

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

SCIENCE IN PARLIAMENT

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SPRING 2020

**THE POWER OF
INNOVATION
CAN...**

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STEM FOR BRITAIN 2020

SEE SPECIAL FEATURE ON PAGES 24-37

WINNERS ALL!



Mathematical Sciences and Physical Sciences (Chemistry and Physics) Exhibitions

Florence Gregson (Gold, Chemistry); **Gemma Smith** (Bronze, Chemistry); **Fabienne Bachtiger** (Silver, Chemistry); **Damian Galante** (Bronze, Maths); **Maeve Madigan** (Bronze, Physics); **Luisa Mihaela Paun** (Gold, Maths); **Graham Bruce** (Silver, Physics); **Adrien Lefauve** (Silver, Maths); **Lui Terry** (Gold, Physics), joined at the back by **Stephen Metcalfe MP**, Chairman, STEM for Britain and **Dr Stephen Benn**, Vice-President, Parliamentary & Scientific Committee,



Biomedical and Biological Sciences and Engineering Exhibitions

Sarah Houston (Gold, Biosciences and Westminster Medal Winner); **Karolina Tuomela** (Silver, Biosciences); **Benjamin Fletcher** (IEEE Communications Society Prize, Engineering); **Ted Roberts** (Bronze, Biosciences); **Benjamin Cerfontaine** (Bronze, Engineering); **Stephen Metcalfe MP**, Chairman, STEM for Britain; **Tomas Ysehak Abay** (Gold, Engineering); **Dr Stephen Benn**, Vice-President, Parliamentary & Scientific Committee; **Elisa Roccia** (Silver, Engineering); **Egzona Morina** (The Physiological Society Prize, Biosciences); **Andres Rivero Bracho** (The Dyson Award); and **George Firth** (The Nutrition Society Prize, Biosciences)



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

Welcome to Spring 2020 edition of Science in Parliament

It is a matter of great frustration that at the very time when Parliament is most interested in – and most needs – access to scientific expertise, advice and discussion the Coronavirus Crisis has closed down normal Parliamentary life and hence prevented the Parliamentary & Scientific Committee from meeting.

This is a matter of great regret to me as Chair not least because our recent meetings over the past few months have been packed to the hilt and we have had some excellent presentations and discussions. We have many more planned – and that will undoubtedly feature

aspects of the COVID-19 crisis that we will need to think through and learn from.

As we look forward we can take heart from the fact that the public and Parliamentary appreciation of science and technology has grown greatly over these past difficult weeks and we should take the opportunity to breathe new life into the work and activity of the P&SC.

If there is one lesson we can all agree on it is that science and technology has never been more vital to the life of the country and the planet.

It seems quite some time ago now, but on the 9th March I was delighted to once again host STEM for Britain and welcome early career researchers from universities and research institutions from around the country to Westminster. This annual competition is an important date in the parliamentary calendar as it gives MPs an opportunity to speak directly to a wide range of the UK's best young researchers. These early career engineers, mathematicians and scientists are the architects of our future and STEM for Britain is the best opportunity for politicians meet them and understand their work. I am pleased to say that over 70 parliamentary colleagues were present at this year's event.

As ever, STEM for Britain would not have been possible without the help of all the major Learned Societies involved in its organisation, and those who generously supported the event including the Clay Mathematics Institute, Warwick Manufacturing Group, UK Research and Innovation, Dyson Ltd, Biotherapy Services Ltd, the Institute of Biomedical Science, the Heilbronn Institute for Mathematical Research, The Physiological Society, the Nutrition Society, the Biochemical Society, IEEE Communications Society, the Comino Foundation and the Society for Chemical Industry. I thank them all, together with the competition Judges and the STEM Organising Team.

In addition to our feature on STEM for Britain, we have a wonderful series of articles for you in this issue, and I am very grateful to each of our distinguished contributors for sparing the time, particularly in the current situation, to bring us the benefit of their expertise and experience on a variety of topics, including COVID-19, smart energy, acoustics, mathematical data, cancer research, and innovation.

Stay safe and well.



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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CORONAVIRUS



Professor Arne Akbar
President of the British Society for
Immunology and Professor of
Immunology at UCL

It is impossible today to be unaware of the Coronavirus pandemic that has swept across the world since the beginning of 2020. Just over one hundred years on from the 'Spanish flu' of 1918-1920, the world faces similar challenges from the COVID-19 disease at a time when we enjoy much more advanced medical treatments and practices but have also enabled the spread of the disease through greater global connectivity.

SARS-CoV-2 is the virus that causes the disease, COVID-19. The coronavirus family includes a number of viruses which cause a range of illnesses from the common cold to the Severe Acute Respiratory Syndrome (SARS) epidemic in 2002. There are also hundreds of other strains of Coronaviruses which infect non-human species, notably bats. Like humans, bats live in close quarters, so easily spread pathogens between each other, and as humans begin to encroach on their habitats, this makes cross-species transmission a particular risk. Whilst the genetic makeup of SARS-CoV-2 points towards the original virus being bat-borne, evidence suggests that it may have been transmitted to humans via an intermediate species¹. In 2016, following the Ebola epidemic, the World Health Organization (WHO) identified the SARSr-COV virus family as having potential for a future epidemic and recommended research into diagnostic tests, vaccines and medicines.

The origin of the novel Coronavirus is Wuhan in China, with a population of over 11 million people. The first confirmed case was recorded on 1 December 2019, but it is speculated that the real first case might have been contracted earlier in November 2019. Once more cases were discovered,

samples from hospitalised patients were analysed at the Wuhan Institute of Virology where the virus was later isolated and identified as a novel coronavirus. China officially notified the WHO of cases of pneumonia with an unknown aetiology on 31 December.

Spread of the virus has been rapid. The first COVID-19 case outside China was announced in South Korea on 8 January. By 31 January, the first UK case was confirmed. Four weeks later, on 28 February, we documented the first case of infection transmitted within the UK; all previous cases had been infected abroad. Within one month, there had been over 22,000 cases and 1,408 deaths in the UK². During this time, other regional epicentres of disease have emerged, noticeably Italy, Spain and the USA. In mid-March, the UK Government began to shepherd the largest expansion of state power outside of wartime through Parliament, legislating to restrict the movement of the UK population and ensure they remained at home except for essential work, exercise, or shopping for food or medicine.

This came as the Government moved away from a policy of building herd immunity. Herd immunity occurs when a large proportion of the population is protected against a particular

disease, preventing its transmission through that population. This can be achieved either through vaccination or when enough people in the population have built up antibodies by fighting the pathogen directly. However, this latter strategy only works to reduce serious disease if, when building that immunity, vulnerable individuals are protected from contracting the virus. If not, the consequences could be severe. As SARS-CoV-2 is a novel virus in humans, it is not yet known how long the immunity built up would last for. Some other viruses in the Coronavirus family that cause common colds build immunity that only lasts for a few months, but this may be related to their co-evolution with the human immune system. Given the uncertainty of the characteristics of this novel virus and how it would interact with the human immune system, the current strategy which will allow herd immunity to be built up slowly together with avoiding exposure of overly vulnerable parts of the population, such as the elderly or the immunocompromised, is to be welcomed.

This new strategy includes a 'delay' phase to slow the spread of COVID-19 after containment measures were no longer feasible. This was aimed at lowering the peak impact and push it away from the winter

season in order to prevent the NHS from becoming overwhelmed. The delay also buys time for research to better understand the course of the disease and to innovate medical responses such as diagnostics, drugs and vaccines.

SARS-CoV-2 is a relatively infectious virus: a person with seasonal flu typically infects 1.4 other people, so if this happens 10 times, then around 29 people will become infected; a person infected with SARS-CoV-2 will typically infect 3 other people, so if this happens 10 times, then approximately 59,000 other people will become infected. This has naturally led to focus on developing a vaccine, a process that most experts believe will take at least 18 months. This timeframe has been facilitated by China sequencing the genetic

UKRI, has begun advertising for human volunteers for trials. It will use an adenovirus vaccine vector, which was chosen as the most suitable candidate because of its capability to create a strong immune response in an individual and for its non-replicating nature, meaning it will not cause an ongoing infection in a vaccinated individual. Coronaviruses have spike shaped proteins on their surfaces and other studies have suggested that this part of the virus is most likely to invoke an immune response. The Oxford vaccine uses this by producing the SARS-CoV-2⁴ spike protein in the vaccinated individual, priming their immune system to attack the virus if it later infects the body.

Conventionally, vaccines have used live, attenuated forms of a virus, or a part of it, which have

into vaccines. No vaccine made from genetic material has yet been successfully approved for human use, however, and it is crucial, both for successfully resolving this pandemic and for future vaccine confidence, that we are not tempted by shortcuts and follow the rigorous safety protocols that govern the approval and manufacture of new pharmaceuticals.

The route that vaccines take from laboratory to clinic is an arduous and long one. Vaccines are risky commercial investments: with so few successfully emerging from clinical trials ready for the market, pharmaceutical companies often prefer to place safer bets with drug development. Indeed, a vaccine against SARS-CoV-2 is by no means an assured certainty. The infrastructure for vaccine

widespread manufacture of a vaccine. In 2018, the Government announced the funding of a new Vaccine Manufacturing and Innovation Centre at Oxford that will be able to carry out vaccine manufacturing at a variety of scales.

Through better understanding of the virus and how it interacts with the immune system, we have a better opportunity to look to developing effective therapeutics. This includes the repurposing of existing interventions that work in the treatment of other illnesses. The UK Government has been active in using rapid response research funding to back this sort of research, including an adaptive trial at Oxford currently looking at two drugs currently used to treat HIV. This is a strategic move that may pay extraordinary dividends if the vaccine research does not deliver the desired results in the appropriate timeframe.

The UK is one of the international partners at the forefront of immunological research. Through the commitment of the international immunological community to share new research information without delay and to jointly conceptualize new avenues for treatment, we will overcome the current threat posed by SARS-CoV-2 worldwide.



material of SARS-CoV-2 early on and sharing this with the rest of the world. There has also been much investment made in developing vaccines for coronaviruses – a reflection of the fact that respiratory illnesses are generally considered to pose the greatest pandemic risk.

Thirty-five research institutions and pharmaceutical companies worldwide are pursuing a vaccine; some with candidates that have entered animal trials, whilst one, produced by the Boston biotechnology company, Moderna, has entered trials in humans³. Another project at the University of Oxford's Jenner Institute, funded in part by the

been inactivated by passage through a foreign host. These have the advantage of quickly conferring immunity to the person being vaccinated and are a low-cost option, so attractive to governments considering the cost of vaccinating of the entire population at once. Another more modern approach includes constructing a recombinant vaccine that involves the extraction of the genetic code for one of the surface proteins on the virus – the part most likely to invoke an immune response – and inserting it into a bacterium which will then produce large quantities of these proteins which are then manufactured

manufacture is often specific to a particular vaccine and the production facilities are not large enough to produce the supply needed in a pandemic situation. Already, the Coalition for Epidemic Preparedness Innovations (CEPI) is calling for financing to ensure that if and when a vaccine is developed in the relatively near future, there is capacity to produce enough to be of use. Previously concerns have been raised about the UK's capacity to manufacture vaccines on a large scale⁵. It is evident that any shortage of production sites will be felt more acutely in a pandemic situation when all countries are also moving to

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THE POWER OF INNOVATION CAN...



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A submicroscopic infectious agent has forced the world to experience an unprecedented level of disruption not seen since World War 2. Coronavirus or COVID-19 has generated uncertainty and fear of the unknown. Governments around the world have taken extraordinary steps to protect their citizens lives and livelihoods. Propping up businesses through various policy and financial measures, thereby ensuring continuity of economies when the virus eventually diminishes.

The Cambridge dictionary terms disruption as the action of preventing something, especially a system, process, or event, from continuing as usual or as expected. Disruption takes different forms such as political (e.g. the UK's exit from the European Union), behavioural (e.g. the increased application of online shopping, meetings and learning using digital platforms), technological (e.g. the application of autonomous systems and artificial intelligence) and expectational (e.g. single-click and biometric purchasing over devices and one-day/same day delivery timeslots). Disruption generates a flux of threats and opportunities with varying levels of impact. Living in these times of seismic shifts, disruption has become the new normal or even the never normal! It generates what economists call an *S-Curve* (*a curve that resembles the character S*). At the bottom part of the 'S' it often feels like not much is happening at all. But then things start to pick up, and once the curve crosses its first inflection point (the bottom curve of the 'S' moving upwards), things suddenly start to go wild. After a while, something changes, and the curve flattens once again, and then drops.

At the present time, COVID-19 is going through its own S curve. It started with hardly any impact, trundling along at the bottom, with people saying 'it's a bit worse than the flu', and then the virus took off, and in parallel the innovations sparked, new testing kits, new ways to oxygenate patients; keeping them out of ICU, and the race is now on for the covid-19 vaccine. As a nation, we're racing up that 'S' curve, throwing innovation after innovation, to find a way out of the mire this virus has hurled us in. Conversely from a normal market 'S' curve, where everything is done to avoid plateauing and dropping off, in the case of the covid-19 'S' curve, we're doing all we can to reach that flattening point. For it will mean cases of those infected will have dropped, and we'll have won against the virus.

'Engineering a Crisis' is something that we speak of in a business-sense regularly. As a professional body responsible for driving innovation, we often encourage companies suffering from business lethargy to 'create a crisis' to disrupt their 'business as usual' complacency and reinvent themselves. Such a radical approach in organisations has witnessed dividends; mobilising a sense of urgency in people, suppliers, partners and other stakeholders within its

ecosystem. Businesses should seize the opportunity and use these current disruptive signals positively, to reflect and transform their business models; embracing and embedding innovation in every aspect of their operations.

Accelerating the pace of innovation to deliver desired outcomes whether at policy level or at business level, is essential in mitigating the negative impact of a crisis like Coronavirus. Challenge-propelled collaboration through Open Innovation activities deliver ideas and solutions at a much-needed transformational velocity, giving the edge and confidence to turn around the statistics.

Evoking change at a scale, however, requires those in charge to demonstrate active leadership for innovation. Exhibiting key critical behaviours such as experimental ethos, growth mindset and an appetite for risk taking, along with the ability to communicate with clarity, impact, and audience empathy is essential.

We at the Institute of Innovation and Knowledge Exchange (IKE Institute) define *innovation as the development of new, or improvement of existing products, services, processes and/or business models*. Innovation represents

the transition process from idea generation all the way to value creation. Innovation in the context of value creation can be represented on a value-spectrum that includes incremental improvements at one end of the spectrum through to transformative innovation, that subsequently results in a dramatic impact on other areas in the spectrum, and how innovation is thus, treated (e.g. transformational innovation of the touch screen transformed the way we interact with devices and systems, and thus changed innovations involved with these devices and systems as a result).

In line with IKE Institute's drive to professionalise and promulgate effective innovation more widely, we have been an active participant in the development of international standards for Innovation Management through the BSI (British Standards Institution) and the ISO (International Standards Organisation). Recently, a new standard guidance – ISO 56002 Innovation Management System has been published as part of the ISO 56000 Innovation Management guidance series (available from BSI). It advocates the need for organisations to engender environmental conditions within their places of work, to support openness, curiosity, creativity and user-focus.

The IKE Institute recognises that for the UK to maintain its innovation ranking position globally, we need to ramp up innovation capability, accelerate innovation readiness and sharpen our innovation edge.

In the SIP issue, Spring 2013, we asked the question of "Can organisations afford not to invest in innovation?" At that time seven years ago, we introduced the Investor in Innovations Standard as a systematic framework that helped organisations increase their innovation capability to drive

competitive advantage and achieve growth. We have now inculcated the newly published ISO 56002 Innovation Management System (and the other related parts of the ISO 56000 innovation management guidance series) within our Investor in Innovations Standard, thus, enabling organisations to embrace and apply these new and emerging ISO standards, in an integrated and time-lined manner, with ease.

Last year, and as part of its role in an Erasmus+ project, entitled 'Creative Engine,' IKE Institute conducted a detailed survey of 240 engineering manufacturing enterprises, ranging from small (29%), medium (30%) through to large multinationals (41%), to examine how innovation was organised, developed and supported in their businesses.

The study, in collaboration with four project partners (South West College, Northern Ireland; Dublin City University, Ireland; Tknika, Spain and Thomas More University, Belgium) focused on six key areas – Creativity and Ideas Management; Innovation Process and Planning; Customer Analysis; Management of New Innovations; Business Development; and Communications and Engagement. Some of the key highlights of the survey analysis are shown below:

- 83% admitted they did not have a structured approach to innovation;
- 37% acknowledged they did not have an innovation plan that is aligned to their business strategy;
- 3 in 5 affirmed their Innovation Plan was not communicated across the business nor stakeholders, to gain input and commitment;
- Business Case development was seen as critical in the innovation process, although over two-thirds of companies weren't using systematic

techniques consistently to support development (25% didn't use it at all; 43% used it sometimes; and only 32% applied it regularly).

It was interesting to note that the pattern in the responses to innovation engagement was relatively consistent across all four countries.

We are now seeing governments, public agencies and research organisations using proactively innovation as a strategic instrument, enabling rapid reconfiguring on the way impact is delivered to customers, sponsors, users and citizens, and how value is achieved for all.

Last year, the IKE Institute was asked by the UK's Ministry of Defence to benchmark and assess the innovation capability of the Defence Innovation Network, bringing together all the Innovation Hubs of front-line command (Royal Navy, Army, RAF and Strategic Command) together with the Defence Innovation Directorate (covering the Defence and Security Accelerator and the Defence Innovation Unit). Through this process, it was pleasing to see all these defence innovation entities applied many good practices, had a real sense of urgency, energy and passion for innovation, and had exploited many new and emerging technologies. Multi-skilled teams across the Defence Innovation Network presented diverse innovative and collaborative capabilities underlying the fact that new, faster and cost-effective solutions were getting into hands of the user, and ultimately, to the front-line fighter.

Universities and colleges are also extending and exploiting their innovation capabilities internally (e.g. new ways for delivering educational offerings) and externally (e.g. driving economic development regionally and on the international stage). For example,

our engagement with the City of Glasgow College has demonstrated how innovation transformed their operating model. By adopting a 'blue ocean' strategy on the development of their product/service portfolio, they were able to develop new, differentiated offerings thus increasing employment opportunities for their students, attracting infrastructure investments and forging international collaborations. In the higher education domain, there are many similar examples. Our collaboration with the University of Plymouth's Acceleration Through Innovation (ATI) initiative, focused on energising businesses in Cornwall. The Cornish economy is one that is dominated by micro-businesses. The initiative's aim was to arm these businesses with the innovation tools and techniques to enable them to compete and grow successfully.

The current COVID-19 crisis highlights viscerally, the cultural and behavioural step change in accelerating adoption of digital technologies and applications across all economic sectors. Digital now, more than ever, is forcing us to re-think and work differently, to yield a positive impact. AI in managing financial transactions, predictive autonomous supply chains in logistics and blockchain-based prescription dispensing in health care, are just a few examples of how digital is becoming ubiquitous in our lives. Innovation is the power that continually reshapes our lives, our norms, assumptions, behaviours and expectations. In the quest for combating the impact of COVID-19, innovation is critical and remains to be the only weapon that will protect our health, livelihoods and society.



SCIENCE IS CHALLENGING CANCER USING THE UK'S SYNCHROTRON



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The limitations of chemotherapy and radiotherapy are driving a global search for novel ways to prevent and treat cancers. And this is why many international research teams are coming to Oxfordshire to use Diamond Light Source, the UK's national synchrotron to investigate many new approaches. Their common goal is to reduce the global impact of cancer by improving our understanding of cancer mechanisms and producing new opportunities for effective cancer therapies.

Diamond is providing industrial and academic user communities with access to state-of-the-art analytical tools to enable world-changing science. Shaped like a huge ring, it works like a giant microscope, accelerating electrons to near light speed, to produce a light 10 billion times brighter than the Sun, which is then directed off into 33 laboratories known as 'beamlines'.

In the last two years alone, Diamond has published over 345 publications related to cancer research. A particular focus has been on utilising the immune system to become more efficient in targeting cancer cells and designing new targeted therapies, the hunt for a universal cancer vaccine, tackling triple negative breast cancer, developing new hope for pancreatic cancer and non-invasive diagnosis of prostate cancer to name just some of the breakthroughs being made. Recent examples conducted by international teams in collaboration with Diamond and its scientists include:-

CANCER CELLS HAVE WAYS TO EVADE THE HUMAN IMMUNE SYSTEM

The human immune system has cells that can attack invading pathogens, protecting us from bacteria and viruses. These cells are also capable of killing cancer cells, but they don't. Cancer cells have evolved defence mechanisms to prevent them being destroyed by our immune system, allowing them to survive and replicate, growing into tumours that spread through the body. Researchers around the world are looking at different ways to overcome these complex mechanisms.

Some exciting new work analyses how breast cancer cells evade the human immune system and could leave them with nowhere to hide. Dr Rohanah Hussain and Prof Giuliano Siligardi of Diamond's B23 beamline in collaboration with an international research team led by Dr Vadim Sumbayev investigated these complex defence mechanisms of the human immune system and how cancer cells in breast tumours avoid it. They used Synchrotron Radiation Circular

Dichroism (SRCD) spectroscopy on beamline B23 to investigate these defence mechanisms.

"Our findings demonstrate the activity of the Tim-3-galectin-9 biochemical pathway in several types of human cancer cells and its possible role in the suppression of the immune system response. We found breast tumours express significantly higher levels of Tim-3 and galectin-9 than healthy tissue revealing increased levels of these key proteins in nine other cancers, highlighting their important role in cancer development. Our ultimate goal is now to find the best way to disable the Tim-3-galectin-9.

This could lead to therapies that allow our immune systems to reboot, reducing the need for more toxic treatments such as chemotherapy and radiotherapy, which have severe side-effects for patients." Explains Dr Sumbayev adding that.

The team are already planning another visit to Diamond, for the next stage in this vital research to discover the best way to disable the pathway to allow the immune system to attack cancer

cells. "Access to Diamond is crucial to our research. The sensitivity that synchrotron radiation allows cannot be replicated using other techniques, and it allows us to really see what's happening to the proteins, even small details."

USING MONOCLONAL ANTIBODIES TO MODULATE IMMUNE RESPONSE

Another promising new approach to cancer therapy is the use of monoclonal antibodies (mAbs) to modulate the immune response and improve the body's ability to destroy cancer cells. To date however use of mAbs such as urelumab has been limited due to intolerable side-effects. An international team redesigned a 4-1BB molecule to form an antibody that had potent stimulatory activity with no associated toxicity. They used High Throughput Small Angle X-ray Scattering (SAXS) on beamline B21 as part of their research. **This novel approach may unlock the potential of immunotherapeutic antibodies in cancer treatment with minimal side-effects.**

THE HUNT FOR A UNIVERSAL CANCER VACCINE

Therapeutic vaccination against tumour-associated antigens (TAA) has been a highly anticipated approach where a patient's own immune system is boosted to treat cancer, in particular harnessing the anti-cancer potential of CD8 cytotoxic T-lymphocytes but to date results have been largely disappointing. However, a team from the Universities of Cardiff and Copenhagen identified and refined 'super-agonist altered peptide ligands' (APLs) from the blood of healthy donors and were also able to induce T-cells from the blood of patients with

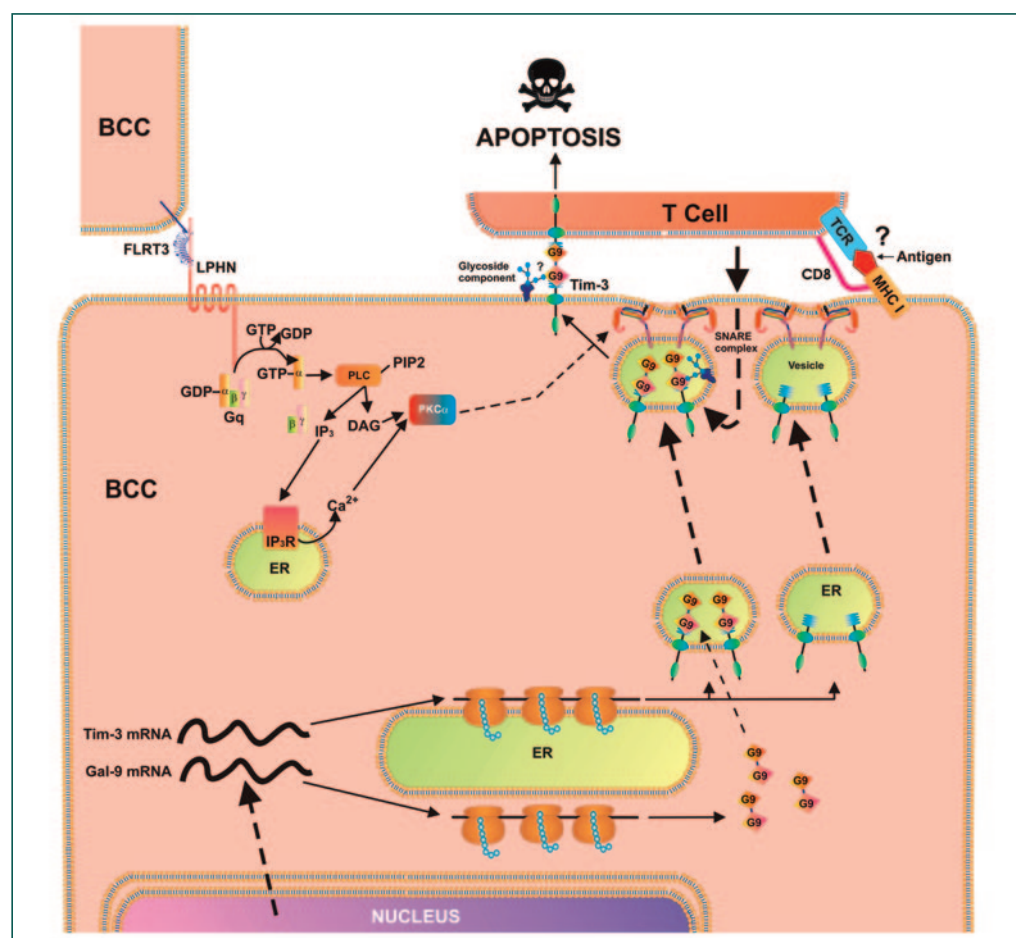
melanoma. Among other methods, the team used macromolecular crystallography on beamline I24 to generate the peptide structures. These APLs were capable of inducing T-cells with greater effectiveness and suggest that this could be a promising approach in the hunt for a universal cancer vaccine.

TACKLING TRIPLE NEGATIVE BREAST CANCER

A diagnosis of triple negative (TN) breast cancer means that the tumour does not have the three most common types of receptor that promotes tumour growth. Common therapies for this cancer type are therefore ineffective and patients have a poor prognosis.

extremely efficient vectors for intracellular delivery but have been associated with undesirable side-effects including mortality in some cases. Recently, much safer synthetic analogues for viruses have been developed. A University of Sheffield research group has designed synthetic Dengue virus-mimicking nanoparticles to selectively target TN breast cancer cells and show that genetic material can be efficiently delivered to the cell nuclei while maintaining high cell viability. They used small angle X-ray scattering and diffraction (SAXS) analysis on beamline I22 to accurately characterise the nanoparticles. **This work shows potential for new therapeutic approaches for the treatment of TN breast cancer.**

Pancreatic ductal adenocarcinoma (PDA) is difficult-to-treat cancer characterised by immune tolerance and resistance to immunotherapies including T-cell checkpoint-based immunotherapy which is becoming the standard of care for several cancers. A team of US researchers discovered upregulation of the protein kinase RIP1 in tumour-associated macrophages in PDA, a promising target in PDA. They developed a selective small-molecule RIP1 inhibitor and used macromolecular crystallography on beamline I02 to show that RIP1 inhibition is protective against pancreatic cancer in vivo. The teams research suggests that **RIP1 could be regarded as an**



Efforts are being made to design new therapies and researchers are looking at the capability of viruses to deliver effective therapies. Viruses are

NEW HOPE IN TREATING PANCREATIC CANCER

Pancreatic cancer is a particularly difficult cancer to treat with no effective therapies.

immune checkpoint and supports RIP1 inhibition as a potential new therapeutic avenue in the treatment of PDA.

Another international study investigated several new compounds for their anti-pancreatic cancer activity. The team focused their attention on dysregulation of discoidin domain receptors (DDRs) involved in several cellular processes including cell differentiation and adhesion often detected in cancer. The crystallographic structure of DDR1 was determined on beamline I04. The team designed and used a DDR1 inhibitor to successfully slow pancreatic cancer progression and to improve sensitivity to standard of care pancreatic cancer therapies. **DDR1 is now being considered as a novel target for drug discovery against pancreatic cancer.**

DEVELOPING NON-INVASIVE DIAGNOSIS OF PROSTATE CANCER

Zinc concentration is a known biomarker for prostate cancer, markedly reduced in cancer while remaining high in benign conditions. Until recently zinc concentration could only be measured using a tissue biopsy, but a research team from the University of Texas has been exploring non-invasive imaging methods using magnetic resonance imaging (MRI) and synchrotron radiation X-ray fluorescence (μ SR-XRF). Using a zinc responsive contrast agent to

detect zinc release in the prostate in a mouse model, they confirmed that zinc concentration was associated with the presence of malignant tissue. The team worked on beamline I18 during the study and highlighted the advantage of using MRI to characterise the distribution and trafficking of zinc in healthy and malignant prostate tissue. **These initial studies may provide an important way forward for the early diagnosis and treatment of prostate disease.**

A NEW APPROACH TO NON-SMALL CELL LUNG CANCER

The RAS/MAPK pathway is a major driver of oncogenesis leading to the growth of tumours and is imperfectly or abnormally regulated in approximately 30% of human cancers, primarily by mutations in the BRAF or RAS genes. The extracellular-signal-regulated kinases (ERK1 and ERK2) serve as central nodes within this pathway. An industry research group used a structure-based design approach and macromolecular crystallography on beamline I04 to identify appropriate ERK1/ERK2 inhibitors. The research led to the identification of AZD0364, a potent and selective ERK1/2 inhibitor which prevents activation of ERK1/2. The compound exhibits high cellular

potency and good pharmacological properties and has demonstrated encouraging anti-tumour activity in pre-clinical models of non-small cell lung cancer. Clinical trials on this new compound are planned to commence soon.

CEO of Diamond, Professor Andrew Harrison concludes; "Diamond serves as an agent of change, addressing 21st century challenges such as disease, clean energy, food security and more. In particular, research taking place at Diamond is improving our understanding of cancer mechanisms and producing new opportunities for effective cancer therapies.

Since operations started in 2007, more than 14,000 researchers from both academia and industry have used our world-leading facilities to conduct experiments and over 8,000 scientific articles have been published by our users and scientists."

UNDERSTANDING THE EPSTEIN BARR VIRUS PORTAL

The Epstein-Barr virus, which belongs to the herpesvirus family, is one of the most widespread human viruses and the main cause of glandular fever (infectious mononucleosis). In addition, it causes several kinds of cancer,

including Burkitt and Hodgkin's lymphoma, stomach cancer and nasopharyngeal cancer, as well as several autoimmune diseases. There is currently no treatment for infections caused by this virus.

An international team of researchers studied the structure of a key protein in the virus known as a portal which is the entrance and exit point for the viral genome. The team solved the structure of the portal at 3.5 Angstrom resolution using the Titan Krios I electron microscope in eBIC. This is the Electron Bio-Imaging Centre at Diamond which provides scientists with state-of-the-art experimental equipment and expertise in the field of cryo-electron microscopy, for single particle analysis and cryo-tomography. Two powerful cryoelectron microscopes allow users to investigate the structure of individual cells and to visualise single bio-molecules, exploiting techniques that are rarely available at home laboratories.

The detailed architecture of this protein that the team achieved suggests that it plays a functional role in DNA retention during packaging. New understanding of the portal structure paves the way for the rational design of inhibitors for the treatment of cancers.



ABOUT DIAMOND LIGHT SOURCE: WWW.DIAMOND.AC.UK

Funded by the UK Government through the Science and Technology Facilities Council (STFC), and by the Wellcome Trust, Diamond is one of the most advanced scientific facilities in the world, and its pioneering capabilities are helping to keep the UK at the forefront of scientific research.

MATHEMATICS, NUMBERS AND DATA IN DAILY LIFE: A HIDDEN CRISIS AT THE BASE OF THE PYRAMID



Professor Chris Linton
Provost & Deputy Vice-Chancellor,
Loughborough University
Trustee, National Numeracy
Past President, Institute of
Mathematics and its Applications

The government has recently announced welcome additional funding to support world-leading mathematics research here in the UK. Readers of *Science in Parliament* will understand the huge contribution that such research makes. You may be less familiar with the work of the independent charity National Numeracy (I joined as a Trustee last year) in support of its mission to enable everyone in the UK to become confident and competent with numbers and data so that they can make good decisions in their daily life.

I am no doubt preaching to the converted in making the case for the importance of having a familiarity with numbers and basic mathematical concepts for good decision making. It's hard to imagine making financial decisions or weighing up the risks of different healthcare options without these skills. Those who have the confidence and skill to use mathematics and understand data, whether at home or at work, are at a significant advantage.

However, given the shared acknowledgement of the importance of mathematical confidence and skills, it may be of interest to you to gain a deeper understanding of the current level of everyday maths skills among the UK population. The most efficient way to do this is to include a sample of the questions from the National Numeracy Challenge online tool that was used in an Ipsos MORI poll for research conducted by King's College London's Policy

Institute to support National Numeracy Day last year:

Before reading on, I would ask you to estimate the percentage of those 2,000 or so adults surveyed who managed to get all 5 questions right (answer given at the end of the article).

Although these questions are straightforward (but not trivial) and absolutely situated in daily life, National Numeracy chose not to lead on the percentage of respondents who achieved 5/5;

Appendix

For the final part of the survey we'd like to ask a few questions. Please take as long as you like and feel free to use a calculator or pen and paper to help your work out the answers.

Q13. If a scarf costs £11.70 after a 10% reduction, what was the original price? (L1)

- £12.50
- £13.25
- £13.99
- **£13.00**
- I don't know

Q14. Mike's lunch contains 640 calories of energy. What percentage is this of his target daily intake of 2000 calories? (L1)

- 45%
- 62%
- 65%
- **32%**
- I don't know

Q15. Rail tickets increased by 2% in year 1, and 5% in year 2. What was the overall increase over the two years? (L2)

- 7%
- **7.1%**
- 10.0%
- 10.7%
- I don't know

Q16. These are three offers on the same ketchup. Which is the best value for money? (L2)

- 275g for £1.05
- 454g for £1.99
- **650g for £2.20**
- 425g: buy two for £3.10
- I don't know

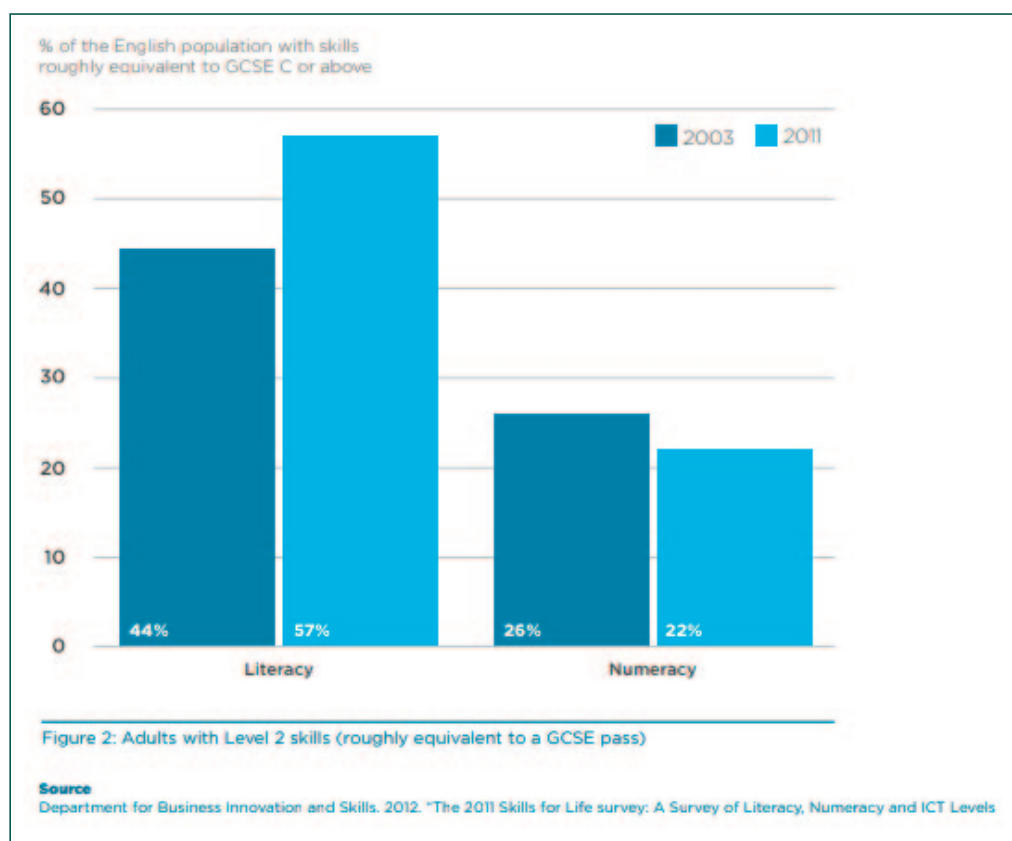
Q17. You buy a laptop that costs £899, including VAT at 20%. How much of the purchase price is VAT? (L2)

- £179.80
- £89.80
- **£125.00**
- **None of these**
- I don't know

their main effort is geared towards a position in which most adults in the UK get most of these kinds of questions right, so they used a threshold of 4 out of 5 as indicative of a reasonable, workable level of numeracy. Even at that lower threshold, only 20% of those surveyed achieved either 4 or 5. The majority, 56%, scored either 0, 1 or 2.

There are flaws with surveying in this way, but these statistics match remarkably closely the data from the 280,000 adults who have engaged with the National Numeracy Challenge. They also match remarkably closely the government-commissioned research shown here that spurred Lord Claus Moser to instigate the work that led to National Numeracy launching as an independent charity in 2012. As former Chief Statistician, he despaired at the results of the Skills for Life Survey, particularly given the effort that had gone into adult literacy and numeracy following his government-commissioned *A Fresh Start* report, which called for the levels of functional illiteracy and innumeracy to be halved within a decade. As you can see, through the skills-based adult education initiatives in the following years strong progress was made on literacy, but adult numeracy levels worsened.

It is worth highlighting the extent to which false assumptions about the everyday mathematical skills of the population are built in to almost all areas of life. Within the education and skills system, the new T-Levels, apprenticeships and most undergraduate courses assume a level equivalent to 5/5 in the questions above – but National Numeracy data from a Nuffield-funded pilot study shows that three quarters of social science undergraduates across ten



universities did not have the 'Essentials of Numeracy'. At work, most employers would expect their employees to be able to correctly answer the questions above – but National Numeracy data from the NHS and elsewhere shows that most cannot. Finally, when at home, the tax and pensions system has assumptions about quantitative literacy built in that far exceed where the majority of the population is. Perhaps the starkest example is Universal Credit; a programme that will not work in its current form as too many of the intended recipients cannot engage at the appropriate quantitative level.

A report commissioned by National Numeracy and produced by Pro Bono Economics suggests that the cost to the UK economy of low levels of adult numeracy is enormous. In 2014 it was estimated at around £20 billion per year, roughly 1.3% of GDP.

What is National Numeracy doing about the problem? Since

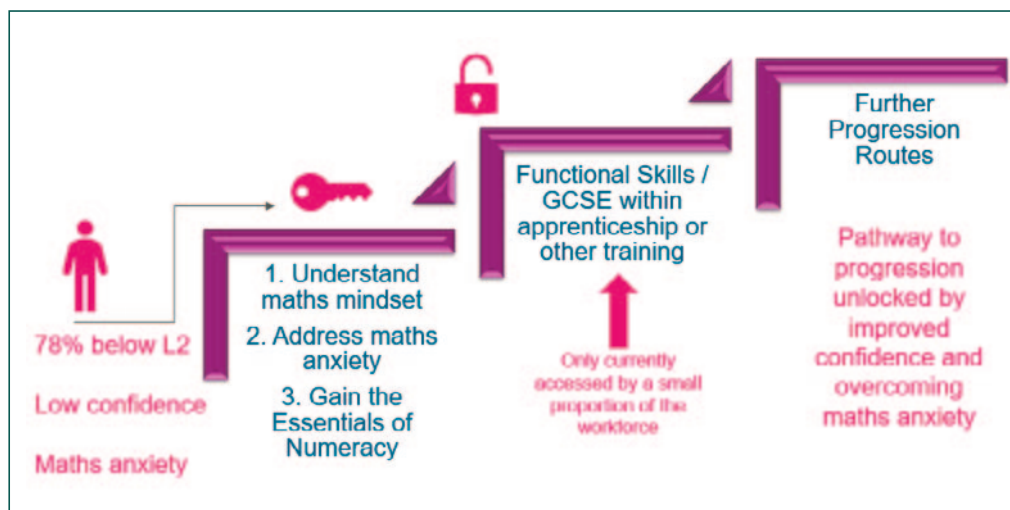
2012, the charity has sought to bring an unrelenting spotlight onto the issue, including challenging the social acceptability of 'I can't do maths'. They have found that this cultural and attitudinal barrier is huge – yet to date has largely been ignored. Their recent report, *Building a numerate nation: confidence belief and skills*, outlines why addressing maths anxiety and building confidence alongside competence is at the heart of their work. Given the scale of the issue, providing digital tools is also central; there are simply not enough teachers and tutors to address the situation.

National Numeracy has recently completed a DfE-funded Flexible Learning Fund project, under the auspices of the National Retraining Scheme, which has shown promising results. By working with partner organisations and by targeting adults directly and digitally, they have shown that it is possible to persuade significant numbers of adults (20,000 within the

project), who had not planned to improve their everyday maths, to engage with doing so by utilising an approach that focuses on building confidence alongside skills.

Partner organisations, in both the private and public sectors, have identified 'broken rungs in the ladder' to apprenticeships and qualification-based provision for adults – and that the low take-up of both is evidence of this gap. The team at National Numeracy has worked with them to attempt to fill this gap by enabling adults to build the confidence and competence to be prepared to engage with the current education and skills system:

This work draws upon evidence both within adult education and from other domains (e.g. combating obesity through campaigns such as 'This Girl Can') that show that taking the first engagement step is crucial. What National Numeracy is trying to do could be seen as equivalent to the NHS Couch to



5K running plan and within that analogy, current qualifications-based provision is equivalent to a marathon and way out of reach.

There would appear to be an excellent opportunity to address both high-end mathematics and 'entry level quant skills'. National Numeracy's work on the latter is

world leading. They have found that for many people a fear of maths is the biggest thing that is holding them back – and just as a basic level of physical fitness is increasingly recognised to be within everyone's grasp, good numeracy is within the grasp of anyone who is currently held back by low confidence. Put

another way, all humans who can communicate moderately effectively in the English language also have the cognitive capacity to correctly answer the questions above; this is not an underlying intelligence issue.

With the right approach, we can collectively address this crisis – making clear progress within

the term of this parliament. We need the government to recognise that helping people at the base of the pyramid engage with the world effectively will be of huge benefit to the nation, as well as to the individuals themselves. But also that this is not about more or better education, it is about helping the millions of people who have emerged from our education system with low levels of mathematical confidence and poor quantitative skills get over that first step to reengage with numbers and data. It is an enormous task and National Numeracy cannot do it alone.

In the meantime, why not try the National Numeracy Challenge yourself?

Answer: 6% of those surveyed scored 5/5

SMART ENERGY: THINKING ABOUT OUTCOMES, DIGITAL INFRASTRUCTURE, AND PEOPLE



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Energy systems around the world are changing in response to climate change. They are becoming increasingly reliant on decentralised renewable resources, experiencing new types of loads such as electric vehicles, heat pumps, and storage, and experience more active demand side participation¹⁻⁶. Aligned with this is a push toward digitisation^{7,8}, with the introduction of smart-meters, greater prevalence of "Internet of Things" devices, and increasing sophistication of automation such as artificial intelligence (AI) used to provide system services. This

"smartness" is driving exponential growth in the scale and diversity of energy system data, presenting opportunities and challenges in equal measure⁹. Understanding how energy system and digital systems are evolving and interacting is key to deliver a smart energy future. While much is happening at the grid edge, a shared vision is necessary to underpin and stimulate collective action; this is a critical opportunity for government, and the time to act is now.

HOW ARE ENERGY SYSTEMS BEING REDEFINED?

Typically, smart energy is discussed in the context of the high-minded goals that smart energy systems aim to achieve, or the technologies or processes they aim to deliver. But can an energy system be smart because it uses these smart technologies, regardless of the results? While the primary purpose of traditional energy systems is to enable energy services to be delivered to end-users of the system^{10,11}, the transition toward "smarter" energy systems may see the

provision of services beyond energy become increasingly important, or even dominant. This blurring means that in addition to providing energy services in more effective or efficient ways, smart energy systems are anticipated to deliver wider benefits such as those outlined in Table 1¹². While these do not entirely re-define the energy system purpose, they set the broader context in which the provision of energy and related services to system users must be delivered.

WHAT DO WE MEAN BY SMART?

At its core, smartness is layered into energy systems by collecting and using more and different forms of data, fusing energy systems with information systems, and allowing energy system objectives to be met in more effective ways^{13, 14}. But smart isn't just about how this data is generated, it is about how it is used.

This data may be used to support autonomous management of the system, for example, allowing the system to automatically control itself to optimise the provision of energy and ancillary services, using technology to make the decisions^{15,16}.

Alternatively, it could be used to support semi-autonomous regulation, optimising the system within the bounds of user input or in line with user set preferences¹⁵. This perspective brings together people with technology in defining the smartness, with users setting parameters, and technology learning and adapting based on revealed preferences

All of this new data and learning may also be used in new processes to provide more useful information to help

Table 1: Seven ways smart energy systems can create value
Effective provision of energy services
Deliver energy services to users in more effective and efficient ways that reduce system costs and costs to users, reducing bills; improve comfort and quality of life, for example reducing fuel poverty.
Enhance environmental eco-system benefits
Deliver environmental benefits including and beyond carbon emissions reductions. These may include biodiversity and other ecosystem services alongside renewable energy provision.
Maximise sufficiency and independence within localities
Locally balance supply and demand, minimising the energy requirements from the national grid and maximising the use of local and low carbon resources.
Enable flexibility within and across vectors
Flexibility across vectors and the ability to switch between different vectors to provide energy services to provide greater efficiency and resilience.
Improve resilience and ability to cope with failure
Cope with generation failure as well as grid outages through better use of real time data, enhanced decision making, or autonomous forms of control.
Improve social justice and energy equity
Engage a wider variety of energy system stakeholders in new ways, in order to deliver greater energy equity and benefits to all.
Meet fundamental community needs
Better serve communities or localities through delivering practical benefits such as making it easier for locals to access and take part in the system. This can offer community benefits (e.g. boosting local employment) as well as wider values-based benefits such as addressing desires to reduce global environmental impacts.

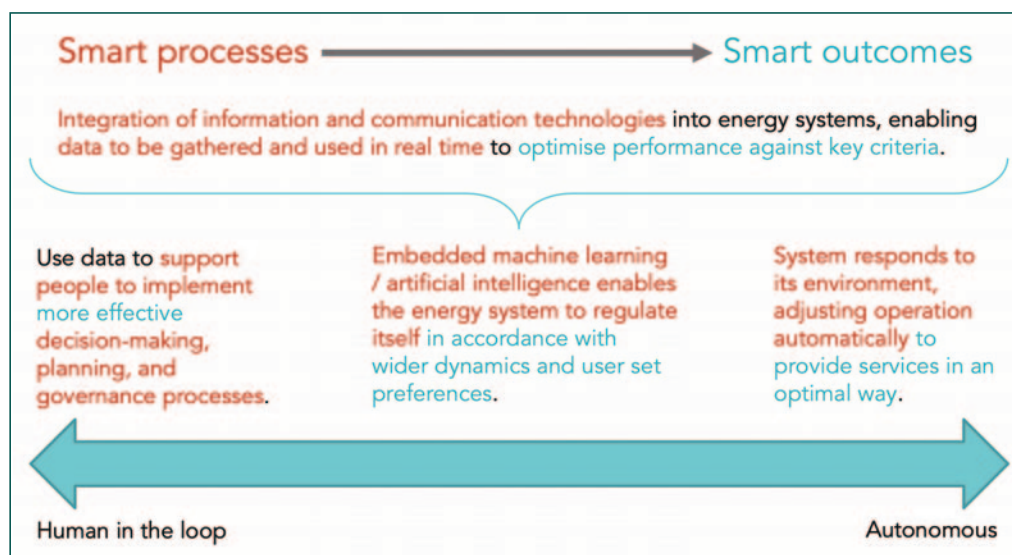


Figure 1 How processes and outcomes define smart energy

people make more informed decisions about how they use energy, or for planning or governance^{12,17}.

Regardless of the process, a 'smart' energy system is expected to enable better and more effective use of resources. This increase in effectiveness

can take many forms. It can mean reducing costs or mitigating losses. It can mean producing larger benefits for individuals, for the system owners and operators, or for the wider world. It can mean producing the right benefits for these groups, more consistent

benefits, or a wider range of benefits. Ultimately, this view of smart is about using smarter processes to drive smarter or better outcomes and opportunities¹².

THE CHALLENGES AHEAD

With the increasing localisation of smart energy, there needs to be a stronger policy direction regarding the realisation of different outcomes, and clearer frameworks to see how different smart energy developments and demonstrations are delivering against each of these key policy areas. Understanding which stakeholders are – or should be – involved is critical, as the starting point for developing a smart energy system could have a significant impact on the legitimacy of the solution, and on the outcomes achieved. Further, the Climate Emergency context raises questions about whether some benefits (e.g. carbon reductions in line with UK targets) should be a mandated goal, while other benefits and co-benefits could be more context specific with different areas of focus emerging in different projects.

Maintaining the smart nature of energy systems is a key challenge. An energy system may cease to be smart if it fails to continually evolve to take advantage of new technologies and opportunities to improve, and to meet the changing needs of the energy system. Changes in the energy system are making existing cyber physical architectures and techniques unfit for purpose. These changes include: (1) more decentralised resources generating data, resulting in lots of data at the grid edge, leading to bandwidth issues when trying to fit into the more traditional centralised analysis and control paradigms, (2) rapidly changing new types of controllable assets like solar panels and EV chargers and (3) the engagement of more, perhaps non-traditional actors who will be expected to play a bigger role in energy system

planning and operation at increasingly local scales.

The key challenge for smart processes is to leverage advances in cyber physical system architectures, data pipelines, control approaches, state estimation techniques, and advances methods such as AI and machine learning, to enhance both autonomous and human elements in the loop decision making.

WHERE WE GO FROM HERE

When developing and building cyber-physical architecture that leverages these new advances, it's important to consider how to make the system: flexible (i.e. the extent to which the system can integrate new data sources, or adapt over time - terms like "plug and play" are common here); scalable (i.e. cope with increasing number of connected devices over time); interoperable (i.e. able to cope with multiple standards and suppliers and non-energy data – e.g. transport, waste, health); predictive (rather than just reactive), and secure¹⁸. Standards and frameworks for developing and deploying digital infrastructure may be required to cope with increasing and emerging data streams.

As well as building a future proof smart energy system from a technical perspective, its future must also be considered from a socio-economic perspective. It is not just generation assets and smarter forms of control that are becoming decentralised, there are also trends toward: local forms of decision-making, energy planning, and system operation; stronger end-user engagement and participation; and growing numbers of intermediaries and businesses emerging as key energy system stakeholders. Understanding what these new roles look like,

how the right skills sets can be created and sustained in the right locations, and how local and national governance structures will need to interact to deliver a smart energy future is key. While much of this may need to happen locally, a shared vision and direction is necessary to underpin and stimulate action across many scales in a co-ordinated direction; this is a critical opportunity for government, and the time to act is now.

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UNLOCKING A MORE SUSTAINABLE FUTURE WITH AI



Maria McKavanagh
Chief Executive Officer
VERV

It's no secret that the health of our planet is declining. Deforestation, melting sea ice, rapidly disappearing species and more have weakened Earth's ecosystems, and climate change is arguably the most pressing issue of our time. We need to think outside of the box – and move swiftly – to recover a sustainable future.

The solution isn't going to come from the small percentage of the world who are willing to overhaul their lifestyle by not travelling by aeroplane, for example. It's going to come from as many people as possible taking their own steps towards a cleaner, greener energy system. And when we add up all of those little steps, that will be the difference between winning and losing the fight against climate change.

So how do we get everyone in the country, or on the planet to do their bit? Let's look at something like the plastic bag tax. Charging 10p for plastic bags has resulted in their use plummeting by 85% compared to the year before it was introduced.

I believe this has become even more sticky due to the strong 10p bags, or cloth bags, which you bring from home, serving the consumer's purpose better than any of the free cheap plastic bags we used before. They are stronger and don't hurt your hand so much. You can get more into them, and sling them over your shoulder which makes them less cumbersome to carry. After the initial transition period, the consumer shopping experience is now better. Ultimately, to make big changes like this, we have to create

experiences that make consumers want to change because it adds value to their lives in some way.

And the same goes for businesses. There is a misconception that sustainability must increase business costs when in fact the two can go hand in hand. AI company DeepMind, for example, have harnessed their machine learning capabilities to reduce the amount of energy needed to cool Google's data centers by 40%.

I believe that AI will be a key technology in helping to tackle climate change in innovative ways. At Verv, we use high speed data monitoring techniques and AI to unlock untapped energy data within the home in a bid to make households smarter and more efficient.

One of Verv's most notable projects involved teaming

blockchain with AI to create a peer-to-peer renewable energy trading platform that adds a new dimension to smart energy. Within the platform, our high speed data monitoring and AI technology is used to gain a detailed, real-time view of energy production (if there is a renewable energy source) and consumption within a household. In turn, forecasts based on supply and demand can be used to enable trading at the best times on blockchain technology.

In practice this means that the platform enables households with solar panels to sell the excess energy that they generate directly to their neighbours. Communities can benefit from cheaper energy whilst those with solar panels can receive an ROI by selling to their neighbours. Given it is not currently legal for consumers to sell energy directly to one another, we were



The Hackney social housing estate where our peer-to-peer energy trading pilot took place

extremely lucky to receive funding from BEIS to develop this project.

In 2018, with further funding provided by Innovate UK, we took our platform to the next level at a social housing estate in Hackney. At this specific location there are solar panels on the 14 blocks of flats, but residents can't currently benefit from the green energy due to the constraints of the UK electricity market. We were given regulatory flexibility by Ofgem through a sandbox programme in order to bring our platform to life, and in April 18 we conducted the UK's first peer-to-peer trade of energy on the blockchain. The impact of our work has been more than we could've imagined with case studies of our work in reports and articles worldwide. In 2019 we supported New Anglia energy in raising a modification to UK law (p379) which takes a massive step towards making peer-to-peer renewable energy trading possible.

Despite that, we are still waiting. And as innovation continues to outpace relegation, we are running out of time. More needs to be done at government level to ensure that technologies that can have a real impact can be commercialised quickly.

So whilst we're waiting for legislation, how can we continue to harness Verv's technology to combat climate change?

A recent study estimates that because of the CO₂ emitted in the manufacturing process, a long-lasting washing machine will generate 1.1 tonnes less CO₂ than a short-lived model over two decades. In addition, an estimated 1 million electrical items are being sent to landfill each week, with e-waste becoming the fastest growing waste stream in the world.

We are tackling this using the same high speed data acquisition techniques and AI used in our previous projects, but this time to monitor the health of white goods in real-time. Our high definition predictive maintenance technology detects anomalies in how white goods are performing by analysing their electrical load signatures or digital footprints. We can identify signs of component fatigue and locate faults that are occurring or are about to occur, in the utmost detail, alerting manufacturers and in turn end-users to recommended action. Through real-time performance monitoring, earlier fault diagnostics and a more streamlined maintenance process, there is significantly more opportunity to repair vs replace white goods and in turn extend their life cycles for a reduced impact on the planet. Not to mention the improved customer experience and reduced business costs in warranty for manufacturers who



The Verv team at the Hackney estate where our peer-to-peer energy trading pilot took place

will be able to avoid engineer call-outs where unnecessary (e.g an issue easily resolved by a consumer) and improve first time fix rates thanks to detailed diagnostics. Due to the embedded nature of the technology (within the appliance), manufacturers and consumers will also be able to contribute to demand side response once the domestic play is ready. As mentioned earlier, sustainability does not have to equal increased costs.

These are all of the benefits appliance manufacturers could receive using smart energy AI (including significantly reduced costs in call-outs!), and consumers who will have less downtime of their appliances.

I am extremely excited to be working in the field of energy technology and look forward to the further progress we will make as an industry to bring the climate crisis under control and meet that all important target of reaching net zero by 2050.



Our predictive maintenance technology

CAN THE OFFSHORE ENERGY SECTOR BE TRANSFORMED TO HELP THE UK BECOME A NET-ZERO NATION?



Professor Gioia Falcone,
Rankine Chair, Professor of Energy
Engineering University of Glasgow,
James Watt School of Engineering

In June 2019, the UK became the 1st major economy to legislate for net zero by 2050. In September 2019, Scotland committed to be net zero by 2045. This article presents the current UK offshore energy picture, discussing future challenges and opportunities towards a just energy transition.

UK OFFSHORE ENERGY PICTURE

Oil and Gas

The UK offshore petroleum sector is in a state of transition. The National Audit Office (NAO, 2019) stated that over 44 billion barrels of oil equivalent (Bboe) have been produced so far, with

an estimated 5.4 Bboe more still to be recovered. Yet it is anticipated that UK oil and gas will contribute ever less to meeting energy demand due to domestic petroleum production decline and increasing government support for cleaner energy to meet its net-zero emissions targets. Figure 1 shows historical and forecast hydrocarbon production in the UK. The Climate Change Committee's net-zero scenarios (2019) give reduction in oil and gas consumption of 82% and 32%, respectively, by 2050.

Since 1967, over 300 fields have produced oil and gas in UK Continental Shelf (UKCS) waters (see Figure 2), but the sector focus is turning increasingly to abandonment and restoration. 150 UKCS fields are forecast for decommissioning over the next decade, with approximately 100 platforms being completely or partially removed, 2000 wells

plugged and abandoned, and 7500 km of pipeline decommissioned.

The World Energy Council (WEC, 2017) forecasts that maximum activity is expected in the period 2020-2030, whilst the NAO reported that UK offshore operators have spent more than £1 billion on decommissioning in each year since 2014 and the Oil and Gas Authority (OGA, 2019a) estimates UKCS abandonment expenditure (abex) over the next decade will be £40-67bn. The WEC estimates that 50-80% of UK oil and gas abex may ultimately be borne by the taxpayer. With abandonment activity increasing, the UK government is paying out more in tax relief for decommissioning at the same time as tax revenues from oil and gas production are falling. These tax reliefs are part of the government strategy to support

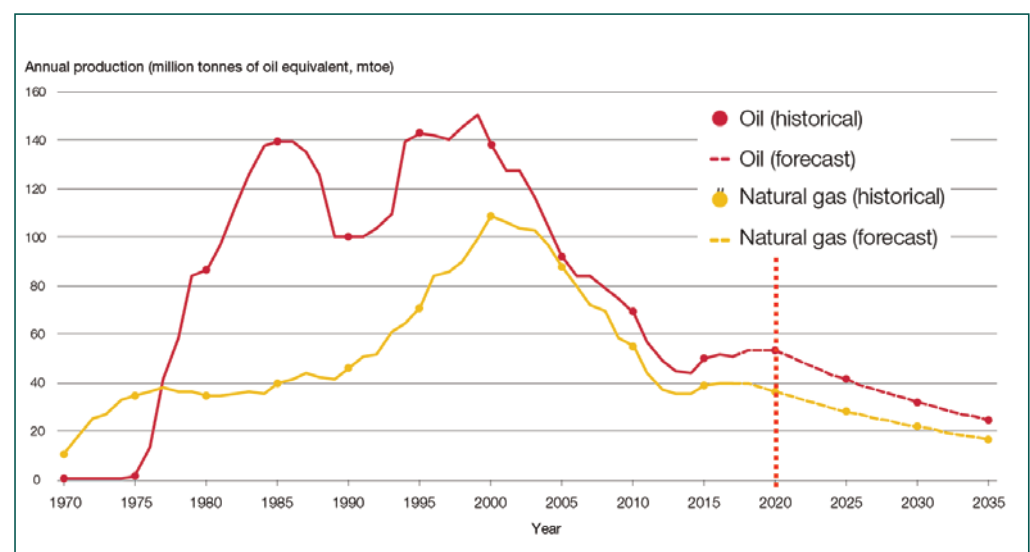


Figure 1: Historical and forecast hydrocarbon production in the UK (after NAO, 2019).

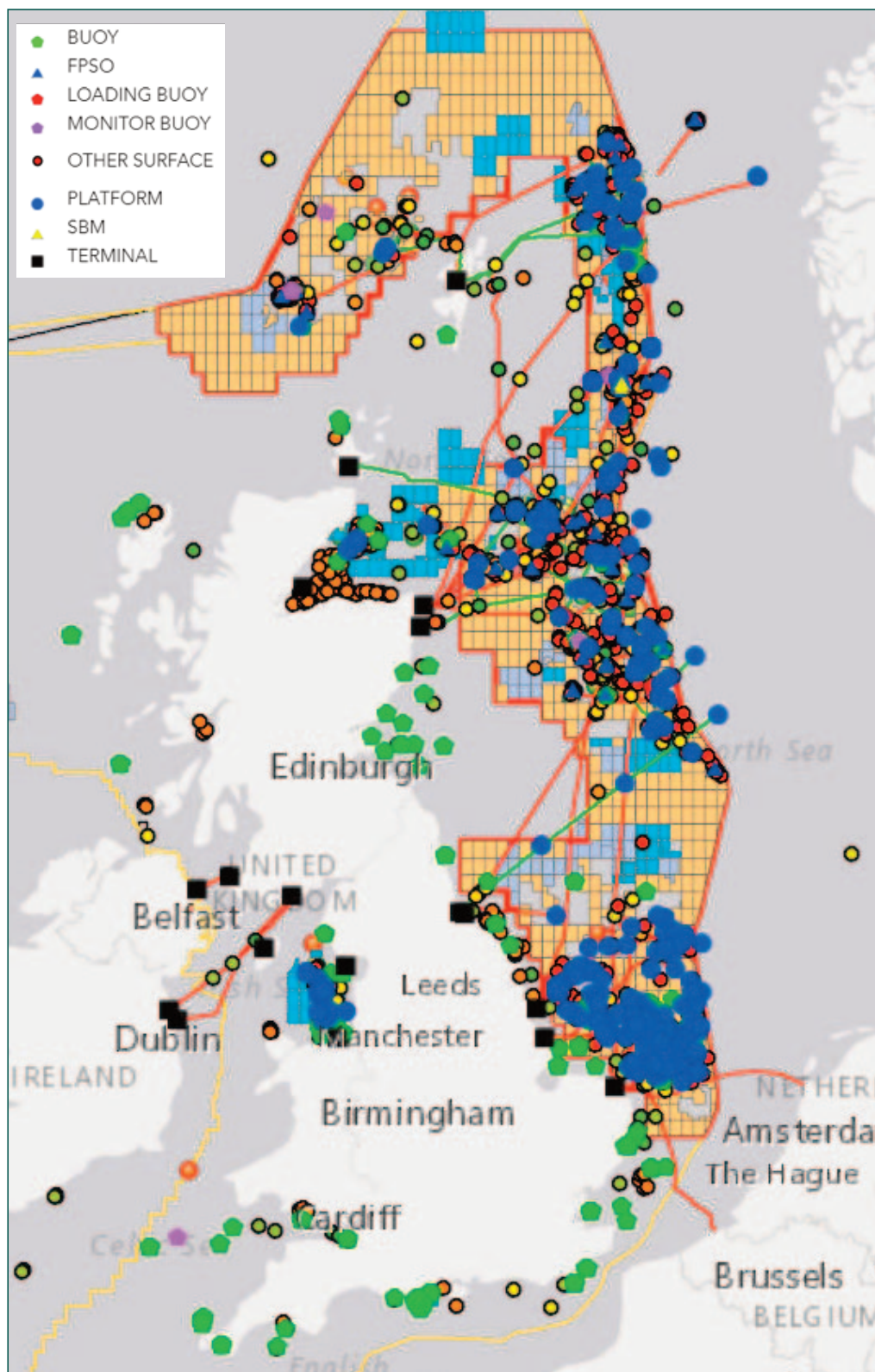


Figure 2: Oil and gas offshore infrastructure map (OGA, 2020)

the industry to maximise economic recovery (MER) of petroleum resources due to its role in the economy, supplying energy and providing employment.

WIND

The UK's total offshore wind operational capacity is approximately 8.5 GW (Crown Estate, Crown Estate Scotland, 2020). See Figure 3 for a map of current offshore wind installations in the UK.

The 2019 Offshore Wind Sector Deal (BEIS, 2019a) set the ambition to deliver up to 30 GW of generating capacity by 2030, at 1-2 GW of new offshore wind per year. Arup (2018) estimated the costs of decommissioning 37 UK

offshore wind farms at various stages of development as £1.28-3.64 billion, anticipating that abex would increase as more developments and bigger structures were being planned. A study by the University of Cambridge (Liu and Barlow, 2017) suggested that there will be 43 million tonnes of blade waste worldwide by 2050, with China possessing 40% of the waste, Europe 25%, the United States 16% and the rest of the world 19%. The blades, made with composites, are currently regarded as unrecyclable.

Both oil and gas and offshore wind operators, as well as the government, must prepare in advance for decommissioning, accurately estimate total costs, including site remediation and monitoring, and be fully aware of abandonment liabilities. The potential for synergies between mature offshore hydrocarbon installations and renewable energy projects is not being fully exploited. Delaying the decommissioning of some oil and gas infrastructure could trigger new circular economy options for the UKCS during the ongoing transition to a net-zero UK by 2050. On the other hand, procrastinating overdue decommissioning while many of the large E&P operators have already left the UK could lead to liabilities falling on taxpayers.

INTEGRATION OPTIONS FOR AN ENERGY TRANSITION

There are complementary offshore energy generation and storage options that would benefit from existing oil and gas infrastructure. Identifying investment priorities and collaboration opportunities among multi-sector stakeholders will inform operators and the government on what oil and gas infrastructure should stay or go, and when. In many cases, there are neither prior examples, nor

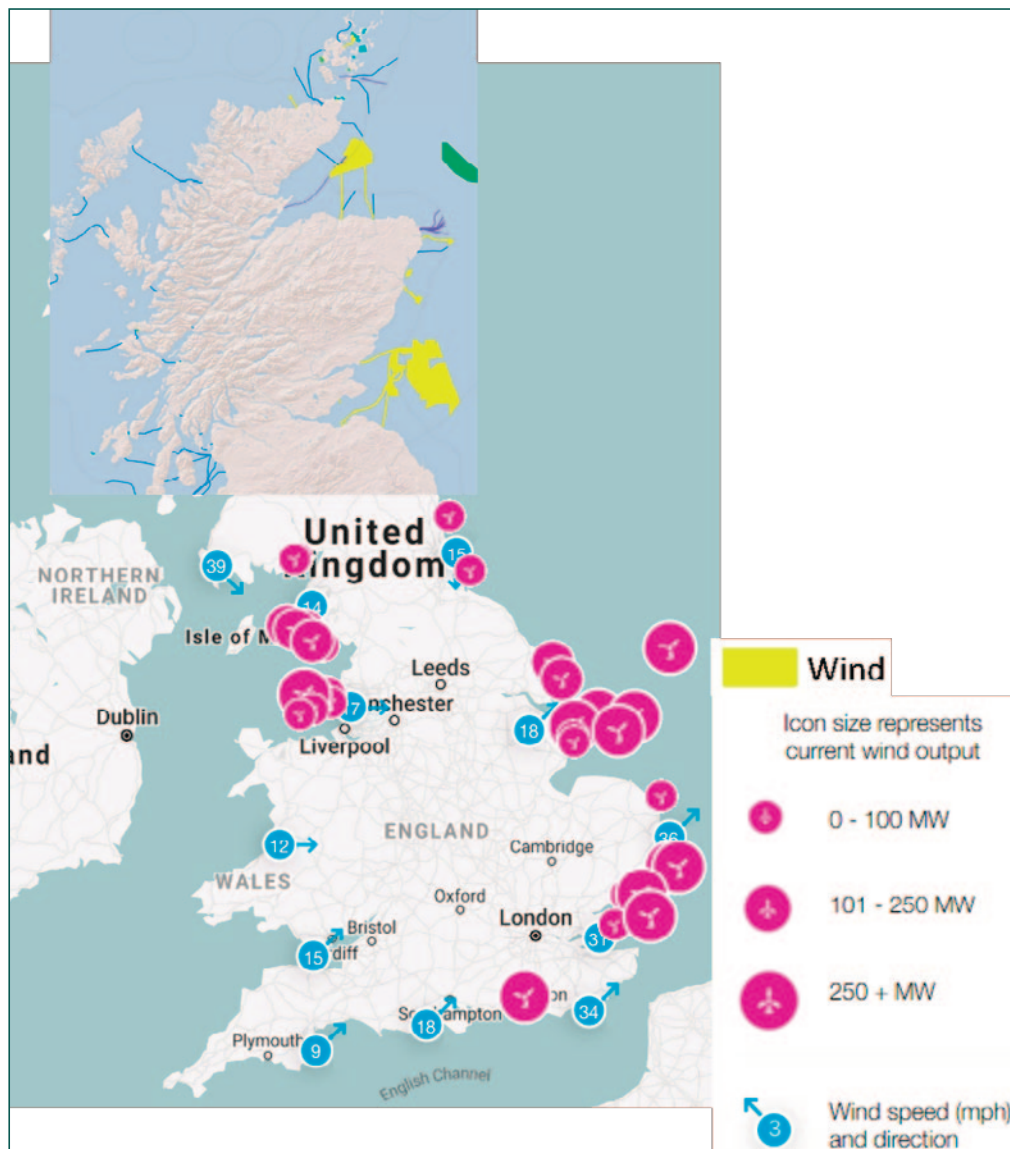


Figure 3: UK offshore wind installations (combined after Crown Estate and Crown Estate Scotland, 2020)

business models to allow oil and gas operators to co-produce 'green' energy and tap into the associated incentives via conventional hydrocarbon infrastructure. In addition, isolated demonstrators of such technologies seldom prove repeatability and scalability. Figure 4 illustrates offshore energy integration options according to the OGA's UKCS Energy Integration Interim findings (2019b).

Perhaps a better way of looking at integration options is shown in Figure 5, where prolonging the life of an asset means keeping it in production for longer, re-using it means that an asset is used for the same original purpose but in

a different location, and re-purposing is when an asset is employed in the same location, but for a new use. This allows one to clearly distinguish between options where hydrocarbon production is envisaged to continue, versus options where hydrocarbon production is ceased.

WHAT ENERGY INTEGRATION OPTIONS ARE REALISTIC?

Assessing options that imply continuation of hydrocarbon production must be carefully assessed vis-à-vis the forecasts of Figure 1, as well as the urgency to achieve net-zero within the next 30 years. Some key questions are:

- How long can existing mature assets continue to produce?
- What commercially viable integration options are there towards net-zero operations?
- Can mature infrastructure become "living laboratories" for different stakeholder groups to effectively collaborate whilst exploring the above options?
- Can stranded "small pools" of oil and gas be brought online via facilities' electrification with renewable energy? Full electrification remains a challenge; Equinor's Hywind Tampen project, the world's first renewable power for offshore oil and gas, will only meet about 35% of the annual power demand of the five Snorre and Gullfaks platforms and the project is only viable because of the large size and longevity of these fields.

For options that assume cessation of hydrocarbon production, a critical question is which infrastructure can be re-purposed and used now and beyond 2050? An example of the latter challenge is the re-use

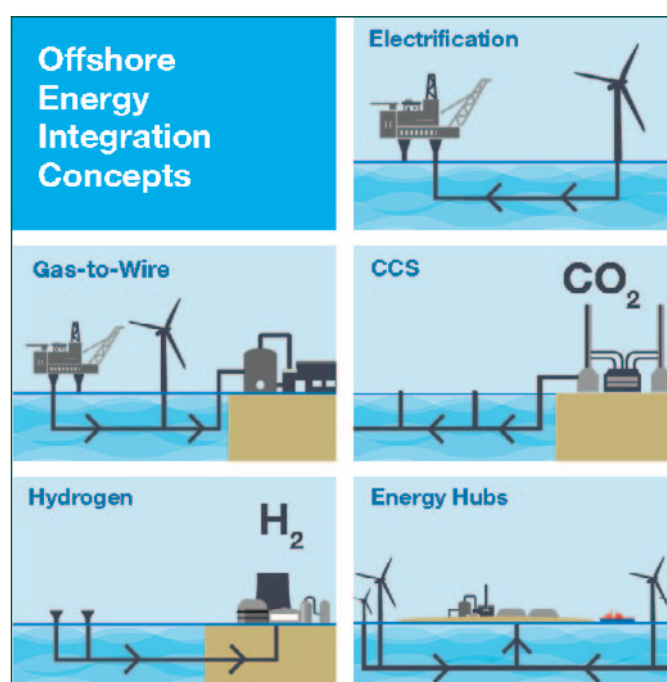


Figure 4: offshore energy integration options (according to OGA, 2019b).

PROLONG	RE-USE	RE-PURPOSE
Electrification	Platform marketing	Carbon capture and sequestration (CCS)
Enhanced Oil Recovery (EOR)	Hotel accommodation for wind farm projects	Geothermal
	Recreational use	Power-to-gas (PtG)
		Gas-to-wire (GtW)
		Compressed air energy storage (CAES)
		Marine energy
		Research site / field laboratory
		Offshore island (host wind farm stations)

Figure 5: life extension options for oil and gas infrastructure (modified after WEC, 2017).

of oil and gas assets for carbon capture usage and injection projects, as raised by the recent Department for Business, Energy and Industrial Strategy consultation (BEIS, 2019b).

With or without continued hydrocarbon production, there is only a small window of opportunity to identify what should stay or go. It is likely that only a small percentage of infrastructure could be re-purposed. There is an urgent need for a realistic timeline to reflect actual opportunities and liabilities.

INVESTMENT MUST SHIFT TO RENEWABLES AND ENERGY EFFICIENCY

The energy transition needs investment for a shift towards renewables and greater energy efficiency. So far, however, investment in carbon capture,

utilisation and sequestration (CCUS) worldwide has been small, as shown in Figure 6, and its deployment remains off track.

According to the Intergovernmental Panel on Climate Change (IPCC, 2018), net-zero can be achieved when CO₂ emissions are balanced by CO₂ removals over a specified period. Hence, net-zero cannot be achieved by only reducing emissions; it also requires their removal by CCS. However, large scale CCS implementation in the UK is still far away. For example, the Acorn CCS project is still progressing towards a final investment decision in late 2021, for a possible start in 2023, with first phase funding coming from the UK government (CCUS Innovation Programme), the European Union and the industry. Yet, its technical and commercial specifics may prove neither

repeatability, nor scalability and, meanwhile, the net-zero deadline is looming.

Europe's Oil Majors' investment in renewables has also been disappointing so far, as shown in Figure 7.

THE NEED FOR A 'JUST TRANSITION'

According to the Office of National Statistics (ONS, 2020), there were 224,800 jobs in low carbon and renewable energy in the UK in 2018, including nuclear (Figure 8). BEIS (2019) set the ambition to increase offshore wind jobs from 7,200 today to 27,000 by 2030.

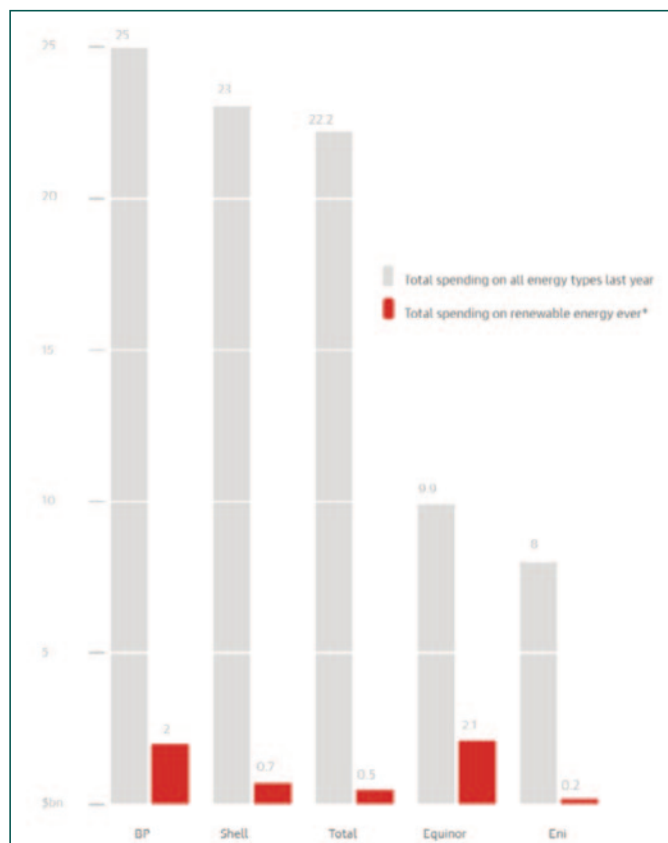


Figure 7: Europe's Oil Majors' investment in renewables (Guardian graphic, 2020 - Source: Rystad Energy, company data) * Rystad excludes R&D spending and clean energy technologies that are not renewable.

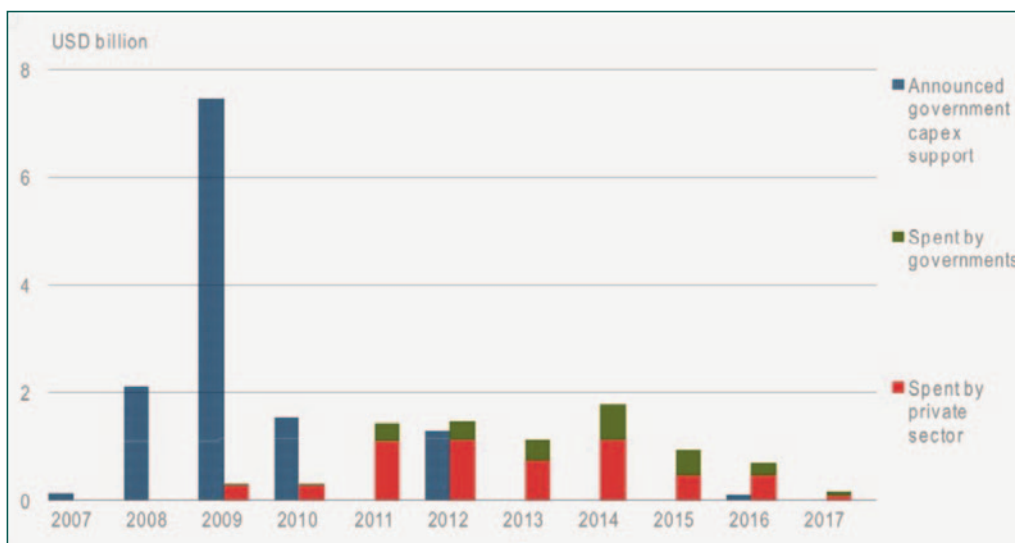


Figure 6: Investment in large-scale CCUS projects from 2007 to 2017 (IEA, 2018)

In comparison, from its 463,900 peak in 2014, the oil and gas offshore industry has lost 194,800 jobs across the UK (Figure 9), with relatively few professionals being redeployed within the energy sector.

Currently, there is an imbalance between the number of employment opportunities in the renewable vs. conventional energy sectors. Thus, careful planning is needed to ensure a just and sustainable energy transition by 2050, considering geographical distribution of both natural and human resources.

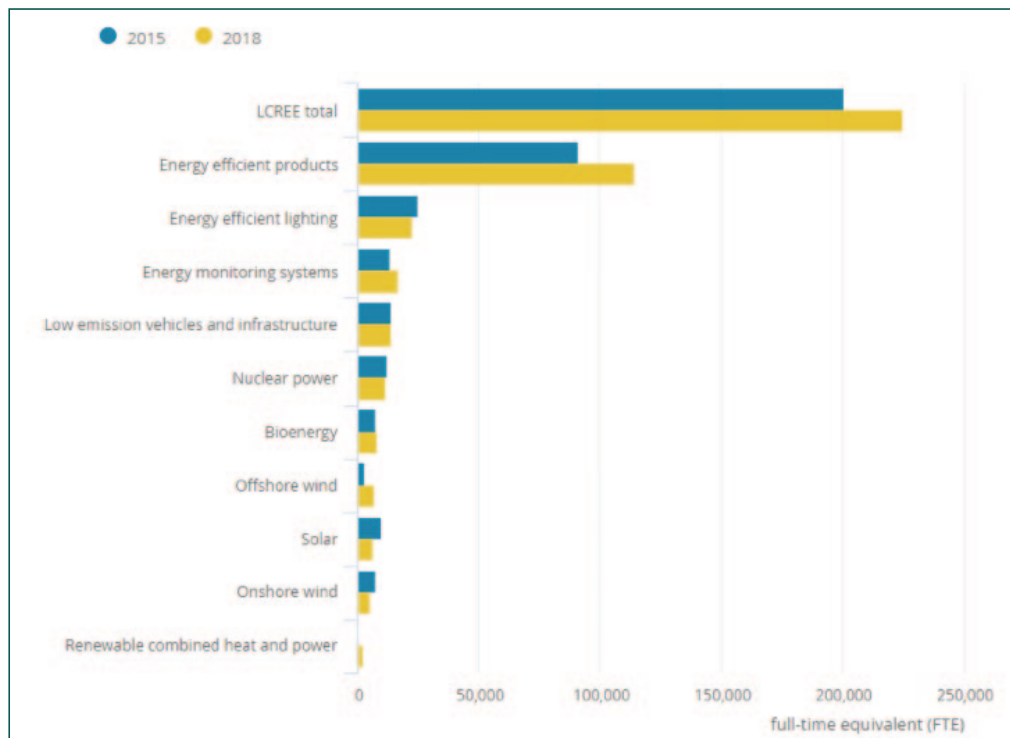


Figure 8: Low carbon and renewable energy economy employment, total and selected sectors, UK, 2015 and 2018 (ONS, 2020)

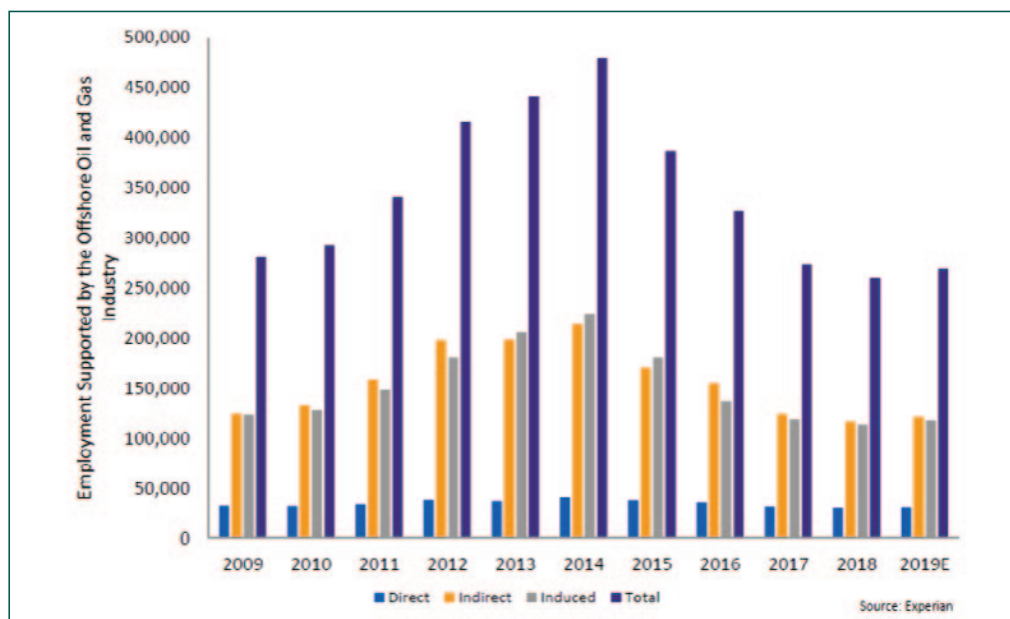


Figure 9: Total employment supported by the offshore oil and gas industry (Oil and Gas UK, 2019)

CONCLUSIONS

The UK offshore energy sector is in a state of flux, which presents opportunities and challenges. Without an integrated approach to energy transition in the UKCS, it is unlikely that technically and commercially viable options for short, medium and long-term energy solutions will be identified in the available time

window to create value and minimise abex. The limitations imposed by ageing hydrocarbon infrastructure, by supply/demand fluctuations and by the looming net-zero targets must be accounted for when developing a realistic timeline for energy projects' integration and prioritising abandonment liabilities. A project-by-project approach to decommissioning

approval does not reflect the need for net-zero basin planning. There is a need to reconcile the MER strategy of extending hydrocarbon production with net-zero targets and potentially competing uses of infrastructure (e.g. pipelines for continued oil and gas production vs. CO₂/hydrogen transport and storage). Better coordination among multi-stakeholders of the

UKCS and decommissioning actors could promote complementary and synchronised abandonment activities, which should lower associated costs by allowing the supply chain to organise itself optimally and help smooth the path towards energy transition.

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THE SKILLS GAP – RECRUITMENT INTO THE ACOUSTICAL ENGINEERING INDUSTRY



Professor Chris Barlow
Professor of Acoustics, Solent University
Chair, Education and Learning Working Group, Institute of Acoustics

Chris has blended industry and academic experience over the past 20 years, working in the audio engineering and acoustics industries as well as the university sector, and is currently Professor of Acoustics at Solent University, Southampton.

Chris is an active researcher, focusing on the human response to noise, including the effects of leisure activities on hearing loss, and the acoustic design for restorative spaces (in both the real and virtual worlds). He is also a Director of Positive Acoustics Ltd., an independent consultancy offering design and advisory services on acoustics and noise control.

Professor Barlow is a member of the Institute of Acoustics' Council and chair of its Education and Learning Working group. He was also on the UK Executive committee of the Audio Engineering Society from 2015-2019, and has been chair of AES South of England Group since 2016.

We are exposed to noise on a daily basis – from traffic, aircraft, industry, mechanical ventilation systems and construction, as well as neighbourhood noise. In the United Kingdom 83% of the population already live in Urban areas (OfNS 2018), and 68% of the world's population are anticipated to be living in urban areas by 2050 (UN, 2018).

From an evolutionary perspective hearing is a defence mechanism – our hearing is able to trigger responses even when we are asleep, activating stress hormones. Even noise which we think that we are accustomed to causes an involuntary response (Waye *et al*, 2003), which increases stress and disrupts sleep. Continuous exposure to noise can lead to an increase in a range of health problems – particularly those associated with stress, such as cardiovascular disease and mental health.

"Noise has a significant impact on mental health and individual wellbeing. Managing sound will be central to the design and construction of future cities." (UKAN 2019)

The Acoustics industry is concerned with all aspects of sound and vibration. We need sufficient acoustical engineers entering the industry to address these issues – whether providing mitigations for existing problems or designing new products which make the world quieter or more pleasant. However it is anticipated that

there will be a shortfall of 59,000 people per year entering the engineering and technology industries over the next 5 years (Engineering UK, 2019), and acoustics is one of the industries suffering from a recruitment crisis.

A major issue is that Engineering in the UK suffers from a lack of gender diversity, with only around 29,000 of the total of 165,000 students (17.5%) being female (Figure 1).

This is a problem which is not unique to Higher Education. Schools, charitable organisations, professional bodies and government have worked in

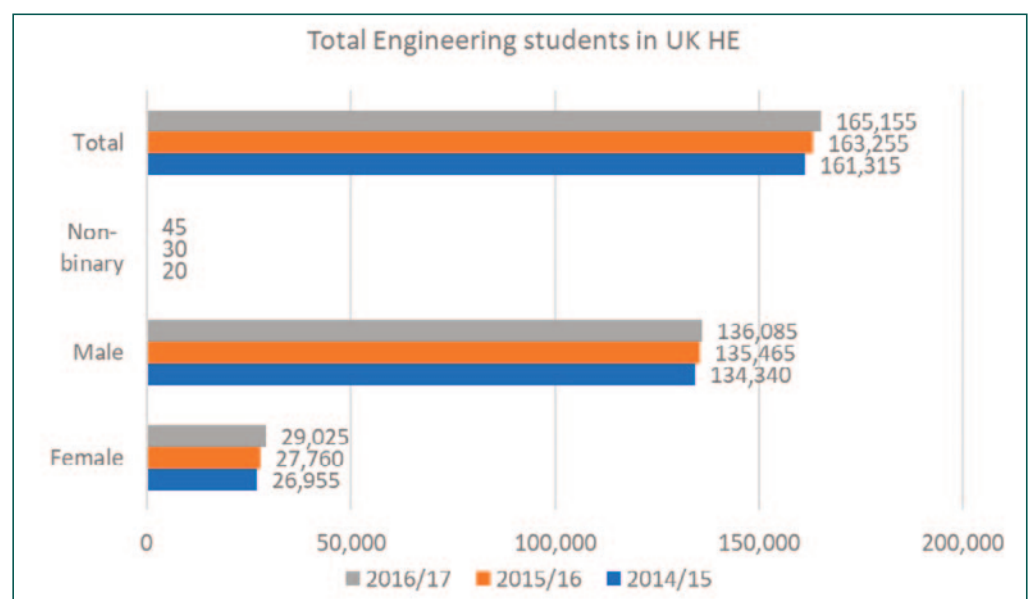


Figure 1: The Diversity gap in Engineering. Source – Higher Education Statistics Agency

recent years with some success to improve recruitment into STEM subjects at school level, and in particular to increase the proportion of female students. In 2018 for the first time more female students than male students took A level science subjects. However while chemistry and biology have made significant increases in the proportions of female students over the past decade (figure 2), for some reason this success has not been reflected in Physics, where the proportion of female students remains very low at around 23%.

addressing the recruitment shortfall in engineering.

THE AWARENESS GAP

Recruitment problems are made worse by a general lack of awareness among young people of engineering occupations. Only 25.5% of young people aged 14 to 16 reported knowing what people working in engineering actually do, and a key attractor into a career is understanding what the job role entails (Engineering UK).

This problem is considerably exacerbated for the acoustics

At the same time, the industry is growing. Although there is no data for direct comparison prior to the 2019 report, the Association of Noise Consultants (ANC), the largest individual trade body in the UK for acoustics, has reported progressive increases in the size of member companies over the past decade, indicative of significant growth in the sector. However 56% of ANC member companies also report problems recruiting appropriately qualified staff.

who would be most likely to enter an engineering career. This issue of awareness is not just restricted to people of school age. A report in the Independent in 2017 classified *Acoustics Consultant* as the second 'weirdest' job title in the UK, which indicates a wider lack of awareness of the industry.

RECRUITMENT, EDUCATION AND TRAINING

There have been traditionally four routes into Acoustics – via an undergraduate degree, postgraduate degree, professional qualification or direct recruitment from mechanical engineering, physics or maths graduates and in-house training in acoustics in the company. With increased competition for engineering graduates they are progressively harder to recruit into acoustics. This is also a sector that is dominated by SMEs. Seventy-two percent of member companies of the ANC have 10 or fewer staff. Small companies find it hard to train graduates internally due to the disproportionate costs of taking senior staff away from income earning activities.

Higher education provision in recent years has been heavily driven by supply and demand, and small, specialist subjects struggle to survive. There are only four institutions offering undergraduate courses in the UK which specialize in Acoustics. Only seven institutions run taught Master's courses in Acoustics. Though there is an increase in the size of the sector, most institutions report stable or gradually declining numbers on acoustics courses. Three institutions have closed acoustics courses or ceased recruiting in the last 8 years.

The Institute of Acoustics recognized as far back as 1975 that there would need to be

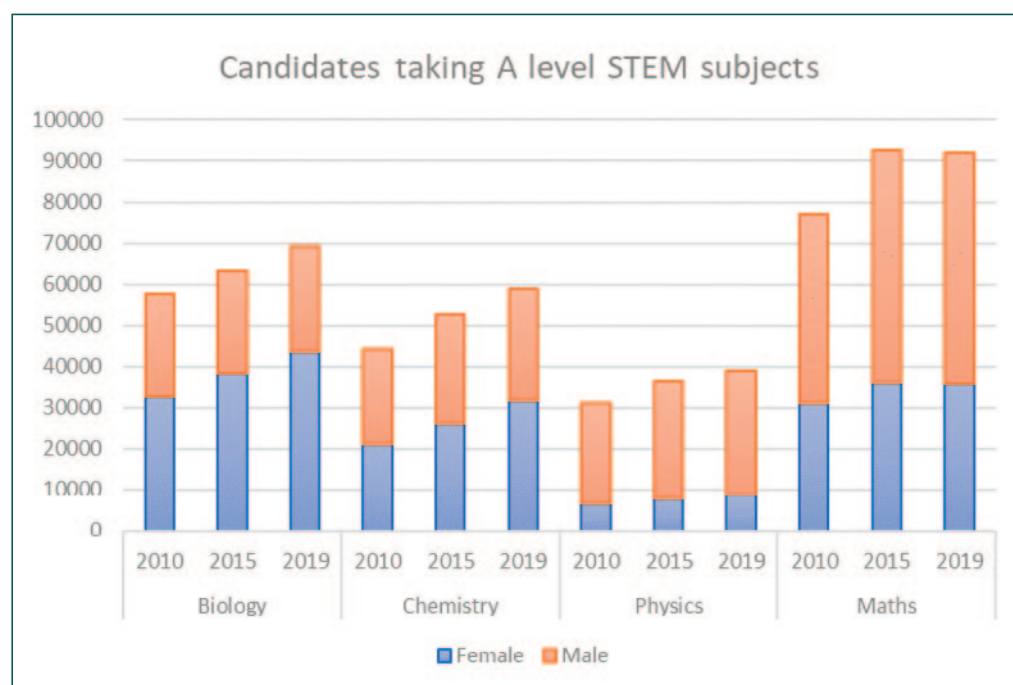


Figure 2: Candidates taking STEM subjects at A Level (Source, Joint Council for Qualifications)

Since the early 1990s, the proportion of girls in the A-level physics cohort has not fallen below 20.7% but not risen above 23.1%. (Institute of Physics).

In addition, only 39% of Maths candidates are female, and as Maths and Physics are generally core requirements for engineering courses, the engineering industries are missing a significant recruitment pool. There are complex reasons for this which include societal perception of these subjects as 'boys' subjects, and a focus on attracting female students into Physics needs to become a key policy when

industry. A report published in 2019 shows that the acoustics industry contributes £4.6 bn annually to the UK economy (UKAN, 2019). This makes it larger than the Music industry at £3.5bn (UK Music, 2019). However as acoustics is an enabler rather than a product in its own right, it is a 'hidden' industry and very few people are aware of career opportunities in the sector in the same way that they are with the music industry.

There are a number of influencing causes for this – not least the awareness of the term itself. Although it is the term which encompasses all aspects of sound and vibration, the word 'Acoustics' is very rarely mentioned in the school curriculum at any level, with the main appearances being in creative subjects such as music. It does not appear in the A level Physics syllabus leading to a lack of awareness in school leavers

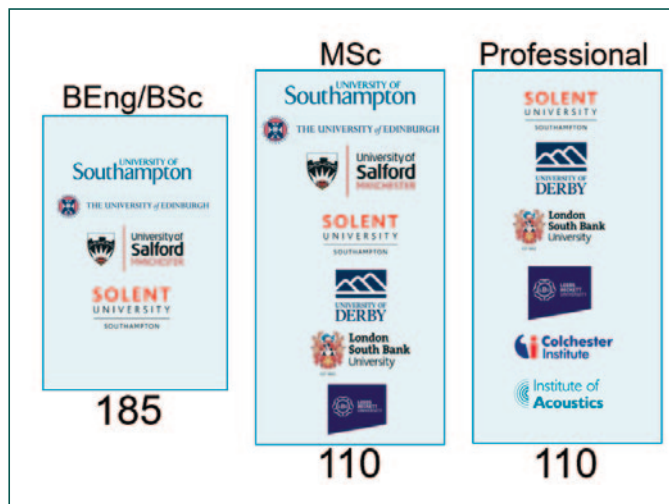


Figure 3: Institutions offering acoustics courses and total numbers of students at each level in the UK

more specialists in the discipline of, and developed its own professional qualification aimed at those coming out of non-specialist qualifications, and is offered by 6 institutions.

Figure 3 shows the approximate total numbers of students specializing in acoustics across all institutions at each level in the UK. This gives a national total of approximately 185 undergraduate students, 110 taught MSc students and 110 professional students studying towards an acoustics qualification, around 270 of whom enter the workforce each year.

Acoustics therefore forms a tiny proportion – less than a quarter of a percent – of the total number of engineering students in the UK.

It is typically expected that people will change careers up to 3 times across their working lives, so we do not just need to look at traditional 'graduate' populations for recruitment. There are considerable opportunities for people changing career from relevant industries such as the audiovisual industries. However people changing careers need the ability to fund their relevant training, and this is something that people often struggle to do.

We need to consider how the UK can better support the cost of reskilling and career change, as this could support our industry as well as many others.

ADDRESSING PERCEPTION ISSUES

As well as awareness there are a number of perception issues which affect recruitment. Many people view acousticians as part of the 'heavy engineering' industries – primarily construction site engineers. This fails to recognize the wide range of roles for acousticians in the high tech industries such as aerospace, computing and smart technologies, all of which extensively require acoustical engineering.

The industry has tried to address this from a number of angles. Both the Institute and professional organizations undertake outreach and awareness campaigns to get young people to better understand the acoustics industry. This includes the ANC's #ExploreAcoustics campaign, the IoA's *A Sound Career* guide (with accompanying video and social media campaigns), and support for the International year of sound 2020 with a range of events.

This year the acoustics industry has launched a level 4 apprenticeship as a new trial. This is new territory for the sector which has traditionally recruited from the graduate market, but has been identified as a way of both attracting young people into acoustics and helping to reduce the skills shortage. Further discussions are taking place regarding developing more apprenticeships at other levels.

The industry are also involved in a wide range of STEM outreach initiatives aimed at getting Acoustics known at a younger age so that people can make appropriate school and career choices. This has included the Institute commissioning *Edinburgh Science* to undertake specialist outreach events across the country, a new exhibition at Winchester Science Centre specifically focused on Sound and Vibration supported by industry and academic partners, and engagement with initiatives such as *Big Bang* and *Tomorrow's Engineers*, which aim to enthuse a younger audience about careers in STEM. The Institute is also liaising with other relevant professional bodies to increase awareness of Acoustics in those professions (including organizations in Construction, Architecture, Environmental Health and Planning).

Is it enough? Simply, no. In order to continue to address the need to deal with noise as a major health problem we need more acousticians in all the industries which are served by acoustic engineers. We need to recognise and promote the diverse sectors in which Acoustics operates and make people aware of the potential job roles for acousticians in high tech industries as well as 'heavy'

industries. We also must address awareness of the industry amongst those choosing careers, for instance by specific mention of Acoustics in relevant school curricula and UCAS guides. This needs some support from policy, to make potential students aware of the potential of acoustics as a career.

In particular, as a country it is essential to address the serious diversity gap in engineering education. This would help all parts of the engineering sector by recruiting from a larger pool of potential and benefit the economy as a whole. This requires much more work to address diversity issues in physics and maths at school level, identifying and addressing the causes of this diversity gap. We also need to improve our funding structures available for career-change, perhaps by making the postgraduate student loan available for professional as well as degree courses?

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Parliamentary and Scientific Committee Showcases Britain's Future

Scientists Engineers Technologists Mathematicians

On Monday 9th March 2020, 180 early career researchers from universities and research institutions from across the United Kingdom came to Westminster to take part in STEM for Britain, the annual poster competition and exhibition organised by the Parliamentary and Scientific Committee and designed to encourage interaction with MPs and Parliament.

During the course of the day these scientists, engineers, technologists and mathematicians had the opportunity to show their posters and explain their research to over 70 Parliamentarians from both Houses.

The competition comprised of five specialist sections: Biological and Biomedical Sciences; Chemistry, Physics, Engineering, and Mathematical Sciences.

Gold, Silver and Bronze winners in each category received certificates and cash prizes, with medals going to the Gold winners. For the first time Dyson Ltd, IEEE Communications Society and the Nutrition Society presented special prizes.

The Physiological Society Prize was awarded for the second year running.

At the end of the day the winners of the five Gold medals competed for the Westminster Medal in memory of Dr Eric Wharton, founder of STEM for Britain. Here, with the quality of the science already proven with a Gold medal, the judges had to decide which of the five posters best demonstrated the presenter's skill in communicating the scientific concept.

Judging panels for each category were formed of distinguished scientists, engineers and mathematicians from the Royal Academy of Engineering, the Royal Society of Chemistry, the Institute of Physics, the Royal Society of Biology, the Council for the Mathematical Sciences, The Physiological Society and the Nutrition Society.

The judges' initial task had been to select the 180 posters for the exhibition and final of the competition from nearly 400 high quality entries.

The event is a two-way process designed to strengthen the dialogue between Parliament and the science, technology, engineering and mathematical communities.

STEM for Britain would not be possible without the help of all the major learned societies involved in organising the event, especially the Royal Academy of Engineering, the Royal Society of Chemistry, the Institute of Physics, the Royal Society of Biology, the Council for the Mathematical Sciences, The Physiological Society and the Nutrition Society.

And also the organisations which have generously supported the event, including the Clay Mathematics Institute, Warwick Manufacturing Group, Dyson Ltd, Biotherapy Services Ltd, UK Research & Innovation, the Institute of Biomedical Science, the Heilbronn Institute for Mathematical Research, The Comino Foundation, the Biochemical Society, IEEE Communications Group, and the Society for Chemical Industry.

However, the researchers who exhibited and displayed their work are the true 'engine room' of R&D. The success of the UK in the competitive knowledge economy of the 21st Century is going to depend crucially on their expertise.





The support of a number of important organisations is vital for STEM for Britain...



**UK Research
and Innovation**

"UK Research and Innovation is delighted to support STEM for Britain. Early-career researchers play a hugely important role in the UK's world leading research and innovation ecosystem. Through our range of funding and fellowships, we are building inspiring, sustainable and flexible pathways within and between research and innovation careers at all levels, enabling talented people to pursue careers across sectors. I have experienced STEM for Britain in my academic career and have seen for myself the remarkable people and their ideas that will create future technologies and innovations for UK and global society."

Professor Rory Duncan, Director of Talent and Skills at UK Research and Innovation



"WMG was delighted to sponsor the STEM for Britain engineering awards for 2020. Britain needs an economy built on technical innovation, improved productivity and long-term investment, it is crucial therefore that we support innovative research which has the potential to change the way we live.

At WMG, we have focused on the practical applications of the highest quality scientific research for four decades, driving innovations in fields as diverse as battery technology and healthcare. Today more than ever sustainability is important, this is a key strength of WMG and one which our academics and engineers are at the forefront of research ensuring the environment and society benefits from our advancements.

In the future, the engineers presenting today can make a similar impact on our society."

Margot James, Executive Chair at WMG, University of Warwick



"Our products are the largest impact we have, and therefore our biggest opportunity. To be successful everyone needs to embed the principles of sustainability throughout the business. This is our challenge. Everyone's ideas needed. With that in mind, we are proud to sponsor STEM for Britain and to offer a new award, a prize for outstanding research towards a more sustainable future. Alongside this, we seek to inspire the next generation of engineers to help us make a positive impact and to help solve some of the biggest problems that the world is facing."

Dr Julian Rose, External Research Manager, Dyson Ltd



"As a Research Institute whose focus is on fundamental mathematics and its applications to UK national interests, and on supporting mathematical research across the country, HIMR is delighted to be associated with STEM for Britain and offers its warmest congratulations to all of the Award winners."

Professor Jon Keating FRS, Chair Heilbronn Institute for Mathematical Research.



"The Institute of Biomedical Science is proud to sponsor STEM for Britain which is an excellent opportunity for biological and biomedical scientists to showcase their research and raise awareness of their valuable work to politicians and the public."

Allan Wilson, IBMS President



"The inclusion of mathematics in STEM for Britain recognises the vitality and strength of the discipline in the UK and the huge part that all branches of mathematics play in underpinning science and technology."

Professor Martin Bridson, President, Clay Mathematics Institute



"STEM for Britain is one of the most exciting platforms to showcase new and aspirant talents from the field of science, technologies, engineering and mathematics. Attending the various fora and sponsoring a key award, I was struck by the calibre of talent and enthusiasm that UK PLC can derive huge benefit from. As an entrepreneur I encourage participants to be bold in developing 'real world' applications and solutions for their research endeavours and reach out to dynamic innovative companies that will value your talents and allow you to expand your expertise to make a real difference in this interconnected world!"

Janet Hadfield, CEO, Biotherapy Services Ltd





"SCI's charitable objective is to bring together chemistry-related sciences and industry to promote applied science for the benefit of society.

The current global challenges we face are significant and complex and require a collaborative, multi-disciplinary and innovative approach.

Supporting early-stage and early-career research scientists, engineers, and technologists is an essential part of that mission.

SCI is proud to be part of STEM for Britain and to support the work of past SCI member, Dr Eric Wharton, who initiated the event's forerunner, SET for Britain in 1997."

Sharon Todd, Executive Director, SCI



"The Comino Foundation is an educational charity that focuses on creativity, science and engineering mostly at primary and secondary school level. We are particularly concerned about the ability of the current education system to provide the right skills for the digital age and also to develop creativity and 'making' as crucial parts of this. Many of the creative subjects are being dropped by secondary schools and as a result those joining the workforce for the first time struggle with problem-solving and developing initiative. STEM for Britain demonstrates for us the need for these skills to be at the forefront of our emerging workforce if this country is to succeed in the future."

John Slater, Chairman



IEEE UK and Ireland Section, Communications Chapter

The IEEE is the world's largest professional organization with members and activities from all areas across the Science, Technology, Engineering and Mathematics spectrum.

It was our great pleasure to be present at this very important, inspiring and enabling event to meet and talk to so many brilliant participants that were energetically supported by not just academia, but industry as well as the political body and policy makers. We are very happy to have seen so many of the UK's future leaders in our profession who will be the drivers of the UK economy, being recognized and rewarded.

Congratulations to all who participated and we look forward to increasing the IEEE's visibility and sponsorship at the next STEM for Britain event.

Prof Izzet Kale, Vice Chair, IEEE UK & Ireland Section and Dr Hoa Le-Minh, Chairman, IEEE Communications Society.



Dr John Chiplin, Chairman, Biotherapy Services Ltd (Sponsor of the Chemistry Awards); Dr ThaoNguyen Nguyen, Scientific Affairs Manager, Biotherapy Services Ltd and STEM for Britain Alumnus; Dr Stephen Benn, Vice-President, Parliamentary & Scientific Committee; and Ms Janet Hadfield, CEO, Biotherapy Services Ltd



Gemma Smith, University of Manchester (Winner of the Best Tweet in the First Session) and Ms Doris-Ann Williams MBE, CEO BIVIDA, and Chair of the STEM for Britain Organising Committee

BIOMEDICAL AND BIOLOGICAL SCIENCES EXHIBITION

The STEM for Britain 2020 Awards:

Gold Award: Sarah HOUSTON

Institute of Ophthalmology, University College London
USING THE EYE AS A WINDOW TO THE BRAIN IN MULTIPLE SCLEROSIS

Silver Award: Karoliina TUOMELA

Lydia Becker Institute of Immunology, University of Manchester
RADIOTHERAPY CAN MAKE CANCER CELLS RESISTANT TO IMMUNE CELL ATTACK

Bronze Award: Ted ROBERTS

School of Biochemistry, Biomedical Sciences, University of Bristol
CULTURING NEUTROPHILS FROM STEM CELLS TO EXPLORE NEUTROPHIL CELL BIOLOGY AND DISEASES

The Nutrition Society Prize: George FIRTH

Biomedical Engineering and Imaging Sciences, King's College London
PET METALLOMICS - USING RADIOACTIVITY TO TRACK ESSENTIAL TRACE METALS IN THE BODY

The Physiological Society Prize:

Egzona MORINA
Sainsbury Wellcome Centre, University College London
CHARACTERISATION AND CIRCUIT ANALYSIS OF POSTURAL ADJUSTMENTS IN MICE



Dr Dominika Gruszka, Trustee & Chair, Early Career Advisory Panel, Biochemical Society (Bronze Award Sponsor); Dr Mark Downs, Chief Executive, Royal Society of Biology, Allan Wilson, President, Institute of Biomedical Science (Gold and Silver Award Sponsor); **Ted Roberts** (Bronze Award Winner); Stephen Metcalfe MP, Chair, Parliamentary & Scientific Committee; **Sarah Houston** (Gold Award Winner); Dr Stephen Benn, Vice-President, Parliamentary & Scientific Committee; **Karoliina Tuomela** (Silver Award Winner); Professor David Paterson, President-Elect, The Physiological Society; Mark Hollingsworth, Chief Executive, Nutrition Society



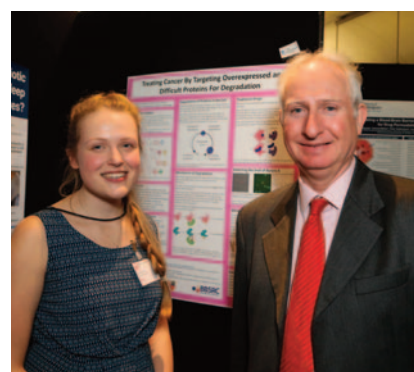
The Physiological Society Prize
Professor David Paterson, President-Elect, The Physiological Society; Dr Stephen Benn, Vice-President, Parliamentary & Scientific Committee; **Egzona Morina** (The Physiological Society Prize Winner); Stephen Metcalfe MP, Chair, Parliamentary & Scientific Committee



Nutrition Society Prize
Stephen Metcalfe MP, Chair, Parliamentary & Scientific Committee; Dr Stephen Benn, Vice-President, Parliamentary & Scientific Committee; **George Firth** (Nutrition Society Prize Winner); Mark Hollingsworth, Chief Executive, Nutrition Society

Our sincere thanks to the **Institute of Biomedical Sciences** for generously supporting the Biosciences Gold and Silver Awards and to the **Biochemical Society** for supporting the Bronze Award and to Allan Wilson, President, IBMS and Dr Dominika Gruszka, Trustee, Biochemical Society, for presenting the awards along with Dr Mark Downs, Chief Executive, Royal Society of Biology, Mark Hollingsworth, Chief Executive, the Nutrition Society, and Prof David Paterson, President-Elect of The Physiological Society.

We are also grateful to the Panel of Biosciences Judges for their work: Professor Alyson Tobin (Chair), Professor Malcolm Bennett, Dr Guy S Bewick, Dr Simon Cork, Dr Bernard Corfe, Professor Phil Gilmartin, Dr Sarah Hall, Dr Celia Knight, Professor Raheela Khan, Dr Kevin O'Dell, Dr Sarah Pitt, Dr Mark Roberts and Professor Chris Seal.



Sian Stockton, University of Cambridge, with Daniel Zeichner MP

ENGINEERING EXHIBITION

The STEM for Britain 2020 Awards:

Gold Award: Tomas YSEHAK ABAY
School of Mathematics, Computer Sciences
and Engineering, City, University of London
DEVELOPMENT OF A NON-INVASIVE
INTRACRANIAL PRESSURE (NICP)
MONITOR FOR NEUROCRITICAL CARE
PATIENTS

Silver Award: Elisa ROCCIA
Biomedical Engineering Department,
King's College London
THREE-DIMENSIONAL CANCER RISK
SCORE MAPPING WITH MAGNETIC
RESONANCE IMAGING TO IMPROVE EARLY
DETECTION AND INDIVIDUALISED
TREATMENT PLANNING FOR MEN WITH
PROSTATE CANCER

Bronze Award: Benjamin CERFONTAINE
School of Science and Engineering,
University of Dundee
OPTIMISATION OF SCREW ANCHOR
DESIGN FOR OFFSHORE FLOATING WIND,
WAVE AND TIDAL ENERGY DEVICES

**The Dyson Award for outstanding
research towards a more sustainable
future:** Andrés RIVERO BRACHO
Bristol Composites Institute, University of
Bristol
FLEXIBLE AIRPLANES? - ACHIEVING
HIGHER FUEL EFFICIENCY BY
CONTINUOUSLY ADAPTING WING
GEOMETRY

IEEE Communications Society Prize:
Benjamin FLETCHER
Department of Electronics and Computer
Science, University of Southampton
3D INTEGRATION USING WIRELESS
INDUCTIVE LINKS - CAN WE MAKE
STACKING SILICON AS EASY AS STACKING
LEGO?



Benjamin Fletcher (IEEE Communications Society Award Winner); **Stephen Metcalfe MP**, Chair, Parliamentary & Scientific Committee; **Benjamin Cerfontaine** (Bronze Award Winner), **Tomas Ysehak Abay** (Gold Award Winner); **Dr Stephen Benn**, Vice-President, Parliamentary & Scientific Committee; **Elisa Roccia** (Silver Award Winner); **Andres Rivero Bracho** (Dyson Award for Outstanding Research Towards a More Sustainable Future)



Dr David Bott, Principal Fellow, Warwick Manufacturing Group, Sponsor of the Engineering prizes



Lois Afua Okerewaa, The Open University and **Bel Ribeiro-Addy MP**



Rt Hon Greg Clark MP, Chair of the Science & Technology Select Committee and **Omayma Alqatawneh**, University of Huddersfield



Jasper James, University of the West of England, and his Mother, **Dr Sarah Wollaston**, former Chair of the Health & Social Care Select Committee

Our sincere thanks to **Warwick Manufacturing Group** for generously supporting the Engineering Awards and **Dr David Bott**, Principal Fellow, WMG.

Dyson Ltd for generously sponsoring the Dyson Award and **Tom Crawford**, Global Director, Corporate, Social & Environmental

IEEE Communications Society for sponsoring the IEEE Communications Society Prize, and **Prof Izzet Kale**, Vice Chair IEEE.

We are also grateful to the Panel of Engineering judges for their work: **Professor Mary P Ryan** (Chair), **Professor Bashir Al-Hashimi**, **Dr Donal Cronin**, **Professor Brian G Falzon**, **Professor Colin Garner**, **Professor Jeff Magee**, **Professor Mark Sandler**, **Professor Ravi Silva**, **Professor Paul Shearing**, **Professor Constantinos Soutis**, and **Professor Robert J K Wood**.

MATHEMATICAL SCIENCES EXHIBITION

The STEM for Britain 2020 Awards:

Gold Award: Luiza Mihaela PAUN
School of Mathematics and Statistics,
University of Glasgow
PARAMETER INFERENCE AND UNCERTAINTY
QUANTIFICATION IN THE PULMONARY
CIRCULATION

Silver Award: Adrien LEFAUVE
Department of Applied Mathematics and
Theoretical Physics, University of Cambridge
FINDING STRUCTURES IN THE CHAOS OF
STRATIFIED TURBULENT FLOWS

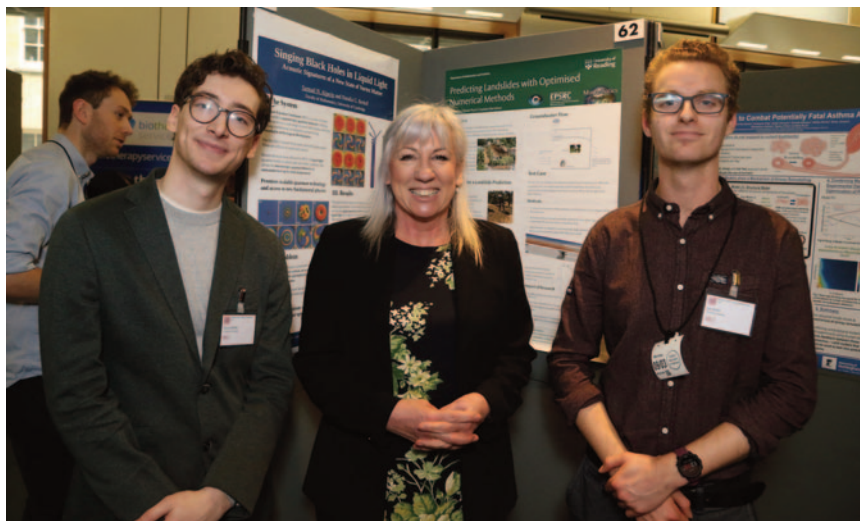
Bronze Award: Damian GALANTE
Department of Mathematics, King's College
London
QUANTUM EMERGENCE OF EXPANDING
SPACETIMES



Dr Nira Chamberlain, President, Institute of Mathematics and its Applications; **Adrian Lefauve** (Silver Award Winner); **Luiza Mihaela Paun** (Gold Award Winner); Dr Stephen Benn, Vice-President, Parliamentary & Scientific Committee; Professor Martin Bridson, President, Council for Mathematical Sciences (Gold and Silver Award Supporter); **Damian Galante** (Bronze Award Winner); Professor Jon Keating, Chair, Heilbronn Institute for Mathematical Research (Bronze Award Supporter); Stephen Metcalfe MP, Chair, Parliamentary & Scientific Committee

Our sincere thanks to the **Clay Mathematics Institute** for generously supporting the Gold and Silver Awards and the **Heilbronn Institute of Mathematical Research** for supporting the Bronze Award, and to Prof Martin Bridson, President of the Clay Mathematics Institute, and Dr Nira Chamberlain, Council for Mathematical Sciences, for presenting the prizes.

We are also grateful to the Panel of Mathematical Sciences Judges for their work: Professor Tim J Pedley (Chair), Professor Martin Bridson, Professor Steven Gilmour, Dr Vincent Knight, Professor Elizabeth Mansfield, and Professor Demetrios Papageorgiou.



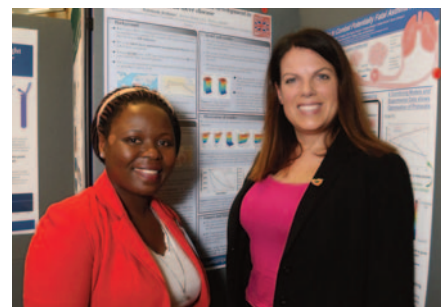
Samuel Alpern, University of Cambridge, Amanda Solway MP, Minister for Science, Ben Ashby, University of Reading



Josephine Solowiej-Wedderburn, University of Surrey and Neil Coyle MP



Thomas Wilder, University of East Anglia and Clive Lewis MP



Fatumah Atuhare, University of Southampton, and Caroline Nokes MP

PHYSICAL SCIENCES EXHIBITION – CHEMISTRY

The STEM for Britain 2020 Awards:

Gold Award: Florence GREGSON
School of Chemistry, University of Bristol
SPHERES OR CUBES - HOW DO SALT DROPLETS DRY?

Silver Award: Fabienne BACHTIGER
Computational Chemistry, University of Warwick
UNRAVELLING THE MICROSCOPIC DETAILS OF ICE FORMATION AND PREVENTION IN BIOLOGICAL MATTER

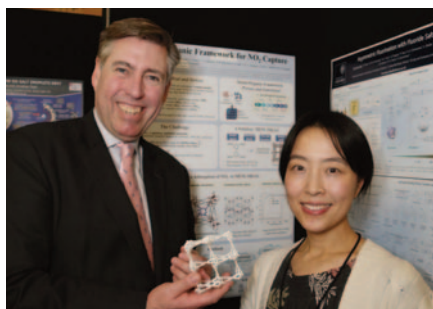
Bronze Award: Gemma SMITH
Department of Chemistry, University of Manchester
STABLE MICROPOROUS MATERIALS FOR REVERSIBLE CAPTURE OF SULFUR DIOXIDE



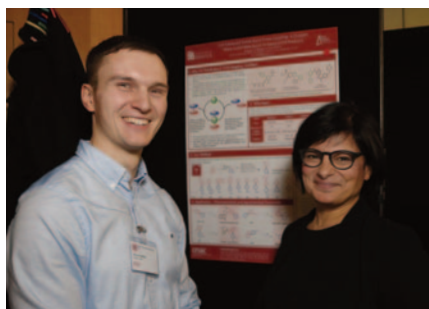
Janet Hadfield, CEO, Biotherapy Services Ltd, Awards Sponsor, **Gemma Smith** (Bronze Award Winner); Dr Stephen Benn, Vice-President, Parliamentary & Scientific Committee; Dr Jo Reynolds, Director of Science and Communities, Royal Society of Chemistry; **Florence Gregson** (Gold Award Winner); **Fabienne Bachtiger** (Silver Award Winner); Stephen Metcalfe MP, Chair, Parliamentary & Scientific Committee

Our sincere thanks to Dr Jo Reynolds, Director of Science and Communities, Royal Society of Chemistry and Ms Janet Hadfield, CEO Biotherapy Services Ltd, for presenting the prizes.

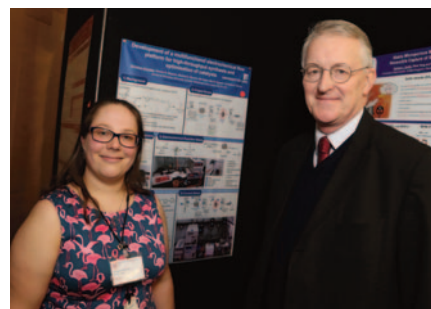
We are also grateful to the Panel of Chemistry Judges for their work: Dr Peter J Machin (Chair), Professor Paul M Cullis, Professor Helen Fielding, Dr Bryan Hanley, and Professor Peter Knowles.



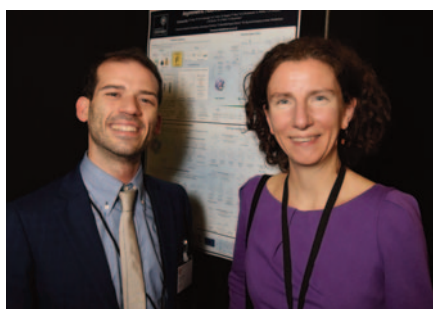
Sir Graham Brady MP and Xue Han, University of Manchester



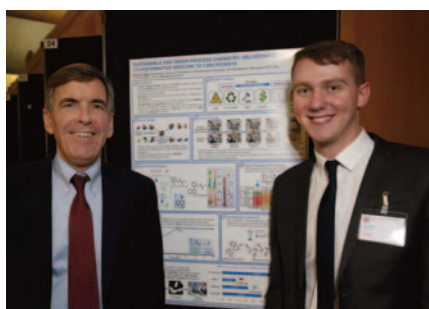
Benjamin Rowsell, University of Bristol and Thangam Debbonaire MP



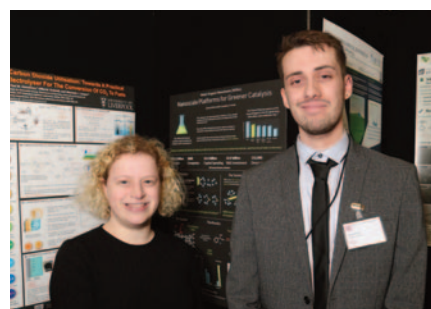
Christiane Schotten, University of Leeds and the Rt Hon Hilary Benn MP



Francesco Ibba, University of Oxford and Anneliese Dodds MP



David Rutley MP and Oliver Ring, Astra Zeneca



Joshua Nicks, University of Sheffield and Olivia Blake MP

PHYSICAL SCIENCES EXHIBITION – PHYSICS

The STEM for Britain 2020 Awards:

Gold Award: Lui TERRY

Mechanical Engineering, University of Bristol
CONFINING HYDROGEN: A LOW ENERGY
ROUTE TO ROOM TEMPERATURE
SUPERCONDUCTIVITY

Silver Award: Graham BRUCE

School of Physics and Astronomy, University
of St Andrews

MAKING THE MOST OF INTERFERENCE:
PRECISION MEASUREMENTS OF LASERS
USING SPECKLE

Bronze Award: Maeve MADIGAN

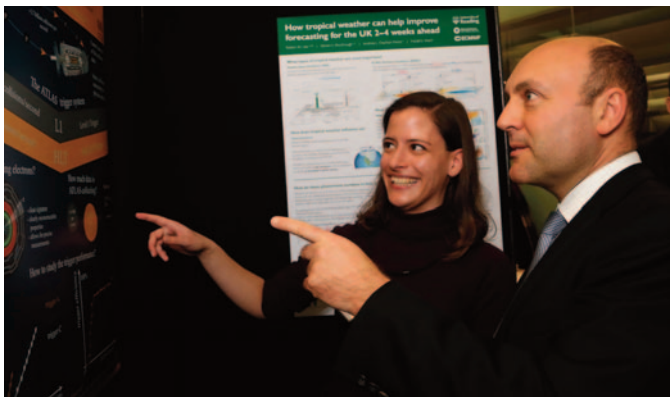
Department of Applied Mathematics and
Theoretical Physics, University of Cambridge
LEPTOQUARKS AT FUTURE COLLIDERS



Dr Tamara Cleford, Trustee, Institute of Physics; **Maeve Madigan** (Bronze Award Winner); **Lui Terry** (Gold Award Winner); Dr Stephen Benn, Vice-President, Parliamentary & Scientific Committee; **Graham Bruce** (Silver Award Winner); Stephen Metcalfe MP, Chair, Parliamentary & Scientific Committee

Our sincere thanks to Dr Tamara Cleford, Trustee, Institute of Physics, for presenting the prizes.

We are also grateful to the Panel of Physics Judges for their work: Dr Mark Telling (Chair), Dr Ceri Brenner, Dr Olivia Keenan, Professor Tara Shears, and Dr Klaus Suhling.



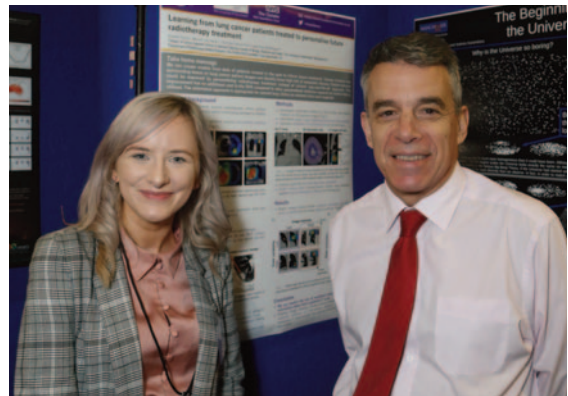
Daniela Koeck, University of Sussex, and Andrew Griffith MP



Adam Forrest, Heriot Watt University and Joanna Cherry MP



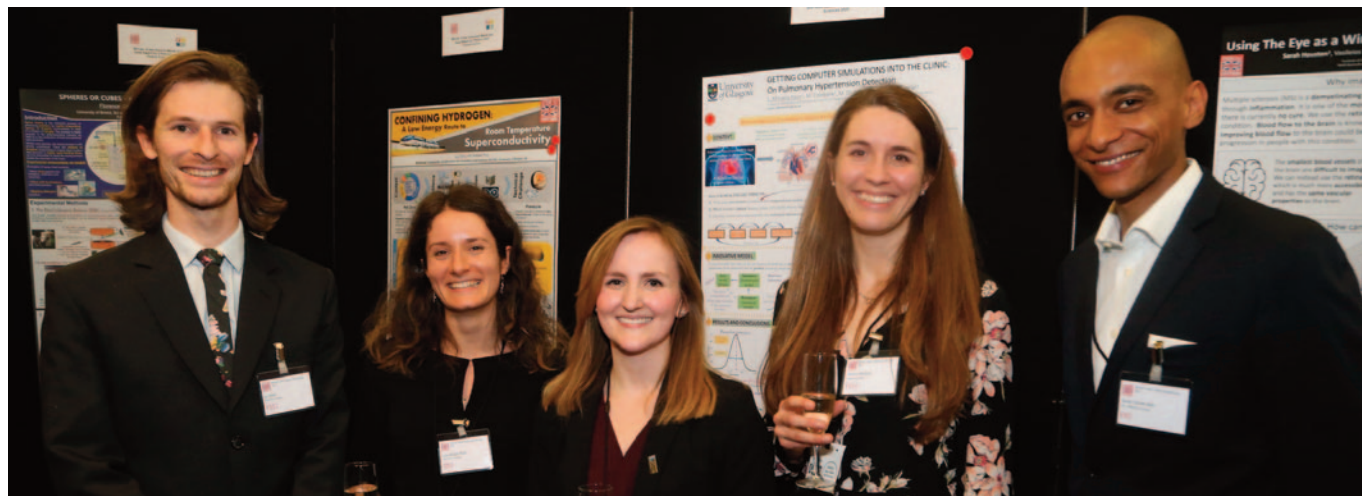
Philip Heron, Durham University and Amanda Solway MP, Minister for Science



Angela Davey, University of Manchester and Jeff Smith MP

THE WESTMINSTER MEDAL

The finalists...



Lui Terry, Gold – Physics; Luisa Mihaela Paun, Gold – Mathematics; Sarah Houston, Gold – Biosciences; Florence Gregson, Gold – Chemistry; Tomas Ysehak Abay, Gold - Engineering

At the end of the day, the winners of the five Gold medals competed for the Westminster Medal, in memory of Dr Eric Wharton, founder of STEM for Britain. Here, with the quality of the science already proven with a Gold medal, the judges decided on which of the five posters best demonstrated the presenter's skill in communicating the scientific concept.

And the winner was...SARAH HOUSTON

Institute of Ophthalmology, University College London

USING THE EYE AS A WINDOW TO THE BRAIN IN MULTIPLE SCLEROSIS



LR: Dr Sarah Main, Director, Campaign for Science & Engineering; Fred Parrett, Trustee, Society of Chemical Industry London Group (Westminster Medal Sponsor); Sue Wharton, STEM for Britain; Dr Stephen Benn, Vice-President, Parliamentary & Scientific Committee; Sarah Houston (Westminster Medal Winner); Stephen Metcalfe MP, Chair, Parliamentary & Scientific Committee

We sincerely thank **The Society of Chemical Industry** for generously supporting the Westminster Medal and are grateful to Fred Parrett, SCI Trustee, and Mrs Sue Wharton for presenting the award.

STEM for Britain is very much a team effort and would not be possible without the help of all the major Learned Societies involved...



"Clear communication is critical as we struggle to address the Covid19 global pandemic, underpinned by an effective explanation of the underlying science. The importance of science communication has always been at the heart of the STEM for Britain competition, but looking forward there can be little doubt that it will be seen as an essential skill sitting as an equal with research quality and integrity: explaining the value and importance of research to parliamentarians has become a critical component of policy making. Congratulations are due to all the entrants for such high quality work."

Dr Mark Downs,
Chief Executive of the Royal Society of Biology



"STEM for Britain is one of the highlights of the parliamentary calendar. We are proud to support it and to present The Physiological Society Prize.

The world faces great challenges in the years to come that will not be addressed by science or politics alone, but by us working together for a common purpose.

For example, in the COVID-19 crisis, physiologists from our Society are working closely with frontline clinicians to analyse the data and help improve treatment options for the disease.

Events like STEM for Britain are vitally important for scientists and politicians to engage with each other on these key issues."

Professor Bridget Lumb,
President of The Physiological Society



"The Nutrition Society is delighted to have participated in STEM for Britain 2020. This unique event continues to provide an exceptional opportunity for early career researchers in the fast-growing field of nutrition science to achieve wider exposure for their cutting-edge research projects through this interaction with Parliamentarians. The Society was particularly pleased to see STEM for Britain attracting a very positive level of support from within Parliament on the day. Finally, it was a landmark occasion for the Society being proud to have awarded the first STEM for Britain Nutrition Society prize at the event."

Mark Hollingsworth
Chief Executive Officer



"We are delighted to see young engineers bringing their research to Parliament, to meet their MPs and share their knowledge and research ideas with policymakers. The Academy believe that it is important that parliamentarians are aware of the advances that are being made and the potential for future economic and social benefit."

Professor Karen Holford CBE FREng FLSW,
Chair of the Royal Academy of Engineering Research Committee



"It is wonderful to showcase the importance of the mathematical sciences to a wider audience. It is paramount to encourage early-career research scientists, engineers, technologists and mathematicians and the STEM for Britain event is a very effective way of doing this."

Dr Nira Chamberlain
Council for the Mathematical Sciences



IOP Institute of Physics

"STEM for Britain enables Members of Parliament to learn first-hand about new research from some of the very best early career UK scientists.

It is a splendid showcasing event, with a competitive element, that has taken place for many years and will, I hope, run for many more.

These kinds of events are invaluable in furthering everyone's knowledge of the ground-breaking work being undertaken by our young scientists. Policy makers and young researchers get to meet and swap ideas and knowledge.

All the exhibitors should be immensely proud of what they have achieved, and I am sure that they valued and enjoyed sharing the excitement of their research with key politicians and policy makers."

Jonathan Flint
President of the Institute of Physics



"It's essential to have quality science informing policymaking – and that's why we're very pleased to once again support STEM for Britain. There is no other event quite like it to bring amazing chemical science research – and the people who work on it – into Parliament. Everyone presenting here is not only doing important scientific research but the equally important role of communicating it widely – an essential skill for future chemical science leaders."

Dr Jo Reynolds, Director of Science and Communities,
Royal Society of Chemistry



STEM for Britain 2021 is scheduled to take place in the Houses of Parliament in the second week of March during British Science Week

Applications are invited from Monday 14th September 2020 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
- Mathematical Sciences
- Physics

The closing date for applications is Monday 7th December.

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 Physiological Society, the Royal Society of Chemistry, the Royal Academy of Engineering, the Council for the Mathematical Sciences, the Institute of Biomedical Science, the Clay Mathematics Institute, the Nutrition Society, the Heilbronn Institute, the Institute of Physics, Warwick Manufacturing Group, United Kingdom Research and Innovation, Dyson Ltd, Biotherapy Services Ltd, IEEE Communications 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 communicate 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.

From 14th September 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

Presenting our research at STEM for Britain

Jasmine and Hans are early career research scientists at the National Physical Laboratory (NPL), Jasmine is in the process of completing her Doctorate in Engineering with the University of Surrey working in NPL's Materials Testing group, and Hans is a Higher Research Scientist in NPL's Electrochemistry research group.

JASMINE BONE

I applied to take part in STEM for Britain as it is a great opportunity to present my research to a new audience, and emphasise its importance. This also enables me to continue to develop my own communication skills in presenting my work in poster form, as well as articulating research to non-experts. This is something that is definitely required more in science and engineering if we want to communicate the impact of research to the wider public! In addition to increasing my own opportunities for personal and professional development, I love attending events where I can also meet and network with other researchers and learn more about their work too. This is also a valuable chance to learn more about how research can translate to meeting wider government strategy in the UK.



Jasmine Bone winning her Champagne for best tweet

The process involved submitting a one page written abstract about the research, and successful applicants were asked to present their poster to MPs and judges at Westminster, with the opportunity to win cash prizes.

The poster presentation session itself involved speaking to poster judges and MPs throughout the afternoon about my research, as well as chatting to the other poster presenters involved. The judges were looking for clarity, brevity and enthusiasm about the work in addition to a good poster.

I presented my research on the durability of composites in marine environments. Polymer composite materials are increasingly being used in offshore and marine industries for subsea structures, shipping, and wind or tidal turbine blades; particularly as demand for renewable energy increases. While these materials are lighter weight and more corrosion resistant than steel for example, there is still an issue of environmental degradation. It is critical to understand the long term behaviour of these materials to ensure it is accurately designed for cost effective, safe, durable life. My research looks at how the materials that are used for wind turbines and subsea platforms break down under environmental conditions and how that degradation then affects the material performance. Understanding this process allows development of material assessment and the capability to design for long term durability in large composite structures; something of great interest to industry.

It was fantastic to talk to so many people about their research, as well as learn more about encouraging conversation between parliament and researchers.

While I didn't come away with one of the top prizes, there was an additional award for 'Tweet of the session' in the form of a bottle of champagne which I won! Using social media to promote STEM and interact with the science and research community is so valuable; it's great to see this being celebrated and I'm always happy to be an advocate for communication in research.

DR HANS BECKER

Last December, I submitted a one-page abstract of my research to join the STEM for Britain 2020 poster competition. It is a competition for Britain's young scientists to communicate their research to MPs in the UK Parliament. It is a rare opportunity to engage our research with the people who have the power to shape the UK's scientific direction. That's why I was very excited when I found out I got invited to present my poster in the Engineering session on the 9th of March.

It was a busy day in the Parliament when I arrived, with the MPs in another room discussing measures to tackle the yet-to-be-pandemic Coronavirus. The room was quite packed (which at the time was not yet an issue!) with young scientists all over Britain, each with their state-of-the-art research. My poster details our latest finding in the metrology of water electrolyzers, the technology that powers a hydrogen refuelling station. I used a unique reference electrode system and found that expensive materials are feasible to be substituted with cheaper alternatives.

I shared my research with various visitors to my poster, ranging from industry representatives to fellow poster presenters. A few scientists there were also working in the same technology, and we ended up exchanging contact details for future correspondence. Munira Wilson, the MP for Twickenham and NPL's local MP, also stopped by and I had the chance to chat about hydrogen technologies with her. I didn't walk away with a prize, but the whole experience is already a prize on its own!



Left to right - Hans Becker, Munira Wilson MP for Twickenham and Jasmine Bone

What did the winners of STEM for Britain have to say?

"I am delighted to be awarded the Dyson Award for Outstanding Research towards a more sustainable future as it is a perfect match to what I'm trying to achieve with my research. Our research group led by Dr Ben Woods is researching in morphing wings (i.e. wings that can change shape during flight in a smooth and continuous way) and our end goal is to increase the aerodynamic efficiency of aircraft. By achieving these optimal wing geometries, we could reduce aircraft's fuel consumption and noise, which would directly translate into more sustainable and environmentally friendly aircraft."



Andres Rivero Bracho – The Dyson Award

"STEM for Britain was a unique opportunity to raise awareness about our work and to champion the deployment of offshore technologies. Foundations are usually unnoticed because they are below the ground surface, but are still essential to ensure the integrity of any man-made structure. This event will enable me to share our results and my enthusiasm with people actually making the decisions. Beyond the simple and clear message of going carbon neutral in 2050, I think discussing my topic with the MPs will give them more information about the practical solutions, opportunities but also hurdles to clear to achieve this goal."



Benjamin Cerfontaine – Engineering Bronze

"I thoroughly enjoyed taking part in STEM for Britain this year. This event provided a great opportunity to share my research with members of parliament, and importantly, with a wider non-scientific audience who wouldn't regularly engage with scientific research. The MPs I spoke to were highly interested in the novel research we do at King's College London in medical imaging with radioactive metals. I was honoured to receive the Nutritional society sponsored prize and will share this award with my friends and colleagues back in the lab."



George Firth – Nutrition Society Prize

"I am delighted to have won the Gold award in STEM this year. This is an amazing event which enables early-career researchers to disseminate their work. I very much enjoyed discussing my poster with the MPs and I strongly encourage other researchers to participate."



Luisa Michaela Paun – Mathematics Gold

"I am absolutely delighted to win the Cavendish Gold Medal for Physics. It is a real honour to receive such a prestigious award from Parliament and recognition for my work on hydrogen storage and superconductivity. It is a field I am passionate about, and know that one day we will be able to make real change against the climate crisis. It was great to be part of STEM for Britain. Events where both scientists and politicians can come together and discuss solutions to the burdens of the day are vital, and I hope to be able to attend lots more in the future."



Lui Terry – Physics Gold

"Before I properly started my PhD, I initiated a project called 'BrainCamp Kosovo' that focuses on teaching high-school students in Kosovo about neuroscience. My institute, SWC, was more than happy to support it and so it has been running since 2018 every year. From here the motivation to do something more grew, and so I founded a charity last year (Xheladin and Xhufe Morina foundation – xhmfoundation.com) focused on providing funding for Kosovan high-school students to attend STEM workshops or courses to further their STEM careers. I myself am from Kosovo and was lucky enough to have grown up in Belgium, a country that gave me many opportunities to get to where I am today. Therefore, I always look for opportunities to support and participate in any endeavour like STEM for Britain, where scientists/researchers come together and share their 'sheer curiosity for the world around us'."



Egzona Morina, Winner, The Physiological Society Prize

"I'm over the moon! I never win anything and I've worked so hard for this, so I'm really, really pleased. I know of couple of people who have applied in the past who weren't successful but they said I should give it a go anyway to see, so I gave it a go and I was ecstatic to just be here – I didn't expect to win!"



Being able to communicate what you do to lay people is really important for policymaking – it informs policy, it informs other people that might actually want to be involved but don't necessarily have that level of expertise – but you can make that accessible by explaining what you do at a more friendly, user-level."

Fabienne Bachtiger – Chemistry Silver

"I am honoured to receive this award. I would like to thank both the judges and the organisers for setting up such an interesting event. I believe it is very important to have a space where scientist can share the beauty of what we do to the rest of the community. Finally, I would like to thank the Theoretical Physics group at King's College London and my collaborators, D. Anninos and D. Hofman, for taking me into this journey of understanding the fundamental structure of space and time."



Damian Galante – Mathematics Bronze

What does STEM for BRITAIN mean to me?



Dan Walker – 2005
Young Engineer for Great
Britain Award Winner

From modelling the largest ocean waves on the planet, to delivering some of BP's most challenging oil and gas projects, Dan Walker has made a career out of chasing engineering challenges. And he's still chasing them in his current role – leveraging new technologies to help BP play a major role in the energy transition. Here, he talks about his passion for the job and the importance of having a global impact.

In many ways, I owe my BP career to the Parliamentary and Science Committee's STEM for Britain (SfB) programme.

I've always been fascinated with the way the physical world around us worked and as a child I had been good at maths and science. But my rural comprehensive school found it hard to show me how those subjects applied in the real world, so it was only out of curiosity that I discovered programmes like those run by the Royal Academy of Engineering that promoted engineering careers. They opened my eyes to the possibility of a career in engineering.

Later, my research on extreme ocean waves led me into graduate and postgraduate studies in mechanical engineering at both Oxford University and the Massachusetts Institute of Technology in the US. We started to build very accurate models and the oil and gas industry began to take notice. This is because if you can model these waves, you can start to look at the wave forces on their structures. And when you can do that then you can intelligently design offshore facilities which safely minimise the use of the concrete and steel. So, while I was in the academic world I worked on a number of projects

with Shell, mainly in Russia and the US.

New career frontiers open up

Everything changed in 2005, though, when I won a gold medal for excellence in engineering and the Young Engineer for Great Britain Award at SfB. This second prize was sponsored by BP, so when at the awards event at the House of Commons, I met several of its senior executives at the time. One asked if I'd ever considered joining the industry full time. The rest, as they say, is history.

That said, I didn't join immediately. I actually went back to research and lecturing at Oxford for another year, but the appeal of going into industry and tackling the biggest frontier energy projects in the world was too great to ignore!

A year later I found myself working on BP's flagship oil and gas projects in some of the deepest water depths (great than 2km), with the highest temperature and pressure reservoirs, and in harshest environments like the Gulf of Mexico, where you can get 25-30-metre hurricane waves. We faced some of the biggest engineering challenges on the planet at the time. And I loved it.

A few years into my career at BP, though, the Deepwater Horizon accident happened. Because of my engineering

background, particularly offshore, I was asked to join the team that ultimately capped and contained the well. I then led a global review into engineering risk across production and drilling for BP. Off the back of that, BP set up an industry taskforce, which I led, working with our peers to pool our resources and strengthen the way in which we collectively manage those risks.

Technology and the energy transition

My career took another, completely different, turn in 2015 when I was asked to set up BP's first ever cross-business emerging and disruptive technology team. A different kind of challenge, but a big one, nonetheless. We wanted to build understanding and capability in new technology areas – often from outside our industry – that have the potential to shape the energy sector in the future; technologies such as batteries and artificial intelligence. Essentially the role of this new team is to leverage new technologies that help BP play a major role in driving the energy transition.

As part of this work, I also lead the team that updates and publishes BP's Technology Outlook, which lays out our thinking on the role that technology might play in shaping the energy sector out to 2060.

Not an easy task when the world around us is changing so rapidly! But understanding that potential impact helps us make informed choices about the direction of our company. And with the need to transition to a low carbon economy ever more urgent, that challenge has only got bigger in recent years.

My decision to move from our upstream oil and gas business into new technologies was a big step at the time – some found it quite surprising, but I knew I wanted to help with the energy transition. I have always been attracted by roles that present the biggest challenges – and they don't come much bigger than how to help society access the energy it needs while reducing our emissions. For me it's about doing work that I'm passionate about; in my experience that means a career in science and technology rarely travels in a straight line.

So, if I was to offer any advice to 15-year-old me, it would be this: be clear about what excites you. Ask yourself 'what am I passionate about?' and then focus on it like a laser. I'd say the same thing to anyone in an engineering career right now – if you're not genuinely passionate about what you're doing, try something else. Keep trying new things until you find the thing that sticks.

NOISE, SOUND AND ACOUSTICS

AN OVERVIEW AND CURRENT POLICY CHALLENGES



Stephen Turner
President-Elect of the Institute of
Acoustics

Acoustics affects each of us every day of our lives. Primarily this is through speaking and listening, but it is also through the acoustic properties of any room we are in and what we can hear when we are outside.

For those under the age of about 40, acoustics was probably responsible for the first time you were seen by your family when the ultrasound image of you in your mother's womb was captured. Acoustics affects the design of concert halls and other music venues; the design of microphones and loudspeakers and the management of the sound that affects our marine life.

ACOUSTICS IN POLICY MAKING

But for those responsible for policy development and decision making, it is acoustics in the form of the management of noise that is the most relevant.

Noise is unwanted sound or sound that causes a perceived or unperceived¹ adverse effect on those experiencing it. This makes noise different from air pollution. Virtually none of us can comment on the level of pollution we experience at any one moment, but we all have a view about the sound environment we are in. Furthermore, our views of that sound environment will not be the same, reinforcing the adage that "One person's music is another person's noise".

WHAT IS THE IMPACT OF NOISE?

At the time of completing this

article, the nation is under lockdown whilst we are tackling the COVID-19 pandemic. One of the consequences has been the stark change in our sound environment with people commenting on the absence of transportation noise and, instead, being able to hear natural sounds such as birdsong more clearly². Having said that, whilst the outside noise impact might have reduced, there is emerging evidence that confining people to their homes is increasing the number of noise complaints about noise from neighbours³.

Prior to the lockdown, the following statistics describe the current degree of noise impact:

- Noise is the second worst environmental cause of ill health in Europe (after air pollution)⁴.
- 100,000 health life years are lost annually in the UK due to transportation noise⁵;
- There are 1,000 premature deaths per annum in the UK due to transportation noise⁶;
- The social cost of transportation noise in England is estimated to be £7bn to £10bn per annum⁷;
- 11% of the population are extremely bothered, annoyed or disturbed by neighbour noise⁸;

- There are typically 350,000 noise complaints made every year to local authorities in England⁹
- 48% of the population feel their home life is spoilt to some extent by noise¹⁰

That is why it is essential that noise is effectively managed.

WHAT FACTORS AFFECT OUR RESPONSE TO NOISE?

Consider the loudest sound you have experienced. It could be from being close to a jet aircraft, or close to gunfire, or fireworks, or being close to the loudspeaker system in a night club. But now consider the most annoying noise you have experienced. It is probably none of those listed above, but instead something like a neighbour's burglar alarm sounding, or the bass beat coming into your property from a nearby entertainment venue, or children playing or your partner snoring, keeping you awake at night. The level of sound from any of these is not as high as those that formed the group of loudest sounds.

Consequently, being annoyed by noise is not just the consequence of its level. There are many other factors as well, as set out in Box 1.

Factors affecting whether a noise is annoying

- Character
- Frequency content (high pitched, low pitched or tonal)
- Whether it is continuous, intermittent or impulsive;
- Duration
- Time of day it occurs
- Day of week it occurs
- Relationship of the receiver to the source (if industrial or commercial, they may work there)
- What the receiver is trying to do when the noise occurs

This means it is challenging to manage noise effectively.

MANAGEMENT OF NOISE IN THE UK

Noise is a devolved matter with each administration having slightly different policies.

- In England, the overarching policy on the management of noise is set out in the Noise Policy Statement for England (<https://www.gov.uk/government/publications/noise-policy-statement-forengland>).¹¹
- In Northern Ireland, the overarching policy is set out in the Noise Policy Statement for Northern Ireland (<https://www.daerani.gov.uk/sites/default/files/publications/doe/noise-policy-statement-ni.PDF>)
- In Scotland, noise policy is set out in Planning Advice Note (PAN) 1/2011 <https://www.gov.scot/publications/planning-advice-note-1-2011-planningnoise/> and
- In Wales -noise policy is found in Planning Policy Wales <https://gov.wales/sites/default/files/publications/2019-02/planning-policywales-edition-10.pdf>

THE NOISE POLICY STATEMENT FOR ENGLAND (NPSE)

The NPSE is ten years old this year and comprises two pages of policy and 4 pages of explanatory notes. Although it first came out under the Labour administration in 2010, it has been adopted by all subsequent Governments and this policy continuity is enormously helpful for practitioners.

It contains an overall vision and three aims as shown in these boxes:

Noise Policy Statement for England

Overall Policy Vision

Promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development.

Noise Policy Statement for England

Noise Policy Aims

Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:

- avoid significant adverse impacts on health and quality of life;
- mitigate and minimise adverse impacts on health and quality of life; and
- where possible, contribute to the improvement of health and quality of life.

At the time of its publication, it was stated that one of the purposes was to make explicit what was implicit in existing policy and legislation concerning noise management. Thus, much of the policy in the NPSE already existed. It was, instead described

in a way that could apply to any situation. Arguably, the only new policy was the third aim which required consideration of using noise management to enhance the quality of the sound environment and not simply to focus on reducing the adverse impacts of noise.

NOISE POLICY OVERVIEW IN ENGLAND

The graphic at Figure 1 shows the current legislative and policy framework for noise management in England

The NPSE can be seen as the over-arching policy. Underneath that is the suite of National Policy Statements for Major

extremely helpful to practitioners.

Figure 2 shows the same information but this time colour-coded to show the different Government departments or parts of departments who are responsible for that policy area.

So, Defra is shown as ■■■■;

MHCLG is ■■■■;

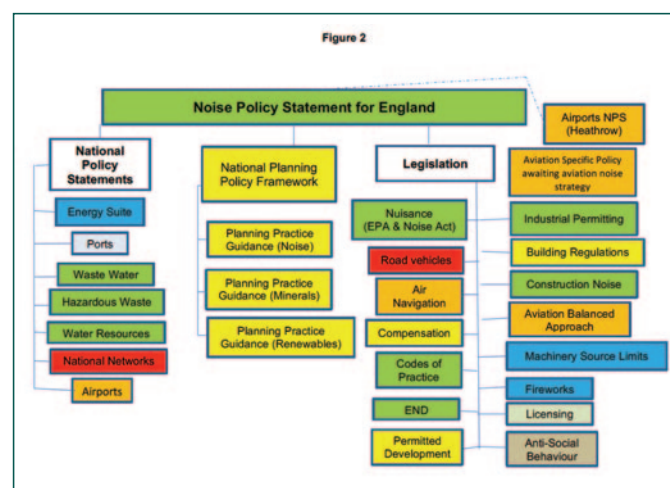
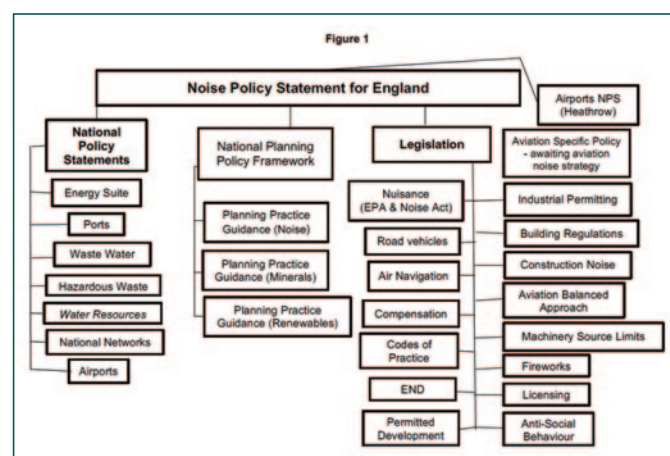
DfT (Aviation) is ■■■■;

DfT (Roads) is ■■■■;

BEIS is ■■■■

and so on.

Noise management is spread over at least 8 different departments or parts of departments.



Infrastructure Projects; the suite of land use planning policies and guidance and the range of legislation, some of which date back to the 1970s. Because of the NPSE, there is now a lot of policy consistency which again is

THE NOISE MANAGEMENT CHALLENGE

In principle, there is nothing fundamentally wrong with this arrangement. The ubiquitous

nature of noise inevitably means that it touches on a large number of policy areas. The challenge comes because for most officials, noise management is only a small part of their portfolio. Furthermore, there are only two trained acousticians in Whitehall to assist them.

Consequently, this arrangement can lead to uneven implementation of policy; incomplete management of noise or unintended consequences.

One example was the granting of permitted development rights to convert offices into residential premises to assist with tackling the housing shortage. Initially, there was no requirement to consider the impact of the nearby noise environment on the new residents. Soon there were complaints from the new residents who found themselves being affected by noise in the evening and night from nearby entertainment venues. Previously, the dwellings had been an office and there was no-one living there who would be disturbed.

It took a while, but eventually there were changes to the Permitted Development Regulations (PDR) that required consideration of the potential noise impact on the new dwellings from nearby commercial activities.

But the current state of the PDR still means that offices close to motorways can be converted to dwellings without any formal requirement to consider the noise impact on those dwellings from the traffic using the motorway.

There are potential future risks as well. In October last year, MHCLG published its consultation on the Future Homes Standard. In it stated that:

We anticipate that the installation of heat pumps, particularly air-to-water and air-to-air heat pumps, will play a major role in delivering low carbon heat for homes built to the Future Homes Standard.

Again, this is an extremely laudable desire, but there was no mention of noise. Effectively, the Government is advocating going from a gas boiler that has a small fan and is located indoors to an air source heat pump which has a larger fan and is located outdoors. The Institute of Acoustics (IOA) have raised its concern in its response to that consultation.

WHAT TO DO?

At present we have members of the IOA who work in all the aspects of noise management mentioned. We also have the range of Government departments with some responsibility for noise management. What appears to be missing is some central political oversight of noise management that can bring together the professionals of the IOA and the relevant policy officials. One possible solution is the establishment of an All-Party Parliamentary Group on Sound and Noise Management. Although it is recognised that there are many of these groups already, the data shown above demonstrates that the effective management of noise is very important for the health and quality of life of the citizens of the UK. The Institute of Acoustics believes that there is a need to secure the right level of political traction to make this happen and is keen to work with the Parliamentary and Scientific Committee to help this to occur.

Note about the Institute of Acoustics:

The Institute of Acoustics is the professional body for those working in the field of acoustics

and noise management. Its members include consultants, academics and regulators. Its activities include working for industry, developers, government and local authorities in all matters associated with sound and noise management in the natural and built environment. It has just over 3000 members and the acoustics profession generates about £4.6bn per annum to the economy.

References

- 1 Research over the last 20 years or so has shown that long exposure to higher levels of environmental noise is associated with an increased risk of cardio-vascular disease and other similar effects. Thus, although someone living close to a busy road may say they are not bothered by the traffic noise, they may yet be experiencing effects that are harmful to their health
- 2 The Institute of Acoustics is using its resources to try to quantify this change in noise impact whilst observing the social isolation rules.
- 3 Source: <https://www.rheglobal.com/news/614913981658890240/noise-complaints-surge-during-covid-19-lockdown>
- 4 Source: World Health Organization
- 5 Source: European Environment Agency
- 6 Ibid
- 7 Source: UK Government
- 8 Source: National Noise Attitude Study 2012
- 9 Source: Public Health Outcomes Framework
- 10 Source: National Noise Attitude Study 2012
- 11 This web page has a banner statement that says "This was published under the 2005 to 2010 Labour government". It has never been clear what is the purpose of such a statement. The date on the document clearly shows when it was published and it is the current policy on noise management which subsequent administrations have confirmed it to be. Yet the presence of this banner risks diluting the weight that should be placed on this key policy document.



PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY (POST)

POST has a new website (<https://post.parliament.uk/>) and its special COVID-19 briefings can be found at: <https://post.parliament.uk/category/analysis/covid-19/>

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.

And those produced in 2019 and 2020 were:

621: Infrastructure and climate change
620: 3D bioprinting in medicine
619: UK insect decline and extinctions
618: Bioenergy with carbon capture and storage (BECCS)
617: Climate change-biodiversity interactions
616: Low-carbon aviation fuels
615: Climate change and aviation
614: Brain computer interfaces
613: Non-custodial sentences
612: Autism
611: Human Germline Genome Editing
610: Misuse of Civilian Drones
609: Access to Critical Materials
608: Online Safety Education
607: Improving Witness Testimony
606: Compostable Food Packaging
605: Plastic Food Packaging Waste
604: Climate Change and Fisheries
603: Climate Change and UK Wildfire
602: Developments in Wind Power
601: Sustaining the Soil Microbiome
600: Climate Change and Agriculture
599: Early Interventions to Reduce Violent Crime
598: Advances in Cancer Treatment
597: Climate Change & Vector-Borne Disease in Humans in the UK

596: Chemical Weapons
595: Reservoirs of Antimicrobial Resistance
594: Limiting Global Warming to 1.5°C
593: Cyber Security of Consumer Devices

POSTbriefs are responsive policy briefings based on mini-literature reviews and peer reviews. Those produced in 2019 and 2020 were:

36: Understanding insect decline: data and drivers
35: Evaluating the integration of health and social care
34: Net Gain
33: Research for Parliament: Preparing for a changing world
32: 5G technology
31: Evaluating UK natural hazards: the national risk assessment

POST has also introduced some new short briefings that summarise the research around COVID-19:

COVID-19: Current understanding
COVID-19: Behavioural and social interventions
COVID-19: Insights from behavioural science
COVID-19: School closures and mass gatherings
Vaccines for COVID-19
Models of COVID-19: Part 1

Ongoing and future projects approved by the POST Board.

BIOLOGY AND HEALTH

In production

Outward medical tourism
Disorders of consciousness
Researching gambling
Influence of industry on public health policy
Resilient food chains

Scheduled

Reformulation of food products
Testosterone and sports performance

ENERGY AND ENVIRONMENT

In production

Food waste
Global deal for nature
Heat networks
Plant genetic resources for food and agriculture

Scheduled

Sustainable cooling
Strategic approaches to ecosystem services
Natural mitigation of flood risk
Marine renewables
Machine learning for environmental remote sensing

PHYSICAL SCIENCES AND ICT

In production

- Algorithms and accountability
- Cloud and edge computing
- Key EU space programmes
- Food fraud

SOCIAL SCIENCES

In production

- Research glossary

Scheduled

- Online extremism
- Screen time in young people

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

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- Dr Grant Hill-Cawthorne: 020 7219 2952

PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY
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HOUSE OF COMMONS SELECT COMMITTEES

Current Select Committee Inquiries

Business, Energy and Industrial Strategy Committee

At the time of going to press nominations were open for the position of Chair, following Rachel Reeves MP's appointment to the Shadow Cabinet.

- My BEIS Inquiry – Opened 3rd March
- Net Zero UN Climate Summits – 6th March
- The Impact of Coronavirus on Business and Workers – 13th March
- Work of the Department & Government response to Coronavirus – 14th April

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

Environmental Audit Committee

Philip Dunne MP was elected Chair on 29th January 2020.

- Possible Future Inquiries – 12th March
- Electronic Waste and the Circular Economy – 13th March
- Technological Innovations and Climate Change – Offshore Wind – 6th April

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

Health and Social Care Committee

Jeremy Hunt MP was elected as Chair on 29th January 2020.

- Management of the Coronavirus Outbreak – 3rd March.
- Pre-Appointment Hearing for the Role of Chair of NICE – 4th March
- Social Care Funding and Workforce – 10th March
- Delivery of Core NHS and Care Services during the Pandemic and Beyond – 22nd April

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

Science and Technology Committee

Greg Clark MP was elected as Chair on 29th January 2020.

- Budget 2020 Research & Innovation Spending – 17th March
- UK Science, Research and Technology Capability and Influence in Global Disease – 20th March
- Commercial Genomes – 9th April
- UK Telecommunication Infrastructure and the UK's Domestic Capability – 9th April
- A New UK Research Funding Agency – 9th April

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



HOUSE OF COMMONS LIBRARY

The House of Commons Library is an independent research and information unit. It provides impartial information 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 the 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:

Coronavirus Bill: Overview (including references to 10 further briefings explaining different parts of the legislation)

Published 23 March 2020, CBP-8857

The Library has produced many research briefings around the debate on Brexit (see

<https://commonslibrary.parliament.uk/category/brexit/>).

These include most recently:

What is happening in the UK-EU future relationship negotiations?

Published 7 April 2020 (insight article)

The UK-EU future relationship negotiations: Level playing field

Published 17 March 2020, CBP-8852

The Science and Environment Section (SES) is one of eight teams in the Research Service in the House of Commons Library. In 2020 they have published, and continue to update, briefings on issues as varied as:

Support for low carbon power

Published 8 April 2020, CBP-8891

This short briefing covers background to the contract for difference mechanism for supporting low carbon power.

COP26: the international climate change conference, Glasgow, UK

Published 2 April 2020, CBP-8868

This paper covers the lead up to the conference; the Government's ongoing preparations for COP 26; and key Parliamentary scrutiny

and stakeholder commentary. Information on other key international conferences on biodiversity and oceans is also included. It will be updated periodically to reflect developments throughout 2020/21.

Plastic waste

Published 31 March 2020, CBP-8515

This includes statistics on plastic waste and information on UK Government and devolved Government plans and ambitions to reduce avoidable plastic waste and examples of voluntary initiatives from the plastics industry, environmental groups and retailers.

Electric vehicles and infrastructure

Published 25 March 2020, CBP-7480

This paper explains what electric vehicles are and how successive governments have planned for infrastructure and provided vehicle grants and incentives to encourage and accommodate their growth. It also sets out how the electricity grid is preparing to accommodate any increased demand from EV charging and looks at comparative emissions from EVs and conventional vehicles.

Carbon capture usage and storage

Published 11 March 2020, CBP-8841

This paper covers carbon capture, usage and storage (CCUS), providing information on the processes involved; key benefits and challenges; Government policy and Parliamentary scrutiny.

Commons Library analysis of the Environment Bill 2019-20

Published 6 March 2020, CBP-8824

New Nuclear Power

Published 4 March 2020, CBP-8176

This briefing summarises current progress on nuclear power, including conventional reactors, advanced designs, waste disposal, and nuclear research.

Medicines and Medical Devices Bill 2019-20

Published 27 February 2020, CBP-8699

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



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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.

AMPS

The Association of
Management and
Professional Staffs.

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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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British Antarctic Survey (BAS), an institute of NERC, delivers and enables world-leading interdisciplinary research in the Polar Regions. Its skilled science and support staff based in Cambridge, Antarctica and the Arctic, work together to deliver research that uses the Polar Regions to advance our understanding of Earth as a sustainable planet. Through its extensive logistic capability and know-how BAS facilitates access for the British and international science community to the UK polar research operation. Numerous national and international collaborations, combined with an excellent infrastructure help sustain a world leading position for the UK in Antarctic affairs. For more information visit [@basnews](http://www.bas.ac.uk)



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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.



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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.



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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.



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The British Society of Soil Science (BSSS) or "BS cubed" as it is fondly known was founded in 1947 by a number of eminent British soil scientists. It was formed with the aims: to advance the study of soil; to be open to membership from all those with an interest in the study and uses of soil; and to issue an annual publication.

Nowadays BSSS is an established international membership organisation and charity committed to the study of soil in its widest aspects. The Society acts as a forum for the exchange of ideas and provides a framework for representing the views of soil scientists to other organisations and decision making bodies. It promotes research by organising several conferences each year and by the publication of its two scientific journals, the European Journal of Soil Science, and Soil Use and Management.



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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.



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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



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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.



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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.



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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



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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.



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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.



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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.



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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.



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Fera provides expert analytical and professional services to governments, agricultural 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.



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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.



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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.



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.



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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.



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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.



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IKE is the UK's professional body for innovators. It accredits and certifies 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.

The Institute of Materials Finishing



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The Institute of Materials Finishing is the premier technical organisation representing industry, academia and individual professionals in both the UK's and global surface engineering and materials finishing sector.

We actively promote continual education and knowledge dissemination by providing both distance learning and tutored training courses, as well as a technical support service. We also provide bespoke courses that are tailored to an employer's specific needs. The Institute also publishes *Transactions of the Institute of Materials Finishing* and a bimonthly newsletter (*IMFormation*), as well as holding regular regional and international technical meetings, symposia and conferences.

Institute of Measurement and Control



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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.



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.



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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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.



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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.



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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

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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.



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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.



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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.



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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.



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.



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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

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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.



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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.



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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.



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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.

QUADRAM
INSTITUTE



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Opening fully in mid-2018, the Quadrant 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 Quadrant 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.



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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.



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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.

Royal Society of Biology

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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.

ROYAL SOCIETY OF CHEMISTRY

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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.

society for applied **SfAM** microbiology

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SfAM 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, SfAM 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 **SCI**: where science meets business

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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.

Society of Maritime Industries

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The Society of Maritime Industries (SMI) is the voice of the UK's maritime engineering and business sector. Promoting and supporting companies in Commercial Marine, Maritime Defence & Security, Ports & Terminals Infrastructure, Marine Science & Technology, Maritime Autonomous Systems and Digital Technology.



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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.



University of Essex

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Established in 1964, the University of Essex is ranked as one of the Top 20 universities in the Research Excellence Framework and is awarded Gold in the Teaching Excellence Framework. It is home to world-leading expertise in analytics and data science, with research peaks spanning the social sciences, sciences, and humanities. Pioneers of quantitative methods and artificial intelligence techniques, Essex is also in the UK top 10 for Knowledge Transfer Partnerships, and works with businesses to embed innovation into operations, through KTPs, knowledge exchange and contract research.



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UFAW, the international animal welfare science society, is an independent scientific and educational charity. It works to improve animal lives by:

- supporting animal welfare research
- educating and raising awareness of welfare issues in the UK and overseas
- producing the quarterly scientific journal *Animal Welfare* and other high-quality publications on animal care and welfare
- providing advice to government departments and other concerned bodies.



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The Welding Institute is the leading institution providing engineering solutions and knowledge transfer in all aspects of manufacturing, fabrication and whole-life integrity management.

Industrial membership provides access to innovative problem-solving from one of the world's foremost independent research and technology organisations.

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SCIENCE DIARY

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The COVID-19 Pandemic resulted in the postponement of the P&SC's Discussion Meetings in March, and for May and June 2020. We have created an extra meeting in the Autumn with a view to preserving the bulk of our programme for this year, and in any case we will endeavour to increase the number of meetings in 2021. Given the situation at going to press, the following dates remain provisional:

Monday 14th September 2020

Discussion Meeting on *Non-Tumour Cancers and Precision Medicine and Genome Mapping*

Palace of Westminster, 5:30pm – 7:00pm

Monday 26th October 2020

Discussion Meeting on *Sources, health benefits and global challenges of protein*

Sponsored by kind permission of the Nutrition Society

Palace of Westminster, 5:30pm – 7:00pm

Monday 9th November 2020

Discussion Meeting on *Healthy Ageing*

Sponsored by kind permission of The Physiological Society

Palace of Westminster, 5:30pm – 7:00pm

Tuesday 24th November 2020

Annual Lunch, House of Lords

12:30pm

Monday 7th December 2020

Discussion Meeting on *Autonomous Transport*

Palace of Westminster, 9:30am – 12:30pm including Christmas Refreshments

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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