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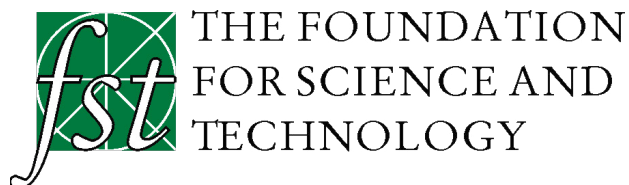
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'Huge challenge' for electric vehicles

The Public Accounts Committee says that while Government has set ambitious targets to phase out new petrol and diesel cars by 2030 and for all new cars to be zero-emission from 2035, with just 11% of new car registrations for ultra-low emission cars in 2020 it will be a "huge challenge" to get this to 100% in the next 14 years.

Achieving this ambition will require convincing consumers of the affordability and practicality of zero-emission cars (with up-front prices still too high for many in comparison to petrol or diesel equivalents) and addressing the current very uneven take-up across the UK.

The number of charging points is increasing rapidly, but many more will be required within a very short period of time to support the envisaged growth in electric cars in the UK, and the PAC is not convinced the Government is on track with this crucial infrastructure.

The Committee says the Department for Transport and the Department for Business, Energy and Industrial Strategy (BEIS) will need to do much more to consider the practical application of this large societal change, and put consumers at the heart of it.

The Departments will need to be on top of the other consequences arising from this transition, says the report, including the impact on the skills and capabilities required to support the changeover in the UK vehicle fleet; the environmental and social implications of the switch-over both in the UK and across global supply chains; the impact on our future power needs; and the impact on the Government tax-take due to the loss of fuel duties.

<https://publications.parliament.uk/pa/cm5802/cmselect/cmpubacc/186/18602.htm>



The number of charging points is increasing, but many more will be needed

IEA sets out concrete steps to net zero

The world has a viable pathway to building a global energy sector with net-zero emissions in 2050, but it is narrow and requires an unprecedented transformation of how energy is produced, transported and used globally, the International Energy Agency said in a special report released in mid-May.

Climate pledges by governments to date – even if fully achieved – would fall well short of what is required to bring global energy-related carbon dioxide (CO₂) emissions to net zero by 2050 and give the world an even chance of limiting the global temperature rise to 1.5°C, according to the report, *Net Zero by 2050: a Roadmap for the Global Energy Sector*.

The report is a comprehensive study of how to transition to a net zero energy system by 2050 while ensuring stable and affordable energy supplies, providing universal energy access, and enabling robust economic growth. The IEA says that it sets out a "cost-effective and economically productive pathway", resulting in a clean, dynamic and resilient energy economy dominated by renewables like solar and

Net Zero by 2050: A roadmap for the global energy system



IEA: a 'cost-effective and economically productive pathway' to net zero CO₂

wind instead of fossil fuels. The report also examines key uncertainties, such as the roles of bioenergy, carbon capture and behavioural changes in reaching net zero.

Building on the IEA's energy modelling tools and expertise, the Roadmap sets out more than 400 milestones to guide the global journey to net zero by 2050. These include no further investment in new fossil fuel supply projects, and no further final investment decisions for new unabated coal plants. By 2035, there are no sales of new internal combustion engine passenger cars, and by 2040, the global electricity sector has already reached net-zero emissions.

www.iea.org/reports/net-zero-by-2050

'Triple investment' to tackle global crises

Annual investments in nature-based solutions will have to triple by 2030 and increase four-fold by 2050 from the current investment of US\$ 133 billion (using 2020 as base year) in order to successfully tackle the interlinked climate, biodiversity, and land degradation crises, according to the UN *State of Finance for Nature* report.

That will mean a total investment in nature of US\$ 8.1 trillion by 2050 – with annual investment of US\$ 536 billion by that date – is required.

The report – produced by the UN Environment Programme (UNEP), the World Economic Forum (WEF) and the Economics of Land Degradation (ELD) Initiative – urges governments, financial institutions and businesses to overcome this investment gap by placing nature at the heart of economic decision-making in the future.

It stresses the need to rapidly accelerate capital flows to nature-based solutions by making nature central to public- and private-sector decision-making related to societal challenges, including

the climate and biodiversity crises.

Structural transformations are needed to close the finance gap between now and 2050, by building back more sustainably in the wake of the Covid-19 pandemic, but also by repurposing harmful agricultural and fossil fuel subsidies and creating other economic and regulatory incentives.

Investing in nature supports human, animal and planetary health, improves quality of life and creates jobs, says the report. However, nature currently only accounts for 2.5% of projected economic stimulus spending in the wake of Covid-19. Private capital will also have to be scaled up dramatically to close the investment gap. Developing and scaling up revenue flows from ecosystem services and using blended finance models as a means to crowd in private capital are among the suite of solutions needed to make this happen, which also requires risk-sharing from private sector actors.

www.unep.org/resources/state-finance-nature

THE FOUNDATION

The Foundation for Science and Technology provides an impartial platform to explore the interface between policy and science. It does this in a variety of ways.

Maintaining UK leadership in clinical research

The UK has always been a world leader in clinical research, but maintaining that position is increasingly difficult in a globally competitive world. To address this challenge, the Government recently published *Saving and Improving Lives: the Future of UK Clinical Research Delivery*¹, its new policy paper on ways to ensure the UK remains an attractive home for clinical trials. However, for this strategy to be a success, it needs to make sure the UK is delivering the most cutting edge, early stage, research as well as large Phase 3 trials.

To look at this in more detail, on 30 April, the Foundation for Science and Technology and Silence Therapeutics supported a roundtable discussion, which was chaired by Lord Patel and attended by a number of leading scientific and policy making experts from across the UK.

Participants heard from representatives of the Department for Health and Social Care as well as the Office for Life Sciences. They discussed how the Government could implement the new strategy in order to reduce the bureaucracy facing early stage clinical trials by intro-

ducing a more risk-based approach to approving research, while learning from the rapid approval and delivery of the COVID-19 vaccines.

Further details about the discussion, and the policy recommendations that attendees suggested, will be published shortly on the Foundation's website. More details will be provided in the next edition of *FST Journal*. □

¹ www.gov.uk/government/publications/the-future-of-uk-clinical-research-delivery/saving-and-improving-lives-the-future-of-uk-clinical-research-delivery

RECENT PODCASTS AND BLOGS

Among the sections on the Foundation's website are the regularly updated podcasts and blogs. These cover a wide range of topics touching on science, technology and innovation. Some, though not all, expand on the discussions that take place in the main Foundation meetings – these are detailed in the relevant sections of this issue. Some of the more recent postings are listed here.

RECENT PODCASTS

Professor Dame Anne Johnson

Academy of Medical Sciences

The work of the Academy of Medical Sciences in tackling the coronavirus pandemic

Dr Rameen Shakur

Cambridge Heartwear

AI and Medicine

Professor Marcel Jaspars

Royal Society of Edinburgh

Science and research issues for the Scottish Parliament election

Maria Tazi

Missions Publiques

Regulating the Internet

Professor Dame Wendy Hall

University of Southampton

AI Strategy

Dr Stephanie Wray

Nature Positive

Biodiversity and upcoming Biodiversity COP

Sarah Chaytor, Grace Gottlieb and Graeme Reid

UCL

Regional Policy and R&D

RECENT BLOG POSTS

Gavin Costigan

Foundation for Science and Technology
2020 at the Foundation: A year in review

Professor Victor Newman

University of Greenwich Business School
Changing the Research Excellence funding game to enable Return On Investment

Alana Cullen

Foundation for Science and Technology
A first look at the Turing Scheme

Professor Robert Field

University of Oxford

Professor Albert Weale

UCL

Water Reuse: it's a Membraner!

Dr Penny Owen and Andy Morris

National Physical Laboratory
Virtual networking – the unexpected benefit of a pandemic for science and technology

Maria Tazi

Missions Publiques

Internet governance with and for citizens

GUEST EDITORIAL

Science makes a huge contribution to society and the economy. Following the upheavals of the past year, we must use the undoubted potential of UK science to help us build for the future.

Backing UK science to deliver

Adrian Smith



Sir Adrian Smith PRS is President of the Royal Society and a mathematician with particular expertise in the field of Bayesian statistics. This widely applicable branch of mathematics represents uncertainties in the form of probabilities, which are then modified through the mechanism of Bayes theorem as new information becomes available. He has been awarded the Royal Statistical Society's Guy Medals in Bronze, Silver and Gold and served from 1995 to 1997 as its President. In the 2011 New Year Honours list, he was awarded the title of Knight Bachelor.

When I became President of the Royal Society in November last year, the role of science in society had been thrust into sharp focus. The pandemic has – and continues to have – terrible consequences in the UK and across the globe but it would have been worse were it not for the scientists who have done so much to understand COVID-19, determine how to tackle it and ultimately how to produce effective vaccines.

The contribution of the science community has been immense. As well as the work to understand the virus and produce those treatments and vaccines, support for evidence-based policy making has been crucial. We have also had so many scientists helping public understanding, whether through public events or contributions to media coverage. Scientific publishers have done everything they can to ensure knowledge is shared as quickly and openly as possible.

All this is a testament to the strength of the UK science base and to international collaboration. None of it happened by accident. The successes are the result of decades of investment in people, ideas and facilities. That is why we cannot afford to ease up in making the case for increased investment in science.

Raising the average

The past year has dealt a huge blow to public finances the world over, but it has also raised the possibility of, as our Government has put it, 'building back better'. Despite some recent skirmishes, which I will come back to, the Government has remained committed to increasing funding for research, declaring the intention to ensure the UK is a global scientific superpower. That has seen a reaffirmation of the commitment to increase investment in research to £22 billion a year by 2025, contributing to reaching a target of investing 2.4% of GDP by 2027.

Since that 2.4% target was set, based on the

average OECD figure, others have stepped up their spending and the OECD average has gone up to 2.5%. So our 'race to the average' is already falling behind. Previous Government commitments saw 2.4% of GDP as a stepping-stone to a longer-term goal of 3% – it is time to reassert that goal. It is also time for a clear plan on how the UK will first reach 2.4%.

That plan must set out not only how the £22 billion will be reached but also how the private sector investment, which accounts for roughly two thirds of the 2.4%, will be attracted to participate. Business needs certainty in order to invest. Multi-year funding commitments are needed to signal clearly to investors how increased public investment in R&D will be delivered, showcasing opportunities, providing confidence and informing long-term planning.

As we strive to reach the average, China, for example, plans to increase its annual R&D spending by more than 7% in the next five years. The French government has announced that the budget of its National Research Agency will triple by 2023, and Spain has unveiled a budget that will see research spending increase by more than 80% this year. Some €20 billion has been set aside to turbo-charge education, research and infrastructure over the next five years in the Netherlands, and Sweden has announced a 10% increase in its research and innovation budget by 2024. Israel is already investing 4.9% of GDP. US investment in R&D is now at 3% of its GDP and the Biden administration has announced massive increases in research funding.

International collaboration

Looking at international competition is important if we want to lead the world, but international collaboration is just as important. The Christmas Eve announcement that the UK would associate to Horizon Europe as part of the Brexit deal was an early Christmas present for UK science. The Royal Society, along with many other voices, had worked tirelessly to make the case for association since the referendum. However, securing that victory was only a first step. Recent months have seen a great deal of uncertainty about

The pandemic would have been worse were it not for the scientists who have done so much to produce vaccines against COVID-19.

how the UK would meet the cost of association.

It is estimated that this will be around £2 billion, on average, per year but because of the way payments are spread it looks like the cost this year will be around £1 billion. Concerns were raised that while the cost of previous EU research funding programmes came from central budgets, the cost of association could fall to the research budget, effectively cutting UKRI's funding.

Just before Easter we had a rather opaque announcement from Government. There was a very welcome additional £250 million and two pots of £400 million and £350 million from sources that are not entirely clear. For now, the potential problem seems to have been averted but again there is a need for clearer, more long-term planning.

Attracting talent

Another challenge where action has been taken is in ensuring that the UK is still able to attract the best overseas researchers to work alongside our homegrown talent. UK science has always thrived on being open to people and ideas and we have a job in front of us to reassure scientists all over the world that we are still open for business. The Global Talent Visa is a good first step in delivering a visa system that is welcoming, faster and more flexible, one which takes into account the long-term aspirations of scientists and their families. It will be crucial to continue to monitor our ability to attract top talent.

As well as remaining open to the best overseas researchers, we also have to support our own homegrown talent. The Government has signalled its ambition for the UK to become 'the very best place in the world to be a researcher, inventor or innovator' – now we need to invest in producing the next generation of those researchers, inventors and innovators.

Then there is the challenge of making sure that UK researchers take full advantage of the Horizon Europe funding streams. Pre-Brexit, the UK did incredibly well at securing funding but for a number of reasons, that had slipped quite a bit in recent years. Once again, we need researchers in every university and research institute to focus on the opportunities available. With any public investment there will always be a requirement for a 'value for money' assessment – we need to make sure Horizon Europe passes that with flying colours.

While our relations with our European partners on science are promising in terms of international collaboration, cuts to the Official Development Assistance (ODA) budget have done serious harm to the UK's reputation as a reliable international partner. Around £400 million has been

Once again, we need researchers in every university and research institute to focus on the opportunities available.

taken out of the research budget with schemes such as the Royal Society's Future Leaders – African Independent Researchers (FLAIR) programme being devastated. While we must recognise the difficult state of public finances right now, you cannot turn the tap on and off on long-term scientific collaboration and think it will not hurt both research and the UK's international reputation. Such actions do not sit well alongside the idea of the UK as a global scientific superpower.

Building back better

One of the forthcoming opportunities for the UK to burnish its global credentials also offers the opportunity to 'build back better'. The pandemic is not the only global crisis that we face – it is also not the only one where science can help provide the solutions. The threats of climate change and loss of biodiversity loom large. The UK has set ambitious targets for reaching net zero and as evidenced in the recent launch of a series of technology briefings by the Royal Society, we also have some of the ideas that can help us deliver on those ambitions and in turn help other nations to decarbonise their economies. We cannot do this alone but the UK must set out a well-funded and detailed roadmap for how we plan to deliver on our ambitions, as we host the climate summit in Glasgow.

That roadmap can also help deliver on the Government's levelling-up agenda. New technologies, whether related to decarbonisation or other areas, can flourish in the universities, research institutes and innovative businesses that can be found all over the UK. Again, what is needed is greater investment based on multi-year funding commitments to clearly signal how that increased public investment in R&D will be delivered.

I am optimistic for the future. This Government has long been an advocate for investment in research and innovation. The past year can only have reinforced the belief that our science base can deliver. The challenge will be to make sure we do not get overtaken by all the other countries which recognise that future economic growth and the wellbeing of their populations will be dependent on research and innovation.

We are in a great position, we must not take that for granted, but instead must back our science base to deliver even more. □

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CONTEXT

The Government announced a commitment for a new funding agency, modelled on the US Advanced Research Projects Agency (ARPA), in the Queen's Speech in 2019, and later in the Conservative Party manifesto of the same year. A budget of £800 million was announced in the 2020 budget, and the creation of the agency was again referenced in the R&D Road Map of July that year. There was considerable discussion as to the rationale for this new body, which was later named the Advanced Research and Invention Agency (ARIA), and how it might work with UKRI and Innovate UK. The House of Commons Science and

Technology Select Committee launched an inquiry in April 2020, which reported shortly after the Foundation's event on this topic. Primary legislation to establish ARIA is currently progressing through Parliament.

On 27 January 2021, the Foundation brought together the Chair of the House of Commons Science and Technology Select Committee, a former Chief Executive of Innovate UK and the Director of Innovation and Digital at the CBI to explore the issues. A video recording of the webinar, presentation slides and speaker audio from the event are available on the FST website.

The place of a new agency in the research and innovation landscape

Greg Clark



The Rt Hon Greg Clark MP is Chair of the House of Commons Science and Technology Committee. He was Secretary of State for Business, Energy and Industrial Strategy from July 2016 to July 2019. He was elected Conservative MP for Royal Tunbridge Wells in 2005. He was Minister of State at the Cabinet Office from October 2013 until March 2015 and Minister for Universities and Science from July 2014 until May 2015. He served as Secretary of State for Communities and Local Government from May 2015 until July 2016.

The Science and Technology Committee which I chair has conducted an enquiry into the subject of a new UK research funding agency¹. During our enquiry we took evidence from a fascinating array of people, including past and present senior executives in the USA, academics in the USA, the UK and in European countries as well as both the current and the former Chief Executives of UKRI and also the Science Minister.

The first thing to say is that the context is very important. The most important aspect is that the science and research budget is set to increase from £12 billion to £22 billion a year by 2024-25 – an extraordinary advance. During the Coalition, David Willetts as Science Minister did a heroic job in protecting the science budget in cash terms. While cuts were taking place across Government Departments he was able to safeguard 'flat cash' for science. As Science Minister, I managed to get flat real-funding from the Treasury and then, as Business Secretary, managed to secure an increase in funding from £9 billion to £12 billion a year. Yet all of that fades in comparison with the current intention to nearly double the science budget.

Now, if this 'new agency' were to compete for existing resources, cannibalising programme budgets that are already in place, its creation might justifiably raise questions. The £800 million allocated for it is a very significant sum of money. However, in the context of an increase of

SUMMARY

- The UK research budget is set to increase to £22 billion by 2024-25, compared to the current £12 billion
- The future of the Industrial Strategy Challenge Fund is not yet known
- The long-term vision of Challenge Fund support should be repeated in the new agency
- There is a place for an agency that helps deliver 'technological leaps'
- An agency that can deliver a step change in technologies and processes would fill a gap in the current landscape.

£10 billion a year in the science budget, there is scope for initiatives that might not be possible in a world where that budget was not increasing.

The Industrial Strategy Challenge Fund

The second important piece of context – so far unknown – is the future of the Industrial Strategy. When we established the Industrial Strategy in 2017, we established an Industrial Strategy Challenge Fund. This has some characteristics of what is being proposed for the new agency: it funds multi-disciplinary, strategic projects with an eye to developing capability to meet future needs.



The development of the Vaccines Manufacture Innovation Centre in 2018 was a prudent response to then unknown future needs such as vaccine manufacture during a pandemic.

One topical example is the VMIC, the Vaccines Manufacture Innovation Centre. In 2018, it was considered desirable and prudent to deliberately develop manufacturing capability so that, as a country, we could respond at pace to (then unknown) future needs, such as pandemics, and at a scale enabling the whole country to be vaccinated. That has proved to be a wise course of action and a wise use of research money.

Similarly, the Faraday Challenge was set up through the Industrial Strategy Challenge Fund to develop UK battery manufacturing capabilities so that the UK automotive industry could prosper in the future. The Faraday Institution and the National Battery Manufacturing Centre in Coventry were set up to realise this goal. Today, we see the phasing out of cars with internal combustion engines and a move to net zero – once again, making this sort of initiative highly appropriate.

The Industrial Strategy Challenge Fund deploys public funds in relatively long-term commitments, while leveraging in funds from the private sector. Of the £5.6 billion that has been invested in these challenges, £2.6 billion has been public money from the science budget and £3 billion has come from private sources.

Some clarity on that issue is necessary. It may be that the proposed new agency can have a narrower focus, but if the Industrial Strategy Challenge Fund were not to continue, it would be desirable for this new institution to take up some of the strain.

Technological transformation

There is an important space for an institution that can look to invest and develop capability in significant technological leaps, rather than incremental improvements, through sustained funding. This

is particularly necessary where such developments are unlikely to be produced by either industry or academia alone. A focus on technological transformation seems, therefore, to be eminently desirable.

The evidence that the Select Committee has taken establishes the need for a clear mission, where such a body should be able to take more risks than UKRI is able to take on.

Translational potential should be a defining criterion for such an initiative. In evidence to the Committee, Baroness Brown of Cambridge, Julia King, said: “The gap I see in our research and innovation landscape is ‘science push’, helping great scientific ideas escape from the laboratory into applications which enable a step change in the way the current technologies or processes work, or into applications that no one has yet thought of.”

That seems to me a good, broad remit that then needs to be translated into particular challenges. The risk of failure needs to be accommodated clearly and explicitly from the beginning. That may involve a commitment to long-term funding so there is confidence that initial setbacks do not prove fatal to the ambition behind the project. □

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¹The report of the enquiry, *A new UK research funding agency*, was published on 12 February. <https://committees.parliament.uk/publications/4665/documents/47032/default>

There is an important space for an institution that can look to invest and develop capability in significant technological leaps.

A fast, flexible approach to addressing challenges

Ruth McKernan



Dr Ruth McKernan FMedSci CBE has wide experience across business, Government and academic worlds. In business, she was Head of the Merck Neuroscience Research Centre, followed by Research Vice President positions in Pfizer in the US and the UK. She spent three years as CEO of InnovateUK, contributing to Government industrial policy, particularly through creation of the Industrial Strategy Challenge Fund. As an academic, she holds a PhD in neuroscience with over 120 publications and 15 patents, mostly in the areas of ion channels and regenerative medicine.

We should think of the new agency as a public sector, new technology, venture fund. Its role is to deliver technology solutions for national security challenges, and the focus should be on speed and delivery. National security challenges can be interpreted quite broadly, including public health, energy or digital security challenges. As Chief Executive of Innovate UK, I led the development of the Industrial Strategy Challenge Fund. During that process, we spent time talking to people from DARPA, the Defense Advanced Research Projects Agency, in the USA. It is instructive to compare the Industrial Strategy Challenge Fund (ISCF), DARPA and the place where I believe the new UK agency should sit (see Table). I believe that ARIA can be delivered by adopting elements from both DARPA and ISCF.

The purpose of DARPA and the new UK agency is national security, broadly. DARPA always said that their investment, or their funding, was to prevent the USA from being strategically surprised. The ISCF, however, was quite different: its goal was to stimulate the UK economy and raise productivity. ISCF's focus was not about security, nor about having Government as a customer. It was to achieve business growth in areas of new technology and maintain the UK's global competitiveness – but learning what did and did not work in the process is relevant here.

In the ISCF, there was a partnership with industry and Government from the very beginning. There was, after all, a considerable amount of public funds involved. There is some strong oversight: from UKRI, BEIS and Treasury as well as a number of levels of approvals. It has been a very rigorous and well-controlled programme: £2.7 billion, with currently 20 challenges. These range from £33 million – the Audience of the Future – up to £274 million for the Faraday Battery Challenge – and these awards require matched funding.

Oversight

DARPA operates differently: oversight is really light, just an annual report to Congress. The DARPA Director is appointed by Congress. It is really important that the new UK agency maintains as light an oversight as possible, so that leaders are able to work at speed and be very competitive.

SUMMARY

- The new agency is, in essence, a venture fund
- It should focus on solutions to national security challenges, envisaged in a broad sense
- It is important that oversight should be as light as possible
- It should be a virtual agency, taking advantage of existing infrastructure
- Programme leaders should sit within a non-governmental body or institute, not in UKRI.

For this new agency, the programme leaders should be hired together with their business plan, as happens with DARPA. They would be funded for three years in the first instance and really left to build their programme and deliver it, much as a Chief Executive would.

Programme leaders could be assigned to a host institute which need not sit within UKRI. So it could be the National Physical Laboratory (NPL), it could be a Catapult centre or a Royce institute, but being based in an arms-length institute would be a good place for them, and there are of course several hundred of these bodies in the UK.

It is important that the programmes do not need matched funding, nor their own labs; they would be virtual organisations, with the programme leader focussing totally on delivering the business plan as set out.

When it comes to recruitment and salary – this is difficult. It was not easy to find challenge leaders for the Industrial Strategy Challenge Fund; we would consider 50 to 100 candidates before we found the right person and they are now UKRI employees with a salary in the range of £120,000. Yet, in my experience, the CEO of a biotech company with investments of £50 million would command an average salary more like £180,000 (which would not be out of line with DARPA).

Evaluating programmes

George Heilmeier, who was DARPA Director in the 70s, drafted a set of questions by which to evaluate proposed research programmes. These have become well-known as the Heilmeier Catechism

Table 1. How the proposed new UK agency compares to others

	ISCF	DARPA	Proposed UK agency
Purpose	Stimulate the UK economy, raise productivity.	National security: 'To not be strategically surprised'.	National security broadly.
Oversight	Monthly Steering Board including BEIS and HMT. Quarterly report to UKRI Board.	Annual written report to Congress.	Annual report to Treasury and to Board. No independent review for three years.
Governance	Challenges developed in partnership with industry and Government, approved by BEIS subject to business case and then by HMT.	Programme managers hired with their proposal. Generally appointed for 3-5 years.	Single, high-level Board. Programme leaders hired with business plan. Funded for ~3 years.
Approval authority	<£10m – Challenge Director. >£10m – ISCF Steering Board. >£50m – BEIS SoS. >£70m – HMT/Ministerial.	Arms-length DARPA review and approvals programmes by DARPA Director.	HMT budget line through BEIS to acceptable arms-length host institute.
Scale	£2.7bn, 20 challenges, 3 waves. Range: £33m-£274m.	\$3.427bn in 2019. Up to 100 challenges, each ~\$100m.	£800m. Start with three challenges of £50-100m in three different areas of security.
Matched funding	50:50 matched funding from industry.	No matched funding, no labs.	No matched funding, no labs. Complete focus.
Recruitment and salary	Typically longlist of 50-100 candidates. Challenge directors are UKRI employees.	1-in-100 appointed. Max salary ~£180k. Report to DARPA office.	CEO level salary ~£180k.

and they cover: what you are doing, how it is done, what is the approach, who the customer is, what it will cost, how long will it take, what is the ultimate goal. They match well with the venture investment checklist of those things that should be in a business plan.

It is important to have a sense that this will work before money is assigned to a CEO and put to work. This new initiative should be, in essence, a venture fund. Obviously, it will not be there to make returns, but the feel of a venture fund, with the associated speed and flexibility, is a good way to look at it.

ARIA should need no additional legislation in order to get it up and running. The programme leaders should be entrepreneurial CEO-style leaders and the organisation should draw on people who have been serial entrepreneurs or who have been investors/venture partners in venture organisations. These would gather around them a small and predominantly industrial advisory group, because it is so important for them to have the advice they need in order to deliver. There would be a single, high-level oversight Board drawn widely from science, technology and Government. This Board might include, for example, the Chair of UKRI, the Chair of the Council of Science and Technology, the Government Chief Scientific Adviser, Ministers from BEIS and Treasury (or their delegates) and maybe one or two others.

The Board would select the challenge areas and the programme leaders (based on the individuals

and the business plan) would then be selected by the Board. Innovate UK should run the processes and funding would be provided as a ring-fenced budget to a suitable host institution that the programme leader would choose themselves.

Managing the projects

The programme leaders would manage projects as they see fit. They could sponsor research in a university department, in a business, in a contract research organisation – it would be their choice. There are already mechanisms for follow-on funding through existing organisations such as Innovate UK or the British Business Bank. Ultimately, these individuals would be expected to deliver intellectual property, licensing and solutions to the challenges set out by Government. And then I would expect Government to be procuring those solutions as they are delivered.

So, to summarise: the new agency has to deliver technical solutions to national security challenges be they digital, health or defence, with a focus on speed – which means governance needs to be light-touch. It should be a virtual agency which takes advantage of existing infrastructure (no need for bricks and mortar) with programme leaders housed within existing institutes, operating more like CEOs of small flexible technology companies. □

It is really important that the new UK agency maintains as light an oversight as possible, so that leaders are able to work at speed and be very competitive.

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Focussing on business insights and requirements

Felicity Burch



Felicity Burch is Director of Innovation and Digital at the Confederation of British Industry. She leads the CBI's policy work to create the conditions that enable businesses to come up with new ideas, invest in research and development (R&D) and adopt new technologies. Felicity's background is in economic policy, focused on business growth. Before the CBI, she was Senior Economist at MakeUK, the manufacturers' organisation, formerly EEF. In this role she led the development of their innovation policy and industrial strategy work and delivered a breadth of economic and industrial trends research.

It is particularly important that a UK version of the US Advanced Research Projects Agency (ARPA) has the potential to set the UK up as a science superpower. This is a unique moment in UK history. In addition to the Covid pandemic and the ensuing economic crisis that has unfortunately resulted, there is also Brexit. We now need to demonstrate to the rest of the world what an independent UK can do after leaving the EU.

Being a science superpower should mean that UK science and innovation is influential and impactful all around the world. The proposed new agency has the potential to play a role here, especially if it can help solve specific social or economic challenges, particularly those that are global challenges not just domestic ones. In areas like health or net zero, the UK has the potential to lead the way.

Solving problems

The establishment of a new agency is also an opportunity to solve problems associated with our existing innovation ecosystem. The first of these is about leveraging business investment. The UK is brilliant at science and innovation, but for a long time we have not done enough of either. R&D spend has remained stubbornly around 1.7% of GDP. We are now in a period of increased Government spending. While that is very encouraging, countries have only successfully raised the level of overall R&D when they have leveraged business innovation as well, so this new initiative needs to be designed to achieve that goal. In addition, there is not enough market pull rather than science push, so we do need to make sure we are creating a market in the UK for innovation.

Then there is the part to play in levelling up. About half of R&D investment in happens in London, the South and South East of England. Yet, there is brilliant R&D all around the country and it plays a really important role in driving growth, so establishing a new agency outside of London could serve as a catalyst for regional

The establishment of a new agency is also an opportunity to solve problems associated with our existing innovation ecosystem.

SUMMARY

- The new agency has a role in establishing the UK as a science superpower and is an opportunity to solve problems with the innovation ecosystem
- Consistent, long-term funding is a key requirement for success
- The freedom to pursue high-risk research requires a degree of independence from traditional oversight frameworks
- ARIA should be designed with the business community in mind.

growth. Establishing it around one of the growing regional hubs for research would be a good way of doing this. Not only would that support levelling up, but it could also support a wider pool of talent from around the UK.

In terms of making it all happen, three things are key. The first is to have a long-term funding model. The second involves setting it up to take risks and then the final one is leveraging investment – with the business community in mind.

Long-term funding

Feast and famine, chop and change are the opposite of good innovation policy. One of the strongest levers Government has when it comes to spurring private sector innovation is not the money – although that matters too – it is the signal it gives through its choices of where and how long to invest. The US model of DARPA exemplifies this. This programme has existed for 60 years and receives over \$3 billion a year in funding. In the UK, the proposed initial £800 million represents a pretty decent starting point.

Piloting a 'UK ARPA' at a small scale before putting funding on a sustained footing could succeed. It will do no good to pilot it and forget it, though. If the initial model does not work, then try new iterations in order to arrive at something that does. This is how businesses scale their endeavours.

It is not easy for Government to work like that. It does not want to be seen to get things wrong in the first place. But if this is to be the pattern for ground-breaking innovation, then it has to work

really well. It will, then, need a strong sponsor within Government to make sure that does happen.

The key benefit of a UK ARPA model is the ability to encourage high-risk research, the kind of research that will not happen if left to the market alone. Two features are particularly important: independence and customer relationships.

The US agency operates outside traditional oversight structures which allows it to pursue high-risk innovation where the market and potential government funders would not do so because of considerations about value for money and return to taxpayers. If the new UK agency sits outside UKRI, that may also provide a degree of independence. But what is exactly its 'branding' and how will it engage with businesses and the science and innovation community? There must be a coherent innovation system, so independence and coherence must be looked at together.

A market for products and services

When a company develops new products and services, it invests in early-stage research because it expects there will be a market for it at some point. Government can play a vital role here in creating new markets with its procurement approach. Where businesses invest in R&D outside of the UK, the decision is often linked to bigger market opportunities elsewhere. So it is really important that Government uses its buying power to support innovation. The success of the ARPA programme in the USA is in part down to that extended pipeline procurement model where the Department of Defense plays a vital role.

Solving broad national security challenges is a clear opportunity for the new agency and there are a few other areas, such as health and energy, where organisations like the NHS could play a real role in acting as a lead customer. While the new agency will be a Government creation, industry expertise and funding will be important factors in its long-term ability to bridge the gap between blue-sky research and marketable products. Therefore,



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both Government and business need to work together closely on its development.

Brand

Other factors: it needs to have a brilliant brand. The agency's brand will need to be bold if it is going to compete internationally and attract investment. To do this, Government must be ambitious in its marketing – identify a new name and a mission statement that inspires and encompasses its purpose and vision. This will also help attract the brightest researchers from around the world.

Second: get the IP right. Intellectual property agreements can often be the blocker preventing good collaborations on innovation.

Finally, funding needs to be designed in a way that works for business. The US ARPA model offers funding in 10-year increments with three-year gates to check if the project is successfully delivering – the presumption being that the funding continues if the project is working. So there are some really practical steps that can be taken to ensure this new agency is fit for purpose. Done well, ARIA presents an opportunity to help the UK become a science and innovation superpower. □

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A UK ARPA needs bold branding and marketing and funding designed to work for business, while the Government should use its procurement approach to create new markets for innovative products and services.

FST BLOGS AND PODCASTS

Developing a UK ARPA – blog by Adam Clarke, Policy and Communications Manager at the Russell Group
www.foundation.org.uk/Blog/2021/Developing-a-UK-ARPA

UK ARPA – podcast with Phil Smith, Chairman of IQE, former CEO and Chair of CISCO UK, former Chair of Innovate UK
www.foundation.org.uk/Podcasts/2021/Phil-Smith-UK-ARPA

UK ARPA – podcast Rachel Coldicutt, Director of Careful Industries
www.foundation.org.uk/Podcasts/2021/Rachel-Coldicutt-UK-ARPA

The debate

After the formal presentations, the speakers were joined by Sarah Hodgetts, Deputy Director in the R&D Directorate at BEIS, to form a panel to answer questions from the audience.

Where will it fit?

One topic raised by a number of the audience was how the new institution would fit into the existing complicated innovation landscape with a range of organisations addressing differing remits and with a number of funding bodies. In the USA, ARPA was specifically designed so that it did not align too neatly with other bodies but was connected to the wider research environment. DARPA, in addition, has its own culture, distinct from that of the other parts of the US funding system.

It was suggested that the new body needs to focus on challenges that people are already trying to solve, whether these are within our current structure for research and innovation or currently outside it. There is an argument for providing a budget line specific to the challenge and the person tackling it, letting them draw on whatever technology is available in search of a solution.

One speaker commented that the agency needed to “reach the science that the other parts of the system don’t reach at the moment”. It needs a unique cultural identity that will be complementary to what is already in place.

A concern was expressed about the desirability of creating a coherent and clear landscape. Research into reasons why businesses do not engage with the innovation support that is available, suggests that they are often not aware of it. And that in turn can be due to the fact that changes to funding programmes happen quite frequently. Here, there is an opportunity to build something new that excites businesses and international investors.

Blue skies or applications?

The panel was asked if the agency risked being too narrowly focussed on applied technology. Is the aim to bridge the ‘Valley of Death’? Or should it explore some of the more esoteric areas of research – or both?

One speaker suggested it should focus on solving problems that the business community has identified in the innovation ecosystem, particularly the pull-through to market. This would be user-generated research. The closest model so far in the UK has been some of the Catalyst programmes, looking at basic innovation and taking that all the way through to market.

The already has processes to deliver outstanding blue skies research. What is missing is very fast, entrepreneurial development of technologies for a specified purpose.

If the Industrial Strategy Challenge Fund is retained, then ARIA can be more blue-sky focussed, as the UK will still have the mechanisms to translate the resulting ideas and to gain competitive advantage from them. But it would not be prudent to place too many expectations and requirements on a single instrument, otherwise it could collapse under the strain.

Risk taking

It is suggested that the new body will be able to take bigger risks than conventional funding streams. Yet taking risks comes with a high political price. Will it be able to take as much risk as is claimed?

One speaker said that if there is no appetite to take risk in a specific area, if people are not given freedom to deliver, then should be funding on that area should be provided via existing organisations. Another argued though that the agency would have to be high risk, high reward. It would need to take a portfolio approach and one would hope that it will succeed in a big way on at least a few of its projects.

Risk-taking is absolutely fundamental, which is why the new body will be different from what we already have. Establishing a new level of risk tolerance, both in the minds of those running it and those regulating it, will be critical to its success.

The remit of ARIA is to engage in areas that are novel and may even be contentious. It will have to be explicitly licensed to take risks. □

FURTHER INFORMATION

BEIS announcement of new funding agency

www.gov.uk/government/news/uk-to-launch-new-research-agency-to-support-high-risk-high-reward-science

House of Commons Science and Technology Select Committee Inquiry

<https://committees.parliament.uk/work/265/a-new-uk-research-funding-agency>

Research and Development Roadmap

www.gov.uk/government/publications/uk-research-and-development-roadmap

Advanced Research and Innovation Agency Bill

<https://bills.parliament.uk/bills/2836>

This year provides a real opportunity to make significant improvements to the UK's critical infrastructure.

Turning ambition into action

John Armitt

There are currently three policy drivers behind the UK's approach to major infrastructure projects: net zero, levelling up, and post-pandemic recovery. Well designed and carefully planned infrastructure can help further each of these aims.

Yet for infrastructure to play its role fully, Government needs to set a clear strategic direction. In doing so, it must engage with industry and regulators as appropriate, and back those policy aims with clear delivery plans which can be monitored effectively. Science and technology are clearly core to the success of infrastructure projects, especially where these disciplines interface with civil engineering or the development of new energy solutions. And when it comes to energy, 2021 holds promise as a year when we might hope to see genuine progress in turning ambition to action.

Long-term needs

In 2018 the National Infrastructure Commission published the first National Infrastructure Assessment¹. It analysed the UK's long-term economic infrastructure needs, outlining a strategic vision over the next 30 years and making recommendations for how the identified needs should be met. In its assessment and subsequent reports, the Commission made various proposals in relation to energy.

The UK should be set on the pathway to a highly renewable electricity system, to reduce greenhouse gas emissions and keep costs low. The Commission recommended that the country should be running off 65% renewable generation by 2030 and has undertaken research to show this is readily feasible, based on current trajectories. However, it is clear we will require ever-more sophisticated operating systems to ensure reliability and security of an electricity system increasingly based on renewables.

The decarbonisation of heating across residential and other properties must be addressed. Changing how the country heats almost all of its buildings in less than 30 years is one of the biggest infrastructure challenges the country faces. Currently, the costs of the two most promising technologies, heat pumps and hydrogen boilers, are high and installations will be disruptive for consumers.

We need a better evidence base for both these technologies before making strategic decisions by the end of this decade. Regardless of the mix of technologies used for heating in the future, the energy efficiency of the building stock must be improved.

We have therefore made the case that Government should set a target of installing 21,000 energy efficiency measures a year throughout the 2020s, focused on loft and wall insulation. This could be achieved by allocating £3.8 billion for such measures in social housing, setting out new regulations for the private rented sector, and trialling innovative approaches for delivering energy efficiency in the owner-occupier market.

In addition, to better assess the viability of hydrogen, a community-scale trial of hydrogen heating should be delivered by the end of 2021 and a larger trial, of at least 10,000 homes, should be launched by 2023, with the hydrogen to supply these trials generated from gas-reforming with carbon capture and storage. Also, by 2021 Government should establish an up-to-date evidence base on the performance of heat pumps within the UK building stock and the scope for future reductions in the cost of installation.

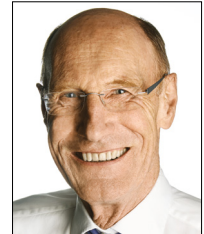
Following our Assessment, we published a separate study looking at the role of economic regulators and how they can best support the transitions needed. Among our recommendations, we proposed that Government should set out a long-term vision for each regulated sector through the publication of a strategic policy statement.

Keeping up the pressure

Since 2018, the Commission has kept up pressure on Government to provide a comprehensive response to our Assessment, to offer both the public and private sectors clarity of strategic direction and therefore enable greater certainty in planning.

I am pleased to say that, in its National Infrastructure Strategy published at the end of last year, we do now have those steers in a range of areas. The fact that Government published the National Infrastructure Strategy in the face of enormous upheaval created by the Covid-19 pandemic is much to its credit.

Within the National Infrastructure Strategy, the Prime Minister's Ten Point Plan for a Green



Sir John Armitt CBE is Chair of the National Infrastructure Commission, National Express Group, and City & Guilds Group. He is also on the Board of the Berkeley Group and Expo 2020. In September 2013, Sir John published an independent review on long-term infrastructure planning in the UK. The recommendations in the Armitt Review received widespread support and resulted in the creation of the National Infrastructure Commission in 2015. In 1997 he became Chief Executive of Costain, going on to become Chief Executive of Network Rail. From 2007 he served as Chair of the Olympic Delivery Authority for the 2012 Olympic Games.

The challenges of reaching net zero in particular suggest both the need and opportunity for bipartisan and public/private collaboration on a whole new scale

Industrial Revolution and the Energy White Paper, Government has set goals for many parts of the energy system. These documents chart a course for the future of renewables, nuclear, hydrogen, heat and electric vehicles.

These goals, alongside clarity on the pace and timetable for decarbonisation, are important to help businesses align their investment and planning decisions and to frame economic regulation.

The Government has committed to deliver 40GW of offshore wind by 2030, which means the UK could be generating 65% of its electricity from renewable sources by 2030. Near-term policy actions have been identified that will help to deliver this, including a commitment to holding Contracts for Difference auctions approximately every two years, ensuring these auctions are open to onshore and solar. The Government is also considering the case for including more innovative technologies, such as floating offshore wind, in these auctions.

The Government has also committed to large-scale trials of hydrogen for heating in homes and has set a target of 5GW of low carbon hydrogen production capacity by 2030. At the same time, it has set a target of deploying 600,000 heat pumps per year by 2028 and has committed significant sums to improving the energy efficiency of England's building stock. However, early steps on this goal have been slower than hoped.

It is critical that these goals are now underpinned by specific policy levers and delivery plans with clear milestones. Strategy documents promised this year for hydrogen and heating, alongside others on topics including electric vehicle charging infrastructure, provide the opportunity to set out such an approach.

Practical delivery

These documents must provide detail on how noble ambition can be turned into practical delivery. When it comes to energy, the Commission would like to see Government:

- develop clear, actionable, and funded plans to deliver on commitments made in the Ten Point Plan and the National Infrastructure Strategy, including setting out next steps on heat decarbonisation and the development of a hydrogen industry;
- further improve energy efficiency schemes to deliver a material increase in the energy efficiency of the country's building stock over the coming year.

We also need to ensure our economic regulation is fit for achieving these major policy aims, and this year we hope to see Government develop a road map to legislate for net zero and collabora-

tion duties for regulators. We also look for mechanisms that will introduce more competition to facilitate strategic investment in utilities and to drive innovation, such as the need for intelligent systems to address future operating challenges in the electricity system. Indeed, science and technology need to be unleashed to help tackle all the major policy challenges – around which there is broad political consensus, though naturally with some differences of emphasis.

Of course, such decisions are being taken in the context of great uncertainty. Even once policy decisions are made, individual infrastructure projects can face a range of challenges – from raising finance, to changes of scope, to local planning opposition. These can best be mitigated through clear engagement with relevant stakeholders on the project rationale, and through taking longer at the project scoping phase to help reduce the chance that decisions need to be reopened later. In my experience, taking longer at the start to focus on objectives tends to mean projects are delivered more quickly in the end.

At a macro level, the OECD's International Transport Forum has recently recognised the value played by independent advisory bodies when it comes to helping governments develop long term infrastructure policy. The UK (including our sister bodies in Scotland and Wales) can stand proud as an exemplar in enabling impartial experts to inform political decision making.

Yet this only really means something when recommendations become delivery. Ultimately, delay in implementing policy will inevitably mean delay in reaping economic and social benefits.

The action plans to achieve these goals are something that only Government itself can provide, but in partnership with industry and regulators as necessary – it would make no sense for unworkable plans to be imposed on sectors. The challenges of reaching net zero in particular suggest both the need and opportunity for bipartisan and public/private collaboration on a whole new scale, echoing that achieved in the US economy in the run up to the Second World War.

I am optimistic that this year can see such progress. The Commission exists to help keep up the pressure in a constructive fashion, to ensure the UK's infrastructure is as well placed as it can reasonably be to face the challenges and opportunities of future decades. □

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¹ National Infrastructure Commission 2018, *National Infrastructure Assessment* <https://nic.org.uk/studies-reports/national-infrastructure-assessment>

Science and technology need to be unleashed to help tackle all the major policy challenges – around which there is broad political consensus

CONTEXT

In 2019, the UK Government committed to reaching net zero emissions by 2050, following recommendations from the Committee on Climate Change – which noted that this target was achievable, but only if the Government's plans included the development of the hydrogen economy, particularly for sectors that are hard to decarbonise. In 2020, the Government established the Hydrogen Advisory Council, co-chaired by BEIS Secretary of State Kwasi Kwarteng and the Chair of Shell UK, Sinead Lynch. Hydrogen can be used to create electricity without CO₂ emissions, but the creation of hydrogen itself is an energy intensive business. Currently, the majority of hydrogen is created by burning gas and releasing

carbon into the atmosphere. How can the hydrogen be created in sufficient quantities without creating more emissions? And how to we move towards a hydrogen economy over the coming decades?

As the UK develops its plans to decarbonise its economy, and in the year that it is hosting the global climate change meeting COP26, the Foundation wished to explore these issues. On 24 February, it brought together the COP26 High Level Climate Action Champion, the Deputy Chair of the Committee on Climate Change and the Chief Executive, Efficient Natural Resources, at Johnson Matthey. A video recording of the webinar, presentation slides and speaker audio from the event are available on the FST website.

A game-changer for the energy economy

Nigel Topping

The UK finds itself in the middle of a pandemic at a time when the world has never been so connected. The scientific and research advances that we have seen, together with the leaps in recent decades, have allowed us to communicate far better than we could have otherwise.

My current role is to build ambition and confidence about the pathways to net zero. An increasing number of actors across the whole value chain are coming together and – pre-competitively – agreeing what the next steps are. Green hydrogen is a prime example of this, but it is still at a very early stage.

The Energy Transitions Commission, which is chaired by Adair Turner and Ajay Mathur, published a report called *Mission Possible*¹ in 2018. This looked at how we tackle all the hard-to-abate sectors – cement, steel, plastics, aluminium, shipping, aviation and long-distance trucking. Most of the Commissioners are CEOs of energy producers or energy-intensive companies.

Through the year that we were commissioning research and reviewing the findings, there was a dawning awareness of the importance of hydrogen in the future energy economy. Electrification will provide direct efficiency benefits and renewable electricity generation will reduce emissions. Yet there are some applications for which either the volumetric or the energy density requirement, or required chemical reactions, mean that renewable electricity will find it difficult to get the

SUMMARY

- Hydrogen has a key role in some areas of the future energy economy
- There are some industrial sectors where decarbonisation may come to rely on hydrogen
- Both supply and demand sides have to be stimulated if this transition is to succeed
- There are a number of global and national initiatives addressing this challenge
- Hydrogen could be a game-changer for countries with large land areas and plenty of sunshine.



Nigel Topping is the COP26 High-Level Climate Action Champion, appointed by the UK Prime Minister in January 2020. The role of the high-level champions is to strengthen collaboration and drive action from businesses, investors, organisations, cities, and regions on climate change, and coordinate this work with governments and parties to the United Nations Framework Convention on Climate Change (UNFCCC). Nigel was most recently CEO of We Mean Business, a coalition of businesses working to accelerate the transition to a zero-carbon economy.

decarbonisation job done. Because of that, steel producers from Sweden to Chile are turning to hydrogen, and companies such as Volvo and Daimler are betting on long-distance trucking with fuel cell technology. Airbus is exploring new concepts for hydrogen planes to take off in 2035. Others, though, believe that battery technology could also work here.

A different business model

Hydrogen, as a gas, presents an alternative business model for innovation by oil and gas companies, with both producers and infrastructure players looking at ways to navigate the path to net zero. There is a good place to start: today, fossil hydrogen production, chiefly from natural gas, amounts to 3-4% of total global emissions. People



Major corporations have developed a programme to deploy 25GW of hydrogen-derived capacity within the next five years.

who have been around in the industry for some time caution that this is the third birth of a low-carbon hydrogen economy, so one has to be a little guarded about the latest announcements. Nevertheless, in the past few years there have been many gigawatts of projects and public sector targets announced for green hydrogen by 2030.

The UK's Business Secretary Kwasi Kwarteng is an enthusiastic advocate and the Government is preparing its own domestic hydrogen strategy.

It is really important to look at both the supply side and the demand side – if all the attention is on the supply side but there is not sufficient demand pull, then the process will come to a stuttering halt. While fossil hydrogen with carbon capture and storage seems a convenient way to decarbonise current gas use, it first has to overcome a critical issue: methane leakage that amounts to 16% of man-made emissions today. Some countries, like Australia and China, are entertaining the idea of hydrogen production from coal. In most countries, though, it appears that renewable hydrogen (i.e. produced by electrolysis or renewable energy) is going to be the winner, economically, by 2030.

One of the most exciting recent developments has been the launch of the Green Hydrogen Catapult. Seven major energy players and Yara (one of the biggest fertiliser producers in the world) have developed a programme to deploy 25GW

capacity within the next five years. Our assessment suggests a price level of \$2 per kg by that time. Green hydrogen will then be cost-competitive with fossil fuels that have carbon capture attached, at which stage real scaling-up can start.

A systems approach

That is going to take a whole system effort on the supply side, but then there has to be a similar demand-side effort based on clusters around shipping, aviation, trucking, steel, etc. There are global, governmental initiatives such as Mission Innovation and the Clean Energy Ministerial as well as mission-driven private sector approaches like the Green Hydrogen Catapult. With all the stars aligning, this could stimulate really rapid development – and by bringing the costs down, the price signal should drive demand up.

Hydrogen also has the potential to change the geopolitics of energy. Countries like Australia, South Africa, Chile and India – with very large land areas and an abundance of sun – are all saying that this could be a game-changing opportunity, allowing them to export clean energy. This could be a new business, for Chile for example, or a replacement for a dying coal business, as in South Africa and Australia. The hydrogen economy will need to grow by a factor of 7-10 times by 2050 in order to get to net zero. If the vast majority of that will be green hydrogen, as expected by the Energy Transitions Commission, that will make this one of the most exciting areas for technological and economic transition. □

COLOUR-CODED HYDROGEN

Grey – where excess CO₂ is not captured from the steam reforming process.

Blue – excess carbon is sequestered using carbon capture and storage (CCS).

Green – produced using non-carbon sources of energy.

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¹www.energy-transitions.org/publications/mission-possible

A crucial role in decarbonisation strategies

Julia King

The Climate Change Committee has developed a 'Balanced Net Zero' pathway¹ out to 2050 as part of the analysis for the sixth carbon budget, including a description of the role that hydrogen can play in that journey. The main uses of hydrogen in 2050 are projected to be in shipping (as ammonia) as well as areas of manufacturing where decarbonisation cannot readily be achieved using electricity.

Hydrogen use is expected to grow from a small base today, to energy usage equivalent to our current electricity consumption – huge growth over a period of just 30 years. A doubling in the size of the electricity system itself will be needed by 2050, as transport is electrified together with much of our heating and some of our industrial processes. On top of the electrification of the core economy, a significant amount of electricity is likely to be used for hydrogen production.

Cost-competitive hydrogen

Today, renewables account for about 30% of grid-connected electricity. By 2050, with the cost of renewables coming down so fast, electricity generation could be around 80% renewables. The 120TWh of hydrogen production will therefore come from low-cost electricity, very low cost at times when hydrogen production is used to balance renewable generation because electricity demand is low – making green hydrogen cost-competitive.

By 2050, the Committee is projecting that about half the methane still used will be for direct power generation with carbon capture and storage (CCS), while the rest is used for blue hydrogen production. Hydrogen demand by that time will be predominantly for manufacturing and shipping with small amounts going into buildings, electricity generation and transport.

The majority of that hydrogen will come from electrolysis, as green hydrogen. It is likely that there will still be some fossil-produced hydrogen, with CCS - blue hydrogen. Further green hydrogen may come from biomass, and imports, but the UK could also be an exporter of hydrogen by 2050.

The UK is going to need significant amounts of hydrogen. It will be essential to decarbonise some key areas and hydrogen could support decarboni-

SUMMARY

- Hydrogen production is expected to undergo huge growth between now and 2050
- With the increasing use of low-cost renewable energy, green hydrogen could become cost-competitive
- There is already a significant supply chain in the UK
- There are challenges to be addressed and solved on this pathway
- Hydrogen has a very significant part to play in the UK's move to net-zero, especially in hard/expensive to decarbonise areas.

sation in quite a broad range of applications.

The opportunities for the UK are extensive. With an 80% renewable grid by 2050, there will potentially be a lot of very cheap electricity. The country also has extensive capacity for carbon storage around the coast.

There is already an impressive UK supply chain, with some key players like ITM Power and Johnson Matthey. Oil companies are looking to supply hydrogen as a major fuel. The UK is home to manufacturers of fuel cells, electrolyzers and specialist storage tanks. This is a real opportunity for the UK to be the original equipment manufacturers (OEMs) of the hydrogen industry, as well as potentially an exporter of hydrogen. The country has a world-class academic base in electrochemistry and materials, as well as other fields that underpin a hydrogen industry.

There are challenges, though, and the first is cost. Hydrogen is typically made from methane with CCS or electricity, so it will be more expensive than either. Therefore if you can use either directly, you will.

A challenging molecule

It is also a challenging molecule. It is very small. There have already been concerns about methane leakage from gas pipelines and hydrogen leakage is going to be more of a challenge. It can also embrittle high-strength steels and welds, so there will need to be careful testing of high-pressure systems. Energy density is an issue. In order to

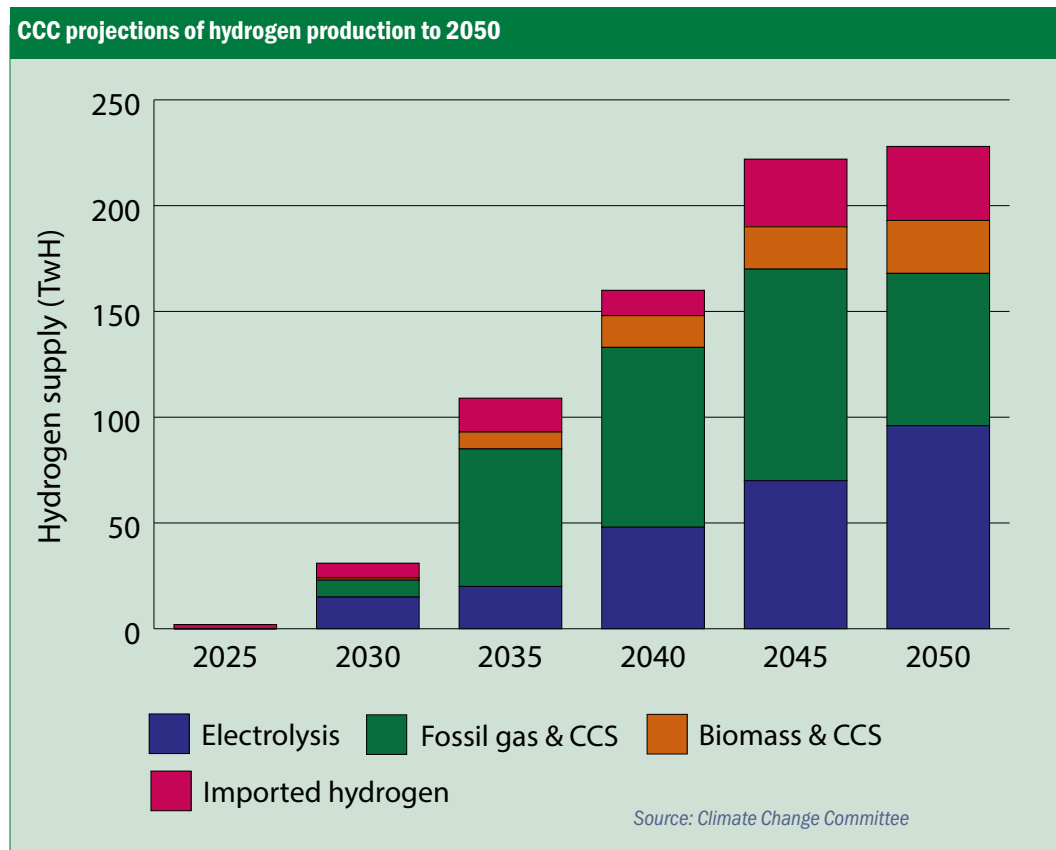


Baroness Brown of Cambridge DBE FRS, Julia King, was Vice Chair of the Climate Change Committee for 12 years and continues to advise the UK Government as Chair of the Adaptation Committee of the CCC and as a member of the Hydrogen Advisory Council. She chairs The Carbon Trust and is a non-executive director of Ørsted and of the Offshore Renewable Energy Catapult. She led the King Review on decarbonising transport (2007) for the Chancellor of the Exchequer and was the Sector Champion for the Offshore Wind Sector Deal, part of the UK Government's Industrial Strategy.

The UK is going to need significant amounts of hydrogen. It will be essential to decarbonise some key areas and hydrogen could support decarbonisation in quite a broad range of applications.

HYDROGEN

Hydrogen features strongly in new energy policy – a commitment to produce 5GW of low carbon hydrogen by 2030 has been raised to 42TWh – consistent with the Climate Change Committee pathway.



store and transport hydrogen, it must be compressed or, ideally, liquefied – a very energy-intensive process.

There has to be a systems approach to the use of hydrogen. It will be critical for production, transport, storage and use and all the other elements of the system to work together. The hydrogen system must also be integrated into the existing energy system. It is a complex systems integration challenge, not just an individual technology issue.

Hydrogen features strongly in new energy policy. The Ten Point Plan last November committed to 40GW of offshore wind and 5GW of low carbon hydrogen production by 2030. The Energy White Paper in December turned the 5GW into 42TWh, which is consistent with the Climate Change Committee pathway. There is the Zero Carbon Hydrogen Fund and a Hydrogen Strategy is due this year. The work of the Government's Hydrogen Advisory Council is feeding into that Strategy. Critically, next year we have the work on hydrogen business models – how to commercialise the opportunities, how early support mechanisms will work. There is a proposal to introduce a 20% blend of hydrogen in the gas grid by 2023.

Hydrogen will be a key part of meeting net zero, but it is not a 'silver bullet'. It will be the energy source for applications that cannot be electrified, but it still has to be zero-carbon. □

DOI: 10.53289/CNL05061

¹www.theccc.org.uk/publication/sixth-carbon-budget

On top of the electrification of the core economy, a significant amount of electricity is likely to be used for hydrogen production.



A major part of the strategy for net zero

Jane Toogood

SUMMARY

- Nearly two-thirds of global GDP is subject to net zero CO₂ emissions reduction targets
- Hydrogen has a role in industrial processes as well as in energy transition
- The speed of adoption of hydrogen technologies will be driven by local and regional factors
- Hydrogen is not sufficient to get the world to net zero but it is a necessary part of any solution
- The UK has an opportunity to become a leader in this technology and a net exporter.

Johnson Matthey is active in chemical production technologies for producing hydrogen, with technologies for producing both green and blue – as well as today's grey hydrogen. Considering that 57% of global GDP now has net zero targets linked to it, there has been a dramatic shift recently and there is a great opportunity for British companies to make a difference here.

Clean electricity is clearly going to play a critical role in decarbonisation and wherever possible we should be using renewable energy: for light-duty transport, for heating homes, for businesses, for most applications and for light industrial processes. Where hydrogen has a role is in those more

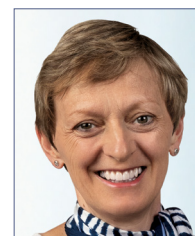
energy-intensive industrial uses, in heavy-duty transportation, in marine applications and indeed for longer-range transport as well.

A wonderful molecule

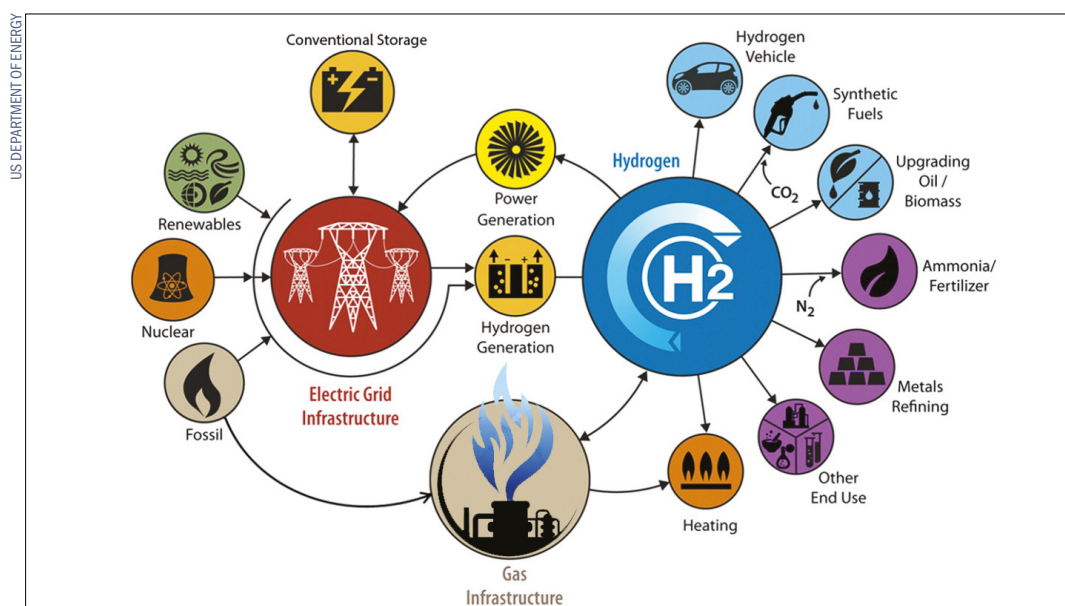
Hydrogen is a wonderful, small molecule. Not only can it enable energy transition, but it is fundamental in chemical building blocks. For example, hydrogen can be used in the production of ammonia which can be used as a marine transportation fuel and for fertilising crops. Hydrogen when reacted with carbon monoxide is also used to manufacture methanol. And methanol itself is a chemical building block for many consumer and industrial products across the civilised world. So it is very important to think of hydrogen as part of a broad system that is not just about energy but about value chains leading through to consumer goods. We have companies in the UK that are at the heart of that.

A great deal more hydrogen will be needed in the future, and it must be clean. So the use of grey hydrogen will have to be disincentivised through the use of carbon taxes. A global approach to carbon taxes is needed.

The adoption of blue hydrogen technologies will be driven partly by the energy intensity of the usage, partly by geology (because to use blue you need to be able to capture the CO₂ that is produced on the



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Hydrogen is part of a broad system that is not just about energy but about value chains leading through to consumer goods.

way), partly by pace (because the planet cannot wait and so we need to move at pace to decarbonise).

Green also needs to be accelerated through to adoption. Green, of course will be driven by geography, by the declining cost of renewable energy, and of course by incentives. It is likely there will be a mix of all of the different types of hydrogen, with (hopefully) grey diminishing quite rapidly as the world moves towards blue and green and we look towards 2050.

Looking to the future, the UK has a great opportunity to be a leader in this area. A target has been set in the 10 Point Plan of 5GW of low carbon hydrogen by the end of 2030. That is on a par with the targets set by France and Germany. We could possibly be even more successful and go

faster. This will be one of our challenges – to see how we can accelerate and so become leaders, exporting rather than importing hydrogen.

Across the whole global market, hydrogen can probably contribute to a reduction of about 6Gt of CO₂, a significant part of the 43Gt that needs to be delivered around the world.

So, hydrogen on its own is not going to get us to net zero, but without it we will certainly not achieve our goal. We do, though, need to be moving at pace on blue and on green hydrogen production and we must make sure we are learning fast and progressing through the requisite technology learning curves. □

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The debate

After the formal presentations, the speakers joined a panel to answer questions from the audience.

The first question, put by a number of the audience, was about the transport of hydrogen and whether it could, for example, be safely used in the gas grid. If so, could that allow hydrogen to be widely used in homes?

There is good confidence that the polyethylene pipe distribution system will be compatible with hydrogen. Indeed, town gas which was used in the last century contained up to 50% hydrogen. There are technical issues to do with the small size of the molecule and also about integrity of the high pressure system which is made of high strength steel with welds, but there are solutions available. The Committee on Climate Change estimates that the most cost-effective option will result in 10-11% of buildings being heated by hydrogen by 2050.

When not being transported in pipelines, hydrogen would need to be compressed with all the associated costs. There are emerging technologies where hydrogen can be adsorbed onto complex nanostructured particles: this could increase the energy density without requiring large amounts of energy for compression. Alternatively, it can be made into ammonia and then shipped in that form. Ammonia production and shipping are well-understood processes. This could also facilitate an export market for hydrogen.

Green hydrogen

Another question concerned how quickly the UK could switch to green hydrogen, and what exactly is to be the best source of electricity for this: nuclear power, offshore wind or other renewables?

If nuclear is part of our electricity system, it will be part of what we produce hydrogen with. The

key, though, to unlock this technology lies in the fact that renewably-generated electricity has seen rapid reductions in price. If 80% of grid supply comes from renewables in future, with the associated variability of production, the grid will need balancing – which could be achieved by creating hydrogen from electrolysis.

The UK already has the technology to produce blue hydrogen with more than 95% of carbon capture. While that is not as sustainable as green, it is available today. So blue is an important part of the mix today while we prepare to transition to green.

COP26

The Conference of the Parties (COP26), taking place in November this year in Glasgow, will not include target-setting for green hydrogen. There could, however, be major announcements about collaborations and commitments on green hydrogen, as part of the broader conversation and context. For countries like South Africa and Australia, the developing hydrogen economy could be part of their 'just transition', where it provides jobs for people currently working in the coal industry as they make that transition quickly. So while the subject may figure quite significantly in Glasgow, it will not be part of the negotiations.

Aviation

A number of people raised the question of what the future of aviation will look like. As Lord Willets noted, this is one sector where conventional solutions may not work.

Cranfield has already flown an electric/hydrogen hybrid aircraft. The Climate Change Com-

mittee projections for aviation in 2050 are based on green hydrogen being used with captured CO₂ to produce synthetic aviation fuel. While this is a more sustainable fuel it is, unfortunately, very energy intensive to manufacture.

Today, sustainable aviation fuels make up 0.01% of the global fuel mix, a tiny proportion. However, industrial transformations always follow an S-curve. Achieving 2% by 2025 may not seem like an ambitious goal, yet it is 200 times today's level. The French bailout of Air France mandated 10% by 2030. With that kind of growth, it will soon become clear which are the best technologies and how soon they will be in a position to compete with kerosene.

Policy requirements

What policies will be needed to stimulate green hydrogen? A carbon tax was suggested as well as invitations to bid for Contracts for Difference. Such mechanisms will help create the levels of competition that have been so successful in bringing down the costs of offshore wind. That will

require standards for hydrogen: blue hydrogen made with 95% carbon capture and storage will have different contracts from green, electrolytic hydrogen. Appropriate support for R&D in order to develop new technologies is crucial. As initial projects get going, investment from both industry and Government must be made available, to prove the viability of the technologies themselves and also that they can work at scale.

One speaker proposed “an industrial strategy that backs British engineering and targets net zero by 2042”. This would drive industrial competitiveness, but in order to be effective it must be backed up with policies that will help the industry overcome the first part of the cost curve. That encompasses R&D into production itself but also associated technologies like carbon capture & storage and hydrogen transport methods. Support is needed on the demand side as well, on hydrogen fuelling stations for example. If the UK committed to fuel cell recharging infrastructure, there would be a much better chance of large numbers of hydrogen-powered vehicles being driven on UK roads. □

Volvo and Daimler are committed to having 100 fuel cell trucks each on the road by the end of this year.

FURTHER INFORMATION

Net Zero: The UK's contribution to stopping global warming – Committee on Climate Change (2019)
www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming

Sixth Carbon Budget
www.theccc.org.uk/publication/sixth-carbon-budget

Hydrogen Advisory Council – details of remit, membership and minutes are at:
www.gov.uk/government/groups/hydrogen-advisory-council

FST BLOGS AND PODCASTS

Hydrogen – how can we overcome its limitations? Blog by Colin Matthews, Managing Director of JouleVert
www.foundation.org.uk/Blog/2021/Hydrogen-can-we-overcome-its-limitations

The role of hydrogen technologies in reaching Net Zero – podcast with Sinead Lynch, Chair of Shell UK and Co-Chair of the Hydrogen Advisory Council.
www.foundation.org.uk/Podcasts/2021/Sinead-Lynch-Hydrogen-Technologies

How does hydrogen fit into the overall energy system? – podcast with Richard Halsey, Capabilities Director of the Energy Systems Catapult.
www.foundation.org.uk/Podcasts/2021/Richard-Halsey-Hydrogen-technologies

Hydrogen powered aviation – podcast with Professor Pericles Pilidis, Head of Power and Propulsion Department, Centre for Propulsion Engineering, Cranfield University.
www.foundation.org.uk/Podcasts/2021/Professor-Pericles-Pilidis-Hydrogen-powered-aircr

Developing hydrogen technologies in the UK – podcast with Baroness Brown of Cambridge (May 2020)
www.foundation.org.uk/Podcasts/2020/Developing-hydrogen-technologies-in-the-UK-Barones

CONTEXT

In December 2020, the Japanese Embassy in London approached the Foundation to ask if a report could be produced on science, technology and innovation policy and funding after Brexit. As a result, Gavin Costigan (Chief Executive of the Foundation for

Science and Technology) and James Wilsdon (Digital Science Professor of Research Policy at the University of Sheffield and Director of the Research on Research Institute) produced a report that was published on 29 April 2021.

UK science, technology and innovation policy after Brexit

In the past decade, three issues have had a profound effect on large areas of UK public policy, science, technology and innovation (STI) policy:

Austerity: Government R&D investment was partially protected during austerity years of 2010-2015, with a flat cash settlement. From 2016, levels of funding began to rise, accompanied by a raft of changes to the governance of Science, Technology & Innovation (STI) policy.

Brexit: The UK R&D community has been extremely successful in securing funding from EU research programmes, but Brexit has prompted a concern about the UK's participation in Horizon Europe.

COVID-19: The research community has been heavily involved in supporting the Government during the pandemic, with significant effort and funding targeted at this challenge.

Investment and the R&D Roadmap

In 2017, the Government endorsed a public R&D expenditure target of 2.4% of GDP by 2027. The 2018 level was 1.7% (£12.6 billion). The March 2020 budget committed to raising public R&D to £22 billion a year by 2025.

Public investment accounts for a little over 30% of the total spent on R&D. Business R&D is around 68%. Additional public investment should generate business multiplier effects. However, given Brexit and Covid-19, there could be a significant decrease in business R&D spending over the short term.

In July 2020, the Government published the R&D Roadmap. Some of the key policies in that document were:

- accelerating the translation of R&D investments into tangible economic and social outcomes;
- levelling up R&D across the UK;
- a commitment to new 'moonshot' goals (which has led to the development of ARIA – see below and also pp6-12 of this issue);
- tackling perceived problems in research cultures;
- a post-Brexit reset of the UK's approach to international collaboration and mobility.

The Government's three-year Spending Review was replaced with a one-year review in November 2020, in which public R&D budgets were increased, to reach £14.6 billion in 2021-22. However, the UK's Overseas Development Aid was cut from 0.7% to 0.5%, leading to cuts in aid-linked R&D funding (see below).

There was concern about how the UK's association to Horizon Europe would be funded, until an announcement on 1 April, which promised £250 million of extra investment and £700 million of unallocated funds from the Department of Energy, Business and Industrial Strategy (BEIS) to cover the first year of that association.

When it comes to how funding is allocated to universities, what is described as the 'dual support system' is now in reality a system of multiple, interdependent funding streams, including: Quality-related Research (QR) funding, allocated on the basis of the Research Excellence Framework (REF); grant funding awarded through UK Research and Innovation

(UKRI) and others; challenge-directed funding; internal cross-subsidies for research within universities drawn from domestic and international student tuition fees; other commercial activities; Horizon Europe; business and industrial funding; and charitable funding.

Structural reforms to the research funding system

The 2015 review led by Sir Paul Nurse proposed the creation of UKRI, which would draw together the seven existing Research Councils, Innovate UK and the research elements of the former Higher Education Funding Council for England (HEFCE). UKRI was established as part of the 2017 *Higher Education and Research Act* and was formally launched in 2018. Its strategic prospectus from May 2018 sets out UKRI's vision, though the Government's July 2020 R&D Roadmap now provides the primary strategic context in which UKRI is operating.

Three years after its establishment, it has achieved some of the aspirations of its architects, including securing additional investment in R&D, the merger of nine organisations, and the introduction of the Future Leaders Fellows scheme. Yet its full potential has yet to be realised, with challenges including perceived bureaucracy and dealing with the ODA cuts.

Much of the increase in UKRI budgets has been in challenge-led funding (rather than responsive grant schemes). Three in particular have been significant in recent years:

- **Industrial Strategy Challenges**

Fund (ISCF) – which has funded 24 sectoral or technological challenges since 2017.

- **Global Challenges Research**

Fund (GCRF) – which funds R&D partnerships with universities, researchers, governmental and non-governmental partners in ODA-eligible countries.

- **Strategic Priorities Fund (SPF)** – which is an £830 million investment in interdisciplinary research across 34 themes.

The recently-announced Advanced Research and Invention Agency (ARIA) will fund high-risk R&D. Based on the US Advanced Research Projects Agency, a Bill to establish it is currently going through Parliament. There have been concerns expressed on how it will interact with other parts of the R&D system such as UKRI. The announced budget is £800 million.

There are also several funds supporting university-business interaction. Innovate UK, part of UKRI, is the main source of funding in this area, with funding streams such as smart grants, Catalyst programmes, Knowledge Transfer Partnerships and the Small Business Research Initiative (SBRI). In addition, there are nine Catapult centres, focussing on priority innovation areas, and the Knowledge Transfer Network. Grants to universities include the Higher Education Innovation Fund (HEIF), the Connecting Capability Fund, and Impact Acceleration Accounts.

In October 2020, the Government announced a review of the Research Excellence Framework, the system of identifying research excellence and following which QR funding is then allocated.

Global Research Collaboration after Brexit

In March 2021, the Government published the *Integrated Review of Security, Defence, Development and Foreign Policy*. This policy document says the Government will “incorporate S&T as an integral element of our national security and international policy” and that the UK will become “an S&T superpower by 2030”. S&T objectives include:

- growing the UK’s S&T power;

- being a responsible and democratic cyber power;
- influencing the design and use of critical technologies;
- improving research to commercialisation;
- protecting intellectual property;
- becoming the top destination for international talent;
- improving our ability to identify, build and use the UK’s strategic S&T capabilities;
- building a strong and varied network of international S&T partnerships.

This strategy contrasts with the 2019 International Research and Innovation Strategy which had emphasised collaboration, including via ODA-funded partnerships with the developing world. As noted above, the decision to reduce ODA from 0.7% to 0.5% of GDP has led to UKRI announcing a 70% cut in its ODA-linked budgets, including £120 million of cuts in the 2021-22 financial year to pro-

Challenges include perceived bureaucracy and dealing with the ODA cuts.

grammes such as the Global Challenge Research Fund and the Newton Fund. It is not clear whether this is a long-term issue or not, but it has affected the ability for the UK to form international partnerships. Some funding might be restored in the upcoming Spending Review.

In terms of EU funding, the UK agreed to associate membership of the EU Horizon Europe programme as part of the UK/EU Trade Agreement in December 2020. However, between 2015 and 2019, due to Brexit uncertainty, there was a 40% drop in UK applications to the predecessor programme Horizon 2020, and the UK’s annual share of EU funding had fallen by around €500 million.

The UK has ground to recover to reach its previous levels of success, once the formal association process has been completed. Funding for year one of association was announced on 1 April 2021, but significantly more will be needed from year two and this may be addressed in the Spending Review.

New rules have been introduced for visas to support migration and encourage the recruitment of highly-skilled workers. These include: a new points-based ‘skilled worker’ route; a ‘Global Talent’ visa; more generous post-study work visas for international graduates; and PhD funding through UKRI for international PhD students.

Post-pandemic priorities

A number of post-Brexit, post-pandemic priorities are emerging:

From Industrial Strategy to a Plan for Growth: The Industrial Strategy, published in 2017, appears to in the process of being phased out, with the March 2021 Plan for Growth filling the space, and a promise of an Innovation Strategy in the summer of 2021.

Regional Inequalities and Levelling Up: There is now an explicit commitment to give geography and place greater weight in the R&D funding system. The UKRI’s Strength in Places fund has so far invested £186 million, and a place-based R&D strategy is expected later in 2021.

Net Zero and Low Carbon Innovation: The Government has published a Ten Point Plan for a Green Industrial Revolution, with R&D a key part. Some additional R&D commitments may emerge following the COP26 climate change conference.

Areas of Research Interest: Since 2017, Government departments have been publishing and updating Areas of Research Interest, helping funders and researchers identify specific needs.

Research cultures and careers: In summer 2020, UKRI published a concordat and action plan to support research careers. An R&D People and Culture Strategy is expected shortly. Related initiatives for open research, simplifying bureaucracy, and recognising teams are all in the works. □

DOI: 10.53289/GUTW3567

UK science, technology & innovation policy after Brexit: priorities, ambitions & uncertainties:

https://figshare.com/articles/report/UK_science_technology_innovation_policy_after_Brexit_priorities_ambitions_uncertainties/14143877

CONTEXT

From the start of the Coronavirus lockdown, there were concerns amongst academics, practitioners and charities about the effect of the lockdown on mental health, particularly of children and young people. When the first lockdown was announced, the Academy of Medical Sciences and the charity MQ Mental Health Research convened an expert panel, which led to a 'call for action' for mental health science during the pandemic. Public Health England has published Covid-19 Mental Health and Wellbeing Surveillance Reports throughout the pandemic, and produced a Mental Health Winter Plan for 2020/21. The House of Lords Science and

Technology Committee took evidence on the mental health impacts of the pandemic as part of its inquiry on the Science of Covid-19. The media were also reporting the effects of the lockdown on the mental health of children. The Foundation wanted to explore the evidence from different perspectives, and brought together a Professor of Developmental Clinical Psychology, the Chief Executive of the charity MQ Mental Health Research, and the National Lead for Mental Health and Wellbeing at Public Health England. A video recording of the webinar, presentation slides and speaker audio from the event are available on the FST website.

The pandemic has exacerbated mental health problems

Cathy Creswell



Cathy Creswell is Professor of Developmental Clinical Psychology in the departments of Psychiatry and Experimental Psychology at the University of Oxford. She is an Honorary Consultant Psychologist and leads The Oxford Psychological Interventions for Children and adolescents (TOPIC) research group¹. Her research focuses on the development, maintenance and treatment of anxiety disorders and she has published several books for parents and clinicians, including the parent guide *Helping Your Child with Fears and Worries*.

Prior to the pandemic it was already clear that there was a substantial problem in the prevalence of mental health problems. In 2017, a nationally-representative survey conducted in England found that, among children and young people, one-in-nine had a probable mental health disorder. That reflected a significant increase from previous surveys in 2004.

While there was already reason to be concerned, the pandemic has brought more challenges. Among these were the concerns that participants had about:

- the direct threat from the virus to young people, their family and friends;
- managing the ongoing uncertainty they face;
- dealing with pressures relating to schoolwork, learning from home, etc;
- the economic impacts on families;
- managing boredom and not being able to do the usual things;
- not seeing friends and feeling isolated.

There have also been increases in domestic violence and reduced access to support outside the home.

A repeat of the 2017 national survey was carried out in July 2020 and it revealed that 1-in-6 children or young people were now found to have a probable mental health disorder. That was a few months into the pandemic. As restrictions had eased somewhat, it is possible that this may have been an under-representation compared with other points in the pandemic.

SUMMARY

- There is increasing evidence of a negative effect on mental health outcomes during the pandemic
- In July 2020, a national survey suggested that one-in-six young people might be suffering from mental health problems
- Those that have struggled most have often had pre-existing vulnerabilities
- It is critical to identify those with enduring problems and take prompt action to tackle these.

Co-SPACE² is a longitudinal study launched in March 2020, in which parents and carers of children aged 4-16 years – and the adolescents themselves – were invited to report mental health symptoms on a monthly basis throughout the pandemic. It aims to identify who is experiencing what and the factors which may explain differences.

Now, it should be noted that this is an online survey and not a nationally representative sample. In particular, this is a relatively affluent group compared to the general population. Yet while we cannot use this data to draw conclusions about the general prevalence of mental health problems, it can tell us how things have changed over time among this sample. That can give an indication of what may be going on more broadly. We can also look at how experiences vary across the participants in the study, those who are living in different circumstances or have particular characteristics.

The study found that mental health symptoms have changed through the pandemic. Using the parent report, we have been able to look across that whole age range, both primary and secondary school students. There are quite dramatic shifts, particularly in restlessness and attention difficulties, and these can be seen especially in the times of maximum restrictions. Difficulties increased during the first lockdown, then started to reduce as lockdown was eased, before rising again over the lockdown of early 2021. There has also been, particularly in those of secondary school age, an increase in emotional difficulties.

People might, rightly, say ‘of course they are going to experience different symptoms, just because the environment is so different in the pandemic’, but what the study also points out is that there was also a marked increase in the number of children and young people who were struggling, i.e. where the symptoms were causing interference and having an impact in a negative way on their lives. Again, there are some striking increases in the numbers who were experiencing difficulties among primary school children, particularly in conduct problems, hyperactivity and inattention.

It is important to highlight that, by looking across this whole population, the very different experiences of individuals within the pandemic can get lost. We are very aware that all have had very different experiences, depending on circumstances.

Looking at changes over time, essentially what we found was that there was one group with very low levels of difficulty at the beginning of the pandemic, which continued to be low throughout. That amounted to about 50-60% of the children. Another group was struggling at the beginning of the pandemic and continued to struggle throughout.

Of additional concern was a further group, which started the pandemic with fairly low levels of symptoms, but these increased as time went on. When we look at who the children who have struggled at some point in the pandemic are, and how they differ from the group which has been fine throughout, we find a number of characteristics. They are more likely to be male, when it comes to hyperactivity and attention, but also these children are more likely to be in families that are living on particularly low incomes, to be younger children and to have special educational needs.

We also found some wider family characteristics that were associated with a more negative pattern. That included parents reporting:

- a higher level of parent depression, anxiety and stress at the beginning of the pandemic;
- higher parent/child conflict at the

beginning of the pandemic;

- lower levels of family warmth at the beginning of the pandemic.

There are similar patterns across the different mental health symptoms we have been measuring. For conduct, for example, there is a substantial group which has done very well throughout. There is another group which has struggled throughout. The broad conclusions of course hide the individual experiences of people in the pandemic. The characteristics associated with the groups who have had difficulties in this area during the pandemic are similar to what we have seen before – including children with special educational needs, those living on low incomes, high parent stress at the beginning of the pandemic, higher conflict at the beginning of the pandemic, and so on.

When it comes to emotional symptoms, we have a slightly more complicated pattern but the findings are quite consistent in many ways. A significant group has experienced low levels of difficulties throughout and then there are groups who have experienced difficulties just in the pandemic. Yet there are also groups that reflect increasing or sustained high levels of difficulty. Again, relevant characteristics include: being on a low income, high parent/child conflict at the beginning of the pandemic, presence of special educational needs, higher parental psychological stress and also, in one case, the child having a chronic health condition.

Increasing evidence

Prior to the pandemic, the prevalence of mental health problems in children and young people was already high. There is increasing evidence, from a range of sources, for an overall negative impact of the pandemic on children and young people, as well as on their parents’ mental health.

Pre-existing vulnerabilities were associated with more negative mental health outcomes during the pandemic. That includes poverty and other challenging family circumstances and children’s special educational needs.

This highlights just how critical it is to make sure those children with enduring problems are identified at this stage and that they can access evidence-based support promptly, so that we can shift those negative trajectories. □

DOI: 10.53289/RIEG4313

¹The Oxford Psychological Interventions for Children and adolescents (TOPIC) research group: www.psy.ox.ac.uk/research/topic-research-group

²Co-SPACE: <https://cospaceoxford.org>

There is increasing evidence, from a range of sources, for an overall negative impact of the pandemic on children and young people, as well as on their parents’ mental health.

We need to do better by our young people

Lea Milligan



Lea Milligan is the CEO of MQ Mental Health Research, Chair of the UK's Mental Health Funders Forum and a member of the All-Party Parliamentary Group on a Fit and Healthy Childhood. With a career spanning the juvenile secure estate, alternative education and healthcare, Lea brings a focus on making research work for those most in need. MQ's vision is to create a world where mental illnesses are understood, effectively treated and one day made preventable.

The 2020 NHS digital survey, that took place just at the start of the pandemic, showed a rise over three years from one-in-nine to one-in-six school-aged children having a diagnosable mental health illness. Suicide was recognised as the leading cause of death between 5-19 year-olds and has been rising for the best part of 10 years.

Yet, children and young people's mental health is not the focus of research today, despite the fact that 75% of all mental health problems develop before the age of 18. Children's mental health services account for less than 1% of all NHS spending. Health services for children and adolescents are under huge strain. One-in-four children referred to specialist mental health treatments are turned away and 75% have such long waits it has a detrimental impact on their mental health. That average wait time has exceeded 12 months in recent years.

Mental health research spending has been flat for the best part of a decade in the UK, while less than 4% of that figure is on prevention of mental illness. To put it in context, around £9 is spent on research per person with a mental health diagnosis, compared with £300 per cancer patient. This huge inequality between physical and mental health was evident well before the pandemic began.

The lockdown

Some 12 months from the start of the first lockdown here in the UK, people have very different experiences. Children and young people, through a number of different research projects, have been highlighted as some of the most vulnerable groups in terms of impacts on mental health, as well as women, groups from low socio-economic backgrounds and particularly those who had recently faced financial crises.

Between 12-25% of children and young people lacked some of the tools or elements of engagement they needed in order to properly participate while schools were closed. The NSPCC reported an all-time peak of a 32% increase in distress calls to their helpline during the first national lockdown.

There have been some groups that started well and continued to do well, but those that started from 'further back' have continued to be challenged. Yet without significant change in understanding of children and young people's mental

SUMMARY

- Mental illness among young people is increasing
- Some 75% of all mental health problems develop before the age of 18
- Children's health services account for less than 1% of all NHS spending
- Without a significant change in understanding in Government, there cannot be much change on the ground
- 'Building back better' in this area means adopting a 'whole child' approach.

health in Government, there is unlikely to be much change in the future.

So what is needed in order to make a brighter future in a post-pandemic world? MQ has launched its new research plan with three thematic areas that we believe need investment. The first, entitled 'Thriving in a post-pandemic world' is focussed on understanding the impact of the pandemic and setting out the next steps for young people, in regard to the workplace and mental health inequalities.

The second is entitled 'Gone too soon', looking at the best way to invest more money into research which can reduce the mortality gap, whether due to death by suicide, or to the interplay between physical and mental health. Those with a mental health diagnosis on the whole die 15 years earlier than mentally-healthy peers because of co-morbidity between physical and mental health.

A recent post-hospitalisation Covid report covering the first 1,000 patients hospitalised in the pandemic, showed the links between contracting Covid, i.e. a physical, respiratory illness as it was then understood and the ongoing, lasting impact. Some five months on, 25% of those people had a diagnosis of depression and 12% a diagnosis of post-traumatic stress disorder (PTSD).

The third area we refer to as 'Out of the shadows'. This looks at radical treatments for depression. This condition is expected by 2030 to be the biggest burden of disease worldwide. Research shows that depression is indeed on the increase within children and young people.

At the start of 2021, we invested a further £750,000 into three new fellowships. One is looking specifically at the impact of the Covid-19 pandemic as a stressor on young people's mental health. The second is concerned with a new treatment for Borderline Personality Disorder, delivered in the community. The third is investigating mental health impacts on autistic individuals as they transition from adolescence into adulthood.

MQ is also carrying out policy and advocacy work. We have sponsored a report by the All Party Parliamentary Group entitled *The Covid Generation: a Mental Health Pandemic in the Making*¹. This involved working with over 25 researchers, all of whom submitted evidence for the report. That brings together all of the thinking that is out there and presents a way forward in terms of policy recommendations.

In partnership with the Royal Foundation we are looking at the inequities of mental health research exacerbated by Covid-19. We recognise

that black females in particular are almost non-existent in research studies. There is therefore much more to be done to ensure fully representative data in understanding the true impact of something like the pandemic.

The way forward

Everyone has heard the political aspiration to 'Build Back Better'. It is a wonderful, alliterative phrase, but to really make that a reality, we have to take a holistic approach and a 'whole child' approach. There must be greater access to routinely collected data, so that there is a more 'live' approach to understanding the impact of policies on children and young people. Ultimately, though, there has to be greater investment in mental health research: it is as simple as that. □

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¹ [www.mqmentalhealth.org/wp-content/uploads/2021/04/COVID-GENERATION-REPORT-April2021](http://www.mqmentalhealth.org/wp-content/uploads/2021/04/COVID-GENERATION-REPORT-April2021.pdf)

Placing the issue in a wider societal context

Gregor Henderson



Gregor Henderson is the National Lead for Mental Health and Wellbeing for Public Health England (PHE). He has led PHE's mental health response to the coronavirus pandemic. Gregor is one of the founding Directors of the Wellbeing What Works Centre and is the Chair of the Research Advisory Group for Place2Be, a national children's mental health charity. Gregor is also an active member of the International initiative for Mental Health Leadership (IIMHL). Gregor writes on mental health and wellbeing and lectures across the UK and internationally.

For a good, up-to-date surveillance of Covid-19 and its impact on mental health, and in particular on children and young people, take a look at Public Health England's *Covid-19 Surveillance Report*¹ on the impact of the pandemic on mental health. This has been published roughly monthly since last September. These contain publicly-available statistics, amalgamated from a range of sources as close to real-time as feasible.

PHE also offers a psychological first aid training course for anyone working with children and young people. It is free and available on the FutureLearn website². By the end of March, around 60,000 people had registered for the course from across the world.

Public Health England is interested in the whole population, across the whole of their lives. That includes the risks and protective factors that influence people's lives as well as the wider social determinants – particularly some of the inequalities and structural defaults that we find within our society such as racism, sexism and misogyny. That makes this issue extremely complex, but we cannot look at the mental health of children and

SUMMARY

- A more targeted and proportionate response is needed to issues of mental health
- Any analysis must take into account the wider structural and cultural context
- In general, children and young people have coped well through the pandemic
- Digital and AI tools can help in looking at and evaluating the evidence
- We should look to our younger generations for future innovation.

young people without taking into account that wider structural and cultural context.

The pandemic

There has been a lack of attention to the prevention of mental illness in young people, together with the risk and protection factors. Before the pandemic, measurement was overly clinically based, focussing on deficits and symptomology. Research on mental health was funded in terms of clinical responses

While children and young people have generally coped well in the pandemic, some have experienced greater negative impacts.



SHUTTERSTOCK/ SAM WORDLEY

and illness treatment. Attempts to engage children and young people, whether in terms of policy development or in terms of delivery, were pretty woeful.

A recent PHE document on children's and young people's mental health states right at the beginning that available evidence suggests children and young people have coped well in the pandemic³. Life satisfaction appears to have been only slightly reduced and children and young people's happiness appears to have been relatively stable. There is evidence, however, suggesting some children and young people, especially those with certain characteristics and social circumstances, have experienced greater negative impacts. So we must not over-estimate, nor under-estimate.

There needs to be a much wider social and cultural response to mental health, which is more than just healthcare. There are other countries that are way ahead of the UK in their attention to some of the key things that matter for a society. New Zealand is looking at wellbeing indicators for future generations, attempting to judge policy responses against an assessment of the impact on wellbeing. In Wales, the wellbeing of future generations is part of the policy and legal framework.

Better partnerships are needed across, obviously, health and education, but also across local government, with the active engagement of communities, families and parents as well as children and young people. I found it disappointing to hear the Children's Commissioner talking about the need to have a counsellor in every school. I am not sure that is the right response to the social, emotional and psychological development of our children. I am lucky enough to work with the children's charity Place2Be, which has developed a very sophisticated, whole-school approach where the culture and the ethos of the whole school aligns with the social, emotional and psychologi-

cal development of the child, the engagement of the parents and the wellbeing of the staff.

Digital technology and artificial intelligence should be employed more. Greater resilience in quality assurance and safeguarding are needed: looking at the evidence and evaluating it with digital and AI tools will help.

Measurement has to be wider, and not just restricted to distress and deficit. Research needs to be much more collaborative, more integrated, more multi-disciplinary. There needs to be much more early intervention as well as investment in prevention, with children and young people at heart.

It is very encouraging to see the Wellcome Trust put several million pounds into programmes addressing the elements of children's and young people's depression and anxiety.

Lastly, I think we should look to our younger generations for future innovation. People of my generation are, quite frankly, past-it in regard to understanding the contextual, personal, professional and social characteristics that young people face these days.

I am lucky enough to work for the Zinc Mental Health Academy. We have 30 pioneers engaged in a nine-month long journey, looking at what they can contribute to mental health. The activism, the advocacy, the encouragement and the positivity of young people in that group is quite astonishing. They are building an initiative where 70 people from around the world will be spending a year concentrating on how to use technology (and digital technology in particular) to improve the mental health and wellbeing of children and young people.

The key is to understand the elements by which different people cope and adapt, as well as the way they build resilience through adversity. I would

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want to accentuate the possibilities of pushing the boundaries of science and technology for good, in order to improve the mental health and wellbeing of children and young people in the future. □

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¹ www.gov.uk/government/publications/covid-19-vaccine-surveillance-report

² www.futurelearn.com/courses/psychological-first-aid-for-children-and-young-people

³ www.gov.uk/government/publications/covid-19-mental-health-and-wellbeing-surveillance-report

The debate

Low income families

Many people living on very low incomes have been reporting particularly high levels of difficulty. It is of course a variable picture; some low-income families who were furloughed appreciated the time they had together, whereas for others the situation has been much more challenging. So, while it is difficult to draw clear conclusions, the data gives reasons for concern. From the UCL social study with adults, two of the major factors associated with better wellbeing during the pandemic were the ability to access the outdoor environment and staying active – both of which are much easier if the family has a garden.

The identification of the drivers of mental issues is really key. Before the pandemic, poverty was already highlighted as one of the major drivers. Unless new policies are implemented, then the problem will remain and continue to cause significant emotional, social and psychological distress, with subsequent mental health problems.

Social media

Did social media reinforce anxieties and mental health problems or did it provide relief? Questions about social media are always present, especially in discussions about young people. Obviously, people have concerns about the impact of social media on young people's mental health. In one study, it was clear that those of secondary school age were well-connected with their peers. The vast majority had regular contact with friends, via texting on phones and video calls, through online gaming; in fact, in all sorts of ways. That was not true for primary school children where only a very small number had any interaction with their peers outside the home.

It was suggested that may be connected to transition points for young people at secondary school as they move from dependence upon the family to interdependence with their community – friends, essentially. Digital engagement has been a huge benefit for that this group. On the other hand, lack of play and interaction has been detrimental for children of primary school age.

Early identification

Studies examining anxiety in children have found that common anxiety problems have an early onset. Half of all lifetime anxiety disorders will start by the age of 11. So they need to be identified early, with effective interventions. Families in need of help can often experience a series of barriers in accessing support: there are problems about the identification of the problems themselves and what support could be effective. There are also issues about knowing where to obtain help and then actually accessing it when they try.

By carrying out screening in schools, though, many of those barriers could be bypassed and those children who could benefit from support could receive it early. It is important to make sure that people get support based on expert evidence. Where there are problems which are causing interference in people's lives, identification needs to be rapid and help provided quickly. In addition, there need to be specialist services that can be called upon when problems need further intervention.

One of the speakers recalled their own experience in an inner-city school. This initially had a dedicated team for safeguarding and mental health issues. Yet very quickly, this moved to a whole school approach where all staff were available and trained to support this activity. It was a recognition that background and upbringing had as much influence as anything from a medical perspective.

Outside the school

Some in the audience suggested that more time in a family setting might have helped people through the pandemic. The speakers saw a mixed picture. Some studies showed an improvement in mental health for a number of people, starting from an initial low level. There were certainly some families where life became easier for the young people when they were not in the school setting. They could learn in a different way at their own pace, the social pressures that they had felt before no longer being there. So it was positive in some ways but it was the absence of stress that led to the improvement.

After the formal presentations, the speakers came together to answer questions posed by the audience.

There is a question of the proportion of existing funding that is directed towards the characterisation and measuring of mental health, as opposed to research into prevention and intervention.

In terms of general wellbeing, many families spoke about the opportunity to spend more time together: that can create stresses too but, in many cases, benefits and positive experiences as well. There were also opportunities just to spend a bit more time doing things people wanted to do: a break from the rapid pace of life that people experience otherwise. It will be important to learn from these findings and make the most of them going forwards.

Investment

There was a call for more investment in mental health research. The country is spending very little on research into what is today a chronic problem. There is also a question of the proportion of existing funding that is directed towards the characterisation and measuring of mental health, as opposed to research into the preven-

tion and intervention processes that are required. If the country can spend billions of pounds on testing and tracing in the current health threat, could it not spend the same amount on health and wellbeing opportunities that will have greater long term impact? A national set of indicators could provide a substantive measure of the wellbeing of future generations.

Investment in mental health and wellbeing for children and young people must cover a range of activities, from promotion, to prevention, to intervention – and none of these things can be done in isolation. However, the pandemic has provided an opportunity to accelerate scientific learning and discovery. In the mental health area, there have been large trials using digital tools which has enabled access to parents much more easily and flexibly, in ways that better suit their lifestyles. □

FURTHER INFORMATION

Research priorities for the COVID-19 pandemic: a call for action for mental health science – Academy of Medical Sciences and MQ Mental Health Research (April 2020)

<https://acmedsci.ac.uk/file-download/53005938>

Paper in *Lancet Psychiatry* on the research needed in mental health science (April 2020)

[www.thelancet.com/journals/lanpsy/article/PIIS2215-0366\(20\)30168-1/fulltext](http://www.thelancet.com/journals/lanpsy/article/PIIS2215-0366(20)30168-1/fulltext)

Covid-19 Mental Health and Wellbeing Surveillance Reports – Public Health England

www.gov.uk/government/publications/covid-19-mental-health-and-wellbeing-surveillance-report

Mental Health Winter Plan 2020-21 – Department of Health and Social Care

www.gov.uk/government/publications/staying-mentally-well-winter-plan-2020-to-2021

FST BLOGS AND PODCASTS

Young people's mental health during the Covid-19 pandemic: what do we know so far?

Blog by Steven Bright and Dr Katherine Young.

www.foundation.org.uk/Blog/2021/Young-people%E2%80%99s-mental-health-during-the-COVID-19-p

Mental Health of children during lockdown – Podcast with Professor Louise Arsenaault, Professor of Developmental Psychology, Kings College London.

www.foundation.org.uk/Podcasts/2021/Professor-Louise-Arsenaault-Mental-health-of-childr

Mental health of children and young people – Podcast with Kate Day, Managing Director, KRD Training

www.foundation.org.uk/Podcasts/2021/Kate-Day-mental-health-of-children-and-young-peopl

Effect of lockdown on mental health of children and young people – Podcast with Monika Jephcott, Chief Executive of Play Therapy UK

www.foundation.org.uk/Podcasts/2021/Monika-Jephcott-Effect-of-lockdown-on-mental-healt

Mental health – a personal perspective – Podcast with Flo Sharman

[www.foundation.org.uk/Podcasts/2021/Flo-Sharman-Mental-Health-\(1\)](http://www.foundation.org.uk/Podcasts/2021/Flo-Sharman-Mental-Health-(1))

Statistics underly much of our economic and political decision-making.
The range and detail of available information is growing at a substantial rate.

The future of official statistics is already here

Ian Diamond

Providing the public, Government and all who make important decisions with independent, robust, and timely statistics has been the remit of the Office for National Statistics (ONS) for years, but the past 12 months have shown just how much our statistical system can really do.

Around this time last year we took an urgent call. The UK needed quick, reliable data on the scale of COVID-19 infections across the country. Without that information it would have been impossible accurately to track the progress of the virus within and among communities in the UK.

We took on that challenge and continue to monitor the status of more than 400,000 survey participants, with the latest data showing a hugely encouraging growth in antibody immunity at older ages, largely from the country's enormously successful vaccination programme.

A huge challenge

The speed and scale required for the initial operation of our COVID-19 Infection Survey was a huge challenge that required collaboration, innovation, and an incredible amount of hard work from many of our office and field staff. Thanks to their efforts, we now produce reliable weekly data on infections, antibodies and more.

It remains a vivid demonstration of how fast data can inform important decisions, but the level of infection was not the only challenge facing the UK at the peak of the pandemic. Decision-makers also needed indicators about the state of the economy and how people were feeling about restrictions on their freedoms, all in virtually real time.

Meeting those demands required multiple actions: first, we ramped up our regular social opinions survey to a weekly schedule, providing information about the mood of the nation, adherence to social distancing rules and expectations for the future.

Second, to measure how much people were travelling we used information from, for example,

traffic sensors, as well as anonymised mobility data from Google, generating a fast estimate of how strictly lockdown restrictions were being observed in different areas of the country.

Third, throughout the pandemic we have continually increased the scope of a series of new faster economic indicators to include more information from card transactions, automated tracking systems on cargo ships and prices data scraped from the internet, all novel data sources that could deliver critical insight faster than ever.

Innovation

This was, of course, innovation born of necessity. The need to socially distance removed our ability to gather information face-to-face from households and at ports of entry. Data gathered by these means were still fundamental to our statistics on vital issues like employment, population change and crime. Indeed, there were some who questioned the ability of the statistical system to produce robust figures under such constrained circumstances.

Such doubts were confounded by the agility with which the statistical system pivoted to new ways of working. Our key economic indicators – including employment, prices, retail sales and the public finances – have all been produced with minimal discontinuity. It was vitally important that these long-running statistical series were maintained. The Labour Force Survey provides uniquely rich detail on the scale and nature of employment but its production takes time. For an immediate view of the impact of the data on jobs we could draw on latest PAYE tax data from HMRC which vividly demonstrated Covid's shock effect as hundreds of thousands of people disappeared from employer payrolls.

Thus, as the traditional economic surveys have



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Traffic sensors, as well as anonymised mobility data from Google, generated a fast estimate of how strictly lockdown restrictions were being observed.

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continued to give a reliable view of the economy through the rear-view mirror, these new, faster data sources are helping to give an indication of the road to recovery following COVID-19.

Communicating clearly

Politicians and the public have followed our data on deaths, infections, vaccinations and more in briefings, news conferences and reports throughout the crisis. We have strived to communicate clearly, showing the limitations of our data, the uncertainty that comes with it and the nuances needed to understand the full picture where other data was involved.

The televised No 10 briefings and the Gov.UK Covid 19 dashboard have been unprecedented examples of public data used to explain important policy decisions. The gathering and presentation of indicators from multiple sources – case rates, hospitalisations, infections, tests, vaccinations and, most regrettably, deaths – have been the result of intense cross-Departmental collaboration and development.

The value of the UK Statistics Authority as an impartial protector of standards, whose interventions have significantly informed the improvements to the public presentation of statistics, has also been demonstrated.

In terms of public attitudes towards data, I would say the past year has not been so much a step change as a rocket boost, carrying expectations and understanding of the statistical system to heights we never imagined, but welcomed wholeheartedly.

As a result of the pandemic, the public have become consumers of statistics like never before, so communicating to them – on a broad range of issues – is something we must do more than ever now. We know there is more to do to make statistics fully accessible and we are committed to improving the way we present our work with different formats, interactive tools and concise, well-articulated analysis.

While our expanded programme of antibody testing will monitor the effectiveness of the vaccine rollout – and we are continuing to investigate radical new data sources – we plan to go even further.

We want to use our experience gained during the pandemic to help the country tackle some of

the big issues we face. Some have been exacerbated or brought to the surface by COVID-19, others are yet to emerge.

The drive to a ‘net zero’ economy and the ‘levelling up’ agenda are examples of the highly complex, long term strategic projects which come with very substantial data requirements, including the need for a detailed understanding of communities, our economy and society.

If we can truly understand and accurately measure the whole of the UK, actively collaborating with experts from other Government Departments, academia and elsewhere, we can begin to build towards those goals. The highly successful 2021 Census in England, Wales and Northern Ireland, is a brilliant starting point for that, but good quality, inclusive data should sit at the foundation of everything Government does.

To that end we are driving efforts for better, more joined-up analysis of data across Government through hosting a new Integrated Data Programme which will, with strong ethical and privacy controls, enable linked data from multiple sources to impact on policy to improve people’s lives. This programme builds on our successful work with the Economic and Social Research Council to develop the Administrative Data Research UK network and with Health Data Research UK to develop a public health data asset.

Joined-up analysis

Some examples of the power of joined-up analysis just from the pandemic include analysis of deaths among ethnic or religious groups which was enabled by linking death registration with census data from 2011. This showed the increased risks experienced by people from some ethnic groups; as well as work to identify the characteristics and symptoms of people who have been infected with the virus, the prevalence of Long COVID, the effectiveness of vaccines and more besides.

Our increasing ability to link data in order to produce these kinds of new insights promises a seismic shift in how Government can manage the operation of our essential public services to provide better services for citizens as well as in ensuring greater value in how taxpayers’ money is spent.

The ONS and the wider Government Statistical Service stands ready to use our expertise and impartiality to drive these changes and unlock the power of our data for the public good – now and in the decades to come. □

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The drive to a ‘net zero’ economy and the ‘levelling up’ agenda are examples of the highly complex, long term strategic projects which come with very substantial data requirements.

OBITUARY

The Earl of Selborne made an enormous contribution to the work of the Foundation. He was Chair of the Foundation for more than 10 years but his involvement with the organisation spanned more than three decades.

The Earl of Selborne

It was with great sadness that the Foundation for Science and Technology learned of the death of the Earl of Selborne FRS GBE DL, its former Chair and Vice-President, on 12 February this year. He was a strong supporter of the Foundation, serving as a Vice President, Trustee and Chair, until he retired from the Foundation in December 2018 and handed the baton on to Lord Willetts.

He spent his professional life promoting the value of science and environmental issues both as a farmer and as a member of the House of Lords, where he chaired the House of Lords Select Committee on Science and Technology from 1993-97 and then again from 2014-2017. Of all the committees in the House of Lords, he said that this was the one on which he had been proudest to serve. He retired from the House on his 80th birthday in 2020.

His quiet and conciliatory but persuasive manner made him an ideal chairman. He served as Chancellor of Southampton University, President of the Royal Geographical Society, Chair of Trustees of the Royal Botanic Gardens at Kew, President of the Royal Agricultural Society of England, President of the Royal Institute of Public Health and Hygiene, Patron of the Chartered Institute of Ecology and Environmental Management (CIEEM) and Master of the Mercers' Company. He was a member of the Government Panel on Sustainable Development and the Royal Commission on Environmental Pollution (RCEP).

His contribution to science was recognised by election as a Fellow of The Royal Society under Statute 12 in 1991, a KBE in 1987, GBE in 2011, and his election as a Fellow of the Linnean Society.

Early years

John Roundell Palmer, the Earl of Selborne, was born in March 1940 into a family that had been, for nearly a hundred years, active participants in Government or opposition as Members of



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Lord Selborne spent his professional life promoting the value of science and environmental issues. His quiet and conciliatory but persuasive manner made him an ideal chairman.

Parliament or in the House of Lords.

His grandfather was elected to parliament in 1910 and remained in the House of Commons until 1942 when Churchill appointed him Minister of Economic Warfare.

His father was killed in a military accident during the war and his mother remarried, his stepfather serving as an MP, Minister and later a Member of the House of Lords. It was therefore, as he noted, "unsurprising that when I got to Oxford in 1958 I took an interest in politics".

Agriculture

After university, he returned to the family estate at Blackmoor in Hampshire, his grandfather having made it clear that he was expected to take over the responsibility of running what was a large horticultural and agricultural business.

He was soon, though, involved in various national organisations which played a role in supporting the agricultural sectors in which he was involved. He was appointed to the Apple and Pear Development Council and was later chairman of the Hops Marketing Board. He also served in a number of other governance roles for associations and advisory committees.

Through this, he came to realise that the most successful farmers and growers developed close links with the agricultural research community and he began to recognise how much modern agriculture owed to publicly-funded research and development.

The early 1970s was a time of turbulence in the agricultural research scene, especially with the publication of the 1971 Rothschild Report, which advocated that research with any practical application should be funded by the relevant Department on a client/contractor basis. With continuing pressure on Departmental budgets, the new framework was not wholly successful.

Appointed Chairman of the Agricultural Research Council, Lord Selborne had the unenviable task of implementing significant rationalisation. He himself recalled that the Agricultural Research Service had become a victim of its own success. Average cereal yields had doubled in the 40 years from 1930 to 1980 and UK farms were contributing to European surpluses in a range of agricultural crops.

He continued to engage in debate over the organisation and funding of agricultural research. From 1991 to 1993 he chaired Sub-Committee D (Agriculture and Food) of the House of Lords Select Committee on the European Communities.

In 1996, as concern grew about veterinary research funding, he was invited to chair a committee of inquiry commissioned by the Royal College of Veterinary Science (RCVS) Trust, supported by the Wellcome Trust. Its 1997 report, known as the Selborne Report, created a



(Left) Lord Selborne speaking at a Foundation meeting; (right) Vice-Presidents Lord Selborne and Dr Dougal Goodman.

lasting legacy of initiatives to encourage and support veterinary research and to support training.

The environment

It was becoming apparent by the early 1990s that the dramatic changes in agricultural production systems had inevitably impacted heavily on ecosystems and ecosystem services. The Selborne farming business was within the parish of Selborne and each new edition of Gilbert White's seminal book of 1789, *The Natural History of Selborne*, would draw attention to the impact that modern agriculture was making on the wildlife of the locality, which had biodiversity records dating back to Gilbert White's time.

Lord Selborne found himself increasingly involved with environmental policy issues. He was a member of the Government Panel on Sustainable Development from 1994 to 1998 and the Royal Commission on Environmental Pollution (RCEP) from 1993 to 1998. An RCEP report in 1994 on public and private transport attempted to persuade the Government that building ever more roads to meet an insatiable demand was doomed to fail and that an integrated public transport system would be more sensible. That was not a welcome message for Government at the time.

In 1991, the Nature Conservancy Council was being broken up into three national agencies for England, Scotland

and Wales. The House of Lords Science and Technology Committee had pointed out that nature was no respecter of national boundaries and that on wider policy issues the UK would need to speak with one voice. The legislation was duly amended to require the country nature conservation agencies to collaborate through a statutory Joint Nature Conservation Committee (JNCC). Lord

Lord Selborne made an enormous contribution to the work of the Foundation. Without his dedication and support we would not be where we are today. His sound advice will be sorely missed.

Selborne found himself appointed Chairman at short notice and went on to perform that role for six years.

Inheriting his peerage in 1971, he did not originally expect to remain in the House of Lords for more than a few years. When the Blair Government at the end of the 1990s proposed reform of the upper house, it could not agree on what the outcome might look like. So, as an interim measure, 92 hereditary peers were retained. Lord Selborne was elect-

ed by his colleagues to be one of those. It was assumed this would be a very temporary measure. However, when he retired at the end of 2020, the House of Lords had undergone no further change.

The Foundation for Science and Technology

Lord Selborne's involvement with the Foundation for Science and Technology goes back more than 30 years. Its first Director, David Hall, recalls that early support for the Foundation in 1989 was "typically positive and generous".

Through the 1990s he served as a Vice President and was a regular participant in the Foundation's evening debates.

In 2006, with the retirement of Lord Jenkin, who became President, Lord Selborne agreed to take on the role of Chair of the Foundation and become a Trustee.

He ensured both the formal speakers and the invited guests had adequate opportunities to pose their questions and put their points. In his efficient, soft-spoken and courteous manner he ensured the smooth running of debates covering some of the most contentious issues at the interface between policy and science.

Lord Selborne made an enormous contribution to the work of the Foundation. Without his dedication and support we would not be where we are today. His sound advice will be sorely missed. He is survived by his wife Joanna and children William, George, Luke and Emily. □

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