



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

SCIENCE IN PARLIAMENT

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SPRING 2023

STEM FOR BRITAIN 2023



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John Deehan Photography

DAPHNE JACKSON TRUST

A charity supporting research returners

The Daphne Jackson Trust provides Fellowships to support research returners after a career break of 2 years or more taken for family, caring or health reasons.

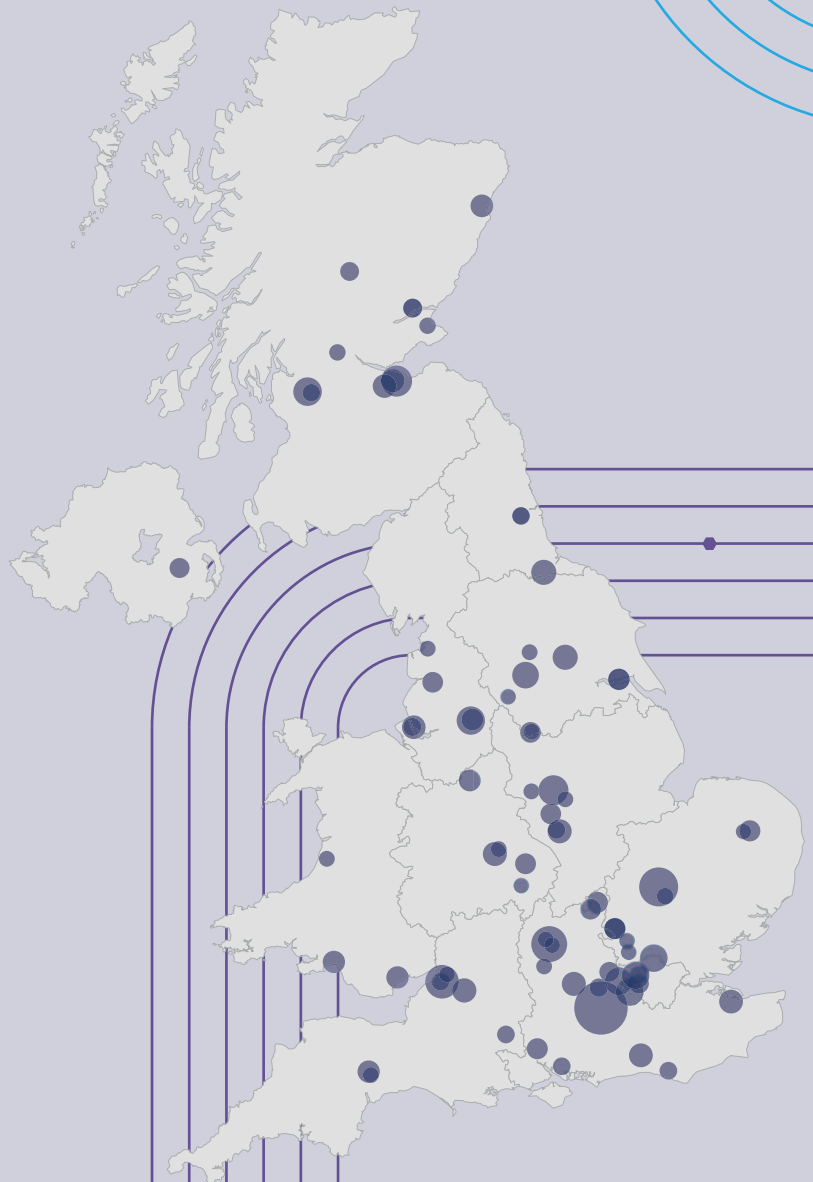
We are the UK's leading organisation dedicated to ensuring researchers are back where they should be. We are actively championing the benefits of issues relating to work/life balance and equality, diversity and inclusion in the workplace.

25 DAPHNE JACKSON FELLOWSHIPS ARE AWARDED EVERY YEAR

461 FELLOWSHIPS HAVE BEEN AWARDED TO DATE

125 ORGANISATIONS HAVE SPONSORED AT LEAST ONE DAPHNE JACKSON FELLOW

Currently there are over **70** Daphne Jackson Fellows undertaking their Fellowships across the UK.



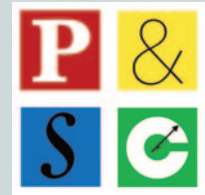
Can you support a Daphne Jackson Fellow?



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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.



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

A warm welcome to our Spring issue.

Our programme got off to an excellent start in January when UKRI partnered with us for a discussion on

This was followed in quick succession by two meetings in February, firstly with Institute of Engineering Technology on the theme of Digital Skills and a couple of weeks later in concert with bit.bio., when the subject was Synthetic Biology.

I want to thank those who spoke at these informative gatherings and the sponsors.

My appreciation to our Programme Manager David Youdan for organising such a busy round of meetings so early in the year.

As you will see from the diary page, following a late April online discussion in cooperation with the National Physical Laboratory, we resume our discussions in Parliament on 22nd May, in partnership with the Royal Society of Chemistry and on 12th June with the Warwick Manufacturing Group. I do hope you will support these events.

Our Annual Luncheon in the House of Lords by kind permission of the President, Stephen Benn, Viscount Stansgate on Tuesday 4th July will draw the first half year of activity to a close. Following the Summer Recess, there will be monthly discussions in September, October and November. David will be providing you with details in the coming months.

I was delighted to host once again our annual poster competition for early-career researchers, STEM for BRITAIN, which took place on the 6th March.

My congratulations to the recipients of the Gold, Silver Awards across the five categories,

More than 50 of my Parliamentary colleagues attended STEM for BRITAIN, many in support of their constituents who were exhibiting. I was also delighted that Greg Clark MP, Chair of the House of Commons Science and Technology Select Committee, was able to join us at the conclusion of proceedings and agreed to say a few words.

My thanks to the sponsors, the Learned Societies, judging panels, Viscount Stansgate, our indefatigable Master of Ceremonies and to Doris-Ann Williams MBE, Leigh Jeffes, Dr Isabel Spence and the whole STEM for BRITAIN organising team, for helping to make the event



The speakers at our 21st February discussion event on Synthetic Biology, sponsored by bit.bio, joined our Chairman at his post-meeting reception.

L-R: **Dr Mark Kotter**, Founder and CEO, bit.bio; **Sara Holland**, Partner/UK & European Patent Attorney, Potter Clarkson. **Stephen Metcalfe MP**, Chairman, P&SC; **Fiona Mischel**, Director of International Outreach, SynBioBeta; and **Dr Joe Healey**, Co-founder and CEO, Nanosyrinx.

Photo credit: Bit.bio/Vernon Hunte

as well as winners of the The Physiological Society Prize, the Nutrition Society Prize and the Dyson Sustainability Awards.

As always the calibre of the 120 finalists and quality of the presentations was of the highest. As I said in my opening remarks at both sets of awards ceremonies, each researcher present was a winner.

such a success. You can read more about the day in our special feature on pages 26 – 32

I was pleased to host Voice of the Future on the 12th March (report on page 12) and thank the Royal Society of Biology for organising this event and also Parliamentary Links Day which takes place on the 20th June.

Finally, I am happy to report that we expect to see a further expansion of our membership in the coming weeks and months, with a number of respected organisations in the process of joining P&SC.

With many thanks for all your support for the work of our Committee and I look forward to seeing you at forthcoming events.

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THREE SCIENTISTS WALK INTO A BAR...

One's a parent, one's a carer and one's a cancer survivor....



Dr Katie Perry, Chief Executive, The Daphne Jackson Trust.

Katie is a physicist with a background in science communication and holds a degree and PhD in Physics from the University of Surrey. In 2022, Katie was awarded an honorary degree by the University of Surrey in recognition of her unwaveringly commitment to securing the legacy of Daphne Jackson's vision – supporting research returners.

Forgive the title – although it reads like the start of a bad joke, it's just the reality of our wonderful STEM research workforce.

The majority of us think of researchers as being super-human, squirrelled away in a lab, working tirelessly day and night as they inch towards their 'eureka!' moment. But if you ask anyone that has worked in research, they will probably tell you the reality is very different. Researchers are people, just like you and I, and we all have lives inside and outside of work that shape what we do, where we do it and how we work.

In research, there's a pervasive expectation that every researcher should follow a linear path... completing University, gaining their first position in a lab to eventually reaching fruition decades later as a fuzzy-haired Professor. But life isn't always so linear – and many researchers take unexpected turns in their work and personal lives that don't follow traditional 'norms'. Career breaks happen surprisingly often. Some are short and specific, such as a gap between grants, or pivoting research interests and switching to a new field. Others are longer and might be related to having a family, caring for a relative or dealing with a health issue.

In this latter group, it can be almost impossible to pick up your career where you left off. Knowledge is no longer cutting edge, skills might have waned and lack of confidence is often an 'Achilles heel' in job interviews. Does that mean they should suffer a penalty for not following a designated career route? Should they be 'kicked out' of science and banished to the wilds?

In this piece, I argue that the opposite should happen. We should embrace non-linear research career paths, welcome diversity in all its guises, and support every brilliant mind that wants to contribute to our fantastic research ecosystem. No matter where they come from, what they studied, nor how convoluted and disjointed their career might have been...every mind matters!

RETAINING TALENT IN THE SECTOR – THE 'OTHER' BRAIN DRAIN

We have highly skilled and talented researchers, scientists, and academics in the UK. But for the UK to be seen as 'the hub' to invest in for global research, we need to make sure we maximise the best research talent. The loss of this talent is a significant concern for the UK as it can result in a brain drain and weaken the country's research capacity, innovation, and competitiveness. It's also morally the right thing to do, to form a country's culture where you aren't punished when you take time off. We still haven't progressed yet to be fully flexible around non-linear paths.

At the Daphne Jackson Trust we often hear about the relentless efforts of scientists trying to re-enter their careers, but there just isn't the flexibility or potential to retrain. In the ever developing and fast-moving world of research, highly skilled and qualified individuals who take a career break often find themselves lagging their peers when returning to research. It can be incredibly difficult to find suitable employment that utilises their knowledge and experience.

A HELPING HAND – FOR THE WIN

That's where Daphne Jackson Fellowships come in. We offer career break researchers the opportunity to undertake a Fellowship on a part-time, flexible basis in universities, research institutes and in industry across the UK and Republic of Ireland. Our Fellowships combine a

1250+
YEARS SAVED

Over the last two decades, Daphne Jackson Fellowships have saved over 1250 years of research experience and talent from being lost from the sector.

tailored retraining programme with a challenging research project in an inclusive environment. Alongside the unparalleled support and mentoring offered by our staff, the Fellowships provide returners with the confidence and skills they need to return to research.

We support and champion a better work/life balance more suitable to a modern-day research workforce. We work with highly skilled researchers from many backgrounds and specialisms across STEM, arts and humanities and social sciences who almost certainly would not have been able to return to their careers without their Daphne Jackson Fellowships. This benefits the individual, the research community, and the wider society.

SUCCESS STORY – PROFESSOR PIA OSTERGAARD

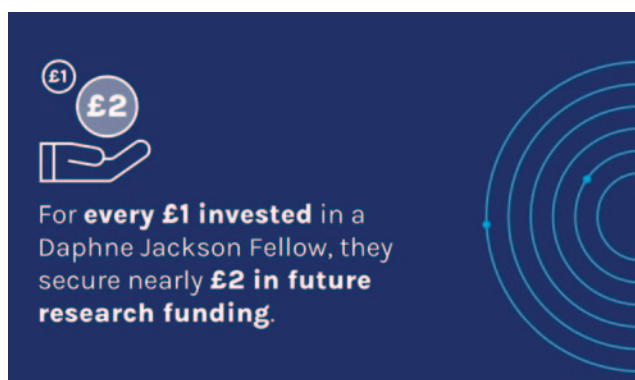


Pia undertook her Daphne Jackson Fellowship between 2005-2007 at St George's University of London after a career break for childcare reasons. Her Fellowship was sponsored by the Medical Research Council. She now works as a Professor in Human Genetics at St George's University of London and was, until recently a Trustee of the Daphne Jackson Trust.

Talking of our Impact Report, Pia notes; "It is an opportunity to remind ourselves that although many things have changed over the last 30 years, other things sadly have not. Only relatively recently have we started tackling cultural issues like gender diversity, equal pay, and inclusion. We are on a journey, moving towards a culture that recognises the role that everyone plays in making research happen. But there is so much more to do. Research returners are still hugely under-represented in the research community. Every person that is lost from our sector because they do not feel that they can return to research after a break is a knowledge, skills, financial and moral loss that we need to address."

CHANGE LIVES - INVEST & RETRAIN

To us, impact isn't just about academic papers or journals or conferences our Fellows have spoken at. It's about helping people to return to research and to stay in research careers for the longterm. Taken from our 2021 Impact Report; 9 out of 10 Daphne Jackson Fellows stay in research or teaching at least 5 years after their Fellowship.



Daphne Jackson Fellowships also contribute to the wider economy having saved £37m of gross institutional costs that may otherwise have been lost.*

LOOKING TO THE FUTURE - INVEST IN THE BEST!

A standout for the Daphne Jackson Trust in the Government's UK Science and Technology Framework is within Section 4, 'Talent and Skills'... "Giving people the opportunity to train, retrain and upskill throughout their lives to respond to changing needs". This is extremely positive, and there is no better time to be part of this sector. We hope this will drive the movement towards a more modern working world, which has certainly changed and will continue to do so.

For the UK to continue the path to becoming a science superpower I would like to see further investment in the almost untapped talent pool of researchers that have diversified off the linear path. A portion of the funds delivered to the UK Science and Technology Framework should be going to those that support the return and retraining of the already incredible talent pool we have in the UK.

At the Trust, we are the UK's leading organisation dedicated to realising the potential of returners to research after a career break for family, caring or health reasons. If you think you could support us in any way, please do get in touch. It's through our partnerships with universities, industry, charities, learned societies and government funders that we are able to operate.

Help us to continue to support and champion a better work/life balance to a modern-day research workforce by doing these four things:

1. Tell three people about Daphne Jackson Fellowships.
2. Ask research funders how they are supporting returners...and if they aren't then we are here to help them!
3. Ask us to put you on our list for event invitations, come to an event to meet a Fellow and you will see first hand why this matters so much.
4. Read our Impact Report available at www.daphnejackson.org and please follow us on social media.

Thank you for reading,

Dr Katie Perry, Chief Executive, Daphne Jackson Trust.

**Taken from our 2021 Former Fellows survey.*

THE UK IS A LAND OF DIGITAL OPPORTUNITY



David Thorpe, Deputy Chief Executive and Chief Operating Officer, STEM Learning

With more than 40 billion-dollar tech companies, known as ‘unicorns’, the UK is an international leader in digital innovation, and aspires to be a Global Science and Tech Superpower. Across fintech, telecoms, AI, e-commerce and beyond, the UK’s tech startups and scaleups are tackling the world’s most urgent challenges. Innovations, vital for the country’s future, include AI to improve medicine and healthcare systems, fintech to improve financial exclusion, or combatting climate change.

Across this sunny landscape are stormy clouds casting dark shadows. The UK has more than one digital skills gap and, without concerted action, they will continue to grow.

DIGITAL SKILLS AND DIGITAL LITERACY

Essential digital skills cover the ability to use digital devices, applications, and networks to access, organise and analyse information. They apply to all manner of situations, across all aspects of life and work. Going beyond functional use of information technologies such as email, social media and search engines, a *digitally literate* person uses technology safely, responsibly and effectively.

More specialised digital skills apply to specific roles and disciplines such as programming, data analysis, computer-aided design, machine learning and AI, app and web development. These skills are in high demand, inviting attractive working conditions and pay.

Both essential and specialised digital skills are in high demand across the entire economy. Job openings calling for digital skills pay much more than those which do not – over £8,000 more per year – with this difference being even larger for high-skill jobs¹.



DIGITAL SKILLS GAPS

In 2021 a third of the workforce *lacked essential digital skills*². When asked in 2022, four out of five UK respondents didn’t feel ready to operate in a digital world, and nearly as many don’t feel equipped to learn the digital skills required by businesses³.

Over 92% of the UK population use the Internet⁴, with the remainder risking being left behind as services move increasingly online. Avoiding digital exclusion is a pre-requisite to developing digital skills.

What impact does this have? The Institution of Engineering

and Technology (IET) explored engineering employer perspectives, finding that around half of those reporting a digital skills gap in the current workforce said it harms productivity. Around a third reported this gap restricts growth, harms innovation and reduces ability to deliver contracts⁵. Such deficits will clearly have implications not only for the economy, but for individual progression and development.

THE FUTURE OF DIGITAL SKILLS

The Unit for Future Skills, based with the Department for

Education, suggest that digital skills are “critical to the future of most jobs”⁶ as we progress through the Fourth Industrial Revolution.

The IET survey found that around half of companies regularly use technology exploiting AI and machine learning or use robotics or other automation technologies. Looking ahead, over one third of employers consider it important that their engineers understand AI by 2027, with an even greater proportion saying the same of cloud computing, machine learning and data security capabilities.

DIGITAL SKILLS GAPS ARE HARD TO CLOSE

Securing universal access to the most essential digital skills is crucial and calls for earlier investment in digital skills in education. In England, the relatively new computing curriculum is a foundation subject for all children aged 5-16; taught well, computing can prepare all young people for their digital lives ahead. Scotland, Wales and Northern Ireland have taken a proactive approach to digital skills, too, through curriculum reform.

Technology has the potential to enhance the way in which teachers explain and model⁷. Applications such as data handling in maths, and simulations in science, can improve learning and attainment in that subject whilst also boosting specialised digital skills and confidence – a win-win.

However, access to high quality curriculum experiences, and to the technology used to embed skills, is unevenly distributed. The advances in EdTech to support the wider curriculum have stalled⁸, following a surge during the pandemic. At home, one in five young people from lower socioeconomic groups lack

access to a laptop, desktop or tablet⁹ making them at risk of being left behind.

Only around half of computing teaching in English state schools is by a teacher with a relevant post-A level qualification; for comparison, almost all teachers of Combined Science held specialist qualifications¹⁰. Young women, lacking confidence that they will succeed in the subject, are also far less likely to take tech and computing qualifications.



SUPPORTING EDUCATORS

The National Centre for Computing Education (NCCE) confronts these challenges head-on. It provides subject knowledge enhancement, high-quality teaching resources and much more to teachers across primary and secondary schools in England. NCCE support improves perceptions of computing, uptake of GCSE Computer Science, and student attainment¹¹. NCCE has researched factors linked to the gender imbalance in computing, seeking to encourage more girls into further study in the subject where they tend to outperform boys. These interventions will scale-up over coming years.

High quality technical qualifications exist, as alternative pathways for students interested in tech. Digital T-Levels are gaining acceptance alongside

more established qualifications. Here, educators with practical experience and teaching excellence are of great value, and we must do more to support their development. Teaching, or working in tech roles, shouldn't be a binary choice – with more flexible work patterns, those with the most to offer technical learners can do both.

The future of digital skills goes beyond computing, across STEM subjects and beyond. It is

important, however, to remember the needs and accountability of teachers in these subjects. Schools and colleges need reassurance and encouragement to deploy proven digital teaching, prioritising the skills of their whole community.

THE NATION WORKING TOGETHER

Young people must see the relevance, and benefits, of digital skills development for their present lives and their future careers, and here is a critical role for government, employers and other stakeholders in the digital economy. We cannot take for granted that young people have an interest in the tech that surrounds them, as much part of their landscape as trees and buses, but together we can provide the spark.

While increased funding to

address digital skills gaps is much needed there are myriad ways to support this joint effort, organised at national, regional and local levels. Convening and channelling campaign and advocacy groups; collaboration and partnership working; and volunteers sharing knowledge, resources and practices from the modern workplace are a few ways in which organisations can contribute, no matter how large or small. Together we can seize the moment and secure the future.

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ENERGY SECURITY, NET ZERO AND ECONOMIC GROWTH – WE REALLY COULD HAVE IT ALL

How research and innovation funded by UKRI is creating the opportunity to build a sustainable, resilient, secure, and prosperous energy system in the UK



Dr Lucy Martin, Deputy Director Cross-Council Programmes, Engineering and Physical Sciences Research Council (EPSRC) within UK Research and Innovation (UKRI)

WHAT DO WE MEAN BY ENERGY SECURITY?

Quite simply, it is a term used to describe our reliance on energy and our basic need to have uninterrupted, reliable, and affordable access to energy to sustain people's lives and daily activities. Access to energy is critical to economic growth, political stability and the overall development and security of our industries (for example, manufacturing and agriculture) making security of supply critical¹.

WHAT ENERGY SECURITY CHALLENGES ARE WE CURRENTLY EXPERIENCING IN THE UK?

The high energy prices impacting households and businesses throughout the UK today have really brought energy security to the fore. They have exposed risks associated with our dependencies on global supply chains for oil and gas and the effect of price rises for those commodities, which can be driven by many factors including increased demand and fuel shortages. However, we are exposed to many other risks including equipment failures, the effects of climate change such as adverse weather events, risks associated with our transition to clean energy sources such as the need for greater system flexibility, a lack of investment or system operability challenges

and now due to the increased digitalisation of our energy system, cyber security risks². Given energy is so critical to the function of our society it is essential that we act to mitigate these risks.

HOW ARE WE WORKING TO TACKLE THESE CHALLENGES THROUGH RESEARCH AND INNOVATION?

As the UK's largest public funder of research and innovation, UKRI is investing in research and innovation to support a sustainable, resilient, secure, and prosperous energy system. These investments are working to help boost our energy security, reach net zero, secure economic growth through the creation of new businesses, jobs and opportunities and bring wider benefits to bear such as improved air quality.

Reducing our energy demand will reduce our reliance on current energy supply chains in the near and medium-term.

Firstly, a major priority is delivering solutions to reduce energy demand including energy efficiency improvements through both technological and social solutions. Less demand means producing less energy which in turn would mean less greenhouse gases being produced and less reliance on current global energy supply

chains. Win, win for energy security and net zero and if we develop the solutions here in the UK, we can create value from the commercialisation and exploitation of those solutions.

The UKRI funded Centre for Research into Energy Demand Solution (CREDS) brings together researchers, businesses, and policy makers. They work together to understand the role of energy demand change in accelerating the transition to a zero-carbon energy system, including the technical, social and governance challenges of demand reduction, flexible demand, and use of decarbonised energy³. CREDS research published recently in *Nature Energy*, provides a world-first framework to understand how much energy demand reduction developed countries can achieve at a national level and identified that the UK can halve its energy demand by 2050⁴.

Energy is required to transform raw materials into products. Therefore, increases in resource efficiency are a critical component of energy demand reduction. The UKRI funded National Interdisciplinary Circular Economy Research (NICER) Programme is working to accelerate solutions. These solutions will enable circularity of specific resource and waste streams to improve resource efficiency focussing on

construction materials, textiles, chemicals, and both structural metals and technology metals⁵. For example, the development of an electric pulse treatment technique by the NICER Circular Metals Centre has resulted in the ability to extend the service life of a steel component by 75%.

The UKRI funded Centre for Sustainable Road Freight has developed both software-based solutions and aerodynamic design modifications that are now in use. These solutions have reduced the energy demand (through fuel efficiency improvements) of freight vehicles, which in turn is leading to cost savings for hauliers⁶.

Diversification of the energy mix and UK production capabilities to boost our resilience

Secondly, UKRI is investing in the development of low and zero carbon solutions to meet our energy needs through extensive electrification and alternative sustainable fuels. This is important for energy security as it enables us to draw on a more diverse suite of energy generation technologies and fuels as we transition to net zero, which provides a huge opportunity to enhance our energy security and resilience in the UK. It means if a risk materialises that impacts one mode of energy generation, we will still have other production methods in service to meet our needs. Such energy generation technologies and fuels include advanced nuclear, offshore (wind, marine and tidal), solar, geothermal, bioenergy and hydrogen. However, all come with their advantages and limitations and therefore coupled to this we need energy storage and flexibility solutions to enable us to match supply with demand and ensure these systems are physically and digitally secure.

For example, UKRI funding led to the discovery of the most efficient solar cells in the world,

which utilise perovskite technology and generate a third more electricity than traditional based solar cells. This formed the basis of Oxford PV who are now commercialising and manufacturing the technology for global markets.

UKRI's long-term investments in offshore wind R&D have ensured the UK has attracted and anchored some of the world's leading offshore wind business R&D capabilities in the UK. This in turn enabled the UK to secure one of the largest offshore wind capacities in the world, which is already contributing to the UK energy mix. For example, EPSRC Prosperity Partnership funding has brought Ørsted, the world's largest offshore wind developer, into collaboration with leading UK academics.

The UKRI funded SPECIFIC Innovation and Knowledge Centre delivered the UK's first affordable energy positive house, which delivers savings of up to £1,000 a year on energy bills and over the course of a year exports 1.3 times more electricity to the grid than it consumes, thus resulting in overall net negative carbon emissions, equating to around -179 kg per year⁷.

The UKRI funded EnergyRev Consortium are leading the way in identifying the standards that are needed to ensure cyber security in smart local energy systems⁸.

Securing UK supply chains for clean energy technologies to reduce global dependencies in the medium to long-term

Thirdly, UKRI is investing in the research and innovation that is needed to transform manufacturing to increase sustainability, create and recover maximum value from products across their whole life cycle and secure UK-based industrial supply chains for clean energy technologies. If we also

make these technologies in the UK, as well as using them, they can be supplied for domestic needs and sold to the rest of the world. This in turn secures economic benefit in the UK while also enhancing our energy security.

For example, UKRI funded research has led to technology breakthroughs that have created companies such as Ceres Power that is manufacturing fuel cell technologies and valued at over £1 billion with over 300 employees and ITM Power, which is now responsible for the largest electrolyser factory in the world in Sheffield. ITM Power manufactures integrated hydrogen energy solutions to enhance the utilisation of renewable energy that would otherwise be wasted.

UKRI manufacturing research investments, led by EPSRC, have resulted in reduced carbon emissions of £5.9 billion at the UK level associated with the successful development of technologies such as fuel savings for more efficient aircraft engines, reduced lighting and display emissions, large-scale photovoltaic solar and more efficient data storage⁹.

Ensuring the UK is the leader for the next generation of clean energy technologies to strengthen our long-term energy security

Finally, UKRI is investing in the blue skies research to pioneer the next generation of clean energy technologies. These include the next generation of battery technologies through the Faraday Institution with increased energy density, reduced cost and enhanced sustainability¹⁰. As well as transformative technologies such as fusion energy. Fusion energy is one of the most promising options for cleaner energy that would bring benefits which include no carbon emissions, abundant fuels, a step change in energy

efficiency (one kilogram of fusion fuel could provide the same amount of energy as 10 million kilograms of fossil fuels) and a safe and reliable power source and could further enhance our energy security if realised¹¹.

WE REALLY COULD HAVE IT ALL

To secure energy security, net zero and economic growth in the UK we need to use less energy; diversify our energy mix and UK production capabilities; manufacture clean energy products, systems, and services in the UK; and continue to push the boundaries to improve our energy capabilities through next generation technologies and solutions. We have the research and innovation capabilities to do this, the time is now here to make sure we exploit it.

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ADDRESSING ENERGY SECURITY THROUGH LOCAL AND DEMAND SIDE ACTION



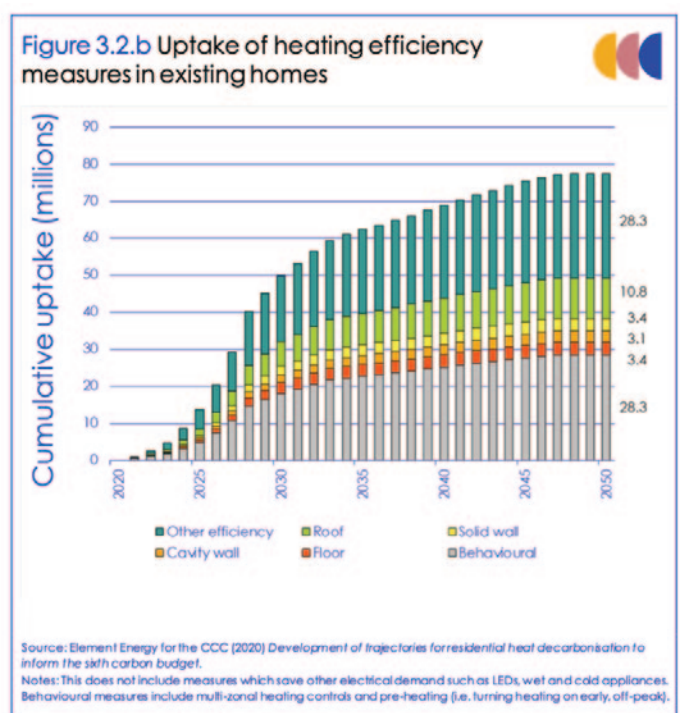
Rebecca Ford
Head of Demand and Flexibility at Regen

Growth of global demand for energy alongside changes in the wider political economy have led to prices of energy skyrocketing in the UK. Action on the demand side presents an important opportunity to address this, while also delivering wider household, community and UK wide benefits. Policy support for households, local authorities, and industry is key to unlocking this action.

There are big changes underway in the UK's energy sector. The last 30 years have seen a move away from coal power generation, and a push toward renewables. In 2022, renewable and nuclear energy accounted for more than 48.5% of all electricity generated in Great Britain. At times, this means that the electricity grid is running on 100% clean power. December 2023 saw the UK break its 'green grid' record, running for 25 hours on only clean power.

But despite this progress and the positive news stories, the UK is still highly reliant on gas. This is true for the power sector where it accounts for almost 40% of electricity generation, as well as for use in heating and cooking. This has meant that the UK has been particularly affected by changes in global gas prices, which have increased steeply in recent years.

For households, one of the biggest knock-on impacts has been in the changes to their energy bills. With Ofgem's price cap changes, the average annual direct debit dual fuel bill has risen from £1200 in 2020, to £2500 in 2022. Despite support provided by the Government's



Energy Price Guarantee, households saw their energy bills double. Over the same period wages have risen by only 10%.

Amid the rising pressures faced by many households to simply keep on top of energy bills is the push for investment in energy efficiency and clean heating. Analysis from the Climate Change Committee¹ shows the scale of action required to upgrade all buildings to an Energy Performance Certificate band C.

Unfortunately, these measures are not being deployed anywhere near as fast as they need to be if we are to successfully deliver net-zero.

2021 saw just 1.48 heat pumps installed per 1000 households in the UK, far below the 15.3 installs per 1000 households required.² This is way below levels seen in some of our near neighbours, including France (17.3 installs per 1000 households), Denmark (25.03 installs per 1000 households)

and Norway (49.77 installs per 1000 households). If we had managed to match rates of install in Estonia (30.29 per 1000 households in 2021), our domestic gas use would have been 34% lower, cutting down gas imports by 19%³ and helping reduce reliance on Russian gas.

Improving energy efficiency and installing clean heating also delivers financial benefits. If all homes below EPC band C were improved to this level, the aggregate saving would be £10.6bn each year⁴. Adding in heat pumps and electric vehicles allows homes to use energy

The first hurdle that needs to be addressed is financial. The cost per house to deliver these changes is insurmountable for many. It has been increasing in recent years and industry professionals suggest it could be upwards of £50,000⁸. Most households don't have access to this type of capital. Where they do, the payback periods are beyond individual investment horizons. We need to see innovative business models,^{9,10} that overcome the upfront cost hurdle and tie the investment to the home. For example, through long term, low-interest loans with repayments via council tax.

the uneven uptake self-perpetuating. Those areas with higher levels of uptake, which tend to be more affluent, create supportive social conditions that enhances further uptake. Or, on the flip side, people who live in areas with lower levels of uptake become trapped.¹²

Local and community-based approaches can help address resource and capacity related challenges for households. They engage citizens to co-create a shared ambition for the future of their neighbourhood or city, and then bring appropriate experts together to develop solutions that meet people's needs. Local

Firstly, we need to attract more young people into the sector, encouraging a diversity of people and providing a diversity of training approaches to meet their needs.

Second, we need to do more to motivate the current workforce, many of whom are employed through small businesses, to take up available training and adopt modern building and retrofit practices.

Third, we need to find a way to navigate the transition path equitably in order to avoid obsolescence of sector workers. Strong leadership from government is crucial here, as long-term obligations, incentives and grants are essential for stimulating market confidence, scaling up training capacity, and reskilling workers¹⁷.

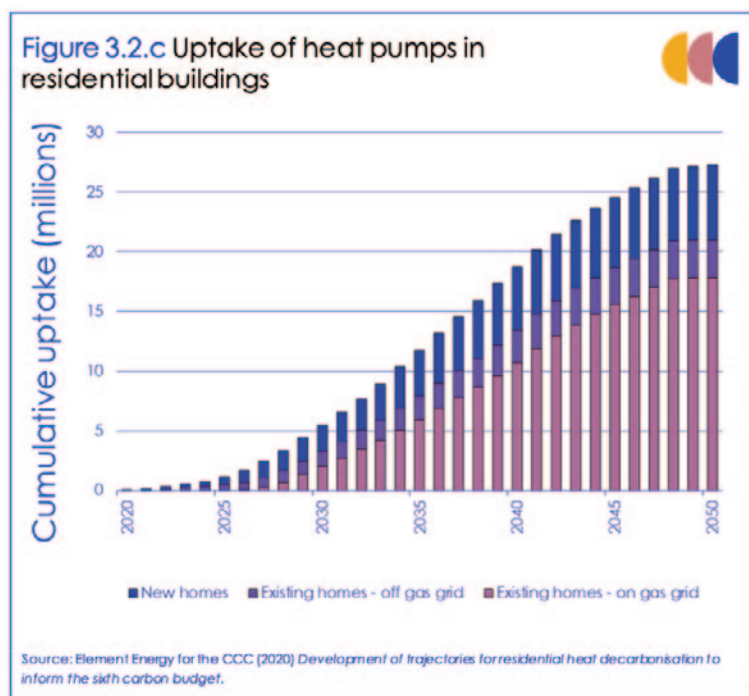
Considering these hurdles together leads to the following recommendations.

1) Address upfront costs

- Provide low-interest access to finance for households.
- Tie investment to the home, not the individual.
- Remove non-financial burdens to access funding, for example, through engaging trusted intermediaries in finance applications.

2) Engage not educate

- Engage people around their wants and needs for their home and community, for example, through citizens assemblies and other democratic approaches.
- Make it easy for people to engage, avoid jargon, and ensure opportunities are not systematically excluding certain groups.
- Focus on the wider outcomes rather than educating or upskilling people to input on technical or operational aspects.



more flexibly, which can create further economy wide savings of £1.7bn a year⁵. Further benefits accrue in other sectors, for example, positive health outcomes from warmer homes⁶. In addition, retrofitting programmes could sustain over 1.2 million direct jobs and 1.5 indirect jobs by 2050⁷.

With the wealth of potential benefits, this begs the question of why the UK is experiencing inaction, and what can be done about this.

The second hurdle is one of exclusion. Research has shown that even when grant funding is provided to support the uptake of low-cost technologies, they are consistently adopted in higher-income areas¹¹. This serves to widen the socio-economic inequalities prevalent in our current energy system. There is still a financial barrier to entry, and those who can afford to, benefit. On top of this, many people do not have the time, resources, or capacity to implement change. This makes

authorities, working with key community organisations in their jurisdictions, are in a prime place to deliver¹³. They are trusted, they have strong links into community, and they can cultivate the connections between diverse stakeholders that are needed to deliver change¹⁴. However, there are significant disparities in capabilities and resources between local authorities. These perpetuate inequalities and risk leaving already disadvantaged areas missing out on the benefits. Empowering local leadership is vital,

and government has an important role to play to ensure local authorities have the necessary responsibilities to deliver and adequate resources and skills to respond.¹⁵

The third hurdle relates to the workforce. Our current workforce is not sufficient in size, diversity, or skills to deliver the changes needed in our homes and workplaces¹⁶. We are facing three interrelated challenges for addressing this and ensuring the availability of the skills and supply chains.

3) Empower local authorities

- Establish long-term policy objectives and instruments, and devolve statutory powers and resources.
- Build capacity through investing in local authority skills and expertise.
- Embed net-zero and equity principles into evaluation of all local and regional public expenditure.

4) Build the industry

- Support people getting into the industry and the industry in growing, e.g., funding for training, incentives for employers, develop peer networks.

- Professionalise vocational education and maintain continuous education capacity, and formalise regulation to make specific qualifications a required prerequisite.
- Provide long term, evidence backed, and non-competitive funding to develop long-term markets and incentivise industry development.

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THE OTHER PROBLEM WITH TECH TRANSFER



Dr Sara Holland
Partner | UK & European Patent
Attorney

There has been increasing discussion around problems with the transfer of technology from universities, and in particular with the spin-out process. The process is often very slow, with negotiations around terms such as the equity stake taken by the university sometimes causing investors to walk away, founders to get frustrated, and companies struggle to get off of the ground.

This process will be looked at in the review recently commissioned by the Treasury, and headed up by Professor Irene Tracey and Dr Andrew Williamson. This is the bit everyone talks about.

But this is a downstream problem of a potentially more impactful upstream bottle-neck – capturing much more of the innovation from the labs in our universities for wider societal benefit.

The current academic mind-set focuses on a drive to publish research to meet targets/career goals, rather than thinking “*what does my research mean in a wider context? What could we (society) actually do with it?*” i.e. thinking *inventively*. If we can shift this mindset and back it up with better education around what it actually takes to get that idea to have a real-world impact I’m confident we will find we have so much more in our universities that our world desperately needs and that will push our science-superpower status.

WHAT’S THE PROBLEM? WE ARE GREAT AT RESEARCH!

We all know that the UK is great at research. After all, we have three universities ranked in the top 10 across the entire world¹.

But what does that mean?

This means that we are good at getting research into scientific journals, and are good at getting those articles cited by others.

Doing good science and disseminating it to the scientific community is a good thing. Tick.

What it does **not** mean is that we are good at doing something with that research.

What impact does publishing research in an obscure journal have on the lives of people in the UK, or for net zero and the planet?

Very little. The main impact it has is to increase some academic’s publication record.

There is, in most cases, no real, meaningful impact that comes from simply publishing research – a real-world dead end. Which is a shame, since I believe most people go into research to

“make a difference”. But because many academic researchers have known nothing but academia, there is a general lack of understanding as to how that difference gets made.

I was in a similar position, having been in academic research until I was 33. I used to think that if I publish my work perhaps someone will one day read it and turn it into a cure for cancer, or the like. I’m not sure who I thought these people would be, or what their motivation would be. It was only until I left academia and stepped into the real world – the world where products do get made and things do get done – that I realised how naïve that notion was.

The way we do get real-world impact is by thinking about this research in commercial terms – something very alien and even abhorrent to the vast majority of academics – but something I believe we need to put much more emphasis on if we are to really make the most of our “research excellence”.

But where do you start? There is little perceived benefit to most academics (particularly those with an established presence) to think about approaching the technology transfer office with their idea. The entire academic career path is built around publishing in the highest impact factor journal you can, getting the next grant, and doing (or getting your PhD students and postdocs to do) the research you said you were going to do.

We don’t want to stop our academics from publishing their research, but if we want to capture innovations for society we do need to make sure they think of any commercial uses before they do publish. This is because, simply put, you can’t protect something with a patent if you’ve published it before you

file a patent application. You can publish the day after you file a patent application – but not the other way round. I have seen many instances of people getting this the wrong way round, scuppering what could be promising technologies for UK PLC to exploit.

WHY DOES THIS MATTER?

Simply put – money makes the world go round. For a lot of technology sectors, particularly in biotechnology and the life sciences, a huge amount of time, money and effort is needed to develop an idea from basic research into a marketable product. That money needs to come from somewhere – typically, at some stage, from investors, and investors need a return to provide to their own investors in due course.

The key to all of this working is *exclusivity*. For a spin-out/start-up to secure that investment to turn the research into a real-world product or service, they will essentially need to be able to show investors that they can stop people copying them. Investors are not going to give you cash to perfect the development of a product, or new drug, only to have someone else copy it and likely undercut you. And to get this exclusivity you generally need a patent.

This simple fact is not something that academics tend to pick up on the degree/PhD/postdoc treadmill. With heads down, focussed on the research, there is often a scornful view of those that do think about patenting their research – it doesn’t “fit” with the academic ethos. Those leaving the academic system can be seen as failed-academics (and those of us leaving the system truly feel that way, until we are able to shake it off).

This needs to be widely challenged and a dose of reality injected into the system. Most researchers do want their work to make an impact and I would suggest that there should be an obligation on researchers to consider the potential impact of their work – particularly since the academic system is largely funded using public money.

There has been public uproar around aspects of the COVID vaccines being funded by public money turning a profit for commercial entities – but where is the uproar around publicly funded research just quietly finding a dead-end in the pages of a scientific journal?

SO, WHAT DO WE DO?

We need to improve education around the benefits of commercialising research, and we need to target this to the PhD students and postdocs. Established academics, who already have their own labs are, in my experience, less inclined to change their ways. If there is hope, it lies in the early career researchers – not least because spinning out their own company is a likely more viable career option that to keep running on the academic treadmill.

We also need to fund the TTOs properly so that they can take a more proactive approach in identifying commercial opportunities that are hiding in the labs. In my experience, most TTOs are doing an amazing job, with not enough staff and not enough funds. This means that they generally aren’t able to go out into the different laboratories in the universities and spend time with the scientists, discuss their research and try to “invention spot”. At present, the few spin-outs we do see have typically come from the academic themselves realising they may have something useful. As we’ve just

covered, those are few and far between – what else can we unearth if we actually go and look? Anecdotally, the one instance I know of where a TTO approached a lab directly, resulted in a spin-out.

So - increasing education of the academics, with a focus on early career researchers, and a proactive approach from the TTO can help in that first step of realising that there may be something really useful coming out of a particular bit of research. Then we need to work on the bit that everyone talks about!

The current academic system does not work – for many reasons outside of the scope of this article.

We can’t afford to be precious about this. We can’t afford to pander to established but outdated ideals.

A recent quote in the Sunday Times from Steve Bates, CEO of the UK Bioindustry Association sums it up “We will fulfil our potential when having a failed biotech company on your CV is as valued in an academic career as a paper in Nature”.²

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YOUNG SCIENTISTS QUIZ KEY POLITICAL FIGURES AT VOF 2023

13 March 2023

Young and early career scientists were given the chance to voice their questions about the future of science to MPs, ministers and Defra's Chief Scientific Advisor.



From left to right: Dr Faten Hussein, Dr Claire Kanja, and Susie Rabin

As part of the Society's annual Voice of the Future event, committee seats in the Boothroyd Room were occupied by a panel of young researchers who were invited to quiz a variety of key political figures sitting in the witness seats about science policy issues.

The proceedings were launched by Dr Claire Kanja, committee specialist in the House of Commons Science and Technology Select Committee, and the event was live streamed on the parliament website.

The first witnesses to give evidence were MPs from the Science and Technology Select Committee: Stephen Metcalfe, Carol Monaghan, and Katherine Fletcher.

The panel were asked questions on nuclear energy, scientists moving into policy, COVID-19, amongst others.

In particular, the Council for Mathematical Sciences highlighted 89% of math professors in the UK are men, compared to 11% of women. They asked what the panel think is the cause of such gender disparities in mathematics, and what should be done to address this?



Panel from left to right: Katherine Fletcher MP, Stephen Metcalfe MP, and Carol Monaghan MP

Carol Monaghan recounted a head teacher of a prominent school commenting "girls can't do hard maths" at a Select Committee hearing. As a former physics teacher, she argued that to get girls doing physics and maths, it is vital to plant the seeds, and find the talent, which in turn will appeal to both students and parents.



Professor Gideon Henderson,
Defra Chief Scientist

YOUNG RESEARCHERS ACTING AS COMMITTEE MEMBERS.

Next Professor Gideon Henderson, Defra Chief Scientist, was questioned by the panel members. He was asked by Ciara O'Brien from the Association of Applied Biologists how will parliament ensure that the public is well-informed about the benefits of genetic technologies. He responded that in terms of genetically modified (GM) crops, many consumers are looking for affordable and healthy food that is of a high quality. For consumers who are concerned about GM, Government need to work out a way to tackle misinformation by giving citizens an avenue to access the information on these technologies.

Following Professor Henderson, Rt Hon Philip Dunne MP, chair of the Environmental Audit Committee, was the next witness. He discussed sewage issues and promoting geothermal energy. On the subject of sewage, Katie Powell from the British Ecological Society asked what is the Government doing to prevent sewage being released and how will they help restore the health of our aquatic ecosystems for nature and people? He commented that the main sewers through London were supposed to last 100 years, taking us to the 1960s. Since then most of our systems were reaching capacity, and although we have developed above ground to cope, we haven't developed capacity underground.

He noted that leaving the EU forced Government to create new environmental regulations, and water quality was one of the issues that came up. Technologies are being developed that will notify us of breaches, and notify the public.

Voice of the Future is an annual event organised by the Royal Society of Biology, which invites young scientists to represent scientific organisations including: Applied Microbiology International, the Association of Applied Biologists, the Biochemical Society, the British Ecological Society, the British Pharmacological Society, the British Society for Immunology, the Council for the Mathematical Sciences, the Geological Society, the Institute of Physics, the Institution of Chemical Engineers, the Nutrition Society, the Royal Astronomical Society, the Royal Society of Biology, the Royal Society of Chemistry, the Society of Chemical Industry, The Open University, and The Physiological Society.

A full video of the Voice of the Future hearing is available on the Parliamentlive.tv website



Rt Hon Philip Dunne MP, chair of the
Environmental Audit Committee



Young researchers acting as committee members



Young Researchers



UNLOCKING THE UK'S DIGITAL POTENTIAL: HOW UPSKILLING AND RESKILLING CAN DRIVE PRODUCTIVITY



Dr Graham Herries, chair of the Institution of Engineering and Technology's (IET) Innovation and Skills panel

The Institution of Engineering and Technology (IET) is working to engineer a better world. It works to inspire, inform and influence the global engineering community, supporting technology innovation to meet the needs of society. As one of the world's largest engineering institutions, it has 154,000 engineering and technology professions in 148 countries. With access to expertise spanning all engineering and technology sectors, such as digital, innovation, energy, built environment, manufacturing, transport, healthcare and engineering safety, it provides expert advice to Governments and other agencies; produces fact files and briefings to the public; and is regularly in the mainstream and specialist media explaining the impacts of engineering and technology on society.



The IET's *Skills for a Digital Future* survey shows that a digital skills gap may be holding back the UK economy. The solution? We need a paradigm shift towards lifelong upskilling and reskilling, underpinned by flexible government support.

By some measures, the UK is leading the world in the innovation of emerging digital technologies. Our universities rank among the world's best for artificial intelligence (AI) research¹. We have more tech unicorns – start-ups with a \$1 billion+ valuation – than France and Germany combined². The UK should be well-placed to capitalise on the fourth industrial revolution, with innovations in AI, robotics, and extended reality poised to spur innovation and productivity.

What we are lacking however, is the critical mediator of digital technology and economic growth: digital skills. The government knows this – official estimates put the economic cost of the UK's digital skills gap at £63bn per annum³. This is almost half of the National Health Service's annual budget, and represents an opportunity cost that is likely to spiral as the pace of technological change accelerates further.

The IET, which is uniquely placed to understand digital skills with access to insight and expertise across a range of sectors, recently published its *Skills for a Digital Future* survey – it asked over 1,200 engineering employers about their digital skills needs. The

headline results are alarming – 47% of employers report a skills gap in their technical workforce. When this result is broken down by category, 'advanced or specialist' digital skills are the most in need. Why?

terms. *The Skills for a Digital Future* survey shows just that – when asked to describe 'digital skills', engineering employers offer a wide range of definitions. Whereas employers in the IT / communications sector are far



58% of large companies are more than twice as likely as SMEs (27%) to give their employees digital skills training

There are two major themes which emerge from the data: firstly, an adoption / awareness gap among some engineering employers about the benefits that emerging digital technologies can bring. Secondly, a resources gap for digital upskilling and reskilling of employees to take advantage of these opportunities where they are identified.

WHAT ARE DIGITAL SKILLS?

Most conversations about digital skills start the same way – what are they? The response to this question often reflects the line of work of the respondent, which makes it a difficult question to answer in general

more likely to talk about specific software engineering skills, those in other sectors – such as construction and manufacturing – often refer to basic IT knowledge.

It's concerning that so few answers refer to the technologies of the fourth industrial revolution, such as AI, robotics, or extended reality. The hard data shows a clear adoption gap between sectors – while 49% of IT / communications employers report that most of their staff 'regularly' use AI, this drops to 15% among manufacturers. **We must improve awareness of the benefits that harnessing emerging digital technologies can bring.**

A DIGITAL SKILLS GAP MAY BE HOLDING BACK THE UK ECONOMY

49% of employers with a digital skills gap say that it reduces productivity. Without awareness of the benefits of emerging digital technologies, employers will not invest in the digital skills needed to drive productivity. In construction for example, an industry which generally takes a risk-averse approach to adopting new technologies, productivity has been virtually stagnant since the 1960s.⁴

AI-powered technologies such as digital twins could help reverse this trend. In short, a digital twin is a virtual representation of a physical system (such as a building), which acts as a one-stop repository for lifetime data about that system. Machine learning can then use this data to continuously optimise the

Finally, the digital skills gap impacts not just the economy, but also the environment. Previously, the IET's *Skills for Net Zero and a Green Recovery survey* showed Net Zero and energy-related businesses are facing a digital skills gap – it is clear that no sector is fully prepared for the fourth industrial revolution.



UPSKILLING AND RESKILLING IN THE DIGITAL FUTURE

While specific areas – like AI, robotics, and extended reality – are destined to remain important, the concept of 'Skills for a Digital Future' transcends any single technology. The digital present is already a fast-moving space, the digital future will move even faster. ChatGPT

to be affected by a lack of resources, being only half as likely to offer digital skills training to their employees compared with large employers (27% vs. 52%)

An agile workforce needs agile support. Government policy should reflect this by giving employers flexible support

to help upskill and reskill their workforce as and when new technology requires. The recently introduced Lifelong Learning Bill – which introduces modular funding for higher education courses – is a step in the right direction, but it is not practical for many workers to take out student loans for continual upskilling.

We should embed flexibility into other funding mechanisms, such as the apprenticeship levy.

Apprenticeships are a vital part of addressing the digital skills gap, primarily by training-up the technicians who help implement and maintain new technologies. However, the levy in its current form does not work – it has raised over £2bn for training which has gone unspent,⁵ and only 4% of paying employers use their full levy entitlements.⁶ Allowing employers to re-invest these funds in digital 'microcredentials' is the type of agile support that we need.

CONCLUSION: 3 RECOMMENDATIONS FOR GOVERNMENT

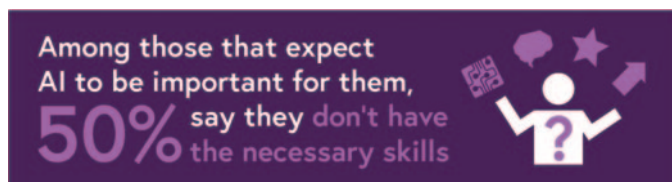
Government policy should target increasing adoption / awareness in sectors where uptake of these technologies is low, and making flexible financial support available for digital upskilling and reskilling:

1. Funding for upskilling and reskilling, for example using the unspent apprenticeship levy. Funding should be more flexible for employers to use where they need it most.
2. Sustained support for skills in emerging digital technologies. Training should not be seen as short term but as an investment in the future.
3. Targeted support for SMEs, who may find it more challenging to provide training to their employees.

Digital upskilling is not a 'nice to have', it is something that must, and needs, to happen. The UK risks missing out on a great economic opportunity here – boosting our digital skills capability can unlock our huge technological potential.

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system's productivity. Digital twins harbour both economic and environmental benefits for the construction sector, but will require skills to implement and operate. So, while it is encouraging that 34% of construction employers see AI as being important to growth by 2027, it is concerning that half of these report that they don't have the relevant skills to take advantage.

Employers also report that a digital skills gap is harming their ability to innovate (35%), grow (35%), and deliver contracts (29%). Consequently, firms are more likely to outsource business to contractors or overseas services companies, which impacts costs and staff in the UK.

epitomises this – just as policymakers were getting to grips with ChatGPT-3, a fourth version is released marking a step-change in the technology's capability.

There has never been a more compelling case for lifelong learning. Continual digital upskilling and reskilling will be necessary for both employees and employers to thrive. We need a paradigm shift in this direction, not just for future generations, but for the 80%+ of the 2030 workforce which is already in work.

Even where there is adoption / awareness of digital technologies, there is often a lack of resources to manage and fund digital upskilling and reskilling. SMEs are most likely



BEYOND ChatGPT: HOW AI IS TRANSFORMING OUR WORLD



Professor Stephen Roberts.
Credit: Mind Foundry Ltd.



Professor Shimon Whiteson.
Credit: University of Oxford



Dr Ross Upton. Credit: Ultramics.



Professor Charlotte Deane, Oxford University.



Associate Professor Sara Khalid.
Credit: Nuffield Department of Orthopaedics, Rheumatology and Musculoskeletal Sciences, Oxford University.



Dr Joss Wright.
Credit: Oxford Martin School.



Professor Sandra Wachter.
Credit: Sandra Wachter.

Once the realm of science fiction, artificial intelligence (AI) technologies are becoming increasingly integrated into our daily lives with tools such as ChatGPT already revolutionizing how we communicate. But many other sectors are embracing AI to unleash new insights and greater efficiencies, including finance, transport, wildlife conservation, and healthcare.

THE FUTURE OF FINANCE

Machine learning methods and algorithms have been at the heart of the financial sector for many years, but the latest advancements are set to transform this industry, particularly insurance. Stephen Roberts, Professor of Machine Learning at Oxford University, explains: "Historically, insurance products have been broad-brush, catering monolithically for a wide range of customers, but we see a future where this is replaced by personalised, timely and flexible policies." Whether health, travel, or personal insurance, AI tools can generate more accurate risk estimates,

thus enabling firms to better understand customers and provide more informed and accurate pricing. As an example, insurance companies have realised that many vehicles are not driven all day every day and that some people drive more carefully than others. Combining computational methods with data from in-vehicle sensors could enable these factors to be effectively and rapidly priced into agile, dynamic premiums.

AI could also be a powerful weapon against fraud, thought to cost the UK around £190 billion a year (National Crime Agency). By monitoring immense volumes of transaction data, AI-powered tools can generate



AI can be used with telematics and in-vehicle sensors to help car insurance companies to understand their customers better.
Credit: Mind Foundry

real-time alerts of suspicious activity, prioritised according to the likelihood that these actually indicate incidences of fraud. Meanwhile, the ability of AI to model the complex interactions and underlying risks between assets and sectors could also help open up finance for more 'risky' ventures.

Nevertheless, the integration of AI with financial services presents risks. "Notable issues can arise when large-scale ultra-fast AI systems interact with one another. For instance, it has been suggested that 'black box' algorithms may be a confounding factor in market flash crashes" Professor Roberts says. "More work is undoubtedly needed to understand how AI systems, even if compliant in isolation, can interact to produce unstable markets and subsequent rapid losses."

DRIVERLESS DRIVING

Almost 30,000 serious or fatal road casualties occur each year in the UK, but autonomously driven vehicles could potentially make our roads much safer. Achieving this, however, represents "one of the most challenging engineering problems of our times," according to Professor Shimon Whiteson, from Oxford University's Department of Computer Science. Nevertheless, UK researchers have made great strides towards this goal.

In 2017, Professor Whiteson founded the company Latent Logic (acquired in 2019 by Waymo, part of Google's parent company), as a spin-out from his research into developing highly realistic simulation environments to train autonomous vehicle software. "The technology works by combining state-of-the-art computer vision with imitation learning. Our models extract the 'latent logic' behind real life examples of natural human

behaviour captured by traffic cameras and drone footage. As a result, the system can respond realistically even in new situations."



Waymo's autonomously driven Jaguar I-PACE electric SUV. Credit: Waymo.

This technology has now been integrated into the Waymo Driver – dubbed 'The World's Most Experienced Driver' – which has already logged more than 30 million autonomously navigated kilometres on public roads. "In a recent study, Waymo's safety team found that the Waymo Driver avoids more collisions and mitigates more serious injury risk than the high benchmark of an unimpaired human driver whose eyes are always alert to a potential collision" says Professor Whiteson. The company has also developed an autonomous ride-hailing service (Waymo One), currently operating in San Francisco, California, and Phoenix, Arizona.

Waymo now has ambitious plans for scaling and expansion. "Here in Oxford, we are focusing on enhancing the Waymo Driver's abilities using the latest advances in machine learning to develop more realistic models of the behaviour of other road users, including 'structured tests' which can simulate rare events that may only happen once in one million miles" says Professor Whiteson. "But to bring the benefits of autonomous driving technology to UK roadways, policymakers need to continue

investing in developing the talent and skills of the next generation of AI professionals, and put the legislation and regulation in place to enable the safe

commercial deployment of autonomously driven vehicles."

DEFEATING DISEASE

Clinical AI applications, meanwhile, could help relieve the acute pressure on our public health systems by enabling more accurate and earlier disease detection, and thus early interventions. For instance, Ultromics, a medical diagnostics company that launched as a spin-out from the University of Oxford in 2017, has brought the power of AI into echocardiography for the early detection of heart failure



Clinician viewing report sent by Ultromics' EchoGo Heart Failure. Credit: Ultromics.

conditions. The company's EchoGo Heart Failure product uses a deep learning model to detect whether a patient has heart failure with preserved ejection fraction (HFpEF), a

condition where the heart is unable to pump enough blood to meet the body's needs. HFpEF is extremely difficult to detect, and can often be mistaken for less severe conditions such as a chest infection. EchoGo can improve the accuracy of echocardiogram interpretation to above 90%; significantly better than the standard achieved by human doctors.

"By facilitating early diagnosis and treatment, we can improve the lives of many and help to reduce the significant burden heart failure has on the NHS, including identifying patients earlier in the pathway before they are admitted to hospital" says Ultromics CEO Dr Ross Upton. Ultromics is currently conducting clinical trials across 20 NHS hospitals to start bringing the technology to the UK but according to Dr Upton more support is needed from policy makers before AI models can truly transform care pathways. "This includes making it easier for NHS sites to procure and test AI models within their hospitals, reducing the barriers for adoption, and setting aside a ring-fenced budget for testing new technologies."

Elsewhere, studies led by the University of Oxford have demonstrated the ability of machine learning tools to analyse electronic health records to predict the risk of emergency

hospital admissions; to track disease deterioration in cystic fibrosis patients; and to identify key developmental features of babies during routine ultrasound scans of pregnant women. Beyond diagnostic tools, AI can also help patients to manage existing conditions. As an example, GDM-health, a software application developed by Oxford University NHS Foundation Trust and the University of Oxford, helps pregnant women suffering from gestational diabetes to monitor their blood sugar levels and share that information in real time with a clinical team. Data recorded from the user's blood glucose meter are analysed by an algorithm to identify the patients most in need of clinician input, with staff able to communicate directly with patients through the system.

Meanwhile, when it comes to discovering new clinical treatments, "AI has the potential to change the game – to make drug discovery quicker, cheaper and more effective," says Charlotte Deane, Professor of Structural Bioinformatics at Oxford University. For instance, when a new target for therapeutic intervention is identified, AI can accelerate the process of searching for potential drug molecules. "This search space is vast – estimated at around 10 to the power of 60" says Professor Deane. "But AI can explore this space in a way humans and other types of algorithms cannot. As an example, AI algorithms borrowed from image processing have been used to predict with high accuracy how well a potential drug molecule will bind to a given target."

SAVING SPECIES

AI-enabled technologies could also help us combat the alarming disappearance of animal and plant species across

the globe. Two critical actions, for example, are to locate undiscovered species before they disappear and identify biodiversity hotspots to prioritise for protection. By combining machine learning approaches with advanced camera technology, researchers can now autonomously classify enormous volumes of images and video footage that would be beyond human capacity to analyse. For instance, Associate Professor Sara Khalid from the University of Oxford's Planetary Health Informatics Group recently assisted a National Geographic Society expedition using an AI tool that could automatically



An AI powered Shark Detector can identify 47 different species with up to 98% accuracy. Credit: Sara Khalid.

locate and classify shark species from underwater video footage. "We trained the algorithm using sharkPulse: a public repository of thousands of shark images submitted by citizen scientists worldwide" she says. The resulting 'Shark Detector' is capable of identifying 47 different species, with up to 98% accuracy.

"We are now exploring potential wider applications of this technology" Dr Khalid adds. "These could include identification tools to help fishermen avoid catching endangered species by accident, or autonomous monitoring systems to check for illegal fishing activity."

Besides counting and monitoring species, AI could help combat the root causes of biodiversity loss, as Dr Joss Wright from The Oxford Martin Programme on the Illegal Wildlife Trade explains: "AI-powered technology is revealing new insights about the illegal wildlife trade, helping us to understand why so many communities depend on it and what incentives might make wildlife more valuable to local people alive than dead."

One of the programme's projects, for instance, used machine learning methods to analyse over 27,000 patents

people's attitudes towards threatened species.

"A particularly exciting project we are currently working on combines AI-enabled technologies with conservation science to mine open-access data and derive the biodiversity impacts of investments" adds Dr Wright. "This will allow investment fund managers to obtain a 'biodiversity risk score' for a portfolio, and thus to assess their investments in terms of their risks to biodiversity."

NEW TECHNOLOGIES, NEW RISKS

The increasing integration of AI-

driven technologies into our societies is already causing ethical issues, as Professor Sandra Wachter, from the University of Oxford's Oxford Internet Institute, explains. "AI technologies are powered using huge amounts of data, which immediately creates a data privacy issue. Algorithms are very good at inferring something about you from data that initially seems harmless, and this can include sensitive information such as sexual identity and health conditions." In addition, because AI algorithms are trained using historical data from the internet, they can inherit and reinforce biases and discrimination, for instance on gender and traditional job roles.

"This could lead to people who already experience discrimination becoming even more disadvantaged, particularly women and people of colour."

Where algorithms are used to make important decisions, explainability becomes another key issue. "Very few people really understand what happens inside the 'black box' of AI" Professor Wachter explains. "If, for example, you were sent to prison or denied a job because

of a decision made by an algorithm, it might not be possible for you to be given an explanation why. Even if those responsible know, the code may be a trade secret"

Meanwhile, generative AI technologies such as ChatGPT are accelerating the speed at which convincing disinformation can circulate. Besides spreading doubt on issues such as climate change and vaccine efficacy, this could reduce public trust in

media and political institutions, allow generation of propaganda, and be used to sway elections.

According to Professor Wachter, the potential far-reaching consequences of AI make it imperative that regulation is not left to the private sector. "As a minimum, governments should invest in increased horizon scanning capacities to identify disruptive technologies early in their lifecycle, so they aren't blindsided by new

developments. Regulators should work more closely with independent academics and researchers, to assess the risks and benefits to create evidence-based guidelines that enable ethical innovation. We also need to invest urgently in early and continual education, so that people making high-stakes decisions in the future – whether doctors, journalists, politicians or judges- are able to discern what is true from what isn't." ■

THE PARADOX OF THE SHIP OF THESEUS AND THE GUT MICROBIOME



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THE PARADOX

The human gut microbiome has been associated both in the scientific and popular press with a number of health conditions. These include "your risk of developing obesity, heart disease, Type 2 diabetes and a wide range of other conditions"¹. In addition, "Higher levels of gut microbiome diversity are generally thought to be a good thing."¹ although such statements are often made with little proof being offered. In addition, colonies comprising single species can be highly biologically active while having zero diversity.

There are over 1,000 different microbial species colonising the human gut. These are grouped into families, genera and strains so the numbers detected depends on the granularity of the level of inspection. Their interaction with the human host is responsible for a range of physiological effects such as enhancing immunity and aiding digestion. Because of advances in DNA sequencing

technologies, the identification of which species are present is now much more complete however this does little to differentiate a 'healthy' from an 'unhealthy' gut microbiome². Different microbes can be affected by diet and linking this to clinical outcomes is emerging. In addition, sequencing of the gut microbiome is highly biased towards the identification of bacterial species. Other organisms (e.g. fungi, viruses, yeasts) which are known to be present are much less completely catalogued. Moreover, sequencing gives composition only and nothing on functionality of the microbes or the potential interaction between microbes.

This leads to two challenges:

1. How can we derive a more complete and more comprehensive map of the microbial species present in the gut microbiome?
2. How can we determine what functional benefit derives from each different

microbial entity - or combination thereof - and how does this impact upon the health of the host?

One approach to the second of these challenges makes use of the concept of replacing one microbial species with another one and determining health outcomes that result. The principle is embedded in the metaphor of the Ship of Theseus. The Ship of Theseus is a paradox which was perhaps most notably included in *The Life of Theseus* by Plutarch. The paradox revolves around the idea of whether a ship that had been restored by replacing every single wooden part remained the same ship. Can two microbiomes that are biologically different (at whatever level of hierarchy we choose as relevant) but functionally identical, actually exist? If so then the further paradox about there being a number of 'healthy' states of the human gut microbiome can be explained. In order to investigate this idea further, we need to define the microbiome itself.



Josephine Hunt

THE BIOLOGICAL PARADOX

A common theme when considering biological systems (including microbiomes) is the search for homeostasis. A homeostatic living system is one that is in equilibrium and is therefore resistant to perturbation.

Within a microbiome, different phyla, genera, species and strains exist and comprise the microbiome. A number of terms are used to define the properties of a microbiome and these give an indication both of how microbiomes are defined and what is considered important.

Species Richness

This is defined as the number of species that are found during a specific measurement however, do the numbers of each species that are present reveal anything useful regarding the functional properties of the microbiome?

Species Diversity

Species diversity is a measure of the proportion of each species that are present.

There are a number of other terms which are used to describe the properties of the species present in a microbiome including Dominance, Evenness, Rarity and Abundance.

Knowledge of species richness and diversity is not particularly useful as it does not provide information about the dynamics of a microbiome, its functional properties or its effect upon the system (including the host). These are far more crucial questions than merely defining composition in a non quantified manner.

One of the drivers for the measurement of types of bacteria present in microbiomes has been advances in nucleic acid sequencing. Particularly noteworthy in this context is the growth in the analysis of 16S rRNA from bacteria³. The

sequences obtained are then compared to microbial genomic databases to identify and profile the bacteria. The identification is only as comprehensive as the constraints of the sampling of the population allow.

A map of the functional attributes of the microbiome will be much more useful. The ecosystem as a whole impacts markedly upon health (and is amenable to change). It is insufficient to merely know what is there and in what relative numbers – we must know what they are doing and how they are interacting with each other and with the host.

THE MICROBIOME AND THE SHIP OF THESEUS

If we apply the 'Ship of Theseus' paradox to the microbiome, we can think of components of the microbiome as the timbers and other components of the ship. If we replace one microbe with another that is genetically different but functionally identical then repeat this for each microbial component then we should, eventually, end up with a microbiome that is completely different in terms of its component species but is functionally identical to that which we started with. Perhaps the most contentious part of this exercise relates to the question – what does functionally identical mean? We can consider the answer to this in several ways:

- Internally the microbe has the same cellular machinery and functions in the same way as that which it is replacing.
- Its relationship with the other microbial components is the same as that which it is replacing. This means that, for example, it produces (and responds) to microbial mediators such as quorum sensing molecules (small molecular signals produced by microbes in mixed

communities) in an identical way as the original microbe.

- It impacts upon and responds to the host in precisely the same way as the original microbe. This means that, for example, it provokes an identical immune response as the original.

While this may seem an esoteric argument, it is crucial to a number of aspects of the microbiome and therefore the host⁴. For example, the human gut microbiome is constantly changing and, in order to prevent harmful dysbiosis, it must act collectively to repress uncontrolled growth of pathogens. Not all healthy microbiomes are identical however at a 'prevention of pathogen growth' functional level, it is reasonable to assume that they share certain characteristics. If we can identify the functional characteristics of this property and how the microbiome organises this in different cases, then we will be closer to having a metabolic map of the microbiome. One way of probing this might be to examine the routes by which different microbiomes become dysbiotic. While they are 'healthy' we assume that they share certain functional characteristics but, depending on their nature, their progression to dysbiosis may occur by a number of routes. This has been described as the 'Anna Karenina Principle'^{5,6} based upon the opening line of Leo Tolstoy's *Anna Karenina*, "all happy families are all alike; each unhappy family is unhappy in its own way". This suggests that "healthy" microbiomes are alike and each disease-associated microbiome is "sick" in its own way. The application of this principle suggests that all health microbiomes share certain characteristics but the principle, as amended by the Ship of Theseus paradox, suggests that the functional result (prevention of dysbiosis) may be the same

even if the means to achieve that aim is different.

CONCLUSION

The Ship of Theseus Paradox combined with the Anna Karenina Principle provides a way of looking at microbiomes which may have consequences on how we can most effectively manipulate it maximum benefit. This is critically important as we know that the microbiome (unlike our genetics) can be altered functionally and therefore has major capacity to straightforwardly improve human health. It should be noted, however, that there is no exact way of describing biological systems (or, indeed any other system) in terms of metaphors. If they were exact then they would not be metaphors⁷. Determining which functional characteristics contribute to different states of the microbiome is a massive step on the way to developing methods (dietary) to maximise the benefits of a healthy microbiome.

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SYNTHETIC BIOLOGY: THE UK'S OPPORTUNITY TO LEAD IN THE NEXT INDUSTRIAL REVOLUTION



Fiona Mischel Director, Human Health Content and Innovation. SynBioBeta

Synthetic biology is the biggest industry you have never heard of. If scaled successfully, it has the power to transform planetary and human health across the world.

I have cystic fibrosis, a life-threatening genetic condition, so I speak from personal experience when I say that synthetic biology is both an opportunity and a necessity.

I have been taking the life-saving medication, Kaftrio, since 2019 (known as Trikafta in the US). This medication has changed my life to the point where it is almost normal—I no longer live as a chronically ill person, just an occasionally sick one. Kaftrio has kept me out of the hospital for over three years, allowed me to gain full-time employment, and enabled me to emigrate from the US to the

UK, the country where I feel most at home. I also believe this drug played a major role in saving my life and many others with CF during the height of the pandemic. To be clear, this drug is not a cure but it is certainly the next best thing.

Kaftrio is not a bioengineered therapeutic but a triple-action small molecule, that is, a synthetic chemical compound. However, only 80% of CF patients are genetically eligible to receive this life-changing drug. The remaining 20% of patients have genetic mutations that are too extreme for today's solutions. Thousands of patients

still bear the burden of this disease and there are millions more with conditions far more genetically complex than CF who have gone untreated for decades.

Why do I write all this? Because I believe that I am one of the last of a generation of patients that will be significantly impacted by small-molecule drugs. We need innovations like synthetic biology to bring new solutions to patients, families, and our planet.

WHAT IS SYNTHETIC BIOLOGY?

Synthetic biology (synbio) is a field of science that applies



A range of products all made from synthetic biology including cultured meat, food colouring, textiles, bio-concrete, aviation fuel, and COVID-19 mRNA vaccines

engineering principles to biological systems to create new functions and materials. Simply put, synbio reprogrammes biology.

Synbio has the potential to impact every industrial sector from foods to fuels, materials, chemicals, and, of course, medicine. Today, our economies are underpinned by petrochemicals. By changing our systems of production to leverage biology, we can localise manufacturing, secure our supply chains, dramatically reduce greenhouse gas emissions, and create safe, high-paying jobs.

One of the best ways to understand the fundamentals of synbio is through fermentation. Just as we ferment yeast to make beer, we can also reprogram and brew single-cell organisms to make critical products like ethanol, polyurethane, surfactants, and fertilisers. We can also reprogramme animal cells for food or human cells to fight disease.

SYNBIO FOR HUMAN HEALTH

The COVID-19 pandemic clearly showed us what synbio can do for human health. mRNA technology (programmed mRNA molecules) was an overnight success over two decades in the making. But mRNA COVID vaccines are one only application of one therapeutic modality in the synbio family.

Synbio has been saving lives in the UK since 2018 through cell and gene therapies. Many cancer patients with fatal prognoses who were treated with CAR-T cell therapy are now considered cured. Meanwhile, the first gene therapy for a fatal childhood disease, metachromatic leukodystrophy (MLD), was just given to a 19-month-old baby. However, these

powerful therapies are currently only available to a few hundred patients as a last resort.

Today, very few genetically programmed therapies are approved. They are also currently difficult to manufacture, meaning cell and gene therapies are some of the most expensive drugs in the world – one (curative) dose for MLD has a list price of £2.8 million.

Because these therapies were developed using synbio, we can also use synbio to scale production, reduce costs, and improve access until these therapies can become front-line treatments. Ideally, this will involve increased financial and tax-credit support for emerging companies in this space, regulatory review, and increased GMP-grade biomanufacturing capacity.

Human health isn't the UK's only opportunity to lead in life sciences. We also have the chance to leverage synbio to meet our Net Zero targets.

SYNBIO'S ROLE IN THE UK'S NET ZERO ROADMAP

The UK is already a leading nation in synbio research and entrepreneurship. In February of this year, 3D Bio-Tissues, a company in Newcastle, revealed the world's first pork steak made entirely of cultured porcine cells. The implications of this are tremendous. Cultured meat is often hailed as a solution to the growing demand for animal-based foods and products. Rather than farm whole animals to harvest only certain parts, cultured meat can grow specific meat cuts or animal-derived products directly. The technology involves taking a small biopsy from a living animal and growing those cells in a bioreactor. The result is the same chicken or pork you buy in stores today but without the carbon footprint,

animal welfare implications, antibiotics, or human exposure to zoonotic disease.

The UK is also leveraging synbio to decarbonise heavy industry. The Government awarded leading synbio company LanzaTech a £25 million grant to build a sustainable aviation fuel plant (SAF) in Port Talbot, Wales. The factory will use genetically reprogrammed microbes to transform greenhouse gas emissions from the local steel mill into ethanol, a key ingredient in SAF.

These kinds of scientific and industrial breakthroughs could be repeated in every household product we buy, in every building we make, and in every meal on our plate. While this is a bold claim, it's hardly far-fetched when taken in the context of the global support behind synbio.

early projections show that synbio investment declined significantly in line with all other venture-capital-backed sectors. However, the current macroeconomic environment should not distract from the tremendous opportunity of synbio for the UK.

In 2020, McKinsey released a special report detailing the potential economic impact of synbio between 2030-2040. The report estimates that the annual economic value of synbio is between \$2-4 trillion USD. At scale, the synbio industry could provide 60% of all material inputs and address 45% of the world's disease burden.

Many regions, especially the United States, have mustered significant financial, political, and regulatory might to support synbio. The Biden administration made headlines late last year



THE GLOBAL COMPETITIVE LANDSCAPE FOR SYNBIO

At SynBioBeta, we track global private investment in synthetic biology. We have seen tremendous investor appetite across all industrial sectors, especially in human health and food and agriculture. In 2021, private investment topped \$18 billion, a record for the industry. We expect that figure to decline for 2022 (as of this writing in March 2023, we are still finalising our 2022 data). Our

with the Executive Order on Advancing Biotechnology and Biomanufacturing. This order directed major US government agencies to submit reports on how they will use synbio to achieve their health and sustainability goals and improve their services for taxpayers. Then, just weeks ago, the Biden Administration released their initial biotechnology goals following the Executive Order. Over the next 20 years, these bold goals aim to produce at least 30% of the U.S. chemical demand via biomanufacturing

pathways, produce 90% of plastics from bio-based polymers, and decrease the manufacturing cost of cell-based therapies 10-fold. These policies, coupled with new biotech hubs emerging across the US, are pushing the US bioeconomy forward in an unprecedented way.¹

Meanwhile, Singapore has taken a different approach to promoting its bioeconomy and securing its future resources. As an island nation, Singapore imports most of its essential goods including food. But in 2020, Singapore became the first country to approve cultured meat, taking significant steps in securing the country's food supply, supply chain resilience, and human health.

ACHIEVING OUR GOALS AS A LIFE SCIENCE SUPERPOWER

The UK is perfectly positioned to take advantage of synbio's

rising tide. The UK's academic strength alongside agencies such as UKRI, ARIA, and the new Department for Science, Innovation, and Technology, are powerful catalysts for promoting and scaling synbio. The NHS is also a global destination for clinical trials, especially for novel therapeutics like cell and gene therapies. These frameworks and know-how can play critical roles in achieving the UK's life science ambitions.

It's important to recognise that synbio is a more capital-intensive industry than other advanced industries such as FinTech, AI, and SasS platforms. There are

two key reasons for this. First, synbio creates material goods, not just digital ones. Second, biology is far more complex than any computer and programming even the most basic single-celled organisms is non-trivial. When considering synbio's role as an industry of the future, it's important to balance the up-front costs against the long-term benefits.

Our societies are burdened by diseases and our planet is approaching a dangerous tipping point. There will never be a better moment to act for our future. Synbio looks to play a critical role in shaping our

societies for generations to come. By harnessing and supporting synbio innovation, the UK can stake out its technological foothold and take a leading role in the global economy of the future.

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WHAT HAS SYNTHETIC BIOLOGY EVER DONE FOR US?

The opportunity for the UK to be a leader in "SynBio" for human health



Dr Joe Healey, Co-founder & CEO of NanoSyrinx Ltd. (www.nanosyrinx.com)

SYN-WHAT?

Synthetic biology ("SynBio") is a term that is likely unfamiliar. This is understandable, given that even within the SynBio community there are still debates about its exact definition, and many even within the wider biotechnology sector are unfamiliar with it.

Those who are familiar, and on the sceptical end of the spectrum, would likely say SynBio is little more than

molecular biology as we already know it "rebranded". I think I occupy a slightly curious centre ground on the topic since I am a huge advocate for the field, but even I can relate to this somewhat cynical idea. To me, there are two types of SynBio. Just as there exists "pure" and "applied" mathematics, I believe there exists the 'purists' discipline, that concerns itself with genetic circuits, modelling, and trying to make biology into,

effectively, a branch of engineering; and the 'applied' flavour, which at its core is about building on the capabilities of nature to create new functions and utility - "putting biology to work".

Whatever your perspective, synthetic biology as it exists today is an incredibly broad church, and covers advancements in everything from smart materials and bioremediation, to sustainability

and therapeutics¹. During the Parliamentary and Scientific Committee (P&SC) session on this topic in February, I made an argument in favour of investing in SynBio for this very reason. Not only does it have the potential to impact practically every challenge that we face in the 21st Century (climate change, ageing populations, food equity and so on), in doing so it draws upon the modern scientific pantheon, including AI/computing, chemistry and engineering. Investing in this “confluence” of modern science also means driving advancements and delivering benefits across far reaching areas of our technology base and economy.

SYNTHETIC BIOLOGY IN HUMAN HEALTH

My passion for SynBio has culminated in co-founding my company, NanoSyrinx, specifically to address a real challenge in a particularly difficult area - namely precision drug delivery. This is an area that I firmly believe synthetic biology

can make, and already has made, significant waves, with the hope being that our technology is similarly disruptive.

Over the past century science has become exceedingly good at finding and developing new medicines. Though almost paradoxically, the failure rate is still >90-95%, and it takes over a decade and billions of dollars in the process². Much of the reason for that failure rate is that *finding* potential therapeutics is merely the beginning, and is arguably the easiest part of the whole endeavour. Where the rubber really meets the road, and failure skyrockets, is when these candidates are taken through *in vivo* development (animal models and early human trials). Suddenly you are faced with the various systems of the body, evolved over millennia specifically to keep the ‘non-self’ (i.e. your drug) out. This is where advancements in drug delivery systems, and “precision medicine” more broadly, come in.

At NanoSyrinx, we are developing a novel delivery

system ‘powered’ by a synthetic biology platform. Originally deriving from a bacterial toxin mechanism, the delivery system resembles a nanometre-scale ‘syringe’ (referred to as “nanosyringes”) that can literally inject protein molecules across the membrane barrier of your cells. Modern SynBio tools give us the capacity to modify practically every single amino acid (~ 100,000) in each nanoparticle, simply by altering its DNA ‘blueprint’.

Advances in gene editing, and the falling costs of DNA synthesis and sequencing are all instrumental parts of SynBio which mean a company like ours could not have feasibly existed even 15 years ago. Drug delivery is just one example of an area which stands to be greatly improved with the power of synthetic biology and a case in point of how investment into synbio - for example DNA synthesis tech - directly impacts wider fields of medicine, industrial biotech and so on.

Part of the reason I am so captivated by our technology,

and SynBio generally, is that they are ‘manifestations’ of what excites me most in science - leveraging nature’s existing solutions to solve human problems. Our nanosyringe system is one esoteric example of an evolutionary solution to the problem of “moving molecules across biological membranes”, and evolution is a far better molecular biologist than we are.

So the question becomes: what other challenges has nature already solved? During the Parliamentary session I gave several examples of cases from within the healthcare space alone where we’re leveraging solutions.

Perhaps the most obvious example to cite here, would be the COVID-19 vaccines developed in the last 3 years (though of course vaccinology as a discipline far pre-dates modern molecular/synthetic biology). Vaccines work *with* the immune system, essentially leveraging nature’s solution to keeping us healthy and protected. Our ability to rapidly design, iterate



The basis of the NanoSyrinx “nanosyringe” technology. (Left) A genetic construct comprises all of the building blocks for the nanosyringe ‘chassis’, the therapeutic payloads it contains (orange), and its “cell targeting” protein (blue-black). (Centre-left) The nanosyringes ‘self-assemble’ when produced using laboratory bacteria, producing a ‘loaded’ delivery vehicle. (Centre-right) The completed nanosyringe protein complex depicted as a cut-away to reveal the payloads (orange) within. (Right) The nanosyringes bind to the surface of the cell and push a needle-like structure through the cell membrane (maroon) to deliver the drug payload.

and manufacture an mRNA vaccine (for instance), is a prime example of what synthetic biology can do, and is hugely exciting for the future of public health³. Much of the same enabling technology for our nanosyringe system applies here too: cheap DNA sequencing and synthesis, advances in expression and purification methods and so on.

Comparatively old hat today, advances in antibody therapy are nevertheless SynBio through and through. These also increased in prominence during the pandemic as we explored monoclonal antibody COVID-19 therapies, but they have been on the front line of new cancer treatments for many years. For example, Keytruda is an antibody therapeutic approved for at least 19 different cancers⁴, making it one of the most impactful therapies to date, and best selling medicines of all time.

Another major recent paradigm in biotechnology has been the development of viral-vector based cell and gene therapies. This subsector of modern therapy concerns the engineering and utilisation of naturally occurring human viruses. Viruses are almost uniquely evolved/equipped for the purpose of conveying genetic material into mammalian cells, and we leverage this behaviour to create novel therapies for diseases previously considered intractable if not incurable. These therapies can address a variety of diseases, from repairing/replacing defective genes, to generating cancer-cell killing immune responses and even curing blindness⁵. It bears repeating that what makes these approaches particularly remarkable is that they can not

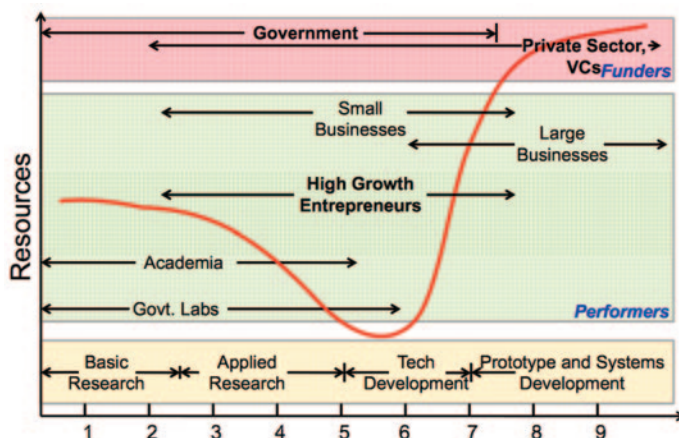
just treat, but cure patients of previously debilitating and incurable diseases in as little as a *single dose*⁶. The list goes on, but I believe these examples more than demonstrate the power of SynBio for human health.

THE UK'S POTENTIAL

The UK has a real opportunity right now to become not only a science superpower, but a *SynBio superpower*. Many pieces of the puzzle are already in place, with a world-leading research base including top tier Universities & non-profits, a progressive and forward-looking NHS who are already embracing the power of gene therapies⁷ (something the US is uncharacteristically slow to do) and a springboard for high-potential ideas in the form of ARIA, UKRI and the excellent VC ecosystem.

To ensure that happens, a number of key themes emerged from the P&SC session. Firstly, SynBio's multidisciplinary nature puts it at risk of 'homelessness' within the UKRI framework, where research is (understandably) siloed. For example, SynBio is nominally

within the remit of the BBSRC, but that typically focuses on industrial biotechnology and sustainability - so what becomes of early stage therapeutic projects that are too 'immature' for the MRC? They are left exposed to the second theme: a



The "Valley of Death" (as seen in the red line) and players involved in translation from early academic and foundational research to commercial prospects. The x-axis numbers are Technology Readiness Levels (TRLs). Image credit: the National Defence Industrial Association.

funding problem. The "Valley of Death" is still a barrier to early stage, high-risk-high-reward, projects progressing through translation/commercialisation. At the other end of the spectrum, there is a dearth of growth capital, and it is considered largely impossible to list a biotech company on UK/EU stock exchanges, making it hard to retain these businesses. Lastly, this funding gap combined with what can, at times, be a 'stifling' academic entrepreneurial environment in the UK (compared with e.g. the US), means translation and commercialisation has roadblocks in its path that need not exist. Programs like InnovateUK's ICUR scheme, which I personally benefited from, are helping enormously here (the secret sauce of which is the shifting of focus to early career researchers-turned-entrepreneurs), but there is work

still to be done in improving general academic attitudes to commercialisation which can disincentivise potential entrepreneurs.

I will conclude in much the same way I did during the P&SC session: SynBio is going to happen - we must ensure it happens *here* or risk the UK being left behind.

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STEM for BRITAIN 2023

On Monday 6th March 2023, 120 early career researchers from universities and research institutions from across the United Kingdom came to Westminster to take part in STEM for BRITAIN.

This annual poster competition and exhibition is 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 50 Parliamentarians from both Houses.

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

Gold, Silver and Bronze winners in each category



received certificates and cash prizes, with medals going to the Gold winners.

The Physiological Society Prize was awarded for the fifth year running, and the Nutrition Society Prize for the fourth. The Dyson Sustainability Award consisted of three prizes.

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 120 posters for the exhibition and final of the competition from nearly 400 high quality entries. We thank the judges for all their hard work in this process.

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

The event would not be possible without the help of all the major learned societies involved in organising the event, together the organisations which generously supported and sponsored the event, including: the Clay Mathematics Institute, Dyson, Warwick Manufacturing Group, AWE, BIVDA, UKRI, the Institute of Biomedical Science, the Heilbronn Institute for

Mathematical Research, the Biochemical Society, and the Society of Chemical Industry.

The Westminster Medal, sponsored by the Society of Chemical Industry, in memory of the late Dr Eric Wharton, who did so much to establish the event, will be presented to one of the five Gold winners adjudged to have most effectively communicated her of his work during an online process, at an SCI dinner in May.

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.

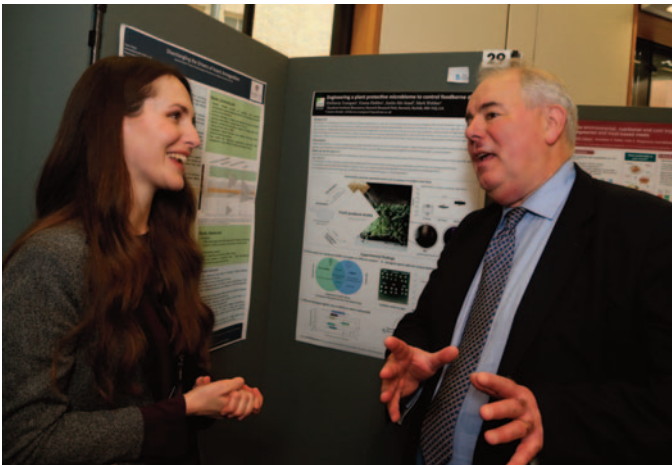
STEM for BRITAIN 2024 will be held on Monday 4th March. Applications open on Monday 11th September and close on Monday 27th November 2023.



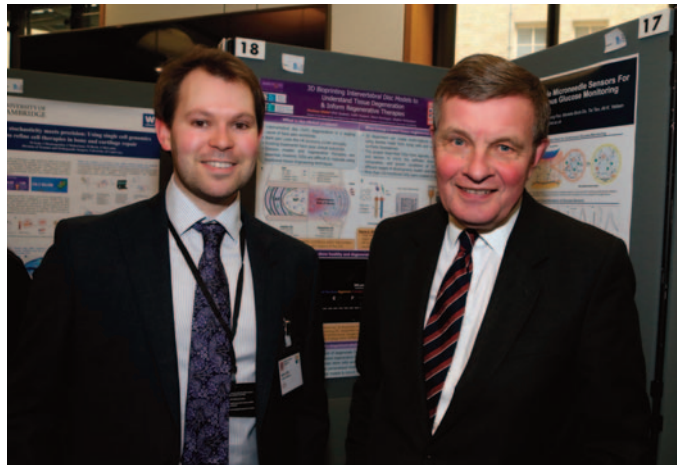
BIOLOGICAL & BIOMEDICAL SCIENCES



L-R: Sarah Dickson, Newcastle University, BRONZE; Olivia Conway, University of Cambridge, SILVER; Devon Crouch, University of Liverpool, GOLD; Isabel Esain, University of Cambridge, THE PHYSIOLOGICAL SOCIETY PRIZE; and Rebecca Evans, University of Liverpool, NUTRITION SOCIETY PRIZE



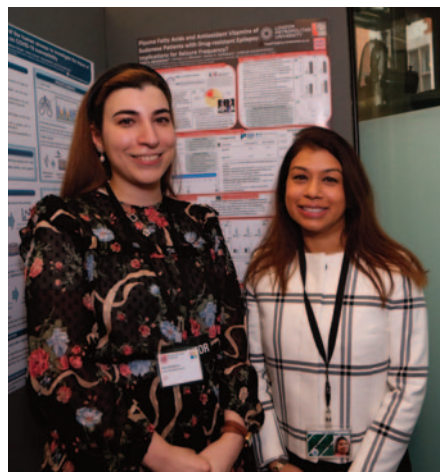
Eleftheria Trampari and Richard Bacon MP



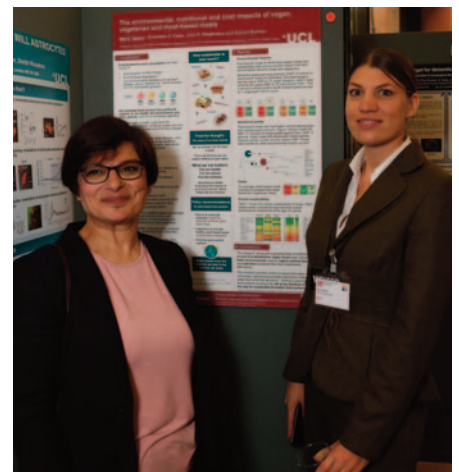
Matthew Kibble and David Jones MP



Anneliese Dodds MP and Samuel Burden



Nada Abuknesa and Tulip Siddiq MP



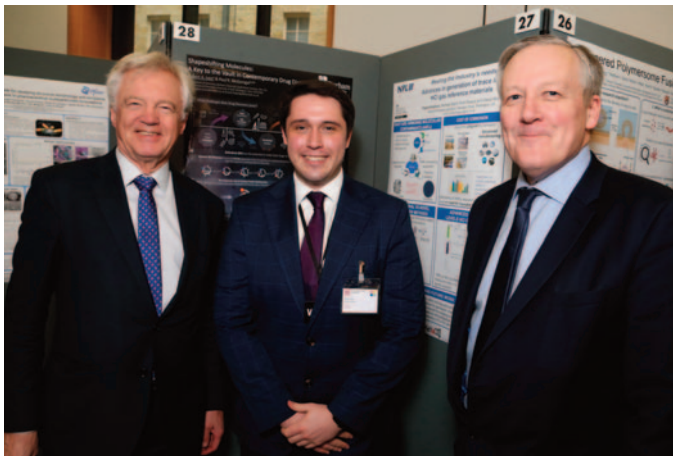
Thangam Debbonaire MP and Beril Takacs

All photographs John Deehan Photography

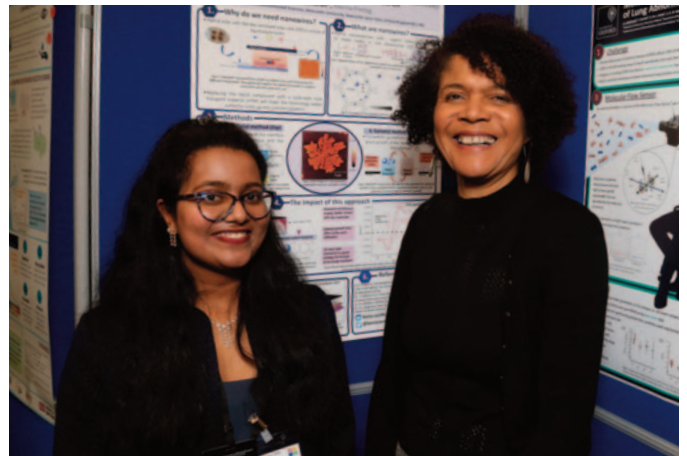
CHEMISTRY



L-R: **Chunchun Ye**, University of Edinburgh, BRONZE; **Beatrice Jones**, University of Cambridge, GOLD; **Dylan Sherman**, University of Oxford, SILVER



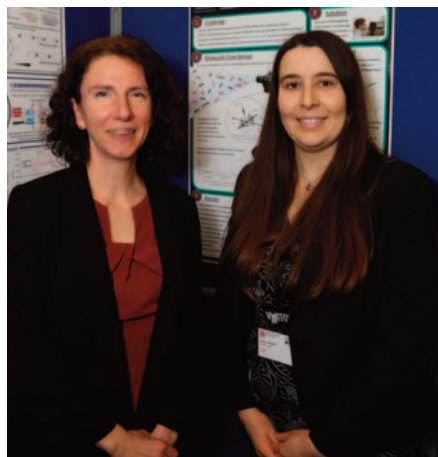
David Davis MP, Robert Ives and Kevan Jones MP



Kezia Sathisharan and Chi Onwurah MP



Elizabeth Legge and Stephen Hammond MP



Anneliese Dodds MP and Jennifer Redmond



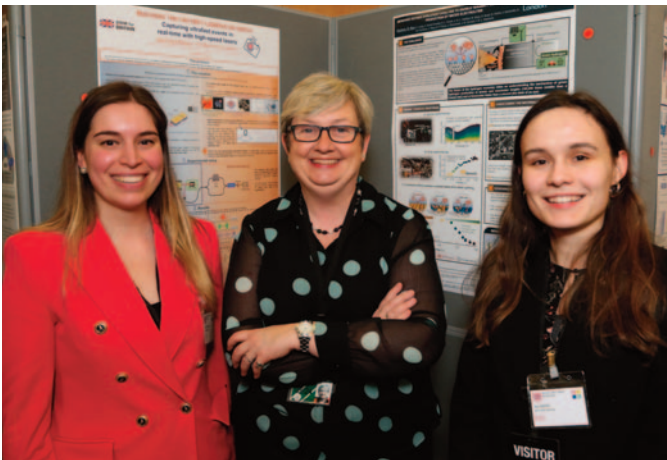
Stephen Metcalfe MP and Sourav Maiti

All photographs John Deehan Photography

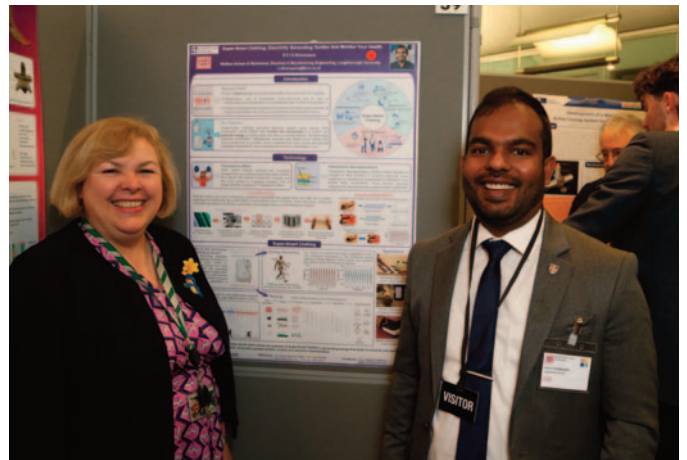
ENGINEERING



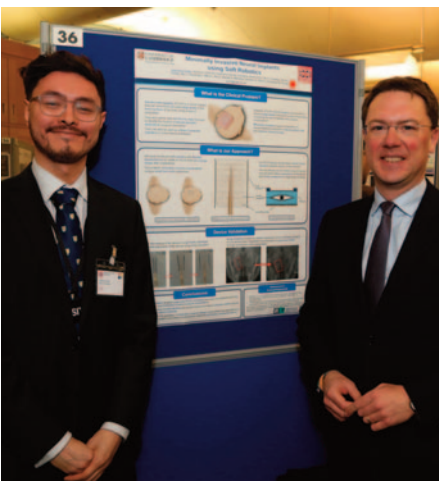
L-R: **Abigail Lister**, University of Oxford, BRONZE; **Francis Dent**, University of Leeds, SILVER; **Shreya Kalyanasundaram**, King's College London, BRONZE; **Yogeshvaran Ramanathapuram Nagarajan**, De Montfort University, GOLD



Carolina Tacchella, Joanna Cherry MP and Ana Ribeiro



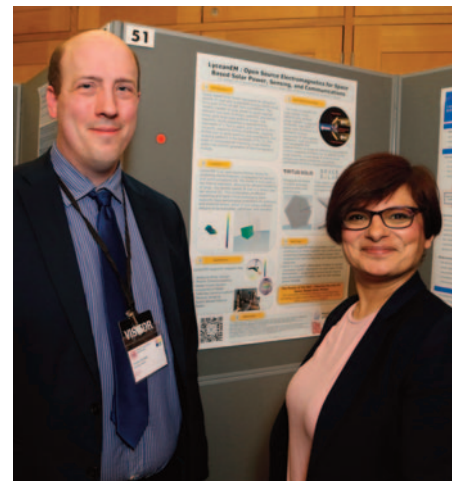
Jane Hunt MP and Ishara Dharmasena



Lawrence Coles and Robert Courts MP



Emma Collett and David Johnston OBE MP



Timothy Pelham and Thangam Debbonaire MP

All photographs John Deehan Photography

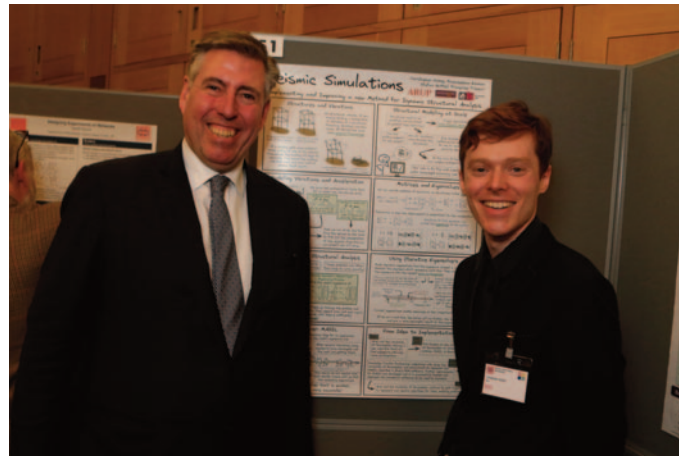
MATHEMATICS



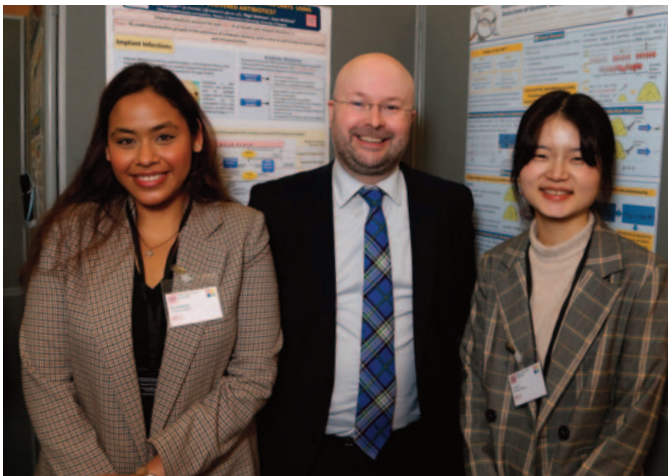
L-R: Christopher Hickey, Arup, BRONZE; Arkady Wey, University of Oxford, GOLD; Jennifer Power, University of Bath, SILVER



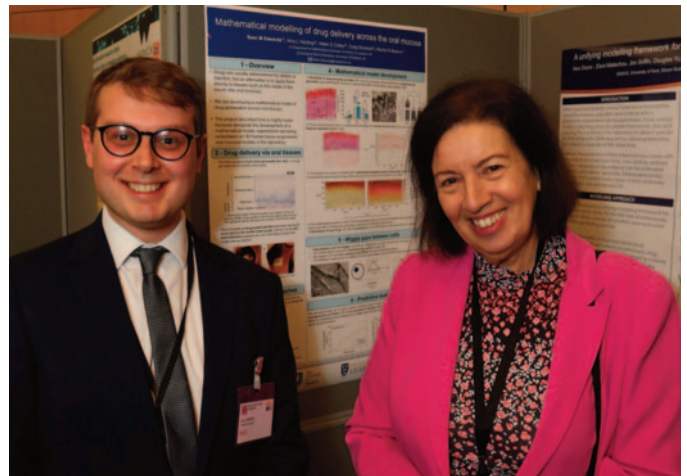
Julia A. Meister and Mims Davies MP



Sir Graham Brady MP and Christopher Hickey



Parna Mandel, Patrick Grady MP and Lanxin Li



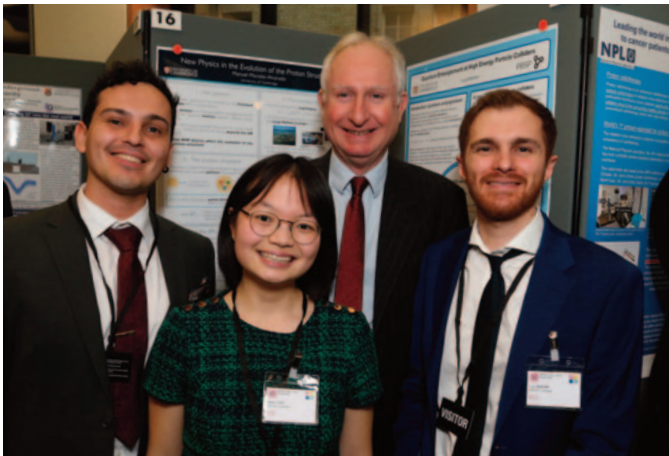
Sean Edwards and Jo Gideon MP

All photographs John Deehan Photography

PHYSICS



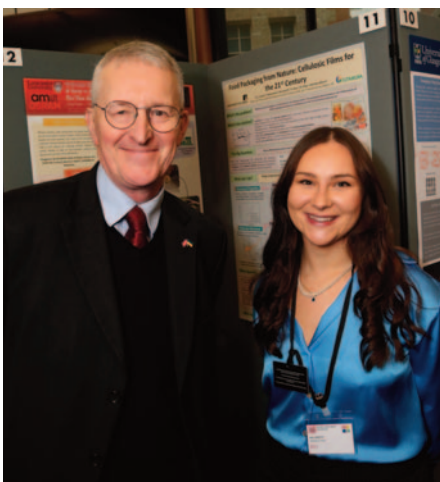
L-R: Ana Lourenco, National Physical Laboratory, BRONZE; Alex Gresty, University of Leeds, GOLD; Laura Hanks, Lancaster University, SILVER



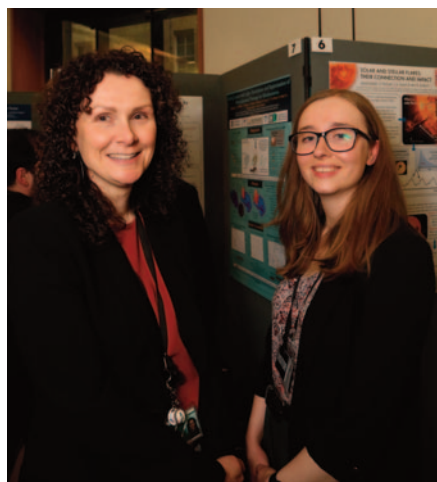
Manuel Morales Alvarado, Helen Leung (*Chemistry*), Daniel Zeichner MP and Luca Mantani



Dr Toni Lilly, Paul Sagoo and Colin Danson, representing AWE, sponsors of the Physics prizes



Hilary Benn MP and Alex Gresty



Wendy Chamberlain MP and Lauren Doyle



Cat Smith MP and Laura Hanks

All photographs John Deehan Photography

THE DYSON AWARD for outstanding research toward a more sustainable future



L-R: Stephen Metcalfe MP; Paul Whittaker, Dyson; Julia A. Meister, University of Brighton, 3rd PRIZE; Luke Woodliffe, University of Nottingham, 1st PRIZE; Alex Gresty, University of Leeds, 2nd PRIZE; Nichola Clifton, Dyson; Viscount Stansgate



Doris-Ann Williams MBE, Chair STEM Organising Committee, and Helen Tucker, Chair, BIVDA, sponsors of the Biosciences GOLD prize



Carol Monaghan MP, Viscount Stansgate, Stephen Metcalfe MP, and Prof Julie Lovegrove, President of the Nutrition Society



Amanda Solloway MP



Sue Wharton and Stephen Metcalfe MP



Greg Clark MP, Chair of the House of Commons Science & Technology Select Committee

All photographs John Deehan Photography



HOUSE OF COMMONS SELECT COMMITTEES

BUSINESS, ENERGY AND INDUSTRIAL STRATEGY COMMITTEE

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

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

Membership:

Darren Jones MP, Labour, Chair
Bif Aflolami MP, Conservative
Alan Brown MP, Scottish National Party
Ruth Edwards MP, Conservative
Jane Hunt MP, Conservative
Mark Jenkinson MP, Conservative
Ian Lavery MP, Labour
Andy McDonald MP, Labour
Charlotte Nichols MP, Labour
Mark Pawsey MP, Conservative
Alexander Stafford MP, Conservative

Current Inquiries:

- Post-pandemic economic growth: State Aid and Post Brexit Competition Policy. Opened 23rd September 2021. Report published 25th October 2022. Government response published 10th February 2023.
- Energy National Policy Statements. Opened 3rd November 2021. Published 25th February 2022.
- Energy Pricing and the future of the Energy Market. Opened 8th December 2021. Written evidence. Deadline 31st January 2022. Report published 26th July 2022. Government response published 13th October 2022.
- Decarbonisation of the power sector. Opened 20th May. Deadline 30th June 2022
- The Semiconductor Industry in the UK. Opened 25th May 2022. Report published 3rd February 2023.
- Post-pandemic economic growth: UK labour markets. Opened 27th May 2022.
- The work of the Investment Security Unit. Opened 15th June 2022.
- Batteries for electric vehicle manufacturing. Opened 17th January 2023.

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

ENVIRONMENTAL AUDIT COMMITTEE

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

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

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

Membership:

Rt Hon Philip Dunne MP, Conservative, Chair
Duncan Baker MP, Conservative
Sir Christopher Chope MP, Conservative
Barry Gardiner MP, Labour
James Gray MP, Conservative
Ian Levy MP, Conservative
Clive Lewis MP, Labour
Caroline Lucas MP, Green Party
Cherilyn Mackrory, Conservative
Jerome Mayhew MP, Conservative
Anna McMorrin MP, Labour
John McNally MP, Scottish National Party
Dr Matthew Offord MP, Conservative
Rt Hon Chris Skidmore MP, Conservative
Cat Smith MP, Labour
Claudia Webbe MP, Independent

Current Inquiries

- Biodiversity and Ecosystems – Opened 13th July 2020. Report published 30th September 2021.
- Fixing Fashion follow up – Opened 6th October 2020
- Water Quality in Rivers – Opened 8th December 2020. Published 13th January 2022. Government response published 30th September 2022.
- Sustainability of the built environment – Opened 25th March 2021. Report published 26th May 2022.
- Mapping the path to net zero: Opened 25th June 2021.
- Net zero aviation and shipping: Opened 20th July 2021.
- Carbon border adjustment mechanism: Opened 24th September 2021. Published 4th April 2022.
- Technological Innovations and Climate Change: Negative emissions and Technologies – Opened 28th September 2021.
- Aligning the UK's economic goals with environmental sustainability Opened 29th November 2021.

- Technological Innovations and Climate Change: Green Steel. Opened 3rd February 2021.
- Accelerating the transition from fossil fuels and securing energy supplies. Opened 31st March 2022. Report published 5th January 2023.
- The financial sector and the UK's net zero transition. Opened 30th May 2022. Deadline 30th June 2022.
- Technological innovations and Climate Change: Geothermal Technologies. Opened 16th June 2022. Deadline 21st July 2022.
- Sustainable timber and deforestation. Opened 25th July 2022. Closed 8th September 2022.
- Technological Innovations and climate change: onshore solar energy. Opened 3rd November 2022.
- Environmental Change and Food Security. Opened 10th November 2022.

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

SCIENCE AND TECHNOLOGY COMMITTEE

For further details: Tel: 020 7219 2793
Email: scitechcom@parliament.uk

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

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

Membership:

Rt. Hon Greg Clark MP, Conservative, Chair
Aaron Bell MP, Conservative
Dawn Butler MP, Labour
Chris Clarkson MP, Conservative
Tracey Crouch MP, Conservative
Katherine Fletcher MP, Conservative
Rebecca Long-Bailey MP, Labour
Stephen Metcalfe MP, Conservative
Carol Monaghan MP, Scottish National Party
Graham Stringer MP, Labour
Christian Wakeford MP, Conservative

Current Inquiries

- The role of technology, research and innovation in the COVID-19 recovery. Opened 24th July 2020.
- The Role of Hydrogen in Achieving Net Zero. Opened 4th December 2020. Report published 4th November 2022.
- UK space strategy and UK satellite infrastructure. Opened 23rd April 2021. Report published 4th November 2022.

- Reproducibility and research integrity. Opened 22nd July 2021. Closed 30th September 2021.
- Diversity and inclusion in STEM. Opened 22nd November 2021.
- The right to privacy: digital data. Opened 16th December 2021.
- My science inquiry. Opened 12th July 2022. Report published 8th November 2022.
- Delivering Nuclear Power. Opened 19th July 2022. Deadline 30th September 2022.
- Governance of artificial intelligence (AI). Opened 20th October 2022.
- The antimicrobial potential of bacteriophages. Opened 9th November. Deadline 20th January 2023.
- Emerging diseases and learnings from covid-19. Opened 15th December 2022. Deadline 31st March.
- Commercialising quantum technologies. Opened 16th March 2023. Accepting submissions.
- Insect decline and food security. Opened 20th March 2023. Deadline 28th April 2023.

HEALTH AND SOCIAL CARE COMMITTEE

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

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

Membership:

Steve Brine MP, Conservative, Chair
Lucy Allan MP, Conservative
Paul Blomfield MP, Labour
Paul Bristow MP, Conservative
Martyn Day MP, Scottish National Party
Chris Green MP, Conservative
Paulette Hamilton MP, Labour
Dr Caroline Johnson MP, Conservative
Rachael Maskell MP, Labour
James Morris MP, Conservative
Taiwo Owatemi MP, Labour

Current Inquiries

- NHS litigation reform: Opened 22nd September 2021. Report published 28th April 2022.
- Workforce: recruitment, training and retention in health and social care – Opened 23rd November 2021. Report published 25th July 2022.
- Digital transformation in the NHS. Opened 13th May 2022.
- Integrated Care Systems: autonomy and accountability. Opened 6th July 2022.

- IMMDS Review follow-up one off session. Opened 1st September 2022.
- Assisted dying/assisted suicide. Opened 5th December 2022. Deadline 20th January 2023.
- NHS Dentistry. Opened 7th December 2022. Deadline 25th January 2023.

- Prevention in health and social care. Opened 18th January 2023.
- Future cancer. Opened 21st March 2023. Deadline 26th April 2023.

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



HOUSE OF LORDS SELECT COMMITTEES

SCIENCE AND TECHNOLOGY COMMITTEE

The Science and Technology Committee has a broad remit “to consider science and technology”. It is chaired by Baroness Brown of Cambridge

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

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

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

Members:

The Baroness Brown of Cambridge DBE FREng FRS, Crossbench, Chair

The Lord Borwick, Conservative

Viscount Hanworth, Labour

The Lord Holmes of Richmond MBE

The Lord Krebs, Crossbench

The Lord Mitchell, Labour

The Baroness Neuberger, Crossbench

The Baroness Neville-Jones, Conservative

The Baroness Northover, Liberal Democrat

The Lord Rees of Ludlow OM

The Lord Sharkey, Liberal Democrat

The Baroness Warwick of Undercliff, Labour

The Lord Wei, Conservative

The Lord Winston, Labour

CURRENT INQUIRIES

Delivering a UK science and technology strategy. Report published 4th August 2022. Government response published 6th March 2023.

People and skills in UK science, technology, engineering and mathematics. Opened 20th July 2022.

Clinical academics in the NHS. Opened 18th November 2022.

The effects of artificial light and noise on human health. Opened 30th January 2023.

For further details: Tel: 020 7219 5750

Email: hlsience@parliament.uk



PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY (POST)

SPRING 2023

The Parliamentary Office of Science and Technology (POST) works to bring the best available research evidence to bear on the legislative process and scrutiny of Government.

RECENT PUBLISHED WORK

POST research is published on our website. POSTnotes produced since December 2022 were:

- 692: Digital technology in freight
- 691: Urban outdoor air quality
- 690: Biomass for UK energy
- 689: Invisible Disabilities in Education and Employment
- 688: Longer duration energy storage

POST has also produced a Rapid Response:

- Immunity to Covid-19: March 2023 update

Ongoing and future projects approved by the POST Board

Over coming months, POST will work on a range of projects, including:

- Marine protected and highly protected marine areas
- Skills for Data Science and Artificial Intelligence (AI)
- Trust in the Police
- One Health approach to climate change
- Problem-solving courts
- Determinants of Distress Associated with Gender Identity
- Free School Meals and Child Poverty
- Indoor Air Quality
- Reforming the mental Health Act – Approaches to Improve Patient Choice
- Local Area Energy Planning
- Environmental impact of and risks for the food production system
- Hormone Treatments for Children with Gender Dysphoria
- Low-carbon hydrogen use
- GB Plant biosecurity
- Electricity Market Reform
- Hypersonic missiles
- Online Advertising Technologies

THE POST BOARD

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

Officers

Chair: Adam Afriyie MP

Vice-Chair: Professor the Lord Winston, FMedSci, FRSA, FRCP, FRCOG, FEng

House of Commons

Rt Hon Greg Clark MP

Katherine Fletcher MP

Stephen Metcalfe MP

Maria Miller MP

Carol Monaghan MP

Dr Ben Spencer MP

Alan Whitehead MP

House of Lords

Baroness Brown of Cambridge

Lord Haskel

Lord Ravensdale

Non-parliamentary

Professor Elizabeth Fisher, FMedSci

Paul Martynenko, FBCS

Professor Sir Bernard Silverman, FRS, FAcSS

Professor Dame Sarah Whatmore, FBA

Ex-officio

Oliver Bennett MBE, Head of the Parliamentary Office of Science and Technology

Grant Hill-Cawthorne, House of Commons Librarian and Managing Director of Research & Information

Ariella Huff, Select Committee Team, House of Commons

Xameerah Malik, Head of Science and Environment Section, House of Commons Library

Nicolas Besly, Clerk of Select Committees, House of Lords

Head of POST

Oliver Bennett MBE

PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY

Houses of Parliament

Westminster

London SW1A 0AA



HOUSE OF COMMONS LIBRARY

The House of Commons Library is an impartial research and information service for Members of Parliament of all parties and their staff. The Science and Environment Section (SES) is one of eight teams in the Research Service in the House of Commons Library.

The Library provides confidential, impartial and bespoke briefing to Members of the House of Commons and their offices supporting the full range of parliamentary work, from policy development to constituency issues. Members and their staff can request briefing by visiting the Member's Library in the Palace or by emailing HCLibrary@parliament.uk. SES has recently provided confidential briefings to MPs on a wide range of issues including energy, planning law, health, environment, water quality, telecommunications and animal welfare.

The Library also publishes a range of products including topical research briefings, shorter insight articles and briefings for non-legislative debates, all of which are available online for MPs and the public. These briefings include analysis of all major pieces of legislation. You can find publications on the Commons Library website (<https://commonslibrary.parliament.uk>) where you can also sign up for alerts.

In recent months, SES has published and updated briefings on issues including:

Electricity Transmission (Compensation) Bill 2022-23: Progress of the Bill

Published Tuesday, 21 February, 2023, CBP 9674

This briefing paper provides information on the Electricity Transmission (Compensation) Bill, introduced in the House of Commons by Dr Liam Fox as a Private Members' Bill on 25 November 2022. The Electricity Transmission (Compensation) Bill, Bill 234 of 2022-23, aims to promote the use of alternative dispute resolution (ADR) procedures to resolve disputes that may arise when network operators acquire private land to put up infrastructure to transmit electricity out of court.

Is planning permission required to house asylum seekers in hotels?

Published Friday, 17 February, 2023, Insight article

The number of people seeking asylum in the UK who require accommodation has increased in recent years. Accommodation providers contracted by the Home Office have been booking hotels while they look for longer-term options to house people. Recent court cases have looked at whether housing asylum seekers in hotels requires planning permission from the local authority. This Insight discusses when planning permission is needed and the result of these cases.

Green Belt

Published Tuesday, 07 February, 2023, CBP 00934

This briefing examines Green Belt planning policy and some of the recent discussions around the Green Belt. It applies only to England.



The fundamental aim of Green Belt policy is to prevent urban sprawl by keeping land permanently open. It is for local authorities to define and maintain Green Belt land in their local areas. The Government expects local planning authorities (LPAs) with Green Belts to establish Green Belt boundaries in their Local Plans, which can be altered as part of the plan review process.

Brownfield development and protecting the Green Belt

Published Monday, 06 February, 2023, CDP 2023/0035

A debate pack prepared ahead of a debate on brownfield development and protecting the Green Belt in Westminster Hall on Thursday 9 February 2023. The Government's National Planning Policy Framework (NPPF) provides a framework against which local plans are drawn up and planning applications are decided. It defines brownfield land as "land which is or was occupied by a permanent structure". Because planning is a devolved matter, this briefing only describes the situation in England.

Planning policy

Published Tuesday, 24 January, 2023, CDP 2023/0002

A debate pack prepared ahead of a Westminster Hall debate on planning policy on Thursday 26 January 2023. The subject for the debate was selected by the Backbench Business Committee. Information on current planning policy and proposed changes is set out on this page. It applies only to England as planning is a devolved matter.

The 2012 Alcohol Strategy for England

Published Friday, 13 January, 2023

A debate pack prepared ahead of a Westminster Hall debate on Wednesday 18 January on the Government's Alcohol Strategy (2012). The Government's most recent Alcohol Strategy was published in March 2012 by the Conservative and Liberal Democrat coalition government. It set out concerns about the availability of low-cost alcohol, related anti-social behaviour and excessive drinking at home. This pack contains information on policy and statistics on alcohol.

The use of antibiotics on healthy farm animals and antimicrobial resistance

Published Tuesday, 17 January, 2023, CDP 2023/0012

A debate pack prepared ahead of a Westminster Hall debate on 18 January 2023 on the use of antibiotics on healthy farm animals and antimicrobial resistance. Antimicrobial resistance (AMR) occurs when infectious agents (bacteria, viruses, fungi and parasites) evolve over time and acquire new characteristics which reduce or stop their susceptibility to antimicrobials. This makes infections harder to treat, easier to spread and more likely to cause severe illness and death. The inappropriate and excessive use of antimicrobials contributes to the development of AMR. This pack contains more information on concerns and policy about the use of antibiotics, as well as Parliamentary material and useful links.

NHS hysteroscopy treatment

Published Tuesday, 31 January, 2023, CDP 2023/0024

A debate pack prepared ahead of a Westminster Hall debate on Tuesday 31 January on NHS hysteroscopy treatment. This debate pack contains background about the procedure as well as information on the RCOG guideline on Best Practice in Outpatient Hysteroscopy, Government policy and recent Parliamentary material.

National HIV Testing Week 2023

Published Wednesday, 01 February, 2023, CDP 2023/0028

A debate pack prepared ahead of a Westminster Hall debate on Wednesday 8 February for National HIV Testing Week 2023. National HIV Testing Week is HIV Prevention England's flagship annual event. It seeks to promote regular HIV testing among the most-affected population groups in England.

What was agreed at COP27?

Published Thursday, 05 January, 2023, Insight article

What new developments came from COP27 and how were they received by the international community?

Independent Review of Net Zero

Published Wednesday, 08 February, 2023, CDP 2023/0036

A debate pack prepared ahead of a debate on Thursday 9 February on the Independent Review of Net Zero. On 13 January 2023, the Department for Business, Energy & Industrial Strategy (BEIS) published Mission Zero: Independent Review of Net Zero. The review was commissioned by the Secretary of State for BEIS in September 2022.

The use of bee-killing pesticides in agriculture

Published Monday, 30 January, 2023, CDP 2023/0025

A debate pack prepared ahead of a Westminster Hall debate on Wednesday 1 February on the use of bee-killing pesticides in agriculture. Until the UK left the EU, pesticides policy was decided at an EU level. The legislation governing the placement of pesticides on the market is Regulation (EC) No 1107/2009. Under the Northern Ireland Protocol, Northern Ireland is still subject to these EU regulations, while Great Britain (England, Wales and Scotland) now operates a separate regime that began 1 January 2021. Great Britain is therefore able to diverge from EU decisions when it comes to pesticide approval. However, Regulation (EC) No 1107/2009 remains part of EU Retained Law and its provisions still apply.

Genetic Technology (Precision Breeding) Bill 2022-23

Published Thursday, 02 March, 2023, CBP 9557

A briefing on the Genetic Technology (Precision Breeding) Bill 2022-23. The May 2022 Queen's Speech [PDF] said the Bill's aims are to "encourage agricultural and scientific innovation" in the UK" and that "legislation will unlock the potential of new technologies to promote sustainable and efficient farming and food production." The Bill applies to precision bred plants and vertebrate animals (excluding humans), meaning they are gene edited, and would remove them from the regulatory system for genetically modified organisms (GMOs).

Farm funding: implementing new approaches

Published Wednesday, 15 March, 2023, CBP 9431

The Government has committed to maintaining pre-Brexit UK farm funding levels for this Parliament, but under new types of support schemes in England. From 2021-27, CAP-style 'direct payments' based on how much land is farmed are being phased out. Farmers and land managers will in future be paid to produce 'public goods' such as environmental and animal health improvements under Environmental Land Management and other new schemes.

Energy support for farms

Published Monday, 20 March, 2023, CDP 2023/0072

A debate pack prepared ahead of a Westminster Hall debate on Tuesday 21 March on energy support for farms.

The Government introduced a series of support schemes in 2022 and 2023 to help customers with rising energy prices. It did not introduce specific support for farms, but farms can access the general support available to non-domestic customers, summarised on this page. Detailed information about each scheme is provided in the Library briefing Constituency casework: Government support for energy bills published 20 March 2023.

Digital telephone switchover

Published Tuesday, 17 January, 2023, CBP 9471

This briefing addresses frequently asked questions about the switch of landline phones to digital services. Over the next few years, landline telephone services will switch to a fully digital network. This means phone calls will be carried over the internet.

Regulation of customer credit retained by energy suppliers

Published Tuesday, 21 February, 2023, CDP 2023/0040

A debate pack prepared ahead of a Westminster Hall debate on Wednesday 22 February on regulation of customer credit retained by energy suppliers. This pack contains information on Ofgem's rules on credit balances, the issues associated with credit balances and recent proposals for reform, as well as recent Parliamentary material and news items.

Performance of South West Water

Published Thursday, 23 February, 2023, CDP 2023/0029

A debate pack prepared ahead of a Westminster Hall debate on Tuesday 28 February on the performance of South West Water. This pack contains information on Government policy on water companies' performance, performance measures and ratings, special performance measures, and water bills, as well as recent Parliamentary material and news items.

Debate on an e-petition on road traffic collisions and cats

Published Thursday, 05 January, 2023, CDP 2022/0246

A debate pack prepared ahead of a debate in Westminster Hall on 9 January 2023 on an e-petition relating to requirements to stop and report road traffic collisions involving cats. The subject for the debate was chosen by the Petitions Committee. The petition calling for the Government to make it a legal requirement for drivers to stop & report collisions with cats in England has received 102,436 signatures. It calls for Section 170 of the Road Traffic Act 1988 to be amended so that cats are included in the list of animals reported to the police in road traffic collisions.

Debate on an e-petition on the use of snares

Published Thursday, 05 January, 2023, CDP 2022/0247

A debate pack prepared ahead of a Westminster Hall debate on 9 January 2023 on an e-petition concerning the use of snares. The subject for the debate was chosen by the Petitions Committee. E-petition 600593 calling for the use of free-running snares for trapping wildlife to be made illegal in England has received 102,616 signatures. In its response to the petition in January 2022 the Government set out existing legislation which bans self-locking snares, regulates how free-running snares are used and more general animal welfare legislation. It also acknowledged concerns about animal welfare and highlighted that it would be issuing a call for evidence on the use of free running snares in due course. Snares that lock tight when sprung are already banned.

Debate on an e-petition relating to commercial breeding for laboratories

Published Friday, 13 January, 2023, CDP 2023/0008

A debate pack prepared ahead of a Westminster Hall debate on 16 January 2023 on an e-petition relating to commercial breeding for laboratories. The subject for the debate was chosen by the Petitions Committee. The petition calls for all establishment licences for commercial breeders of animals to be revoked. It also calls for amendments to the Animals (Scientific Procedures) Act 1986 (ASPA). Firstly, for the 3Rs principle (replace, reduce, refine) set out in Section 2A of the Act to be replaced with legislation focused on the use of non animal methods for scientific research and testing.

Shark Fins Bill 2022-23

Published Wednesday, 18 January, 2023, CBP 9591

The Shark Fins Bill, which would ban the import and export of shark fins, was introduced as a Private Members Bill by Christina Rees. It had its Second Reading in the House of Commons on 15 July 2022 and its Report Stage in the Commons on 20 January 2023.

Climate change and biodiversity

Published Wednesday, 08 February, 2023, CDP 2023/0033

A debate pack prepared ahead of a Westminster Hall debate on Wednesday 8 February on climate change and biodiversity. This is a brief overview of climate change and biodiversity policy, including recent international developments, provided as background for the debate.

e-petition debate on the open season of woodcock

Published Friday, 24 February, 2023, CDP 2023/0041

A debate pack prepared ahead of a Westminster Hall debate on Monday 27 February on the open season of woodcock. The subject for the debate was chosen by the Petitions Committee. A petition

introduced by UK wildlife charity, Wild Justice, calling for a shorter shooting season for woodcock, a native bird, will be debated in Westminster Hall on 27 February 2023. The petition which has received 107,916 signatures calls for the season across the UK to start on 1 December, rather than 1 September in Scotland and 1 October in the rest of the country.

Shellfish aquaculture

Published Wednesday, 15 March, 2023, CDP 2023/0066

A debate pack prepared ahead of a Westminster Hall debate on Wednesday 15 March on shellfish aquaculture. Shellfish exports from the UK to the EU have been affected by restrictions on imports from third countries (which the UK is classified as since leaving the EU). These do not allow the import to the EU of bivalve molluscs unless they are harvested from areas with the cleanest water classification or have been purified (or deputed) prior to export. This restriction did not apply to the UK when it was a Member State.

Hunting Trophies (Import Prohibition) Bill 2022-23

Published Thursday, 16 March, 2023, CBP 9684.

The Hunting Trophies (Import Prohibition) Bill's remaining stages in the Commons took place on 17 March 2023. It was a Private Member's Bill introduced by Henry Smith MP. The Bill has Government support and will ban the import of hunting trophies from species of conservation concern.

Animals (Low-Welfare Activities Abroad) Bill

Published Thursday, 16 March, 2023, CBP 9720

The Animals (Low-Welfare Activities Abroad) Bill was a Private Member's Bill put forward by Angela Richardson, and had Government support. Remaining stages of the Bill in the House of Commons took place on 17 March 2023. There have been number of long-running campaigns to raise awareness about the negative welfare implications of some activities involving close encounters with wild animals outside the UK, and which are available to those who live in the UK when travelling abroad. Activities that animal welfare campaigners have raised concerns about include elephant rides, dolphinariums and close encounters with big cats.

Electric vehicles and infrastructure

Published Tuesday, 21 February, 2023, CBP 7480

This briefing paper provides an overview of the transition to zero emission vehicles, including the policies and investments the Government is using to support this transition and some of the key challenges ahead.

Constituency casework: help with energy bills for businesses, voluntary sector and public sector organisations

Published Monday, 20 March, 2023, CBP 9692

This briefing provides a guide to reliable sources of information to help answer common questions on support with energy bills for non-domestic customers, including businesses, public sector organisations and charities.

Constituency casework: Government support for energy bills

Published Monday, 20 March, 2023, CBP 9685

This paper answers FAQs on new government support schemes for energy bills, including: the Energy Price Guarantee, Energy Bills Support Scheme, Energy Bills Discount Scheme, Energy Bill Relief Scheme and Alternative Fuel Payments.

Tackling the energy trilemma

Published Tuesday, 21 March, 2023, CDP 2023/0074

A debate pack prepared ahead of a debate in the Commons Chamber on Thursday 23 March on tackling the energy trilemma. The subject for the debate was chosen by the Backbench Business Committee. The 'energy trilemma' encompasses: the cost of energy; energy security; and decarbonising energy.

Sudden unexplained death in childhood

Published Monday, 16 January, 2023, CBP 2023/0013

A debate pack prepared ahead of a debate on Tuesday 17 December in Westminster Hall on Sudden Unexplained Death in Childhood. The term 'sudden unexplained death in childhood' (SUDC) is typically used to describe the death of a child, aged between 1 and 17 years, who died suddenly and whose death remains unexplained despite a detailed investigation. "Sudden Infant Death Syndrome" (SIDS) is the term used to describe the "sudden, unexpected and unexplained death of an apparently healthy baby" aged under 12 months. This short briefing focuses on SUDC and highlights where further information on the matter can be found.

Impact of Cystic Fibrosis on living costs

Published Tuesday, 31 January, 2023, CBP 2023/0026

A debate pack prepared ahead of a Westminster Hall debate on Thursday 2 February on the Impact of Cystic Fibrosis on living costs support. This briefing contains background information, parliamentary and press material, as well as suggested further reading.

Abortion in Northern Ireland: recent changes to the legal framework

Published Monday, 06 February, 2023, CBP8909

This Commons Library briefing paper provides an overview of recent changes to the law on abortion in Northern Ireland. It covers the changes that were introduced by the Northern Ireland (Executive Formation etc) Act 2019, as well as the Abortion (Northern Ireland) Regulations 2020, 2021 and 2022.

Coronavirus: Covid-19 booster vaccines frequently asked questions

Published Wednesday, 08 February, 2023, CBP9332

This Commons Library briefing addresses commonly asked questions about the roll-out of the Covid-19 booster vaccine.

Brain tumour research funding

Published Tuesday, 07 March, 2023, CDP 2023/0057

A debate pack prepared ahead of a debate in the Commons Chamber on Thursday 9 March on brain tumour research funding. The subject for the debate was chosen by the Backbench Business Committee. Information

about funding for brain tumour research, and the APPG on Brain Tumours recent report, are provided in this briefing, together with parliamentary and press material on the topic.

National no smoking day

Published Tuesday, 07 March, 2023, CDP 2023/0056

A debate pack prepared ahead of a Westminster Hall debate on Thursday 9 March for National no smoking day. National no smoking day has occurred annually since 1984 and is aimed at those who are looking to quit smoking. This year, the theme for no smoking day is "stopping smoking improves your brain health" and is supported by Alzheimer's Research UK.

Patients with rare diseases

Published Wednesday, 08 March, 2023, CDP 2023/0055

A debate pack prepared ahead of a Westminster Hall debate on Thursday 9 March on patients with rare diseases. A rare disease is generally considered as one affecting fewer than 5 people in 10,000. While the occurrence of individual rare diseases is low, it has been estimated that around 3.5 million people in the UK are living with one of over 7,000 rare diseases, such as muscular dystrophies or Huntington's disease. Rare diseases also disproportionately affect children; according to the Department of Health and Social Care "75% of rare diseases affect children and more than 30% of children with a rare disease die before their fifth birthday".

World Down Syndrome Day

Published Tuesday, 21 March, 2023

A debate pack prepared ahead of a debate for World Down Syndrome Day on Thursday 23 March. This debate pack provides background information on the Down Syndrome Act 2022 and the current rights and duties covering people with Down's syndrome. ■



SCIENCE DIRECTORY

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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.



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.

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



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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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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.



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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 is the leading UK charity organisation representing scientists and clinicians who study the immune system in humans or animals. As a membership organisation, we act as a focal hub for the immunology community, supporting and empowering immunologists working in academic, industry and clinical settings to drive forward scientific discovery and application together.



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The British Society of Animal Science (BSAS), the principal body for animal science in the UK, was established in 1944. We work globally with members and partners to shape the future of animal science, supporting the advancement of responsible, environmentally and economically sustainable animal production, addressing issues such as the role of animal science in resolving the world's food crisis. BSAS disseminates research findings to ensure practical and beneficial application of positive outcomes to include livestock, animal health and welfare, the care of equine, companion, and zoo animals.

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**BRITISH SOCIETY
OF SOIL SCIENCE**

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

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



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

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**Cavendish
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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:

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Trust**



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

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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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The Geological Society of London is the UK's national society for geoscience, providing support to 12,000 Fellows (members) worldwide.

The Fellowship encompasses those working in industry, academia and government, with a wide range of expertise on policy-relevant science, and the Society is a leading communicator of this science to government bodies and other non-technical audiences.

The Society aims to be an inclusive and thriving Earth science community advancing knowledge, addressing global challenges, and inspiring future generations.



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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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www.InnovationInstitute.org.uk

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.

Institute of Measurement and Control



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Registration Charity number: 269815

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

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

SCIENCE DIRECTORY

IOP Institute of Physics

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

IPEM Institute of Physics and Engineering in Medicine

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Physicists, engineers and technologists play vital roles in delivering our healthcare. The Institute of Physics and Engineering in Medicine (IPEM) is the professional organisation that represents this diverse workforce. We are a charity with more than 4,600 members drawn from healthcare, academia and industry.

Our Mission is Improving Health through Physics and Engineering in Medicine. Our vision is one in which professionalism drives improvements in diagnosis, treatment and care, transforming the lives of patients.

Our members, the professional community of medical physicists, biomedical engineers and clinical technologists working in hospitals, academia and industry around the world are the people who make it happen. We work to support them through professional development, community and leadership services and initiatives. IPEM is licensed by the Science Council to award CSci, RSci and RSciTech, and by the Engineering Council to award CEng, IEng and EngTech.

IChemE ADVANCING CHEMICAL ENGINEERING WORLDWIDE

The Institution of Chemical Engineers

The Institution of Chemical Engineers (IChemE) advances chemical engineering's contribution worldwide for the benefit of society. We support our members in applying their expertise and experience to help address the Sustainable Development Goals.

We are the leading professional qualifying body for chemical, biochemical and process engineers, and are the only organisation worldwide to award Chartered Chemical Engineer status.

We support the development of chemical engineering professionals, and provide connections to a powerful network of over 29,000 members in more than 100 countries.

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IET The Institution of Engineering and Technology

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



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LGC is a leading global life science tools company, providing genomics and quality assurance solutions into high growth application areas within human healthcare and applied market segments. Our core purpose is Science for a Safer World.

Our 180 years of scientific heritage, combined with a focus on innovation and value-enhancing acquisitions, has enabled us to build a highly valued product portfolio, and to closely collaborate with our customers, partners and the global scientific community.

As the UK Government Chemist www.gov.uk/government/organisations/government-chemist, LGC acts as the referee analyst and advises Government and the wider analytical community on analytical measurement matters for policy, standards and regulation.

LGC is also the UK's National Measurement Laboratory for chemical and bio-measurement, finding solutions to fundamental and emerging measurement challenges, driving innovation, productivity and economic growth.

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.

The LINNEAN SOCIETY of London



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

A Forum for Natural History

Marine Biological Association



Est. 1884
Incorporated by
Royal Charter 2013

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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.

SCIENCE DIRECTORY



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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 has a worldwide membership based in universities, industry, hospitals, research institutes, schools, and other organisations.

Our members have a unique depth and breadth of knowledge about the discipline. The Society's role is to help unlock and harness the potential of that knowledge.

Our principal goal is to strengthen our culture of being a community-driven Society by amplifying our members' voices, wherever they are in the world, and empowering them to embed the benefits of microbiology within wider 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
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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.

SCIENCE DIRECTORY

QUADRAM INSTITUTE



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The £75m Quadrant Institute opened in 2019 and is focused on fundamental and translational research into the interfaces between the gut microbiome, food, and human health. The Quadrant Institute combines leading-edge bioscience capabilities with NHS endoscopy, clinical trials and biobank facilities. The Quadrant Institute is a partnership between the Norfolk and Norwich University Hospital, University of East Anglia, Quadrant Institute Bioscience and BBSRC.



Royal Academy of Engineering

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



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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 SOCIETY

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



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



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

Applied Microbiology International

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Applied Microbiology International 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, AMI 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

SCIENCE DIRECTORY

Society of Cosmetic Scientists



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

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



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



THE SOCIETY FOR RADIOLOGICAL PROTECTION

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The Society for Radiological Protection is the principal independent professional body for radiation protection in the UK. Its members operate in the fields of medicine, the nuclear power cycle and other industries, research, and teaching. We offer a profession-wide view to regulators and are involved in training and educational outreach. We ensure that professional standards are maintained at the highest levels.



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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.



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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.

Universities Federation for Animal Welfare



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The Universities Federation for Animal Welfare (UFAW) is an international independent scientific and educational animal welfare charity and membership society.

UFAW's vision is a world where the welfare of all animals affected by humans is maximised through a scientific understanding of their needs and how to meet them. We promote an evidence-based approach to animal welfare by funding scientific research, helping develop the next generation of animal welfare scientists and sharing animal welfare science knowledge with both experts and the wider public.



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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.

Non-Corporate services include membership and registration, education, training and certification for internationally recognised professional development and personnel competence assurance.

TWI provides Members and stakeholders with authoritative and impartial expert advice, knowhow and safety assurance through engineering, materials and joining technologies.

SCIENCE DIARY

PARLIAMENTARY AND SCIENTIFIC COMMITTEE – ALL-PARTY PARLIAMENTARY GROUP

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FORTHCOMING DISCUSSION AND OTHER MEETINGS

Monday 24th April Discussion Meeting on Measurement of Time

In partnership with the National Physical Laboratory
5.15pm to 6.45pm, ONLINE meeting

Tuesday 25th April Annual General Meeting and Reception

Speaker: Baroness Brown of Cambridge, Chair, House of Lords Science & Technology Select Committee
5.00pm to 6.30pm, Palace of Westminster

Monday 22nd May Discussion Meeting The Deep Tech SME Ecosystem - Supporting research-intensive SMEs to maximise their contribution to economic recovery

In partnership with the Royal Society of Chemistry
5.15pm to 6.45pm, Palace of Westminster

Monday 12th June Discussion Meeting Making things – sustainably In partnership with the Warwick Manufacturing Group (WMG)

5.15pm to 6.45pm, Palace of Westminster

Tuesday 4th July
Annual Luncheon
12.30pm to 2.00pm
Cholmondeley Room, House of Lords

Monday 10th July
Discussion Meeting with the STEM for
BRITAIN Gold Medalists
5.15pm to 6.45pm, Palace of Westminster

ROYAL SOCIETY OF BIOLOGY

For further details please contact
events@rsb.org.uk

ROYAL SOCIETY OF CHEMISTRY

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events@rsc.org

ROYAL SOCIETY

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

invites you to

Parliamentary Links Day 2023

Science and Economic Development

Tuesday 20 June 2023 | 09:00-13:00

The Attlee Suite, Portcullis House, Houses of Parliament, London SW1A 2LW

Register at: www.rsb.org.uk/LinksDay23



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