthrough came from Oxford's John

Goodenough, who discovered lithium cobalt oxide, which is still used in our mobile phones and electric vehicles today. As for the next big shift in battery technology, there are several possibilities. We could move to lithium-sulfur batteries, which could replace cobalt with cheaper materials like sulfur. Another option is sodium-ion batteries, which are cheaper and more abundant than lithium. Solid-state batteries, which replace liquid with solid materials, offer higher performance and safety. The ultimate goal, however, is to crack the use of metallic alkaline metals, like lithium, sodium, or potassium, which could create batteries with ten times the energy density, representing a massive leap forward.

Professor Andy Sloan: The UK certainly has the capability to build complex subterranean tunnels. From a civil engineering perspective, tunneling in the UK is relatively straightforward, but the challenge lies in replicating the cost structures seen in Scandinavian countries, especially when it comes to the cost-benefit analysis for smaller populations. In places like Scotland, there's debate about whether these tunnels are financially viable. However, studies from places like the Faroe Islands show that connecting islands through tunnels boosts economic activity, reduces healthcare costs, and increases quality of life. While engineering-wise we can build these tunnels, the real challenge is how to finance them and whether politicians are willing to invest in rural communities

Q7. Riley Eddiford (UTC Portsmouth)

Question: What do you think is the best current change the UK is making to address the climate crisis, and what more could the UK do in the future to combat it?

Professor Paul Shearing: The UK has made significant progress in renewable adoption, especially with the closure of our last coal power station, which is fantastic. But what's next? We need more energy storage. Solar power, for example, only works when the sun is shining, so we need batteries to store energy for when it's dark. While short-term storage solutions like batteries for electric vehicles can help, we also need to think about longer periods when renewable energy generation is low. For example, during a "wind drought" in 2008, there was a significant drop in wind power across Europe. We need resilience in a fully renewable system, which means building large-scale storage solutions. Andy and his team are working on a 30 gigawatt-hour storage system, which is ten times the size of the current largest battery in the world. We need more of these, and they need to be even bigger to ensure we have enough storage to power us through periods of low renewable generation.

Professor Andy Sloan: To deliver long-term storage, developers need clarity on the cap and floor mechanism, which ensures they're compensated fairly for holding water up in reservoirs without overcharging when generating electricity. The government has announced this mechanism, but developers need more details. Another key issue is planning permission, which is a major barrier to renewable infrastructure development in the UK. For example, when I was Chairman of the Thames Crossing project, we spent hundreds of millions on the planning process. So, planning and the cap and floor system are the critical issues we need to address.

Q8. Heer Ved (King's College London Mathematics School)

Question: I was curious about how mathematical models account for uncertainty, since many of them rely on future data that we haven't seen yet.

Professor Paul Shearing: Mathematical models deal with uncertainty well because engineering operates in the real world, which is full of uncertainties. From control systems on boats to battery management in phones and wind farms, all these systems are designed to handle some level of error. However, the bigger challenge comes with climate change. While we know the weather is changing, its exact impact is still unpredictable. The known unknowns are things we can factor in, but the real issue is the unknown unknowns or problems we don't even know we don't know yet. As climate change accelerates, our tools for handling uncertainty will definitely be tested.

Q9. Rhiannon Workman (Headington School)

Question: I have a question for Professor Sloan, but anyone can answer. You mentioned that to go green, every company and job needs to get closer to it. How do you think AI's development will impact going green, especially as many job opportunities are being replaced by AI?

Professor Andy Sloan: From my experience with emerging technologies, we tend to overestimate their short-term impact and underestimate the long-term effects. In the short term, I don't think AI will drastically affect job security. It will evolve over time, and AI is already widely used in smartphones, iPads, and computers. It's particularly useful in parametric design and sophisticated analysis, especially when handling large data sets, helping engineers create more efficient designs.

Q10. Emily Sun (St Helen's and St Katherine's)

Question: Will there be any efforts to minimise damage to wildlife habitats while constructing things like electric dams?

Professor Andy Sloan: It's crucial that we consider not just the embedded carbon in infrastructure, but also net biodiversity gain when building anything going forward. The UK is severely depleted in biodiversity, and it's not just about protecting certain species; biodiversity is vital for the country. Pump storage is different from traditional hydroelectric because it doesn't flood valleys, just pumps water up and down between two reservoirs. In the Coire Glas scheme, they're damming a quarry that's already nature-depleted, so there's minimal impact, but there's great potential to enhance habitats further down. Developers and planners must prioritise net biodiversity gain.

Professor the Lord Mair closed discussions by thanking the distinguished speakers and excellent guests, particularly for their wide-ranging questions.