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The Journal of the Parliamentary and Scientific Committee – All-Party Parliamentary Group

SCIENCE IN PARLIAMENT sip

AUTUMN 2021

Event information on page 18

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Stephen Metcalfe MP
Chairman, Parliamentary & Scientific Committee (All-Party Parliamentary Group)

Welcome to the Autumn edition of the journal. I hope you had an enjoyable Summer.

In addition to our usual features we have 12 excellent articles dealing with a wide range of STEM topics, which I hope you enjoy reading.

I am delighted that we have a new Parliamentarian amongst our ranks with Viscount Stansgate, otherwise known as Dr Stephen Benn, recently taking his seat in the House of Lords.

We wish Stephen well in his new Parliamentary career and look forward to his continuing and valued involvement with P&SC.

It was a pleasure to chair the first discussion of our Autumn programme, on the 13th September, on the theme of Mathematical Modelling and Algorithms, in cooperation with the Institute of Mathematics and its Applications (IMA).

This meeting drew our largest ever Zoom audience of 171.

I was delighted to be joined by a distinguished panel of speakers: Professor Nira Chamberlain, Dr Kit Yates, Dr Ellen Brooks Pollock, and Dr Hannah Fry.

Our thanks to David Youdan, outgoing Executive Director of IMA, and his colleagues for their assistance in organising this event.

Our Programme Committee, chaired by Carol Monaghan MP, will meet in November to confirm topics for next year.

All being well we hope to return to the Houses of Parliament for our discussions in January. We also exploring the possibility of live-streaming these events.

Congratulations to George Freeman MP on his recent appointment as Minister for Science, Research and Innovation. We look forward to working with George, a former Minister for Life Sciences, in the period ahead.

Our thanks to his predecessor Amanda Sollaway MP for all her work, and in addition her support for such events as STEM for BRITAIN.

STEM for BRITAIN 2022: This important event in our calendar, showcasing the best work of our early-career researchers, is scheduled for Monday 7th March in the Palace of Westminster.

We invite all members of P&SC, MPs and Peers to promote this event amongst their networks.

Finally, I should like to extend a warm welcome to CLOSER, the home of longitudinal research (University College London Social Research Institute), and Dr Bryan Hanley, who has had a distinguished 30 year career in research and industry.

CONGRATULATIONS, STEPHEN!

Warmest congratulations to our P&SC Vice-President and Chair of Council, Dr Stephen Benn, on his elevation to the House of Lords as Viscount Stansgate.

Stephen is pictured taking the Oath of Allegiance on Monday 6th September 2021.

SCIENCE IN PARLIAMENT
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The Journal of the Parliamentary and Scientific Committee (All-Party Parliamentary Group).

Science in Parliament has two main objectives:

1. to inform the scientific and industrial communities of activities within Parliament of a scientific nature and of the progress of relevant legislation;
2. to keep Members of Parliament abreast of scientific affairs.

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The Journal of the Parliamentary and Scientific Committee (All-Party Parliamentary Group).

CLIMATE SCIENCE FOR NET ZERO

Professor Stephen Belcher,
Met Office Chief Scientist

If any of us needed reminding of the urgency of climate change, then 2021 has provided a spate of record-breaking weather, with the record-shattering heat wave in North America[1] which has been shown to be virtually impossible without climate change, and the heatwave in eastern Europe[2] providing the conditions for devastating wildfires. In June 2019 we saw the French temperature record exceed 45.0°C for the first time, an event which Met office analysis showed is at least five times more likely because of climate change.

In August the Inter-Governmental Panel on Climate Change published the first part of its 6th Assessment Report (AR6), which provided unequivocal evidence that climate change is due to human activities, and that all societies on Earth will be affected. For the UK the impacts are well-described in the third Climate Change Risk Assessment, published in June 2021,[3] these include health effects of overheating in buildings, climate-related failure of the power systems, as well as risks from the impacts of climate change overseas on supply chains into the UK. But there is hope. While challenging, it is still possible to limit global warming to 1.5°C. However, time is running out if we are to keep to this target. My colleagues provide more details of the evidence we are seeing of changes in the climate system and what these could mean for the future in their article on pages 4-6 of this issue.

In November, world leaders will gather in Glasgow for COP26 – the 26th Conference of the Parties – under the presidency of the UK, to take stock of global efforts to reduce greenhouse gas emissions building on the landmark Paris agreement in 2015. Back then leaders pledged to limit global average temperature rises to well below 2.0°C above pre-industrial levels, with an aspiration to keep the temperature rise below 1.5°C .

Science identified the existence and risks of climate change, and the UK has been at the forefront of these research efforts. Baroness Margaret Thatcher, then Prime Minister, formally opened the Met Office Hadley Centre on 25 May 1990, which over the subsequent 30 years has led the world in the science of climate change. Acting as the UK's national climate capability, the Met Office has worked in partnership with researchers across the world to lay out the science behind global warming: developing with the University of East Anglia the world-famous observational record of global warming HadCRUT; and providing projections of future climate: most recently UKCP18, the climate projections for the UK commissioned by Defra and launched in 2018, which underpin the Climate Change Risk Assessment. Through these research efforts, the Met Office has provided the UK Government with robust evidence to inform climate change policies. Met Office scientists have also played a leading role in each of the IPCC reports and have been part of the UK delegation to previous COP meetings.

The destination to stabilise climate is clear: net zero emissions. Our pathway to net zero still has choices that depend on the speed of development, deployment and uptake of new technologies such as electric vehicles and sustainable agriculture. But climate science too has a role. The climate system is unforgiving, every tonne of carbon dioxide accumulated in the atmosphere raises the temperature and so to stabilise climate below 1.5°C means that we have a fixed budget of carbon dioxide that can be released. AR6 estimated that for a 50% chance of limiting warming to 1.5°C the remaining budget is 460 billion tonnes of CO_2, but acknowledged large uncertainty. More science is

needed to firm up this number and the Met Office and UK science community has huge strength in this area.

Science and innovation now need to be central to solutions and the UK can remain at the forefront as we tackle the climate crisis. To help us reach our net zero destination in good time, we need to lay out the possible routes to get there, we need to develop tools to help us chart our progress and we must be able to rise to the challenges and overcome the hazards we meet on this journey.

We need to track emissions of greenhouse gases – current estimates rely on assessments of fuel consumption, land use, and other factors – so-called inventory methods. This tried and trusted technique can be complemented with an objective approach that directly measures greenhouse gas concentrations, together with state-of-the-art computer models to draw up emissions in near real time. The UK is piloting such a system now with estimates of emissions of methane, nitrous oxide and other greenhouse gases. But further research is needed to make the system work for carbon dioxide, and to enable emissions from different regions and sectors to be segregated. As we deploy the new clean technologies and emissions drop, such a system would also detect fugitive emissions and help focus policy on polluting sectors.

Even with immediate action to reduce emissions, we shall need to build resilience to extreme weather events. We urgently need to know the local weather extremes which new climates will throw at us, and to deal with the impacts. The science to understand weather extremes in a changing climate is developing rapidly, but much more work is needed. In April 2021 the Met Office signed an agreement with Microsoft for the provision of a world-leading supercomputing capability that will take weather and climate forecasting to the next level. This facility will provide the technical infrastructure to make a step change in our ability to compute future weather extremes, such as heatwaves, heavy rainfall, and droughts and to combine these forecasts with other disciplines and data sets to assess their impacts to build resilience at home and overseas. In this way we need to move from simulation of climate to a digital twin of the climate: a system that brings together observations of present climate with forecasts of the future and makes the data available as a decision support tool.

Furthermore, the worst of the impacts of climate change will be disproportionately faced by people who are least able to adapt. This is a global issue which we cannot solve alone – international collaboration and capacity development is needed now more than ever, to share our knowledge and resources. The Met Office works in partnership with the Foreign, Commonwealth and Development Office and other UK Government departments and international development agencies to develop and deliver climate services which help societies prepare for and adapt to the impacts of climate change. For example, through the Weather and Climate Information Services for Africa (WISER)[4] programme (which runs from 2016-21) the Met Office worked with partners in the UK and East Africa to improve the quality, accessibility and use of weather and climate information. Drought alerts developed through the programme in 2016 helped prevent worsening food security conditions in East Africa; the programme also improved access to weather and climate services for three million households across East Africa, enabling people to better prepare for expected conditions. This was done in collaboration with in-country national meteorological services, who will be able to build on this work and continue improving their national resilience. The role of climate science in building resilience to climate change and variability is discussed in more detail in the article from my colleagues on pages 4-6 of this issue.

Science and innovation have been at the heart of the climate debate and must now be part of the solution. The Met Office and the broader UK research community has unique and world-leading expertise, which put the UK at the heart of the debate, and we will continue to work together to provide the evidence base needed to tackle the challenges ahead. Last year, we established the Joint Centre for Excellence in Environmental Intelligence (JCEEI): a ground-breaking partnership based in the South West between the Met Office and the University of Exeter. The JCEEI is pioneering the use of Environmental Intelligence to provide meaningful insight needed to inform decision-making and improve risk management, leading us towards a sustainable interaction with the natural environment and delivery of net zero. The JCEEI will host its second virtual Environmental Intelligence Conference on 16-17 December 2021, which will include two half days of inspiring, innovative discussions on "The Road to Net Zero".

The need for action is urgent. But we have a unique opportunity, when society and industry are rebuilding in the wake of the COVID-19 pandemic, to address climate change in a fair and just way.

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MANAGING WEATHER HAZARDS IN A CHANGING CLIMATE

Professor Jason Lowe, OBE,
Head of Climate Services at the Met Office Hadley Centre

Ms Kirsty McBeath,
Senior Stakeholder Relationship Manager

Dr Jane Strachan,
Strategic Head of International Applied Science

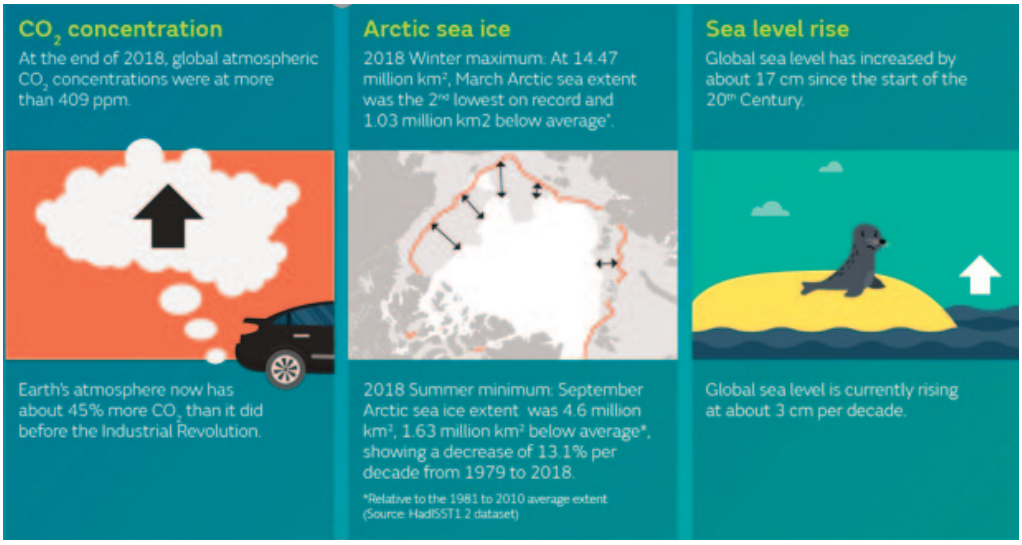
If any of us needed reminding of the urgency of climate change, then 2021 has provided a spate of record-breaking weather, with the record-shattering heat wave in North America[1] which has been shown to be virtually impossible without climate change, and the heatwave in eastern Europe[2] providing the conditions for devastating wildfires. In June 2019 we saw the French temperature record exceed 45.0°C for the first time, an event which Met office analysis showed is at least five times more likely because of climate change.

CHANGES IN CLIMATE HAVE BEEN OBSERVED AND MANY CHANGES CAN BE LINKED TO HUMAN ACTIVITY

Over the last few decades it has become increasingly clear that our climate is changing. In addition to global average temperatures increasing by around 1.2°C since pre-industrial times; Earth's atmosphere now has about 45% more CO_2 than it did before the industrial revolution; the summer extent of Arctic has decreased by around 13% per decade since 1979; and global sea level is currently rising at about 3 cm per decade, which is an increase over the average for the last century.

These changes are consistent with our physical understanding of how the climate system – made up of the atmosphere, oceans, land and ice – works. This knowledge has been developed over many decades using a combination of detailed observations, theoretical understanding, and simulations of how different parts of the system interact with one another.

Climate impacts are experienced locally through the weather conditions we experience every day, which are highly variable. This variability is combined with the long-term trend of climate change. The 2020 State of the UK Climate Report[1] published by the Met Office in July 2021 highlighted that climate change continues to be evident across the UK. The report found that 2020 was the UK's third warmest, fifth wettest and eight sunniest year on record: no other year has fallen in the top 10 for all three variables for the UK. All of the top-ten warmest years for the UK, in records back to 1884, have occurred since 2002; and for central England, the 21st century so far has been warmer than the previous three centuries. As with the global climate, temperature is not the only indicator where changes are being seen. The UK has been on average 6% wetter over the last



30 years (1991-2020) than the preceding 30 years (1961-1990), with six of the ten wettest years for the UK (in a series from 1862) having occurred since 1998.

Many climate trends and changes in climate extremes can be linked to long-term human emissions of greenhouse gases. For instance, the long-term trend in central England temperature has been linked to human drivers (Karoly and Stott, 2006[2]). The high temperatures which the UK experienced in summer 2018 (the joint-hottest UK summer on record) during which there were 836 excess deaths (Public Health England, 2019[3]) was found to be 30 times more likely as a result of climate change (McCarthy et al. 2019[4]). Additionally, the flooding which caused £1.3bn of damage in southern England during Winter 2013-14 has been made both more likely and more severe as a result of climate change (Schaller et al. 2016[5]). Not all extreme events can be linked to long-term climate change: it is not always possible to establish if this is because there is no link, or the link is obscured by natural variability.

INFORMING THE FUTURE

To plan for the future, we can make estimates of the expected future climate, including global average warming. These predictions and projections make use of climate models which contain our understanding of climate system processes and enable us to examine how the climate might evolve for alternative scenarios of future greenhouse gas emissions. We have confidence that the models can credibly replicate many features of the real climate because of the physical basis of the models, and from evaluating their performance when driven with historical greenhouse gas emissions or concentrations. Additionally, we compare many different models to discern those features that are most robustly seen across multiple models.

Scenarios of future emissions (an input to the climate model simulations) are constructed to represent a range of socio-economic metrics that have an impact on emissions, including GDP, population, and policy choices. Some of these scenarios include details of national pledges made through the Paris Agreement process. When these pledges, referred to as nationally determined contribution (NDCs) are taken into account, our models give a median chance of global temperatures reaching around 3°C above their pre-industrial levels. Model projections also show that limiting temperature rises to 1.5°C or 2°C is still feasible but will require large-scale, rapid and deep emissions reductions.

In addition to the global temperature rise already seen, a robust feature of the model projections is that there is already further warming locked into the system, even for the lowest emissions scenario considered, to which the world will need to adapt. Furthermore, uncertainty in the detail of how sensitive the climate system is to increases in CO_2 mean that even with reductions in emissions, there is still a chance that future warming will be higher than the expected limits.

Whilst the "global mean warming" is a useful metric for many policy discussions, in the real world it is local weather and climate that is important. The Met Office has examined in detail the potential changes in the UK climate to provide information suitable for national and local climate risk assessment, and adaptation planning: UK Climate Projections (UKCP). This shows the potential for significant changes in temperature and precipitation, including extreme seasons and weather. UKCP also highlights that without global emission reductions, the extent of temperature and precipitation changes in the UK are set to be very large.

Whatever path future emissions take, we will have to follow a parallel adaptation and resilience-building pathway to prepare for and respond to the changing climate.

ADAPTING TO A CHANGING WORLD

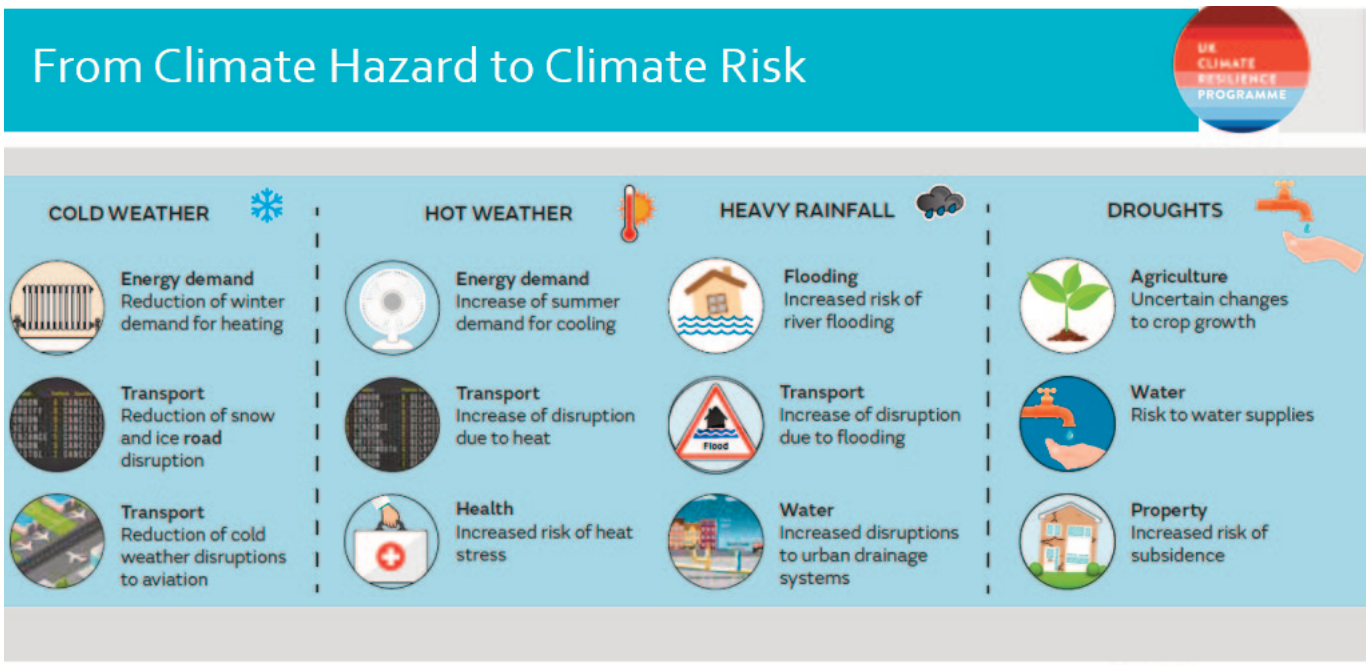
Making wise adaptations to a changing climate needs a multi-faceted approach with a range of people coming together to share expertise and lived experiences. Understanding the frequency, intensity, and the location of climate hazards, and how these will change as the climate continues to change, is an important starting point.

The Met Office is jointly leading the Strategic Priorities Fund UK Climate Resilience Programme (UKCR) alongside UKRI (with Natural Environment Research Council taking the UKRI lead on behalf of Arts and Humanities Research Council, Economic and Social Research Council and Engineering and Physical Sciences Research Council). UKCR brings together often fragmented climate research and expertise to undertake robust, multi- and inter- disciplinary climate risk and adaptation research to build UK capacity for resilience to climate variability and change. The programme covers three themes:

1. characterising and quantifying **Climate Risks** to the UK such as drought, storms and heat extremes;
2. managing climate-related risks through **Climate Adaptation** measures such as sea and flood defences and a resilient food system;
3. working with partners to turn climate information and knowledge into action and usable **Climate Services** such as city planning and land management.

One output of this programme has been the development of prototype urban climate services for Bristol City Council. These have been created through a process of co-development: where service providers and users work together to reach a collective outcome that is accessible and useable. This has drawn out the detailed needs of the Council and allowed parties to work together to meet these needs. New work was produced to satisfy the requirement for locally tailored information to help raise awareness of what climate change will mean for Bristol. This took the form of prototype factsheets[6] providing non-technical summary of UKCP headlines for Bristol. These have provided a foundation for ongoing work on derived metrics and support to city planning.

The co-development approach to working through the chain from climate hazard to climate risk is also used when working with international partners. For example, in the Asia Regional Resilience to a Changing Climate (ARRCC) programme, - a UK Aid-funded programme - the Met Office is working in partnership with the World Bank and Foreign, Commonwealth and Development Office. The four-year programme (started in 2018) aims to strengthen weather-forecasting systems across Asia: delivering new technologies and innovative approaches to help vulnerable communities use weather warnings and forecasts to better



prepare for climate-related shocks. By working with local stakeholders and experts in weather and climate-sensitive sectors through workshops, science exchanges and training, the ARRCC programme is developing and implementing impact-based weather forecasting for early warning services; strengthening seasonal forecasting activities and advice for sectors such as agriculture and water management; and improving the uptake and use of climate projections to articulate future risks and guide decision-making. These activities will help communities become more resilient to extreme weather both now and as the climate changes. The programme is also working to identify knowledge gaps and measure the socio-economic value of services being developed.

Global lockdowns and various travel restrictions provided an additional challenge to the delivery of these services as Met Office colleagues were unable to meet with partners and local stakeholders in-person. However, a combination of online technology and proactive partnerships has enabled projects to continue around the world, and demonstrated how much can be done remotely, particularly when built upon a strong international partnership and networks. Adopting more of these virtual engagement tools will enable us to continue to build and maintain international relationships and deliver co-developed science and services, while reducing our own environmental impact by reducing the amount of travel associated with international work.

CONCLUSIONS

It is now unequivocal that the climate system is changing because of greenhouse gas emissions; with changes seen across a range of climate indicators. Further changes are still expected regardless of the course which future emissions take. However, the size of potential impacts can be reduced significantly by actions to reduce greenhouse gas emissions.

Whatever path future emissions take, changes in the climate system mean that we need to adapt our human environment if we are to thrive in a different climate. This adaptation needs to be local: taking into account the needs of communities and a range of specialist knowledge. Adaptation actions can also improve resilience to current weather hazards, delivering benefits on a range of timescales.

Climate science is providing ever-more detailed and complex information about our environment, but further scientific progress will be needed to better support the implementation of solutions which will limit future changes; improve resilience to current weather hazards and provide a resilient future for our communities.

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DESIGNING BATTERIES OF THE FUTURE

Isabelle Boscaro-Clarke, Head of Communications and Engagement at Diamond Light Source.

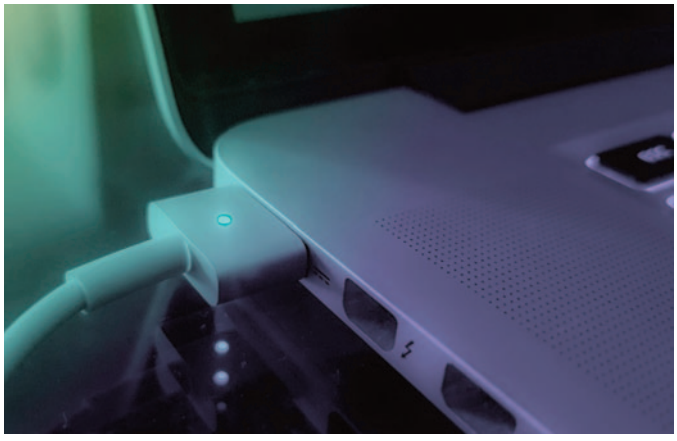
Battery powered portable electronics have dramatically transformed modern life. Almost every hour of every day we have one or more battery fuelled devices strapped to our wrists, in our ears, or in our pockets. To most of us our mobiles, laptops, tablets are essential, if irritating, as they can fail when we need them most and require us to diligently recharge them daily.

The lithium-ion battery has driven the portable electronics revolution enabling sleeker and smaller devices. However, the insatiable demand for longer battery life and more compact forms continues to drive innovation in battery technology and the materials they require. Additionally, there is huge global impetus to decarbonise our transport networks to mitigate climate change. Electrification offers a very attractive route to tackle these issues by replacing petrol tanks and engines with a rechargeable batteries and electric motors.

Here, the lithium-ion battery is poised to power another electric revolution but, the performance demands on battery durability and size are intensely high.

Following 30 years of advances in cell engineering, the energy density of state-of-the-art Li-ion batteries is now primarily restricted by fundamental limitations of the battery chemistry. New materials are required to achieve the much-needed breakthrough in performance as well as energy storage solutions and decentralised solutions to the grid, especially in developing countries.

Worldwide, leading research groups from academia and industry have taken up the challenge to improve the sustainability, efficiency, capacity and performance of batteries while also improving safety and environmental impacts. Many are working in partnership with Diamond Light Source, the UK's national synchrotron which provides X-Ray light 10 billion times more powerful than the sun to make the invisible visible. And over the last two years several significant breakthroughs in developing the batteries of the future have been achieved.



CRACKING UP

To power a significant transition to electric vehicles, we need smaller, lighter batteries that can store more energy and charge much faster. One way of achieving this is to replace the graphite anode typically found in commercial lithium-ion cells with a material with much higher energy storage capacity, such as a lithium anode. However, simply replacing the anode, in a conventional battery results in dendritic growth of lithium which rapidly causes short circuits and catastrophic failure.

Researchers at the University of Oxford and The Faraday Institution investigated the development of dendrites in solid-state batteries with lithium anodes and a solid ceramic electrolyte. In work recently published in Nature Materials, they used synchrotron X-ray techniques at Diamond to uncover crucial information about how lithium grows into the ceramic electrolyte and sets off a process of crack formation and subsequent lithium ingress that can lead to battery degradation and failure. Their results provide critical information for the development of new materials for next-generation batteries. (Visualizing plating-induced cracking in lithium-anode solid-electrolyte cells.

INCREASING BATTERY LIFETIME

Professor Clare Grey's group from the Department of Chemistry at Cambridge University is researching the range of new batteries required for transport, storage and load-levelling on the electrical grid. This ranges from the materials for electrodes and electrolytes, and interfaces between them. Using advanced characterisation tools at Diamond, they are studying the nature of these materials and interfaces, and how they evolve during the charging and discharging of batteries to gain a detailed understanding of battery performance.

Working with the University of Liverpool and Diamond they recently examined why state-of-the-art 'nickel-rich' battery materials for electric vehicles degrade and cannot be fully charged after prolonged use. Nickel-rich cathodes are preferred over cobalt for their minimal environmental damage and also because they tend to degrade faster than other materials. Cobalt is also one of the most expensive strategic metals so reducing the amount used is important Using synchrotron technology and other complementary characterisation tools, they observed the structure of the material at an atomic scale and identified why the fatigue process occurs . They found that atoms at the surface of the

cathode had rearranged to form new structures after ageing and this material could hold less charge. This research may allow the design of protective coatings and additives that could prevent or slow the degradation process and extend the life of batteries. *(Chao Xu et al. Nature Materials 2020, DOI: 10.1038/s41563-020-0767-8)*

The Cambridge group is also conducting research on sodium-ion (Na-ion) batteries which are emerging as cheaper and more efficient alternatives to lithium-ion (Li-ion) batteries in larger scale applications. These batteries are also a more sustainable alternative and could alleviate some of the stress on the global lithium market due to the growing electric car and portable electronics market. *(Tsiamtsouri M et al. Chemistry of Materials 2018, DOI: 10.1021/acs.chemmater.7b03753)*

CORRELATING MATERIAL PROPERTIES WITH PERFORMANCE

The Ångström Advanced Battery Centre at Uppsala University in Sweden, largely focuses on correlating the fundamental properties of the materials inside a battery with its performance as the ageing and failure of a battery is often a result of degradation of the materials inside the battery.

Ongoing projects from the Swedish group at Diamond include investigating new cathode and anode materials for Na-ion and potassium-ion (K-ion) batteries, and to understand how these materials react with the liquid electrolyte to create a stable battery system with good performance. These studies are critical for the development of the batteries of the future.

Dr Andy Naylor, lead researcher comments, "Using synchrotron facilities like Diamond allows us to tune the photon energy to probe multiple energies depths and build up a non-destructive depth profile. Beamline I09 at Diamond is unique in that we can use both softer and harder X-rays than our in-house instrument, so we can probe more surface-sensitively or much deeper. The higher flux of the synchrotron beam also allows us to measure many more samples in a short period of time."

The Uppsala group has conducted numerous studies using photoelectron spectroscopy at Diamond. One of their most recent studies showed that a chemical electrolyte additive helps to form protective surface layers and reduces the degradation on electrodes in Li-ion batteries, thereby providing a boost in cycle life. The combination of Nickel-rich cathodes with high-capacity silicon-graphite anodes can increase the energy density of Li-ion batteries. *(Liu H et al, Advanced Materials Interfaces 2020, DOI: 10.1002/admi.202000277)*

THE ROUTE TO HIGHER CAPACITY

Associate Professor, Louis FJ Piper, in the Physics Department at Binghamton University, New York, USA and Director of the Institute for Materials Research, Materials Science and Engineering and his group has primarily used X-ray spectroscopy techniques at Diamond to understand how to bridge the gap between theoretical and practical capacities of next generation Li-ion batteries.

They worked with Professor Grey's Cambridge group and Diamond to further understand the process of cathode degradation in Li-ion batteries. Nickel-rich layered oxides remain at the forefront of research on practical high-energy density Li-ion battery cathodes, but several cathode degradation pathways hinder the full use of these systems, contributing to poor cycling performance. Cathode and electrolyte modifications are often employed to inhibit these degradation pathways to improve high voltage stability. Coating layers, particularly of aluminium oxide compounds, are used as a barrier to eliminate direct contact and thereby improve cathode-electrolyte stability. The group used a combination of X-ray photoelectron and absorption spectroscopy on beamline I09 to identify aluminium surface environments and extent of transition metal reduction and dissolution at the cathode surface. This work will aid the rational design of coatings to improve capacity retention at high voltages in these batteries. *(Lebens-Higgins ZW et al. Scientific Reports Nov 2019, DOI: 10.1038/s41598-019-53932-6)*

Another recent project focused on improving capacity of nickel-rich layered cathodes. Currently full theoretical capacity cannot be reached as the material severely degrades when >60% of the accessible lithium is extracted. The group focused on what happens when all the lithium is extracted. The traditional view was that as lithium ions are extracted the metal ions change oxidation state and the oxygens ions are mere bystanders. Professor Piper comments "Oxygen participates more than expected and showed that oxygen redox is an exciting prospect for cathodes, offering a route towards higher capacities at high voltages. Observing the onset of oxygen redox in conventional cathodes opens up new design rules for enabling both metal and oxygen redox in new materials." *(Lebens-Higgins ZW et al, Materials Horizons 2019, DOI: 10.1039/C9MH00765B)*

AMBITIONS FOR THE FUTURE

Synchrotron research is set to play a key role in the development of the vast range of batteries that will be required in the future. Dr Naylor predicts the chemistries of Li-ion batteries will become even more diverse and aimed at different applications, with high performance electric vehicles requiring the most powerful and energy-dense batteries.

However, emerging technologies including Na-ion, K-ion and lithium-sulphur will offer opportunities in other areas where low weight or volume is less important but sustainability and price are prioritised. As new electrode materials are developed, and safer liquid electrolytes and solid electrolytes, understanding the interplay between the various components becomes even more important. Dr Naylor says, "To meet this challenge, we are developing *in situ* and *operando* methods to probe the reaction interfaces between electrodes and electrolytes. The battery is a closed system with difficult-to-access interfaces, which makes this task particularly complicated."

Dr Chao and the Cambridge team aim to explore and develop new tools for battery research alongside Diamond. He comments, "We are eager to push the understanding of how some of the state-of-the-art battery chemistries degrade and develop strategies to prolong their lifetime. Also, we are actively developing more advance materials for future next-generation battery technologies."

Professor Piper says that because batteries suffer both intrinsic material and material processing limitations, "We need an integrated 'atoms to modules' approach where cutting edge fundamental research combines with advanced manufacturing." Adding that synchrotron research at Diamond makes *operando* studies of real batteries during charging/discharging more accessible to researchers, and the constant development of new capabilities at synchrotrons means that we are getting better at solving the intrinsic material problems for next generation batteries. "I'm looking forward to integrating new insight from synchrotron studies into the development of the next-next generation of batteries."

The University of Oxford team led by Professor Bruce expect that further research partnerships with Diamond over coming years will include the new rechargeable lithium-oxygen 'Li-air' system which uses oxygen from the atmosphere and move towards replacing liquid electrolytes to create all solid-state batteries which could lead to major improvements in battery storage and performance as well as reducing the risk from the inflammable liquids.

Another team from the Department of Materials, University of Oxford led by Professor Robert House working with Diamond says; "As the demand for higher energy density batteries from the automotive, aviation and consumer electronics industries continues to intensify, we will increasingly need to turn to new cathode chemistries to achieve step changes in performance. The implementation of layered Li-rich cathodes in real-life commercial cells may still be hindered by practical challenges, but advances are continually being made particularly with new synthesis methodologies and surface modifications. The identification of O2 formation and its role in voltage hysteresis will inform and direct future material design efforts towards enabling O-redox technology in the next generation of Li-ion batteries." *First-cycle voltage hysteresis in Li-rich 3d cathodes associated with molecular O2 trapped in the bulk* https://www.nature.com/articles/s41560-020-00697-2

The paper by a joint team from the University of Oxford, the Henry Royce and Faraday Institutions and Diamond, examines the results of their investigations to better understand the important compound known in the battery industry as Li-rich NMC . They show how they were able to fully identify the nature of oxidised oxygen in Li-rich NMC – using RIXS (Resonant Inelastic X-ray Scattering) at Diamond. This compound is being closely considered for implementation in next generation Li-ion batteries because it can deliver a higher energy density than the current state-of-the-art materials, which could translate to longer driving ranges for electric vehicles. They expect that their work will enable scientists to tackle issues like battery longevity and voltage fade with Li-rich materials.

Ambitions for the future at Diamond means being visionary and planning for what scientists will need in the next 15 years. The planned upgrade and new capabilities of Diamond-II will mean that operando research studying in situ problems and processes live as they happen will be even more accessible. The upgrade will enable new breakthroughs for things like battery materials and processes by exploiting the increased 70-fold brightness of its X-ray Light Source. And its brighter, finer beams will go hand in hand with a 100-fold increase in data storage, together with greatly enhanced computation speeds to enable raw data to be visualised and processed on timescales that allow users to make informed decisions about experiments in near-real time, adding substantial value to their experiments. □

UK SCIENCE'S SECRET ADVANTAGE WHICH COSTS LESS THAN A CUP OF COFFEE…

Lorna Campbell, Diamond Light Source

Not everyone knows about the UK 'secret' advantage that's played a key part in many of the major science advances of the last decade. But, that could all be about to change. A new study has revealed that the UK's national synchrotron, Diamond Light Source, has had a socio-economic impact on UK science and the economy of at least £1.8 billion. And as taxpayers we get all of this for less than a cup of coffee at £2.45 per person each year .

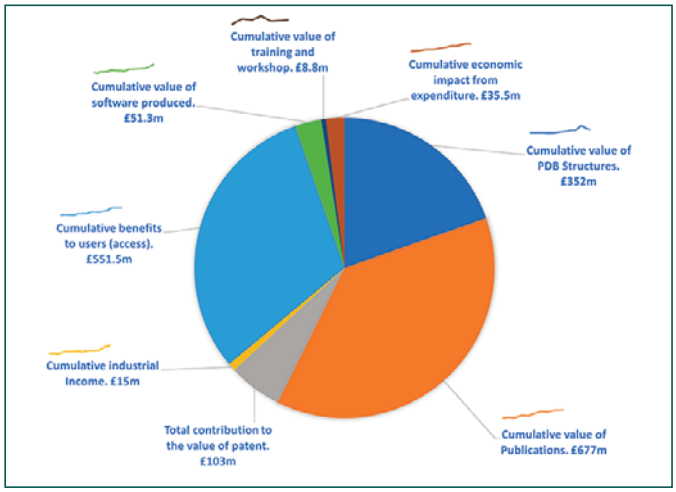
Put simply, synchrotrons enable scientists from academia and industry to make the invisible visible. They are used in imaging and non-destructive testing of materials and structures, as well as in drug discovery and development. They harness the power of electrons to produce light 10 billion times brighter than the sun which enables scientists to study a vast range of subjects, from new medicines, viruses and vaccines to innovative engineering, new materials, batteries, and fuels as well as cultural heritage. (At Diamond this includes the conservation of the Mary Rose and the world's oldest hominin Little Foot.)

The study, by research consultancy Technopolis and Diamond, measured the scientific, technological, societal, and economic benefits of the UK's synchrotron and reported on its 'mission' to keep the UK at the forefront of science. The results speak for themselves. Since Diamond started operations in 2007, work conducted there has resulted in:

* **9600+ research articles** calculated to have a cumulative impact to date of £677 million
* **Patents** citing Diamond contributions valued at £10.2 billion* (2018 prices) A conservative estimate suggests that at least 1% of this considerable sum can be 'claimed' as a result of work at Diamond.
* **28 cases of breakthrough science** from the plastic degrading enzyme to the new synthetic vaccine against the Foot-and-Mouth disease virus, as well as academic and industrial innovations
* **Software and applications** worth £51.3 million.
* **Many 'softer' impacts** include training and teaching researchers worth £8.8 million
* **Wider Societal Benefits** - 80,000+ visitors reached through a programme of engagement supporting the UK Skills' agenda in science, technology, engineering, and mathematics (STEM).

Commenting on the report, chief executive of Diamond, Professor Andrew Harrison, OBE said; "The headline figure of £1.8 billion is almost definitely an under-estimate, but it shows what a fantastic return on investment the facility represents. It's very difficult to monetise the value to industry from increased profits because of confidentiality issues but these gains will continue to emerge for many years to come, underlining the brilliant science being achieved by our 14,000-strong user community, who are tackling some of the most challenging scientific questions of the 21st century."

Diamond was set-up in 2002 as an independent not for profit company through a joint venture, between the Government funded - UKRI's Science and Technology Facilities Council (STFC) and one of the world's largest biomedical charities, the Wellcome Trust - each respectively owning 86% and 14% of the facility. Diamond has received £1.2 billion in investment over 14 years.



Diamond Socio chart - updated3 - Copyright of Diamond Light Source Ltd 2021

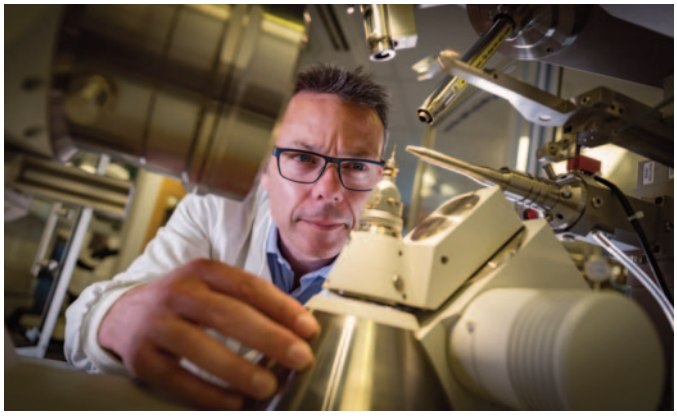
SIGNIFICANT SCIENCE BREAKTHROUGHS

Plastic digesting enzyme

The 28 science breakthrough case-studies developed for the study include the work of John McGeehan, professor of structural biology and, Director of the Centre for Enzyme Innovation at the University of Portsmouth. His team has used Diamond to study the bacterial enzyme PETase, which digests plastic. "Diamond's I23 [long-wave macromolecular crystallography] beamline is unique in the world. It allowed us to solve the 3D structure of the PET-degrading enzyme, first found in plastic dumps in Japan in 2016. Three years ago, it was the highest resolution image of

the enzyme measured and remains so today. Having this information allows us to understand how the enzyme works, and how to make it work faster and better."

As a result, the team has been able to visualise the active site of the enzyme and how it consumes plastic. The researchers discovered that the active site was slightly wider than cutinase, a similar enzyme that bacteria use to break down natural plant polyesters. "The technology leading from this research means plastic waste can be broken down and put back together into bottles (infinite recycling), or can be made into higher value products such as resins for wind turbine blades," says McGeehan. Patents are pending.



Professor John McGeehan 2 - CREDIT Stefan Venter, UPIX Photography - www.upixphotography.com - Copyright University of Portsmouth Centre of Enzyme Innovation

Important biomedical applications

Manchester University's, Professor Saiani's research focuses on the characterisation of molecular materials across length scales in particular the correlations between chemical architecture, structure / morphology, and physical properties in complex polymeric systems. Over 15 years ago, he and his colleague Professor Aline Miller, synthesised a family of self-assembling peptides, with interesting gelling properties. They used Diamond to gain a better understanding of how peptide design affects the fibres' structure and how these fibres assemble to form hydrogels.

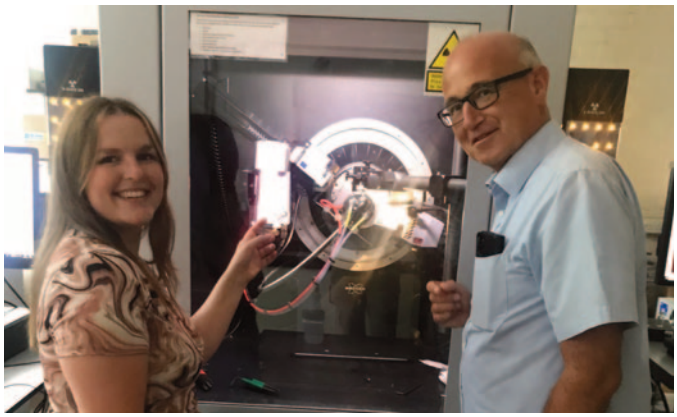
Professor Alberto Saiani

These hydrogels are commonly used for cell culture and tissue engineering applications, providing structural support and a natural physiological extracellular environment for cells. They also offer additional opportunities, including in the development of more effective drug delivery systems and biosensors. Industry and academic demand for the peptide hydrogels led to the co-founding by Professors Saiani, Miller and Dr. G. Saint-Pierre of Manchester BIOGEL™ in 2014. This start-up licensed the technology from the University of Manchester and now offers a range of self-assembling peptide hydrogel products (PeptiGels®), suited for use in 2D and 3D cell culture, 3D bioprinting (PeptiInks®) and incorporation into medical devices.

The Diamond-based research contributed to the fundamental knowledge of the product and process control required for the design of these hydrogels with precise properties. These off-the-shelf formulations are now sold to a range of clients working in the biomedical field (e.g.: disease modelling, tissue engineering and regeneration, drug delivery).

Phase Change Materials with potential to reduce CO_2 emissions and fuel bills

Forty-two per cent of UK energy consumption is in the form of heat so there is growing interest in finding more efficient heating solutions, especially through heat-storage systems. Professor Colin Pulham, Professor of High-Pressure Chemistry at the University of Edinburgh, regularly uses Diamond to examine the properties and behaviour of various materials (pharmaceuticals, fuels, energetic materials) under a range of pressure and temperatures. One of his highest profile research areas has been the crystallisation of phase-change materials and their role in heat storage. In collaboration with Sunamp Ltd, a small rapidly growing Scottish company that designs and manufacturers thermal batteries for heat storage, his research has contributed to the development of its "heat batteries" to store thermal energy at higher energy densities than more traditional methods (e.g. hot water tanks).



Ms Hannah Logan & Professor Colin Pulham, Powder X-ray diffractometer – Copyright of School of Chemistry, University of Edinburgh 2021

Professor Pulhams's work at Diamond helped provide evidence to develop a more controllable and commercially viable product, with the potential to reduce CO_2 emissions and domestic fuel bills. Thermal batteries use phase-change materials (PCMs); chemical compounds that can store and release large amounts of energy (heat) through melting and solidification (and importantly much more energy per unit volume than traditional methods of heat storage, such as hot-water tanks). The technology therefore has the potential to reduce CO_2 emissions and domestic fuel bills, contributing to the alleviation of fuel poverty.

Dr David Oliver, then a materials science PhD candidate at Edinburgh and Professor Pulham, used X-rays on the Diamond I11 beamline to examine the crystal structures of PCMs – how the atoms are arranged and how these change during crystallisation – as well as to explore possible degradation pathways.

The high intensity of Diamond's X-rays meant data could be collected in seconds,

allowing them to study changes to crystal structures in real time under variable temperature conditions. The research determined the temperature at which one PCM formulation developed by Dr David Oliver would cease to function properly and identified the various crystalline species present during heating and freezing cycles. One 48-hour session of beamline time at Diamond helped confirm the PCM formulation worked as intended and could be commercially viable.

The work at Diamond has had important commercial benefits for Sunamp. Knowing the temperature that PCM formulations begin to degrade enabled them to build in appropriate temperature cut-offs to their batteries. The research also provided clear scientific evidence that the novel PCM formulation works, and the enhanced phase-change materials will continue to function over extended periods of some 40,000 cycles. This helped reassure investors about long-term battery performance and appropriateness for domestic installation. The data helped Sunamp secure a several million-pound investment and it's now valued at tens of millions of pounds with its heat batteries currently in 1,000 UK homes and a memorandum of understanding in place to supply Chinese homes.

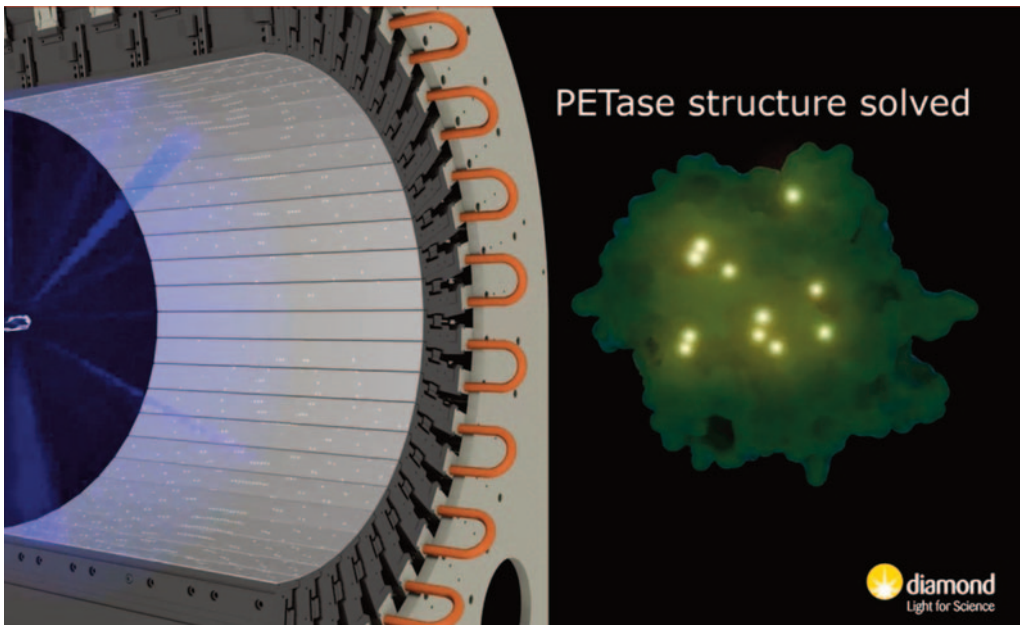
Diamond Light Source Aerial View 3 - Copyright of Diamond Light Source Ltd 2020

DELIVERING AGAINST REAL-WORLD CHALLENGES

Professor Mark Thomson, Executive Chair of STFC, concluded: "With support from STFC, the Diamond research facility continues to deliver both economic growth and research impact on behalf of the UK. It brings together the best of British science, as well as fostering multi-disciplinary research activity with a wide range of global collaborators. It continues to deliver against real-world challenges, with some of their recent successes including enhancing our understanding of the Covid-19 virus."

Tom Collins, Acting Head of Genetics and Molecular Sciences at Wellcome, added: "Diamond has delivered world-leading scientific advances through the innovation and excellence of the people who built and operate the synchrotron, in collaboration with the UK's scientific community. The report highlights the real-world impact of it's research and the continued efforts that it makes to engage the wider public, complementing Wellcome's mission to solve the most urgent health challenges facing everyone."

For a full copy of the report see: https://doi.org/10.5281/zenodo.4769839 □



PETase structure solved at I23 beamline at Diamond Light Source - Copyright of Diamond Light Source Ltd

NATURAL CAPITAL EVIDENCE: IMPACT ON POLICY AND MANAGEMENT

Vicky Morgan leads for Marine Natural Capital at the Joint Nature Conservation Committee (JNCC), which is the statutory adviser to the government and devolved administrations on UK and international nature conservation.

My generation of nature conservationists has had some hard-won success, slowing down biodiversity loss and protecting some important sites. It has not been enough. Globally, 'biodiversity is declining at an unprecedented rate, and the pressures driving this decline are intensifying'[1]. Although the picture in the UK is brighter, the UK Biodiversity Indicators[2] show that 14 of its 52 measures are in decline, including our threatened habitats and species, birds and insects of the wider countryside, fish size classes in the North Sea and biodiversity and ecosystem services.

Early in my career, in the 1980s, I was literally told by decision-makers that 'nature conservation is a luxury we can afford when we get the economy right' and on another occasion 'it needs to be able to pay for itself'. Instinctively, I felt this was wrong because it ignored our reliance on nature, but as a field ecologist I lacked the knowledge and language to argue the case and could not find them in a quick library search of economics textbooks.

Since then numerous projects and reports, most recently the Dasgupta review,[3] have made the case for the value of nature, seen as a capital asset, just as produced capital (roads, buildings and factories) and human capital (health, knowledge and skills) are assets. Simple definitions of the main concepts are:

Ecosystem – all the plants, animals, and microorganisms in a given area, interacting with all of the non-living physical and chemical factors of this environment.

Barbara Hepworth *Pelagos* ('open sea' in Greek), 1946. ©Vicky Morgan.

Ecosystem services – The contributions that ecosystems make to human well-being.

Natural capital – The stock of renewable and non-renewable natural assets (e.g. ecosystems) that yield a flow of benefits to people (i.e. ecosystem services).

We now know, or are working out, how to identify our Natural Capital assets and to measure the flows of ecosystem services from them, and can apply this evidence to manage land and seas for benefits to society and the economy.

Evidence for how much nature means to people is all around us, including in music, literature and visual art. The most effective nature conservation is, and always has been, about PEOPLE and PLACES: Natural Capital builds on that, to put benefits to people at the heart of the story of Nature, and of decisions and policies for the environment.

WHAT NATURAL CAPITAL IS NOT

Some people worry that the Natural Capital approach aims to

monetise everything into soulless accounts or cost-benefit calculations at the expense of deeper values. In some cases, we can put precise financial estimates on natural assets and the services we get from nature. In others, we can't, but can still identify important services and use our understanding to inform decisions alongside economic valuation. Where we can reliably monetise natural assets and flows of services we can counteract the damaging effects of the 'market failure', whereby the true cost is not paid by those who benefit from the depletion of nature. The market failure drives the failure of too many nature conservation policies and Dasgupta shows that our unsustainable engagement with Nature endangers the prosperity of current and future generations.

As suggested in Figure 1, although 'traditional' nature conservation was always motivated by underlying human values, they were rarely mentioned in the technical work of conservation. The natural capital approach allows these deeper values, sometimes called 'non-use values' by the ever-prosaic economists, to be emphasised in decision-making. It also uses many of the same tools and evidence as nature conservation, alongside new types of evidence revealing values, beneficiaries and users.

MAKING A DIFFERENCE

Although thinking has advanced in the last two decades, examples where Natural Capital evidence has been used to make different, better decisions, despite entrenched short-term interests, have been rare.

We are however beginning to see some inspiring cases, of which a selection is described here. Because Natural Capital is about people as much as nature, it is not surprising that all these successes include dialogue with users and local people.

The Sussex Inshore Fisheries and Conservation Authority (IFCA) has pioneered a Natural Capital approach to achieve its Near Shore Trawling Byelaw, which will exclude trawling from 304 square kilometres of seabed (Figure 2) and was formally announced in March, following extensive and intensive consultation with stakeholders. It aims to restore kelp habitats and associated natural services, including fisheries, in the long term, but will reduce the income of some local fishers in the shorter term. Current total ecosystem services are estimated at c£80k a year (of which <5% is the commercial fishery); if the kelp forest recovers to near its extent in 1987, this would rise to £3.2m a year. The largest contribution to this value is from coastal protection (from surge waves and erosion). The value as a nursery for commercial fish exceeds the value of fish caught in the area.

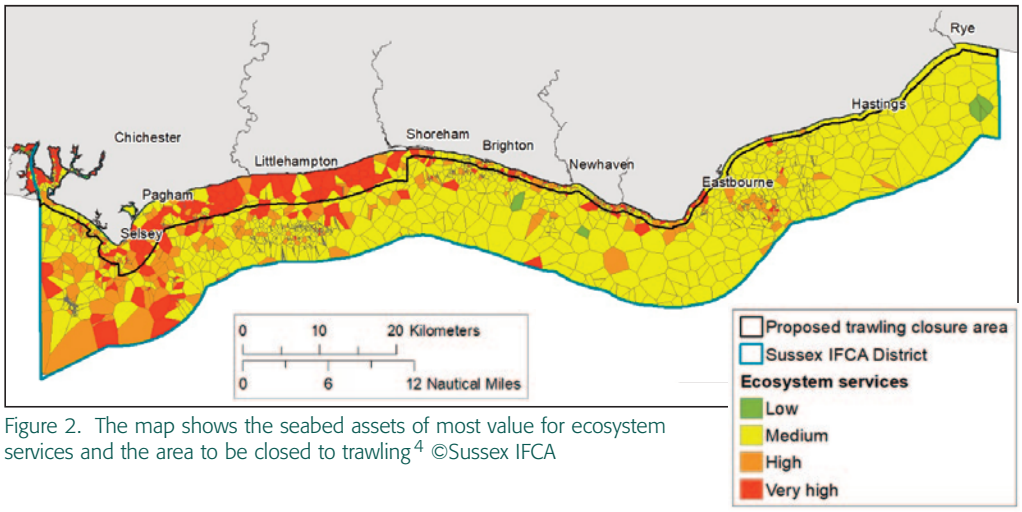


Figure 2. The map shows the seabed assets of most value for ecosystem services and the area to be closed to trawling[4] ©Sussex IFCA

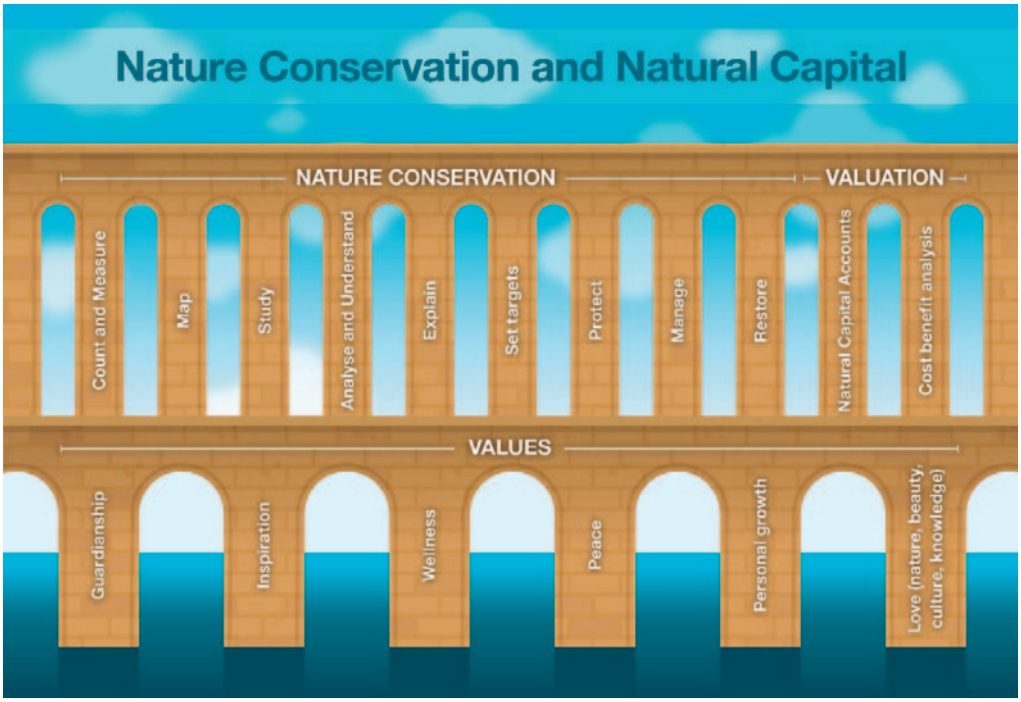


Figure 1. All of these aspects, together with new types of evidence about natural services, goods, benefits and beneficiaries, comprise the Natural Capital approach and support sustainability. ©JNCC.

Oarweed (*Laminaria digitata*). This and other kelp species have declined by more than 96% in Sussex since the 1980s, thought to be due to trawling, storm damage and the dumping of sediment spoils. ©Ashley Cordingley.

On land, flood protection can use the Natural Capital approach to maximise benefits. For example, the City of Hull has some of the highest flood risk outside London and was hit by devastating floods in 2007. A partnership of statutory bodies developed solutions such as 'blue-green' spaces which soak up water, then release it slowly; these are complemented by more traditionally engineered options where necessary. Yorkshire Water has calculated[5] that to deliver blue-green spaces over ten years cost £9.7 million. When all benefits of the schemes (such as reduced flooding and access to open space) are estimated they come to £46.4 million over the same period; most of these benefits accrue to society without appearing on Yorkshire Water's balance sheet.

In all four countries of the UK, governments are designing new agri-environment schemes to replace EU-funded schemes. All are looking at ways that subsidies can be used to support public goods such as biodiversity and ecosystem services.

The UK government is applying Natural Capital to Overseas Development Assistance. For example, Defra's *Darwin Initiative* funded work to achieve 'No Net Loss' not just of biodiversity (through offsets), but of related social and cultural values, wellbeing and livelihoods, for communities affected by two Hydropower Projects in southern Uganda.[6] The project team held focus group discussions and carried out household surveys, to find out preferences for options to offset impacts from the dams. The area is important to different members of society for cultural heritage, sacred sites, medicinal herbs and other forest products including bark cloth. Policy outputs include draft national biodiversity offset guidelines for Uganda and draft international guidelines for incorporating social costs and benefits into biodiversity offsetting.

The inner bark of the Mutuba tree (*Ficus natalensis*) is used to make bark cloth, listed as a UNESCO Intangible Cultural Heritage https://ich.unesco.org/en/RL/barkcloth-making-in-uganda-00139. ©Victoria Griffiths

Gathering data to understand local preferences for options to offset biodiversity impacts in Uganda. ©Victoria Griffiths

THE FUTURE

In England, Defra's Natural Capital Ecosystem Assessment (NCEA) pilot programme has run for two years, developing Natural Capital evidence to support a range of important policies such as Net Zero, the 25 Year Environmental Plan, sustainable fisheries and land management. High quality data on the location and condition of natural capital assets and ecosystem services, and how these are changing over time, would help us to transform decision-making on land and at sea and contribute to better national accounts. Opportunities are being developed to expand inclusion through volunteer networks and citizen science. New data streams, such as from space and robots, as well as new survey and monitoring, are to be integrated with existing evidence and made more usable and accessible. The biggest gaps in our knowledge are in marine and coastal environments. The NCEA's ambition is that policy and decision-makers have robust evidence to apply to sustainable management for a prosperous future.

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HOW HAS THE COVID-19 PANDEMIC AFFECTED UK CANCER SERVICES?

Caroline Wood is a Communications Officer for the Nuffield Department of Population Health, University of Oxford

Professor Eva Morris, Nuffield Department of Population Health, University of Oxford

The direct effects of the COVID-19 pandemic have been devastating enough, but it is likely we will never know the full extent of the wider impacts. With no aspect of the NHS being untouched, patients with many other life-threatening conditions have experienced severe disruptions in their treatments and care. In this article, Dr Caroline Wood explores how cancer services in particular were affected.

When the first COVID-19 wave swept the world in March 2020, all focus was naturally on strengthening the NHS frontline as much as possible. But redeploying staff, closing outpatient clinics and suspending in-person appointments had devastating consequences for people with cancer. Figures from Cancer Research UK [1] show that there were more than 380,000 fewer urgent suspected cancer referrals in the UK between March 2020 and March 2021 – down 13% compared with before the pandemic. Over the same period, the number of patients starting cancer treatment in the UK fell by 45,500 (down by 13% compared with before the pandemic). In both cases, the effect was strongest for the most deprived socio-economic groups. Meanwhile, the amount of people on cancer waiting lists skyrocketed, so that by the end of April 2021 the number waiting six weeks or more for a diagnostic cancer test in England was eight times higher compared with April 2019.

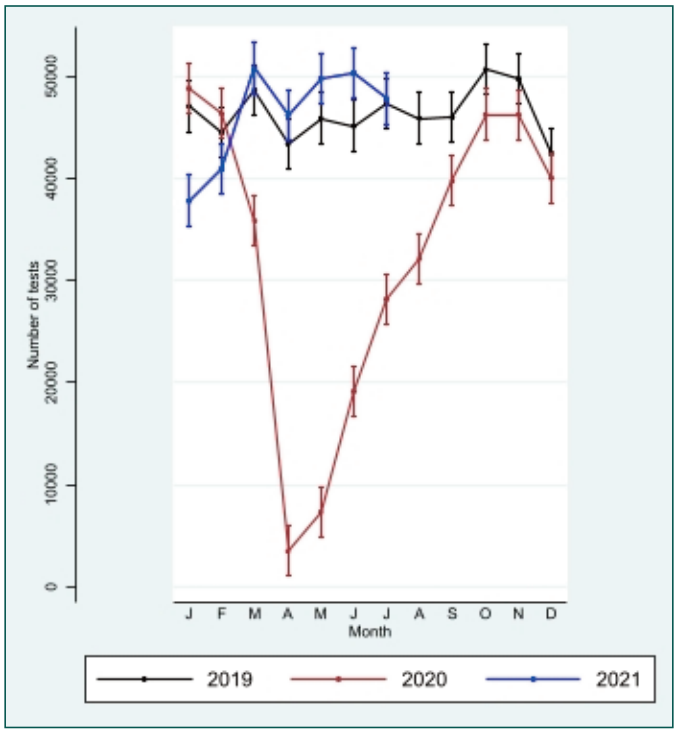

Figure 1: Monthly number of colonoscopies undertaken in England (UK Colorectal Cancer Intelligence Hub)

Eva Morris, Professor of Health Data Epidemiology at Oxford University's Nuffield Department of Population Health, has worked with the UK Colorectal Cancer Intelligence Hub to specifically investigate the impact of the pandemic on the diagnosis and treatment of bowel cancer. Their research found that during April 2020 (the peak of the first COVID-19 wave), the number of diagnostic colonoscopies and surgical operations for bowel cancer in England fell by 92% and 31% respectively, compared with an average month in 2019 (Figure 1) [2].

"We think various factors caused this dramatic decrease, including reduced clinical capacity and disruption to bowel cancer screening programmes" Professor Morris said. "Individuals with suspected bowel cancer symptoms may also have put off arranging a GP appointment due to the Government's call to 'stay at

home' and 'protect the NHS', and because of fears about catching coronavirus."

RISKY PROCEDURES

Many cancer-related procedures (particularly invasive diagnostic tests and surgical operations) were seen as 'high-risk' due to the potential for coronavirus transmission. Nevertheless, the NHS adapted swiftly to continue cancer treatments, based on new guidelines rapidly issued from service providers, commissioners, and professional bodies within the UK. These specifically recommended approaches to protect vulnerable cancer patients from catching coronavirus, such as switching from surgery to radiotherapy for cancers that could be effectively treated this way. For instance, in May 2020, the number of radiotherapy courses delivered by the NHS in England for bladder cancer and oesophageal cancer increased by 143% and 71% respectively, compared with May 2019 [3].

Early diagnosis and timely treatment are critical to give patients the best chance of survival. Photo credit: Cambridge University Hospitals.

For other types of cancer, radiotherapy courses were significantly shortened to minimise the exposure risk for patients. This was particularly true for breast cancer, where the proportion of radiotherapy treatments using a shorter course increased from just 0.2% in April 2019, to 60.6% in April 2020. This was enabled in part by new data from a UK trial published just as the pandemic struck, which showed that a one-week course of radiotherapy was just as effective as a three-week course for many breast cancer patients [4].

"These changes show that the NHS adapted impressively during an immensely challenging time to continue delivering cancer services safely" said Professor Morris.

RESTRICTED RESEARCH

Nevertheless, research trials into new cancer treatments were still heavily affected. Normally, around one in six cancer patients take part in clinical trials, allowing them to access cutting-edge treatments and help generate evidence that could improve cancer care for future patients. But during the COVID-19 lockdowns, most cancer research studies ground to a halt. According to Cancer Research UK, during March to May 2020, thousands of cancer patients – including those with no remaining treatment options – lost the chance to participate in a clinical trial and receive potentially life-extending drugs [5]. Even though most of these studies are now recruiting participants again, their investigative power will be limited by the disruptions to treatment courses and data collection that occurred.

At the same time, the pandemic has also delivered a major blow to cancer research funding, with Cancer Research UK estimating a £250 million downturn in their income for the three-year period between 2020/21 and 2022/23 [6]. This prevented the charity from funding any new studies last year: usually Cancer Research UK fund around ten new trials every year in addition to funding trials already underway. "Just as science is our route out of the pandemic, science is our route to beating cancer" said Zoe Martin, Policy Manager (Research and Charity) for Cancer Research UK. "But although patient recruitment to UK cancer clinical trials has seen some recovery, this has stagnated and is now at around half of pre-pandemic levels. COVID-19 research remains the priority at the local level, making it harder for non-COVID researchers to acquire the resources needed to restart research and reopen recruitment."

END OF LIFE CARE

The impacts of the pandemic were particularly distressing for cancer patients receiving end of life care, as Ruth Driscoll, Head of Policy and Public Affairs England at Marie Curie, explained. "In the first pandemic year, the number of deaths at home in the UK increased by around 40%. Our Better End of Life report [7] found that the quality of palliative and end of life care was compromised due to hospices not being recognised as a frontline, essential service. This meant that palliative care teams struggled to access PPE and other essential equipment, medicines and staff."

Marie Curie's survey of carers bereaved during the pandemic found that three quarters didn't get all the care and support they needed, and nearly two thirds said that their loved one's pain wasn't fully managed [8]. These include Susan Lowe, whose mum Sheila died at home of metastatic bowel cancer in April 2020. With hospices in lockdown, Susan moved in with her mum to care for her. Apart from several visits from district nurses, Susan was left to manage Sheila's medication and personal care herself. "I struggled to get the palliative care drugs mum needed and I spent a lot of time trying to find the right pain killers for her by driving to lots of pharmacies. It made me panic to think that mum would be in pain if I couldn't find what she needed" Susan said [9]. Unable to access a night sitter, Susan, her father and sister were forced to cover the night shifts themselves. "It's such a shame because what the hospice would have offered in normal times would have been such a huge help" she said.

End-of-life care for cancer patients was severely disrupted during the COVID-19 lockdowns. Photo credit: Cambridge University Hospitals.

A SYSTEM STILL UNDER PRESSURE

Although cancer services have mostly now recovered to pre-pandemic levels, including screening programmes and the numbers of new patients starting treatments, the NHS faces an enormous backlog of cases, with unprecedentedly high numbers missing waiting times targets since the pandemic began.

Cancer outcomes in England already lag behind those of comparable high-income countries [10] and Professor Morris cautioned that unless this shortfall is addressed, this gap is set to widen further.

Cancer screening services have largely returned to pre-pandemic levels, but there remains a considerable backlog of patients. Photo credit: Cambridge University Hospitals.

"For bowel cancer alone, our research suggests that between April and October 2020, more than 3,500 fewer patients than expected were diagnosed in England" she said. "Diagnosis and treatment rates haven't yet exceeded pre-pandemic levels, which is what we would expect if these patients were now coming through the system. Diagnosing bowel cancer early is critical because delays of even four weeks have a significant impact on survival. Over 90% of patients diagnosed with bowel cancer at Stage I of the disease survive for at least five years, compared with only 10% of patients diagnosed at Stage IV. Consequently, thousands of these 'missing patients', whose diagnosis was delayed or has yet to be made, may die unnecessarily."

"NHS staff have innovated throughout the pandemic to protect and, where possible, improve cancer care" added Zoe Martin from Cancer Research UK. "But cancer services were struggling before COVID came along. There simply isn't enough staff and resources to make improvements at the pace and scale needed to have world-leading survival. We need to see the Government address workforce and equipment shortages through investment in Health Education England to expand staff in key cancer professions, and funding for more diagnostic equipment."

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TACKLING THE CLIMATE CRISIS THROUGH SCIENCE AND INNOVATION

Professor Dame Ottoline Leyser, Chief Executive of UK Research and Innovation.

When the Intergovernmental Panel on Climate Change (IPCC) published part one of its sixth assessment report in August 2021, the warning was stark. The changes in the Earth's climate are now at unprecedented and, in some cases, irreversible levels. The message has never been clearer - now is the time to act! Now is the time for science and innovation to take centre stage and provide real solutions that allow us to take climate action.

Like the COVID-19 pandemic, climate change demonstrates just how important research and innovation are when we are faced with a global crisis. Decades of publicly funded research, delivered through UK Research and Innovation (UKRI) and its predecessors, helped deliver the vaccines to tackle COVID-19. And it is decades of investment in climate research and innovation will that provide us with the near-term solutions to take action for our planet.

As we look forward to the UN COP26 summit in November, aimed at building an international coalition to counter the existential threat posed by climate change and biodiversity collapse, research and innovation is once again playing a crucial role. It will be key to mitigating the problem, dealing with the social and economic costs and allowing us to build back better from a crisis.

For more than 50 years, UKRI and its councils have invested in cutting-edge research and innovation to understand, tackle and mitigate the effects of climate change and embed evidence in decision-making and climate policy. This long-term investment in climate research and innovation has been a key element of the progress made so far in tackling climate change. For example, our investments identified the hole in the ozone layer and how to close it, developed new technologies to reduce carbon emissions from energy, transport and industry, and provided a crucial baseline for monitoring the impacts of climate change.

The IPCC report offers a stark reminder of the impact of human activities on our planet, which have caused widespread and rapid changes to the atmosphere, ocean and land. We are still able to make a difference but only with immediate and sustained global action. Climate Change is a global problem and whilst the UK is at the forefront of tackling it, this will only succeed with international cooperation and a truly global endeavor, with ideas pooled and insights shared from a breadth of expertise.

There is no better time to champion the role of research and innovation in tackling this generational challenge. Research and innovation are needed not just for measuring and predicting impact, but also for identifying how to accelerate the technological, social, economic, cultural and political change needed to reach Net Zero.

The UK has a strong track record of investing in the many new ideas arising from our research and innovation system in this area. Building on this track record, the UK's unique position of leadership – holding the Presidency of the UN Climate Change Conference (COP26), in partnership with Italy – presents a huge opportunity to strengthen global commitment to climate change mitigation, adaptation and resilience through international collaboration.

UKRI is using its role as a steward of the research and innovation system to work with national and international partners to reduce carbon emissions and encourage new ways of living that enable nations to meet ambitious net zero commitments by 2050 while protecting our environment and the people who live within it.

Research and innovation can ensure the UK is at the forefront of a new, green industrial revolution which will reduce

UK Research and Innovation

waste and greenhouse gas emissions, create healthy, resource-efficient urban and domestic environments, deliver sustainable agricultural and food systems, create circular economies, grow clean energy solutions and expand green finance, low-carbon services and the digital economy as well as support UK businesses to get a foothold in growing global markets to create prosperity for the UK.

UKRI-funded research is contributing to all these areas and more. We are supporting people across the research and innovation community who have the track record and new ideas to help us all tackle climate change and live more sustainably. And we are investing in the next generation of talent, too. In partnership with industries like energy and manufacturing, we are delivering the highly-skilled roles needed to underpin the UK's move to Net Zero.

UKRI-funded climate change research and innovation spans work in many disciplines: solutions for cleaner energy, building smarter energy systems, identifying and delivering the changes needed in our everyday lives such as how we travel, what we eat, and how we shop, studying how climate change affects our health, and understanding the changing arctic environment. UKRI also helps create the right ecosystem to allow businesses to develop new solutions and then grow at scale so that these innovations can have the real impact as we transit to Net Zero.

Highlighted below are just a few UKRI investments that are contributing to the fight against climate change.

CASE STUDY: INTERNATIONAL THWAITES GLACIER COLLABORATION (ITGC)

The ITGC monitors the Thwaites Glacier, one of the most unstable glaciers in Antarctica. Ice loss from the glacier, which is roughly the same size as Britain, currently contributes to around 4% of all global sea-level rise – if it was to collapse entirely, global sea levels would increase by 65 cm. The ITGC monitors and evaluates crucial data such as how the ice boundary is changing, and rates of ice melt, as well as examining the core of the glacier.

Better awareness of the processes that drive the glacier to retreat is critical to improving models of the glacier's future behaviour and exploring conditions that could lead to a rapid increase in ice loss.

The ITGC project is a collaboration between The National Environment Research Council and the US National Science Foundation.

The Thwaites Glacier in West Antarctica contributes to 4% of all global sea-level rise. It is being closely monitored thanks to the International Thwaites Glacier Collaboration.
Image courtesy of NASA, Creative Commons

CASE STUDY: ACTIVE BUILDING CENTRE

The Active Building Centre in Swansea is revolutionising the way buildings are designed, constructed, and operated – reducing the amount they cost to run and their energy demands. Two demonstration buildings, conceived by the SPECIFIC Innovation and Knowledge Centre, show how new technologies can be used to create buildings that generate and store enough renewable energy to meet their own needs or more.

Globally, buildings are responsible for 40% of carbon emissions, and in the UK they consume 40% of all energy produced, so any solution to the energy crisis must address their efficiency. New buildings need to be designed differently and many existing buildings retro-fitted with sustainable-energy solutions. The Centre is working closely with government and industry to break down the barriers to mass adoption of Active Buildings across the UK.

The Active Building Centre is funded through the Industrial Strategy Challenge Fund (ISCF) Transforming Construction Challenge, Innovate UK, and the Engineering and Physical Sciences Research Council.

Carbon emissions can be reduced by designing buildings to include sustainable energy solutions.
Image Courtesy of Tristan Surtel, Creative Commons

CASE STUDY: FUTURE FASHION FACTORY

The Future Fashion Factory is reducing waste and cost in the fashion industry by developing advanced digital and textile technologies that are transforming the industry's agility in the luxury fashion design process. It is exploring ways of using real-time data, machine learning and artificial intelligence (AI) to judge what will fly off the shelves and not be left unsold, as well as trialling tools which use virtual reality to simulate the behaviours of textiles in 3D.

The UK's fashion design sector contributes around £30 billion to the economy annually but it is also a heavy consumer of resources and creates significant waste. New approaches and technologies can both transform environmental impact and drive future economic value.

Future Fashion Factory is funded through UKRI and the ISCF Creative Clusters Challenge, Innovate UK, and Arts and Humanities Research Council.

The Future Factory is addressing waste by using machine learning and AI to judge what will fly off the shelves and not be left unsold. Image courtesy of Future Fashion Factory

CASE STUDY: ENERGY CATALYST

Clean energy start up PyroGenesys aims to transform electricity supply in Nigeria where an estimated 43% of the population live off grid. Image courtesy of Yusuff Suleiman, Creative Commons

Energy Catalyst is accelerating the innovation needed to end energy poverty. Through financial and advisory support, and by building strategic partnerships and uncovering new insights, Energy Catalyst supports the development of technologies and business models that can improve lives in Africa and Asia.

One example is the clean energy start-up PyroGenesys which is developing low-cost, environmentally friendly technology to transform the way off-grid communities in Nigeria receive electricity. Its innovative PyroPower technology turns agricultural waste into renewable heat and electricity. As well as a source of heat and power, it has created Biochar. These smokeless fuel briquettes can be used for cooking, replacing firewood and wood-derived charcoal, a cause of severe deforestation and human health issues.

Energy Catalyst is an Innovate UK programme with co-funding from the Foreign, Commonwealth and Development Office, Global Challenges Research Fund, BEIS and the Engineering and Physical Sciences Research Council. □

APPETITIE EMERGES WHILST EATING: ADAPTING A PROVEN INNOVATION MODEL FOR THE UK

Simon Andrews, Executive Director, Fraunhofer UK Research Ltd

The Government's recent Innovation Strategy [1] includes an upcoming review of the institutions in the innovation landscape and identifies seven key transformative and disruptive technology areas. Having adapted the much-referenced [2,3] Fraunhofer model to work effectively in the UK, in two of these technologies, we offer some thoughts and perspectives on what we have learned about this proven German innovation model and how that might be applied further to benefit the UK, in light of this strategy.

ADAPT AND SURVIVE

Nobel Laureate Sir Paul Nurse has been tasked with examining the UK's landscape of innovation organisations. No small task. The Royal Society identifies and categorises [4] the UK's 53 Public Sector Research Establishments, 39 Research Council Institutes, 44 MRC units, 9 Catapult centres (one of which has many parts), 63 Independent Research Organisations and 28 Private non-profit research organisations. These cover myriad disciplines, needs, services, and within some categories there are radically different operating models and strategies.

This complexity appears to have evolved and adapted with those enduring organisations meeting real needs, filling real niches. Many enduring Research and Technology Organisations (RTO to use the broader term) have a structure, funding and model which fits what they are needed to do or they simply would have gone out of business. Others however have changed their offering to match their changed circumstances.

Some RTOs serve sectors very successfully. Others, like Fraunhofer centres, focus on a transformative or disruptive technology (aka emerging and enabling technology) which is applicable to many sectors. Almost without exception Fraunhofer centres, in Germany and around the world, have key expertise in a specific area of science or engineering which is applied usefully for many companies across multiple markets. There is a resilience in this discipline-based, core technology model as ongoing science continually refreshes the offering whilst the customer base is broad, not exposing the centre to the frailties of a particular sector's difficulties. But whether a sectoral or technical focus, each model has its strengths and weaknesses. The established RTO community is well placed already to meet the challenges of more being required on the applied end of R and D [5] in many disciplines. Neither technical or sector approach is inherently superior, each has to adapt and refresh to survive.

Fraunhofer CAP team outside the Technology and Innovation Centre, Glasgow City Innovation District.

LEARN AND RE-GROW

Staying close to the research base is not an empty slogan for Fraunhofer, but the very mechanism it uses to stay fresh to keep the cupboard full of new ideas.

One critical difference in adapting the Fraunhofer model to the UK is that German Fraunhofer Institutes enjoy healthy support from their BMBF (Federal Ministry of Education and Research). However, our first centre, Fraunhofer Centre for Applied Photonics, CAP, does not draw on such EPSRC-type support. This leaves us requiring other means of keeping research fresh, ideas flowing and access to the latest breakthroughs. Here the in-built university partnership (Strathclyde), and Professorial leadership, Prof Martin Dawson, gives us a jointly supervised PhD student cohort, strategic part-time secondees, joint projects, access to additional facilities and experts, all collocated in the Glasgow City Innovation District. This is no PR exercise but a hardwired conduit for mutual benefits and enabling both organisations to deliver more.

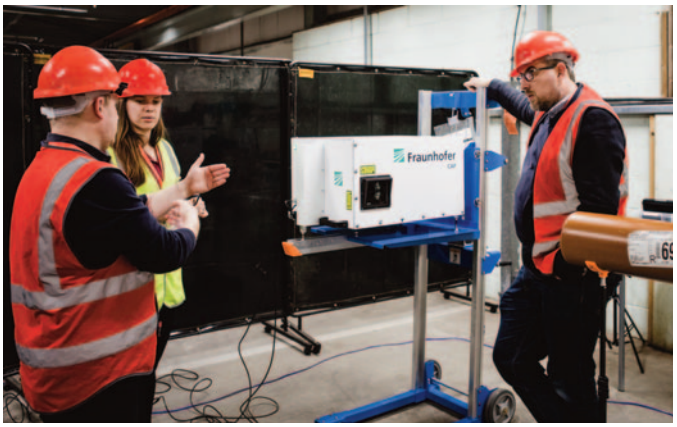
This specific location is flourishing as an innovation hub, but more broadly place is a vitally important aspect, again from our own experience of

establishing Fraunhofer in the UK. It can be enlightening to see ourselves as others see us. When invited to work with the UK, (by the then Science Minister) those in Germany committing their hard-earned reputation chose a place with excellent science, as well as absorptive capacity in local companies. They didn't assume that the most prominent or oldest institutions were automatically the most fitting. Central Scotland was already a leading area in photonics and quantum academically, with an established and increasingly ambitious cluster of companies. Further investment in technologies would do well to seek such sweet spots.

centre does not drift towards emulating a university research unit nor an industrial consultancy.

As an organisation run by scientists and engineers it is not surprising that KPIs or engagement metrics are not paramount [6]. An Engineer designing a system which is intended to be ongoing, and adapts to changing circumstances, will of course install a control mechanism with a feedback loop. (a simple household thermostat won't allow the temperature to range too far from the set point)

This crucial feedback mechanism is operated by the central Fraunhofer HQ in each

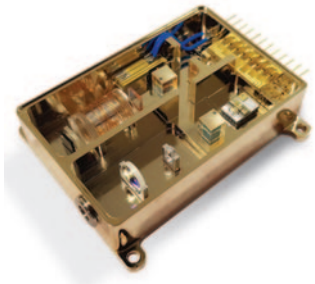


Fraunhofer CAP's remote Hydrogen detection system being evaluated at Sellafield Ltd

THE PRICE OF SUCCESS, BORN HUNGRY

Investing in technology is expensive, non-linear, and its success depends on so much more than the bright idea or the mythical lone inventor. The financial part of the Fraunhofer model is abbreviated to the well-known "thirds" financial model headline. A broad-brush approximation describes one third core funding, one third of industrial income and one third of collaborative project income being sought by each centre each year. The superficial headline is misleading. Firstly the core is insufficient to survive. The true aim is to invest core wisely in order to win a balanced portfolio of direct and collaborative work. A balanced, won, portfolio ensures that the country which, once a year, allocates core funding to each institute/centre in that country based on its performance over the previous year. A variety of factors are weighed in a simple equation to determine how much each centre receives. Crucially, maximising the core funding can only be done by winning a healthy proportion of direct industrial work, but not too much. Thus a Fraunhofer centre maintains the fresh understanding of the cutting edge through some projects and hones its skills in delivering the practical in others.

Each centre director is motivated to maximise their core funding as this allows the exciting exploration of new ideas through PhD studentships, a measured number of internal priming projects, and purchasing new capital equipment. Delivering well for industry leads to the freedom to be ahead of, and therefore more attractive to, industry next year. A simple, positive feedback loop, maximises effectiveness through tensioned motivations.



A Quantum Tech laser source, commercialised with Alter Technology TUV Nord Ltd.

To generate return on Government investment the control of tensioned motivations is more powerful and effective than toothless metrics or KPIs, let alone measuring how quickly the money is spent. Fraunhofer centres are inherently trained to provide the latest practical technology.

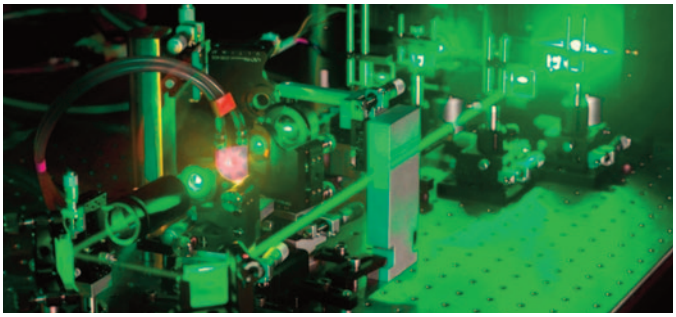
KEYS TO THE FUTURE

The Innovation Strategy identifies key technologies. We welcome this clarity and the understanding that for the UK to have successful industries, these underpinning, enabling or 'transformative' technologies will be required and having these tools ready and sharpened makes their use in commercialisation considerably more likely. Complex new technologies often require novel progress simultaneously in electronics, materials, photonics, AI and many of the key technologies prioritised. The more of these specialisms within easy reach the more rapid progress can be made. At the same time the UK cannot do everything alone so must choose topics where we are already excellent and build on success and make best use of our supply and knowledge partners elsewhere.

These key technologies can all be addressed with a proven model, proven internationally, and in the UK, with a self-limiting control mechanism, no need for endless reviews or bottomless budgets. All a bit boring perhaps, dare I say Germanic, but effective. Proudly embracing and adapting other nation's models may become a habit. ARIA, inspired by USA's DARPA, is the high-risk high reward route, which we welcome too, as there must be room in the UK portfolio of investments for a full range of risk.

ROOM FOR MORE

All our colleagues in Fraunhofer CAP, Glasgow, find that the challenges of working for and with industry on accelerating innovation is both famishing and satisfying. Our stakeholders too are sated with £13 of new R and D cash being raised for all partners, from every taxpayer £1 consumed by Fraunhofer CAP. The more we do, the more we crave. In Germany they say "der Appetit kommt bein Essen", hunger emerges whilst eating.



A novel laser set-up in Fraunhofer CAP's lab, before packaging.

Innovation centres building on our excellent university base, with the right motivations and feedback control from customers and stakeholders alike, can ensure that their offerings meet

the needs and ambitions of a boldly innovative UK.

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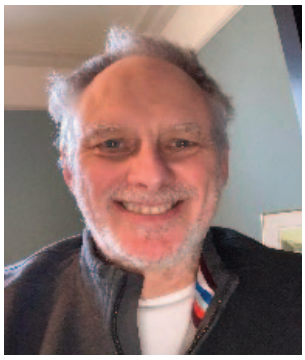
P.S.
GERMAN SUPER-MODEL MARRIES BRITISH GENIUS

In a perfect match of ambition and opportunity they tied the knot in 2012. Lord Drayson, then Science Minister, introduced the happy couple in 2009.

The German super-model of innovation, Fraunhofer-Gesellschaft, is highly regarded around the globe for its effectiveness. Invited to get hitched with a UK university, Fraunhofer courted many but found the perfect partner in Glasgow, the University of Strathclyde.

Common interests and mutual respect were already strong with these two, with complimentary depth of character in laser expertise and supportive communities around them both. The relationship blossomed and the 10th Anniversary party is set for 2022. □

GENE EDITING – A BRIGHT TOMORROW OR A FALSE DAWN?



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Gene editing is one of the buzz phrases in modern molecular biology. Thanks to high-profile controversy over the past decade and more recent positive press, the term has even entered more common usage. Gene editing involves the alteration of the function of genes through relatively subtle changes (edits).

Controversy notwithstanding, these changes are both carefully considered and enacted so as to ensure that what is achieved is precisely what is targeted. The future of medicine and of the human race itself may depend on gene editing technology and its application.

THE SCIENCE OF GENE EDITING

Genes are strings of DNA that carry the code to make proteins with a specific function. Gene editing (changing the code in a planned way) has some conceptual similarity to restriction enzymes. Restriction enzymes work by recognising a specific DNA sequence then cutting it. Each restriction enzyme just recognises one specific DNA sequence. Gene editing has a similar starting point but the recognition site can be changed in a specific way and the DNA joined together again. In gene editing, a recognition site is identified in the lab and an enzyme cuts the DNA in the cell at this specific point. The researchers then allow the cells' own repair machinery to either join the DNA together again or to insert a new piece of DNA. In this way a gene can be specifically modified (edited).

Gene editing techniques have been known for over 20 years, however the breakthrough that led to the Nobel Prize in chemistry being awarded to biochemist Jennifer Doudna and microbiologist Emmanuelle Charpentier was the use of the cutting enzyme Cas9 and a targeting system called CRISPR. The CRISPR-Cas9 system has a short sequence of RNA that binds to a specific target sequence of DNA. The Cas9 enzyme is already joined to the RNA. The enzyme then cuts the DNA sequence at the specific point. The two ends can be joined up again with another sequence inserted. In this way the CRISPR-Cas9 system can make changes to specific points in specific genes.

While the CRISPR-Cas9 system has perhaps had the most

significant amount of publicity, two other editing systems are also used. Zinc-finger nucleases (ZFN) have a zinc-finger protein (ZFP) fused to the cleavage domain of a restriction enzyme. By changing the ZFP it is possible to alter the specificity of the binding region. Transcription activator-like effector nucleases (TALEN) systems similarly have a protein sequence that can recognise specific DNA sequences and which can then be cut by the cleavage enzyme. In all cases repair and inclusion of a generated sequence can be carried out.

for enhanced nutrition and food production.

With a tool as precise and exact as gene editing, much of the interest has been driven by looking at diseases in which single point gene alterations could have an impact. The application of gene editing in these cases is still being assessed –often in animal models – however the potential for genetic interventions to deal with more complex diseases is also being studied. It should be noted, however, that gene editing is not a short cut to cures. It is still necessary to understand how the disease process is initiated and plays out. Indeed, if gene editing is to be part of an effective treatment protocol, then this type of understanding is even more important. Some of the most important diseases that may be amenable to gene-based treatments are shown in Table 1

THE APPLICATION OF GENE EDITING - DISEASE

Much of the interest in gene editing has centred around potential applications. These have, not surprisingly, focused on the prevention or treatment of human (or animal) disease and the improvement of plants

and others have been described[1]. It should be emphasised that there are currently no first line gene therapy solutions to human diseases, however as technical and mechanistic knowledge increases these will become more usual as a preferred option. There are a number of issues that may impact upon the delivery of successful therapies including delivery of the gene editing machinery to the cell and the host immune response to an engineered protein.

In addition to those diseases with a known specific causal gene, there are others for which the complex interplay of several genetic factors may be implicated. These include a range of metabolic diseases and conditions.

THE APPLICATION OF GENE EDITING – PLANTS

Increasing population levels, global warming, the exhaustible nature of resources and loss of agricultural habitat have all contributed to the widespread realisation that we live on a planet with finite resources whose limits are fast being approached. While the resilience of the planet's ecosystem is being tested by the demands made on it, this is not merely some esoteric discussion but rather a clear and present danger for humans. In 1800 the global population was around 1bn and the annual growth rate was 1%. Between 1900 and 2000 population growth accelerated and the population rose to over 6bn. Current predictions suggest that the global population will reach 9.7bn by 2050. Thanks to the Green Revolution with increased use of plant protection agents, fertilisers and improved agronomic practice, yields have increased – particularly in the second half of the 20th century. This has now ceased and global yields of major crops are stagnant [2]. While plant and animal breeding has been of significant value, the use of gene editing techniques could be an important tool in the quest to produce more food for the growing population.

While genetically modified (GM) crops have been developed successfully, there is a degree of resistance among some parts of the population

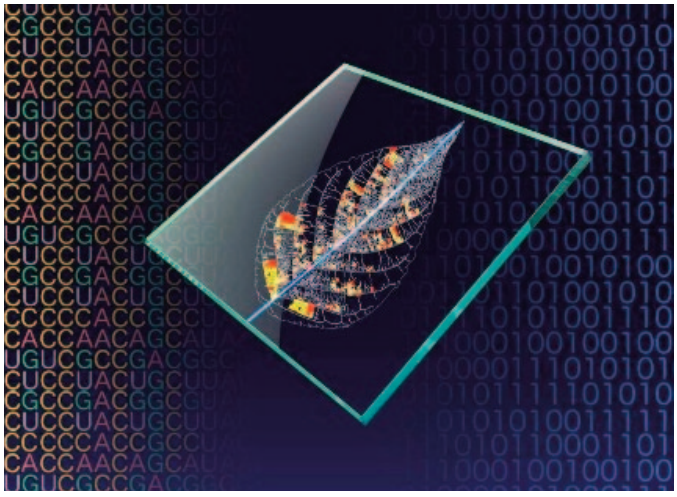
DISEASE	GENETIC BASIS	APPROACH
Cystic fibrosis	CFTR gene mutations	Repair of the most common mutations.
Neurodegenerative diseases (Alzheimer's, Parkinson's)	Multiple genetic factors involved in the disease and in susceptibility including beta amyloid, APOE4, alpha synuclein and others.	Mechanistic studies to determine gene/ disease interactions.
Blindness (e.g. congenital amaurosis, glaucoma and other diseases with mutation as a contributing factor)	Various subtypes caused by mutations in different genes	A range of target mutations have been approached with varying degrees of success in animal models.
Muscular Dystrophy	Dystrophin gene mutations	Correction of mutant alleles and production of functional protein.
Cancer	Multiple including evasion of the immune system, tumour suppressor genes and others	Modification of T cells, repair of tumour suppressor genes.
Huntington's Disease	Mutant Huntingtin (HTT) gene	Reduction of expression of HTT protein. Use of animal models with HTT gene expressed to examine mechanisms.

Table 1 – Genetic diseases that may be amenable to gene editing approaches

worldwide. Whether this resistance remains as more and more crops are modified using 'conventional' GM technology and no significant adverse effects are noticed, remains to be seen. The use of more specific gene editing techniques combined with technologies such as rapid breeding and next-generation genotyping linked to specific trait identification and phenotyping will allow crops to be developed faster, with larger yields, greater pest and climatic (e.g. drought) resistance and more healthy product profiles (e.g. better vitamin and micronutrient profiles).

THE NEED FOR REGULATION

The use of gene edited techniques in plants (and potentially in farm animals) offers a very precise way of making specific changes that will provide benefits to the farmer, processor, food producer and, ultimately, the consumer. In order to realise these benefits, robust and appropriate regulation must be in place and must have the trust of all stakeholders.



The European Court of Justice ruled in 2018 that techniques to alter the genome of an organism should be governed by existing EU rules on GMOs. The European Commission however concluded that its 2001 legislation was "not fit for purpose". The question revolves around whether any alteration to the genetic material of a plant is by definition GM (as Greenpeace and others argue) or whether gene editing simply accelerates processes that occur naturally (as the biotech industry and scientists active in the area contend). The resolution of this question will be crucial to science, industry and, ultimately to feeding the planet.

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ZERO CARBON BUILDINGS AND COVID

Dr Shaun Fitzgerald OBE FREng
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Fellow, Girton College

Covid-19 has wreaked havoc on the world in so many devastating ways over the last 18 months. One of the major learnings about the SARS-CoV-2 virus is that ventilation of buildings can be a really effective way of reducing the risk of transmission. Sir Patrick Vallance, the Government's Chief Scientific Adviser, commissioned a report from the Royal Academy of Engineering on how to reduce the risk of infection indoors. In the study, published on 16 July 2021, the experts say there is an "urgent need" to improve ventilation.

The recommendations are that multiple occupancy spaces should be well ventilated in order to minimise the build-up of virus should there be infectious persons present. The benefits of a well ventilated space go beyond helping reduce the risk of transmission of SARS-CoV-2; higher ventilation rates can lead to enhanced levels of concentration, reduced likelihood of mould growth, and reduced risk of transmission of other airborne pathogens.

It is relatively easy to deliver plentiful amounts of outdoor air when it is late spring or early summer. If a building is ventilated with opening windows, then throwing these open to flood the space with outdoor air can create a very natural and pleasant space. However, there are questions about the appropriate amount of ventilation in colder weather

especially as we need to reduce the energy consumption of buildings.; how does increased ventilation in cold weather square up with reducing heating energy? This is a particularly pertinent question as the UK looks forward to helping host COP26 in November 2021.

One of the main challenges we face regarding the reduction in energy use of many current buildings lies in addressing the heat loss through conduction, the loss through uncontrolled air leakage, and the loss via radiation. It is true that increasing the flow rate in winter can lead to increases in energy use, but only if the current strategy and systems are good – in many cases it will be possible to improve the strategy or system and not only provide more air flow during the occupied period, but reduce energy use too.

Improving insulation levels helps to reduce the heat lost by conduction through the building fabric. Action is needed to not only improve the insulation of panels, but also the quality of the areas where they are joined. These areas are given the term 'cold bridges' and can effectively undo the benefits of improved insulation in a building façade.

The second action of helping seal up gaps in the building fabric means that when a building is empty, it will not leak out the warm air from the previous day or occupied period. This will then help keep the building warm and reduce the need for the heating system to come on prior to the occupied period to pre-heat the building. Finally, installing coatings on windows or foil-backed insulation in the attic space can help reduce heat loss by radiation.

Once the building fabric has been upgraded to a good level, then when the building is occupied, the space can be well ventilated even in cold weather without excessive energy use. The reason is that natural heat gains within the space can often be sufficient to maintain the interior at a comfortable 21C and provide ventilation of around 10 litres/second/person without additional heating or a heat recovery scheme, even when the external temperature falls down to 5C. The combined heat gains from IT equipment, lighting, solar, and the occupants themselves are considerable (often something like 200W/person). As long as the ventilation system is designed and operating to exploit these heat gains by pre-mixing the incoming cold air with warm room air, adequate levels of ventilation can be provided without cold draughts.

Unfortunately, many existing buildings have poorly maintained ventilation systems. For example, if a building has opening windows, not all of the windows may be in fact work. It is a fact of life that many windows which are at low level and easily accessed by occupants are better maintained than higher level windows. Consider sash windows for example – the bottom sashes are much easier to open than the top ones, so these get used. Top windows can get painted shut, and they are then basically out of action. Whilst losing a few opening windows may not seem particularly problematic in the spring or autumn, it really is a problem in winter if they are the top ones. The reason is that by cracking open all the high level windows a small amount you can get rather good levels of ventilation but without cold draughts – the incoming cold fresh air can mix with the air in the space and be warmed before it hits the nearest occupant. Without the high-level windows, in cold weather people will find it intolerable to be provided with the same level of ventilation directly via low level windows. The first option is that occupants will close them, and this is what we need to avoid from a health perspective now. However, if there are radiators under the windows, these will get used to ameliorate the cold draughts, even though the heating itself isn't needed from an energy perspective. This is what we need to avoid from a climate perspective.

Finally, there is a question regarding the balance of ventilation in winter to reduce risks of SARS-CoV-2 transmission to an acceptable level whilst also keeping energy use low. The current thinking is that risks of SARS-CoV-2 transmission reduce with increased levels of ventilation. However, there is a law of diminishing returns; once a reasonable level of ventilation has been achieved, the benefits in terms of SARS-CoV-2 transmission risk reduction get ever smaller for each litre per second person of outdoor air provided. However, the energy costs continue to rise. Therefore, the focus should be on addressing buildings which don't meet the current building regulation standards for ventilation because it is these buildings which arguably present the greatest risk for transmission event, and which are likely also to be the higher energy consuming buildings as a result of poor building fabric and systems.

Well designed and maintained ventilation systems can help overcome the challenges of Covid-19 resilience and contribute to the transition to zero carbon buildings. It is not a choice between Covid-19 and climate friendly buildings; it is a case of improving buildings to meet both goals. □

Example of building designed for Monkseaton High School (Newcastle) with ventilation provision being considered from the outset and e-stack units atop the roof. Photo courtesy of Breathing Buildings.

CLIMATE CHANGE IS THE ELEPHANT IN EVERY ROOM.

The UCL Climate Action Unit helps MPs and Peers to discover *how* to act.

The UCL Climate Action Unit aims to transform how society acts on climate change. Its approach is underpinned by a systems-based understanding of why governments, businesses and citizens are not acting at the scale and pace needed - and how this can be resolved. Earlier this year the Climate Action Unit worked with a group of MPs and Peers to explore how to - in the words of one participant - "play the best leadership role that we can".

Freya E Roberts, Programme Coordinator, UCL Climate Action Unit

Andrew Jackson, Programme Lead, UCL Climate Action Unit

Dr Kris De Meyer, Neuroscientist, UCL Climate Action Unit

Dr Lucy Hubble-Rose, Expert Facilitator, UCL Climate Action Unit

Professor Chris Rapley CBE, Climate Scientist, UCL Department of Earth Sciences

It's no easy job working in Parliament. It requires the ability to grasp the minutiae of a host of challenging issues affecting public life, as well as the skill to handle complex and wicked problems - without any subject-specific training to do so. This is especially the case for MPs and Peers confronted with the need to take action on climate change.

THE CONTEXT

Ask people in the street where the main responsibility lies for tackling this global crisis, and more than half will say: "It's up to governments".[1] "What can *I* do?" individuals often ask - implying 'not all that much'. And yet we expect our representatives to know what to do, even though they, like us, are citizens too.

Despite being awarded a prestigious title, the job comes with very little training or preparation. This is acutely true for parliamentarians working on the difficult subject of climate change. Newly appointed representatives who abruptly need to become a master of all trades can find themselves having to learn on the job.

That's not to say they don't have access to the world's best experts when it comes to the science: they absolutely do. University academics and research institutions provide parliament with comprehensive briefings.[2] MPs and Peers also have access to the world's foremost summary of climate science for policy makers: the IPCC report.[3] The UK government even has its own independent committee to advise how the nation can cut its carbon emissions: the Climate Change Committee.

THE CHALLENGE

But understanding climate science doesn't really help people know how to act on it - just as understanding the biology of cancer doesn't make us qualified to be a doctor. The acting part requires special skills, practice and experience. And acting on climate change is something all parliamentarians will need to do, since there is no area of public life which will ultimately be unaffected by the issue.

This is an enormous undertaking. So who or what provides that support; that place for MPs and Peers to develop a toolkit of skills fit for the challenge? This is the unmet need the UCL Climate Action Unit set out to fulfil. In March 2021, it delivered its first

UCL Climate Action Programme for UK Parliament - Key Facts

Eligibility: open to MPs and Peers from either House and all parties

Specifics: 5 online sessions delivered in March 2021

Aim: a series of activities to examine how people respond to the complex nature of climate change

Participant demographics: MPs from the Conservative, Labour and Scottish National Party, plus crossbench Peers. From rural and inner city regions across several nations

Figure 1

Climate Action Programme for UK Parliament (see Figure 1).

POLITICIANS ARE PEOPLE TOO

Research by Prof. Rebecca Willis, several years ago, already established that simply understanding climate change is insufficient to drive large-scale action. After conducting interviews with 14 MPs in 2017,[4] Willis explained:[5] "The politicians I spoke to understood the need to act on climate change. But it's long been known that the way in which people act on scientific evidence is complex. We don't just look at the evidence and calculate a rational response; instead our understanding is mediated by our social setting, outlook and experience. Politicians are no exception."

This idea – that acting on climate change can't be done without dealing with people factors - is at the core of the Climate Action Unit's work. These 'people factors' are the individual differences in perception, opinion, lived experience, knowledge, understanding, values, worldviews etc. All of these affect how the stakeholders involved engage in delivering concrete climate policy or action.

And so over the course of five weekly online sessions, a group of MPs and Peers were introduced to a set of psychological barriers and levers to improve the delivery of action on climate across society. These are succinctly known by the Climate Action Unit as 'the seven insights' (see Figure 2).

THE INSIGHTS

The programme is designed by a neuroscientist, a climate scientist and communication specialists – which explains its atypical approach. If participants had wanted a geography lesson, they weren't going to get one. Instead, the programme introduced them to the science of how people become divided on what actions are meaningful – a form of political polarisation. Or how an individual's values affect what kinds of messages and actions resonate with them.

The participants also explored how stories of impending climate disaster often fail to drive action. Instead, what drives action is... **action**[6]. It may sound paradoxical, but by starting with the 'doing' - even if imperfect at first - one action will lead to the next. As a result individuals build their understanding and ability to do ever more.

There were lessons too about the language used to talk about climate change. One of the CAU insights illustrates the perils of using abstract and technical terminology - particularly because such words will develop different meanings with different audiences. "Ask a climate scientist and a risk expert what 'conservative risk estimate' means and you may find their interpretations of the word are actually the opposite of each other", explained neuroscientist De Meyer.

THEORY APPLIED

From the outset, participants were given the space to apply these insights to the context of their own climate-related challenges. Some wanted to know how to deal with their constituents' indifference and how to get climate change higher on their agendas. One MP was facing a constituency divided on Low Traffic Neighbourhoods (LTN); a local government scheme which has proven to be particularly polarising. Others were struggling to work out how to accelerate the uptake of low-carbon technologies in a particular sector (e.g. agriculture or shipping).

The programme is fundamentally about effective collaboration and communication: how MPs and Peers could do it better, and generate more action on climate change as a result.

In one particularly poignant conversation, two MPs who had been on opposite sides of a high-stakes debate earlier that day, came to realise that action on climate change could be worked out with something other than divisive party politics. The alternative? "Taking forward more cross-party backbench climate initiatives", resolved one

Figure 2

of them at the end of the programme.

UNCONVENTIONAL OUTCOMES

The aim of the programme was to enable parliamentarians to think differently about their own levers for action. Feedback gathered during the programme suggests it worked.

"I really valued the opportunity to take a few steps back and consider the thought processes and instincts which underpin so much of our communication in relation to climate change," said one Labour MP.

"I understood the importance of seeing their challenge from another person's viewpoint, filtered through someone else's value system" added a Crossbench Peer.

Aside from sharing golden nuggets on how our human brains respond to the challenges of tackling climate change, the programme did something very simple and practical for the MPs and Peers involved. It provided a confidential and non-judgemental 'space' for reflection.

When asked what they liked most about the programme, one responded simply: "the chance to think". Another commented on how the environment created during the programme enabled "stimulating discussions" to happen across parties and houses.

NEXT STEPS

So what's next for this unusual parliamentary intervention? The Climate Action Unit is keen to deliver the programme for future cohorts. With COP26 fast approaching, and the real nuts-and-bolts work that will need to happen afterwards, there is no time like the present.

"I strongly recommend this programme to any colleagues thinking about taking part" one MP remarked at the end of session 5 of the programme. "All of us have a responsibility to be working on climate change, and all of us have a responsibility to make sure that we are properly equipped to play the best leadership role that we can."

"Ask a climate scientist and a risk expert what 'conservative risk estimate' means and you may find their interpretations of the word are actually the opposite of each other", explained neuroscientist De Meyer.

So here is an open invite: If you are an MP or Peer who wants to take part in the next iteration of the Climate Action Programme for UK Parliament, email climateactionunit@ucl.ac.uk.

Sending an email is the first action: let's see where it leads.

Website: https://www.ucl.ac.uk/public-policy/climate-action-unit

References

1 Source: YouGov Plc. Total sample size was 2,093 GB adults (18+). Fieldwork was undertaken between 28th - 29th April 2019. The survey was carried out online. In response to the multiple-choice question "Who do you think has the most responsibility for addressing the issue of climate change?" 53% of respondents answered 'government'; 12% answered 'businesses'; 18% answered 'individuals' and 17% answered 'others/don't know'.

2 POSTnotes on climate change, UK Parliament website.

3 IPCC, 2021: Summary for Policymakers. Climate Change 2021: The Physical Science Basis. Cambridge University Press.

4 Willis, R., 2017. How Members of Parliament understand and respond to climate change. The Sociological Review, 66(3), pp.475-491.

5 Willis, R., 2017. What does climate change look like through the eyes of a politician? Green Alliance blog

6 De Meyer et al, 2020. Transforming the stories we tell about climate change: from 'issue' to 'action'. Environmental Research Letters, 16 (1), p.015002. □

NATURAL CAPITAL: WHY? WHAT? HOW? AND WHO?

Professor Nicola Beaumont
Head of Science, Sea and Society
Plymouth Marine Laboratory

"Natural capital refers to the elements of nature that produce value or benefits to people (directly or indirectly), such as the stock of forests, rivers, land, minerals and oceans, as well as the natural processes and functions that underpin their operation" **(Natural Capital Committee, 2014).**

WHY NATURAL CAPITAL?

The dependence of human wellbeing on healthy environmental systems is long established. Historically, whilst we lived in close connection with the environment that sustained us the significance of this relationship was explicitly apparent. *Indigenous communities across the world have ancient practices based entirely around the concept of understanding, valuing and respecting nature's benefits*. The understanding that if we damaged the natural world we would in turn be damaged was embedded in our culture. *In 400BC Plato described the link between human deforestration and the loss of soil stability and spring water provision with catastrophic consequences for the associated communities*.

During the past 150 years our reliance on the environment has not changed, but our relationship with the natural world has. The estrangement of

society from nature began most notably during the industrial revolution and intensified through the 20th century. Globalisation has further distanced societies from the environments on which they depend. *According to a 2008 National Trust survey, one in three could not identify a magpie; half could not tell the difference between a bee and a wasp; yet nine out of ten could recognise a Dalek*. As society has become increasingly separate from the environment, we have become increasingly unaware of the consequences of the decisions we make. This poorly informed decision making can often lead to over-exploitation and environmental degradation. This environmental damage has the same negative implications for human wellbeing as it has for centuries, but as the connections between our actions, environmental decline and human suffering are incredibly complex, it is now near impossible to conceptualise these linkages. *An example of this is the increasing appetite for avocados, in part due to aspirations to increase plant-based diets, that has led to environmental issues including deforestation and increased greenhouse gas emissions, which in turn have negative implications for human wellbeing*.

This disconnect from nature and the ensuing negative impacts on both the environment and humans, is an unfortunate, unintended, and unexpected consequence of industrialisation and globalisation, but it can equally be argued that it is unnecessary and avoidable. In the 1960s the awareness that our actions were unsustainable gathered momentum. *Carson's book "Silent Spring" (1962) played a key role in reminding society of the intrinsic coupling between human development and the environment*. This awareness inspired a rise in the environmental movement, but also a growth in academic fields and policies focused on de-coupling human activity from environmental degradation to support sustainable development. *Economists such as Pearce (1989) pioneered a 'new' sub-field, namely environmental economics, which brought the environment to the core of economic theory. In parallel, concepts such as 'Planetary health' referring to "the health of human civilization and the state of the natural systems on which it depends" were developed (Whitmee et al. 2015)*. At the heart of these activities is a need to understand societies dependence upon the environment, what was once implicit due to our close connection to nature now requires conscious endeavour. The Natural Capital approach unites previous activity making the linkages between humans and their environment explicit and providing a key to enabling development whilst avoiding environmental degradation and to safeguard human health and our economies. *Costanza et al. (1997) valued the world's ecosystem services at US$33 trillion per year.*

Whilst the ecosystem service approach focused on the flow of benefits to humans, it was less comprehensive in understanding the source ecosystem, the associated beneficiaries and the resultant values. To address the accompanying economic and social decline.

WHAT IS NATURAL CAPITAL?

In 1977 the term ecosystem services was coined (Westman 1977), meaning *'the benefits provided by ecosystems that contribute to making human life both possible and worth living'* (UK National Ecosystem Assessment 2011), including food provision, climate regulation, and a host of cultural benefits such as recreation and tourism. This concept elucidates the importance of being environmentally aware if we are

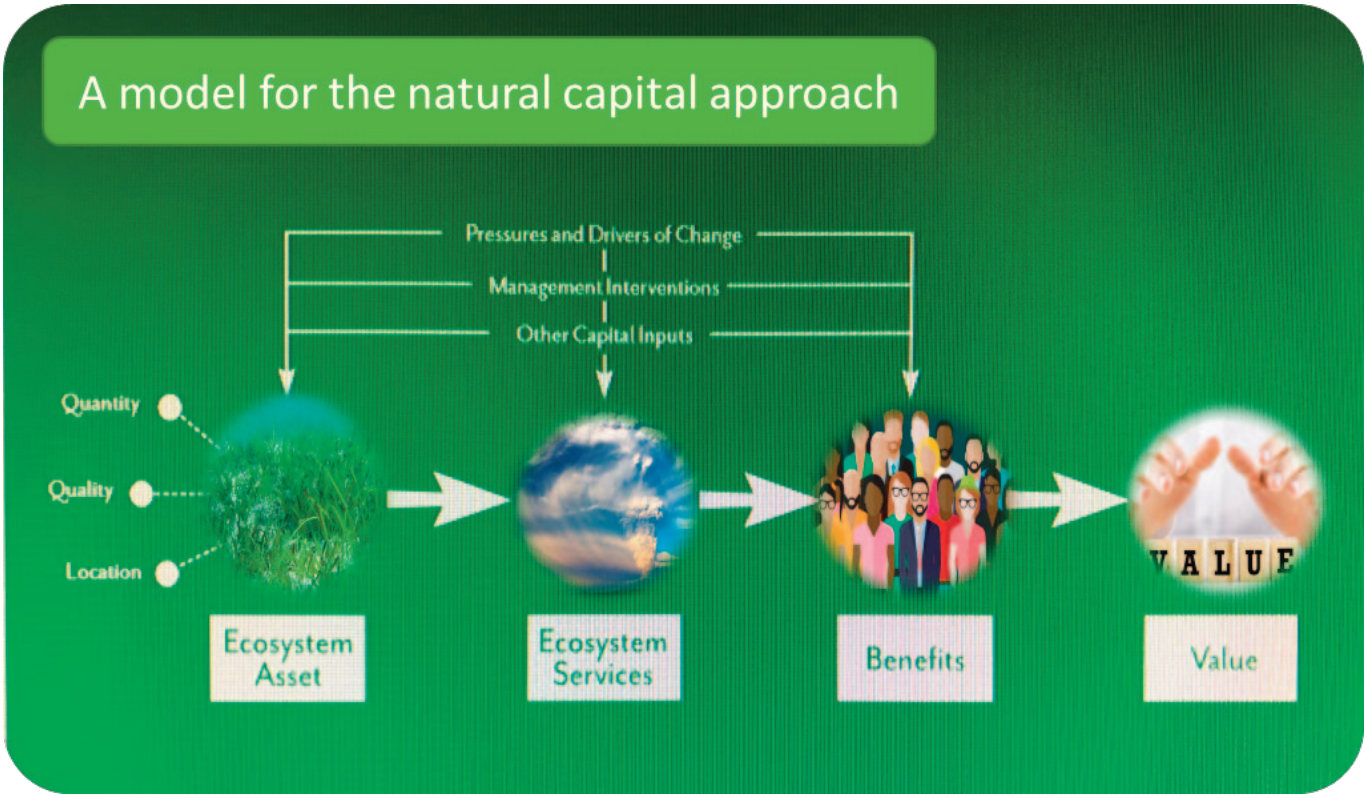

Figure 1: Generalised natural capital logic chain (Lear et al. 2020)

these gaps the Natural Capital concept was developed (Figure 1), providing a framework to clarify the linkages between the ecosystem stocks or assets (e.g. forests), the services they provide (e.g. timber and carbon sequestration), and the resultant benefits and values (e.g. wood to build houses and an equable climate). This framework facilitates the understanding of societies dependence upon a healthy environment, the full implications of our actions, and as such informs sustainable decision making.

HOW IS NATURAL CAPITAL APPLIED?

To utilise Natural Capital in decision making it can be considered within a broader context. There are five foundational assets which support human wellbeing: produced (manufactured), produced (financial), natural, social and human capital (Figure 2). The recently published *Dasgupta Review (2021) estimates that natural capital forms 22.6% of all capital*. For wellbeing to be sustained and increased over generations these capital stocks should be enhanced rather than depleted or degraded. However, in the majority of developments, from house building, to the energy transition, to healthcare choices, there will be a requirement for some substation between the different types of capital. *"There are no solutions. There are only trade-offs." Thomas Sowell*. When decisions are made between different options the various costs and benefits will be distributed across the different capital types, and also across different people, space and time (Bateman and Mace 2020). For example, restoring saltmarsh might increase carbon sequestration and reduce coastal erosion, but it may also mean that the area can no longer be used for conventional agriculture. Historically there has been a tendency to over-exploit or degrade the Natural Capital component due to its "free" availability and difficulties in quantification. The unsustainable use of this capital will however have immediate ramifications for the other capitals as they are all fundamentally reliant on natural capital. The Natural Capital approach aims to bring this element onto a level footing with the other capitals, providing guidance for decision makers in measuring and understanding the full trade-offs between potential future scenarios.

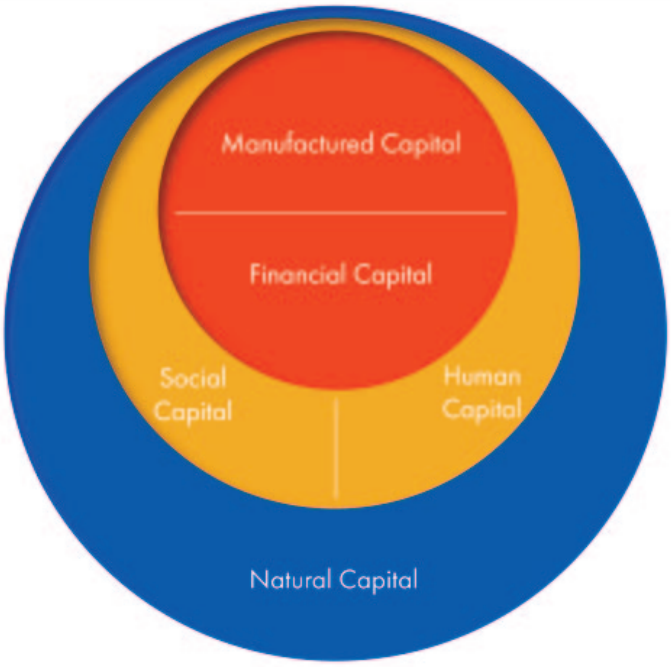

Figure 2: The Five Capitals - a framework for sustainability. Forum for the Future

WHO IS NATURAL CAPITAL FOR?

The Natural Capital approach clarifies the consequences and potential trade-offs of future options and as such is relevant to all decision makers. Natural Capital and ecosystem service concepts are now ingrained in UK policies, *HM Government, Natural Environment White Paper (2011), HM Government, 25 Year Plan to Improve the Environment (2018))*. The UK Natural Capital Committee was established in 2012 to act as an independent body to advise government in achieving their vision *'to be the first generation to leave the natural environment in a better state than it inherited'* using a Natural Capital approach to drive this change (Natural Capital Committee, 2014). Stemming from this Defra currently lead a Natural Capital & Ecosystem Assessment (NCEA) Programme to evidence and test how natural capital can be used to support policy decision making with an aim to develop a 3 year transformation programme. Further resources on Enabling a Natural Capital Approach (ENCA), including data, guidance and tools are available online: https://www.gov.uk/guidance/enabling-a-natural-capital-approach-enca

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The Parliamentary & Scientific Committee's STEM for BRITAIN 2022, hosted by Stephen Metcalfe MP, will take place in the Houses of Parliament on Monday 7th March, during British Science Week

Applications are open from early-career research scientists, engineers, technologists and mathematicians who wish to exhibit posters in one of the following five areas:

- **Biological and Biomedical Sciences**
- **Chemistry**
- **Engineering**
- **Mathematics**
- **Physics**

The closing date for applications is Monday 6th December 2021.

A wide range of important scientific, engineering and mathematics institutions and organisations are lending their support to this event, including the Royal Society of Biology, the Institute of Physics, The Physiological Society, the Royal Society of Chemistry, the Royal Academy of Engineering, the Council for the Mathematical Sciences, Dyson Ltd, the Institute of Biomedical Science, the Clay Mathematics Institute, the Nutrition Society, the Heilbronn Institute, United Kingdom Research and Innovation, Society, the Biochemical Society, and the Society of Chemical Industry.

This reflects the importance we all attach to the encouragement of researchers at this stage in their careers.

Prizes will be awarded for the posters presented in each discipline which best communicates high level science, engineering or mathematics to a lay audience.

The Westminster Medal for the overall winner will be awarded in memory of the late Dr Eric Wharton, who did so much to establish SET for Britain as a regular event in the Parliamentary calendar.

In promoting STEM for BRITAIN 2022 we are inviting Members of Parliament who have a University or Universities in their constituency to write to the Vice-Chancellor encouraging their early career science and engineering researchers to apply.

Members of the Parliamentary and Scientific Committee are requested to flag up this prestigious event through their various networks and on social media.

Full details of the competition and exhibition including the application form can be found on the STEM for Britain website at: www.stemforbritain.org.uk.

HOUSE OF COMMONS SELECT COMMITTEES

BUSINESS, ENERGY AND INDUSTRIAL STRATEGY COMMITTEE

The Business, Energy and Industrial Strategy Committee scrutinises the policy, spending and administration of the Department for Business, Energy and Industrial Strategy and its public bodies, including Ofgem, the Financial Reporting Council and the Committee on Climate Change.

The Committee regularly holds accountability evidence hearings with Government Ministers and with bodies such as the Financial Reporting Council, the Committee on Climate Change and Ofgem. The BEIS Committee also hears from a range of stakeholders in the course of its work, receiving evidence from academics, business groups, NGOs and charities to its inquiries

Membership:

Darren Jones MP, Labour, Chair
Alan Brown MP, Scottish National Party
Judith Cummins MP, Labour
Richard Fuller MP, Conservative
Nusrat Ghani MP, Conservative
Paul Howell MP, Conservative
Mark Jenkinson MP, Conservative
Charlotte Nichols MP, Labour
Sarah Owen MP, Labour
Mark Pawsey MP, Conservative
Alexander Stafford MP, Conservative

Inquiries:

- Net zero and UN climate summits - Opened 6 March 2020. Government response published 17th May 2021.
- The impact of coronavirus on businesses and workers - Opened 13 March 2020. Government response published 19th May 2021.
- Delivering audit reform - Opened 18 March 2020.
- Work of the Department and Government Response to coronavirus - Opened 14 April 2020
- Post-pandemic economic growth - Opened 3 June 2020.
- Post-pandemic economic growth: Industrial Strategy – Opened 23rd July 2020. Government response published 24th September 2021.
- Post-pandemic economic growth: Levelling up local and regional structures and the delivery of economic growth – Opened 24th July 2020.
- Forced Labour in UK value chains – Opened 18th September 2020. Government response published 8th July 2021.
- Decarbonising heat in homes – Opened 2nd October. Accepting written evidence until 13th November 2020.
- Business and Brexit preparedness – Opened 17th November 2020.
- Mineworkers' Pension Scheme – Opened 18th March 2021. Government response published 5th July.
- Findings of the Report of Climate Change Assembly UK – Opened 19th April 2021. Government response published 9th September.
- Liberty Steel and the Future of the UK Steel Industry – Opened 27th April 2021.
- Net Zero Governance: Opened 23rd June 2021.
- Post-pandemic economic growth: State Aid and Post Brexit Competition Policy. Opened 23rd September.

For further details: Tel: 020 7219 5777 Email: beiscom@parliament.uk

ENVIRONMENTAL AUDIT COMMITTEE

The remit of the Environmental Audit Committee is to consider the extent to which the policies and programmes of government departments and non-departmental public bodies contribute to environmental protection and sustainable development, and to audit their performance against sustainable development and environmental protection targets.

Unlike most select committees, the Committee's remit cuts across government rather than focuses on the work of a particular department.

From its beginning in 1997, in carrying out its environmental 'audit' role the Committee has had extensive support from the National Audit Office, providing seconded staff and research and briefing papers.

Membership:

Rt Hon Philip Dunne MP, Conservative, Chair
Duncan Baker MP, Conservative
Dan Carden MP, Labour
Sir Christopher Chope MP, Conservative
Barry Gardiner MP, Labour
Rt Hon Robert Goodwill MP, Conservative
James Gray MP, Conservative
Helen Hayes MP, Labour
Ian Levy MP, Conservative
Caroline Lucas MP, Green Party
Cherilyn Mackrory, Conservative
Jerome Mayhew MP, Conservative
John McNally MP, Scottish National Party
Dr Matthew Offord MP, Conservative
Claudia Webbe MP, Independent
Nadia Whittome MP, Labour

Inquiries

- Preparation for COP26 - Opened 17 March 2020.
- Greening the post-Covid Recovery - Opened 13 May 2020. Government response published 22nd June 2021.
- Energy Efficiency of Existing Homes - Opened 18 May 2020. Government response published 13th May 2021.
- Biodiversity and Ecosystems – Opened 13th July 2020
- Fixing Fashion follow up – Opened 6th October 2020

- Technological Innovations and Climate Change: Tidal Power –Opened 9th November 2020
- Green Jobs – Opened 17th November 2020.
- Water Quality in Rivers – Opened 8th December 2020.
- Next steps for deposit return schemes – Opened 12th February 2021.
- Technological Innovations and Climate Change: Community Energy – Opened 19th February
- Sustainability of the built environment – Opened 25th March 2021
- Technological Innovations and Climate Change: Supply chain for Battery Electric Vehicles – opened 4th May 2021
- Mapping the path to net zero: Opened 25th June 2021.
- Net zero aviation and shipping: Opened 20th July 2021.
- Carbon border adjustment mechanism: Opened 24th September 2021.

For further details: Tel: 020 7219 5776 Email: eacom@parliament.uk

SCIENCE AND TECHNOLOGY COMMITTEE

For further details: Tel: 020 7219 2793

Email: scitechcom@parliament.uk

The work of many Government departments makes use of — or has implications for — science, engineering, technology and research. The Science and Technology Committee exists to ensure that Government policies and decision-making are based on solid scientific evidence and advice. It is chaired by Greg Clark MP.

The Committee has a similarly broad remit and can examine the activities of government departments that make use of science, engineering, technology and research (otherwise known as science for policy). In addition, the Committee scrutinises policies that affect the science and technology sectors, such as research funding and skills (often referred to policy for science).

Membership:

Rt Hon Greg Clark MP, Conservative, Chair
Aaron Bell MP, Conservative
Dawn Butler MP, Labour
Chris Clarkson MP, Conservative
Katherine Fletcher MP, Conservative
Andrew Griffith MP, Conservative
Mark Logan MP, Conservative
Rebecca Long-Bailey MP, Labour
Carol Monaghan MP, Scottish National Party
Graham Stringer MP, Labour
Zarah Sultana MP, Labour

Inquiries

- UK Science, Research and Technology Capability and Influence in Global Disease Outbreaks.
  Opened 20 March 2020. Government response published 14th May 2021.
- Commercial genomics - Opened 9 April 2020.
- The role of technology, research and innovation in the COVID-19 recovery – Opened 24th July 2020.
- Coronavirus – Lessons Learnt – Opened 6th October 2020.
- The Role of Hydrogen in Achieving Net Zero – Opened 4th December 2020.
- UK space strategy and UK satellite infrastructure – Opened 23rd April 2021.
- Reproducibility and research integrity. Opened 22nd July 2021. Closed 30th September 2021.

HEALTH AND SOCIAL CARE COMMITTEE

The Committee scrutinises government and in particular the work of the Department of Health and Social Care. It is chaired by Jeremy Hunt MP.

The Committee also scrutinises the work of public bodies in the health system in England, such as NHS England and Improvement, Public Health England and the Care Quality Commission, and professional regulators such as the General Medical Council and the Nursing and Midwifery Council. They do so by holding inquiries on specific topics and accountability hearings with the Secretary of State, and Chief Executives of relevant public bodies.

Membership:

Rt Hon Jeremy Hunt MP, Conservative, Chair
Paul Bristow MP, Conservative
Rosie Cooper MP, Labour
Dr James Davies MP, Conservative
Dr Luke Evans MP, Conservative
Barbara Keeley MP, Labour
Taiwo Owatemi MP, Labour
Sarah Owen MP, Labour
Anum Quaiser-Javed MP, Scottish National party
Dean Russell MP, Conservative
Laura Trott MP, Conservative

Inquiries

- Social care: funding and workforce - Opened 10 March 2020. Government response published 17th February 2021.
- Safety of maternity services in England – Opened 24th July 2020. Government response published 21st September 2021.
- Workforce burnout and resistance in the NHS and social care – Opened 30th July 2020. Published 8th June 2021.
- Coronavirus – Lessons Learnt – Opened 6th October 2020.
- Coronavirus – Recent developments –Opened 5th January 2021.
- Children and young people's mental health – Opened 29th January 2021.
- Treatment of autistic people and individuals with learning disabilities – Opened 3rd February 2021. Report published 13th July 2021.
- Department's White Paper on health and social care – Opened 25th February 2021. Report published 14th May 2021.
- Supporting those with dementia and their carers – Opened 12th May 2021.
- Cancer services: Opened 6th July 2021.
- General Practice Data for Planning and Research: Opened 15th July 2021.
- NHS litigation reform: Opened 22nd September 2021. Deadline 20th October 2021.

For further details: Tel: 020 7219 6182 Email: hsccom@parliament.uk

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HOUSE OF LORDS SELECT COMMITTEES

SCIENCE AND TECHNOLOGY COMMITTEE

The Science and Technology Committee has a broad remit "to consider science and technology". It is chaired by Lord Patel.

The Committee scrutinises Government policy by undertaking cross-departmental inquiries into a range of different activities. These include:

- public policy areas which ought to be informed by scientific research (for example, health effects of air travel),
- technological challenges and opportunities (for example, genomic medicine) and
- public policy towards science itself (for example, setting priorities for publicly funded research).

In addition, the Committee undertakes from time to time shorter inquiries, either taking evidence from Ministers and officials on topical issues, or following up previous work.

Members

The Lord Patel KT, Crossbench, Chair
The Baroness Blackwood of North Oxford, Conservative
Viscount Hanworth, Labour
The Lord Holmes of Richmond MBE
The Rt Hon. the Lord Kakkar, Crossbench
The Lord Krebs, Crossbench
The Baroness Manningham-Buller LG DCB, Crossbench
The Lord Mitchell, Labour
The Baroness Rock, Conservative
The Lord Sarfraz, Conservative
The Baroness Sheehan, Liberal Democrat
The Baroness Walmsley, Liberal Democrat
The Baroness Warwick of Undercliff, Labour
The Lord Winston, Labour

Inquiries

- Ageing: Science, Technology and Healthy Living - Opened 25 July 2019 Government response published 15th March 2021.
- The science of COVID-19 Opened 7 May 2020.
- The Contribution of Innovation Catapults to Delivering the R&D Roadmap – Opened 11th November 2020. Government response published 6th April 2021.
- Role of batteries and fuel in allowing Net Zero – Opened 3rd March 2021.
- Nature-based solutions for climate change: Opened 9th June 2021. Deadline 30th September 2021.

For further details: Tel: 020 7219 5750
Email: hlscience@parliament.uk □

PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY (POST)

POST is a bicameral body that bridges research and policy, providing reliable and up-to-date research evidence for the UK Parliament. It is overseen by a Board of MPs, Peers and external experts.

POST briefings are impartial, non-partisan, and peer-reviewed. Timely and forward thinking, they are designed to make scientific research accessible to the UK Parliament. POSTnotes are four-page summaries of public policy issues based on reviews of the research literature and interviews with stakeholders from across academia, industry, government and the third sector. They are peer reviewed by external experts. POSTnotes are often produced proactively, so that parliamentarians have advance knowledge of key issues before they reach the top of the political agenda. Our research is published on our website.

POSTnotes produced since April 2021 were:

655: Digitalisation of the energy sector
654: Defence of Space-based Assets
653: Children's mental health and the COVID-19 pandemic
652: Local nature recovery strategies
651: Blue carbon
650: Environmental housing standards
649: Early Childhood Education and Care
648: Mental health impacts of the COVID-19 pandemic on adults
647: Coastal Management
646: Regulating product sustainability
645: Low carbon hydrogen supply
644: Effective biodiversity indicators
643: Developing essential digital skills
642: Sustainable cooling
641: Living organ donation
640: Childhood obesity
639: Distance learning

POSTbriefs are responsive policy briefings based on mini-literature reviews and peer reviews. Those produced since May 2021 were:

41: Biodiversity indicators

40: Water supply resilience and climate change

POST has also continued rapid response articles that summarise the research around COVID-19:

COVID-19 vaccines and virus transmission

Which SARS-CoV-2 variants reduce the effectiveness of vaccines?

COVID-19 Vaccine misinformation

COVID-19 Vaccines safety and blood clots

What is the real-world impact of COVID-19 vaccines on community transmission?

COVID-19 vaccines: effectiveness against the B.1.617.2 variant and latest updates from trials

COVID-19 vaccine coverage and targeted interventions to improve vaccination uptake

How does the virus that causes COVID-19 spread?

Immunising children against COVID-19

Water fluoridation and dental health

POST has also published new 'Spotlights' to promote its fellowship programme.

Ongoing and future projects approved by the POST Board:

BIOLOGY AND HEALTH

In production

Disorders of consciousness

Testosterone and sports performance

Developments in vaccine technologies

Preventing zoonotic diseases

ENERGY AND ENVIRONMENT

In production

International shipping and emissions

Energy sector digitalisation

Genome editing and the future of food

Managing soils for carbon and plant productivity

Pesticides and health

Reducing agricultural pressures on freshwater ecosystems

Sustainable land management

Geothermal energy resources

Sustainable mining

Peat land restoration

DIGITAL AND PHYSICAL SCIENCES

In production

Public sector use of data

Energy consumption of computing

Smart cities

Net zero and decarbonising construction

SOCIAL SCIENCES

In production

Conversion therapy

Upskilling and retraining the adult workforce

Remote and flexible working

The POST Board oversees POST's objectives, outputs and future work programme. It meets quarterly.

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- Nicolas Besly, Clerk of Select Committees, House of Lords

Head of POST

- Oliver Bennett MBE

PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY

Houses of Parliament
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□

HOUSE OF COMMONS LIBRARY

The House of Commons Library is an impartial research and information service for Members of Parliament of all parties and their staff. This service supports MPs in their work scrutinising Government and legislation, and supporting constituents.

The Library provides confidential, impartial and bespoke briefing to Members of the House of Commons and their offices on a daily basis supporting the full range of parliamentary work, from policy development to constituency issues.

The Commons Library publishes a range of products including research briefings, shorter insight articles and briefings for non-legislative debates, all of which are available online for MPs and the general public. These briefings include in-depth and impartial analysis of all major pieces of legislation. The briefings also cover areas of policy, frequently asked questions and topical issues. You can find the briefings on the Commons Library website (https://commonslibrary.parliament.uk) where you can also sign up for personalised alerts for new or updated briefings in subject areas.

A recent focus of briefing has been Coronavirus and a webpage provides access to all the relevant material published by the Commons Library as well as the Lords Library and POST (see https://commonslibrary.parliament.uk/coronavirus/). This includes:

A series of briefings on Coronavirus restrictions:
https://commonslibrary.parliament.uk/coronavirus/coronavirus-restrictions/

A series of briefings on Vaccination:
https://commonslibrary.parliament.uk/coronavirus/coronavirus-vaccination/

The Science and Environment Section (SES) is one of eight teams in the Research Service in the House of Commons Library. In recent months they have published, and continue to update, briefings on issues as varied as:

Opportunities for geothermal energy extraction

Published 14 September 2021 CDP-2021-143

A briefing for the debate in Westminster Hall on Wednesday 15 September on opportunities for geothermal energy extraction.

Gigabit-broadband in the UK: Public funding
Published 2 September 2021 CBP-9207
A briefing on the UK Government's current and past funding programmes for gigabit-broadband roll-out.

Fly-tipping – the illegal dumping of waste
Published 25 August 2021 CBP-5672
A general overview of the extent of the problem of fly-tipping in England and the powers and responsibilities of the Environment Agency, local authorities and landowners to deal with it. It also sets out recent Government actions to tackle it and proposals for reform.

Building telecommunications infrastructure
Published 12 August 2021 CBP-9156
This briefing explains the rules and permissions needed to build broadband and mobile infrastructure including proposals for reforms to make building infrastructure easier.

Telecoms: fairness and protection for consumers
Published 11 August 2021 CBP-9245
A briefing on how UK telecoms markets serve consumers and how they are regulated. It describes recent concerns about fairness for consumers (including vulnerable groups) in telecoms markets, and reforms aimed at improving customer fairness, protection and affordability.

Research and Development funding policy
Published 5 August 2021 CBP-7237
This briefing provides an overview of the research and development funding landscape in the UK.

Covid-19 status certification
Published 28 July 2021 CBP-9288
This briefing explores the Government's policy on certification. It also provides discussion on the scientific evidence and other issues associated with the use of certification.

COP26: the international climate change conference, Glasgow, UK
Published 21 July 2021 CBP-8868
This briefing on the COP26 climate change conference to be held in Glasgow in November 2021 covers the work of the UK and president designate, Alok Sharma in the lead up COP26. It also covers the priorities set out for the conference together with progress to date on these.

Advanced Research and Invention Agency Bill 2019-21
Published 15 July 2021 CBP-9176
A briefing on the Government Bill to establish a new research funding agency specifically aimed at providing long-term support for high risk 'blue-skies research'.

Obesity
Published 12 July 2021 CBP-9049
A briefing covering policy on preventing and reducing obesity.

UK-EU Trade and Cooperation Agreement: Fisheries
Published 9 July 2021 CBP-9174
A short overview of the changes that took place for the fisheries industry on 1 January 2021 after the Brexit transition ended.

e-petition debate on motor neurone disease
Published 8 July 2021 CDP-2021-114
A briefing for the e-petition debate on Monday 12 July on research into motor neurone disease.

The Independent Medicines and Medical Devices Safety Review
Published 7 July 2021 CBP-9274
This briefing provides an overview of the Independent Medicines and Medical Devices Review and its recommendations, and the Government's response to this.

Community Energy
Published 29 June 2021 CBP-9271
A briefing on community energy which refers to energy projects that are wholly or partially owned and controlled by local communities. □

UK Research and Innovation

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Big challenges demand big thinkers - those who can unlock the answers and further our understanding of the important issues of our time. Our work encompasses everything from the physical, biological and social sciences, to innovation, engineering, medicine, the environment and the cultural impact of the arts and humanities. In all of these areas, our role is to bring together the people who can innovate and change the world for the better. We work with the government to invest over £7 billion a year in research and innovation by partnering with academia and industry to make the impossible, possible. Through the UK's nine leading academic and industrial funding councils, we create knowledge with impact.

Arts and Humanities Research Council

Website: www.ahrc.ukri.org

AHRC funds outstanding original research across the whole range of the arts and humanities. This research provides economic, social and cultural benefits to the UK, and contributes to the culture and welfare of societies around the globe.

Biotechnology and Biological Sciences Research Council

Website: www.bbsrc.ukri.org

BBSRC invests in world-class bioscience research and training. This research is helping society to meet major challenges, including food security, green energy and healthier, longer lives and underpinning important UK economic sectors, such as farming, food, industrial biotechnology and pharmaceuticals.

Economic and Social Research Council

Website: www.esrc.ukri.org

ESRC is the UK's largest funder of research on the social and economic questions facing us today. This research shapes public policy and contributes to making the economy more competitive, as well as giving people a better understanding of 21st century society.

Engineering and Physical Sciences Research Council

Website: www.epsrc.ukri.org

EPSRC invests in world-leading research and postgraduate training across the engineering and physical sciences. This research builds the knowledge and skills base needed to address scientific and technological challenges and provides a platform for future UK prosperity by contributing to a healthy, connected, resilient, productive nation.

Innovate UK

Website: www.gov.uk/government/organisations/innovate-uk

Innovate UK drives productivity and economic growth by supporting businesses to develop and realise the potential of new ideas, including those from the UK's world-class research base. They connect businesses to the partners, customers and investors that can help them turn these ideas into commercially successful products and services, and business growth.

Medical Research Council

Website: www.mrc.ukri.org

MRC is at the forefront of scientific discovery to improve human health. Its scientists tackle some of the greatest health problems facing humanity in the 21st century, from the rising tide of chronic diseases associated with ageing to the threats posed by rapidly mutating micro-organisms.

Natural Environment Research Council

Website: www.nerc.ukri.org

NERC is the driving force of investment in environmental science. Its leading research, skills and infrastructure help solve major issues and bring benefits to the UK, such as affordable clean energy, air pollution, and resilience of our infrastructure.

Research England

Website: www.re.ukri.org

Research England creates and sustains the conditions for a healthy and dynamic research and knowledge exchange system in English universities. Working to understand their strategies, capabilities and capacity; supporting and challenging universities to create new knowledge, strengthen the economy, and enrich society.

Science and Technology Facilities Council

Website: www.stfc.ukri.org

STFC is a world-leading multi-disciplinary science organisation. Its research seeks to understand the Universe from the largest astronomical scales to the tiniest constituents of matter, and creates impact on a very tangible, human scale.

Association of the British Pharmaceutical Industry

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The Association of the British Pharmaceutical Industry (ABPI) represents innovative research-based biopharmaceutical companies, large, medium and small, leading an exciting new era of biosciences in the UK. Our industry, a major contributor to the economy of the UK, brings life-saving and life-enhancing medicines to patients. Our members are researching and developing over two-thirds of the current medicines pipeline, ensuring that the UK remains at the forefront of helping patients prevent and overcome diseases. Topics we focus on include:

- All aspects of the research and development of medicines including clinical research and licensing
- Stratified medicine
- Vaccines, biosimilars, small and large molecules, cell therapy and regenerative medicine

Contact: Dr Jane Gate, Executive Director
AIRTO Ltd: Association of Innovation
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AIRTO, the Association of Innovation, Research and Technology Organisations, comprises approximately sixty principal organisations operating in the UK's Innovation, Research and Technology (IRT) sector. The IRT sector has a combined turnover of £6.9Bn, employs over 57,000 people and contributes £34Bn to UK GVA. AIRTO's members work at the interface between academia and industry, for both private and public sector clients. Members include independent Research and Technology Organisations, Catapult Centres, Public Sector Research Establishments, National Laboratories, some university Technology Transfer Offices and some privately held innovation companies.

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Tony Harding
07895 162 896 for all queries whether for membership or assistance.
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Website: www.amps-tradeunion.com

We are a Trades Union for Management and Professional Staff working in the pharmaceutical, chemical and allied industries.

We have produced a training programme funded by the EU on diversity and helping women managers remain in the workplace after a career break. This training programme is aimed at both men and women and is intended to address the shortfall in qualified personnel in the chemical and allied industries.

We are experts in performance based and field related issues and are affiliated to our counterparts in EU Professional Management Unions.

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AWE plays a crucial role in our nation's defence by providing and maintaining warheads for the UK's nuclear deterrent and delivers advice and guidance on a 24/7 basis to UK government in the area of national security.

We are a centre of scientific, engineering and technological excellence, with some of the most advanced research, design and production facilities in the world. AWE is contracted to the Ministry of Defence (MOD) through a Government-owned-contractor-operated (GOCO) arrangement. While our sites and facilities remain in government ownership, their management, day-to-day operations and maintenance of Britain's nuclear stockpile is contracted to a private company: AWE Management Limited (AWE ML). AWE ML is a consortium comprising three partners: Jacobs Engineering Group, the Lockheed Martin Corporation and Serco Group plc.

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The Biochemical Society works to promote the molecular biosciences; facilitating the sharing of expertise, supporting the advancement of biochemistry and molecular biology and raising awareness of their importance in addressing societal grand challenges. We achieve our mission by :

- bringing together molecular bioscientists;
- supporting the next generation of biochemists;
- promoting and sharing knowledge and
- promoting the importance of our discipline.

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Twitter: @BESPolicy

The British Ecological Society is an independent, authoritative learned society, and the voice of the UK's ecological community. Working with our members we gather and communicate the best available ecological evidence to inform decision making. We offer a source of unbiased, objective ecological knowledge, and promote an evidence-informed approach to finding the right solutions to environmental questions.

British In Vitro Diagnostics Association (BIVDA)

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BIVDA is the UK industry association representing companies who manufacture and/or distribute the diagnostics tests and equipment to diagnose, monitor and manage disease largely through the NHS pathology services. Increasingly diagnostics are used outside the laboratory in community settings and also to identify those patients who would benefit from specific drug treatment particularly for cancer.

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The British Pharmacological Society is a charity with a mission to promote and advance the whole spectrum of pharmacology. It is the primary UK learned society concerned with drugs and the way they work, and leads the way in the research and application of pharmacology around the world.

Founded in 1931, the Society champions pharmacology in all its forms, across academia, industry, regulatory agencies and the health service. With over 3,500 members from over 60 countries worldwide, the Society is a friendly and collaborative community. Enquiries about the discovery, development and application of drugs are welcome.

Tracey Guise, Chief Executive Officer
British Society for Antimicrobial Chemotherapy (BSAC)
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BSAC is a learned society whose members are among the world's leading infectious disease physicians, pharmacists, microbiologists, and nurses.

With more than 45 years of leadership in antibiotic research and education, BSAC is dedicated to saving lives by fighting infection. It does this by supporting a global network of experts via workshops, conferences, evidence-based guidelines, e-learning courses, and its own high-impact international journal.

BSAC also provides national surveillance and susceptibility testing programmes, an outpatient parenteral antimicrobial therapy (OPAT) initiative, research and development grants, and the secretariat for the All-Party Parliamentary Group on Antibiotics.

BSAC has members in 40 nations and active learners in more than 135 countries.

British Society for immunology

Contact Dr Doug Brown, CEO
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The British Society for Immunology's mission is to promote excellence in immunological research, scholarship and clinical practice in order to improve human and animal health. We are the leading UK membership organisation working with scientists and clinicians from academia and industry to forward immunology research and application around the world. Our friendly, accessible community of over 3,500 immunologists gives us a powerful voice to advocate for immunological science and health for the benefit of society.

BRITISH SOCIETY OF SOIL SCIENCE

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The British Society of Soil Science (BSSS) was founded in 1947 and is an established international membership organisation and charity committed to the study of soil in its widest aspects. The society brings together those working within academia, practitioners implementing soil science in industry and all those working with, or with an interest in soils.

We promote research and education, both academically and in practice, and build collaborative partnerships to help safeguard our soil for the future. This includes hosting the World Congress of Soil Science 2022 in Glasgow, where those with an interest in soil science can meet to discuss the critical global issues relating to soil.

Brunel University London

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Brunel University London is an international research active university with 3 leading research institutes:

Institute of Energy Futures: Led by Professor Savvas Tassou, the main themes of the Institute are *Advanced Engines and Biofuels, Energy Efficient and Sustainable Technologies, Smart Power Networks*, and *Resource Efficient Future Cities.*

Institute of Materials and Manufacturing: The main themes of research are *Design for Sustainable Manufacturing, Liquid Metal Engineering, Materials Characterisation and Processing, Micro-Nano Manufacturing*, and *Structural Integrity*. The Institute is led by Professor Luiz Wrobel.

Institute of Environment, Health and Societies: Professor Susan Jobling leads this pioneering research institute whose themes are *Health and Environment, Healthy Ageing, Health Economics Synthetic Biology, Biomedical Engineering and Healthcare Technologies*, and *Social Sciences and Health*.

Brunel University London offers a wide range of expertise and knowledge, and prides itself on having academic excellence at the core of its offer, and was ranked in the recent REF as 33rd in the UK for Research Power (average quality rating by number of submissions) and described by The Times Higher Education as one of the real winners of the REF 2014.

Cavendish Laboratory

UNIVERSITY OF CAMBRIDGE

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The Cavendish Laboratory houses the Department of Physics of the University of Cambridge.

The research programme covers the breadth of contemporary physics

Extreme Universe: Astrophysics, cosmology and high energy physics

Quantum Universe: Cold atoms, condensed matter theory, scientific computing, quantum matter and semiconductor physics

Materials Universe: Optoelectronics, nanophotonics, detector physics, thin film magnetism, surface physics and the Winton programme for the physics of sustainability

Biological Universe: Physics of medicine, biological systems and soft matter

The Laboratory has world-wide collaborations with other universities and industry

Chartered Institute of Ergonomics & Human Factors

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Our vision is integrated design to improve life, wellbeing and performance through science, engineering, technology and psychology. The Institute is one of the largest in the world representing the discipline and profession of Human Factors and Ergonomics. We have sector groups in most industries from defence to aviation and pharmaceuticals that provide expert advice to industry and government. We accredit university courses and consultancy practices and work closely with allied learned societies.

The Cosmetic Toiletry & Perfumery Association | ctpa

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www.thefactsabout.co.uk

CTPA is the UK trade association representing manufacturers of cosmetic products and suppliers to the cosmetic products industry. 'Cosmetic products' are legally defined and subject to stringent EU safety laws. CTPA is the authoritative public voice of a vibrant and responsible UK industry trusted to act for the consumer; ensuring the science behind cosmetics is fully understood.

CLIFTON SCIENTIFIC Trust

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The Council for the Mathematical Sciences

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The Council for the Mathematical Sciences is an authoritative and objective body that works to develop, influence and respond to UK policy issues affecting mathematical sciences in higher education and research, and therefore the UK economy and society by:

- providing expert advice;
- engaging with government, funding agencies and other decision makers;
- raising public awareness; and
- facilitating communication between the mathematical sciences community and other stakeholders

THE FRANCIS CRICK INSTITUTE

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The Francis Crick Institute is a biomedical discovery institute dedicated to understanding the fundamental biology underlying health and disease. Its work is helping to understand why disease develops and to translate discoveries into new ways to prevent, diagnose and treat illnesses such as cancer, heart disease, stroke, infections, and neurodegenerative diseases.

The Crick was formed in 2015, and in 2016 it moved into a brand new state-of-the-art building in central London which brings together 1500 scientists and support staff working collaboratively across disciplines.

SCIENCE DIRECTORY

Daphne Jackson Trust

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Founded in 1992 in memory of the UK's first female Professor of Physics, the Trust is the UK's leading charity dedicated to realising the potential of scientists and engineers returning to research after career breaks for family, caring and health reasons. Recently, we have expanded our remit to incorporate the social sciences and arts & humanities. Our Fellowship programme, working in partnership with universities, UKRI, charities, learned societies and industry, enables individuals to undertake part-time research in universities and research institutes. Fellowships comprise a research project alongside an individually tailored retraining programme, with additional mentoring and support, enabling recipients to re-establish their research credentials, update skills and redevelop confidence, in a suitably supportive environment.

energy institute

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The Energy Institute (EI) is the chartered professional membership body bringing together expertise for urgent global challenges. Our ambition is that energy, and its critical role in our world, is better understood, managed and valued. We're a unique network with insight spanning the world of energy, from conventional oil and gas to the most innovative renewable and energy efficient technologies. We gather and share essential knowledge about energy, the skills that are helping us all use it more wisely, and the good practice needed to keep it safe and secure. We articulate the voice of energy experts, taking the know-how of around 20,000 members and 200 companies from 120 countries to the heart of the public debate. And we're an independent, not-for-profit, safe space for evidence-based collaboration, an honest broker between industry, academia and policy makers.

EngineeringUK

Suzanne King
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EngineeringUK is an independent organisation that promotes the vital role of engineers, engineering and technology in our society. EngineeringUK partners business and industry, Government and the wider science and technology community: producing evidence on the state of engineering; sharing knowledge within engineering, and inspiring young people to choose a career in engineering, matching employers' demand for skills.

fera

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Fera provides expert analytical and professional services to governments, agrichemical companies, food retailers, manufacturers and farmers to facilitate safety, productivity and quality across the agrifood supply chain in a sustainable and environmentally compatible way.

Fera uses its world leading scientific expertise to provide robust evidence, rigorous analysis and professional advice to governments, international bodies and companies worldwide. Our food integrity, plant health, agri-tech and agri-informatics services ensure that our customers have access to leading edge science, technology and expertise.

First Group

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FirstGroup are the leading transport operator in the UK and North America and each day, every one of our 110,000 employees works hard to deliver vitally important services for our passengers. During the last year around 2.2 billion passengers relied on us to get to work, to school or college, to visit family and friends, and much more.

GAMBICA

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GAMBICA is the voice of the laboratory technology, instrumentation, control and automation industries, providing influence, knowledge and community. We offer members a common platform for voicing their opinions and representing their common interests to a range of stakeholders. GAMBICA seeks to spread best-practice and be thought leaders in our sectors.

The Geological Society

serving science, profession & society

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The Geological Society is the national learned and professional body for Earth sciences, with 12,000 Fellows (members) worldwide. The Fellowship encompasses those working in industry, academia and government, with a wide range of perspectives and views on policy-relevant science, and the Society is a leading communicator of this science to government bodies and other non-technical audiences.

IBMS Institute of Biomedical Science

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Advancing knowledge and setting standards in biomedical science

With over 20,000 members in 61 countries, the Institute of Biomedical Science (IBMS) is the leading professional body for scientists, support staff and students in the field of biomedical science.

Since 1912 we have been dedicated to the promotion, development and delivery of excellence in biomedical science within all aspects of healthcare, and to providing the highest standards of service to patients and the public.

By supporting our members in their practice, we set quality standards for the profession through training, education, assessments, examinations and continuous professional development.

Institute of Food Science + Technology ifst

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We are the UK's leading professional body for those involved in all aspects of food science and technology. We are an internationally respected independent membership body, supporting food professionals through knowledge sharing and professional recognition.

Our core aim is the advancement of food science and technology based on impartial science and knowledge sharing.

Our membership comprises individuals from a wide range of backgrounds, from students to experts, working across a wide range of disciplines within the sector.

IKE

Institute of Innovation & Knowledge Exchange

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IKE is the UK's professional body for innovators. It accredits and certificates innovation practices. We influence the inter-relationship between education, business, and government through research and collaborative networks. Our Innovation Manifesto highlights our commitment to support the development of innovative people and organisations. IKE runs think-tanks, conducts research, develops new business models and tools and supports organisations to benchmark their innovation capabilities.

Institute of Marine Engineering, Science and Technology (IMarEST)

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Established in London in 1889, the IMarEST is a leading international membership body and learned society for marine professionals, with over 15,000 members worldwide. The IMarEST has an extensive marine network of 50 international branches, affiliations with major marine societies around the world, representation on the key marine technical committees and non-governmental status at the International Maritime Organization (IMO) as well as other intergovernmental organisations.

Institute of Measurement and Control

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Reg Charity number: 269815

The Institute of Measurement and Control is a professional engineering institution and learned society dedicated to the science and application of measurement and control technology for the public benefit. The InstMC has a comprehensive range of membership grades for individuals engaged in both technical and non-technical occupations. Also, it is licensed by the Engineering Council to assess and register individuals as Chartered Engineers (CEng), Incorporated Engineers (IEng) and Engineering Technicians (EngTech).

The InstMC works to develop the knowledge and skills of individual engineers, fostering communication and advancing the science and practices within the industry.

IOP Institute of Physics

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The Institute of Physics (IOP) is the professional body and learned society for physics in the UK and Ireland. The IOP's mission is to raise public awareness and understanding of physics, inspire people to develop their knowledge, understanding and enjoyment of physics and support the development of a diverse and inclusive physics community. As a charity, the IOP seeks to ensure that physics delivers on its exceptional potential to benefit society.

IPEM Institute of Physics and Engineering in Medicine

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IPEM is a registered, incorporated charity for the advancement, in the public interest, of physics and engineering applied to medicine and biology. Its members are medical physicists, clinical and bio-engineers, and clinical technologists. It organises training and CPD for them, and provides opportunities for the dissemination of knowledge through publications and scientific meetings. IPEM is licensed by the Science Council to award CSci, RSci and RSciTech, and by the Engineering Council to award CEng, IEng and EngTech.

IChemE ADVANCING CHEMICAL ENGINEERING WORLDWIDE

The Institution of Chemical Engineers

The Institution of Chemical Engineers (IChemE) advances chemical engineering's contribution worldwide for the benefit of society. We support the development of chemical engineering professionals and provide connections to a powerful network of around 35,000 members in 100 countries.

We support our members in applying their expertise and experience to make an influential contribution to solving major global challenges, and are the only organisation to award Chartered Chemical Engineer status and Professional Process Safety Engineer registration.

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Kuala Lumpur | London | Melbourne | Rugby | Singapore | Wellington

IET The Institution of Engineering and Technology

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The IET is a world leading professional organisation, sharing and advancing knowledge to promote science, engineering and technology across the world. Dating back to 1871, the IET has over 163,000 members in 127 countries with offices in Europe, North America, and Asia-Pacific.

LGC

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LGC is a global leader in the life sciences tools sector, including human healthcare and applied markets (food, agbio and the environment). LGC provides a comprehensive range of measurement tools, proficiency testing schemes, supply chain assurance standards and specialty genomics tools (oligos, PCR tools, NGS reagents), underpinned by leading analytical and measurement science capabilities. Under the Government Chemist function, LGC fulfils specific statutory duties as the referee analyst and provides advice for Government and the wider analytical community on the implications of analytical measurement for matters of policy, standards and regulation. LGC is also the UK's National Measurement Laboratory for chemical and bio-measurement.

With headquarters in Teddington, South West London, LGC has laboratories and sites across Europe, the US, China, Brazil, India, and South Africa.

L'ORÉAL UK AND IRELAND

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L'Oréal employs more than 3,800 researchers world-wide and dedicates over €877 million each year to research and innovation in the field of healthy skin and hair. The company supports women in science research through the L'Oréal UNESCO For Women In Science Programme and engages young people with science through the L'Oréal Young Scientist Centre at the Royal Institution. L'Oréal also collaborates with a vast number of institutions in the UK and globally.

SCIENCE DIRECTORY

The Linnean Society of London

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As the world's oldest active biological society, the Linnean Society is an essential forum and meeting point for those interested in the natural world. The Society holds regular public lectures and events, publishes three peer-reviewed journals, and promotes the study of the natural world with several educational initiatives. The Society is home to a world famous library and collection of natural history specimens. The Society's Fellows have a considerable range of biological expertise that can be harnessed to inform and advise on scientific and public policy issues.

A Forum for Natural History

London School of Hygiene & Tropical Medicine

London School of Hygiene & Tropical Medicine
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www.lshtm.ac.uk

The London School of Hygiene & Tropical Medicine (LSHTM) is a world-leading centre for research and postgraduate education in public and global health with over 4,000 students and more than 1,300 staff working in over 100 countries across the world – including at two MRC Units in The Gambia and Uganda which joined LSHTM in 2018. Our depth and breadth of expertise encompasses many disciplines, and we are one of the highest-rated research institutions in the UK.

Marine Biological Association

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Since 1884 the Marine Biological Association has been delivering its mission *'to promote scientific research into all aspects of life in the sea, including the environment on which it depends, and to disseminate to the public the knowledge gained.'* The MBA represents its members in providing a clear independent voice to government on behalf of the marine biological community. It also has an extensive research programme and a long history as an expert provider of advice for the benefit of policy makers and wider society.

Institution of Mechanical Engineers

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The Institution provides politicians and civil servants with information, expertise and advice on a diverse range of subjects, focusing on manufacturing, energy, environment, transport and education policy. We regularly publish policy statements and host political briefings and policy events to establish a working relationship between the engineering profession and parliament.

Met Office

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The Met Office doesn't just forecast the weather on television. Our forecasts and warnings protect UK communities and infrastructure from severe weather and environmental hazards every day – they save lives and money. Our Climate Programme delivers evidence to underpin Government policy through the Met Office Hadley Centre. Our Mobile Meteorological Unit supports the Armed Forces around the world. We build capacity overseas in support of international development. All of this built on world-class environmental science.

Microbiology Society

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The Microbiology Society is a membership charity for scientists interested in microbes, their effects and their practical uses. It is one of the largest microbiology societies in Europe with a worldwide membership based in universities, industry, hospitals, research institutes and schools.

Our principal goal is to develop, expand and strengthen the networks available to our members so that they can generate new knowledge about microbes and ensure that it is shared with other communities. The impacts from this will drive us towards a world in which the science of microbiology provides maximum benefit to society.

NPL National Physical Laboratory

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The National Physical Laboratory (NPL) is the United Kingdom's national measurement institute, an internationally respected and independent centre of excellence in research, development and knowledge transfer in measurement and materials science. For more than a century, NPL has developed and maintained the nation's primary measurement standards - the heart of an infrastructure designed to ensure accuracy, consistency and innovation in physical measurement.

Natural History Museum

Advancing the science of nature

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We challenge the way people think about the natural world – its past, present and future

We use our unique collection and unrivalled expertise to tackle the biggest challenges facing the world today.

We are leaders in the scientific understanding of the origin of our planet, life on it and can predict the impact of future change.

We study the diversity of life and the delicate balance of ecosystems to ensure the survival of our planet.

We help enable food security, eradicate disease and manage resource scarcity.

We inspire people to engage with science to solve major societal challenges.

University of Northampton

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The University of Northampton is an institution committed to science education through initial teacher training, a STEM Ambassador network which works within the community and teaching and research to doctoral level. We are an Ashoka U 'Changemaker Campus' status university recognising our commitment to social innovation and entrepreneurship.

The University of Nottingham

UNITED KINGDOM · CHINA · MALAYSIA

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With 43,000 students and campuses in Nottingham, China and Malaysia, The University of Nottingham is 'the nearest Britain has to a truly global university'. With more than 97 per cent of research at the University recognised internationally according to the Research Excellence Framework 2014, the University is ranked in the top 1% of the world's universities by the QS World University Rankings.

The Nutrition Society

Advancing Nutritional Science

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The Nutrition Society is a not for profit, membership organisation which is dedicated to delivering its mission of advancing the scientific study of nutrition and its application to the maintenance of human and animal health. Highly regarded by the scientific community, the Society is one of the largest learned societies for nutrition in the world and anyone with a genuine interest in the science of human or animal nutrition can become a member.

The Physiological Society

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As the largest network of physiologists in Europe, with academic journals of global reach, we continue our 140-year tradition of being at the forefront of the life sciences.

We bring together scientists from over 60 countries, and our Members have included numerous Nobel Prize winners from Ivan Pavlov to John O'Keefe.

prospect

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Prospect is an independent, thriving and forward-looking trade union with over 120,000 members across the private and public sectors and a diverse range of occupations. We represent scientists, technologists and other professions in the civil service, research councils and private sector.

Prospect's collective voice champions the interests of the engineering and scientific community to key opinion-formers and policy makers. With negotiating rights with over 300 employers, we seek to secure a better life at work by putting members' pay, conditions and careers first.

QUADRUM INSTITUTE

Quadram Institute
Science • Health • Food • Innovation

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Opening fully in mid-2018, the Quadram Institute will be an interdisciplinary research centre capitalising on the academic excellence and clinical expertise of the Norwich Research Park. Its mission is to understand how food and the gut microbiota link to the promotion of health and preventing diet and age related diseases. The Quadram Institute brings together fundamental and translational science with a clinical research facility for human trials and one of Europe's largest gastrointestinal endoscopy units. This will synergise interactions between basic and clinical research, delivering a step change in the understanding of the role of food in health.

Royal Academy of Engineering

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As the UK's national academy for engineering, we bring together the most successful and talented engineers for a shared purpose: to advance and promote excellence in engineering. We have four strategic challenges: drive faster and more balanced economic growth; foster better education and skills; lead the profession; and promote engineering at the heart of society.

Kew

ROYAL BOTANIC GARDENS

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RBG Kew is a centre of global scientific expertise in plant and fungal diversity, conservation, and sustainable use, housed in two world-class gardens. Our scientific vision is to document and understand global plant and fungal diversity and its uses, bringing authoritative expertise to bear on the critical challenges facing humanity today.

Kew's strategic priorities for science are:

1. To document and conduct research into global plant and fungal diversity and its uses for humanity.
2. To curate and provide data-rich evidence from Kew's unrivalled collections as a global asset for scientific research.
3. To disseminate our scientific knowledge of plants and fungi, maximising its impact in science, education, conservation policy and management.

These priorities enable us to curate, use, enhance, explore and share Kew's global resource, providing robust data and a strong evidence base for our UK and global stakeholders. Kew is a non-departmental government body with exempt charitable status, partially funded by Defra.

The Royal Institution

Science Lives Here

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The Royal Institution (Ri) has been at the forefront of public engagement with science for over 200 years and our purpose is to encourage people to think further about the wonders of science. We run public events and the famous CHRISTMAS LECTURES®, a national programme of Masterclasses for young people in mathematics, engineering and computer science, educational activities at the L'Oréal Young Scientist Centre and policy discussions with science students. And through the Ri Channel we share the stories behind cutting-edge science with people around the world.

THE ROYAL SOCIETY

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The Royal Society is the academy of science in the UK and the Commonwealth comprising 1400 outstanding individuals representing the sciences, engineering and medicine. The Society has played a part in some of the most fundamental, significant and life-changing discoveries in scientific history and Royal Society scientists continue to make outstanding contributions to science across the wide breadth of research areas. Through its Fellowship and permanent staff, it seeks to ensure that its contribution to shaping the future of science in the UK and beyond has a deep and enduring impact, supporting excellence in science and encouraging the development and use of science for the benefit of humanity.

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The Royal Society of Biology is a single unified voice, representing a diverse membership of individuals, learned societies and other organisations. We are committed to ensuring that we provide Government and other policy makers – including funders of biological education and research – with a distinct point of access to authoritative, independent, and evidence-based opinion, representative of the widest range of bioscience disciplines. Our vision is of a world that understands the true value of biology and how it can contribute to improving life for all.

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The Royal Society of Chemistry is the world's leading chemistry community, advancing excellence in the chemical sciences. With over 50,000 members and a knowledge business that spans the globe, we are the UK's professional body for chemical scientists; a not-for-profit organisation with 170 years of history and an international vision of the future. We promote, support and celebrate chemistry. We work to shape the future of the chemical sciences – for the benefit of science and humanity.

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*Sf*AM utilises the expertise of its international membership to advance, for the benefit of the public, the application of microbiology to the environment, human and animal health, agriculture, and industry. Our values include equality, diversity and inclusivity; collaboration to amplify impact; scientific integrity; evidence-based decision-making and political neutrality. With Wiley-Blackwell, *Sf*AM publishes five internationally acclaimed journals.

Society for Underwater Technology

Society for Underwater Technology
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The SUT is a multidisciplinary learned society that brings together individuals and organisations with a common interest in underwater technology, ocean science, and offshore/subsea engineering. The society was founded in 1966 and has members from over 40 countries, including engineers, scientists, other professionals and students working in these areas.

Society of Chemical Industry

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Established by Royal Charter in 1881, SCI is a unique multi-disciplinary community. Set up by a prominent group of forward thinking scientists, inventors and entrepreneurs, SCI continues to be a multi-science and industry network based around chemistry and related sciences. Our charitable objective is to promote links between science and industry for the benefit of society. Our passion is invention and creation.

We deliver our charitable objective by:

- Supporting the commercial application of science into industry
- Tackling global challenges across Agrifood, Energy, Environment, Health and Materials

Society of Cosmetic Scientists

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Advancing the science of cosmetics is the primary objective of the SCS. Cosmetic science covers a wide range of disciplines from organic and physical chemistry to biology and photo-biology, dermatology, microbiology, physical sciences and psychology.

Members are scientists and the SCS helps them progress their careers and the science of cosmetics ethically and responsibly. Services include publications, educational courses and scientific meetings.

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The Society of Maritime Industries (SMI) is the voice and champion of the UK maritime engineering, marine science & technology and business service sectors.

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The **UK Innovation & Science Seed Fund** is a leading patient capital investor with more than £330 million private investment leveraged to date. The Fund works to build technology companies from the earliest stage by working closely with its partners led by STFC, BBSRC, NERC and Dstl, with the National Research and Innovation Campuses they support, and with entrepreneurial science-led teams. UK Innovation & Science Seed Fund is also closely aligned with the Catapults and InnovateUK, helping to commercialise key technological advances in industrial biotech, agricultural technology, healthcare, medicine, clean energy, materials, artificial intelligence, software and space.

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Understanding Animal Research is a not-for-profit organisation that explains why animals are used in medical, veterinary, environmental and other scientific research. We aim to achieve a broad understanding of the humane use of animals in medical, veterinary, scientific and environmental research in the UK. We work closely with policymakers to ensure regulation is effective and are a trusted source of information for the national and international media. We are funded by our members who include universities, professional societies, trade unions, industry and charities.

Royal Society of Biology

Parliamentary Links Day 2021

Dame Eleanor Laing MP

Alok Sharma MP

Katherine Fletcher MP

Greg Clark MP

Parliamentary Links Day, held on 22nd June was a timely opportunity to address issues of climate change and to build momentum ahead of November's COP-26. The annual event which brings together scientists, policymakers, politicians and sector leaders, was organised on behalf of the science sector by the Royal Society of Biology.

A range of keynote speakers discussed collaborative, international and individual approaches to tackling climate change. The event was opened by Dame Eleanor Laing MP, Deputy Speaker of the House of Commons, and was chaired by Stephen Metcalfe MP, Chair of the Parliamentary and Scientific Committee, with a pre-recorded keynote address from Alok Sharma MP, the president of COP26.

Mr Sharma highlighted the importance of collaboration in ensuring evidence reaches a wide audience. "It is vital that science lights the way and that relationships continue to be built between researchers, politicians and peers," he said. Katherine Fletcher MP, the Parliamentary Private Secretary for the COP26 President Designate, took questions from the audience on behalf of Alok Sharma.

There were also presentations from Shadow Minister of Science, Research and Digital, Chi Onwurah MP, Vice Chair of the Parliamentary & Scientific Committee; the Chair of the Commons Science and Technology Select Committee, Rt Hon Greg Clark MP; and Government Chief Scientific Adviser, Sir Patrick Vallance. An international panel was brought together to share views and take questions, the were Professor Sir Adrian Smith, President of the Royal Society, Monica Dean, senior expert advisor supporting the special presidential envoy for climate from the US State Department, and Sunan Jiang, minister counsellor for science and technology affairs at the Chinese Embassy in the UK.

This report is provided by the Royal Society of Biology

SCIENCE DIARY

PARLIAMENTARY AND SCIENTIFIC COMMITTEE – ALL-PARTY PARLIAMENTARY GROUP

Email: office@scienceinparliament.org.uk
www.scienceinparliament.org.uk
follow us on Twitter @ParlSciCom

FORTHCOMING DISCUSSION AND OTHER MEETINGS

Monday 8th November
Discussion Meeting on COP 26
In partnership with the National Physical Laboratory
5.30pm to 7.00pm

Monday 29th November
Discussion Meeting on topic to be advised
Sponsored by the Nuffield Council
5.30pm to 7.00pm

Monday 6th December
STEM for Britain 2021 Awards Ceremony
Attlee Suite, Houses of Parliament
10.30am to 12.30pm

Monday 17th January
Discussion Meeting
'Translating Knowledge and Research into Impact'
In partnership with the Physiological Society
5.30pm to 7.00pm

Monday 21st February
Discussion Meeting
5.30pm to 7.00pm

Monday 7th March
STEM for Britain 2022

Monday 14th March
Discussion Meeting
10.30am to 12.00pm

Monday 28th March,
Discussion Meeting
5.30pm to 7.00pm

ROYAL SOCIETY

Details of all events can be found on the events calendar at events@royalsociety.org
For scientific meetings queries: scientificmeetings@royalsociety.org

THE ROYAL INSTITUTION

Details of all events and booking Information can be found at www.rigb.org/whats-on

ROYAL SOCIETY OF BIOLOGY

For further details please contact Karen Patel or Dr Stephen Benn at events@rsb.org

ROYAL SOCIETY OF CHEMISTRY

For further details please contact Events@rsc.org

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Supporting Science

Successful science is the output of a full team of researchers, technologists, technicians and communicators. The essential role played by the science workforce in Government has never been more obvious than during the COVID-19 pandemic.

The Science Council aims to support the science workforce, acting as guardian of registration standards, licensing members to award professional registration. It provides member bodies with a forum to raise standards through sharing knowledge and discuss current policy issues, to hold each other to account through a peer-review approach, and further their own commitment to advance science for the public's benefit.

Get in touch & find out how out the Science Council's work supports science in Government here: **sciencecouncil.org/science-in-parliament**

Professor Carole Mundell
President of Science Council

Carole G Mundell

Science Council

Image: University of Bath

STEM FOR BRITAIN

The Nutrition Society is honoured to be continuing its support for STEM for Britain in 2022 with both the Nutrition Society Prize and sponsorship of the Chemistry Gold, Silver and Bronze Awards.

THE NUTRITION SOCIETY
Advancing Nutritional Science

Advancing the scientific study of nutrition and its application to the maintenance of human and animal health.

PROPOSED NEW ALL PARTY PARLIAMENTARY GROUP

NUTRITION: SCIENCE AND HEALTH

The scope of the meetings will include:

- human health benefits of a sustainable diet
- enabling tomorrow's doctors: Nutrition in medical education
- emerging nutrition deficiencies in the UK
- transforming health outcomes via National Food Strategy
- nutrition and health claims.

The Society is looking for founding members. To express your interest please email appg@nutritionsociety.org

The International Symposium on Nutrition (ISN 2022), organised jointly by the UK and French Nutrition Society's will bring together expertise from academia, policy, industry and city representatives to present and debate issues related to urban policies for sustainable nutrition and health.

4th International Symposium on Nutrition

ISN 2022

January 2022
Lille, France

URBAN FOOD POLICIES FOR SUSTAINABLE NUTRITION AND HEALTH