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

SCIENCE IN PARLIAMENT sip

SUMMER 2023

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

A warm welcome to our Summer edition.

Since the Spring issue, I have been very pleased to chair three excellent discussion meetings, in partnership, respectively, with the National Physical Laboratory, the Royal Society of Chemistry and the Warwick Manufacturing Group. We are grateful to each for supporting these events.

I was delighted to welcome guests to our Annual Lunch in the Cholmondeley Room, House of Lords, on the 4th July, kindly hosted by our President, Stephen Benn, Viscount Stansgate, and thank our distinguished speaker Lord Krebs of Wytham for his excellent speech.

My congratulations also to Stephen on his election to the House of Lords Science and Technology Select Committee.

At the Annual General Meeting in May, we were delighted to have as our guest speaker, Dame Julia King, Baroness Brown of Cambridge, Chair of the Lords' Science and Technology Committee. My thanks to fellow elected Officers, Vice Presidents, the Council and all members of P&SC for their support.

A warm welcome to our new Honorary Member, Oliver Bennett MBE, Chief Executive of the Parliamentary Office of Science and Technology (POST).

I was also pleased to sponsor the Annual Parliamentary Links Day on the 20th June. As always a superb event, organised by the Royal Society of Biology on behalf of the STEM community.

Beyond the Summer Recess, we look forward to the Autumn and early Winter meetings and I thank Carol Monaghan MP for chairing the Programme Committee, which has now agreed themes for the first half of part of 2024.

Also in the planning stages is the Christmas Parliamentary Science Reception, which will be organised for the first time by P&SC, in conjunction with a number of Learned Societies members.

Preparations are already underway for the 27th annual STEM for BRITAIN which takes place on Monday 4th March. We will launch the 2024 competition for Early Career Researchers in Parliament on Monday 18th September, just prior to the first of our Autumn series of discussion meetings, which will appropriately be in partnership with Northumbria and Newcastle Universities.

The closing date for submissions is Monday 27th November.

At the time of publication we were about to celebrate our five 2023 STEM for BRITAIN Gold winners, Devon Crouch (Biosciences and the Westminster Medal); Alex Gresty (Physics), Bea Jones (Chemistry), Yogesh Ramathapuram Nagarajan (Engineering) and Arkady Wey (Mathematics) at a special discussion meeting in Parliament. Congratulations to them all!

My thanks to the P&SC Team led by Leigh Jeffes. David Youdan has done an excellent job in his first year as Administration and Programme Manager and I am delighted to welcome back Karen Smith who has agreed to take on a number of tasks, in support of Leigh and David, including finance and membership, together with Dr Isabel Spence and all her work on STEM for BRITAIN, Ben Allen for expertly managing the website, and Alfie Hoar for writing up excellent meeting reports. We wish Alfie well in his finals at Oxford.

It is my pleasure to welcome three members who have joined P&SC in recent months: Newcastle University, the Warwick Manufacturing Group and Dr Adrienn Tomor, from University College London. I am also delighted that Lord Robert Mair has joined us a Parliamentary Member.

Finally I was very sorry to learn of the passing of Reg Sell, a Life Member of P&SC for many years. Our thoughts are with his family and friends. My thanks to John Slater for writing a fitting appreciation of Reg.

With best wishes for an enjoyable Summer.

SCIENCE IN PARLIAMENT

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

Science in Parliament has two main objectives:

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

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

KEEPING OUR NATION SAFE AND POWERING ITS PROSPERITY

Professor Sam Medhat
PhD MPhil CEng FIET FCIM FCMI FRSA FIKE FIoD
Chief Executive
Institute of Innovation & Knowledge Exchange
Visiting Professor of Innovation and Digital Transformation, University of Westminster

Back in 2019 the UK's Defence and Security Accelerator (DASA) started on their journey to achieve their Investor in Innovations ISO56002 Standard Accreditation - the UK's only standard benchmarking award in Innovation, provided by the Institute of Innovation and Knowledge Exchange. At the time, the leading science and technology agency had been in operation for just over three years, but even then it had a defined intention to stretch its strategic goals over the next three year to find and fund exploitable innovations that would eventually find their homes in the world of defence and security. In 2019, DASA had 446 projects, in 2020 that had risen, despite the pandemic, to 673, and in 2022/23 that number had risen beyond a thousand. Given its laser focus on innovation, and the fact that innovation is embedded within the DNA fabric of DASA, it's unsurprising that DASA achieved the highly coveted ranking of Best Practice in all six of the Investor in Innovations Standard categories, namely: Strategy and Alignment, Organisational Readiness, Core Capabilities, Technologies and IP, Industry Foresight, Customer Awareness and Impact and Value, following their review validation process in June 2023.

Achieving this substantial milestone demonstrates DASA's extraordinary capability in innovation that extends beyond its strategic imperative to find and fund exploitable innovations, into its people and culture; how it builds relationships with its stakeholders and how it manages its ecosystems of customers and suppliers; reconfiguring its business model to drive innovation better; improving operational abilities including harnessing digital to make processes and practices more efficient and effective, and the way in which it assesses the impact and value of every project, supplier partner and customer engaged with, to ensure projects funded attain real impact and power up prosperity in the twelve UK regions represented.

Each of these areas are fundamental to building innovation strength, although many organisations tend to look at them in isolation, DASA, in contrast, has addressed them in concert, enabling a threading through of integration and interaction to support their strategic goals, and ultimately, spur a new wave of advancements and pioneering projects that will protect and safeguard the nation. However, alongside delivering the best innovations for the betterment of national security and defence, what mustn't be forgotten is DASA's fundamental role in powering UK prosperity, with over 50% of their projects' funding (£103.2M) going to Small to Medium sized Enterprises (SMEs). From the initial funding model derived from the Chief Scientific Advisor science programme via Dstl, Defence Innovation Fund and Front Line Commands funds, DASA have launched new services, such as Defence Innovation Loans, the First Customer Fund, Defence and Security Seed Fund, as well as Regional Partnering Funds. All of which are powering forward tech-driven SMEs' growth and strengthening the UK's broader industrial base.

The prosperity drive and support for the small business tech community has been enabled greatly by DASA's Access to Mentoring and Finance (A2MF) Programme, supported by twelve regionally placed Innovation Partners who actively do the 'finding and funding' in their respective regions. They have an in-depth knowledge and understanding of their region, and are in regular contact with their business and academic prospect partners. As a result of this close engagement, DASA's network has grown significantly, with on average, 40% of proposals on each challenge call coming from new organisations. The A2MF team along with each of the Innovation Partners are dedicated to supporting and building business continuity and resilience in SMEs, and to helping small tech businesses who are successful in securing DASA challenge funds, leverage and attract further funding avenues and business development. A recent Small Business Research Initiative (SBRI) evaluation report – the initiative started in 2001, and

has, to date provided £788M to UK SMEs – showed that DASA funding had, in the time from its inception in 2016, represented 36% of the overall SBRI, and has supported over a third of all benefits highlighted, including those SBRI businesses leveraging £290M of private investment and experiencing 9% growth, compared to businesses not engaged in SBRI funding.

DASA lives and breathes impact and value across everything they do, and is the first organisation to have achieved Best Practice in this critical category in the Investor in Innovations Standard. Strong KPIs and impact metrics, particularly positive outcome responses from their customers – that extend not just in the MoD, but are in six other UK government departments including the Home Office and Department of Transport – show that DASA is enabling the right solutions to be found for their customers. Such a targeted ability is founded in DASA's in-depth connectivity to the science, engineering and technology community, both academic and industrial, with over four thousand organisations with accounts on their Marketplace portal, and over a thousand of these already engaged in challenge submissions. Such a growing ecosystem provides DASA with unprecedented access to the best minds, delivering the right solutions to meet the stringent desirability, viability and feasibility criteria to take an idea forward.

DASA underlines its dedication to fostering a forward-thinking environment where the ideas of tomorrow can take shape today. It achieves this through its Advisory and Foresight Group which continuously horizon scans, assesses markets and technologies, and aligns back into DASA's strategic imperatives. DASA's systematic and structured view of where it focuses its innovation activities ensures that it can lead proactively, and anticipate future customer innovation needs. It is for this reason, why DASA has been able to support quickly such critical calls as the Defence Technology Exploitation Programme (DTEP) and the Security Open Call.

Creation of challenges both open and themed pertinent to present and future customer need, management of a growing and active ecosystem with a network of knowledgeable innovation partners, and access to different tiers of funding, have all been enabled by cultivating an innovation culture that constantly challenges the status quo, and isn't afraid to disrupt. In the light of this brave attitude, DASA started a Decuple programme (10 things to improve in DASA in 10 months) to strengthen Understanding, Team and Exploitation Pathways. Outputs of this work included the ground-breaking development of DASA's High Level Operating Model (HLOM), and its eventual mapping of the MoD and Industry Innovation Operating Model (MIIOM) into the HLOM, thus demonstrating its development had been in accordance with the principles of the MIIOM.

Having a world-class innovation accelerator like DASA delivers a number of profound gains to the UK's defence and security sector, such as:

1. **A Catalyst for Novel Defence Technologies:** DASA's accreditation will stimulate the creation and adoption of a range of innovative solutions particularly those that are within the lower spectrum of technology readiness levels (TRL), leveraging its strong relationship with Dstl.

2. **Enhanced Security Innovations:** By demonstrating best practice in the Investor in Innovations Validation Assessment, DASA signifies its commitment to driving cutting-edge security solutions. These solutions exploit advances in artificial intelligence/ machine learning, biometrics, data security, and threat detection to ensure the country's safety and resilience against ever-evolving threats.

3. **Greater Collaboration and Partnerships:** This recognition underscores DASA's role as an intelligent connector within the innovation ecosystem. As a result, partnerships with universities, tech-driven SMEs, and other stakeholders are likely to flourish even more, leading to an increased exploitation of innovative solutions across defence and security sectors.

4. **Robust Support for Innovative SMEs:** DASA's accomplishment will bolster its mission to find, fund and nurture tech-driven SMEs that produce trailblazing solutions for the UK's defence and security. These SMEs will play a critical role in advancing the country's strategic interests, thereby enhancing national security and economic prosperity.

5. **Promotion of a Pro-Innovation Culture:** The IKE Institute's award affirms DASA's commitment to an innovation-centric culture. This mindset will further stimulate the development and exploitation of novel technologies, encouraging a broader base of contributors and innovators.

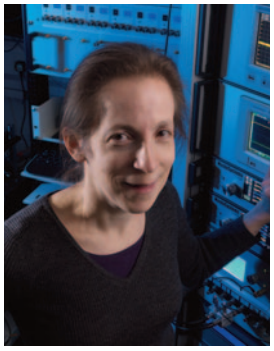
DASA's Head, Anita Friend said: "*Earning the IKE Institute's Investor in Innovations ISO56002 Standard reinforces our resolve to spur innovation in defence and security. Our commitment to exploit advanced technologies will significantly boost the UK's capabilities in these critical sectors.*

DASA's achievement is not merely a feather in its cap, but a strategic milestone that promises to transform the UK's defence and security sectors. The upcoming era of innovation promises to bring about advancements that fortify the UK's national security, enrich its economy, and cement its status as a global pioneer in defence and security innovations", DASA's Head added.

Professor Sam Medhat, IKE Institute CEO said: "*We have conducted a three-year longitudinal assessment and analysis of DASA's innovation strategy and its evolution over this period. Senior leading industrialists and academics with distinguished innovation track records formed the Verification and Validation Panel. DASA's scoring of Best Practice in all of the six categories of the Investor in Innovations has put them in a worldclass leading position within the innovation space. By earning the Investor in Innovations ISO56002 Standard, DASA has not only proven its commitment to fostering innovation, but has also demonstrated its role as a leader in enhancing the UK's security. We commend DASA's ongoing efforts to boost the country's prosperity through strategic investments and applaud their continued support for innovative initiatives.*"

All of DASA's achievements documented in the Investor in Innovations illustrates their constant, unwavering dedication to deliver and enhance the UK's defence and security capabilities, as well as propelling economic growth, reinforcing our nation's prosperity through its regional economic engagement of innovative stakeholders, particularly small and medium enterprises and linking them to other top tier suppliers. Put simply, DASA is driven by innovation passion and it beats within the hearts of every person there. ■

TIMEKEEPING FIT FOR THE FUTURE



Prof Helen Margolis
Head of Science (Time and Frequency), National Physical Laboratory (NPL)

Precision timing underpins the infrastructure and services we depend on in our daily lives. For example, mobile phone networks, global navigation satellite systems (GNSS) and the energy grid all require accurate atomic clocks and synchronisation technologies to operate properly. But this dependence on precise timing is not widely appreciated – time is sometimes called an "invisible utility".

Most users of accurate time and frequency signals, including operators of critical national infrastructure, currently rely on timing signals from GNSS. This is because they are free and widely available. But they are also weak. This makes them vulnerable to natural, accidental, and deliberate interference, for example by solar storms, spoofing or jamming. This vulnerability, coupled with lack of awareness of the extent to which critical national infrastructure depends on GNSS, poses a significant risk. The 2018 Blackett review "Satellite-derived time and position: a study of critical dependencies" [1] and the National Risk Register [2] both emphasise the need to increase resilience to GNSS disruption, for example by adopting suitable backup systems.

The UK already has an alternative source of time and frequency signals. At the National Physical Laboratory (NPL), we operate the national time scale UTC(NPL). This has been the UK reference for time and frequency for over 30 years, providing signals traceable to the global time scale Coordinated Universal Time (UTC). But UTC(NPL) is not as resilient as we would like, being based on atomic clocks and other timing infrastructure located on a single site. And although we operate several UTC-traceable time and frequency distribution services, it is also not as accessible as we would like.

Most users access our free services – our internet time service or the MSF radio time signal – but these only provide millisecond timing accuracy. The NPL*Time*® time-over-fibre service to users in the financial sector has far better accuracy, with a service level agreement of 1 microsecond. However its geographical reach is limited to users in the south of the UK at present.

THE UK NATIONAL TIMING CENTRE

The NPL-led National Timing Centre (NTC) programme is taking steps to reduce the over-

NPL's caesium fountain primary frequency standard

reliance of critical national infrastructure on timing signals from GNSS, and to improve user access to trusted timing signals across the UK.

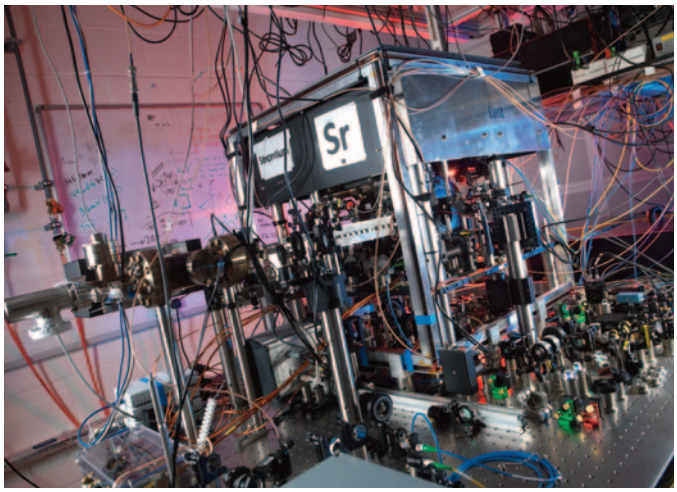
At its heart is the construction of a new, more resilient UK time scale. Our design is for a mesh of four geographically distributed, linked sites containing atomic clocks and other time scale hardware, with far more remote monitoring capabilities and automation than UTC(NPL) has today. For example, if one of the clocks in the network fails, then the switch to another will happen automatically, without human intervention. Construction of the new time scale is underway and in due course it will become the source of UTC(NPL). At that point all our existing time and frequency dissemination services will switch over to the new infrastructure.

The programme is also providing innovation opportunities for UK companies through access to time and frequency signals, expertise and funding. Three innovation nodes have been set up in partnership with the universities of Strathclyde, Surrey and Cranfield, and are being made available to successful applicants in funding calls run in partnership with Innovate UK. These innovation nodes each provide a combination of timing signals traceable to UTC(NPL) and laboratory space for industry research and development, to test new technologies and applications. The aim is to support business-led innovation, and stimulate the UK supply chain and capability, whilst developing a blueprint for future scale-up of the distribution infrastructure. To help address the known skills gap in time and frequency, two e-learning courses have also been developed[3,4].

ANTICIPATING CHANGE

The new UK time scale and the innovation nodes are based on today's time and frequency technologies, with almost all the equipment being sourced from outside the UK. We are taking steps to stimulate a UK supply chain, but in the meantime we are also anticipating the future.

The next generation of atomic clocks used for timekeeping will be based on atomic transitions at optical, rather than microwave, frequencies. The performance of these optical clocks already far surpasses that of today's caesium fountain primary frequency standards, and so a change in the definition of the unit of time (the second) is anticipated. An international roadmap towards the redefinition has been drawn up by the international metrology community, with a target date of 2030.



NPL's next-generation strontium optical lattice clock

It is critical that we anticipate this change – the redefinition will have an impact on the future clocks we need for the UK time scale and on the technologies used for distribution, as well as on end-user applications. For this reason, NPL is playing a leading role in the international work towards the redefinition.

One key goal on the roadmap is the validation of optical clock uncertainties through international comparisons. In March 2022, NPL coordinated the largest optical clock comparison ever performed, involving 11 optical clocks in 7 different countries, linked by optical fibres and via satellites. An alternative comparison approach is to use transportable optical clocks, and in March 2023 we hosted visiting optical clocks from Japan and Germany for this purpose.

Another goal is for optical clocks to contribute regularly to the global time scale UTC, to ensure that end users benefit from an improved quality of this time scale after the redefinition. UTC is derived from International Atomic Time (TAI), computed by the International Bureau of Weights and Measures (BIPM) using data from atomic clocks. In March 2023 we reached a major milestone when data from our strontium optical lattice clock provided the first UK optical steer of TAI. We are also working towards introducing optical clocks into our national time scale UTC(NPL).

Routine contributions to time scales need continuously running optical clocks and associated infrastructure, rather than research prototypes. Such systems are included in the facilities we are building in NPL's new advanced quantum metrology laboratories and will be used to generate an optically steered local time scale as well as to make regular contributions to international time scales in preparation for a redefinition of the second.

Atomic clocks are one type of technology falling within the umbrella of the UK Quantum Technologies programme, and the state-of-the-art reference frequencies in the new laboratories will be used to provide a test and evaluation facility for such technology. Companies developing quantum technology products – from laser systems to the most advanced optical atomic clocks – will be able to characterize their performance, helping them to accelerate innovation and bring new products and services to market more rapidly.

Initially this will be possible in collaborative innovation space within the new facilities. Our longer-term aim is that companies will also be able to access the time and frequency reference signals remotely via optical fibres. As a first step, an optical fibre link from NPL to the University of Birmingham is being set up as part of our contribution to the UK Quantum Technology Hub in Sensors and Timing. But our distribution hub is being set up to allow for much wider expansion of the optical fibre network in future.

FUTURE VISION

This will take us a step closer to realizing our longer-term vision: a high-accuracy time and frequency backbone running the length of the UK. Branches stemming off that backbone will provide a range of services with different performance levels, not just by fibre but also using broadcast technologies. All time and frequency signals delivered to users will be traceable to UTC(NPL), as the highest point

of reference within the UK. This distribution network will enable trusted timing signals to be made widely available to users, wherever and whenever they are needed, with the accuracy appropriate for their applications.

Our daily lives already rely on time and frequency, and as our world becomes ever more connected, the demands on timing and synchronisation will increase further. A resilient UTC(NPL), in combination with a nationwide time and frequency distribution network, will deliver assured time and frequency references to UK critical infrastructure. It will also provide the UK with a unique resource on which to build research, innovation and high-value manufacturing, stimulating the future supply chain necessary to underpin next-generation applications.

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TIME IS MONEY

Dr Leon Lobo
Head of the National Timing Centre programme at the National Physical Laboratory (NPL)

London is the fintech capital of the world and has led technology innovation for the global markets for decades. In 2022 alone, fintech firms raised $9.7B of investment [1], more than any city globally. Time is historically associated with London and since the markets first started trading, early access to information and minimising the time (latency) to receive this information has always been a driver to success. Time really is money.

Over the past few decades, there's been a transition from open outcry to electronic trading in the markets, and specifically, high-frequency trading, where electronic systems conduct hundreds of thousands of trades every second. This form of high volume, high-rate trading, requires traders to operate very fast computing systems co-located in the same data centre halls as the stock exchange to rapidly respond to changes in the market.

Accessing market information early is key to successful trading strategies. To minimise the time taken between accessing market information and performing a transaction, market participants have driven the development of low-latency infrastructure to reduce the delay in transferring data. This race to zero latency is sought after [2] as the quest for alpha (highest returns above the benchmark), incurs significant investment to maintain market advantage.

Underpinning the markets is time, an invisible utility, synchronising the digital infrastructure, supporting trading algorithm development through accurate timestamps, enabling vast amounts of data to be transferred intra and inter markets between participants at high data rates, providing the measurement basis by which low latency infrastructure is managed and operated, and supporting the regulators to ensure market clarity, detect potential market anomalies and fraudulent activity, and conduct robust forensics in the event of a market crash.

BACKGROUND

The May 2010 flash crash, when the US equity market dropped by 600 points in 5 minutes, eliminated approximately US$800B of value, and then regained almost all the losses within 30 minutes, severely eroded market confidence. In response, Sir John Beddington commissioned a report [3], which recommended the implementation of high-accuracy traceable timestamps for high frequency trading and highlighted the role of standards.

Regulators face challenges assessing potential market abuse and fraud due to data from multiple exchanges having offsets in time, or grey areas where multiple events had the same timestamp. Accurate timestamps are key to market clarity, understanding the order of events and forensics. Timing underpins the digital infrastructure the sector depends on, for operational use, but also for high precision synchronisation of local trading infrastructures to leverage small differences in the price of instruments.

Most access time from Global Navigation Satellite Systems (GNSS) such as the US' Global Positioning System (GPS). Although primarily known for the positioning and navigation capabilities, it is not widely known that they are used across our digital infrastructure for time. The signals these satellite constellations broadcast are primarily timing signals.

However, significant challenges are faced including disruption and denial of the weak signals from space, lack of roof access for antennas, multipath errors in built up environments, sparsity of skillsets to implement and operate systems, lack of calibration and monitoring inconsistencies, resulting in discrepancies in time between market participants and venues, negative latencies, reversed orders of execution, and infrastructure failures due to loss of sync. The varying implementations across trading architectures, can result in discrepancies across market participants and venues, resulting in a similar problem the UK faced with the Victorian railways, no one had the same time, except now, not at the minute level, but at the tens of microseconds.

Having a common time is critical to stable digital infrastructures (synchronisation), exchange of information, reporting and to determine causality. The global reference time scale, Coordinated Universal Time (UTC), is the basis of civilian time across the world. The concept of traceability for time, requires an unbroken chain of comparisons, from the point of generation of the timestamp or synchronisation of a clock, back through the network and systems, to the global reference. UTC is calculated based on data submissions from around 500 atomic clocks from 80 national timing laboratories across the world, the real-time realisation of UTC being the time scales at the laboratories themselves. In the UK, the National Physical Laboratory (NPL), as the UK's National Metrology Institute, manages the national time scale, UTC(NPL), and disseminates it to the UK.

"NPL's support was instrumental in the development of the Regulatory Technical Standards on clock synchronisation (RTS 25), which were essential to ensure a consistent approach to recording precisely when market transactions happen. We were able to leverage NPL's technical expertise and their practical experience in implementing high-precision business clocks for use in the financial industry.

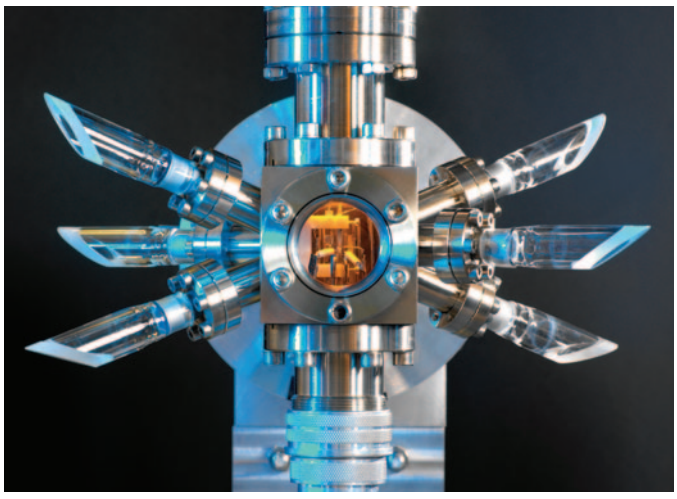
Makoto Seta, Trading Conduct and Settlement Policy, Financial Conduct Authority (FCA)

THE DEVELOPING REGULATORY LANDSCAPE

Working closely with the UK's Financial Conduct Authority (FCA) and the European Securities and Markets Authority, NPL helped develop a new Regulatory Technical Standard for timestamp traceability for reportable events across the European financial sector, ensuring market achievability, and delivering benefits to market clarity and forensics. The standard is structured to allow ease of iteration to more stringent requirements as the markets develop.

The Markets in Financial Instruments Directive II (MiFID II) went live on 3rd January 2018, and for the first time, timestamp accuracy, traceable to UTC, was mandated for trading in Europe[4]. The most stringent requirement in the new regulatory technical standard, RTS25, requires high frequency trading reportable events to be accurate to 100µs (100 microseconds, 100 millionths of a second), traceable to UTC.

NPL engaged with international finance regulators to raise awareness of the importance of UTC traceability and the development in the UK. Further discussion with the international regulatory bodies through IOSCO, has resulted in a formal recommendation that global markets use UTC as the reference for all timestamps across markets[5].



The next generation of atomic clocks at NPL, using laser cooled trapped ions or atoms, should achieve accuracies around 100 times better – equivalent to gaining or losing no more than one second in the age of the universe

A NEW DIGITAL TIMING SERVICE

NPL developed a new time service, NPL*Time*®, delivering high precision, traceable time to the trading system, monitored at the user, within 1µs (1 microsecond) of the global time scale UTC. This is the first time, globally, a reference standard has been delivered digitally to the point of need, monitored at the end user for accuracy and provided with service levels for accuracy to UTC, availability and certification for traceability.

THE FUTURE OF TIME

New applications such as distributed ledger technologies[6], enhanced solutions for algorithm optimisation and playback, cross market and cross venue data aggregation and tick warehousing, new infrastructures such as trading platforms, low latency networks (trans-oceanic and terrestrial) based on microwave links and hollow core fibre networks, all have increasing demands on time and timing for instrumentation, metrology and timestamp traceability. Data rates and

volumes are increasing, and the underpinning timing capabilities need to cope with performance demand. The current Ukraine crisis has highlighted the vulnerability and threat to weak satellite signals, with the potential for disruption and long-term outages affecting business continuity, market confidence and public trust.

Regular failures in financial sector IT infrastructures have driven regulatory bodies to place strong emphasis on operational resilience, extended to third party services such as cloud services. The European Union's Digital Operational Resilience Act (DORA)[7] (coming into effect in late 2024) and the UK regulatory bodies' rules[8] on operational resilience (coming into effect by March 2025), are starting to address operational resilience standards to ensure stable market operation.

Through NPL's National Timing Centre programme we're developing a national timing infrastructure to provide a resilient alternative to GNSS. London as the historical datum for time, and the fintech capital of the world, has certainly been ahead of its time with technology, now extending UK leadership through resilient and traceable time, providing a new layer of trust for the future.

The race to zero and the quest for alpha continues…

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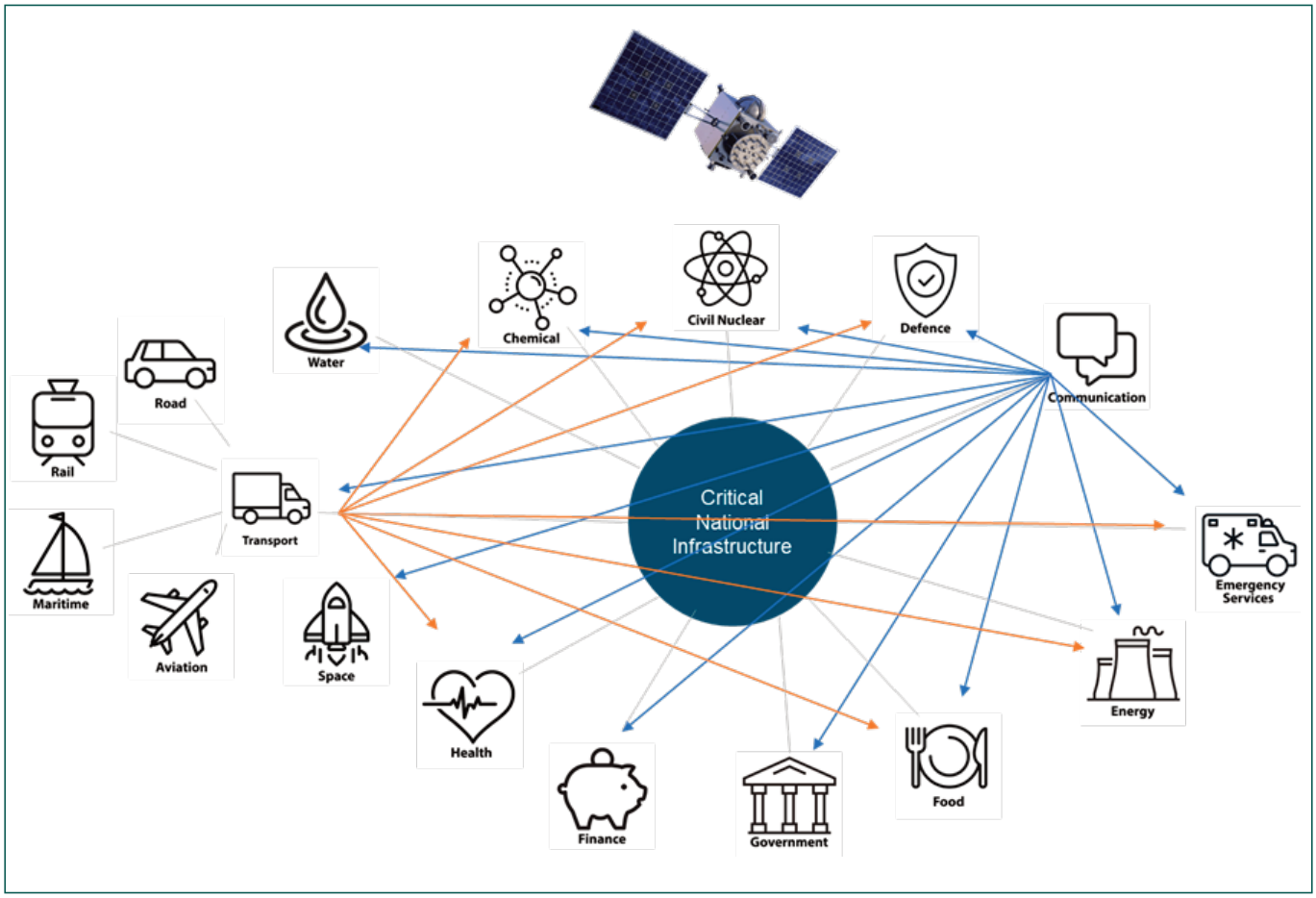

Critical national infrastructure describes the resources, systems, processes, and facilities that keep society and the economy functioning, from generating electricity and transmitting it around the country, to producing and transporting food in agricultural supply chains. The communications networks and transport systems that underpin so many other sectors are heavily reliant on GNSS.

DRUG REPURPOSING – NEW WINE IN OLD BOTTLES

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"And no one pours new wine into old wineskins. Otherwise, the wine will burst the skins, and both the wine and the wineskins will be ruined. No, they pour new wine into new wineskins."

Mark 2:22

INTRODUCTION

The concept that drugs can be 'repurposed' to create added clinical and commercial value through the establishment of new medical uses for already known drugs is one which is superficially attractive. Drugs which have already been approved will have passed all the appropriate regulatory hurdles and this should mean that they can be brought to market more quickly and time and resources can be saved in the use of available drugs rather than having to synthesise or produce sufficient quantities of new bioactive entities de novo. Nonetheless, it is important to bear certain caveats in mind including the nature of drug screening, the delivery of drugs in a pharmacological dose to the site in the body where they are required (this is underpinned by ADME – Absorption, Distribution, Metabolism and Excretion – studies), and the therapeutic window which, for some purposes may be too narrow to allow a drug to be successfully repurposed.

DRIVERS FOR DRUG REPURPOSING

A major factor in the use of repurposing for drugs is the cost of drug development. It has been estimated (based on published data) that the R&D costs of developing a drug ranged from $161 million to $4.54 billion. The highest costs were associated with Drug Discovery and Optimization (50%) while pre-clinical and clinical trials accounted for the bulk of the remainder (49%). The cost of obtaining FDA approval was only 1.3% of the total cost[1]. If a bioactive can be repurposed in its original form for a new therapeutic endpoint then considerable costs can be saved[2]. It should be noted, however, that the clinical costs also include those drugs that are abandoned because of safety and lack of efficacy in a range of tests. It has been estimated that the failure rate for new drugs is around 90%. Repurposing (aided by AI and other Structure: Activity techniques) can greatly improve the hit rate, shorten the time to market and provide new clinical insights.

A recent study of drug repurposing suggested that there were a number of factors that influenced the drive for repurposing[3]. These included "the ability to form multi-partner collaborations (n=38), access to compound databases and database screening tools (n=32), regulatory modifications (n=5)." One significant facilitator for the re-examining of chemical entities for new purposes was the need for the rapid development of effective therapies to counter the Covid epidemic, however even before the pandemic, a report by the Association of Medical Research Charities (AMRC) in the UK[4], suggested that a licensing route should be established for repurposed, off-patent drugs and that "A UK Catalyst Fund should be explored to establish the UK as a leader in medicines repurposing".

Even before the pandemic, it was estimated that repurposed drugs generated around 25% of the annual revenue for the pharmaceutical industry[5]. In addition to the reduced cost, perhaps the most significant driver for repurposed drugs is the significantly shortened drug development timeline. In particular, if the pharmacological use is already known (but not commercially exploited) and the pharmaceutical dose is lower or equivalent to the existing approved usage level, some of

the preclinical testing and safety evaluation becomes unnecessary.

THE PANDEMIC AND DRUG REPURPOSING

Following the growth of the pandemic, a number of initiatives were started to try to find existing drugs that could be repurposed. Such variation of use is more likely to be successful if the original use of the drug encompasses some clinical aspect of the virus aetiology.

In the US the CORONA (COvid19 Registry of Off-label & New Agents) project was launched in March 2020 to track clinical studies designed to lessen the impact of Covid[6]. The stated aim of the project was to provide a data repository for trials related to Covid-19 and to thereby facilitate the more rapid development of effective therapeutics. The RECOVERY (Randomised Evaluation of Covid-19 Therapy) and the SOLIDARITY trial were set up to test multiple drug treatments for Covid. These trials have indicated that hydroxychloroquine, lopinavir–ritonavir, and interferon did not reduce mortality. The trials have also shown how prevalent ideas about some types of therapeutics can take hold. One example is that of hydroxychloroquine. Data suggests that one in three patients globally has received hydroxychloroquine, despite only one of 18 randomised trials showing an effect or benefit.

One of the issues with Covid (and long Covid, indeed) is the long list of co-morbidities associated with the infection. In addition to respiratory symptoms, there is an apparent association between infection and cardiovascular disease, kidney damage, hypertension and diabetes. There have been a range of studies that have implicated Covid infection with several subsequent cardiovascular events including myocarditis, heart failure, arrhythmia, acute coronary syndrome, and venous thromboembolism. It has, therefore, been suggested that repurposing of drugs to deal with the pathologies resulting from Covid infection rather than just the infection itself is a valid approach[7].

REPURPOSING WITHIN AND OUTSIDE CLINICAL AREAS.

Where a mechanism (or even a side effect) of a specific drug has been documented, its application to related conditions can be predicted with a higher degree of certainty. For example, in the case of the drug **pembrolizumab**, it was originally developed as a treatment for advanced melanoma. It is now used for a range of cancers including lung and cervical cancer and lymphoma. Its mechanism of action (activating a T-cell mediated immune response against tumour cells) has allowed it to be tested against a number of cancer types for which such an approach can be predicted to be successful. There are other examples within the cancer field.

The antibiotic, **clarithromycin** has also been shown to have activity against some types of cancer (often in a combination therapy with other drugs). **Methotrexate** is an antirheumatic drug that is widely used for the management of autoimmune and chronic inflammatory disorders. It has been used in the treatment of cardiovascular disease by reducing systemic inflammation (but should not be used to prevent cardiovascular events in the general population)[8] and, perhaps most recently, as a means of damping down the inflammatory response resulting from Covid infection[9].

Statins are used to lower cholesterol but have also been found to be efficacious in a range of other clinical effects including reduction of inflammation, immunomodulation and even as antimicrobials[10]. At the root of much of their activity lies their biochemical mechanism as competitive HMG-CoA reductase (HMGCR) inhibitors.

CONCLUSION

Repurposing drugs may be a useful and interesting way of developing new therapeutic approaches without having to have all the skills (and costs) of a full-blown drug discovery programme. Rapid (essentially random) screening can certainly help to identify potential lead compounds but a better approach is to make use of the knowledge base built up around a given drug in terms of its biochemical mechanism of action, side effects and other potential targets. In this way both clinical and economic advantages may accrue. Care must be taken to understand as much as possible about the disease and the 'not new' therapeutic, if one is to avoid the consequences of pouring "new wine into old wineskins".

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INERTIAL FUSION BREAKTHROUGH: WHAT IT MEANS FOR FUSION ENERGY

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A major milestone on the journey to fusion energy was realised by a team at the Lawrence Livermore National Laboratory (LLNL), USA on the 5th of December 2022, on the National Ignition Facility (NIF). For the first time in any fusion experiment the team demonstrated getting more fusion energy out from the fusion reactions than was input. This major scientific achievement was announced at a press briefing on the 13th December 2022 by the US Department of Energy's National Nuclear Security Administration (NNSA). This was a historic milestone and the culmination of decades of effort.

INTRODUCTION:

Fusion has the potential to provide humankind with a near infinite source of carbon free, safe, secure, and reliable baseload energy. The scientists at the NIF use high energy laser beams to compress and heat a pellet of fuel in a technique called Inertial Confinement Fusion (ICF). ICF is one of two extensively researched techniques to achieving fusion energy, the other main method being Magnetic Confinement Fusion (MCF) using Tokomaks. As realising fusion energy is so challenging, and the rewards of fusion energy so huge, scientists are actively pursuing both methods.

NIF's implosion produced a total of 3.15 MJ of fusion energy with 2.05 MJ of laser energy, demonstrating that the process can produce more fusion energy than the laser energy delivered to the target. This major milestone, showing a gain of 154%, follows a previous key achievement on NIF, demonstrating an igniting plasma on August 8, 2021. On that occasion the yield was estimated to be 72% of the laser input energy, with 1.35 MJ of fusion energy generated from 1.93 MJ of incident laser energy into the target [1].

The U.S. Secretary of Energy Jennifer Granholm at the DOE Press Conference Announcing Major Nuclear Fusion Breakthrough on December 13, 2022 stated "Last week at the Lawrence Livermore National Laboratory in California, scientists at the National Ignition Facility achieved fusion ignition. And that is creating more energy from fusion reactions than the energy used to start the process. It's the first time it has ever been done in a laboratory anywhere in the world. Simply put, this is one of the most impressive scientific feats of the 21st century." [2]

UK scientists played key roles in this work, both at UK institutions and within the LLNL team. Despite this, and extensive research expertise within the UK, there is currently no UK investment going into laser-driven ICF grant funding in the UK.

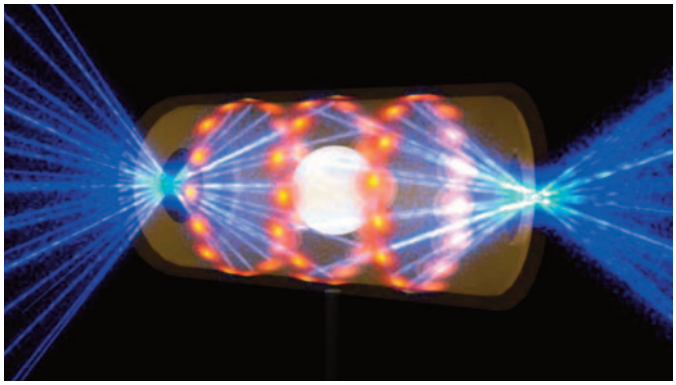

Figure 1: NIF Hohlraum: This artist's rendering shows a NIF target pellet inside a hohlraum capsule with laser beams entering through openings on either end. The beams generate X-rays that compress and heat the target to the necessary conditions for nuclear fusion to occur. Ignition experiments on NIF are the result of more than 50 years of inertial confinement fusion research and development, opening the door to exploration of previously inaccessible physical regimes.
(Image copyright LLNL)

NIF uses the technique of indirect drive Inertial Confinement Fusion (ICF) where the millimetre scale capsule containing the nuclear fuel, a mix of deuterium and tritium, is enclosed in a gold cavity, the Hohlraum. The inner walls of the cavity are irradiated by the 192 NIF laser beams, giving rise to intense X-ray emission that ablates the outer surface of the capsule, accelerating the fuel inwards in a rocket-like behaviour. The following implosion makes the capsule shrink many times, compressing the fuel and increasing its density by up to 4000 times. It is designed to self-ignite (very crudely in a similar fashion to a car's diesel engine) when the compressed fuel achieves the required density and temperature to enable fusion reactions to start from a central hot spot and propagate outwards to burn the surrounding fuel.

HISTORY:

In seminal papers published in 1972, the concept of ICF was proposed both in the US and USSR[3, 4]. The US abstract stated that 'Hydrogen may be compressed to more than 10,000 times liquid density by an implosion system energized by a high energy laser. This scheme makes possible efficient thermonuclear burn of small pellets of heavy hydrogen isotopes and makes feasible fusion power reactors using practical lasers.'

This began a global concerted effort, particularly in the US, for over 50 years to understand the physics behind ICF and finally demonstrate ignition. At LLNL a series of lasers were constructed from the mid-1970s with ever increasing energies and specifications: Janus and Cyclops in 1975; Argos in 1976; Shiva in 1977; Novette in 1983; Nova in 1984 and finally NIF[5]. A progression of the development of lasers; their optical systems; diagnostics for both lasers and plasmas; targets; and computer architectures and codes for simulation and prediction – all critical to the delivery of the ICF programme.

NIF[6], funded by the U.S. DOE's NNSA is the largest and highest energy laser facility in the world with a footprint occupying three football pitches. It comprises 192 beams, operating at 351 nanometres (blue light), delivering in total more than 2 MJ of energy which can be simultaneously focused on to a millimetre scale target placed at the centre of a 10 metre diameter vacuum chamber. Its design and construction started in the 1990s, with first light demonstrated in 2003, and conducted its first full-scale experiments in 2009. NIF is still the only facility globally that can conduct full scale ICF experiments.

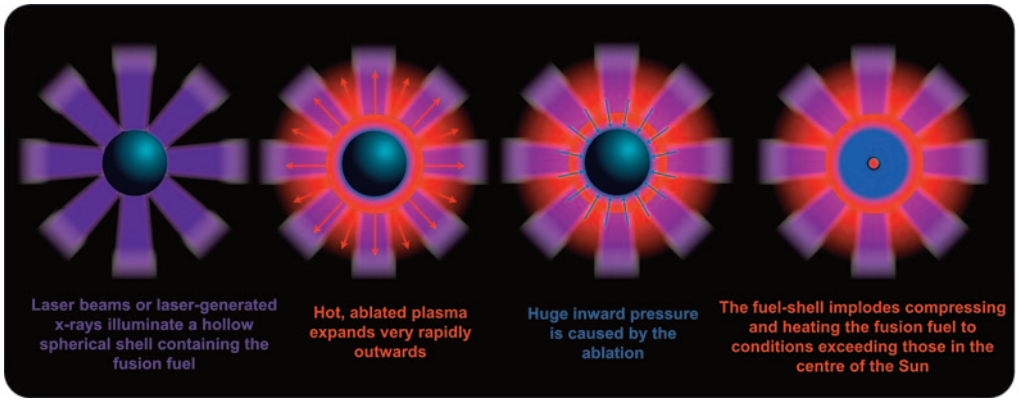

Figure 2: The stages of direct-drive Inertial Confinement Fusion

WHERE NEXT:

In the perspective of future fusion energy production, achievement of ignition was considered by the scientific community as the key milestone required to enable the development of Inertial Fusion Energy production, aimed at the proof of principle demonstration and, eventually, a realistic concept of a power plant. In this process, LLNL is expected to continue with experiments on NIF, to demonstrate repeatability of ignition and hopefully enhanced gain.

The recent NIF demonstration is a "single shot event", demonstrating that the ICF concept works. The path to a fusion power plant will require developing lasers with higher shot repetition rate and efficiency (the UK's STFC Central Laser Facility are world leaders in this). There are also alternative, more efficient schemes including direct-drive, where the lasers interact with the fuel capsule directly, which will also be investigated. The direct-drive key processes are shown in Figure 2.

It will also be necessary to address many other aspects required for energy production including: target manufacturing and delivery; first wall materials; and tritium breeding. These aspects were extensively discussed in the US Basic Research Needs (BRN) Workshop in June 2022[2] that was aimed at "exploring the science, technology, and investments needed to realize Inertial Fusion Energy (IFE)'s potential as a source of safe, clean energy in the coming decades".

These initiatives are also aimed at building the ecosystem required for the growing number of private companies to attract funding for the development of fusion schemes and technologies required for future power plants. It is expected that globally, inertial fusion energy research will receive a major boost by the recent advances at NIF and will lead to acceleration of existing national IFE programmes or establishment of new programmes.

Unfortunately, there is a lack of strategic funding for ICF in the UK and throughout Europe. This contrasts the situation with MCF, which has extensive governmental research funding. Research activities in ICF are funded through individual research grants and grass roots networking. In the UK, policy developments have helped push the UK's fusion industry forward for example by creating an agreement on the regulatory framework for future reactors, however the government published Fusion Strategy does not currently mention Laser Fusion. A UK ICF consortium (the UK Inertial Fusion Consortium) led by STFC includes 85 members from seven universities and AWE has developed a UK Roadmap focussed on Laser Fusion. The UK is seeking to start a new project called UPLiFT which will develop the technologies required to advance NIF's proof-of-principle experiment on the journey to Laser Fusion power production.

The UK is not isolated in this endeavour and interacts extensively with the global community. Europe is currently looking into the establishment of a comprehensive IFE project, HiPER+[7], following the approach developed in the previous HiPER project[8], which was led by the UK's Central Laser Facility. This is supported by novel ICF related

experiments at existing laser facilities and extensive computer modelling. HiPER was based on the direct-drive scheme as it is more efficient than NIF's indirect-drive method, which is important for fusion power generation.

CONCLUSIONS

The recent achievement at NIF, namely the demonstration of fusion ignition with laser-driven inertial confinement fusion, is the successful outcome of a fifty-year journey starting with the seminal idea of Nuckolls and Basov in 1972. While a number of challenging scientific and technological open issues remain, the main uncertainty on the way to inertial fusion energy production, namely the validity of the ICF concept, has been removed and the journey can continue and aim at the next milestones.

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THE UK HAS AN OPPORTUNITY TO LEAD THE WORLD IN SYNTHETIC BIOLOGY, WE MUST GRASP IT

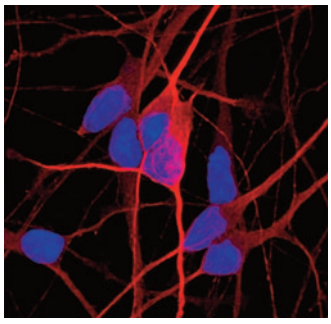
Dr Mark Kotter
Founder & CEO, bit.bio

In my previous contribution to Science in Parliament (Summer 2021)[1] I argued that without an investment mindset containing a bolder, long-term vision for life sciences, particularly synthetic biology (synbio), the UK risks falling behind countries such as the U.S. Despite increased Government priority placed upon life sciences since then, I want to reinforce this point.

MANUFACTURING HUMAN CELLS AT A LIMITLESS SCALE WITH SYNBIO

The timing of this article also allows me to report on a major breakthrough in the manufacturing of human cells, made possible because of our synbio approach – the idea that we can precisely engineer biology – and in this case, precisely engineer the identity of a particular human cell.

Last month, bit.bio, the company I head up, presented data at the International Society for Stem Cell Research (ISSCR) Conference in Boston, showing unprecedented consistency across multiple human cell type



ioGlutamatergic Neurons - Immunocytochemistry staining at day 4 post revival, shows expression pan neuronal marker MAP2 (red) (counterstained with Hoechst (blue)).

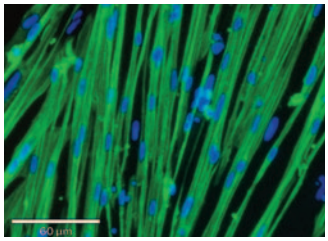
products produced from pluripotent stem cells using a synthetic biology-based manufacturing approach called cell programming. bit.bio's opti-ox technology licensed from the University of Cambridge also underpins Meatable, a scale up company that uses the same technology to manufacture cultured meat - trillions of cells on a daily basis.

The technology addresses two major challenges that have held back the application of iPSC-derived cells in medical and industrial settings: consistency and scale. Being able to manufacture human cells with consistency and scale opens the door to application in regenerative medicine, the use of cells in high throughput screening in the context of drug discovery, the generation of reproducible organoids, and the development of cell standards that help to address the lack of

reproducibility that has plagued the life sciences industry.

bit.bio's unique cell products are already enabling scientific breakthroughs and applications ranging from the discovery of novel drug targets against Alzheimer's[2,3], the development of biohybrid devices to restore paralysed limb function[4] and outside of human cells, cultured meat. These developments represent true disruptive innovation in stem cell biology, and the first true engineering of human biological systems.

We believe that this breakthrough in cell manufacturing can be compared to the revolution in car manufacturing as pioneered by Henry Ford in terms of the integration of standard assembly components. As the first technical solution addressing the consistency and scale issue in cell manufacturing, it could have extraordinary impact.



ioSkeletal Myocytes - Immunocytochemistry staining at day 10 post revival demonstrates robust expression of Titin (green) (counterstained with Dapi (blue)).

UK science is renowned for its integrity and capacity to deliver impact through its world-leading research. Yet the lack of reproducibility in research is a central challenge to the life science sector – in large part due to limited standards. In science, standards serve as universal benchmarks that facilitate accurate comparison. Achieving such standards in life sciences is much more complex as it requires standard models of biological systems like cells that are highly defined and reproducible. Current widely used cell lines are known to have varying characteristics, making them unsuitable as a standard.

bit.bio's cell products have now reached a definition and specificity with close to no batch-to-batch variation that enables the creation of a set of standard cells.

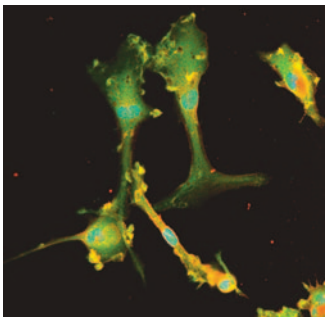
The UK has a track record in defining and exporting standards across several industries. This presents a moment for policy leaders to realise the opportunity for the UK to take a leading role in the development and strategic application of cell standards.

THE US IS SETTING THE STANDARD WITH BIOECONOMY VISION

In February, I spoke at a meeting of the Parliamentary and Scientific Committee (P&SC) alongside Dr Joe Healey (Co-Founder & CEO, NanoSyrinx), Dr Sara Holland (Partner, Potter Clarkson) and Fiona Mischel (Director of Human Health Content and Innovation, SynBioBeta) on the opportunities and wider landscape for the UK as a leader in synbio for human health, compared to other leading nations.

Since then, the US has set out a leading ambition for its bioeconomy. The White House's report *Bold Goals for US Biotechnology and the Bioeconomy*[5] sets out its strategy as to how US Federal Departments and industry could work "*to help establish R&D priorities that will be critical to advance the bioeconomy*". The report sets 5 and 20-year specific goals for five thematic areas of the bioeconomy including the advancement of human health and within that to "*increase the manufacturing scale of cell-based therapies… and decrease the manufacturing cost of cell-based therapies 10-fold*."

This work is a result of President Biden's Executive Order[6] last September instructing federal departments and agencies to assess the potential for biotech and biomanufacturing. Taking this collaborative approach is the correct way to develop an industry with enormous potential to drive growth across the economy and tackle some of society's most pressing challenges. A clear statement of leadership from the US, the Executive Order sets a standard for other nations aiming for leadership status in the emergent bioeconomy.



ioMicroglia - Immunocytochemistry staining at day 10 post revival demonstrates expression of IBA-1 (green) and phalloidin (red) (counterstained with Dapi (blue)).

The UK needs to equal this level of ambition and coordination. Obviously, we start from a strong position considering the concentration of talent within the UK research ecosystem. In 2022, the UK's innovative life sciences and biotech sector secured its 5th best fundraising year with £1,785m raised by UK companies[7]. Research by McKinsey in 2021 showed that between 2018 and 2020, the UK launched more new biotech start-ups than any other European country[8].

However, the UK is falling behind the US, China, and several European countries in the number of patents granted per scientific publication; 8 per 1,000 compared to 54 in the US and 72 in China. Although the UK accounted for more than 1/3 of the total venture capital raised by European deals, the average UK deal size, at £12.4m, was lower than both the European and US averages of £18.9m and £49m respectively[9].

As the UK's peers put words into actions, it is imperative that we do the same in fostering direct exchange between government and industry.

LIFE SCIENCE AT THE HEART OF SCIENCE SUPERPOWER AMBITIONS

Across the UK political landscape, it is encouraging to see the increasing priority placed upon life sciences. I was pleased to see Government recognise Engineering Biology as one of its five critical technologies in the Science and Technology Framework[10].

Government seems to be listening and answering our industry's concerns with the planned reform of R&D tax credits. The campaign, well-led by the Bioindustry Association and supported by Anthony Browne MP (South Cambridgeshire) amongst other Parliamentarians, ensured the implementation of the new enhanced R&D tax relief rate for R&D intensive SMEs. An important correction to ensure the UK's early-stage science base is incentivised to continue its innovation here.

Snapshot of the growing skilled workforce at bit.bio on the Babraham Campus in Cambridge

However, the benefits of this reform will only be realised if other bottlenecks affecting life science companies are addressed, notably the availability of suitable laboratory space. Growing companies need to be able to expand but space is limited, with just 10,000sq ft of laboratory space available in Cambridge compared with 2 million sq ft of demand [11]. In the US, supply is higher with 14.6m sq ft available in Boston in 2020 [12]. On this point, the recent Spring Budget commitment to boost the supply of laboratory space is welcome.

USING REGULATION TO DRIVE INNOVATION

The ongoing work by Government on regulating emerging technologies places a premium on incentivising and driving innovation. Dame Angela McLean's recommendations from *Pro-innovation regulation of Technologies Review: Life Sciences* [13] around the focus on streamlined approvals and international partnerships for the MHRA and NICE and the creation of an Engineering Biology Regulatory Network have been accepted by Government. The regulatory approvals process is a clear area where improvements can be delivered to bring the UK closer to the speedier approval timelines for equivalent products in the US. It is reported that some approvals can take three times as long compared to those in the US, showing the scale of opportunity for UK life sciences should we be able to compete on a more level regulatory playing-field.

INVESTMENT NEEDS TO MATCH AMBITION

Put simply, Government investment in life science needs to match its ambitions and the recent Life Science for Growth package is a statement of intent. Moreover, the further £3 billion of funding for British Patient Capital for the next 10 years is welcome. In return for this investment, the UK should be looking to secure its interest in the most exciting companies and technologies.

The announcement in the Spring Budget of a Long-term Investment for Technology and Science (Lifts) scheme establishes new investment vehicles to crowd-in investment from institutional investors, particularly defined contribution pension funds. As the science minister observed back in 2018, the UK is a finance superpower and a science superpower, yet ironically, failed to lead on the financing of science. Now is the moment where Government could firmly harness both of these "superpowers" to secure the full economic dividend from leading UK scientific research.

With a General Election approaching in the next 18 months, we are at a key moment in terms of policy consideration of biotech R&D and application to societal challenges. As acknowledged by Chloe Smith MP, Secretary of State for Science, Innovation and Technology, synbio has the potential to "*revolutionise many aspects of our lives, making them longer, happier, and healthier* " [14]. The UK should look to the US and its statement of leadership in the bioeconomy on the next steps we can take to ensure a joined-up, collaborative approach to drive the synbio industry forward.

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SUSTAINABLE STEEL MANUFACTURING

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The steel industry is one of the major contributors to global CO_2 emissions, being responsible for around 5% of CO_2 emissions in the EU and 7% globally [1]. In the UK the steel industry contributes 2.8% of our CO_2 emissions, accounting for 14% of industrial green house gas emissions [2]. However, the steel sector is now undergoing a major transition away from high CO_2 emitting manufacturing processes with an accelerating pace of change being driven, in part, by increasing customer demands for 'green steel' to support reduction of Scope 3 emissions.*

The current steel making approaches are predominantly based on blast furnace-basic oxygen steelmaking (BF-BOS), which emits 2.32 tonnes of CO_2 per tonne of steel produced (tCO_2e/t) and electric arc furnace (EAF) production at 0.67 tCO_2e/t. Approximately 70% of world production was BF-BOS in 2021 and the global production (and consumption) of steel is almost 2 billion tonnes per year and continuing to grow, figure 1. Global steel consumption is predicted to continue to increase following population growth, with continued increased demand also predicted in the UK. An alternative to BF-BOS production is replacement with EAF, where the reduction in CO_2e is primarily associated with the substitution of iron ore and coke as the raw material feedstock by recycled scrap steel. EAF production accounts for around 30% of global steel production so is an established technology, however this is predominantly for lower quality steel grades such as re-enforcement bar for construction [4]. This is due to the pick up of residual elements (e.g. Cu, Sn, Cr) from the scrap steel, which affect the steel processing and properties. Where EAF is used to produce high performance steels careful sorting and selection of scrap steel is required and often additions of clean iron (direct reduced iron, DRI) are used to dilute the residual element content in the composition. Unfortunately, the production of DRI has associated CO_2 emissions, being 1.4 tCO_2e/t for natural gas fired DRI [5], however the trend is to move to hydrogen produced DRI. Significant investments are being made in hydrogen steelmaking, including sector leading projects such as Hybrit in Sweden / Finland [6], where fossil free production of iron pellets has been achieved at pilot plant levels and plans are in place to bring fossil free steel to the market by 2026. Investments are proposed by major steel producers in the EU to generate hydrogen DRI (for example at Tata Steel Netherlands [7]). This is alongside major investments to replace BF-BOS with EAFs and DRI (for example Eur 1 Bn for Salzgitter [8]). With the planned increase in EAF production there is growing demand for steel scrap, which is graded by quality. Increasing competition for steel scrap as a feedstock into EAF steelmaking will disrupt current supply chains; for example ArcelorMittal have acquired the Scottish recycling business John Lawrie Metals Ltd., as part of the company's strategy of increasing

* Scope 3 emissions are the result of activities from assets not owned or controlled by the reporting organization, but that the organization indirectly affects in its value chain.

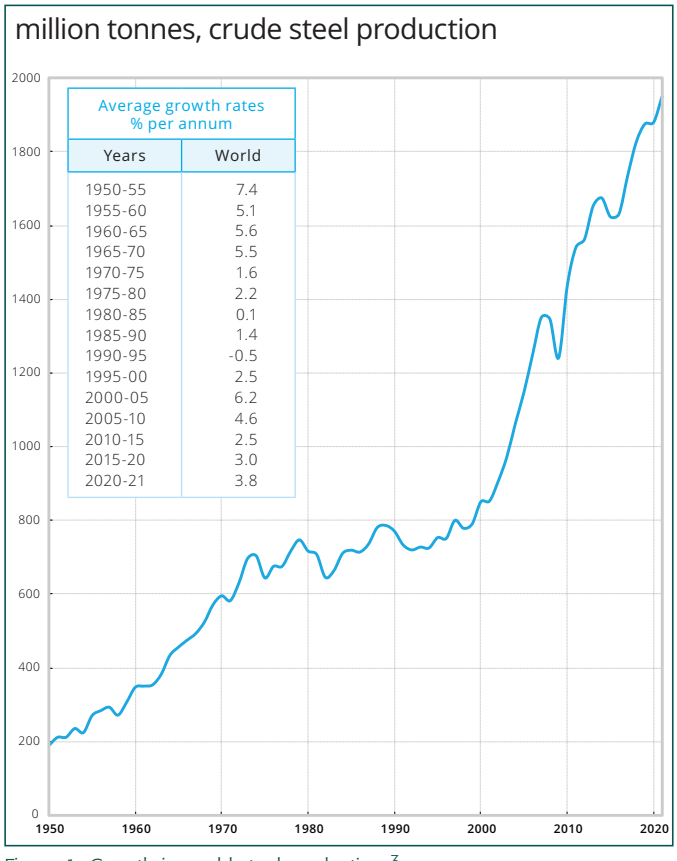

Figure 1: Growth in world steel production [3]

the use of scrap steel to lower CO_2 emissions from steelmaking[9].

The UK produces approximately 7 Mtpa of steel and contributes approximately £2.4 billion, 0.1% of the UK economy and 1.2% of manufacturing output and supported 39,000 jobs in Great Britain in 2021[10]. Current production is based on 78% BF-BOS and 22% EAF, with the EAF production being split between construction products (Celsa) and high performance steels (Liberty Steel and Forgemasters). The UK is in a favourable position for the transition to low CO_2 steelmaking via EAF as it produces 11.3 Mtpa of scrap steel, of which 8.7 Mtpa is exported. Therefore, there is potential for the UK to develop a sustainable supply chain for recycled scrap steel as feedstock into EAF steelmaking to meet the required UK demand for steel production. However, not all steel grades can be produced by the current quality of recycled scrap steel requiring investment in improved sorting technologies and parallel production (or importing) of (low CO_2) DRI. In addition, clean energy is required, at reasonable cost, to allow steel production to be 'green' and competitive as steel is a globally traded commodity.

The change in steel production away from BF-BOS to EAF (with DRI) requires huge investments due to the expensive infrastructure associated with the industry. Alignment with planned refurbishment or replacement of ageing plant is obviously preferred but also requires associated development in green energy, such as hydrogen production and networks. Implementation of new technologies to the steel industry are also being considered for reducing CO_2 emissions using the current infrastructure. Carbon capture utilisation and storage (CCUS) trials with the steel industry are being announced globally[11, 12], potentially allowing BF-BOS steelmaking at very low tCO_2e/t levels, which could be an important approach for production of high quality steels. Approaches to use low CO_2 energy vectors, such as biomass, within the BF-BOS route and increasing the input of recycled steel scrap (current levels can be up to 20% scrap use) can help soften the transition and provide shorter term benefits in reducing CO_2 emissions.

A sustainable UK steel industry provides significant benefits to the wider UK manufacturing sector. For example, approximately 900 kg of steel is used per vehicle[13] with Britain's biggest car factory, Nissan in Sunderland, making around 500,000 cars a year with around half the steel being supplied from the UK[14]. At around 2.32 tonnes of CO_2 per tonne of steel produced by the BF-BOS route significant savings will arise from transitioning to 'green steel', with domestic supply chains providing manufacturing resilience and low transportation CO_2 costs.

Sustainability in the steel sector not only requires changes to the steel production methods but consideration of material efficiency and material circularity. Material efficiencies include strategies such as using higher strength thinner sections, reducing product size (for example smaller cars) and designing for longer life (including repair). Material circularity includes reuse and remanufacturing of steel components. The construction sector already promotes the reuse of steel construction products, with expected increases in the amount of steel that can be reused as design for disassembly becomes more widespread, which is being facilitated by standardisation of components and connections[15]. The Steel Construction Industry (SCI) has published a protocol setting out recommendations for data collection, inspection and testing to ensure that reclaimed structural steelwork can be reused with confidence[16]. Research carried out by the Steel Construction Institute [17 ref. in 15] has estimated that there is around 100 million tonnes of steel in buildings and infrastructure in the UK. This 'stock' of steel is an important and valuable material reuse that will be reclaimed and either reused or recycled in the future. Increasing material reuse and reducing material usage is important as it may lead to lower cost of products, leading to improved standards of living as longer term (by 2050), it is expected that material prices will rise as the earth's natural resources get depleted[18].

Increased reuse and advances in design for disassembly and sortation of end-of-life products, to provide high quality 'scrap' steel as feedstock into low CO_2 steelmaking, will provide sustainability to the steel industry and wider sustainability for UK manufacturing.

Acknowledgements:
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Further reading recommendation:
UK Parliament POSTNOTE Number 672, May 2022

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MAKE SUSTAINABLE MANUFACTURING THE HEART OF THE UK'S NET ZERO TRANSFORMATION

Professor Mark Jolly
Director of Manufacturing and Materials and TransFIRe, Cranfield University

The UK's net zero future will depend on making things in sustainable ways, with close attention to the whole cycle: the materials we use, the energy and carbon emissions involved in processes, and the opportunities for re-use, re-manufacturing and (last of all) recycling.

But for the time being the manufacturing sector in the UK — the sector that globally generates around a third of all carbon emissions — is mired in old ways. The sector has become stuck within a wasteful system based around imports of products and materials, and exports of materials that could have been re-used or recycled. There is still a take-make-dispose mindset. We have industries without the means or motivation to move away from energy intensive, carbon-heavy processes. And while the UK's carbon footprint is 'off-shored' to other nations, increasingly important materials, resources and business opportunities are draining away; consumers are misled over the actual environmental impacts of their choices.

There needs to be a new vision for the future. One that puts sustainable manufacturing at the centre of the UK's net zero ambitions and achievements. That means a long-term strategy integrated with plans for energy and net zero emissions as a whole, that moves away from limited, linear thinking to thinking about wider systems.

In this context, the lack of an industrial strategy at this stage is a massive void — particularly given the essential need for setting out the case for long-term investment: transformational, system-wide investment. Short-term financing of discrete projects based on an expectation of immediate payback is no longer an answer. Investment decisions need to be based on the bigger picture, on the much greater returns in terms of 'value': long-term reductions in carbon emissions, the impact on climate change, reduced use of scarce natural resources, reduced energy use — all helping to deliver sustainability and resilience to the UK economy, businesses and society.

As one example of how UK thinking is faltering compared with other nations, in 2021 a single Spanish steelworks was given €1 billion funding by government to become the world's first full-scale zero carbon emissions steel plant. In the UK, British Steel has been promised £300 million in instalments to secure jobs, only a proportion of which is to be used to replace blast furnaces with more sustainable electric arc furnace technology.

The strategy for sustainability needs to take into account the following five key issues.

We need to understand the full picture of the flow of materials and energy use in UK manufacturing: for example, Cranfield's TransFIRe research project has identified how CO_2 emissions per kg in the manufacture of a product such as cement in the UK is very similar to the average globally, but that processes here involve 15% more energy. Why? The 'foundation' industries — chemicals, cement, ceramics, glass, metals and paper — produce 75% of all materials in the UK economy and account for about 10% of the nation's total CO_2 emissions. If we know where the hotspots of materials and resources usage are, investment can be targeted to transformative technologies that will have a cumulative and much larger impact on reducing carbon emissions nationally (and internationally), as well as identifying opportunities for capturing energy and 'waste' materials for re-use.

Don't legislate around one measurement: it leads to short-sighted decisions and encourages the wrong kinds of

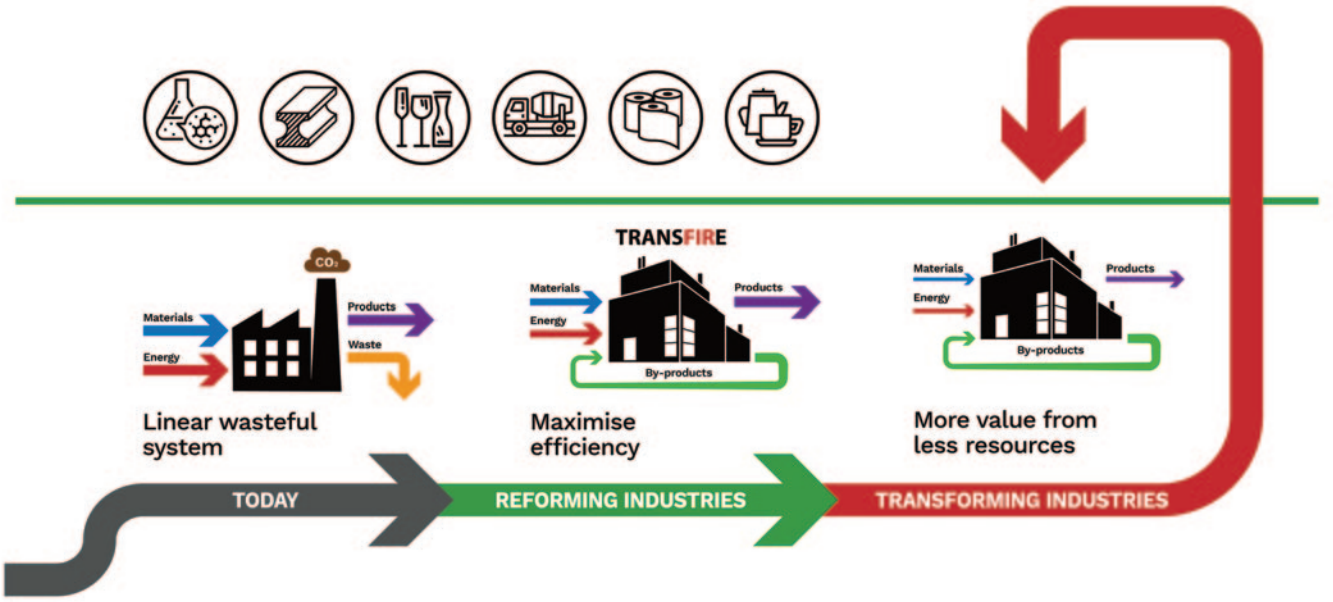


Figure 1: Showing the journey our foundation industries need to take to get to net zero. Moving first to reusing waste materials and improving process efficiencies and finally to reducing the amount of resources used with the concomitant change of business models taken the full value of materials into consideration.

behaviours among both manufacturers and consumers. The implications of the legislation on tailpipe emissions and CO_2 are a serious lesson in unintended and damaging consequences. This single measure, used around the world as an indicator of what makes for an environmentally-friendly motor vehicle, is misleading for consumers, governments and societies as a whole, and has the potential to drive up CO_2 emissions, given the number of cars on the world's roads is expected to reach 2 billion by 2035.

Cranfield's Sustainable Manufacturing Systems Centre has looked at exactly what the push for lower tailpipe emissions — more lightweight vehicles with aluminium engines — has actually meant. Less fuel is used, emissions are lower, but what about all the energy required for manufacturing the lighter engines? The production of each aluminium cylinder block consumes 1.8 to 3.7 times more energy than the production of cast iron. The almost fourfold energy increase results when the aluminium cylinder blocks are produced by casting. Overall, more than 70% of the global aluminium production is based on fossil fuels. Under these conditions, the energy intensive production of aluminium generates over 10 kg of CO_2 per kilogram of aluminium. That means a typical aluminium blocked car would need to be driven for between 120,000 km and 560,000 km before there were any environmental benefits at all from the lower fuel use involved. The average life expectancy of motor vehicles is only 210,000 km, so the great majority of cars aren't helping, they're just increasing CO_2 emissions.

Keep sovereignty over materials: because relying on imports of both products and materials exposes UK industry and society more generally to risks (as demonstrated during the Covid-19 pandemic). There needs to be more careful stock-taking and monitoring of the movement of materials, a recognition of the critical importance of keeping stocks of materials within the UK and not relying on imports — an appreciation of what materials should not be treated as 'waste'. Materials shouldn't ever be seen as something that can just be discarded. There needs to be a shift in the idea of 'value' in general, away from the typical business model driven by cost per unit and where value is understood to plummet at the point of consumption, the instant that any product or material has been used.

The UK has fallen well behind other more developed nations in terms of the recycling and recovery of materials, having become reliant on the cheaper option (at least for the moment) of importing materials and sending 'waste' overseas. This has, so far, been a missed opportunity in terms of new

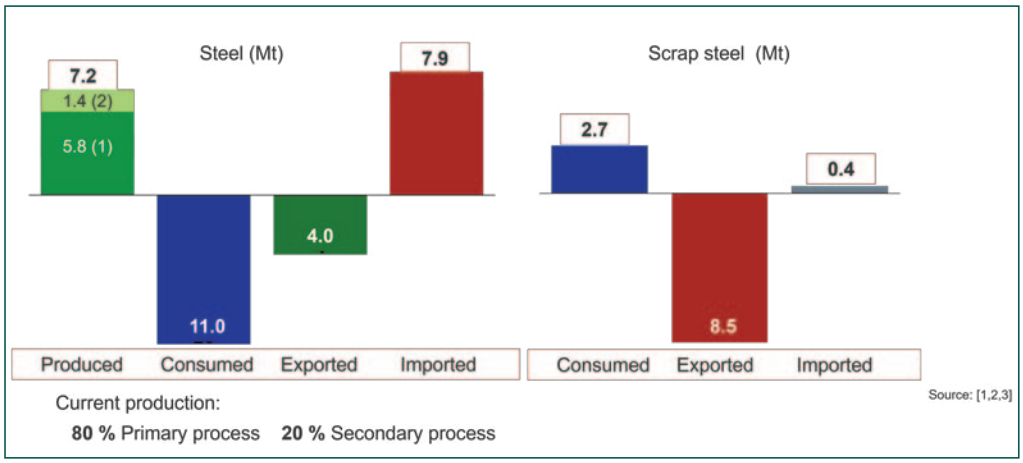


Figure 2: Chart showing production, import and export of Steel and Steel scrap for the UK in 2019.

[1] BGS. United Kingdom Minerals Yearbook. BGS, 2021
[2] International Trade Administration. "Steel imports report: United Kingdom". ITA, 2021.
[3] International Trade Administration. "Steel exports report: United Kingdom". ITA, 2021

enterprise opportunities for reprocessing and re-use — and for keeping materials stocks within the UK. Other nations have a much greater degree of sovereignty over materials. China, for example, is currently estimated to be responsible for 90% of the processing of the world's materials, 80% of their extraction.

Steel and aluminium are good examples of where national requirements in industry far outweighs our local production, and yet we export large volumes of scrap steel (8.5 million tonnes according to 2019 figures) and aluminium which both could be processed locally — if there was the infrastructure available. At the same time, the UK also imported 400,000 tonnes of scrap steel in 2019.

Switching to light electric vehicles by 2035 is an example of the challenges ahead on the ownership of materials. Research carried out at the University of Nottingham estimates the demand for EV batteries alone would mean the need for access to an unlikely proportion of the world's finite stocks of nickel, cobalt, manganese and lithium. Within five years of the 2035 target, the demand from the UK would come to exceed that of the entire European Union. Only through extensive recycling and re-use will there be a reliable supply of EVs. Keeping hold of and re-using stocks of EV batteries within the UK would mean there could be a 50/50 balance of imports of primary materials alongside the secondary materials from re-cycling and re-use by 2045.

Re-incentivise research and innovation within companies: to make UK manufacturers a source of new initiatives for transformation towards sustainability. The 1980s saw a trend of manufacturing companies divesting themselves of R&D capability, relying instead on work going on within universities. Many of the largest UK manufacturing operations are also only satellites of overseas parent companies, without their own R&D function and the passive recipients of innovations to implement. Given the scale of challenges relating to sustainability — the need for energy and carbon reductions, to introduce circular economy principles through recycling, re-use and re-manufacturing — there is a need for an active culture of research and innovation within businesses themselves.

Encourage more diversity in the leadership of manufacturing: because UK industries such as cast iron and steel have been using the same methods for a few hundred years; the macho culture and image have stayed the same, limiting the appeal to people who could bring new ideas, approaches and open attitudes to change. A future of making things sustainably needs a different team. The UK would benefit exponentially from encouraging new generations of leaders for manufacturing, by more actively promoting the career opportunities in driving the transformation of industry.

Technology alone will not enable the UK to achieve its net zero targets. There will need to be different attitudes to consumption: using less, making products last longer. In support of a new vision for manufacturing industries, we need to move forward as a society based on a shared sense of responsibility. Businesses need to manufacture with less, use a smaller bill of materials and be actively looking to simplify their products so materials are easier to re-use. We all need to be 'good' consumers, open to ideas of consuming less, as well as leasing and sharing rather than ownership. In this way the responsibility for end-of-life falls with manufacturers, there are more opportunities for re-use and re-manufacturing of their simpler products, and more of the value of the materials stays in the system. 'Cheap' should only ever be a dirty word. ■

FOOD PACKAGING FROM NATURE: CELLULOSIC FILMS FOR THE 21ST CENTURY

Alex.L.L.Gresty

This spring, I had the privilege of receiving an invitation to present my PhD research at The STEM for Britain Poster Competition held at the Houses of Parliament. Amidst the remarkable array of diverse and groundbreaking research, I was thrilled that my poster received two awards: the Gold award in the Physics category and the Silver award for the Dyson Sustainability Awards. This experience has been truly unparalleled for me as an early-career scientist, instilling a confidence in my own abilities and alleviating the daunting challenge of combating the notorious 'Imposter Syndrome'.

My PhD research is based in the Soft Matter Physics Group at the University of Leeds. 'What is Soft Matter Physics?' you might ask. Without running the risk of sounding too scholarly; I like to call it: 'The Science of things that are Soft'…. frustratingly vague, I know. This field explores a wide range of materials including polymers, colloids, liquid crystals, rubbers, foams, and more. We use physical, mathematical, and chemical sciences, to explain phenomena exhibited by materials in our everyday lives [1]. What makes my PhD even more exciting is collaboration with industry giants, Futamura; the world's leading producer of cellulose films. This dynamic

partnership between academia and industry has enabled the privilege of visiting their UK factory, using their facilities, and forging excellent friendships and mentorships with their staff, creating an environment of lively discussion (and debate!) during meetings. By employing academic resources, I am able to address real-life problems, which, in my opinion, embodies the true essence of scientific pursuit that we all yearn for.

Ok, so what problems are we talking about then? Well perhaps the biggest problem that my generation will have to face. How can we sustain and enable a developed lifestyle worldwide to our growing population with our finite resources? One critical aspect of this global challenge lies in our escalating plastic consumption. We are rapidly approaching the threshold of plastic consumption that our planet can sustain and the reckless overuse of synthetic plastics has become a focal point for climate activists. The packaging industry alone contributes a staggering 141 million tons of plastic packaging annually, accounting for up to 36% of total plastic pollution[2]. Synthetic plastics, derived from fossil-based resources, have dominated the field of material sciences throughout the past century, providing innovative and functional solutions for a wide range of applications. However, due to the limited nature of this resource, coupled with the fact that many synthetic polymers are non-biodegradable, there is an imperative drive for a more sustainable alternative.

One solution to address the issue of plastic pollution lies in the development of biodegradable materials; and where better to look for these than in nature? One such resource that is paving the way in this objective is cellulose, the main chemical component in most plants; making it Earth's most abundant organic polymer, constituting 1.5 trillion tons of the planet's annual biomass[3]. Cellulose is a linear chain polymer composed of 1000s of glucopyranosyl units, as illustrated in Figure 1, linked together[4]. Cellulose can be extracted from plants and converted to films using a technique known as 'The Viscose Process'. These biofilms possess high tensile strength and excellent barrier properties, making them well-suited for food packaging applications. These films are seeing a real resurgence in popularity as we instigate the phasing out of synthetic plastics for alternatives that are biodegradable and renewable.

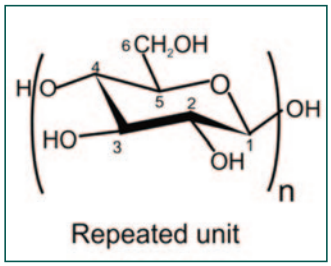


Figure 1: Cellulose monomer unit

Ok, so what's the catch? Well, one inherent obstacle with the wide-scale commercialisation of this process is that plants are capricious creatures, exhibiting a vast range of physical properties from one species to another. The architecture of the plant cell wall exists as a complex and varied blend of cellulose, hemicelluloses, pectin and lignin; whose combination has been optimised for individual plant's needs by nature over millions of years. The symbiotic relationship between each of these components is key to understanding a plant's (and their derived product's) mechanical, structural and biological traits. However, due to the vast divergences in cell wall structure between plant species, a comprehensive understanding of the relationships that drive a plant's characteristics remains elusive. This knowledge is vital in the drive for unlimited utilisation of plants for endless applications in the materials and agricultural industries, in order to accelerate the switch to renewable and biodegradable materials.

The research I presented at STEM for Britain focused on the properties of two cellulose-based films made using the exact same process and conditions, with the only difference being the starting wood pulp was derived from two different plant species: Eucalyptus and Western Hemlock. The aim was to understand how variation in plant species affects the mechanical and structural properties of the films. This project was particularly engaging as it stemmed from genuine customer complaints regarding the underperformance of Hemlock films. By identifying the structural properties that impact film performance, we can provide insights for Futamura to enhance their manufacturing process and ensure consistent films.

In order do this, I applied a range of physical analysis techniques; including:

• **Tensile tests** determined mechanical performance and confirmed customer complaints that the Western Hemlock Film was underperforming.

• **Dynamic Mechanical Thermal Analysis** determined the molecular motion of the cellulose molecule within the films. These tests showed that the molecular dynamics of cellulose was consistent for both films, suggesting that this is not affecting mechanical properties.

• **Vacuum oven testing** and purging under a nitrogen atmosphere discovered that the Eucalyptus film has a higher water content. This result is associated with superior mechanical properties due to the way that water interacts with the various side groups on the cellulose molecule, resulting in increased ductility.

• **Enzyme Linked Immunosorbent Assays** found that the Eucalyptus film contains a higher composition of the

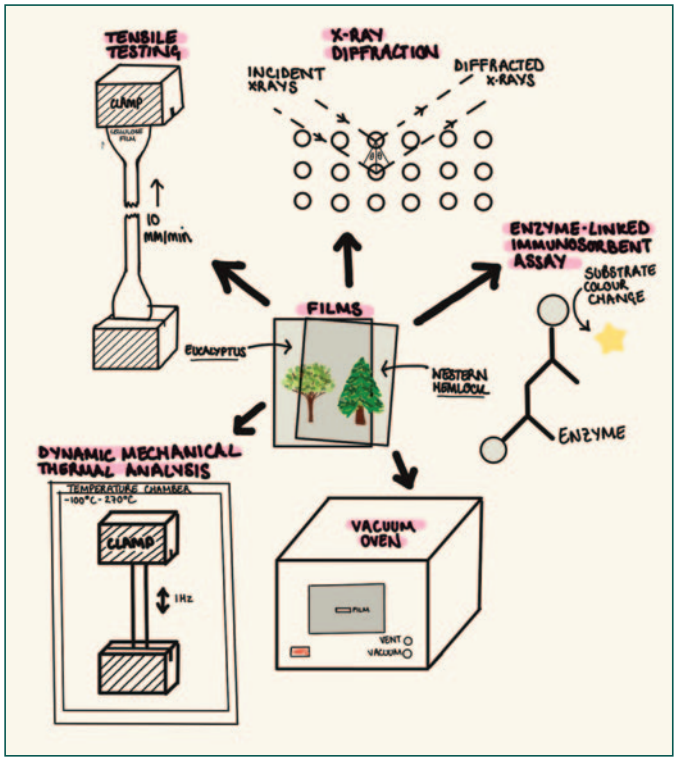


Figure 2: Schematic summary of physical analysis techniques

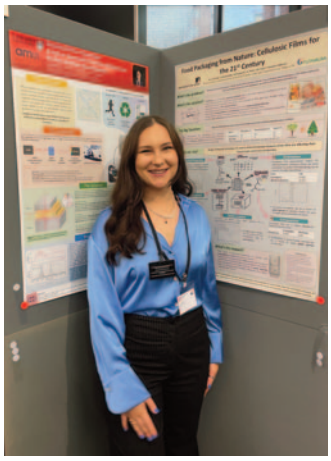
hemicellulose 'Xyloglucan', this compound is associated with increasing the water content of cellulosic-materials, thus altering the mechanical properties of the films this way.

• **X-Ray Diffraction analysis** determined that the orientation on cellulose chains in the eucalyptus film was higher, this can be a result of the length of the cellulose chain in the original plant material and is also associated with superior mechanical properties.

To summarise, my work has shown that the choice of plant species has an impact on the water content, composition and orientation of films, thus influencing their mechanical performance. This work has led Futamura to discontinue usage of Western Hemlock wood pulp, as well as incorporating Eucalyptus into all films to enhance mechanical properties. Ultimately, we want to understand the relationships between each of these structural and mechanical properties to enable the use of any plant species to create an optimally tuned, uniform film. Plant choice is deliberated extensively by industry; with sustainability and cost being extremely important factors. Continued research will enable the possibility of using agricultural waste feedstocks, improving Futamura's green credentials even further.

Earlier this year I had the chance to present this work at The Houses of Parliament for STEM for Britain competition. Being in my final year, I thought I had overcome the pre-conference nerves, known well to PhD students. However, as I approached Big Ben along Westminster Bridge, the stature of this event truly struck me. This was a pivotal moment, I remember thinking 'Ok, this is sink or swim' – a chance to share my obscure corner of research to a wider, and influential audience. The poster session ran for around 1.5 hours, with each judge offering a different perspective on my poster, creating a dynamic (and challenging) session of presentations, questions and defending! In between judges I chatted with the fellow students around me, the sheer range of outstanding research showcased from various institutions was truly staggering. The whole room vibrated with the buzz of scientific interest, creating an electrifying atmosphere. This was the most significant take away from the event, the passion for sharing research with an engaged audience is any researcher's dream. Once judging was over, I was visited by my local MPs; Hilary Benn and Alex Sobel. Their support and genuine interest provided me with a much-needed reset after an intense judging process. To have encouragement from Leeds representatives, really reinforced the value and importance of my research.

Announcement of the winners was accompanied with inspiring talks from MP Stephen Metcalfe and representatives from esteemed professional bodies. During the Physics awards, Dr Elizabeth Cunningham from the IOP spoke about the breadth of research that she'd encountered that day, as well as her own experiences at STEM for Britain. Cliché, I know, but I had to do a double (and then a triple) take when she read my name for Gold in Physics. Amongst the phenomenal work I had seen throughout the session, I was honoured to be selected as the winner. We were recognised with certificates, medals and an enthusiastic photo shoot – my supervisors commented they had never seen someone smile with their whole body like I do in these photos. Once this had just started to sink in, it was time to announce the Dyson



Sustainability Awards for Outstanding Research towards a more Sustainable Future. Dyson representative, Nicola Clifton, announced that I had also won Silver in this category. So, overwhelmed with joy, I went up to once again to receive my certificate and prize! A PhD can be a thankless and often extremely lonely pursuit, however, these wins have been the ultimate recognition and culmination of all the labs, tests and tears.

The significance of this competition has been a defining moment in my academic journey. To stand with two other remarkable women as winners of a Physics award is a powerful testament to the progress we have made, something that my Grandma's would have dreamed to see. This experience has instilled a courage and fearlessness to pursue my work. I have been giving the elusive gift as a scientist of confidence to make bold and creative steps, alleviating the burden of self-doubt that most of us battle with daily. More importantly though, these awards highlight the significance of sustainability research and the advancement of materials. They signify the growing recognition within society of the importance of embracing sustainable solutions for a sustainable future. In the midst of all the challenges, the drive for the future of sustainability fuels my perseverance and dedication in my work, making me ever more relentless in my pursuit of knowledge.

Acknowledgements

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THE DATA SECURITY AND MODERNISATION ADAPTION TO THE CLOUD BY ORGANISATION

Roger Brown
CGS Group

Dan Carter
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Mike Moran
Director, The Floow

Peter Tarbitten
Director Service,
CGS Group

Eric Forcythe-Reid
Director Security, CGS

Shaun Orpen
CEO, SCAD Software Group

It has been a fundamental challenge for companies historically around the world and in the UK on how to modernize their old legacy systems that runs their business. CGS has completed its research which includes the findings from a Microsoft white paper and a view from industry & consulting with organizations at the heart of the change such as The Floow Insurance, The Consultancy Group, SCAD Software, amongst some of the organizations taking on the challenge, and has been approached to help Companies transform in today's world. We review the why's and do nots of the modernization challenges and what the future brings for organizations that don't take the challenge to modernize. The research was completed after the COVID pandemic that took the world by surprise.

HISTORIC UNDERSTANDING OF LEGACY SYSTEMS

In Introduction: In today's digital age, businesses are relying more and more on technology to provide their customers with the best possible experience. With this increased reliance, it's become increasingly important to modernize systems and IT systems to keep up with the demands of a fast-paced, digital world.

What is System Modernization? System modernization is the process of upgrading legacy systems to new, modern technology platforms. This includes updating hardware, software, and processes to make the systems more efficient, scalable, and secure. The goal of System Modernization is to transform legacy systems into modern, cloud-based platforms that can support the evolving needs of businesses.

Why is System Modernization Important? Legacy systems can often be slow, expensive to maintain, and unreliable, which can negatively impact the user experience. Upgrading these systems to modern platforms can improve performance, reduce costs, and increase security. Additionally, modernizing systems can help businesses to take advantage of new technology innovations, such as artificial intelligence and machine learning, to enhance their offerings and stay ahead of the competition.

Modernization is the act of updating organizational performance, systems and tools to the most current versions or new improved infrastructure. In the context of cloud computing, modernization is the process of transitioning an organization's systems, processes, and data management to a cloud-first approach. The goal is to improve organizational and technological performance, enhance the quality of customer and employee experiences, and accelerate time to market for new offerings and updates.

LEGACY VS SECURITY

The Currency issue (continuing to run your business on legacy hardware and software models) is a hot topic in Cyber Security right now. Legacy hardware and software pose several cyber security risks such as known vulnerabilities, incompatibility with modern security measures, lack of support, outdated technology, and increased attack surface.

These systems may have known security vulnerabilities that have not been patched, making them easier targets for cyberattacks, and may not be compatible with modern security measures, making it difficult to protect against cyber threats. Additionally, legacy systems may

CGS
CIOUX GLOBAL SERVICES

no longer receive support or updates from the manufacturer, leaving them vulnerable to security threats and may use outdated encryption and authentication methods that are now easily cracked by modern cyber criminals. It is important to regularly assess and update security measures to minimize these risks.

KNOWN DATA CYBER THREATS

However, some of the main types of cyber threats that organizations may face in the coming year include: -

• **Ransomware:** This is a type of malicious software that encrypts an organization's data and demands a ransom for the decryption key.

• **Phishing**: This involves tricking individuals into revealing sensitive information, such as login credentials or financial data, through fake emails or websites.

• **Malware**: This refers to any software that is designed to cause harm to an organization's systems or steal sensitive data.

• **IoT attacks**: As the number of internet of things (IoT) devices continues to grow, organizations will need to be vigilant about the security of these devices, which can be vulnerable to cyber-attacks.

• **Cloud attacks**: As more organizations adopt cloud computing, they will need to be aware of the potential for cyber-attacks on their cloud-based systems and data.

• **Supply chain attacks**: This involves compromising an organization's suppliers or other partners to gain access to the organization's systems or data.

LEGACY SYSTEM CHALLENGE IN INDUSTRIES

In most industries, the IT department plays a crucial role in facilitating efficient and streamlined processes. However, there are industries that are averse to change and often rely on legacy systems that have not been updated. Many third-party organizations supporting companies in these industries lack the financial resources to update and manage their IT services, resulting in the continued use of outdated systems makes it difficult to future-proof & upgrade services.

A VIEW FROM IT BUSINESS LEADERS ON LEGACY SYSTEM CHALLENGES

The Floow Insurance

Claims inflation is a significant challenge in today's insurance industry, and it particularly affects the profitability of motor insurance policies. Outdated legacy systems that are still widely used prevent insurers from taking advantage of the latest technology to control costs and prevent claims leakage. As a result, policyholders are forced to bear the consequences, which include substantial increases in policy premiums.

Mike Moran, Director of Product at The Floow Insurance

The Consultancy Group

A growing emphasis on Digital Transformation across the market has seen a trend in organizations reviewing their legacy system landscape, in part driven by the changes enforced on us all during the pandemic. CRM and ERP platforms are at the heart of these modernization plans, particularly as cloud-based solutions have become more popular due to advantages around scalability, cost efficiencies and improved data management capabilities.

Dan Carter, Senior Consultant at The Consultancy Group

Cioux Consultancy Practice

Legacy systems pose security vulnerabilities and lack support due to their complex code and instability in the fast-paced world of technology. Organizations are advised to transition to green and carbon-friendly services /data centers in the cloud to

reduce costs and stabilize their production platforms. While there may be initial costs, managing the transition effectively can greatly improve IT infrastructure efficiency. Delaying this move becomes increasingly costly for organizations each year. As we are witnessing a gradual shift away from legacy systems.

Roger Brown, Principal Consultant Vice President at Cioux Global Services Group

"Legacy anchors organizations to the past, whilst the cloud beckons them towards a future of innovation and agility. Projects often with many unknowns makes the journey more challenging. The key is a Partner with whom you can together embrace these challenges head-on and resolve as a team"

Shaun Orpen CEO at SCAD Software

INCREASING TECHNOLOGY CHANGES

Modernizing legacy systems involves assessing, planning, selecting a platform, such as cloud or updating hardware/software, and implementing automation to improve efficiency, security, and support evolving needs. This can help businesses stay ahead and offer better customer experience.

LEGACY SYSTEMS TO CLOUD COMPUTING

Cloud computing refers to the delivery of computing resources, such as servers, storage, software, and services, over the internet. It offers several different deployment models and service models, which can be categorized into the following concepts:

Deployment Models:

Public Cloud: These are cloud services provided by third-party providers over the internet and are accessible to anyone who wants to use them.

Private Cloud: These are cloud services hosted on a private network and are accessible only by a particular organization or company.

Hybrid Cloud: This is a combination of public and private cloud services, where a company can use both to meet their computing needs.

Multi-Cloud: This is the use of multiple cloud services from different providers, to meet the computing needs of an organization.

Service Models:

Infrastructure as a Service (IaaS): This is a cloud service model that provides virtualized computing resources such as servers, storage, and networking over the internet.

Platform as a Service (PaaS): This is a cloud service model that provides a platform for developing, running, and managing applications over the internet.

Software as a Service (SaaS): This is a cloud service model that provides software applications over the internet, typically accessed through a web browser.

Cloud computing adoption has been rapidly increasing in the industry, as it provides several benefits such as cost savings, scalability, flexibility, and accessibility. According to Gartner, the worldwide public cloud services market is projected to grow to $397.4 billion in 2024, up from $242.7 billion in 2019. Industries such as healthcare, finance, education, and retail are among the top adopters of cloud computing.

ORGANIZATION LEGACY SYSTEMS

It is estimated that a significant number of organizations globally still use legacy systems, often due to their familiarity and the difficulty in transitioning to new technology.

This information is not publicly available, and the number can vary greatly depending on the definition of "legacy systems." However, it is safe to say that a substantial portion of businesses in the UK are still using legacy systems, as they are often deeply integrated into the company's processes and may be challenging to replace.

WHAT ARE THE FINANCIAL BENEFITS MOVING FROM LEGACY TO MODERN?

Moving from legacy systems to modern systems can bring a range of financial benefits, including:

Increased efficiency: Modern systems are designed to be user-friendly, efficient, and flexible, which can lead to increased productivity and reduced costs.

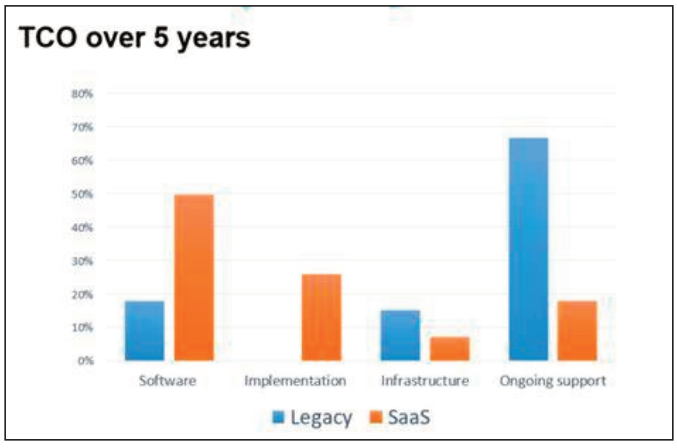
Scalability: Modern systems are designed to scale as a business grows, which can help organizations avoid the cost of investing in new hardware or software as they expand.

Lower maintenance costs: Legacy systems often require ongoing maintenance and support, which can be expensive. Moving to modern systems can help reduce these costs, as they are often designed to be more self-sufficient and require less maintenance.

Improved security: Modern systems are designed with security in mind, and often have built-in security features that can help reduce the risk of data breaches and minimize the cost of recovery.

Better decision making: Modern systems often have advanced analytics and reporting capabilities, which can help organizations make more informed decisions and improve overall financial performance.

This was prepared by CGS Consultancy Services part of the CGS Group
Contact - enquiries@cgs.uk.com



WHAT ARE THE FINANCIAL BENEFITS MOVING FROM LEGACY TO MODERN?

Increased competitiveness: By adopting modern technologies, organizations can stay ahead of the competition and remain relevant in their respective industries, which can lead to increased revenue and market share.

Overall, moving from legacy systems to modern systems can bring significant financial benefits to organizations, including increased efficiency, scalability, and improved decision-making capabilities.

THE FUTURE LEGACY CHALLENGE

The future for companies using legacy systems depends on several factors, including the specific needs of the company and the current state of technology. In general, companies that continue to rely on legacy systems may face difficulties in modernizing their operations, keeping up with the latest technology advancements, and meeting the demands of customers and stakeholders. However, some legacy systems may still serve a business's needs and may be more cost-effective to maintain than to replace.

Ultimately, the future for companies using legacy systems will depend on their ability to effectively manage and update their systems to ensure that they continue to meet the needs of the business. This may involve a gradual transition to modern systems, or a complete overhaul of their technology infrastructure. Companies that embrace digital transformation and invest in modern technology will likely be better positioned to meet the challenges of a rapidly changing business landscape.

Microsoft have now stopped support on old legacy systems, and if they do it's at a large cost to encourage organizations to move to the cloud to gain cost efficient savings. This way organization can gain more efficiencies and reduce their carbon footprint.

DELIVERING SYSTEM MODERNIZATION IN ORGANIZATIONS

Deploy to production: Deploy the modernized system to production and monitor it to ensure it is performing well and meeting the needs of users.

Continuously evaluate: Continuously evaluate the performance of the modernized system and make necessary improvements to ensure its success in the long term.

By following these steps and engaging all stakeholders in the process, you can successfully deliver a system modernization project that meets the needs of the business and supports its goals.

USING IT CONSULTANCY COMPANIES TO MOVE TO DIGITAL AWAY FROM LEGACY SYSTEMS

There are several reasons why companies might use IT consultancy firms to move away from legacy systems and towards digital technologies:

Expertise: IT consultancy firms have a wealth of experience in helping organizations modernize their technology infrastructure and move away from legacy systems. They can provide expertise on the latest technology trends and best practices for digital transformation.

Objectivity: IT consultancy firms provide an objective perspective on a company's technology needs, which can be helpful in making unbiased recommendations for change.

Project Management: Migrating from legacy systems to digital technologies can be a complex and time-consuming process. IT consultancy firms can provide project management expertise to ensure that the transition is smooth and efficient.

Technical Knowledge: IT consultancy firms have the technical knowledge and skills to help organizations implement new technologies and integrate them into their existing systems.

Cost Savings: By working with an IT consultancy firm, companies can often reduce costs associated with digital transformation, as the firm will have experience negotiating with vendors and suppliers.

Overall, IT consultancy firms such as Accenture, IBM, Microsoft, Cioux (CGS), The Consultancy Group, SCAD, and others can provide valuable support to companies looking to move away from legacy systems and embrace digital technologies. They can help organizations navigate the challenges of digital transformation and ensure a smooth and successful transition. ■

POLICYMAKERS AND SCIENTISTS COME TOGETHER FOR PARLIAMENTARY LINKS DAY 2023

Stephen Metcalfe MP, Chair of the Parliamentary & Scientific Committee, welcomes attendees to the event.

20 JUNE 2023

This year's Parliamentary Links Day was a huge success with a packed room at the House of Commons. MPs, representatives from scientific organisations and those related to parliamentary science policy convened to discuss science and economic development.

Stephen Metcalfe MP, Chair of the Parliamentary & Scientific Committee, introduced Parliamentary Links Day, emphasising the importance of the interaction between parliamentarians and the scientific community, as it enriches the policy making process.

Links Day is the largest science event on the annual parliamentary events calendar. It is organised by the RSB on behalf of the science and engineering community to strengthen dialogue with parliament, and to provide MPs with a more rounded understanding of the scientific issues we face.

George Freeman MP and Chi Onwurah MP, Minister and Shadow Minister for Science, Research and Innovation respectively, gave speeches on the importance of science and how it can propel the UK economy.

George stressed that science in relation to our economy is something that we can all agree on and that we have to invest more and do more to make this country a laboratory for the innovations of tomorrow.

Chi discussed the necessity of sustainable growth and how it can only come from a science and technology based economy, which is why the Government must continue to invest in R&D.

A panel of academics then examined how science and the economy interlink, highlighting the value of a strong connection between both parliament and the sciences in all capacities to advance in policymaking. Dr Jo Reynolds, Royal Society of Chemistry, chaired the panel and Professor David Leslie, Lancaster University, kicked off the discussion by speaking about his expertise: Artificial Intelligence (AI).

He touched on how the skills shortage is a key blocker for collaboration, as well as data sharing issues both legally and practically. He mentioned that modern AI is great but has requirements that many companies cannot meet, both in terms of resources and data. He noted that more traditional stats skills can fill in the gap, as bringing these into play is a powerful addition to the AI toolkit.

George Freeman MP, Minister for Science, Research and Innovation

Chi Onwurah, Shadow Minister for Science, Research and Innovation

Professor Dame Angela McLean, Chief Scientific Adviser for Government

Professor Sarah Main, CaSE, further supported this point by noting three dimensions of a science based economy: people and skills, maximising local impact of R&D, and business R&D. She stressed that we need a people strategy, to ensure that we match education provision to changing skills requirements.

Following the panel discussion, Professor Dame Angela McLean, Government Chief Scientific Adviser, gave a keynote address on exploiting R&D to produce measurable change for the people of the UK. She highlighted that science is for everyone, for people from all backgrounds, and that we should encourage more people to become scientists.

Other panellists and speakers included Professor Diane Coyle, Bennett Institute for Public Policy, and Professor Jonathan Napier, Rothamsted Research.

Links Day, now in its 35th year, is run by the Royal Society of Biology on behalf of the following organisations: Anatomical Society, Applied Microbiology International, Association of Applied Biologists, Biochemical Society, British Ecological Society, British Pharmacological Society, British Society for Immunology, Council for the Mathematical Sciences, Genetics Society, Geological Society, Institute of Physics, Nutrition Society, Physiological Society, Royal Society of Chemistry, Society for Experimental Biology, Society for Radiological Protection.

Thank you to everyone online and in person who joined us for the event, a recording will be available on the RSB's YouTube channel. ■

This report, including the images, is provided courtesy of the Royal Society of Biology

DISCUSSION MEETING, 22ND MAY – 'DEEP TECH SME ECO SYSTEM – SUPPORTING RESEARCH INTENSIVE SMES FOR GROWTH'

The Royal Society of Chemistry were our partners for the 22nd May Discussion Meeting in the House of Commons on: '*Deep Tech SME Eco System – supporting research intensive SMEs for growth*'.
L- R: **Dr Alexander Reip**, Chief Technical Officer, Oxford NanoSystems; **Stephen Metcalfe MP**, Chairman, P&SC; **Tanya Sheridan**, Head of Policy and Evidence, Royal Society of Chemistry; **Dr Joe Marshall**, Chief Executive, National Centre for Universities and Business; **Adam Afriyie MP**, Chair, Parliamentary Office of Science and Technology (POST) Board; **Stephen Benn, Viscount Stansgate**; President, P&SC and **Professor Martin Freer**, Vice-President for Science and Innovation, Institute of Physics' Council.

HOUSE OF COMMONS SELECT COMMITTEES

BUSINESS AND TRADE COMMITTEE

(Replaced the Business, Energy and Industrial Strategy Committee on 26th April 2023)

The Committee scrutinises the policy, spending and administration of the Department for Business and Trade, and its public bodies.

Membership:

Darren Jones MP, Labour, Chair
Bif Aflolami MP, Conservative
Alan Brown MP, Scottish National Party
Jonathan Gullis MP, Conservative
Antony Higginbottom MP, Conservative
Jane Hunt MP, Conservative
Ian Lavery MP, Labour
Anthony Mangnall MP, Conservative
Andy McDonald MP, Labour
Charlotte Nichols MP, Labour
Mark Pawsey MP, Conservative

Current Inquiries:

- Decarbonisation of the power sector. Opened 20th May. Report published 28th April 2023.
- 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. Report published 21st April 2023.
- The work of the Investment Security Unit. Opened 15th June 2022. Published 23rd March 2023.
- Batteries for electric vehicle manufacturing. Opened 17th January 2023.
- Export-led growth. Opened 26th May 2023.
- The performance of investment zones and freeports in England. Opened 9th June 2023. Deadline 8th September 2023.

For further details: Tel: 020 7219 5777
Email: commonsbtc@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

- Mapping the path to net zero: Opened 25th June 2021.
- Net zero aviation and shipping: Opened 20th July 2021.
- Accelerating the transition from fossil fuels and securing energy supplies. Opened 31st March 2022. Report published 5th January 2023. Government response published 23rd March 2023.
- The financial sector and the UK's net zero transition. Opened 30th May 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.
- Enabling sustainable electrification of the UK economy. Opened 4th May 2023.
- Outdoor and indoor air quality targets. Opened 10th May 2023.

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

SCIENCE, INNOVATION AND TECHNOLOGY COMMITTEE

(Replaced the Science and Technology Committee on 26th April 2023)

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

The Science, Technology and Innovation Committee is appointed by the House of Commons to examine the expenditure, administration and policy of the Department of Science, Innovation and Technology, and associated public bodies.

It also exists to ensure that Government policies and decision-making are based on solid scientific evidence and advice.

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.
- 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. Report published 10th May 2023.
- Diversity and inclusion in STEM – Opened 22nd November 2021. Report published 24th March 2023. Government response published 16th June 2023.
- 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.
- Governance of artificial intelligence (AI). Opened 20th October 2022.
- The antimicrobial potential of bacteriophages. Opened 9th November.
- Emerging diseases and learnings from covid-19. Opened 15th December 2022.
- Commercialising quantum technologies. Opened 16th March 2023.
- Insect decline and UK food security. Opened 20th March 2023.

HEALTH AND SOCIAL CARE COMMITTEE

The Committee scrutinises government and in particular the work of the Department of Health and Social Care.

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.
- Digital transformation in the NHS. Opened 13th May 2022.
- Integrated Care Systems: autonomy and accountability. Opened 6th July 2022. Report published 30th March 2023. Government Response published 14th June 2023.
- Assisted dying/assisted suicide. Opened 5th December 2022.
- NHS Dentistry. Opened 7th December 2022.
- Prevention in health and social care. Opened 18th January 2023.
- Future cancer. Opened 21st March 2023.
- Pharmacy. Opened 8th June 2023.

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

ENERGY SECURITY AND NET ZERO COMMITTEE

(Created 26th April 2023)

The Energy Security and Net Zero Committee scrutinizes the policy spending and administration of the Department of Energy Security and Net Zero and its public bodies, including Ofgem and the Committee on Climate Change.

Membership:

Angus Brendan McNeil, Scottish National Party, Chair
Rt Hon Hilary Benn MP, Labour
Rt Hon Vicky Ford MP, Conservative
Barry Gardiner MP, Labour

Mark Garnier MP, Conservative
Sir Mark Hendrick MP, Labour
Mark Jenkinson MP, Conservative
Mark Pawsey MP, Conservative
Dr Dan Poulter MP, Conservative
Lloyd Russell-Moyle MP, Conservative
Alexander Stafford MP, Conservative

Current Inquiries:

- The work of the Department for Energy Security and Net Zero.Opened 14th June 2023.

For further details: Media 07720 202 985
Email: commonsesnz@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"*.

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
The Viscount Hanworth, Labour
The Lord Holmes of Richmond MBE
The Lord Krebs, Crossbench
The Baroness Neuberger, Crossbench
The Rt Hon. the Baroness Neville-Jones DCMG, Conservative
The Rt Hon. the Baroness Northover, Liberal Democrat
The Lord Rees of Ludlow OM
The Lord Sharkey, Liberal Democrat
The Viscount Stansgate, 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: hlscience@parliament.uk ■

IN MEMORIAM REG SELL 1929 – 2022

Sadly Reg Sell, a life member of the Parliamentary and Scientific Committee, died at the end of last year, aged 93.

Reg was born in in Twickenham in 1929, attended the Latymer school for boys and went on to study psychology at UCL, graduating in 1953. In 1956 he obtained a Post Graduate Diploma from Birkbeck College in occupational psychology. His interest was in ergonomics and human factors – focusing on designing jobs and equipment around people.

During his long and distinguished career Reg became a Fellow of the British Psychological Society, the Ergonomics Society (now Chartered Institute) and the Chartered Institute of Personnel and Development. He made a very substantial contribution to the development of ergonomics primarily as a practitioner but also in an advisory capacity in academia.

He served as Honorary Secretary to the Parliamentary and Scientific Committee from 1993 to 1996 and was elected a Life Member of the Committee

Reg met his wife Peggy Bangay while they were both doing their national service and they married in 1957. Peggy died in 2005. He is survived by his children, Peter and Sue, grandchildren, Charlotte, Emily, Simon and Andrew, and great-grandson, Oscar.

Reg Sell at meeting of the Parliamentary and Scientific Committee in Portcullis House, 2010

PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY (POST)

SUMMER 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 March 2023 were:

- 695: Reforming the Mental Health Act- Approaches to Improve Patient Choice
- 694: Electricity Market Reform
- 693: Trust in the Police

POST has also produced a Rapid Response:

- Human challenge studies in the study of infectious diseases

Ongoing and future projects approved by the POST Board

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

- Demand side response
- Psychedelic drugs and mental health
- Consumer debt and mental health
- Just sustainable transitions
- Biodiversity net gain
- The future of horticulture
- Factors shaping gender incongruence and gender dysphoria, and impacts for health services
- Marine protected and highly protected marine areas
- Problem-solving courts
- One Health approach to the impacts of climate change on public health
- Determinants of Distress Associated with Gender Identity
- Free School Meals and Child Poverty
- Indoor Air Quality
- Environmental impact of and risks for the food production system
- Hormone Treatments for Children with Gender Dysphoria
- GB Plant biosecurity

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, FREng

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 Susan Owens

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:

Debate on e-petitions relating to food labelling and support for people with allergies

Published Friday, 12 May, 2023, CDP 2023/0103

A debate pack published ahead of a Westminster Hall debate on e-petitions relating to food labelling and support for people with allergies. The e-petitions were no. 585304. 'Owen's Law' – Change the law around allergy labelling in UK restaurants and no. 589716, Appoint an Allergy Tsar as a champion for people living with allergies. The subject for the debate was been chosen by the Petitions Committee. This pack contains more information on allergies, NHS allergy services, food labelling and the petitions, as well as recent PQs, news items and useful links.

Debate on Allergy Awareness Week

Published Wednesday, 10 May, 2023, CDP 2023/0099

A debate pack published ahead of a Westminster Hall debate on Thursday 11 May on Allergy Awareness Week. The subject for the debate was chosen by the Backbench Business Committee. This pack contains background information on allergies, Allergy Awareness Week, support and NHS services for people with allergies, and includes recent PQs, news items and useful links.

Energy Bill [HL] 2022-23: Overview

Published Friday, 05 May, 2023, CBP 9693

The Energy Bill [HL] had its Commons Second Reading stage on 9 May 2023. This briefing provides an overview of the Bill, provides

some general policy background and stakeholder reaction and highlights the five Government defeats in the Lords where five new clauses were added to the Bill and one clause was amended.

This briefing links to the five Library briefings have been published covering the provisions of the Bill in more detail:

Energy Bill [HL] 2022-23, parts 1, 2 & 3: carbon storage, hydrogen, and new technologies covers parts 1 to 3 of the Energy Bill, including carbon dioxide usage, transport and storage, hydrogen production, the hydrogen village trial and new technologies.

Energy Bill [HL] 2022-23, parts 4-6: Electricity and gas markets covers parts 4-6 of the Bill, including the Independent System Operator and Planner, governance of gas and electricity industry governance codes, multi-purpose interconnectors, electricity storage and smart meters.

Energy Bill [HL] 2022-23, parts 7-10: heat networks, smart appliances, load control and energy performance of buildings covers parts 7-10 of the Bill, including heat networks, energy smart appliances and load control, energy performance of buildings and Energy Savings Opportunity Schemes.

Energy Bill [HL] 2022-23: Parts 11 and 12 – Offshore wind, oil and gas covers parts 11-12 of the Bill, including core fuel sector resilience, offshore wind electricity generation and oil and gas.

Energy Bill [HL] 2022-23, part 13: Provisions on civil nuclear regulation covers part 13 and sections of part 3 that relate to nuclear regulation, including geological disposal facilities for radioactive waste, nuclear sites where the risk of radiation is low and allowing the UK to join a UN convention on providing compensation to victims of nuclear incidents.

Debate on the Infected Blood Inquiry

Published Tuesday, 20 June, 2023, CDP 2023/0138

A debate pack published ahead of a debate in the Commons Chamber on Thursday 22 June on the Infected Blood Inquiry. The subject for the debate was chosen by the Backbench Business Committee. This debate pack provides further information on the development of a compensation framework for those infected and affected by contaminated blood and blood products in the UK.

Support for cancer in England

Published Friday, 09 June, 2023, CBP 9766

A House of Commons Library briefing on Government and NHS policy on cancer in England and cancer research.

Debate on access to psilocybin treatments

Published Thursday, 18 May, 2023, CDP 2023/0108

Debate pack published ahead of a debate on 18 May on access to psilocybin treatments. The subject for the debate was chosen by the Backbench Business Committee. The debate considered a motion which called on the Government to, among other things, "conduct an urgent review of the evidence for psilocybin's current status as Schedule 1 under the Misuse of Drugs Regulations 2001 with a view to rescheduling, initially for research purposes only, in order to facilitate the development of new mental health treatments".

Debate on public access to nature

Published Wednesday, 17 May, 2023, CDP 0107

A debate pack published ahead of a debate on public access to nature. The subject for the debate was chosen by the Backbench Business Committee. The Countryside and Rights of Way Act 2000 (Amendment) Bill, a Private Members Bill introduced to the House of Commons by Caroline Lucas, aims to extend the right of public access to the countryside, including to woodlands, the Green Belt, waters and more grasslands.

Debate on the voluntary scheme for branded medicines and the Life Sciences Vision

Published Tuesday, 02 May, 2023, CDP 2023/0097

A debate pack published ahead of a Westminster Hall debate on Wednesday 3 May on the voluntary scheme for branded medicines and the Life Sciences Vision. All pharmaceutical companies that supply licensed branded medicines to the NHS are subject to one of two schemes designed to control the NHS' overall spend on branded medicines:

The Voluntary Scheme for Branded Medicines Pricing and Access (VPAS), or;

The Statutory Scheme.

Any company that does not choose to join the VPAS is automatically enrolled under the Statutory Scheme.

Potential impact of artificial intelligence on the labour market

Published Tuesday, 25 April, 2023, CDP 2023/0090

A debate pack published ahead of a Westminster Hall debate onWednesday 26 April on the potential impact of artificial intelligence on the labour market. This pack contains background on artificial intelligence, the regulation of workplace AI, and the impact of AI on employment levels in the UK. It also includes recent Parliamentary material, press and news items and further readings.

Research and Development funding policy

Published Wednesday, 05 April, 2023, CBP 7237

This Commons Library briefing provides an overview of the research and development funding landscape in the UK. It includes information on the Government's commitment to spending 2.4% of GDP on R&D by 2027, the R&D strategies, the new funding body: Advanced Research and Invention Agency (ARIA), and the international outlook.

Medical technology regulations and the NHS

Published Monday, 27 March, 2023, CDP 2023/0077

A debate pack published ahead of a debate on Tuesday 28 March on medical technology regulations and the NHS. The pack includes information on the future regulation of medical devices, links to further reading, recent Parliamentary material and news items.

Obesity policy in England

Published Tuesday, 20 June, 2023, CBP 9049

This briefing provides an overview of the Government's obesity policy in England. It discusses obesity prevalence and policy in England, including restricting volume price and location promotions, calorie labelling, advertising restrictions and includes links to other relevant Library briefings.

The Smokefree 2030 ambition for England

Published Monday, 19 June, 2023, CBP 9655

In 2019, the government set out an ambition for England to become "smokefree" by 2030 but the 2022 Khan review said England may miss this target. This briefing provides further information.

Debate on preventing obesity and fatty liver disease

Published Wednesday, 07 June, 2023, CDP 2023/0121

A debate pack published ahead of a Westminster Hall debate on Thursday 8 June on preventing obesity and fatty liver disease. The subject for the debate was chosen by the Backbench Business Committee. The debate was held on International NASH Day (non-alcoholic steatohepatitis). This is a public education campaign, launched in 2018, which seeks to raise awareness and action surrounding NASH – an advanced form of fatty liver disease. The campaign is owned by the Global Liver Institute, and supported by the British Liver Trust. Background on obesity as a health condition, its management, prevalence and the Government's policy on reducing its prevalence are available in the Library's briefings on obesity and obesity statistics.

What is the proposed WHO Pandemic Preparedness Treaty?

Published Friday, 02 June, 2023, CBP 9550

The WHO is negotiating a treaty on pandemic preparedness. The briefing outlines what has been proposed, where negotiations are up to, and what comes next.

Asbestos in the workplace

Published Friday, 14 April, 2023, CDP 2023/0079

A debate pack published ahead of a Westminster Hall debate on Wednesday 19 April on asbestos in the workplace. The pack

includes information on asbestos related injuries and mortality, health and safety requirements, the status of the Control of Asbestos Regulations 2012 as retained EU law beyond 2023 and asbestos compensation payments.

Clean Air Zones, Low Emission Zones and the London ULEZ

Published Thursday, 15 June, 2023, CBP 9816

Road user charging zones are intended to reduce air pollution in cities, by charging drivers of older, more polluting vehicles to enter them. This briefing includes background on charging for road use in England, Clean Air Zones in England, London's ULEZ and LEZ, low emission zones in Scotland, clean air zones in Wales, national road user charging and the air quality context.

Debate on litter on motorways

Published Monday, 24 April, 2023, CDP 2023/0092

A debate pack published ahead of a Westminster Hall debate on Tuesday 25 April on litter on motorways. This pack sets out detail on the duty to clear litter on motorways, the offence of littering, the scale of litter on motorways and calls for change. It also includes recent PQs on the subject and some useful links.

Animal Welfare (Kept Animals) Bill

Published Wednesday, 21 June, 2023, CBP 9299

A briefing published ahead of an opposition day debate in the House of Commons on 21 June 2023 on a motion tabled by Labour for all remaining Commons stages of the Animal Welfare (Kept Animals) Bill to take place on 12 July 2023. The Animal Welfare (Kept Animals) Bill 2021-22 was introduced in the House of Commons on 8 June 2021 as a Government Bill. It would have made provisions about the welfare of certain kept animals that are in, imported into, or exported from Great Britain (see below). Second Reading took place on Monday 25 October 2021. Committee stage took place between 9 and 18 November 2021. The Bill was carried over to the 2022-23 parliamentary session and was awaiting a date for Report stage. On 25 May 2023, Mark Spencer, the Secretary of State for Environment, Food and Rural Affairs, announced that the Bill would not continue any further. Instead, the government would taking forward measures in the Kept Animals Bill individually as single-issue bills during the remainder of the current Parliament. The Secretary of State referred to concerns about "scope-creep" for the Bill, including that the Labour Party would attempt to widen the scope of the Bill. The statement also set out the areas the government would be taking forward:

Debate on World Ocean Day

Published Wednesday, 07 June, 2023, CDP 2023/0125

A debate pack published ahead of a Westminster Hall debate on Thursday 8 June on World Oceans Day. The subject for the debate was chosen by the Backbench Business Committee. The UN World Oceans Day takes place on 8 June every year. The purpose of the day is to, "to inform the public of the impact of human actions on the ocean, develop a worldwide movement of citizens for the ocean, and mobilize and unite the world's population on a project for the sustainable management of the world's oceans."

The theme for 2023 was Planet Ocean: the tides area changing, calling for an increased focus on the world's oceans.

Farming on Dartmoor

Published Monday, 17 April, 2023, CDP 2023/0088

A debate pack published ahead of a Westminster Hall debate on Tuesday 18 April on farming on Dartmoor. The debate followed the publication of a letter from Dartmoor MPs on 2 April 2023 raising concerns from farmers who graze livestock on common land within Dartmoor National Park which is part of a Site of Special Scientific Interest (SSSI), a nature protection designation.

Genetic Technology (Precision Breeding) Bill 2022-23

Published Tuesday, 28 March, 2023, CBP 9557

A briefing on the Genetic Technology (Precision Breeding) Act 2023. It explains what the Act does, how the Act will change the regulation of precision breeding, and stakeholder reactions and concerns over health and animal welfare and marketing and labelling.

Government policy on reaching Net Zero by 2050

Published Friday, 02 June, 2023, CDP 2023/0124

A debate pack published ahead of a debate on Government policy on reaching net zero by 2050 in Westminster Hall on Tuesday 6 June 2023. This landing page provides an overview of key Government policies and links to relevant material.

The role of local government in reaching net zero

Published Friday, 02 June, 2023, CDP 2023/0122

A debate pack published ahead of a general debate on the role of local government in delivering net zero on Monday 5 June. The subject for the debate was selected by the Backbench Business Committee. The pack discusses the role of local government in meeting the target in relevant areas, local commitment to net zero and barriers to local delivery of net zero.

Cybersecurity in the UK

Published Thursday, 22 June, 2023, CBP 9821

This briefing provides an overview of cybersecurity in the UK. It explains the nature of the cyber threat, including how cyber attacks work. It describes the policy and regulatory frameworks, as well as areas of reform such as 'ethical hacking'.

The Data Protection and Digital Information (No. 2) Bill 2022-23

Published Tuesday, 28 March, 2023, CBP 9746

The Data Protection and Digital Information (No.2) Bill was introduced in the House of Commons on 8 March 2023. In a Written Ministerial Statement of 8 March 2023, Michelle Donelan, Secretary of State for Science, Innovation and Technology, said the new Bill followed a detailed co-design process with industry, business, privacy and consumer groups. The Bill would seize the post-Brexit opportunity to "create a new UK data rights regime tailor-made for our needs". It would reduce burdens on businesses and researchers and would boost the economy by £4.7 billion over the next decade. The governance structure and powers of the Information Commissioner's Office (ICO, the data protection regulator) would also be reformed and transferred to a new body, the Information Commission.

Debate on Marine Protected Areas

Published Thursday, 27 April, 2023, CDP 2023/0094

A debate pack published ahead of a Westminster Hall debate on Tuesday 2 May on Marine Protected Areas. A variety of pressures, including fishing and physical structures such as oil rigs, are impacting marine wildlife and habitats globally. Creating Marine Protected Areas (MPAs) can help combat the adverse consequences.

The UK Government supports international ambitions to see 30% of the world's oceans protected by 2030. It has set up the Blue Belt programme which aims to provide long term protection across more than four million km2 of marine environment within UK Overseas Territories waters.

The UK has several types of MPA. In combination, these are intended to form an ecologically coherent and well-managed network supporting effective conservation and sustainable use of the marine environment:

Holocaust Memorial Bill

Published Friday, 23 June, 2023, CBP 9741

The Holocaust Memorial Bill 2022-23 would remove restrictions on building a Holocaust Memorial and Learning Centre in Victoria Tower Gardens next to Parliament. The Bill would also give the Government powers to use public funds to build and operate the Holocaust Memorial and Learning Centre.

The Bill is a hybrid bill according to the Examiners of Petitions for Private Bills.

Second reading of the Holocaust Memorial Bill is scheduled for Wednesday 28 June 2023.

Sustainability of heritage sites across the UK

Published Monday, 19 June, 2023, CDP 2023/0134

A debate pack published ahead of a Westminster Hall debate on the sustainability of heritage sites across the UK on Tuesday 20 June 2023. Some information is included on planning rules for heritage assets, energy efficiency of heritage assets, local listed building consent orders (LBCOs), proposals for change, the role of Historic England and its Climate Change Strategy, and the situation in the devolved administrations.

Building regulations and safety

Published Tuesday, 06 June, 2023, CBP 8482

This briefing discusses building regulations and standards for building safety as well as the government's response to the Grenfell Tower fire.

Building regulations set standards for construction and refurbishment work in England. The Grenfell Tower fire in 2017 prompted a review of the rules and processes governing building safety.

In response, the government passed the Building Safety Act 2022. It creates rigorous rules specifically for the construction, refurbishment and occupation of high-rise residential buildings.

Building regulations and safety are devolved matters. This briefing focuses on the situation in England with section 8 covering the devolved administrations.

Tackling the under-supply of housing in England

Published Friday, 19 May, 2023, CBP 7671

This paper covers trends in housing supply and barriers and potential solutions to delivering more homes in England.

It includes information on government ambitions for new housing supply, how much new housing is needed, trends in housing supply, barriers and solutions and both historical and recent statistical data on housing supply.

Unfinished housing developments

Published Tuesday, 16 May, 2023, CBP 9689

This briefing examines the problems caused by unfinished housing developments and roads, and the powers available to local authorities to prevent and deal with them. It explores the planning issues (permission and obligations), proposed planning reforms, issues with unfinished roads, building standards and utility connections. ■

SCIENCE DIRECTORY

UK Research and Innovation

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

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Website: www.ahrc.ukri.org

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Biotechnology and Biological Sciences Research Council

Website: www.bbsrc.ukri.org

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

Economic and Social Research Council

Website: www.esrc.ukri.org

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

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Website: www.epsrc.ukri.org

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

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Website: www.ukri.org/councils/innovate-uk/

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

Medical Research Council

Website: www.mrc.ukri.org

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

Natural Environment Research Council

Website: www.nerc.ukri.org

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

Research England

Website: www.re.ukri.org

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

Science and Technology Facilities Council

Website: www.stfc.ukri.org

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

SCIENCE DIRECTORY

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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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Applied Microbiology International believes that global challenges need to be solved by global, interdisciplinary experts who apply their diverse experience and unique voices to achieve a common goal. Because of this, we're a truly inclusive, international organisation. With a strong focus on influencing international policy, we are organised around seven goals which align with core UN Sustainable Development Goals and encourage partnership between industry and academia to increase our impact. At Applied Microbiology International we publish the leading industry magazine, *The Microbiologist*, and in partnership with Wiley and Oxford University Press, we publish six internationally acclaimed journals.

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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.

British In Vitro Diagnostics Association (BIVDA)

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

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

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

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BSAC is a learned society whose members are among the world's leading infectious disease physicians, pharmacists, microbiologists, and nurses.

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

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

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

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The British Society for Immunology 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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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:

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

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

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

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

Cavendish Laboratory

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

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

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

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

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

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

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The Francis Crick Institute is an independent charity, established to be a UK flagship for discovery research in biomedicine.

The Crick's mission is discovery without boundaries. We don't limit the direction our research takes. We want to understand more about how living things work to help improve treatment, diagnosis and prevention of human disease, and generate economic opportunities for the UK.

In our institute more than 2,000 staff and students use their wide-ranging knowledge and expertise to work across disciplines and explore biology at all levels, from molecules through cells to entire organisms.

SCIENCE DIRECTORY

Daphne Jackson Trust

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

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

fera

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Website: www.fera.co.uk

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

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

GAMBICA

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

The Geological Society

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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.

IBMS Institute of Biomedical Science

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Advancing knowledge and setting standards in biomedical science

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

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

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

Institute of Food Science + Technology ifst

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

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

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

IKE Institute of Innovation & Knowledge Exchange

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www. InnovationInstitute.org.uk

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

Institute of Marine Engineering, Science and Technology (IMarEST)

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

SCIENCE DIRECTORY

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.

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.

LGC

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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

THE 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.

SCIENCE DIRECTORY

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

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

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The Microbiology Society is a membership charity for scientists interested in microbes, their effects and their practical uses. It 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.

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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.

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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.

SCIENCE DIRECTORY

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

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

QUADRAM INSTITUTE

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

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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.

Contact: Office of the Science Directorate
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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.

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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.

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.

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.

UK INNOVATION & SCIENCE SEED FUND

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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.

Understanding Animal Research

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

University of Essex

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

Universities Federation for Animal Welfare

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Registered in England Charity No: 207996

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.

The Welding Institute

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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

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

FORTHCOMING DISCUSSION AND OTHER MEETINGS

Monday 18th September
Discussion Meeting on 'Digital Health for the 21st Century'
In partnership with Newcastle and Northumbria Universities
5.15pm to 6.45pm
Chairman's Reception 6.50pm to 7.30pm

Monday 16th October
Discussion Meeting on 'Changing how we see life'
In partnership with the Rosalind Franklin Institute
5.15pm to 6.45pm, Palace of Westminster
Chairman's Reception 6.50pm to 7.30pm

ROYAL SOCIETY OF BIOLOGY

For further details please contact Karen Patel: events@rsb.org

ROYAL SOCIETY OF CHEMISTRY

Monday 9th October
Science and Stormont
12.30pm to 7.30pm, Parliament Buildings, Belfast
For further details please contact events@rsc.org

ROYAL SOCIETY

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

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The Parliamentary & Scientific Committee's STEM for BRITAIN 2024 takes place on Monday 4th March, in the Attlee Suite, Portcullis House, House of Commons.

Applications are invited from, Monday 11th September 2023, from early-career research scientists, engineers, technologists and mathematicians who wish to exhibit posters in one of the following areas:

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

The closing date for applications is Monday 27th November 2023.

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

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

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

The Westminster Medal in memory of the late Dr Eric Wharton, who did so much to establish SET for Britain as a regular event in the Parliamentary calendar, will be awarded at a P&SC event in Parliament in April 2023, following online judging.

From 11th September full details of the competition and exhibition including the application form will be on the STEM for Britain website: **www.stemforbritain.org.uk**